GEOTECHNICAL INVESTIGATION AND SOILS REPORT

UTILITIES SERVICE EXTENSION
PROPOSED STATE CORRECTIONAL FACILITY
ABERDEEN, WASHINGTON

Submitted To:

Murray, Smith & Associates, Inc.
121 Southwest Salmon, Suite 1020
Portland, Oregon 97204

Submitted By:

AGRA Earth & Environmental, Inc.
7477 S. W. Tech Center Drive
Portland, Oregon 97223-8025

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AGRA
Earth & Environmental

AGRA
Earth & Environmental

AGRA Earth & Environmental, Inc.
7477 SW Tech Center Drive
Portland, Oregon
U.S.A. 97223-8025
Tel (503) 639-3400
Fax (503) 620-7892

December 23, 1996
21-08424-01

Mr. James Helton, P.E.
Murray, Smith & Associates, Inc.
121 Southwest Salmon, Suite 1020
Portland, Oregon 97204

Dear Mr. Helton:

RE: GEOTECHNICAL INVESTIGATION & SOILS REPORT
UTILITIES SERVICE EXTENSION
PROPOSED STATE CORRECTIONAL FACILITY
ABERDEEN, WASHINGTON

In accordance with your authorization and our proposal, AGRA Earth & Environmental, Inc. (AEE), is pleased to present this geotechnical report for the proposed utility services extension project in Aberdeen, Washington. We appreciate the opportunity to assist you and look forward to continued involvement on this and other projects.

If you have any questions regarding this report or desire further information, please contact the undersigned at your convenience.

Sincerely,

AGRA Earth & Environmental, Inc.

A Wesley Spang
for Rajiv Ali
Geotechnical Engineering Staff

Stuart Albright, P.E.
Senior Geotechnical Engineer

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SUMMARY

This report presents the results of a geotechnical engineering study performed by AGRA Earth & Environmental, Inc. (AEE), for the proposed Utility Services Extension Project, State Correctional Facility in Aberdeen, Washington. Key findings are briefly highlighted below:

- The soil profile along the utility corridor consists of manmade fill associated with construction operations for SR-105 and the railroad underlain by Quaternary alluvium which consists of very soft to medium stiff, clay, silt, fine sand and peat. Quaternary terrace deposits consisting of medium dense to dense, sand and gravel were encountered at depths ranging between 15 and 20 feet near the proposed Campbell Creek crossing location. In the waste water storage tank areas, wood-chip landfill debris up to a depth of 20 feet underlain by quaternary alluvium and terrace deposits was encountered (Section 3.0).

- Groundwater was encountered within the depth of the explorations conducted on the site at depths varying from 4.5 to 25.5 feet below ground surface. Seasonal perched groundwater may also occur during times of heavy precipitation especially in the wood-chip landfill. Groundwater and surface water levels will also vary with tidal fluctuations in Grays Harbor.

- Excavation for utility trenches may be accomplished using standard rubber tired backhoe. Ductile iron pipes with fully restrained joint system are recommended. Pipe bedding may be required at certain locations where workers may be present. Adequate shoring and dewatering systems will be required. The on-site material may be suitable for backfill (Section 5.1 through 5.7).

- Slough crossing may be completed utilizing jack-pits or directional drilling techniques. Directional drilling will require relatively flat angle of approach to cross the creeks at a depth of at least 20 feet below the creek bottom. Significant shoring and dewatering operations will be required if jack-pits are utilized (Section 5.7).

- The waste water pump station and storage tank may be founded on pile foundations embedded at least 10 feet into dense sand and gravel. Since the structures are proposed to be 20 feet below ground surface, shoring and dewatering operations will be required to keep the excavation dry and safe for workers (Section 5.8).

- Imported granular fill should be used as structural fill material at this project site. Compaction recommendations are as follows:

Material	Percent of Maximum Dry Density (ASTM D-1557)
Granular Structural Fills	95%
Landscaping Fills	85%
Slab and Pavement Subgrades	95%

The preceding summary is intended for introductory and reference uses only. This report should be read in its entirety to understand the details of the recommendations and to be familiar with their conditions and limitations.

1.0 PURPOSE AND SCOPE

This report presents the results of a geotechnical investigation performed by AGRA Earth & Environmental, Inc. (AEE), for the proposed City of Aberdeen - Utility Service Extension to the Stafford Creek Correctional Facility. The purpose of this study was to review available geologic and geotechnical information in the project vicinity (AEE Report 21-08424-0, dated May 1996), perform a geotechnical field investigation and the preparation of this report. Recommendations for site preparation, utility trench excavation & backfill, temporary trench slope stability, waste water storage tank and pumphouse foundations, and other pertinent design and construction recommendations are provided in this report.

This report has been prepared for the exclusive use of Murray Smith and Associates (MSA) and their agents for specific application to this project in accordance with generally accepted geotechnical engineering practice.

2.0 SITE AND PROJECT DESCRIPTION

The project, as we understand it, is to consist of a water transmission main and a sewage force main. The lines are planned to be 12 inches in diameter or less, and will be placed at depths typically less than six feet, except at slough crossings where the depth will be on the order of 35 feet. All of the utility lines are proposed to be placed in individual trenches. Three associated facilities include a waste water pump station, a water booster pump station, and a waste water storage reservoir. The site location and proposed utility lines and structures are shown in figures 1, 2 and 4.

The proposed utility corridor traverses three general areas. The first area is located near the proposed correctional facility site and consists of a hillside that slopes moderately to gently down to the north towards the tidal flats of Grays Harbor. Features along this segment include a former wood waste landfill and wetlands area.

Between the proposed correctional facility and South Aberdeen the alignment is located on the right-of-way for State Route SR-105. The alignment is located on the north side of the highway which crosses a flat, low-lying tidal plain of peat bogs and wetlands. Numerous water filled ditches and creeks cross this area. Near surface soils and topography suggest that this area was once a tidal mud flat that has been uplifted and water tolerant vegetation has become established. The proposed alignment follows SR-105 through the middle portion of the wetlands. Both the highway and the adjacent Burlington Northern rail-bed appear to have been constructed atop fill that was placed across the low-lying tidal plain. Both the railroad and the highway have several timber pile supported bridges crossing tidal creeks.

The final leg of the alignment is located within urban South Aberdeen. The proposed sewer alignment follows city streets, reaching the pump station where sewage crosses the Chehalis River. The proposed water line will connect to the existing water service lines within South

Aberdeen. This area is characterized by flat, low-lying topography, extremely shallow groundwater, and organic peat-like soils.

3.0 GEOLOGY AND SOIL CONDITIONS

3.1 GEOLOGIC SETTING

AEE has completed a subsurface exploration program for the proposed utility alignment. Our understanding of the geologic conditions on the alignment is based on research conducted for our previous reconnaissance report and subsurface conditions encountered during our field exploration program.

Underlying the surface root mat and manmade fills, native soils consisting of Quaternary age (less than 10,000 years old) estuarine sediments such as bay mud, peat, and/or organic marsh deposits, along with recent alluvial deposits of clay, silt, and sand were encountered. These deposits were encountered in all of our explorations for the utility alignment and the proposed pump station and waste water tank location. Much of the sediment has been deposited by floods of the Chehalis River system and local tributary rivers and creeks that drain directly into Grays Harbor. A number of researchers have studied Quaternary alluvial sediments that contain layers of beach sand overlying estuarine marsh or peat deposits and have proposed that this sequence represents deposits left by co-seismic subsidence and tsunami flooding.

Older geologic deposits on the hillside to the south of the proposed utility alignment have been mapped as an undifferentiated Quaternary Terrace Deposit. These terrace deposits includes older river alluvium and uplifted coastal marine and estuarine sediments. Age determinations indicate an approximate age range of 190,000 years to 120,000 years ± 40,000 years. Soils weathered from these deposits appear to consist of well-graded gravelly sand with some silt. Terrace deposits were encountered at a depth of 15 to 20 feet in the borings conducted at the Campbell Creek crossing, and at a depths of 45 to 55 feet in borings conducted at the proposed pump station and waste water tank location. However, terrace deposits were not encountered in any of the other borings conducted on the alignment. Pebbly soils were observed in a ditchline in our geologic reconnaissance at the site and sporadic areas of near surface sands and gravel associated with Quaternary Terrace Deposits may be encountered.

The coastal lowlands and estuaries in the Pacific Northwest have been studied in detail to evaluate geologic evidence of past seismic and tsunami activity. Many of the sites studied exhibit evidence of rapid co-seismic subsidence accompanied by Tsunami deposits. The Johns River and probably other rivers in the local project area have deposits that are consistent with earthquake induced subsidence and rapid burial by tsunami deposits. Recent research suggests that massive earthquakes have occurred within the Cascadia Subduction Zone between the Juan De Fuca Plate and the North American Plate. Age determinations of buried coastal marsh deposits and drowned forests suggests that the last subduction zone earthquake occurred approximately 300 years ago. Older geologic evidence suggests that recurrence

intervals for subduction zone earthquakes along the northwest coast range from approximately 350 to 700 years. The average recurrence intervals for subduction zone earthquakes appears to be approximately 500 years.

3.2 SUBSURFACE CONDITIONS

The general soil profile for the proposed pump station, waste water tank and the overall utility alignment is discussed in the sections below. The soil descriptions are based on the exploratory borings conducted by our firm. The approximate boring location are shown on Figures 2 and 4.

Exploration logs are presented in Appendix A of this report. Soil descriptions and interfaces are based on discrete samples obtained from widely spaced borings, and do not necessarily represent the conditions between borings. The contacts between the observed geologic units are expected to be variable. The boring locations shown on Figures 2 and 4 were established by pacing from apparent property boundaries and existing site features, and should be considered approximate.

3.2.1 Proposed Pump Station and Waste water Tank Site

WOOD WASTE LANDFILL: The pump station and waste water tank site near Stafford Creek has previously been utilized as a wood-waste landfill. Wood-debris including large logs or branch sized material was encountered to depths of approximately 20 feet. The transition between wood-waste layer and the underlying woody and peat soils is difficult to delineate due to the similarity of the two units. This material is very soft and organic and is not considered suitable for structural support.

QUATERNARY ALLUVIUM: Beneath the wood waste landfill, quaternary alluvium consisting primarily of silt and sand with varying thickness of peat and scattered larger woody debris was encountered. These deposits were encountered in all of the pump station borings. Borings B-14 and B-15 were terminated within this unit at a depth of 41.5 feet. The basal contact of this unit was encountered in borings B-16, B-17 and B-18. The basal contact of this unit ranged from 45 feet in boring B-18 to 60 feet in boring B-16. These deposits are generally very soft to medium stiff, and have high organic contents. As with the wood waste, this layer is not considered suitable for structural support of the proposed pump station and waste water holding tank.

QUATERNARY TERRACE DEPOSITS: A layer of dense to very dense, sand and gravel was encountered beneath the alluvium in borings B-16, B-17 and B-18. This material is similar to the granular sediments located near the surface in the hills to the south of the site. As noted above this material was located at depths ranging from 45 feet in boring B-18 to 60 feet in boring B-16. Deep foundations bearing on this strata may be suitable for the support of waste water storage tank and pump station.

Groundwater was encountered at depths varying from 5 to 16 feet from the ground surface in boring B-14 to B-18 located in the general area of waste water storage tank. Perched groundwater may be encountered at shallow depths at unexpected location in the wood waste landfill area. AEE has installed piezometers screened between 5 to 40 feet from ground surface from water level measurements in boring B-14 and B-15.

3.2.2 Utility Alignment

MANMADE FILL: A large portion of the proposed utility corridor parallels the existing SR-105 highway and Burlington Northern railroad alignments. Fill materials associated with these structures were encountered sporadically during our exploration. Drainage ditches located adjacent to the highway contain a number of culverted and filled, access drive crossings. The observed fill materials typically consist of native silts or silty granular soils with some larger near surface quarry rock.

QUATERNARY ALLUVIUM: The majority of the alignment is located within a layer consisting of very soft to medium stiff, clay, silt, fine sand and peat. This material has been deposited in bogs, and migrating streams and rivers flowing into Grays Harbor. The various soil horizons within this unit are expected to be laterally discontinuous due to the associated depositional environments.

QUATERNARY TERRACE DEPOSITS: Medium dense to dense, sand and gravel was encountered at depths ranging between 15 and 20 feet near the proposed Campbell Creek crossing location. This soil appears to be correlative with the local gravelly terrace deposit noted previously. Local gravelly soils along the alignment may indicate other areas with near surface gravelly terrace deposits. This unit was not observed in any of the borings at the other creek crossing locations.

Groundwater was encountered in all of the borings along the utility alignment at highly variable depths. The depths varied from 4.5 to 25.5 feet below ground surface. The soil strata is highly variable and interconnected zones of sand and gravel may be present. Thus shallow groundwater, within a few feet of the surface may be encountered during construction. The groundwater levels may also vary with the tides in the Grays Harbor. It is also possible that major portions of the utility lines may be inundated for parts of the day by surface water with tidal variations.

4.0 DISCUSSION

Although the Quaternary alluvial and estuarine sediments that are present along the proposed utility alignments can vary significantly over short distances, the character of the deposits is broadly uniform. Our research, field reconnaissance and subsurface exploration indicates that the same general soil conditions are present along the proposed highway alignments.

Geotechnical design considerations would be considered roughly equivalent throughout the proposed highway alignments.

A significant issue to the proposed highway alignment is that of the numerous tidal creek crossings. The proposed highway alignment would require 6 creek or slough crossings. Several of the creek crossings observed during our field reconnaissance and exploration program had abandoned, cut-off timber piles that presumably once supported old highway bridges. The abandoned piles could potentially obstruct installation of underground utilities at the creek crossings. It is our understanding that directional drilling is being considered at this stage to accomplish creek crossing. In accordance with the Washington Department of Ecology, the utility lines should be installed at least 20 feet below the creek bed. This will require that directional drilling be commenced at considerable distance from the creek to maintain a relatively flat angle of approach. If jackpits are utilized, significant shoring and dewatering operations may be required. If jackpits are considered in future, AEE should be contacted for further recommendations.

The two most significant structures proposed for the project are the pump station and waste water storage tank located near the prison site (Figure 4). We understand that the proposed pump station structure will be approximately 18 feet in diameter and 30 feet deep. The storage station will be approximately 140 feet in diameter and 20 feet deep. The general soil profile in the waste water tank area consists of wood-debris including large log or branch sized material to depths of approximately 20 feet underlain by quaternary alluvium consisting primarily of silt and sand with varying thickness of peat and scattered larger woody debris which is underlain by a layer of dense to very dense, sand and gravel. The dense sand and gravel deposits were encountered at depths ranging from 45 feet in boring B-18 to 60 feet in boring B-16. Deep foundations bearing on this strata may be suitable for the support of waste water storage tank and pump station. The soils at the bottom of the tank may have to be overexcavated and a building pad constructed of 18 to 24 inches of crushed rock over geogrid installed. Significant shoring and dewatering operation may be required in these areas.

The following sections discuss design and construction considerations in detail.

5.0 DESIGN AND CONSTRUCTION CONSIDERATIONS

5.1 TRENCH EXCAVATION

The near-surface fine-grained soils and peat encountered in most of our exploratory borings along the proposed utility alignment are expected to be easily excavated with a standard rubber-tired backhoe. However, logs or other obstructions may be buried within the alluvial deposits and overexcavation beyond planned ditch lines may be required to remove them. Potentially difficult excavation conditions could be encountered in Quaternary Terrace deposits at the site. Quaternary terrace deposits were encountered in boring B-7 and B-8 on the sides of Campbell Creek.

It appears that the highway was constructed on embankment which was constructed across the low-lying tidal plain. Such fills can be relatively sensitive to post construction disturbance. Excavations into the side of the embankments may be difficult to repair to the original configuration. We would recommend against locating the proposed pipelines within the fills of the existing embankments.

5.2 SHORING AND DEWATERING

Previous studies indicate that for shallow excavations (less than six feet in depth) the bay mud may stand on near-vertical slopes for short periods of time. However, they may collapse suddenly and without warning, especially in the presence of shallow ground water. All excavations in soft, fine-grained clayey silty mud and organic soils should be shored. Excavations in granular soils that do not encounter groundwater may be sloped in accordance with OSHA regulations. Excavations should be located away from settlement sensitive structures a distance of at least 1.5 times the trench depth. Temporary stock piles should also be located outside of this zone. The construction site safety is the sole responsibility of the contractor who shall also be responsible for the means, methods and sequencing of construction operations. The sides of any trench and excavation in which workers will be present, regardless of depth, must comply with local, state or federal safety regulations.

Shallow groundwater was encountered during our field exploration in most of the borings. Previous explorations in the Aberdeen area generally indicate that groundwater is frequently encountered near the ground surface over much of the proposed utility alignment. Due to the fine grained nature of the alluvial soils, previous excavations in the area have utilized sump pumps for dewatering. For shallow excavations we would anticipate that sumping will address most groundwater problems. Deeper excavations will likely require exterior dewatering or buoyancy resistant design. Excavations in granular soils that penetrate the water table may require pumping of temporary well points at substantial rates to accomplish necessary dewatering. Dewatering systems are generally designed and constructed by the contractors.

5.3 PIPE ISSUES

It is our understanding that ductile iron pipes with thrust restraint joints are being considered to be used for water and sewer lines. Buoyancy will not be an issue if ductile iron pipes are used. However pipes manufactured using polyvinyl chloride (PVC), and high density polyethylene (HDPE) will present a greater buoyancy problem than the ductile iron. Preliminary data indicates that each foot of native backfill over the pipe would provide 20 pounds per square foot of buoyancy resistance. For compacted crushed rock, each foot of backfill would provide 60 pounds per square foot of buoyancy resistance. The buoyant force to be restrained would be the external diameter of the pipe multiplied by the unit weight of water less the weight of the pipe itself. Additional buoyancy resistance could be obtained by periodically constructing a concrete cap over the top of the pipe. However, the use of imported granular material may cause significant settlement in the underlying tidal deposits.

The soils are extremely compressible and will deflect large distances before developing any significant load. For this reason, it should be assumed that the thrust restraint developed along the sides of the pipe will be minimal. AEE understands that restraint joints will utilized throughout the proposed pipelines, and that thrust restraint will be needed at angled pipe connections. At specific locations, it may be necessary to develop structural restraints which derive their support from soils at depth in order to provide thrust restraint where needed.

5.4 PIPE BEDDING

Based on our subsurface explorations in the area it appears that the native soils underlying the proposed pipeline would generally be suitable for conventional foundation support of the proposed pipeline. However, variations may occur and some overexcavation and backfill with granular structural fill will likely be necessary. It may be necessary to provide bedding material for the pipe especially in areas where workers will be present. This bedding material would typically consist of sand or fine gravel. A minimum thickness of six inches will be needed to prepare a suitable surface for placing the pipe. In particularly soft areas, a geotextile may be required below the sand or gravel pad. In order to limit the transmission of water through the pipeline bedding and/or backfill, clay dams should be provided at appropriate locations. These are recommended at creek crossings, at predetermined intervals as well as at any vaults, manholes, or other control structures.

5.5 BACKFILL

It is our understanding that the water and sewer lines will consist of ductile iron pipes. Thus buoyancy is not considered to be an issue. However, if pipes constructed of lower density materials, like PVC or HDPE are used, buoyancy issues may become critical. Native soils may be used for backfill if iron pipes are used. This material will need to be stockpiled away from the trench and protected from rainfall and erosion. It is possible that some of the native soil will not be suitable for backfill due to high organic content and high moisture contents. The estuarine sediments which display moisture contents in excess of 80 percent are likely to be very sensitive. When disturbed they will exhibit no shear strength and will flow like a fluid.

It will not be possible to compact the native soil to any great degree and placement will likely consist of tamping. The resulting backfill will have quite low shear strength and will be prone to settlement. For areas where structural backfill may be required (road crossings, tank areas, etc.) we would recommend the use of imported granular material. If such areas occur in the wetlands, then the use of periodic clay plugs to limit water transmission is recommended.

5.6 TEMPORARY CONSTRUCTION ROADWAY

In order to construct the pipelines in the wetland areas, it may be necessary to construct temporary access roads to support construction equipment, and allow delivery of materials to

the work site. Commonly the access road structure consists of a pit run quarry rock (six inch to eight inch maximum size with no more than 5% by weight passing a No. 200 sieve)

Due to the temporary nature of the road it would be neither beneficial nor necessary to strip the organic from the surface of the site. The rock for the access road should be installed in a single lift with trucks end-dumping off an advancing pad of granular fill.

Due to the soft nature of the soils present in the low-lying tidal plain areas access roads may require a working blanket thickness of two feet or more. It will also be beneficial to utilize a reinforcement grid or geotextile under the rock section. This material will provide additional support and may assist in the recovery of the rock for reuse elsewhere on the project.

Construction practices can greatly affect the amount of rock necessary. By using tracked equipment and special haul roads for delivery of material to the work site, the working blanket area can be minimized. Normally the design, installation and maintenance of granular haul roads and working blanket is made the responsibility of the contractor.

5.7 TIDAL CREEK AND SLOUGH CROSSINGS

Six creek crossings will be necessary along the proposed highway alignment. We understand that the crossings must pass at least 20 feet under the creek bottom and that a buffer zone of 50 feet on each side of the creeks is to remain undisturbed (Washington Department of Ecology). Based on these constraints, it would appear that either a jacking or tunneling program would need to be undertaken at these locations. At the present time a tunnelling technique is being considered. As noted previously, cut-off timber piles that presumably once supported old highway bridges could potentially obstruct installation of underground utilities at the creek crossings.

The most conventional method available to advance the pipes across the creek areas would be a jacking approach. This approach involves the excavation of a jack pit on either side of the creek. An oversized pipe is forced horizontally from one pit to another using a hydraulic jacking system. The pipe is then reamed out and the service pipeline is blocked into place. The most significant issue for the use of such a system would be the difficulty of constructing the pits. Due to the soft soils, and shallow groundwater table, it is likely that a braced, sheet pile cell would be required. In order to resist hydrostatic forces, a concrete floor may need to be placed within the cell. Significant dewatering operations may be required to keep the excavation dry.

The approach being considered at this stage to complete the creek crossings is the use of directional drilling. Directional drilling has recently been used on the Chehalis River force main project with some success. The method consists of drilling a small diameter pilot hole with a jetting bit. The pilot hole is then expanded to 125 to 150 percent of the pipeline diameter using a larger bit. The finished pipe is then pulled through the hole utilizing the drill string. The

principal disadvantage with directional drilling would be the cost, and that the entry and exit angles must be relatively flat. As such, the total length necessary to pass under the creeks may be significant. Installation of multiple utility lines in the same borings may also provide some practical difficulties.

5.8 STRUCTURES

The two most significant structures proposed for the project are the waste water pump station and storage tank located near the prison site (Figure 4). We understand that the proposed pump station structure will be approximately 18 feet in diameter and 30 feet deep. The storage station will be approximately 140 feet in diameter and 20 feet deep.

The general soil profile in the waste water tank area consists of wood-debris including large logs or branch sized material to depths of approximately 20 feet underlain by quaternary alluvium consisting primarily of silt and sand with varying thickness of peat and scattered larger woody debris which is underlain by a layer of dense to very dense, sand and gravel. The dense sand and gravel deposits were encountered at depths ranging from 45 feet in boring B-18 to 60 feet in boring B-16. Deep foundations bearing on this strata may be suitable for the support of waste water storage tank and pump station.

Groundwater was encountered at depths varying from 5 to 16 feet from the ground surface in boring B-14 to B-18 located in the general area of waste water storage tank. Perched groundwater may be encountered at shallow depths at unexpected locations in the wood waste landfill area.

Based on the soil profile described above, it is recommended that the structures be founded on quaternary terrace deposits (sand and gravel). The table on the following page provides recommended vertical pile capacities for pipe and H piles.

All the piles should be embedded at least 10 feet into the dense sand and gravel layers. Before the construction operations commences, a termination criteria, i.e. blow count per foot should be established. This termination blow count criteria should be used in addition to the minimum embedment depth criteria given above. The termination blow count is established based on pile type, pile capacity and pile-driving equipment. Since these parameters are not selected, a termination blow count criteria cannot be established at this stage. AEE should be contacted to establish this criteria pile before the construction starts.

Structures embedded into the ground should be designed to account for the possibility that the groundwater table may periodically come into contact with the structure. The structures should be waterproofed and the structural design should accommodate buoyancy forces. The resistance of buoyancy forces may be accomplished through the dead weight of the structure, through the dead weight of soil, or potentially through tension structures such as earth anchors or piling.

	Pile Capacity (Tons)			
Preliminary Embedment Into Alluvium (ft) = > Pile Description	**10 feet**	**20 feet**	**30 feet**	**40 feet**
10" Pipe Pile	40	65	80	95
12" Pipe Pile	60	95	110	125
14" Pipe Pile	80	125	145	160
16" Pipe Pile	105	160	180	200
HP 10 x 42	65	100	120	140
HP 12 x 53	75	120	140	160
HP 13 x 73	85	140	160	180
HP 14 x 73	100	160	180	205

The construction of the waste water tank may require excavations on the order of 20 to 25 feet. It is recommended that the soft soils encountered below the tank bottom be overexcavated to a depth of 2 feet and a construction pad be installed over it. The construction pad is normally 18 to 24 inches of crushed rock (6 to 8 inches maximum size) placed over a geogrid. The construction pad will provide a work area for workers and equipments and also a firm base to pour the slab. The construction pad may require regrading once the pile driving operations are completed.

Groundwater was encountered at depths varying from 5 to 16 feet in borings B-14 to B-18. The presence of shallow groundwater and soft soils indicates that all excavations should be properly shored and braced. The recommendations provided in section 5.2.2 will also be applicable to the excavations for waste water tank and pump station construction. AEE has installed piezometers in borings B-14 and B-15. The water levels in these piezometers may indicate the ground water levels variations in the project site. Significant dewatering operations may also be required to keep the excavation dry. Excavation shoring and dewatering systems are typically designed and constructed by the contractor. Construction site safety is the sole responsibility of the contractor.

The booster pump station located near Newskah Road may be founded on a rock pad. The rock pad should be at least 18 inches thick and underlain by a geotextile membrane. The rock pad is normally constructed of crushed rock (6 to 8 inches maximum size) placed over a geotextile membrane. This rock pad will provide a dry work area and a firm subgrade to pour the slab. The effects of buoyancy should be considered for the design of this rock pad.

6.0 CONSTRUCTION OBSERVATION

The analyses, conclusions, and recommendations contained in this report are based on site conditions as they presently exist, and on the assumption that the conditions observed in our exploration are representative of the subsurface conditions throughout the site. It is the nature of geotechnical work that soil conditions encountered during construction vary from the conditions identified during the geotechnical investigation, even when a normally acceptable program of exploration has been implemented. While some variations from anticipated conditions may appear slight, their impact on the performance of facilities and structures can be significant. It is therefore recommended that AEE be retained to observe the construction of portions of this project relating to geotechnical engineering, particularly site preparation, subgrade inspection, fill construction, backfilling, pile inspection etc. This will allow us to correlate our findings with the actual soil conditions encountered during construction and to check for construction conformance to the recommendations in our report.

Unanticipated subsurface conditions frequently require additional expenditures in the form of changed procedures and additional observations to attain a properly constructed project. It is therefore prudent to allow for such unforeseen conditions in both the project schedule and construction budget.

7.0 LIMITATIONS

The recommendations in this report are based on information gathered in the office review phase of this investigation and the site conditions observed at the time of field exploration. If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, or if the project scheme is significantly modified with regard to the type and extent of construction, AEE should be requested to review this report to evaluate the conclusions and recommendations considering the lapse of time or changed conditions. A copy of the plans and specifications, particularly final grading plans, should be forwarded to the undersigned when available, so that AEE may evaluate whether any change in concept has affected the validity of the recommendations in this report, and whether these recommendations have been accurately interpreted.

AGRA Earth & Environmental, Inc.

a wesley spang for

Rajiv Ali
Geotechnical Engineering Staff

Stuart Albright, P.E.
Senior Geotechnical Engineer

STUART ALBRIGHT
STATE OF WASHINGTON
27196
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES 9/25/97

RA/sh

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APPENDIX A

FIELD EXPLORATION

A visual geotechnical site reconnaissance and subsurface exploration program were conducted from October 08 through October 17 and from November 11 through 13, 1996. A total of 13 borings were drilled and sampled to depths ranging from 19.5 to 28.5 feet for the proposed utility alignment. One borings was located on each side of the six creeks (12 borings) and one at the proposed location of water booster Pump Station at the intersection of SR105 and Newskah Road. An additional five borings were drilled at the proposed pump station site near Stafford Creek. The pump station borings were drilled and sampled to depths ranging from 41.5 to 71.5 feet. A truck-mounted drill rig was utilized at the pump station location. All of the borings were logged by a representative from our firm. Selected soil samples were placed in moisture-tight containers and were transported to AEE's in-house materials testing laboratory for further testing. Borings logs are presented in the following pages.

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 6-61M-08424-1**

Boring Number: B-1

Boring Method: Hollow Stem Auger

Borehole Diameter: 6.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES
0	Subrounded to rounded gravel with silt and organics (FILL) (drill cuttings).			
	Loose, moist, light brown to dark gray, silty coarse sand to fine gravel (FILL).			
5	Very soft drilling at 4.5 feet.			
	Very soft, wet, gray, CLAY with organics. Decomposed wood pieces at sampler tip.			
	Sampler pushed under hammer weight.	OH to Pt		P
10	Very soft, wet to saturated, gray, silty organic CLAY with some sand. (Organic odor.)		WD	
	Sampler pushed under hammer weight.			P
	Concentrated spots of fibrous PEAT.			
15	Loose, wet to saturated, black, coarse SAND.	SP		
	Soft to medium stiff, saturated, blue, mottled, silty CLAY.	ML to CL		
20	Medium stiff to stiff, wet to saturated, gray, silty CLAY to clayey SILT.			
	Medium dense, wet, blue to brown, silty SAND to GRAVEL.	SM to GM		
25	Softer drilling at 24 feet.			
	Very soft, saturated, blue, CLAY.	CL		
	Boring terminated at 28.5 feet bgs.			
30				

STANDARD PENETRATION RESISTANCE

▲ Blows per foot(140 lb. hammer/30" drop)

10 20 30 40

●=76%

●=64%

●=78%

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/8/96 **Drilling Completed:** 10/8/96 **Logged By:** RA a:\GEOTECH\SCSEWER\8424B1.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 6-61M-08424-1**

Boring Number: B-2

Boring Method: Hollow Stem Auger

Borehole Diameter: 6.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
0	Very soft, wet, gray, organic CLAY. (Organic odor.) Concentrated pockets of fibrous PEAT.	OH to Pt		▲	•=69%
5				▲	•=77%
10	Sampler pushed under hammer weight.		WD	P	•=72%
15	Sampler pushed under hammer weight. Loose, saturated, gray, medium-grained SAND.	SP		P	•
20	Very soft, saturated, gray, silty organic CLAY. Wood pieces.	OH to Pt		▲	•=116%
25	2-inch layer of PEAT at 21.8 feet. Decomposed wood debris.				
30	Loose, saturated, light gray, medium-grained SAND followed by soft to medium stiff, wet. light gray, highly plastic CLAY. Boring terminated at 28.5 feet bgs.	SP to CH		▲	•

LEGEND

	2.0" O.D. split spoon sampler with percent recovered	P	Sampler pushed
	3.0" O.D. undisturbed sampler with percent recovered	•	% moisture content
	3.0" I.D. Universal sampler	*	Sample not recovered
	3.0" I.D. Ring sampler		Water level fluctuation
G	Grab sample interval		Static water level
L(C)	Laboratory/chemical analysis	WD	Groundwater level at time of drilling
	Piezometer tip		

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

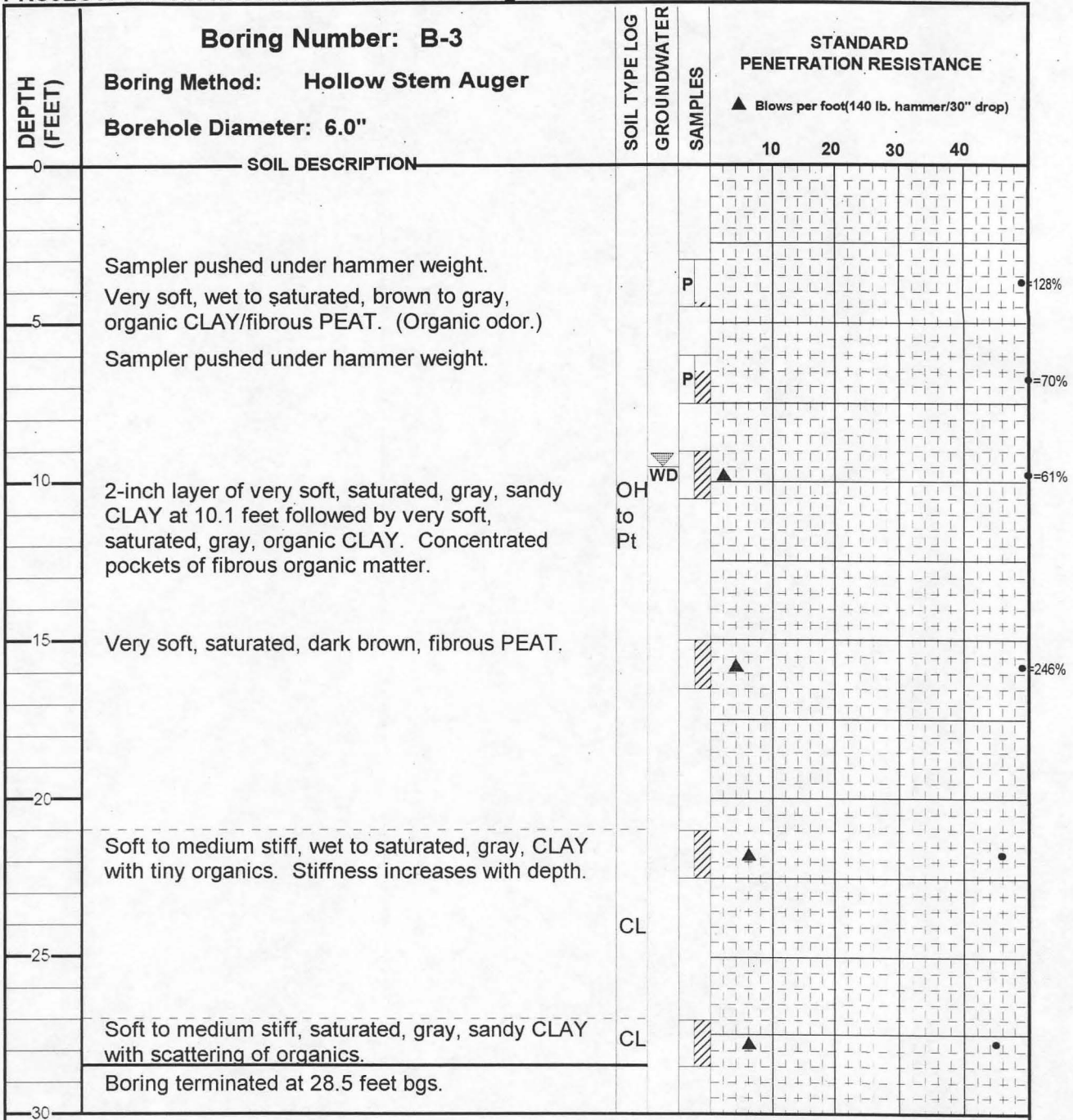
Drilling Started: 10/8/96 **Drilling Completed:** 10/8/96 **Logged By:** RA a:\GEOTECH\SCSEWER\8424B2.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 6-61M-08424-1**

Boring Number: B-3

Boring Method: Hollow Stem Auger

Borehole Diameter: 6.0"



LEGEND

	2.0" O.D. split spoon sampler with percent recovered	P	Sampler pushed
	3.0" O.D. undisturbed sampler with percent recovered	•	% moisture content
	3.0" I.D. Universal sampler	*	Sample not recovered
	3.0" I.D. Ring sampler		Water level fluctuation
G	Grab sample interval		Static water level
L(C)	Laboratory/chemical analysis	WD	Groundwater level at time of drilling
I	Piezometer tip		

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/9/96 Drilling Completed: 10/9/96 Logged By: RA a:\GEOTECH\SCSEWER\8424B3.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment PROJECT NUMBER: 6-61M-08424-1

Boring Number: B-4

Boring Method: Hollow Stem Auger

Borehole Diameter: 6.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
0	Soft, saturated, blue to gray, organic CLAY (drill cuttings).	OL			
5	Very soft, saturated, gray to black, organic CLAY and fibrous PEAT.	OH to Pt		P	•=82%
	Very soft, saturated, gray to black, organic CLAY with spots of concentrated organics.			P	•=84%
10				P	•=90%
15				P	•=88%
	Very soft, saturated, gray to brown, organic CLAY to PEAT.			P	•=83%
20	Boring terminated at 19.5 feet bgs due to rig instability.				
25					
30					

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- I — Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek
Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/10/96 Drilling Completed: 10/10/96 Logged By: RA a:\GEOTECH\SCSEWER\8424B4.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 6-61M-08424-1**

Boring Number: B-5

Boring Method: Hollow Stem Auger

Borehole Diameter: 6.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))	
0					10 20 30 40	
	Very soft, wet, gray to brown, highly organic CLAY. Undecomposed wood debris.	OH			▲	•=87%
5	Very soft, wet, gray, CLAY with some organics.	OH	WD ▽			
	Very soft, wet to saturated, gray to brown, fibrous PEAT.	Pt		P		•=86%
10	Very soft, wet to saturated, gray to brown, organic CLAY.	OH		P		•=87%
15	Very soft to soft, saturated, gray, CLAY with organics and some sand.				▲	•=61%
20		CL		*	▲	
25	Very soft, saturated, gray, CLAY with organics and some sand.				▲	•=69%
	Boring terminated at 28.5 feet bgs.					
30						

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax (503) 620-7892

Drilling Started: 10/10/96 **Drilling Completed:** 10/10/96 **Logged By:** RA a:\GEOTECH\SCSEWER\8424B5.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 6-61M-08424-1**

Boring Number: B-6

Boring Method: Hollow Stem Auger

Borehole Diameter: 6.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES
0				
	Medium stiff to stiff, moist, brown, mottled, sandy SILT with some subrounded to rounded gravel.	ML		
5				
	Very soft, moist to wet, gray, organic CLAY and fibrous PEAT.			
	Very soft, wet, gray, organic CLAY to fibrous PEAT.	OH to Pt		P
10				
15	Medium stiff, wet, brown, fibrous PEAT.			
20				
	Medium stiff to stiff, saturated, CLAY with subrounded to rounded gravel, organics, and wood pieces.	CL to OL		
25			WD	
	Medium stiff, saturated, gray, gravelly SILT.	ML		
	Boring terminated at 28.5 feet bgs.			
30				

STANDARD PENETRATION RESISTANCE

▲ Blows per foot(140 lb. hammer/30" drop)

10 20 30 40

●=70%

●=82%

●=238%

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/11/96 **Drilling Completed:** 10/11/96 **Logged By:** RA a:\GEOTECH\SCSEWER\8424B6.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 6-61M-08424-1**

Boring Number: B-7

Boring Method: Hollow Stem Auger

Borehole Diameter: 6.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES
0	Soft drilling. Organics.	Pt		
5	Medium dense, moist, brown to gray, sandy subrounded to rounded GRAVEL.	GP		
	Loose, wet to saturated, gray, coarse-grained SAND with subrounded to rounded gravel.	SP	WD	
10	Very soft, saturated, dark gray, organic CLAY. Concentrated organic pockets present.	OH to Pt		
15	Very soft, saturated, gray, mottled, CLAY with some sand.	CL		
20	Medium dense, saturated, brown, mottled, clayey SAND and rounded gravel.	SC to GC		
25	Dense, saturated, gray, silty coarse-grained SAND to GRAVEL. Some organic spots.			
	Boring terminated at 28.5 feet bgs.			
30				

STANDARD PENETRATION RESISTANCE
▲ Blows per foot(140 lb. hammer/30" drop)
10 20 30 40

=55%

=53%

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/14/96 **Drilling Completed:** 10/14/96 **Logged By:** RA a:\GEOTECH\SCSEWER\8424B7.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 6-61M-08424-1**

Boring Number: B-8

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
0	Medium dense, moist, brown, silty coarse-grained SAND to GRAVEL.	SP to GP			
5	Soft, moist, gray, CLAY with organics. Some concentrated organic spots.				•=69%
10	Very soft, wet, gray, organic CLAY with concentrated organic spots and wood debris.	OH to Pt			•=90%
15	Dense, saturated, gray, coarse-grained SAND to GRAVEL.		WD		▲>50
	Large GRAVEL encountered at 19 feet.				
20	Dense, saturated, gray to brown, clayey coarse-grained SAND to GRAVEL.	SP to GP			▲>50
	Heaving SAND.				
25	Boring terminated at 25 feet bgs due to heaving.				
30					

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/15/96 **Drilling Completed:** 10/15/96 **Logged By:** RA a:\GEOTECH\SCSEWER\8424B8.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 6-61M-08424-1**

Boring Number: B-9

Boring Method: Hollow Stem Auger

Borehole Diameter: 6.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES
0	Loose, wet to saturated, brown, coarse-grained clayey SAND to GRAVEL.	SC to GC		
5	Very soft, wet, gray to black, organic CLAY to fibrous PEAT.			=80%
10	Very soft to soft, wet, gray, CLAY with organics to sand. Concentrated pockets of organics.			=51%
15	Very soft, wet, gray, highly organic CLAY. Concentrated pockets of organics.	OH to Pt		=68%
			WD	
20	Very soft, saturated, gray to black, CLAY with some organics and sand.			=62%
25	Very soft, wet to saturated, gray to black, organic CLAY. (Organic odor.) Concentrated organic pockets.			=90%
	Boring terminated at 26.5 feet bgs.			
30				

STANDARD PENETRATION RESISTANCE
▲ Blows per foot(140 lb. hammer/30" drop)
10 20 30 40

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/15/96 **Drilling Completed:** 10/15/96 **Logged By:** RA a:\GEOTECH\SCSEWER\8424B9.DRW

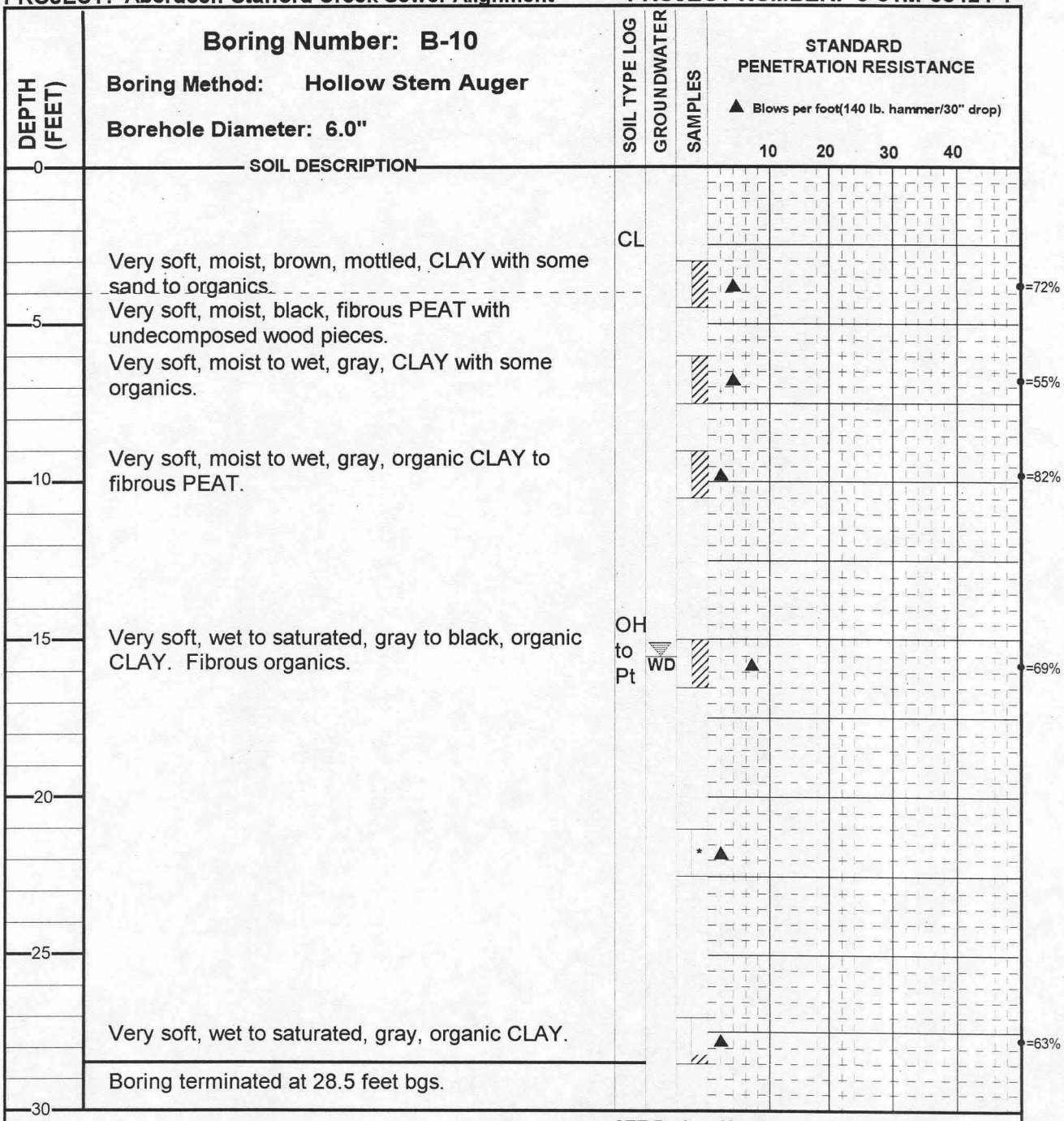
PROJECT: Aberdeen-Stafford Creek Sewer Alignment

PROJECT NUMBER: 6-61M-08424-1

Boring Number: B-10

Boring Method: Hollow Stem Auger

Borehole Diameter: 6.0"



Very soft, moist, brown, mottled, CLAY with some sand to organics.

Very soft, moist, black, fibrous PEAT with undecomposed wood pieces.

Very soft, moist to wet, gray, CLAY with some organics.

Very soft, moist to wet, gray, organic CLAY to fibrous PEAT.

Very soft, wet to saturated, gray to black, organic CLAY. Fibrous organics.

Very soft, wet to saturated, gray, organic CLAY.

Boring terminated at 28.5 feet bgs.

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/15/96 Drilling Completed: 10/15/96 Logged By: RA a:\GEOTECH\SCSEWER\8424B10.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment

PROJECT NUMBER: 6-61M-08424-1

Boring Number: B-11

Boring Method: Hollow Stem Auger

Borehole Diameter: 6.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES
0				
	Loose, saturated, brown to red, coarse-grained SAND to subrounded to rounded GRAVEL.	SP to GP	WD	
5				
	Very soft, saturated, gray, organic CLAY with wood debris and fibrous organics.	OH to Pt		
10	Very soft, saturated, gray, CLAY with a trace of organics.			
15	Very soft, saturated, gray, slightly mottled, CLAY with some sand.	CL		
	Plastic CLAY at 18 feet. Medium stiff, saturated, gray, slightly mottled, CLAY with some sand.			
20	Boring terminated at 19.5 feet bgs.			
25				
30				

STANDARD PENETRATION RESISTANCE

▲ Blows per foot(140 lb. hammer/30" drop)

10 20 30 40

•=104%

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- I — Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/16/96 Drilling Completed: 10/16/96 Logged By: RA a:\GEOTECH\SCSEWER\8424B11.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 6-61M-08424-1**

Boring Number: B-12

Boring Method: Hollow Stem Auger

Borehole Diameter: 6.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES
0	Very soft, wet, fibrous PEAT with some clay. Undecomposed grass.	Pt		P
5	Very soft, wet to saturated, fibrous PEAT with some sand.			
10	Very soft, wet, brown-gray to black, fibrous PEAT with clay.		WD	
15	Very soft, saturated, gray, plastic CLAY with a trace of organics.	CL		
20	Plastic CLAY at 19 feet. Very soft to soft, saturated, gray, plastic CLAY with some sand.			
25	Very soft, saturated, gray, plastic CLAY with some sand layers. Boring terminated at 25.5 feet bgs.			
30				

STANDARD PENETRATION RESISTANCE
▲ Blows per foot(140 lb. hammer/30" drop)
10 20 30 40

●=96%
●=82%
●=176%

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- ● — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/16/96 **Drilling Completed:** 10/16/96 **Logged By:** RA a:\GEOTECH\SCSEWER\8424B12.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 6-61M-08424-1**

Boring Number: B-13

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES
0	Rock, 2-inch to 3-inch maximum (FILL).			
5	Very soft, wet, gray to black, organic CLAY with spots of fibrous organic matter.	OH to Pt	WD	*
10	Very soft, saturated, gray-brown to black, fibrous PEAT.			
15	Decomposed wood pieces. PEAT.	Pt		
20	Very soft, saturated, gray to black, CLAY with some sand to organics.	CL		
25	Dense, saturated, gray-brown, SAND with gravel to organics. Water flow in sand.	SP to GP		
	Boring terminated at 26.5 feet bgs.			
30				

STANDARD PENETRATION RESISTANCE
▲ Blows per foot(140 lb. hammer/30" drop)
10 20 30 40

●=64%
●=139%
●=96%

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- ● — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/16/96 **Drilling Completed:** 10/16/96 **Logged By:** RA a:\GEOTECH\SCSEWER\8424B13.DRW

PROJECT: Stafford Creek Sewer Alignment PROJECT NUMBER: 6-61M-08424-1 PAGE 1

Boring Number: B-14

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
0	Silty, gravelly, sand with some quarry spoils (FILL).				
	Wood debris.				
5	Medium dense, wet, dark gray, silty SAND with some gravel. Wood at sampler tip. Difficult drilling due to logs. Logs end at approximately 9.5 feet.				▲>50 ●=71%
10		SC	WD	* ▲	
15	Loose, saturated, brown, silty SAND with wood debris.			▲	●=144%
20	Wood at sampler tip resulting in high blow count.			▲	●=108%
25	Dense, saturated, gray, silty SAND. Heaving sand.	SC		▲	
30					

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- ● — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment Sanitary Pump Station SR105 Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/17/96 Drilling Completed: 10/17/96 Logged By: JRZ a:\GEOTECH\SCSEWER\8424B14.DRW

Boring Number: B-14

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop); 10 20 30 40)
30	Loose, wet, gray, silty SAND with fibrous PEAT.				●=153%
35	Soft, wet, brown, SILT with wood fragments and fibrous PEAT.	Pt			●=183%
40	Medium dense, saturated, gray, SAND with interbedded stiff, wet, SILT with some PEAT.				●=202%
	Boring terminated at 41.5 feet bgs.				
45					
50					
55					
60					

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- I — Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
Sanitary Pump Station
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

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Drilling Started: 10/17/96 **Drilling Completed: 10/17/96** **Logged By: JRZ**

PROJECT: Stafford Creek Sewer Alignment PROJECT NUMBER: 6-61M-08424-1 PAGE 1

Boring Number: B-15

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
0					
5	Medium dense, moist to wet, dark brown, silty SAND with wood debris. Wood at sampler tip.				●=52%
	Dark brown to black, PEAT with some gravel (drill cuttings).				
10	Dense, dark brown to black, PEAT. Wood at sampler tip.	Pt			●=78%
			WD		
15	Dense, saturated, dark brown to black, PEAT. Wood at sampler tip.				▲>50 ●=129%
	CLAY lense.	CL			
20	Wood. No soil recovered.	Pt			▲>50 ●=212%
	VOID.				
25	Wood at sampler tip. No sample recovered.	Pt		*	
30					

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- ● — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment Sanitary Pump Station SR105 Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED

7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 10/17/96 Drilling Completed: 10/17/96 Logged By: JRZ a:\GEOTECH\SCSEWER\8424B15.DRW

Boring Number: B-15

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
30	Logs. Medium stiff, wet, blue-gray, sandy SILT with trace clay.	ML to OL			●=129%
35	Soft, wet, brown, SILT. Soft, wet, brown, fine, fibrous PEAT.	Pt			●=296%
40	Medium stiff, wet, brown, SILT with a lense of wet, brown, fine fibrous PEAT.				●=286%
	Boring terminated at 41.5 feet bgs.				
45					
50					
55					
60					

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
Sanitary Pump Station
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

a:\GEOTECH\SCSEWER\B15P2.DRW

Drilling Started: 10/17/96 **Drilling Completed:** 10/17/96 **Logged By:** JRZ

Boring Number: B-16

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
0	Broken rock and brown, silty sand with some gravel (road base material).				
5	Encountered large obstruction - rock, logs to other wooden debris.	Pt			
10	Broken rock.				
	Logs and wood debris.	Pt			
15	4-inch to 6-inch GRAVEL zone.		WD		
20	Hard, saturated, dark brown. SILT with wood debris.	OL to Pt			▲ >50 ● =64%
25	Wood debris.				
30					

LEGEND

	2.0" O.D. split spoon sampler with percent recovered	P	Sampler pushed
	3.0" O.D. undisturbed sampler with percent recovered	•	% moisture content
☒	3.0" I.D. Universal sampler	*	Sample not recovered
◯	3.0" I.D. Ring sampler		Water level fluctuation
G	Grab sample interval		Static water level
L(C)	Laboratory/chemical analysis	WD	Groundwater level at time of drilling
I	Piezometer tip		

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 11/11/96 **Drilling Completed:** 11/11/96 **Logged By:** JRZ a:\GEOTECH\SCSEWER\8424B16.DRW

Boring Number: B-16

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
30	Wood debris and SILT.			*	▲>50 •=78%
	Saturated, brown to dark brown, fibrous wood debris/SILT.				
35	Saturated, brown, SILT (flowing state) with wood debris/PEAT. (Organic odor.)	OL to Pt			
40	4-inch layer of medium dense, saturated, gray, silty SAND followed by stiff, wet, brown, clayey SILT to PEAT.			▲ •	•=79%
45	Silty PEAT at sampler tip.			* *	▲
50	Fibrous PEAT with some silt and sand. (Rocks to wood debris.)	OL to Pt		▲	•=54%
55	Wood followed by silty, sandy GRAVEL at sampler tip.			▲	▲>50 •=50%
60					

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

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Drilling Started: 11/11/96 **Drilling Completed:** 11/11/96 **Logged By:** JRZ

Boring Number: B-16

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
60	Hard, wet, brown to dark brown, silty PEAT followed by GRAVEL to very dense, wet, brown, silty SAND.	SP to GP			•=80% ▲>50
65	Very dense, wet, gray, silty SAND with gravel.				▲>50
70	Very dense, wet, light brown, silty, sandy GRAVEL and silty SAND.				▲>50
	Boring terminated at 71.0 feet bgs.				
75					
80					
85					
90					

STANDARD PENETRATION RESISTANCE: 10 20 30 40

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

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Drilling Started: 11/11/96 **Drilling Completed:** 11/11/96 **Logged By:** JRZ

PROJECT: Stafford Creek Sewer Alignment **PROJECT NUMBER: 6-61M-08424-1** **PAGE 1**

Boring Number: B-17

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
0	Loose, wet, dark brown, sandy SILT/silty SAND with some gravel. Wood debris.				
5	Soft at 4 feet. Wood debris in tailings with little soil.		WD		
10	Organic debris.	Pt		* ▲	
15					
20	Organic debris - brown roots. Very soft to soft, wet, organic-rich CLAY followed by CLAY.			▲	•=93% •=77%
25	Gray, CLAY (tailings).	OL to CL			
30					

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 11/12/96 **Drilling Completed:** 11/12/96 **Logged By:** JRZ a:\GEOTECH\SCSEWER\8424B17.DRW

Boring Number: B-17

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop); 10 20 30 40)
30					
35	Saturated, gray, CLAY (tailings).	CL		*	▲
40	Stiff, wet, brown to gray, CLAY with organics followed by medium dense, moist to wet, silty SAND (tip).	CL			▲ ●=81%
45	Hard, wet, gray, silty CLAY/clayey SILT. Dense, moist to wet, brown to gray, silty SAND with bits of organics.	ML-CL / SP			▲ ●
50	Medium dense, moist, gray, medium-grained SAND grading to coarse GRAVEL at 52 feet.	SP to GP			▲ ●
55	Hard, wet, brown, SILT followed by very dense, wet, gray, silty, sandy GRAVEL.	GM to GP			● ▲>50
60					

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- ● — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

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Drilling Started: 11/12/96 **Drilling Completed:** 11/12/96 **Logged By:** JRZ

Boring Number: B-17

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
60	Medium dense, gray, medium-grained SAND (slough).				
	Very dense, wet, light brown, silty, sandy GRAVEL.	GM			▲>50
65	Heaving SAND at 64 feet.				▲>50
	Boring terminated at 66.5 feet bgs.				
70					
75					
80					
85					
90					

STANDARD PENETRATION RESISTANCE: 10 20 30 40

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

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Drilling Started: 11/12/96 **Drilling Completed:** 11/12/96 **Logged By:** JRZ

Boring Number: B-18

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
0	Loose, wet, dark brown, silty SAND with gravel to broken rock. Wood debris. Logs.				
5			WD		
10	Very loose, wet to saturated, dark brown, silty organics/wood debris.	Pt		▲	•=64%
15					
20	Very loose, organic-rich, silty SAND.			▲	•=212%
25		SM			
30					

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- I — Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 11/12/96 Drilling Completed: 11/12/96 Logged By: JRZ a:\GEOTECH\SCSEWER\8424B18.DRW

Boring Number: B-18

Boring Method: 4.25" Hollow Stem Auger

Borehole Diameter: 8.0"

DEPTH (FEET)	SOIL DESCRIPTION	SOIL TYPE LOG	GROUNDWATER	SAMPLES	STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))
30	Very loose, organic-rich, silty SAND.	SM			●=99%
	Stiff, wet to saturated, gray, CLAY with some fine-grained sand.				
35	Wet, gray, clayey SILT/silty CLAY with some sand (tailings).	ML-CL			
40	Stiff, wet, dark brown, organic-rich CLAY.	OL			
	Medium dense, wet, gray, silty SAND.	SM			
45	Hard, wet, gray, silty CLAY.	CL			▲>50 ●=92%
	Very dense, moist to wet, brown and gray, silty SAND with zones of organics. Hard drilling starts at 47 feet.	SM			
50	Very dense, moist to wet, brown, silty, fine- to medium-grained SAND grading to SAND. GRAVEL encountered at 53 feet.				▲>50
55	Very dense, wet, gray, sandy GRAVEL with some silt. Very hard drilling.	SP to GP			▲>50
	Silty, sandy GRAVEL. Boring terminated at 60 feet and 1 inch bgs.				
60					▲>50

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- 3.0" I.D. Universal sampler
- 3.0" I.D. Ring sampler
- G — Grab sample interval
- L(C) — Laboratory/chemical analysis
- Piezometer tip
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered
- Water level fluctuation
- Static water level
- WD — Groundwater level at time of drilling

AEE Project Number: 6-61M-08424-1

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH AND ENVIRONMENTAL INCORPORATED
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

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Drilling Started: 11/12/96 **Drilling Completed:** 11/12/96 **Logged By:** JRZ

APPENDIX B

LABORATORY TESTING

Laboratory tests were conducted on selected soil samples obtained during the field exploration program. These samples were tested according to standard ASTM procedures in our laboratory and used to generate our recommendations. The laboratory test results are described below.

Moisture Contents: Moisture contents of selected soil samples were determined in accordance with ASTM D 2216. The moisture contents are shown on boring logs.

Grain Size Analysis: The grain size analysis for selected soil samples were conducted in accordance with ASTM 421 and D 422. This analysis consisted of both mechanical and hydrometer analysis. The results of these tests are tabulated below:

Sample	% Gravel	% Sand	% Fines	% Silt Size	% Clay Size
B-1, 6-7.5		20 %	80 %	60 %	20 %
B-1, 15-16.5		22 %	78 %		
B-1, 27-28.5		23 %	77 %	47 %	30 %
B-16, 40-41.5			76 %		
B-17, 50-51.5	0 %	93 %	7 %		
B-17, 60-61.5	27 %	62 %	11 %		
B-18, 30 -31.5			67 %	43 %	24 %

Atterberg Limits: Liquid and Plastic Limits for selected soil samples were evaluated in accordance with ASTM D 4318. The liquid and plastic limits are tabulated below:

Sample	Liquid Limit (%)	Plastic Limit (%)	PI (%)	USCS
B-1, 6 - 7.5	61 %	46 %	15 %	OH
B-1, 12 - 13.5	62 %	38 %	24 %	OH
B-1, 27 - 28.5	46 %	24 %	22 %	CL
B-11, 18 - 19.5	39 %	27 %	12 %	ML - CL
B-16, 40 - 41.5				Non-Plastic
B-18, 30 - 31.5	35 %	29 %	6 %	ML/OL

Organic Contents: Organic contents of selected soil samples were determined in accordance with ASTM D 2974. The organic contents are shown in the table below:

Sample	Organic Contents (%)
B-1, 12 - 13.5	6 %
B-11, 18 - 19.5	12 %
B-16, 20 - 21.5	19 %
B-16, 55 - 56.5	23 %
B-17, 20 - 21.5	19 %
B-18, 10 - 11.5	33 %

FIGURE 1

W.O.	6-61M-8424-1
DESIGN	RA
DRAWN	DF
DATE	OCT 1996
SCALE	NTS

AGRA
Earth & Environmental
7477 S.W. Tech Center Drive
Portland, OR, U.S.A. 97223-8025

PROPOSED UTILITY SERVICES EXTENSION
WASHINGTON STATE DEPT. OF CORRECTIONS
ABERDEEN, WASHINGTON

SITE LOCATION MAP

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \PROJECTS\21\08424\SITE.DWG

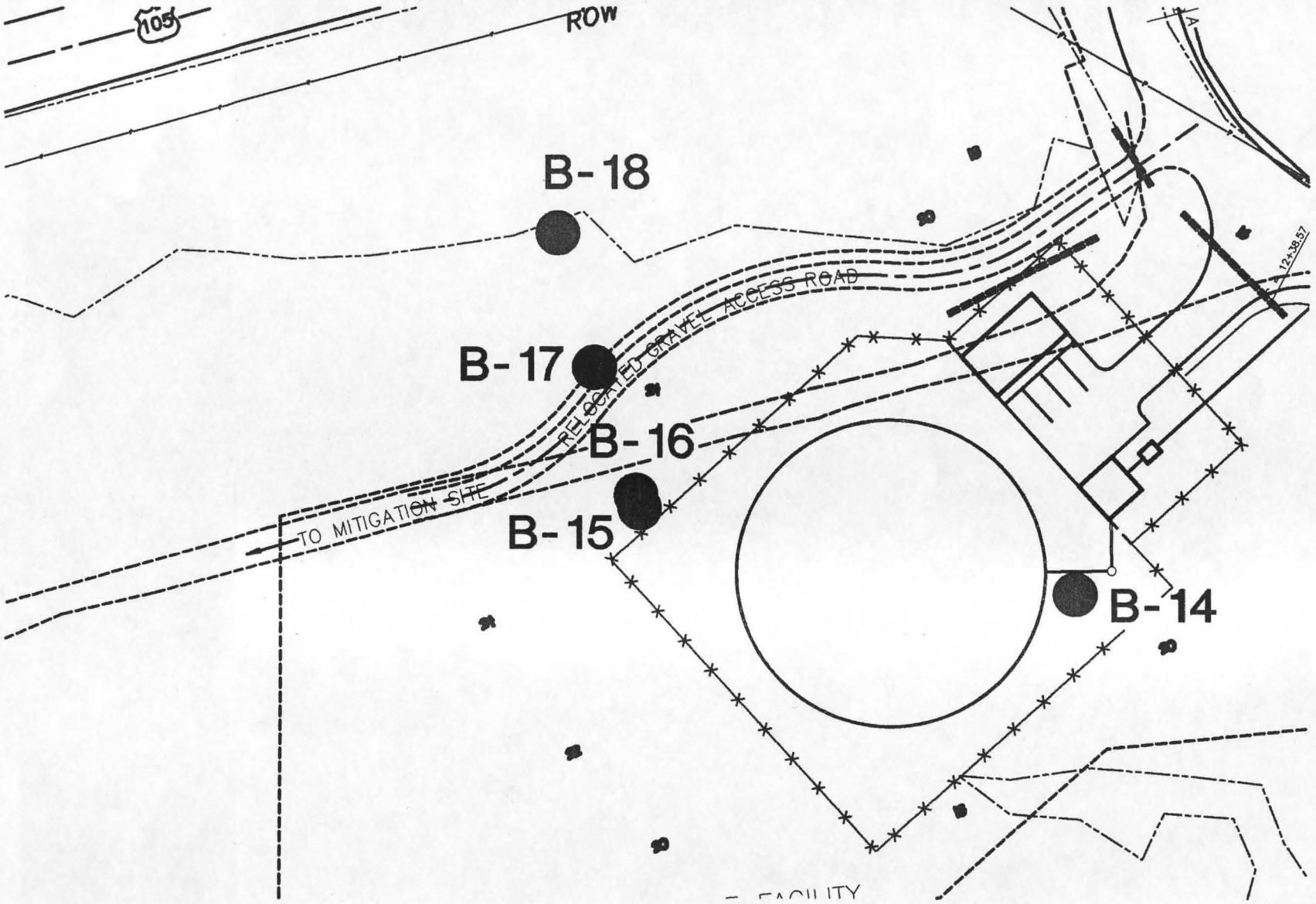


FIGURE 4

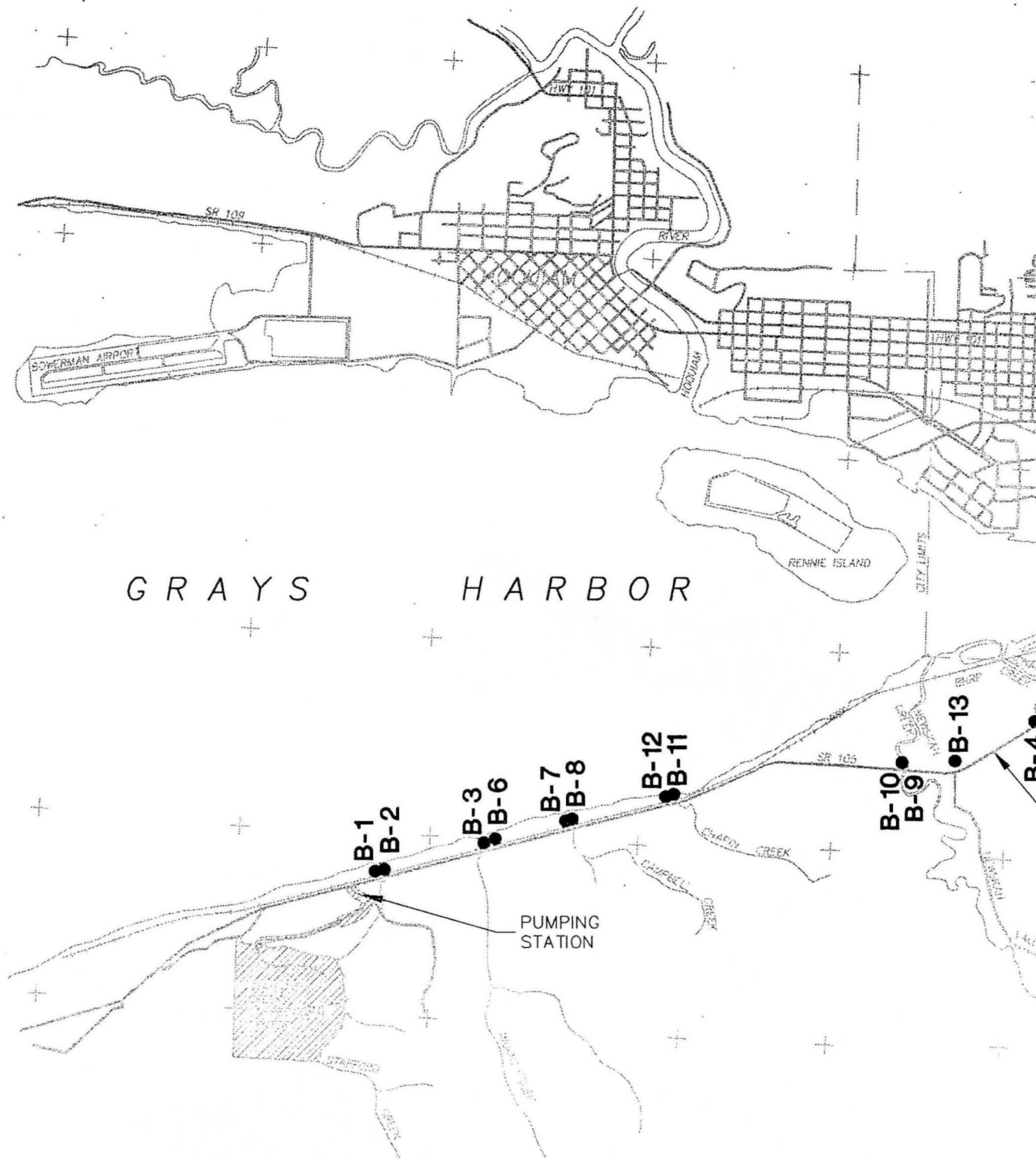
AGRA
Earth & Environmental
7477 S.W. Tech Center Drive
Portland, OR, U.S.A. 97223-8025

W.O.	6-61M-8424-1
DESIGN	RA
DRAWN	DF
DATE	DEC 1996
SCALE	1"=200'

PROPOSED UTILITY SERVICES EXTENSION
WASHINGTON STATE DEPT. OF CORRECTIONS
ABERDEEN, WAHINGTON

SCCC SEWAGE STORAGE TANK
AND PUMPING STATION

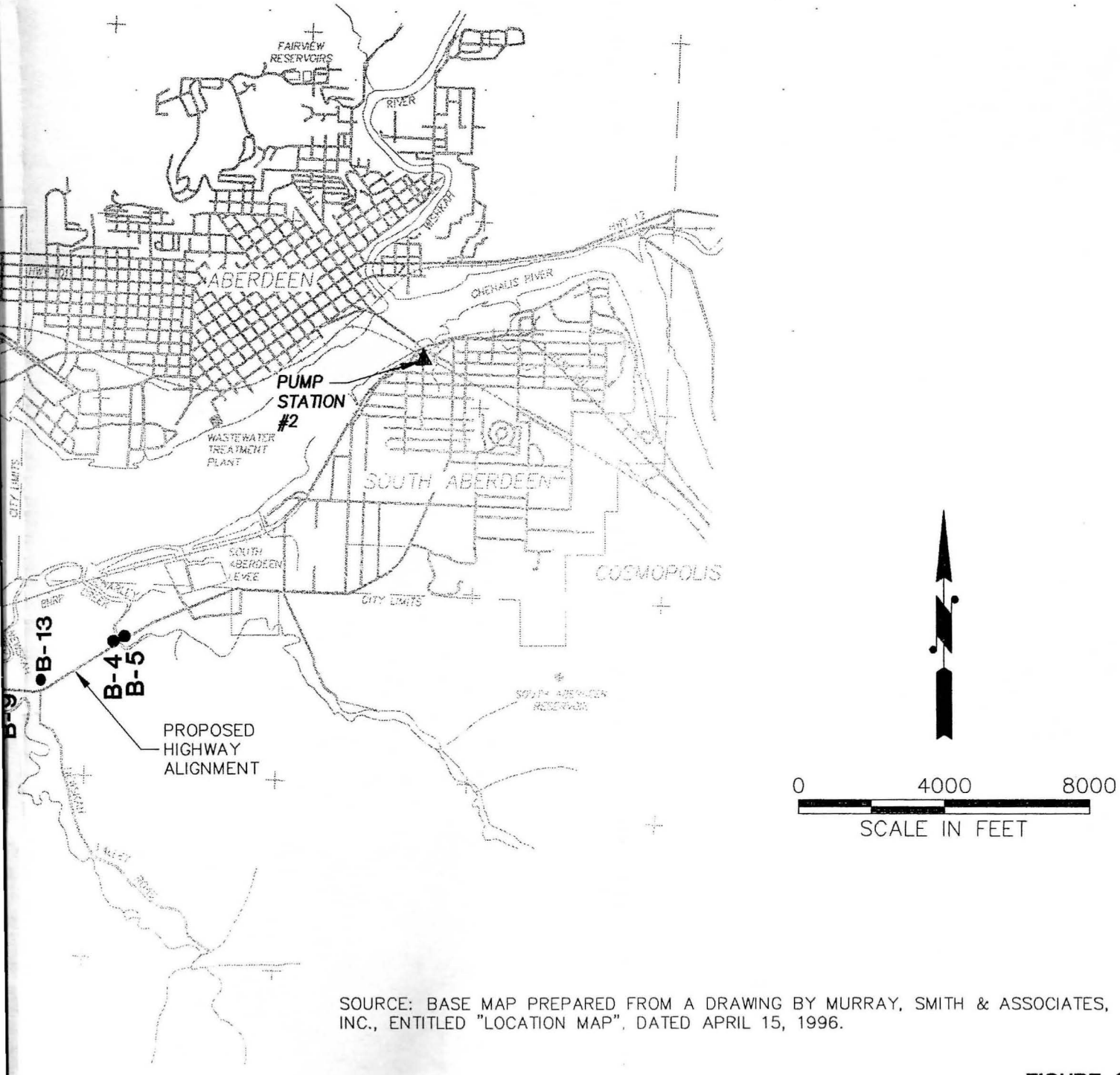
AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \8424\TANK2.DWG



LEGEND

B-2 ● SOIL BORING NUMBER AND APPROX. LOCATION

Ear
7477
Portl



SOURCE: BASE MAP PREPARED FROM A DRAWING BY MURRAY, SMITH & ASSOCIATES, INC., ENTITLED "LOCATION MAP", DATED APRIL 15, 1996.

FIGURE 2

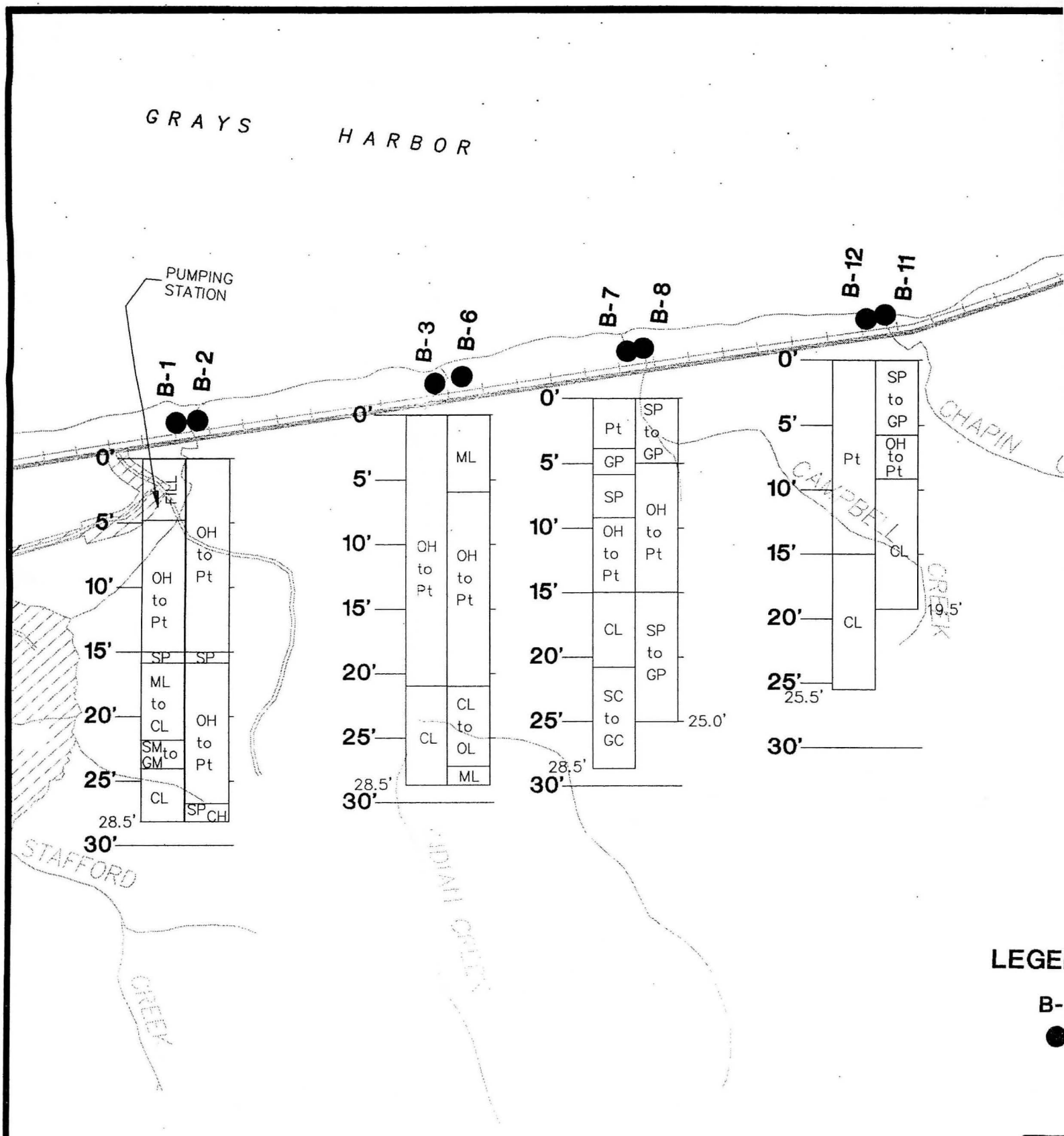
AGRA
Earth & Environmental
7477 S.W. Tech Center Drive
Portland, OR, U.S.A. 97223-8025

W.O.	6-61M-8424-1
DESIGN	RA
DRAWN	DF
DATE	OCT 1996
SCALE	1"=4000'

PROPOSED UTILITY SERVICES EXTENSION
WASHINGTON STATE DEPT. OF CORRECTIONS
ABERDEEN, WASHINGTON

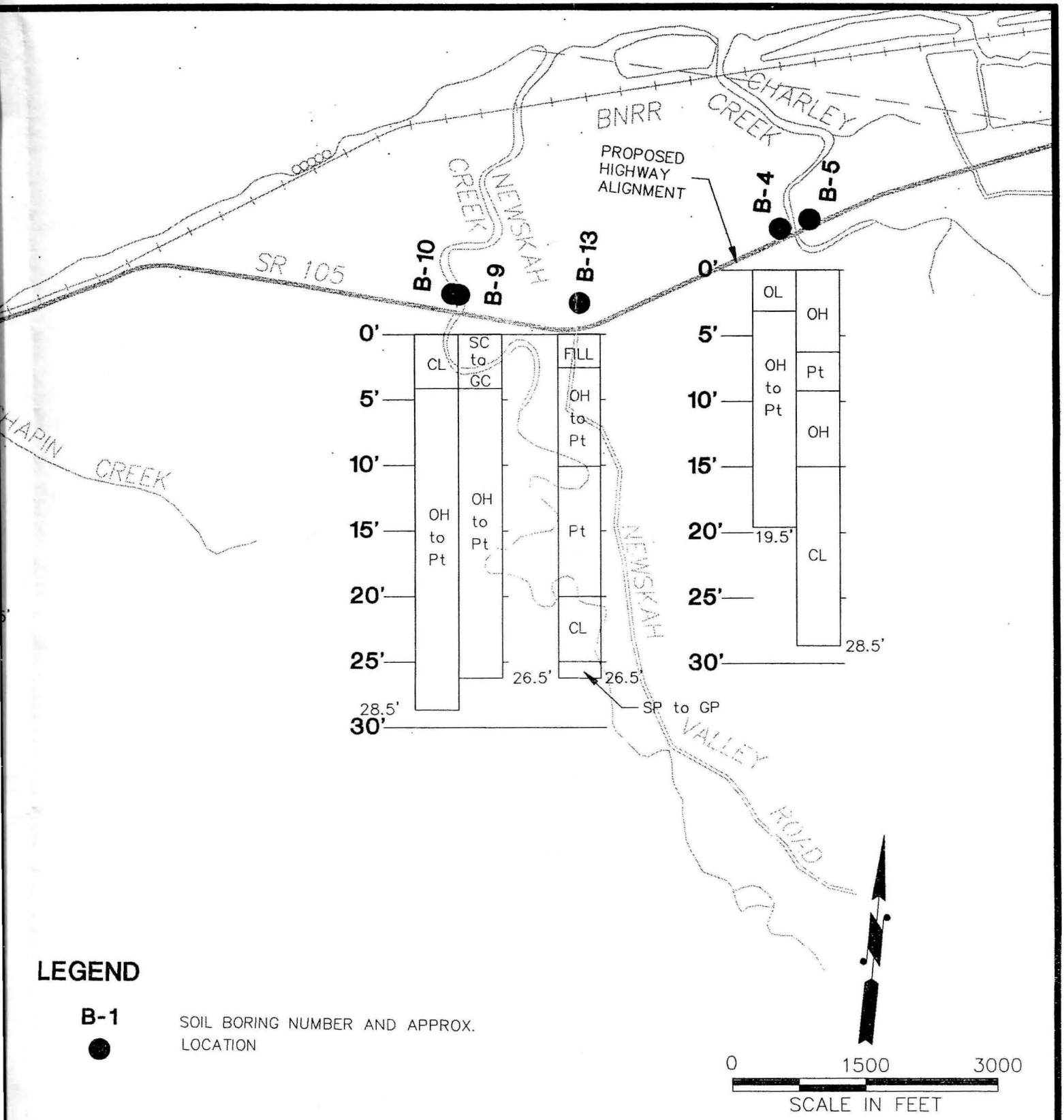
SITE PLAN AND BORING LOCATIONS

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \PROJECTS\21\08424\SITE.DWG



SOURCE: BASE MAP PREPARED FROM A DRAWING BY MURRAY, SMITH & ASSOCIATES, INC., ENTITLED "LOCATION MAP", DATED APRIL 15, 1996.

Ea
747
Por



LEGEND

B-1 ● SOIL BORING NUMBER AND APPROX. LOCATION

FIGURE 3

AGRA
Earth & Environmental
7477 S.W. Tech Center Drive
Portland, OR, U.S.A. 97223-8025

W.O.	6-61M-8424-1
DESIGN	RA
DRAWN	DF
DATE	DEC 1996
SCALE	1"=1500'

PROPOSED UTILITY SERVICES EXTENSION
WASHINGTON STATE DEPT. OF CORRECTIONS
ABERDEEN, WASHINGTON

SECTIONS AT CREEK CROSSINGS

REPORT ADDENDUM
GEOTECHNICAL INVESTIGATION & SOILS REPORT

UTILITIES SERVICE EXTENSION
PROPOSED STATE CORRECTIONAL FACILITY
ABERDEEN, WASHINGTON

Submitted To:

Murray, Smith & Associates, Inc.
121 Southwest Salmon, Suite 1020
Portland, Oregon 97204

Submitted By:

AGRA Earth & Environmental, Inc.
7477 S. W. Tech Center Drive
Portland, Oregon 97223-8025

8-61M-08424-2

April 1998

AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

AGRA Earth & Environmental, Inc.
7477 SW Tech Center Drive
Portland, Oregon
USA 97223-8025
Tel (503) 639-3400
Fax (503) 620-7892

April 16, 1998
8-61M-08424-2

Mr. James Helton, P.E.
Murray, Smith & Associates, Inc.
121 Southwest Salmon, Suite 1020
Portland, Oregon 97204

Dear Mr. Helton:

RE: REPORT ADDENDUM
GEOTECHNICAL INVESTIGATION & SOILS REPORT
UTILITIES SERVICE EXTENSION
PROPOSED STATE CORRECTIONAL FACILITY
ABERDEEN, WASHINGTON

In accordance with your authorization and our proposal, AGRA Earth & Environmental, Inc. (AEE) is pleased to present the results of the supplemental geotechnical investigation for the Utility Service Extension from the City of Aberdeen, Washington to the proposed Stafford Creek Corrections facility.

The emphasis of this study involves geotechnical characterization of the State Route 105 right-of-way. The enclosed report describes the subsurface explorations, laboratory testing, and geotechnical design and construction recommendations for the proposed utility alignment.

We appreciate the opportunity to assist you and look forward to continued involvement on this and other projects. If you have any questions regarding this report or desire further information, please contact the undersigned at your convenience.

Sincerely,

AGRA Earth & Environmental, Inc.

R. Warren Krager, C.E.G.
Senior Engineering Geologist

Stuart Albright, P.E.
Senior Geotechnical Engineer

RWK/klp

8424-2Al&r.wpd

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1.0 PURPOSE AND SCOPE

This report presents the results of a supplemental geotechnical investigation performed by AGRA Earth & Environmental, Inc. (AEE) for the proposed City of Aberdeen - Utility Service Extension to the future Stafford Creek Correctional Facility. This report describes geotechnical conditions within Washington State Route 105 (SR-105) roadway embankment between Charley Creek and Stafford Creek. A previous geotechnical report prepared by AEE, provided subsurface information and design criteria for a proposed utility alignment located on the north side of SR-105 outside of the existing roadway embankment. Because of environmental concerns a utility corridor design alternative is now being considered within the existing SR-105 embankment. This report is an addendum to the report entitled "Geotechnical Investigation and Soils Report, Utilities Service Extension, Proposed State Correctional Facility, Aberdeen Washington, dated December 1996. This addendum report describes subsurface conditions within the south shoulder of SR-105, and design recommendations for utility design and construction within or adjacent to the existing roadway. This report does not void or replace the previous report. Final design should be based on geotechnical recommendations presented in both geotechnical reports.

The scope of work for this project included review of previous geotechnical, and geologic reports for the project area, subsurface explorations, laboratory testing, engineering analyses, and preparation of this report. This report has been prepared for the exclusive use of Murray, Smith & Associates, Inc. (MSA), the City of Aberdeen, and their agents, for specific application to this project in accordance with generally accepted geotechnical engineering practice.

2.0 PROJECT AND SITE DESCRIPTION

The project, as we understand it, is to consist of installation of a water transmission pipeline, a pressurized sewage pipeline, and a gas pipeline. The proposed alignment is located within SR-105 right-of-way between the proposed correctional facility and South Aberdeen. AEE understands that the water line will be installed within the north paved shoulder of SR-105, and the sewer and gas line will be installed within the south shoulder. The water and sewer utility pipe lines are planned to be 12 inches in diameter or less, and will most likely be constructed of ductile iron. The gas line will be installed concurrently with the sewer line in a 42 inch wide trench. The water line will be installed in a separate 30 inch wide trench. All utility lines will be installed at depths greater than 30 inches. At each of six creek crossings the pipelines will be installed through directional drilling techniques to a minimum depth of 20 feet below the level of the creek beds. A 12 to 20 degree angle of entry/exit is required for directional drilling, and each segment of utility line installed in this manor may span approximately 500 lineal feet. Maximum depths of the directional drilling will most likely be on the order of 35 to 40 feet. Trapped air release valves will be installed at each of six creek crossings, and at up to three additional locations along the sanitary sewer pipeline. The air

release valves will require minor embankment construction, part of which will serve as temporary construction pads for direction drilling equipment. Final side slopes of air valve embankment will be graded at slopes of 3 horizontal to 1 vertical (3H:1V). The site location map, and subsurface exploration locations are shown in Figure 1 and Figure 2.

3.0 SUBSURFACE INVESTIGATION

The geotechnical subsurface explorations for this phase of work were conducted within the paved shoulder of the east bound (south) lane of SR-105 between March 23 and March 25, 1998. The subsurface investigation consisted of six shallow borings and one deep boring drilled with a CME-55 truck mounted drill rig using continuous flight hollow stem-auger. The auger borings were followed by 19 air-track drilled test holes conducted under observation of AEE's geologist to characterize depth of roadway embankment material. The exploration locations were selected by representatives of MSA and AEE to provide supplemental geotechnical data for design and utility construction within the existing roadway embankment. The drilling and sampling was directed by a senior engineering geologist from AEE who is familiar with local soil conditions. Descriptive logs of the subsurface explorations are included in Appendix A at the end of this report. Note that the boring numbering sequence for this phase of work starts with boring B-19 to be consistent with the previous boring numbering sequence. The air-track drill probes are designated as AT-1 through AT-19.

Both disturbed and relatively undisturbed samples were obtained from the auger borings in accordance with ASTM D 1586, and ASTM D 1587, respectively. Samples were logged in the field and transported to AEE's geotechnical laboratory for further classification and testing of engineering properties. Geotechnical test results are included in Appendix B at the end of this report. Geotechnical test data for the native soil is generally consistent with laboratory test results presented in our previous report.

4.0 SUBSURFACE CONDITIONS

The soil descriptions are based on the exploratory borings conducted by AEE. The approximate boring locations are shown on Figure 2. Subsurface exploration logs are presented in Appendix A of this report. Soil descriptions and interfaces are based on discrete samples obtained from widely spaced borings, and do not necessarily represent the conditions between borings. The contacts between the observed geologic units are expected to be variable. The boring locations shown on Figure 2 were established by pacing from apparent property boundaries and existing site features, and should be considered approximate.

The general soil profile for the roadway embankment begins with approximately 1½ to 2½ inches of asphaltic concrete pavement. Approximately 6 inches of asphaltic concrete pavement was penetrated in B-19. Underlying the asphaltic concrete pavement the subsurface explorations penetrated dense to medium dense gravelly sand with variable silt to a maximum

depth of approximately 5.5 feet. This material represents road base fill, and the thickness of this layer varies between approximately 2 feet and 5.5 feet.

Underlying the road base fill, native soils consist of soft, wet, silty clay, organic silts, peat, and loose silty sand to sandy silt. These soft to loose fine-grained organic sediments correspond to the younger Quaternary alluvial deposits described in our earlier reports.

In B-22 a layer of medium dense silty sandy gravel with a trace of organics was penetrated between depths 5 and 12 feet. This gravel layer is interpreted to have eroded from the older Quaternary Terrace deposits that form the uplands to the south of the utility alignment. In B-23 a layer of medium dense silty to sandy gravel was noted between depths of 23 and 30 feet, which is also interpreted as weathered Quaternary Terrace deposits.

Below 40 feet in B-23 very dense to hard silty sandy gravel and gravelly sand was encountered. Previous borings (B-7 and B-8, Dec.1996) in the vicinity of Campbell Creek have penetrated dense gravel soils of similar character. AEE interprets this dense gravel strata as that of the older Quaternary Terrace Deposits.

5.0 DISCUSSION

Subsurface conditions within the SR-105 right-of-way appear suitable for support of the proposed utility installation and associated features subject to AEE's design recommendations. The depth of the roadway embankment varies between approximately 2 feet and 5.5 feet. It is anticipated that the proposed utility lines within the roadway will have a minimum of depth of cover 2½ to 3 feet. Therefore, the invert elevation of the pipelines will lie approximately 4 to 5 feet below surface grades, at or below the interface between embankment and native soil. For the most part it should be assumed that required utility trenches will penetrate the roadway embankment fill, and native soils will provide pipe subgrade support. Variable depths of excavation may be employed to eliminate high points in the sewer line to minimize air release valve requirements.

The native Quaternary alluvial and estuarine sediments that are present along the proposed utility alignment can vary significantly over short horizontal and vertical distances. However, based on AEE's work on the project to date it appears that the character of the Quaternary Alluvial deposits is broadly uniform, with minor local variations. Items of geotechnical concern for these shallow alluvial soils include poor pipe foundation support in the soft and/or organic soils, saturated easily disturbed clay and silt soils, control of groundwater during construction, and maintaining the integrity of SR-105 roadway embankment during and after construction.

The following information is provided for use in planning, design, and construction of the utility alignment corridor within existing roadways, and for new embankment required for the project. The information in this report is considered supplemental to design and construction

recommendations provided in AEE's previous report for this project. Both this report and AEE's December, 1996 report should be used for final design.

6.0 DESIGN AND CONSTRUCTION CONSIDERATIONS

6.1 OPEN TRENCH EXCAVATION / BACKFILL

The near-surface fine-grained silty and clayey silt soils contain peat beds, disseminated organic matter, and occasional logs and larger wood debris, including abandoned timber piles at creek crossings. Most of the soils should be easily excavated using conventional excavation techniques. However, logs, timber piles, or other large wood debris and/or other possible obstructions may be encountered within the alluvial deposits. Difficult excavation conditions and possible overexcavation beyond planned trench lines may be required to remove occasional obstructions. Potentially difficult excavation conditions could be encountered in gravels of the Quaternary Terrace deposits in the general vicinity of Campbell Creek. However, based on the subsurface explorations cemented gravels or boulders are not likely to be encountered in the near surface soils.

The existing highway embankment was constructed across the low-lying tidal plain using silty gravelly sand and sandy gravel. Such fills can be relatively sensitive to post construction disturbance. Trench excavation into the shoulders of the existing embankment may be difficult to repair to the original configuration. It is likely that the shoulders of the embankment may need to be reconstructed using imported granular fill. It is possible that some of the existing roadway embankment material may be reused for compacted trench back fill. However, the existing roadway embankment fill at depths greater than two to three feet is expected to be excessively wet and possibly mixed with saturated fine-grained native soil. To avoid potential problems associated with compacting wet silt/clay contaminated soil as trench backfill, AEE recommends removing trench excavation spoils from the work area and stockpiling the material for future reuse as back fill in the pump station portion of the project.

AEE recommends use of a well-graded crushed rock product with no greater than 5% by weight passing the #200 sieve for pipe bedding, trench backfill, and imported structural fill for shoulder reconstruction and additional embankment. Differential settlement between trench backfill and existing embankment may be minimized by the use of well graded granular backfill that has been adequately compacted. Areal settlements in the road grade are dictated by native subgrade soils. After construction trench backfill is not expected to undergo areal settlement in excess of existing embankment.

Structural backfill (above the pipe zone) and new embankment should be placed in two foot or greater horizontal lifts, and surface compacted with a hoe-pack or equivalent method of compaction. Granular structural fills should be compacted to a minimum of 95% of the maximum dry density obtained by test method ASTM D 1557. Care should be taken to avoid

heavy compaction of structural fills within in one foot (vertical) of the moisture sensitive native subgrade. If State of Washington Department of Transportation (WSDOT) construction specifications dictate construct practices within the roadway, AEE recommends against heavy vibratory compaction until two or more feet of fill have been placed above saturated fine-grained subgrade soils.

Where new embankment must be added to the existing roadway shoulders, AEE recommends that the fill be placed by keying and benching into the existing embankment. Figure 3.0 illustrates the recommended key and bench detail for fills built on to existing embankment. Finished slopes should be graded no steeper than 2H:1V.

It is likely that upon trenching, the existing roadway embankment fill will ravel and slough beyond excavation lines. Sloped excavations are recommended to minimize trench sidewall stability problems. Typically, excavation side slopes of between 1/2H:1V to 1H:1V will remain stable for short periods. However, conditions at the time of construction will dictate required trench sidewall slope angles. Trenches should not be left open for extended periods unless OSHA approved shoring methods are employed. For general trench safety guidelines it is recommended that unshored trenches be backfilled before the end of a daily shift. Traffic control, and other construction constraints may require the use of vertical trench sidewalls. Under these conditions, OSHA approved shoring methods should be employed for all trench excavations regardless of depth.

It is likely that runoff from pavements and or seepage from ditches or tidal inlets may enter trenches. It should be the contractor's responsibility to maintain adequate trench dewatering operations. Water must not be allowed to accumulate in excavations. It is anticipated that sumps and dewatering pumps would be sufficient to control water in excavations.

6.2 DIRECTIONAL DRILLING CONSIDERATIONS

The utility installation technique under consideration for the creek crossings involves directional drilling. Directional drilling has recently been used on the Chehalis River force main project with success. The method consists of drilling a small diameter pilot hole with a jetting bit. The pilot hole is then expanded to 125 to 150 percent of the pipeline diameter using a larger bit. The finished pipe is then pulled through the hole utilizing the drill string. The sanitary sewer and gas pipelines constructed through directional drilling will have a horizontal separation of approximately 7 feet. However, possible obstructions may require maneuvering the drill string inside of the planned separation distance.

The principal disadvantage with directional drilling would be the cost, and that the entry and exit angles must be relatively flat. As such, the total length necessary to pass under the creeks may be significant, possibly as much as 400 to 600 lineal feet for each creek crossing. Another consideration for direction drilling is potential for encountering buried logs, abandoned

timber piles and similar obstructions. Other than possible obstructions, subsurface conditions represented in the subsurface explorations are not likely to impede directional drilling. Subsurface conditions in the vicinity of Campbell Creek include gravel soils. However, cobbles, boulders, or cemented conglomerate are not anticipated within the depth of proposed directional drilling. The soft, saturated near-surface soils encountered throughout the proposed utility alignment may pose a possible concern for guiding the directional drill string. Drilling contractors should take into account the low strength soil so that appropriate directional drilling guidance systems may be employed. Drilling mud or polymer additives may also be required to maintain the bore and assist with circulation of cuttings.

7.0 LIMITATIONS

The recommendations in this report are based on information gathered in the office review phase of this investigation and the site conditions observed at the time of field exploration. Final design plans and specifications, particularly final grading plans, should be forwarded to the undersigned when available, so that AEE may evaluate whether any change in concept has affected the validity of the recommendations in AEE's reports, and whether the recommendations have been accurately interpreted.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, or if the project scheme is significantly modified with regard to the type and extent of construction, AEE should be requested to review our reports to reevaluate the conclusions and recommendations considering the lapse of time or changed conditions. Any questions regarding the information presented in this or previous AEE reports prepared for this project may be directed to the undersigned.

AGRA Earth & Environmental, Inc.

R. Warren Krager, C.E.G.
Senior Engineering Geologist

Stuart Albright, P.E.
Associate Geotechnical Engineer

EXPIRES 9/25/98

WK/klp

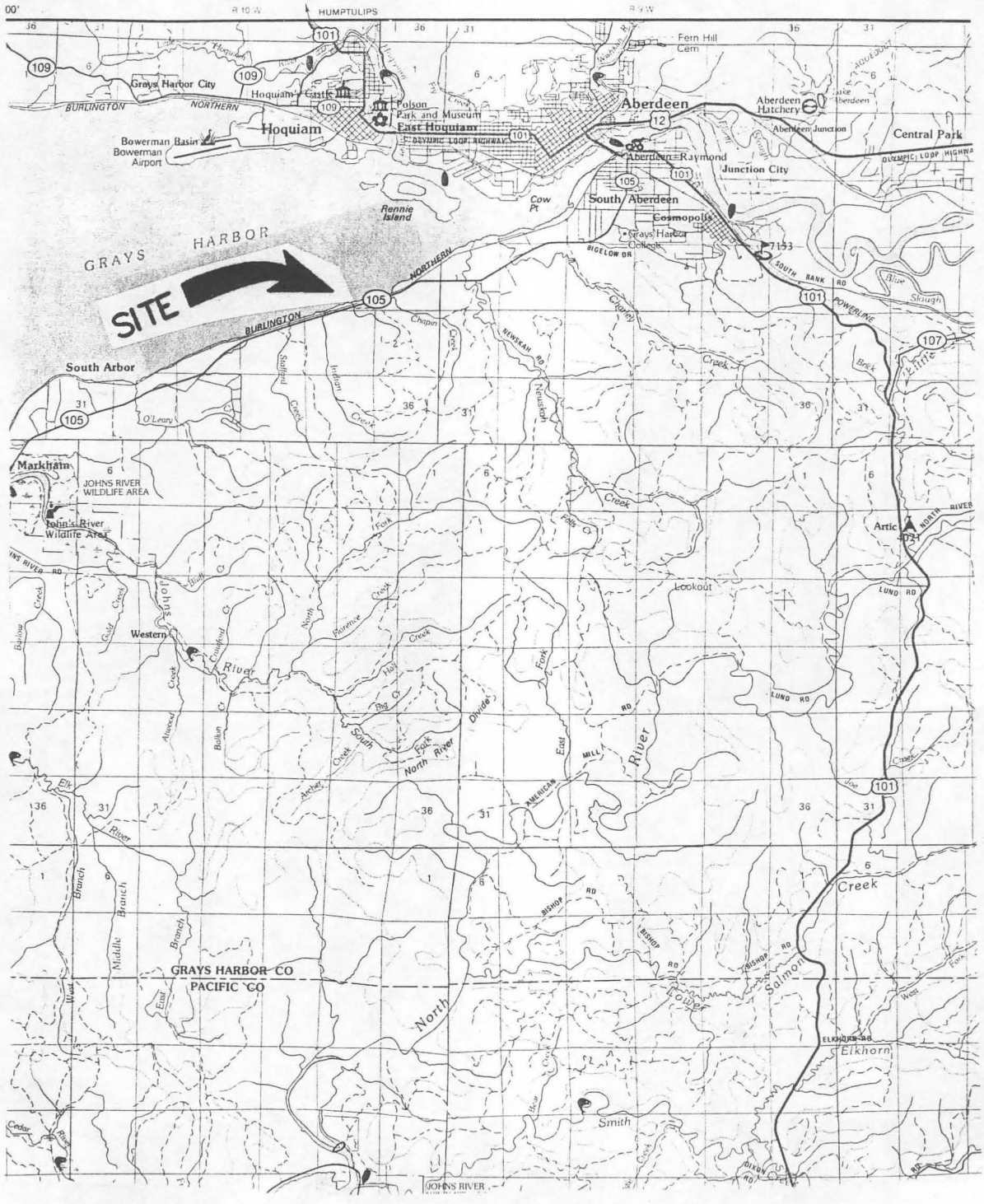


FIGURE 1

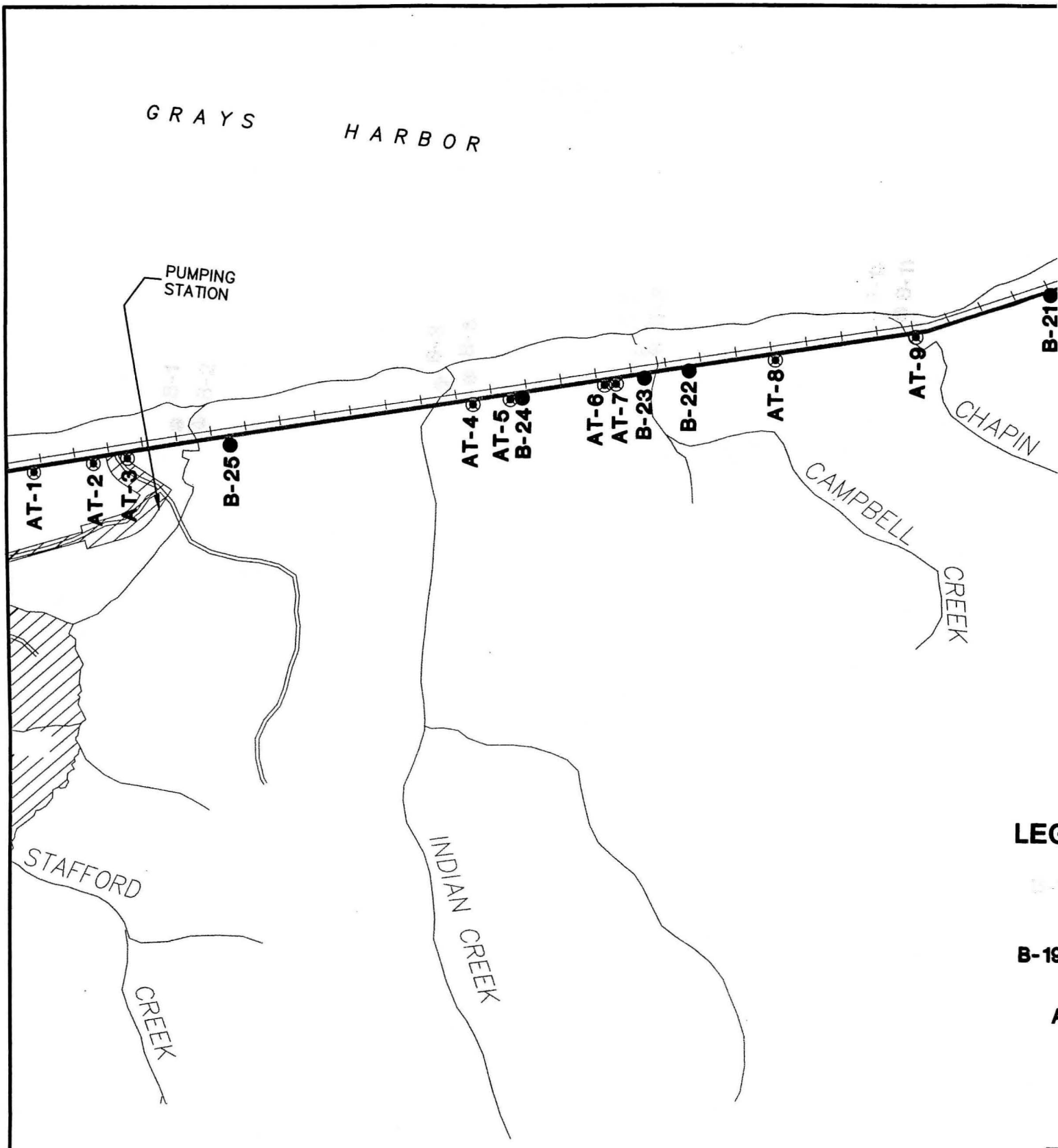
AGRA
Earth & Environmental
7477 S.W. Tech Center Drive
Portland, OR, U.S.A. 97223-8025

W.O.	6-61M-8424-1
DESIGN	RA
DRAWN	DF
DATE	OCT 1996
SCALE	NTS

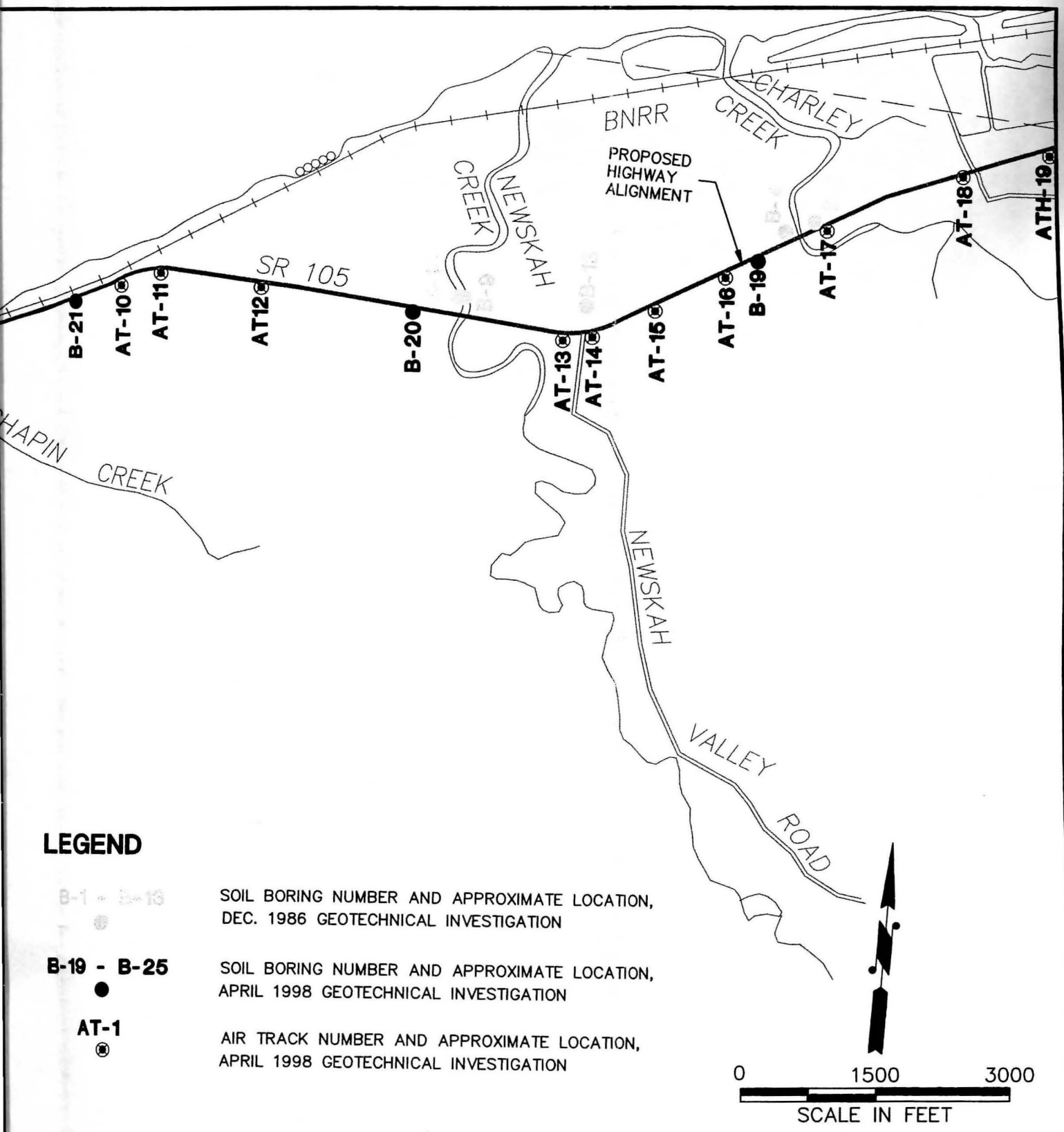
PROPOSED UTILITY SERVICES EXTENSION
WASHINGTON STATE DEPT. OF CORRECTIONS
ABERDEEN, WASHINGTON

SITE LOCATION MAP

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \PROJECTS\21\08424\SITE.DWG



SOURCE: BASE MAP PREPARED FROM A DRAWING BY MURRAY, SMITH & ASSOCIATES, INC., ENTITLED "LOCATION MAP", DATED APRIL 15, 1996.



LEGEND

B-1 - B-13 — SOIL BORING NUMBER AND APPROXIMATE LOCATION, DEC. 1986 GEOTECHNICAL INVESTIGATION

B-19 - B-25 — SOIL BORING NUMBER AND APPROXIMATE LOCATION, APRIL 1998 GEOTECHNICAL INVESTIGATION

AT-1 — AIR TRACK NUMBER AND APPROXIMATE LOCATION, APRIL 1998 GEOTECHNICAL INVESTIGATION

FIGURE 2

AGRA
Earth & Environmental
7477 S.W. Tech Center Drive
Portland, OR, U.S.A. 97223-8025

W.O.	6-61M-8424-2
DESIGN	RWK
DRAWN	DRF
DATE	APR. 1998
SCALE	1"=1500'

PROPOSED UTILITY SERVICES EXTENSION
WASHINGTON STATE DEPT. OF CORRECTIONS
ABERDEEN, WASHINGTON

SECTIONS AT CREEK CROSSINGS

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \PROJECTS\21\08424\ADDITIONS.DWG

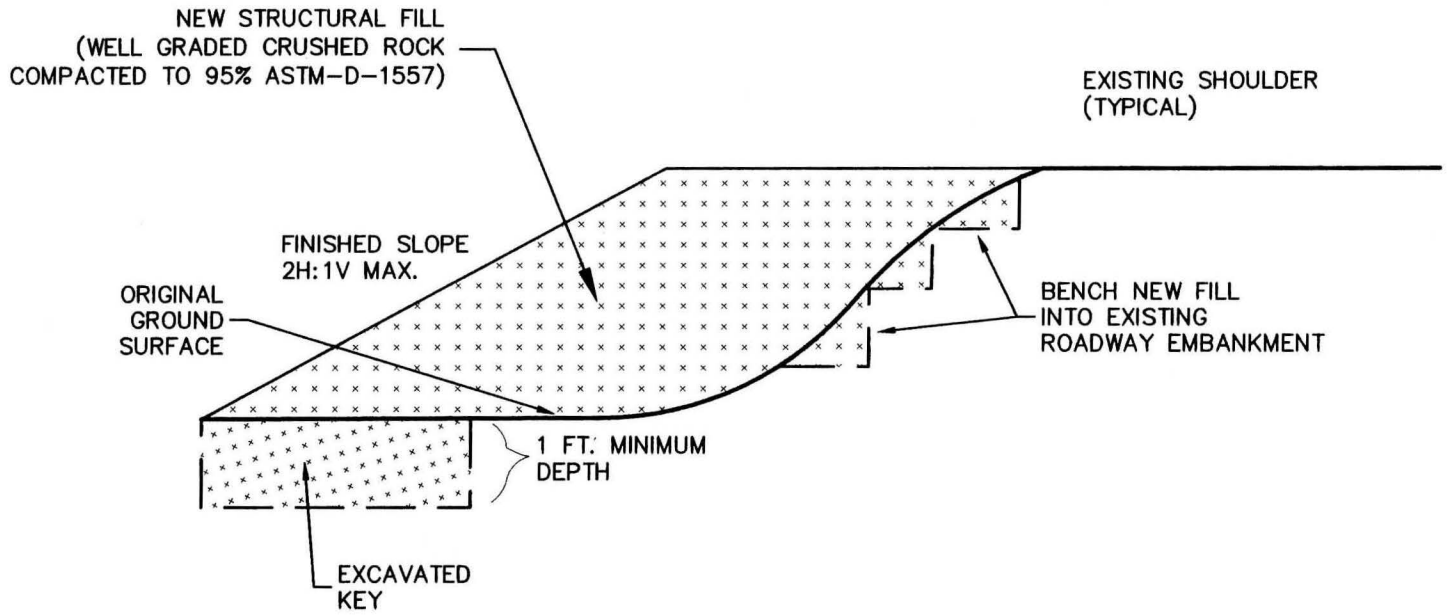


FIGURE 3

AGRA
Earth & Environmental
7477 S.W. Tech Center Drive
Portland, OR, U.S.A. 97223-8025

W.O.	8-61M-8424-2
DESIGN	RWK
DRAWN	DRF
DATE	APR. 1998
SCALE	

PROPOSED UTILITY SERVICES EXTENSION
WASHINGTON STATE DEPT. OF CORRECTIONS
ABERDEEN, WASHINGTON

KEYED AND BENCHED SLOPE FILL

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \PROJECTS\21\08424\SLOPE-FILL.DWG

APPENDIX A

Subsurface Explorations

PROJECT: Aberdeen-Stafford Creek Sewer Alignment PROJECT NUMBER: 8-61M-08424-02

Boring Number: B-19

Boring Method: Hollow Stem Auger
Borehole Diameter: 8.0"
Approximate Elevation: 14.0 Feet

DEPTH (FEET) | SOIL TYPE LOG | GROUNDWATER | SAMPLES | STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop)) | SOIL DESCRIPTION

0

6.0-inch layer of asphalt over dense to medium dense, damp to moist, brown, silty sandy GRAVEL (road shoulder FILL).

S-1

Soft, wet, mottled orange-tan, silty CLAY.

5

S-2

S-3

Very soft to soft, wet, gray, silty CLAY with some organics.

WD

S-4 =78.2

10

S-5 P

PEAT and wood debris at 13.0-14.0 feet.

=78.3

15

S-6 P

Boring terminated at 16.5 feet bgs.

20

25

30

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- WD Groundwater level at time of drilling
- P Sampler pushed
- • % moisture content

AEE Project Number: 8-61M-08424-02

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH & ENVIRONMENTAL, INC.
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 3/23/98 **Drilling Completed: 3/23/98** **Logged By: HWB** a:\8424\8424B19.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 8-61M-08424-02**

Boring Number: B-20

Boring Method: Hollow Stem Auger
Borehole Diameter: 8.0"
Approximate Elevation: 14.5 Feet

DEPTH (FEET) | SOIL TYPE LOG | GROUNDWATER | SAMPLES | STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop); 10 20 30 40)

SOIL DESCRIPTION

0 — 1.5-inch layer of asphalt over dense to medium dense, brown, silty sandy GRAVEL (road shoulder FILL). — S-1

Soft to medium stiff, wet, slightly orange mottled tan, fine sandy SILT with some clay and trace organics. — S-2

5 — S-3

Medium dense, moist to wet, mottled orange-tan, silty fine- to medium-grained SAND with some clay and trace gravel. — S-4

10 — SILT lense at 11.5 feet. — WD S-5

Becoming wet to saturated.

Becoming burnt orange. — S-6

15 — Medium stiff, wet, tan, sandy SILT with some clay and trace gravel.

Becoming gray.

Boring terminated at 16.5 feet bgs.

20

25

30

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- • % moisture content
- WD Groundwater level at time of drilling

AEE Project Number: 8-61M-08424-02

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH & ENVIRONMENTAL, INC.
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 3/23/98 **Drilling Completed: 3/23/98** **Logged By: HWB** a:\8424\8424B20.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 8-61M-08424-02**

Boring Number: B-21

Boring Method: Hollow Stem Auger
Borehole Diameter: 8.0"
Approximate Elevation:

DEPTH (FEET) | SOIL TYPE LOG | GROUNDWATER | SAMPLES | STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop))

DEPTH (FEET)	SOIL DESCRIPTION	SAMPLES
0	2.5-inch layer of asphalt over dense to medium dense, damp to moist, brown, silty sandy GRAVEL (road shoulder FILL).	S-1
5	Soft, wet, gray, silty CLAY with some organics.	S-2
	Very loose, wet to saturated, orange-tan, silty fine- to medium-grained SAND with some clay.	WD S-3
10	SILT lense at 10.2 feet.	S-4
	Becoming gray.	S-5
	PEAT lense at 13.5-14.0 feet.	
15	Interbedded very loose, saturated, medium gray, silty fine-grained SAND with very soft, wet, dark brown, organic clayey SILT and PEAT.	S-6
	Boring terminated at 16.5 feet bgs.	
20		
25		
30		

=66.0

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- WD Groundwater level at time of drilling
- • % moisture content
- * Sample not recovered

AEE Project Number: 8-61M-08424-02

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH & ENVIRONMENTAL, INC.
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 3/23/98 **Drilling Completed: 3/23/98** **Logged By: HWB** a:\8424\8424B21.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment PROJECT NUMBER: 8-61M-08424-02

Boring Number: B-22

Boring Method: Hollow Stem Auger
Borehole Diameter: 8.0"
Approximate Elevation: 15.0 Feet

DEPTH (FEET) | SOIL TYPE LOG | GROUNDWATER | SAMPLES | STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop); 10 20 30 40)

SOIL DESCRIPTION

0 — 2.0-inch layer of asphalt over dense to medium dense, damp to moist, brown, silty sandy GRAVEL (road shoulder FILL). — S-1

5 — S-2

WD — Medium dense, saturated, gray, silty sandy GRAVEL with trace organics. — S-3

10 — S-4

S-5

15 — Very soft, wet to saturated, dark gray, silty CLAY with some sand and organics. — S-6 P

Boring terminated at 16.5 feet bgs.

20

25

30

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- WD — Groundwater level at time of drilling
- P — Sampler pushed
- • — % moisture content

AEE Project Number: 8-61M-08424-02

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH & ENVIRONMENTAL, INC.
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 3/23/98 **Drilling Completed: 3/23/98** **Logged By: HWB** a:\8424\8424B22.DRW

PROJECT: Aberdeen-Stafford Creek Sewer PROJECT NUMBER: 8-61M-08424-02 PAGE 1

Boring Number: B-23

Boring Method: Hollow Stem Auger
Borehole Diameter: 8.0"
Approximate Elevation: 15.0 Feet

DEPTH (FEET)	SOIL DESCRIPTION
0	1.5-inch layer of asphalt over dense to medium dense, moist, brown, silty sandy GRAVEL to gravelly SAND (road base FILL).
	Stiff, wet, tan, clayey SILT with trace gravel.
5	Very soft, wet, gray, CLAY with concentrated pockets of PEAT.
10	PEAT in top of sampler.
	Loose, saturated, gray, silty fine- to medium-grained SAND with trace gravels and organics.
15	Loose, saturated, mottled orange-tan-gray, silty fine- to medium-grained SAND with some clay.
20	Soft, wet, mottled orange-tan-gray, silty CLAY.
	Very soft, wet to saturated, bluish gray CLAY.
25	Medium dense, saturated, bluish gray, silty sandy GRAVEL with trace to some clay.
30	

SOIL TYPE LOG | GROUNDWATER | SAMPLES | STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop); 10 20 30 40)

S-1 S-2 S-3 S-4 P S-5 S-6 S-7 S-8

WD

●=59.7

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- WD Groundwater level at time of drilling
- P Sampler pushed
- • % moisture content
- * Sample not recovered

AEE Project Number: 8-61M-08424-02

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

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7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 3/24/98 **Drilling Completed:** 3/24/98 **Logged By:** HWB a:\8424\8424B23.DRW

Boring Number: B-23

Boring Method: Hollow Stem Auger
Borehole Diameter: 8.0"
Approximate Elevation: 15.0 Feet

DEPTH (FEET) | SOIL TYPE LOG | GROUNDWATER | SAMPLES | STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop); 10 20 30 40)

SOIL DESCRIPTION

30 — GRAVEL lense at contact.

Medium stiff, wet, gray CLAY with PEAT fibers and trace carbon organics throughout.

S-9

35 — S-10

Medium dense, saturated, gray, fine- grading downward to coarse-grained SAND with some sand.

40 — S-11 ▲>50

Very dense, saturated, greenish gray, silty sandy GRAVEL.

Very dense, wet, orange-tan, silty sandy GRAVEL to gravelly SAND. Blow count overstated due to gravel in tip of sampler.

45 — S-12 ▲>50

Boring terminated at 45.5 feet bgs.

50

55

60

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- WD — Groundwater level at time of drilling
- P — Sampler pushed
- • — % moisture content
- * — Sample not recovered

AEE Project Number: 8-61M-08424-02

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH & ENVIRONMENTAL, INC.
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 3/24/98 **Drilling Completed:** 3/24/98 **Logged By:** HWB a:\8424\B23PG2.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 8-61M-08424-02**

Boring Number: B-24

Boring Method: Hollow Stem Auger
Borehole Diameter: 8.0"
Approximate Elevation: 22.0 Feet

DEPTH (FEET) | SOIL TYPE LOG | GROUNDWATER | SAMPLES | STANDARD PENETRATION RESISTANCE (▲ Blows per foot(140 lb. hammer/30" drop); 10 20 30 40)

SOIL DESCRIPTION

0 ft — 2.0-inch layer of asphalt over dense to medium dense, damp to moist, brown, silty sandy GRAVEL (road base FILL). — S-1

Medium stiff, wet, gray CLAY with some black organics throughout. — S-2, S-3, S-4

=62.2

5 ft — Blow count overstated; drove SPT over lost Shelby sample.

10 ft — S-5, S-6

Medium stiff to stiff, wet, gray, clayey SILT with trace organics. — S-7

15 ft — Boring terminated at 16.5 feet bgs.

20 ft

25 ft

30 ft

LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- 3.0" O.D. undisturbed sampler with percent recovered
- • % moisture content
- * Sample not recovered

AEE Project Number: 8-61M-08424-02

Aberdeen-Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

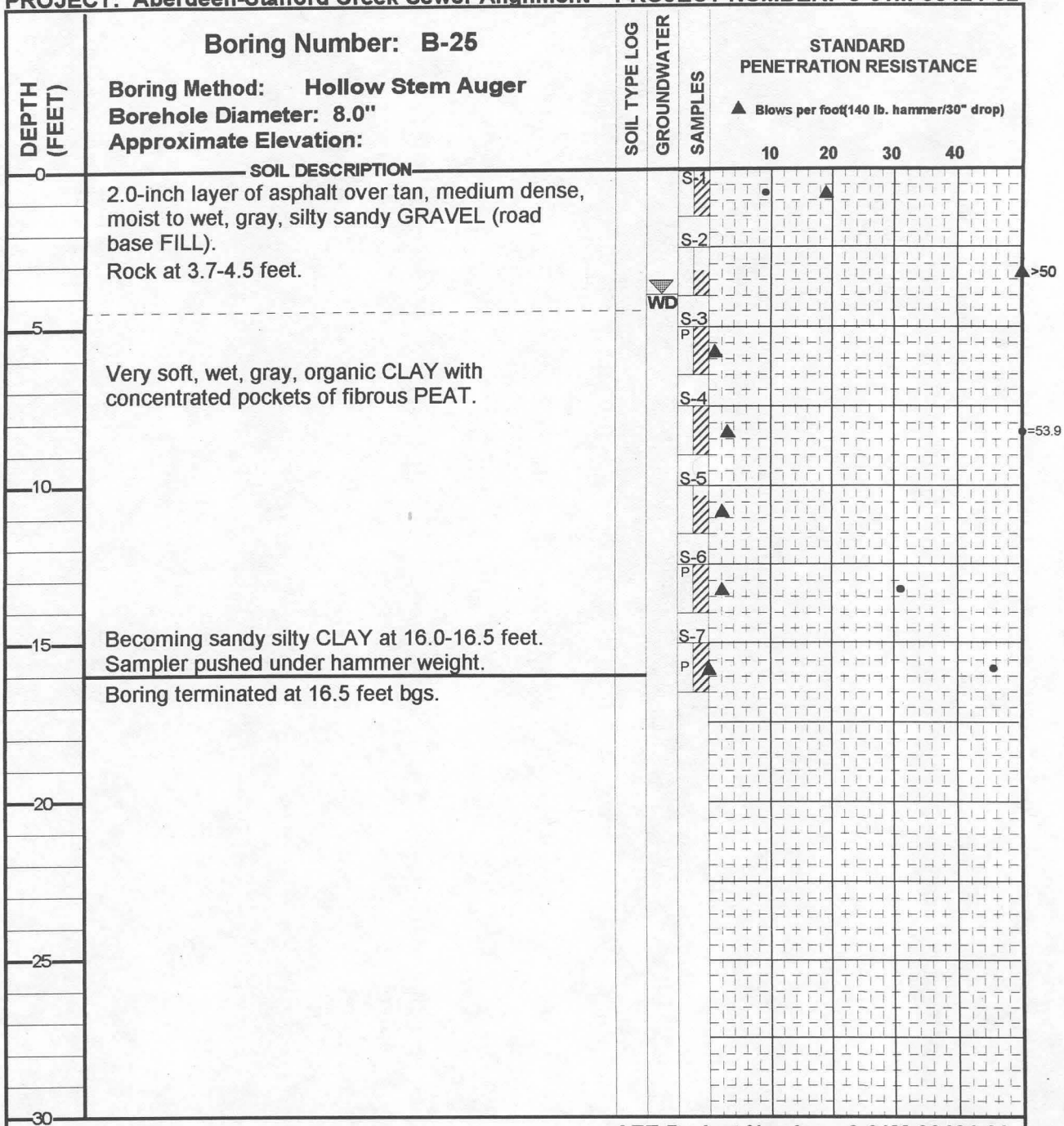
AGRA EARTH & ENVIRONMENTAL, INC.
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 3/24/98 **Drilling Completed: 3/24/98** **Logged By: HWB** a:\8424\8424B24.DRW

PROJECT: Aberdeen-Stafford Creek Sewer Alignment **PROJECT NUMBER: 8-61M-08424-02**

Boring Number: B-25

Boring Method: Hollow Stem Auger
Borehole Diameter: 8.0"
Approximate Elevation:



LEGEND

- 2.0" O.D. split spoon sampler with percent recovered
- P Sampler pushed
- • % moisture content
- WD Groundwater level at time of drilling

AEE Project Number: 8-61M-08424-02

Aberdeen-Stafford Creek
Sewer Alignment
SR105
Aberdeen, Washington

AGRA EARTH & ENVIRONMENTAL, INC.
7477 S.W. Tech Center Drive
Portland, Oregon 97223-8025
Phone: (503) 639-3400 Fax: (503) 620-7892

Drilling Started: 3/24/98 **Drilling Completed: 3/24/98** **Logged By: HWB** a:\8424\8424B25.DRW

Air Track Test Boring Number: AT-1

Elevation: 14.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	Medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
	Soft, wet, gray, clayey SILT with some organics.					
5	Wood log or stump.					
	Very soft to soft, wet, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

Air Track Test Boring Number: AT-2

Elevation: 14.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	Medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
	Very soft to soft, wet, gray, clayey SILT with some organics.					
5	Wood log or stump.					
	Air track test boring terminated at 7.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

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PROJECT NUMBER: 8-61M-08424-02
Aberdeen - Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

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Air Track Test Boring Number: AT-3

Elevation: 14.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	2.0-inch layer of asphalt over medium dense to dense, moist, tan, silty, gravelly SAND (road shoulder FILL).					
5	Medium dense, moist to wet, gray, silty, gravelly SAND (road shoulder FILL).					
	Very soft to soft, wet, gray, clayey SILT with some organics.					
10	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
15						

Air Track Test Boring Number: AT-4

Elevation: 21.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	3.0-inch layer of asphalt over medium dense to dense, moist to wet, gray, silty, gravelly SAND (road shoulder FILL).					
5	Loose/soft, wet, gray, silty, gravelly SAND and clayey SILT with some organics.					
	Very soft to soft, wet, gray, clayey SILT with some organics.					
10	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
15						

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Aberdeen - Stafford Creek Sewer Alignment
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Aberdeen, Washington

a:\8424\8424AT3.DRW

Air Track Test Boring Number: AT-5

Elevation: 22.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	Medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
5	Loose to medium dense, wet, gray, silty, gravelly SAND (road shoulder FILL).					
	Very soft to soft, wet, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

Air Track Test Boring Number: AT-6

Elevation: 18.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	3.0-inch layer of asphalt over medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
5	Soft to medium stiff, wet, mottled orange-tan, sandy SILT to clayey SILT.					No cuttings at 6.0-8.0 feet.
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

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Aberdeen - Stafford Creek Sewer Alignment
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Aberdeen, Washington

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Air Track Test Boring Number: AT-7

Elevation: 17.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	Medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
	Medium dense, wet, gray, silty, gravelly SAND (road shoulder FILL).					
5	Very soft to soft, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

Air Track Test Boring Number: AT-8

Elevation: 14.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	1.5-inch layer of asphalt over medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
	Medium dense, wet, gray, silty, gravelly SAND (road shoulder FILL).					
5	Very soft to soft, wet, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

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Aberdeen - Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

a:\8424\8424AT7.DRW

Air Track Test Boring Number: AT-9

Elevation: 15.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	3.0-inch layer of asphalt over medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
5	Medium dense, wet, gray, silty, gravelly SAND (road shoulder FILL).					
	Very soft to soft, wet, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

Air Track Test Boring Number: AT-10

Elevation: ~13.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	2.0-inch layer of asphalt over medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
	Medium dense, wet, gray, silty, gravelly SAND (road shoulder FILL).					
5	Very soft to soft, wet, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

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PROJECT NUMBER: 8-61M-08424-02
Aberdeen - Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

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Air Track Test Boring Number: AT-11

Elevation: 12.5 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	Medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
5	Very soft to soft, wet, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

Air Track Test Boring Number: AT-12

Elevation: 13.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	2.0-inch layer of asphalt over medium dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
5	Very soft to soft, wet, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

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Portland, Oregon 97223-8025
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Aberdeen - Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

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Air Track Test Boring Number: AT-13

Elevation: 15.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	5.0-inch layer of asphalt over medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
5	Medium dense, wet, gray, silty, gravelly SAND (road shoulder FILL).					
	Very soft to soft, wet, gray, clayey SILT with some organics.					Groundwater was not encountered.
10	Air track test boring terminated at 8.0 feet below existing grade.					
15						

Air Track Test Boring Number: AT-14

Elevation: 16.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	Medium dense to dense, moist to wet, dark tan, silty, gravelly SAND (road shoulder FILL).					
5	Very soft to soft, wet, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

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Aberdeen - Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

a:\8424\8424AT13.DRW

Air Track Test Boring Number: AT-15

Elevation: 15.0-16.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	4.5-inch layer of asphalt over medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
5	Loose, wet, dark tan, silty, gravelly SAND (road shoulder FILL) and soft, wet, gray, clayey SILT with some organics.					
	Very soft to soft, wet, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

Air Track Test Boring Number: AT-16

Elevation: 14.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	4.5-inch layer of asphalt over medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
5	Loose, wet, tan, silty, gravelly SAND (road shoulder FILL) and soft, wet, gray, clayey SILT with some organics.					
	Very soft to soft, wet, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

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PROJECT NUMBER: 8-61M-08424-02
Aberdeen - Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

a:\8424\8424AT15.DRW

Air Track Test Boring Number: AT-17

Elevation: 14.0 Feet

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	Medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
	Loose/soft, wet, gray, silty, gravelly SAND (road shoulder FILL) and clayey SILT with some organics.					
5	Very soft to soft, wet, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

Air Track Test Boring Number: AT-18

Elevation:

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	3.5-inch layer of asphalt over medium dense to dense, moist to wet, tan, silty, gravelly SAND (road shoulder FILL).					
5	Very soft to soft, wet, gray, clayey SILT with some organics.					
	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
10						
15						

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PROJECT NUMBER: 8-61M-08424-02
Aberdeen - Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

a:\8424\8424AT17.DRW

Air Track Test Boring Number: AT-19

Elevation:

Date:

Logged By: HWB

Depth (feet)	SOIL DESCRIPTION	Sample	Ground Water	% Moisture Content	Sample Type or Test	Comments
0	1.0-inch layer of asphalt over medium dense to dense, moist, tan, silty, gravelly SAND (road shoulder FILL).					
5	Medium dense, moist, tan, silty fine- to medium-grained SAND with some gravel (road shoulder FILL).					
	Soft, wet, clayey SILT with some organics.					
10	Air track test boring terminated at 8.0 feet below existing grade.					Groundwater was not encountered.
15						

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Phone (503) 639-3400 FAX (503) 620-7892

PROJECT NUMBER: 8-61M-08424-02
Aberdeen - Stafford Creek Sewer Alignment
SR105
Aberdeen, Washington

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APPENDIX B

Geotechnical Test Results

MOISTURE CONTENT & INPLACE DENSITY

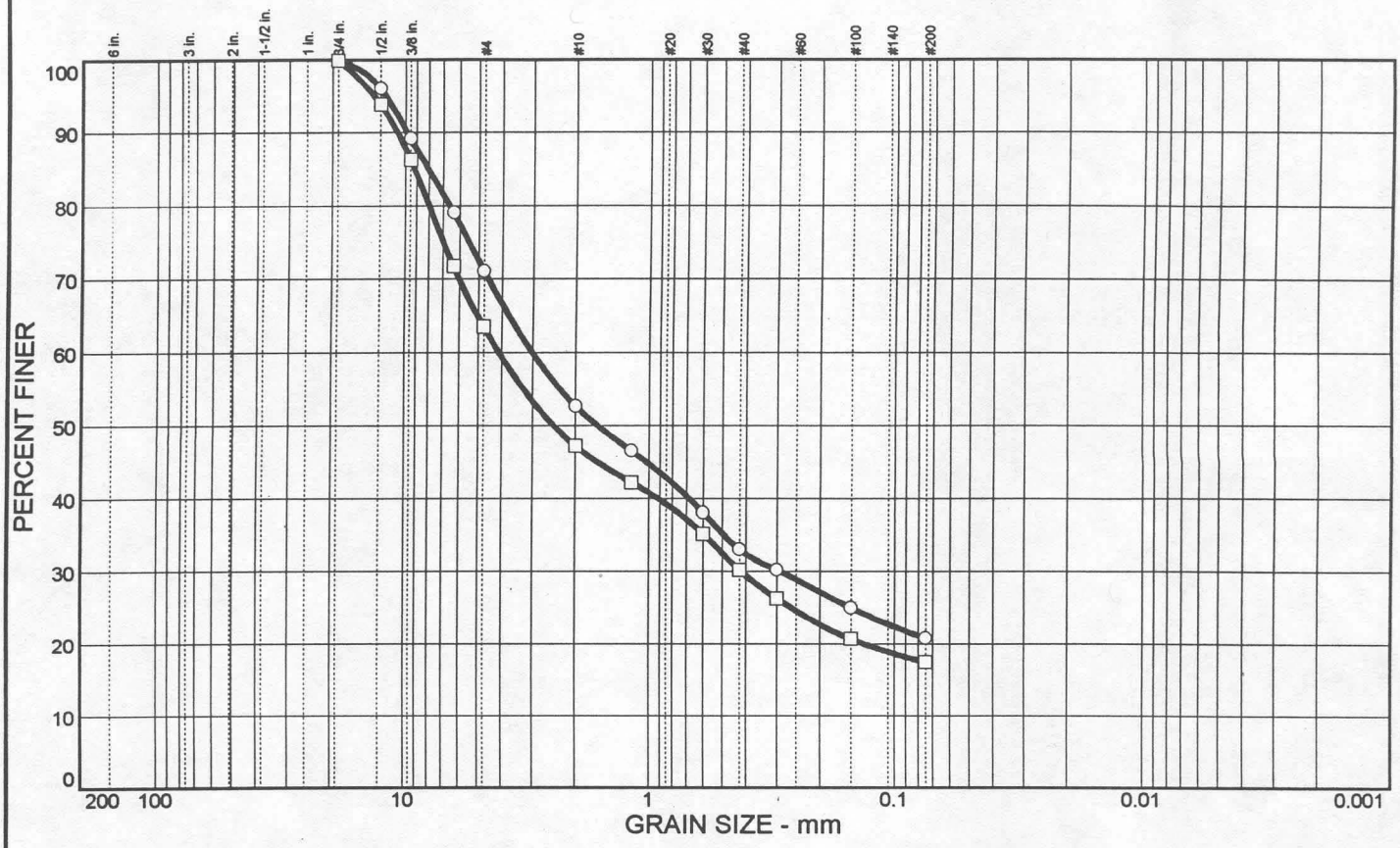
Job Name: Aberdeen-Stafford Creek Sewer Alignment
Job Number: 8-61M-08424-02
Date: 4-8-98

Exploration:	B-19	B-19	B-=19	B-19	B-19	B-20	B-20	B-20	B-20	B-21
Sample Number:	S-1	S-2	S-3	S-5B	S-6B	S-1	S-2	S-4	S-6	S-1
Depth:	2.5-4.0'	5.0-6.5'	7.5-9.5'	14.0'	16.5'	2.5-4.0'	5.0-6.5'	15.0-16.5'	15.0-16.5'	2.5-4.0'
Wet weight:										
Dia. of sample:										
Length of Sample:										
Volume (cf):										
Wet Density:										
Dry Density:										
-#200 Wash							42%			
Wet sample + tare:	88	66	67	40	102	59	76	67	85	108
Dry sample + tare:	67	46	37	23	73	42	54	49	60	97
Water:	21	20	30	18	29	18	22	17	25	11
Tare:	0	0	0	0	0	0	O	0	0	0
Moisture Content:	31%	43%	80%	78%	39%	43%	41%	36%	42%	12%

Exploration:	B-21	B-21	B-21	B-21	B-22	B-22	B-22	B-22	B-22	B-23
Sample Number:	S-4	S-5A	S-5B	S-6	S-1	S-2	S-3	S-6	S-1	S-5
Depth:	10.0-11.5'	12.5'	14.0'	15.0-16.5'	2.5-4.0'	5.0-6.5'	7.5-9.5'	15.0-16.5'	2.5-4.0'	12.5-14.0'
Wet weight:										
Dia. of sample:										
Length of Sample:										
Volume (cf):										
Wet Density:										
Dry Density:										
-#200 Wash	15			50						42
Wet sample + tare:	112	73	52	61	84	63	55	70	64	73
Dry sample + tare:	81	56	31	47	71	51	39	55	46	46
Water:	31	17	21	14	13	12	16	16	18	27
Tare:	0	0	0	0	0	0	0	0	0	0
Moisture Content:	38%	30%	66%	30%	18%	23%	41%	29%	39%	60%

Exploration:	B-23	B-23	B-23	B-24	B-24	B-24	B-25	B-25	B-25	B-25
Sample Number:	S-7	S-10	S-12	S-1	S-2	S-7	S-1	S-4	S-6	S-7
Depth:	20.0-21.5'	35.0-36.5'	45.0-46.5'	0.2-1.7'	2.5-4.0'	15.0-16.5'	0.2-1.7'	7.5-9.0'	12.5-14.0'	15.0-16.5'
Wet weight:										
Dia. of sample:										
Length of Sample:										
Volume (cf):										
Wet Density:										
Dry Density:										
				21				18		
Wet sample + tare:	82	78	91	91	60	68	106	57	75	79
Dry sample + tare:	66	56	80	84	37	49	97	37	57	54
Water:	16	22	12	7	23	20	9	20	18	25
Tare:	0	0	0	0	0	0	0	0	0	0
Moisture Content:	24%	40%	15%	8%	62%	40%	9%	54%	31%	46%

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		28.9	50.3			SP/GM	na	na	na
□		36.5	46.0			SP/GM	na	na	na

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □
.75	100.0	100.0
.5	96.1	93.9
.375	89.2	86.3
.25	79.1	71.8
GRAIN SIZE		
D_{60}	3.01	4.11
D_{30}	0.291	0.419
D_{10}		
COEFFICIENTS		
C_c		
C_u		

SIEVE number size	PERCENT FINER ○	PERCENT FINER □
#4	71.1	63.5
#10	52.7	47.2
#16	46.5	42.2
#30	38.1	35.2
#40	33.0	30.2
#50	30.2	26.3
#100	25.0	20.7
#200	20.8	17.5

SOIL DESCRIPTION

○ Brwn silty gravelly sand (MC:8.05)

□ Grey silty gravelly sand (MC:9.1%)

REMARKS:

○ Tested by: JB
Reviewed by: ML

□ Tested by: JB
Reviewed by: ML

○ Source: B-24 Sample No.: S-1 Elev./Depth: 0.2-1.7'

□ Source: B-25 Sample No.: S-1 Elev./Depth: 0.2-1.7'

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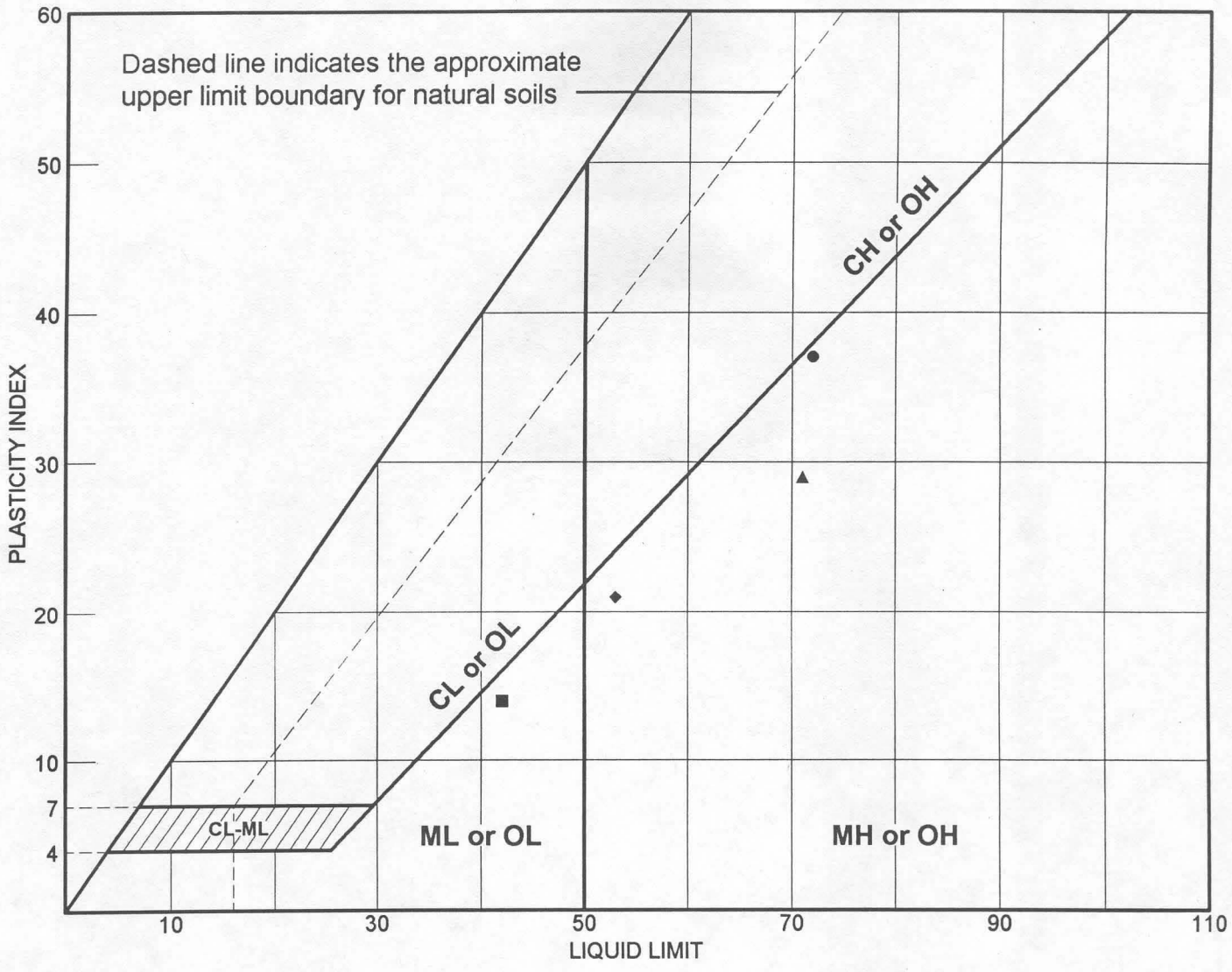
Client: AGRA / PORTLAND

Project: ABERDEEN-STAFFORD CREEK SEWER ALIGNMENT

Project No.: 8-61M-08424-02 Plate

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-19	S-3	7.5-9.5'	78.2%	35	72	37	ML
■	B-20	S-1	2.5-4.0'	43.1%	28	42	14	MH
▲	B-22	S-3	7.5-9.5'	40.6%	42	71	29	MH/OH
◆	B-24	S-2	2.5-4.0'	62.2%	32	53	21	MH

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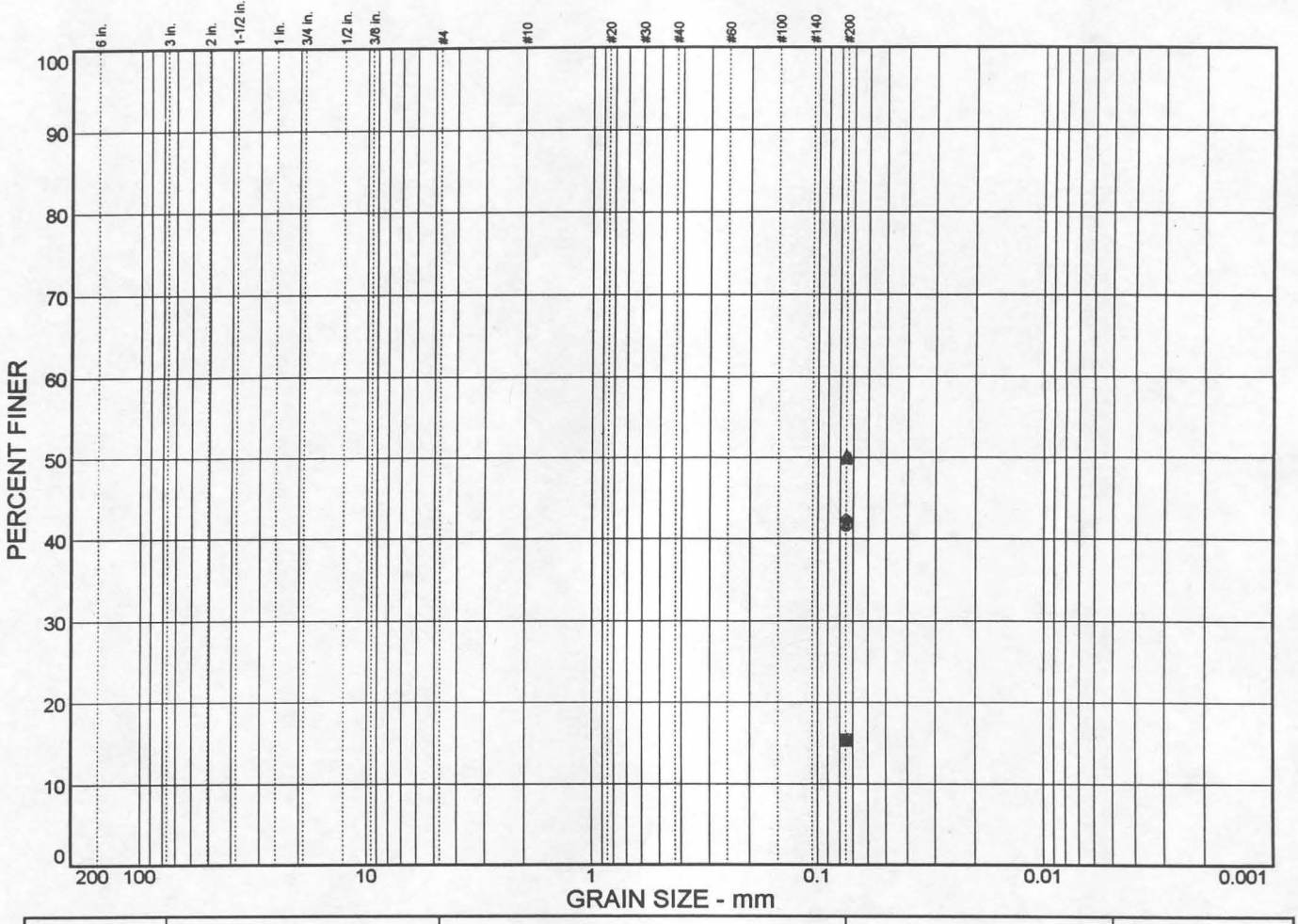
Project No.: 8-61M-08424-02 **Plate**

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○				41.6	
□				15.4	
△				50.2	
◇				42.3	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-20	S-2	5.0-6.5'	Lt brwn silty sand (MC:40.8%)	SM
□	B-21	S-4	10.0-11.5'	Grey silty sand (MC:38.1%)	SM
△	B-21	S-6	15.0-16.5'	Dk brwn sandy silt/silty sand (MC:30.4%)	ML/SM
◇	B-23	S-5	12.5-14.0'	Dk grey silty sand trc grvl /organics noted (MC:59.7%)	SM

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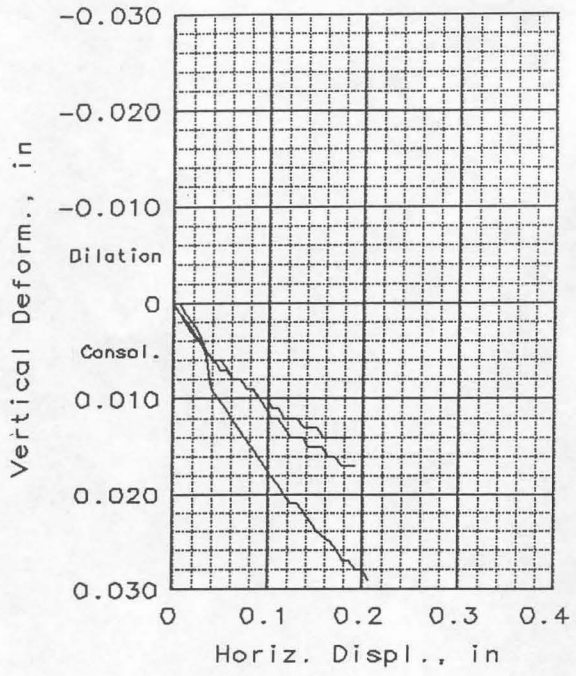

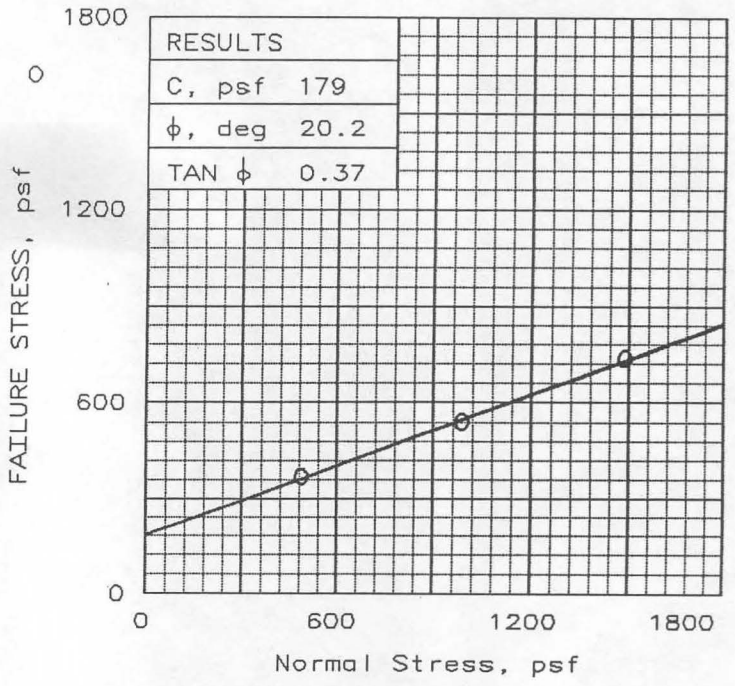

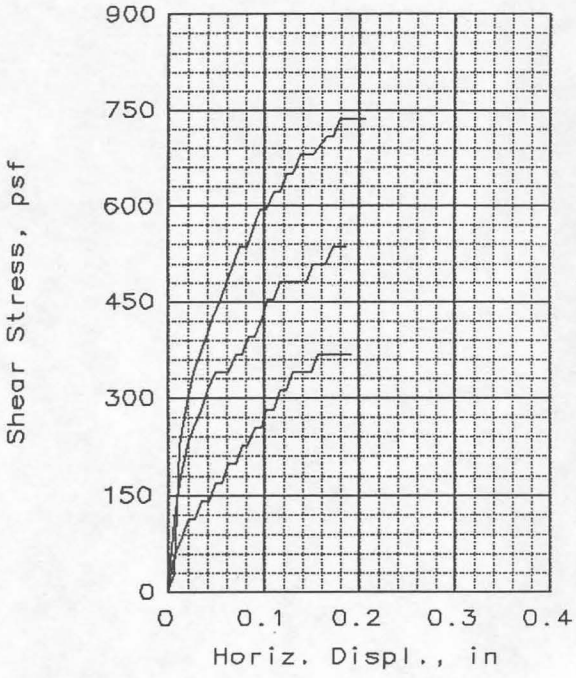

SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	78.9	71.2	80.4
	DRY DENSITY, pcf	47.8	52.9	49.1
	SATURATION, %	84.9	88.8	90.0
	VOID RATIO	2.464	2.126	2.370
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	1.00	1.00	1.00
AT TEST	WATER CONTENT, %	75.9	68.1	80.4
	DRY DENSITY, pcf	55.0	59.0	52.6
	SATURATION, %	100.0	100.0	99.4
	VOID RATIO	2.010	1.804	2.144
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.87	0.90	0.93
NORMAL STRESS, psf		1500	1000	500
FAILURE STRESS, psf		736	538	368
DISPLACEMENT, in		0.21	0.17	0.16
ULTIMATE STRESS, psf		736	538	368
DISPLACEMENT, in		0.18	0.17	0.17
Strain rate, %/min		0.50	0.50	0.50

SAMPLE TYPE: Shelby Tube
DESCRIPTION: Dk Grey Clayey Silt
LL= 72 PL= 35 PI= 37
SPECIFIC GRAVITY= 2.65
REMARKS: Tested by: ML
Reviewed by: ML

Fig. No.: _____

CLIENT: AGRA / PORTLAND

PROJECT: ABERDEEN-STAFFORD CREEK SEWER ALIGNMENT
SAMPLE LOCATION: B-19, S-3 7.5-9.5'

PROJ. NO.: 8-61M-08424-02 DATE: 4-8-98

DIRECT SHEAR TEST REPORT

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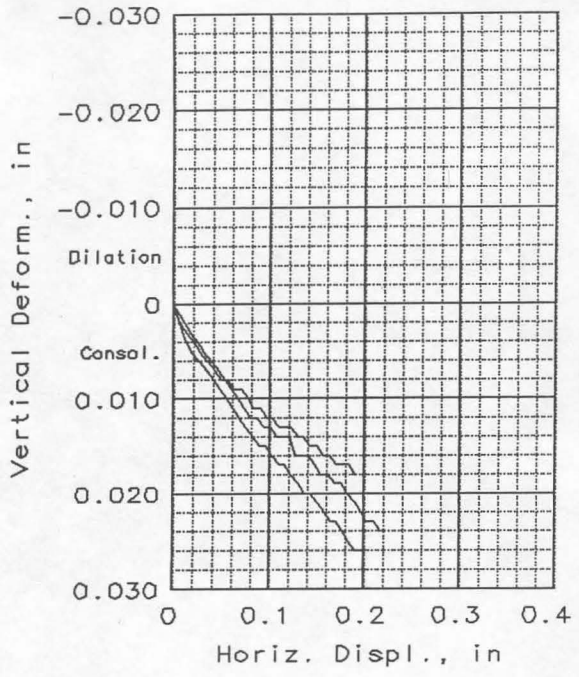

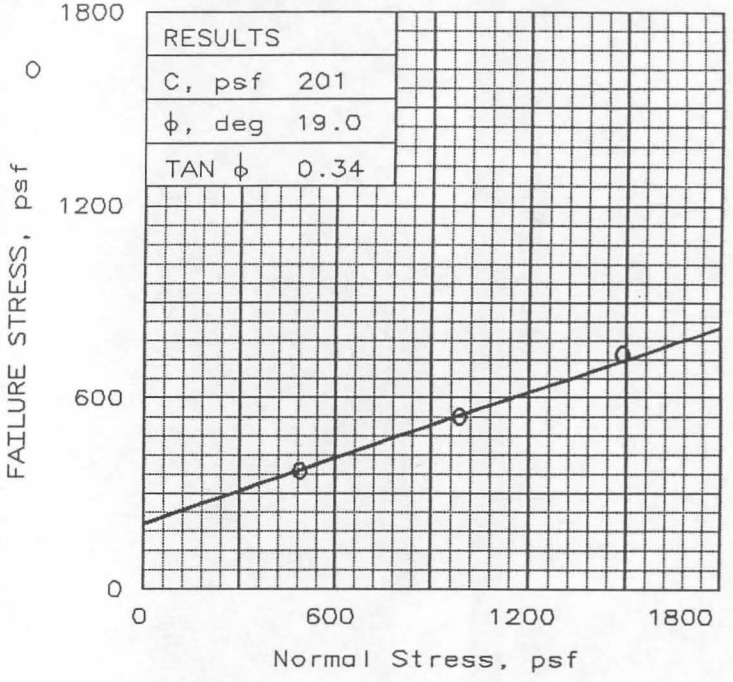

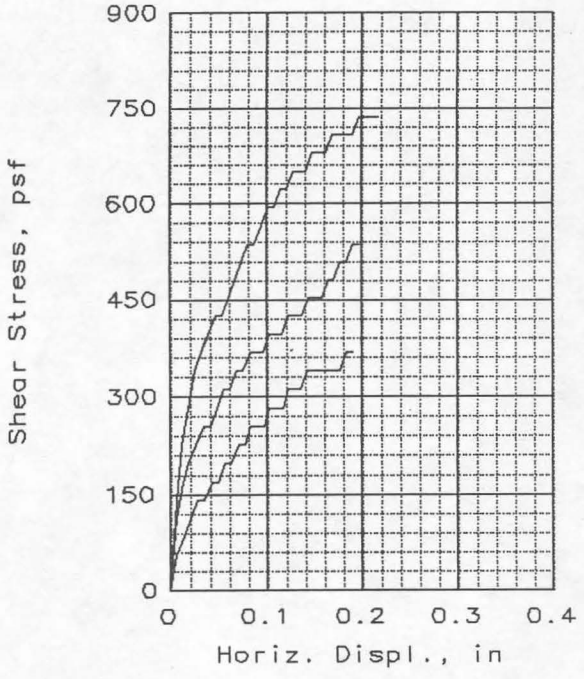

SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	68.1	72.1	92.2
	DRY DENSITY, pcf	50.4	49.4	40.6
	SATURATION, %	79.1	81.4	79.5
	VOID RATIO	2.282	2.348	3.072
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	1.00	1.00	1.00
AT TEST	WATER CONTENT, %	68.1	72.1	92.2
	DRY DENSITY, pcf	58.8	55.2	43.4
	SATURATION, %	99.6	95.7	86.7
	VOID RATIO	1.812	1.997	2.815
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.86	0.90	0.94
NORMAL STRESS, psf		1500	1000	500
FAILURE STRESS, psf		736	538	368
DISPLACEMENT, in		0.20	0.19	0.18
ULTIMATE STRESS, psf		736	538	368
DISPLACEMENT, in		0.20	0.19	0.18
Strain rate, %/min		0.50	0.50	0.50

SAMPLE TYPE: Shelby Tube
DESCRIPTION: Dk Grey Clayey Silt

SPECIFIC GRAVITY= 2.65
REMARKS: Tested by: ML
Reviewed by: ML

Fig. No.: _____

CLIENT: AGRA / PORTLAND

PROJECT: ABERDEEN-STAFFORD CREEK SEWER ALIGNMENT
SAMPLE LOCATION: B-22, S-3 7.5-9.5'

PROJ. NO.: 8-61M-08424-02 DATE: 4-8-98

DIRECT SHEAR TEST REPORT

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