Albany WSIP Pump Station and Force Main Supplemental Geotechnical Evaluation

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DATE: October 30, 2007

Introduction

This memorandum presents the findings of supplemental geotechnical explorations for the proposed new wastewater force main and pump station for the City of Albany. Appropriate foundation and construction recommendations for the new alignment and pump station site are also provided. The proposed pump station location has changed from the previous location near the intersection of Water Ave and Montgomery St. to the new location along Spring Hill Rd and the near the Albany-Corvallis Highway. One section of the force main alignment has been changed from Water Ave. to Front St. between Main St. and Cleveland St. The new geotechnical explorations were drilled at location proposed by Carollo Engineers who are the lead designers for the force main and pump station. The new pump station wet well will be approximately 18 foot by 20 feet and about 30 feet deep (at approximate elevation 170 feet). The new force main will be 18 inch-diameter, made of either HDPE or PVC. The force main will be installed approximately 6 feet deep along most sections of the alignment.

A supplemental geotechnical subsurface exploration program has been performed at the pump station site as well as 6 borings along the force main alignment. These locations are shown in Figure 1 and Figure 2. These are in addition to the existing seven borings performed at the previous pump station location and force main alignment in 2006. An existing technical memorandum (TM-1), dated July 3, 2006 was prepared for the previously proposed force main alignment and pump station location. The memorandum dated July 3, 2006 included a summary of regional geology, seismicity, seismic hazards, and seismic design criteria which are also applicable to the new alignment section and pump station location. Therefore these discussions will not be duplicated herein.

Supplemental Borings

Supplemental field explorations conducted for the modified pipeline and pump station locations consisted of six new soil borings designated B-8 through B-14b located approximately as shown in Figure 1 (background and details provided by Carollo Engineers) and Figure 2.

The soil borings were drilled on September 6-14, 2007 by Western States Drilling from Aurora, Oregon. The soil borings were advanced using a CME 55 rubber-tired drill rig using hollow-stem auger and mud rotary drilling techniques. Boring B-14a was drilled using hollow-stem auger drilling techniques, however, because of difficulty removing the drill plug at approximate depth of 30 feet in a sand layer, drilling was terminated and subsequently B-14b was drilled immediately adjacent to B-14a using mud rotary drilling. CH2M HILL provided continuous observation and logging of the boreholes.

Soil samples were typically collected from borings generally at either 2.5 or 5-foot intervals using a standard 2-inch-outside-diameter split-spoon sampler in accordance with the standard procedures outlined in American Society for Testing Materials (ASTM) D 1586, *Penetration Test and Split-Barrel Sampling of Soils*. This test is used to characterize the consistency of fine-grained soil or the relative density of coarse-grained soil by measuring penetration resistance expressed as blow counts, or N-value. The blow count is the number of blows required to advance a standard split-spoon sampler 6 inches with a 140-pound hammer falling 30 inches. The sampler is driven 18 inches and the blow count is recorded for each 6-inch increment. The sum of the blow counts for the second and third increments (1 foot) is referred to as the N-value in blows per foot (bpf). Low N-values indicate soft or loose soil; high N-values are evidence of hard or dense materials. After the sampler is driven and the blow counts are recorded, the sampler is withdrawn from the boring to recover a disturbed soil sample.

Relatively undisturbed, soil samples were obtained in 30-inch long, 3-inch diameter, thin-walled seamless steel tubes in general accordance with the standard procedures outlined in ASTM D 1587 (*Thin-Walled Tube Sampling of Soils*). The steel tubes were pushed, in one continuous stroke, approximately 24 inches into undisturbed soil with the hydraulic drive head of the drill rig. The tube, together with the encased soil, was removed from the ground and sealed. Tube samples were sealed and stored for use in laboratory testing and additional soil classification.

Soil samples from the borings were examined and visually classified in accordance with ASTM D 2488, *Visual-Manual Procedure for Description of Soils*. The visual classification of soil samples allows convenient and consistent comparison of soil samples using a standard method for describing the soil. Soil classification systems attempt to group soil having similar engineering behavior. Several classification systems have been developed, usually for a specific application. The system most generally accepted for a wide range of engineering applications is the Unified Soil Classification System (USCS). This method of classification provides a basis for comparing soils from widespread geographic areas.

Sampling intervals and field classifications of the soil samples are recorded on the boring logs which are provided in Attachment A. The existing geotechnical exploration logs and technical memorandum is included in Attachment B.

Subsurface Conditions

Subsurface conditions encountered in the September 2007 supplemental borings are generally consistent with those encountered in the borings performed in 2006. These consist of low plasticity silt or lean clay from 0 feet to as deep as 11 feet with underlying dense

silty/sandy gravel. Beneath the silty/sandy gravel layer, a greenish gray, lean to fat clay was encountered at approximately 34 feet below the ground surface in borings B-10 and B-11, in the vicinity of Periwinkle Creek, and approximate depth of 45 feet in boring B-14b, in the vicinity of the proposed new pump station.

The upper silt/clay is generally firm to very stiff in consistency and in some cases included some fine sand. From previous laboratory testing, Atterberg limits test run on samples in the upper layer indicated liquid limits of 29 and 42 and plasticity indexes of 7 and 17. Natural moisture contents were 25 and 26 percent. Pocket penetrometer tests estimated unconfined compressive strength of about 3000 pounds per square foot. This material is generally consistent Willamette Silt formation

The intermediate silty/sandy gravel layer is generally well-graded to silty gravel with sand. The gravel is generally subrounded, and in many cases the gravel is larger than the sampler head (about 1.5 inches), indicating larger sized gravels or cobbles. SPT N-values ranged from a low of 26 to greater than 50 blows per 6-inches. Some lenses of poorly graded sand or gravel were also encountered. This layer is generally consistent with the Linn Gravel formation.

The lean to fat greenish gray clay is firm to hard in consistency with SPT N-Values ranging from 8 to 49 blows per foot. Up to about 40 percent fine sand was also encountered at times in the clay. It is likely this is part of the Calapooia Clay formation.

No indication of hazardous waste contamination was found in any of the test borings.

Groundwater Conditions

Groundwater levels were measured in borings B-08, B-09, B-12, and B-14a upon completion of the drilling activities. These groundwater levels, elevations, and dates are shown in Table 1.

Boring Number	Date	Groundwater Depth (feet)	Approximate Groundwater Elevation (feet)
B-08	9/6/07	19.0	189
B-09	9/6/07	18.8	191.2
B-12	9/7/07	20.0	195
B-14a	9/7/07	27.5	174.5

These groundwater levels tend to fluctuate throughout the season with the changes in the Willamette River level and during periods of high precipitation and seasonal rain.

Discussion and Analyses

Foundations

It is my understanding from information provided by Carollo Engineers, that facilities at the new pump station will consist of (i) an at-grade cmu control building with a 21.3 ft by 29.3 ft footprint; (ii) a 10 ft by 16 ft valve vault located 9 feet below the ground surface; and (iii) a 15 ft by 17 ft pump station located 32 feet below ground surface. Maximum bearing pressures should be limited to 1,900 pounds per square foot (psf) for the at-grade control building, 2300 psf for the valve vault, and 4,000 psf for the wet well. It is anticipated that the pump station will be founded in the dense gravel layer previously described where the bearing capacity will be sufficient to support the structure.

It is recommended that the force main be supported on a minimum of 12 inches of bedding material, consisting of compacted, imported sandy gravel. During excavation, the subgrade should be inspected and any areas that are observed to be noticeably soft or loose and yielding, should be over excavated and replaced with foundation stabilization rock, typically consisting of 3-inch minus gravel.

Coefficient of Sliding

The recommended coefficient of sliding for the proposed pump station facilities, founded on a minimum of 12 inches of compacted granular fill are shown in Table 2.

Structure	Coefficient of Sliding Friction
Control Building	0.49
Valve Vault	0.33
Pump Station Wet Well	0.58

Lateral Earth Pressures

Lateral earth pressures are needed for designing below grade walls. Three states of static soil pressure can develop from movement of below grade structures:

- At-rest state: Walls that are restrained from yielding at their tops
- Active state: Walls that are free to yield at their tops and that can freely move away from the backfill
- Passive state: Walls that are free to yield at their tops and that can move toward the backfill

It is anticipated that the new below-grade structures will be primarily non-yielding; therefore, at-rest earth pressure conditions should apply. Additionally, it is expected that due to property limitations that open-cut of the pump station will not be possible, requiring excavation support or caisson construction techniques. Therefore undisturbed native soils

are expected to be the primary source of lateral earth pressures, given the minimal amount of backfill or flowable fill required.

For native soil, walls should be designed to resist the lateral earth pressures given as equivalent fluid pressures in pounds per cubic foot (pcf) of wall height (Table 3).

TABLE 3
Lateral Earth Pressures

State of Stress	Earth Pressure Coefficient	Undrained Equivalent Fluid Pressure (pcf/ft)	Drained Equivalent Fluid Pressure (pcf/ft)
At-rest	Ko = 0.5	92	60

Notes:

1. The magnitude of the lateral earth pressure at a given height of wall is given in units of pounds per cubic foot of wall height (H), where wall height is the distance between the ground surface and the base of the wall. Walls should be designed to resist surcharge loads and adjacent at-grade structures. The lateral earth pressure caused by a surcharge load is equal to the anticipated surcharge load in psf multiplied by the applicable earth pressure coefficient Ko, Ka, or Kp.
2. In addition, earthquake loadings should be considered. The design earthquake should be applied in addition to the static soil pressure and surcharge loads.
3. Compaction within 5 horizontal feet of the structure should be performed using lightweight, hand-operated equipment so that compaction-induced lateral stresses are limited. It is recommended that walls be designed to withstand compaction-induced pressures of no less than 500 psf (even in the upper 4 to 6 feet of the wall), assuming lightweight, hand-operated equipment. If heavy or large equipment is used for compaction immediately adjacent to the wall(s), lateral stresses will be larger than those shown in this table.

Dynamic Earth Pressures

Earthquake loading will lead to an increase in the active earth pressures and a decrease in the passive earth pressure acting on a wall. These pressures are estimated using procedures presented by Seed and Whitman (1970) and Towahata and Islam (1987). These procedures are simplifications of what is commonly referred to as the Mononobe-Okabe method of estimating dynamic earth pressures. These simplifications assume that the wall displaces and mobilizes the active and passive conditions, as noted above.

According to Seed and Whitman (1970), the estimated increase in force caused by the earthquake for active conditions can be estimated as ¾ k_h. Because the peak horizontal ground acceleration (PHGA) occurs for only a brief period during an earthquake, the seismic coefficient (k_h) is typically specified as a fraction of the PHGA. It is recommended that a value of k_h equal to 65 percent of the PHGA be used.

Based on this theory, a dynamic lateral active force (ΔP_{ae}) is estimated as:

$$\Delta P_{ae} = (¾)(0.65PHGA)(\gamma_{moist})(½H^2)$$

For a PHGA of 0.24g and a moist soil unit weight of 115 pcf, the estimated dynamic active lateral force is equal to $6.7H^2$ psf, where H is the wall height. Seed and Whitman (1970) indicate that this force acts at a distance of 0.6H above the base of the wall. It is

recommended that the dynamic lateral force be applied as a trapezoidal pressure distribution, with the pressure at the top of the wall (or ground surface) being equal to $1.6(\Delta P_{ae}/H)$ and the pressure at the base of the wall being equal to $0.4(\Delta P_{ae}/H)$. This pressure distribution provides a resultant force that is located at a distance of 0.6H from the base of the wall. This dynamic active pressure distribution is then summed with the static active earth pressure distribution to determine the total active earth pressure acting on the wall.

During an earthquake the passive resistance is decreased. Towhata and Islam (1987) recommend that the decrease in resistance be estimated as $\frac{17}{8}k_h$. A dynamic lateral passive force (ΔP_{pe}) decrease can be estimated as:

$$\Delta P_{pe} = (\tfrac{17}{8})(0.65PHGA)(\gamma_{moist})(\tfrac{1}{2}H^2)$$

For a PHGA of 0.24g and a moist soil unit weight of 115 pcf, the estimated dynamic lateral passive pressure decrease is equal to $19.1H^2$ psf, where H is the wall height. This force acts at a distance equal to $\frac{2}{3}H$ above the base of the wall. It is recommended that the dynamic lateral force be applied as an inverse triangular distribution, with the pressure at the top of the wall equal to $2(\Delta P_{pe}/H)$. This dynamic passive pressure distribution is then subtracted from the static passive earth pressure to determine the total passive earth pressure acting on the wall.

For the non-yielding wall, it is recommended that for the dynamic design the larger of the following be used for the dynamic earth pressures:

1. The at-rest pressure distribution from Table 3.
2. The static plus dynamic active earth pressure distributions.

General Construction Considerations

Excavation Support

Pump Station

Because of the limited area on the parcel for construction of the pump station, it is anticipated that full open cut excavation methods will not be possible. Therefore, it is anticipated excavation support systems will be required. While excavation support systems are generally up to the contractor to develop their preferred methods, some restriction may be necessary depending on existing facilities. It is likely that two alternatives are possible for excavation support of the pump station excavation. These are caisson construction or installation of sheet piles. Caisson construction consists of precast sections of large concrete caissons that are installed during excavation that are used for both excavation support and the finished exterior of the wet well. If the wet well is to be rectangular, caisson construction may not be cost effected because of the increase in size require and therefore sheet piles would be a preferred alternative. Because of the dense gravel and cobbles located in the

lower portion of the pump station, it may be difficult to achieve the proper depth using pile driving techniques. Therefore the contractor should be prepared to use large steel sheet sections that provide more rigidity or the addition of a sheet pile vibrator, that may provide better penetration thought the dense gravels. As existing facilities or residential homes are located within a close proximity of the site, it is recommended that special provisions be included in the contract documents for safe handling of excavation support components, such as sheet piles, to protect the existing structures and residents. Careful examination of installation components such as pile drivers or vibrators should also be performed and discussed with the contractor during submittal phases to minimize possibility of damaging existing facilities during installation, in addition to achieved sufficient penetration depths.

If sheet piles are used rather than a caisson system, backfill materials around the wet well should be carefully selected to minimize consolidation or settlement of backfill materials and adjacent structures. If spacing between the wet well structure is only a couple feet, then flowable fill (CDF) is recommended.

Periwinkle Creek Undercrossing

It is anticipated that the most cost effective method for installation of the force main through Periwinkle Creek will be an open cut and cover construction technique. It is recommended that the pipeline be placed a minimum of 5 feet (to top of pipe) under the invert of the creek and using backfill materials to resist scouring of the pipeline. However this should be confirmed with hydraulic studies to determine the maximum scour depth over the design life of the pipe. This method will require diversion of the creek with a culvert and dewatering of the trench. Additionally, all necessary work permits will need to be obtained to allow the in-water work.

If permits for in-water work cannot be obtained, then jack and boring, or similar techniques will need to be implemented. This is done by excavating a jacking pit on one side of the creek and receiving pit on the other side of the creek. Typically, the casing pipe is advanced under the crossing with the drilling bit to prevent caving of granular or weak materials. Once the casing pipe is constructed, the carrier pipe can then be installed and should be sealed with light-weight grout to limit stress on the carrier pipe.

Dewatering

As summarized previously, groundwater is expected to be encountered in the dense gravel formation (at a depth ranging from approximately 19 to 28 feet) during the summer and fall seasons and is expected to rise during winter and spring. The dense gravel formation is expected to have noticeable groundwater flow; however it has been our experience that because it tends to be well graded, the groundwater flow can at times be restricted with seeps more noticeable in poorly graded gravel or sand lenses. Based on groundwater measurements recorded and soil conditions observed, it is likely that the groundwater level will be above the bottom of the wet well and jacking pit excavations. For the pump station wet well, it is recommended that for either caisson construction, or sheet pile construction, a tremmie seal be poured into the bottom of the excavation. This will facilitate pumping out the remaining water in the excavation and prevent groundwater from seeping into the bottom of the excavation.

Jacking pit dewatering may require a combination of local sumps with high-capacity pumps and well-point systems to provide a sufficient working area. It is expected that water removed from the excavation will need to be stored in a decant pit, excavated nearby, or a Baker tank, before pumping back in to the creek. It is recommended that dewatering plans submitted by the contractor be reviewed carefully so that the finished product is not impacted by excessive seeping during construction, and that a safe working area is established that also does not excessively impact local water quality. It is also recommended that with the potential for groundwater in some of the excavations that construction be performed primarily during summer and early fall to limit dewatering requirements.

Limitations

This report has been prepared for the exclusive use of Carollo Engineers, and the City of Albany, for specific application to the proposed Albany Force Main and Pump Station project which is part of the wastewater treatment plant expansion project. This report has been prepared in accordance with generally accepted geotechnical engineering practice. No other warranty, express or implied, is made.

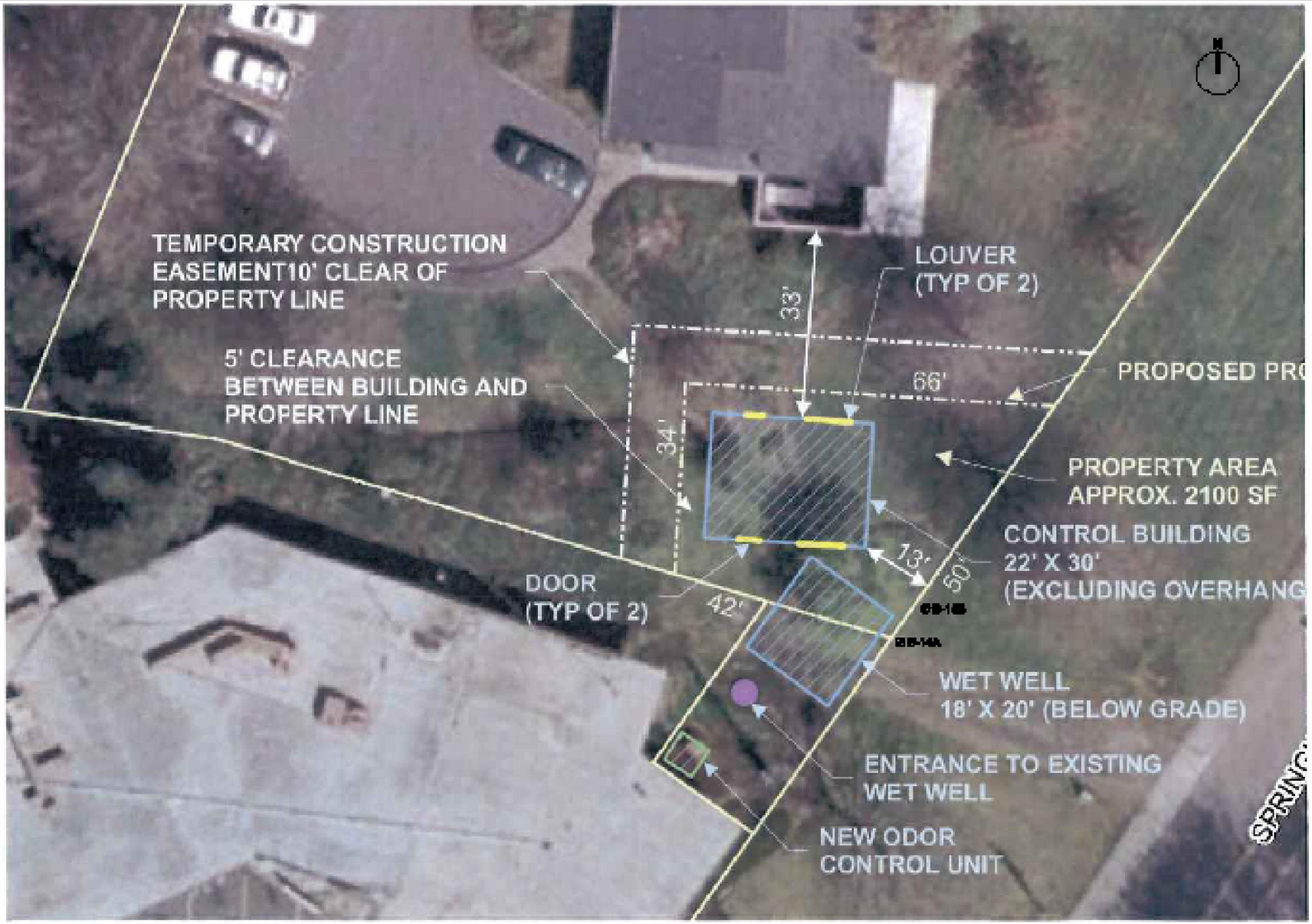
The information contained in this report is based on the data obtained from the field exploration described herein. The explorations indicate soil conditions and groundwater levels only at specific locations, and only to the depths penetrated. They do not necessarily reflect variations that may exist between exploration locations. Also, the passage of time may result in a change in the conditions at these locations.

In the event that any changes in the nature, design, or location of the facilities are planned, the information contained in this report should not be considered valid unless the changes are reviewed and the data verified in writing by CH2M HILL. CH2M HILL is not responsible for any claims, damages, or liability associated with interpretation of subsurface data, or for the reuse of subsurface data, without the express written authorization of CH2M HILL.

References

Seed, H.B. and Whitman, R.V. 1970. "Design of Earth Retaining Structures for Dynamic Loads." ASCE 1970 Specialty Conference on Lateral Stresses in the Ground and Design of Earth Retaining Structures. June 22-24, 1970.

Towahata and Islam. 1987. *Prediction of lateral movement of anchored bulkheads induced by seismic liquefaction*. Soils and Foundations, Vol. 27 No. 4, pp 137-147.



LEGEND:

- GEOTECHNICAL BORING LOCATIONS - CH2M HILL SEPTEMBER 2007

FIGURE 1
PUMP STATION BORING PLAN
GEOTECHNICAL MEMORANDUM NO. 2
AUSTIN AIRWAY PUMP STATION
AND FORCE MAIN PROJECT

CH2MHILL

N

0 80 160 240

Scale in Feet

LEGEND:

- GEOTECHNICAL BORING LOCATION - CH2M HILL MARCH 2006
- GEOTECHNICAL BORING LOCATION - CH2M HILL SEPTEMBER 2007

FIGURE 2
GEOTECHNICAL MEMORANDUM NO. 2
FORCE MAIN BORING PLAN
NORTH ALBANY PUMP STATION
AND FORCE MAIN PROJECT

CH2MHILL

Attachment A – 2007 Boring Logs

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326918.DE.FD.GE	B-08 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : SE Corner of Front Ave and Main St

ELEVATION : Approx. 208 ft DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, 140 lb Autohammer, HSA

WATER LEVELS : 19.0 ft below ground surface START : 9/6/07 09:00 END : 9/6/07 10:30 LOGGER : R. Lawrence

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1						Asphalt pavement at surface (3"), 1.5' AB under asphalt
2	2.5					
3		1.2	1-SS	2-3-5 (8)	SILT (ML): light brown, moist, firm, mottled with different shades of brown, estimated 5% fine grained sand, low plasticity.	SS-1 @ 09:05
4	4.0					
5	5.0					
6		1.3	2-SS	7-5-8 (13)	5.0-5.5' Sandy SILT (ML): brown, moist, stiff, low plasticity, estimated 20-30% fine to coarse sand. 5.5-6.3' SILT (ML): tan, stiff, low plasticity, estimated 5% fine grained sand.	SS-2 @ 09:10 SS-2A 5.0-5.5' SS-2B 5.5-6.3'
7	6.5					
8	7.5					
9		1.3	3-SS	5-7-12 (19)	SILT with Sand (ML): light brown, moist, hard, low plasticity, estimated 15-20% fine to coarse sand, occasional subrounded gravel.	SS-3 @ 09:18
10	9.0					
11	10.0					Driller notes harder at 9.5'
12		1.1	4-SS	21-40-31 (71)	Silty GRAVEL with Sand (GM): brown with 2" light gray lense in middle of sample, moist, very dense, angular to subrounded gravels, estimated 15% fines, estimated 20-30% fine to coarse sand.	SS-4 @ 09:30
13	11.5					
14						
15						
16	15.0					
17		1.0	5-SS	12-32-33 (65)	Silty GRAVEL with Sand (GM): very dense. 15.0-15.2' brown, wet, estimated 20-30% CH fines? estimated 20-25% sand. 15.2-15.4' orange and brown, moist, weathered rock, estimated 40% gravel, 30% sand. 15.4-15.6' gray, moist, angular gravel, sand, no fines. 15.6-16.0' light gray, moist, angular gravel, estimated 30-40% fine to coarse sand.	SS-5 @ 09:41 GWT @ 19.0'
18	16.5					
19						
20						
21	20.0					
22		1.2	6-SS	17-27-31 (58)	20.0-20.3' Silty SAND with Gravel (SM): brown, wet, very dense, fine to coarse sand, subrounded gravels, 15-25% high plastic fines, similar to 15.0-15.2' 20.3-21.2' Poorly graded GRAVEL with Silt and Sand (GW-GM): multiple colors, wet, very dense, subrounded gravels, estimated 25-35% fine to coarse sand, estimated 5-15% fines, appears to be highly weathered rock.	SS-6 @ 09:57 SS-6A 20.0-20.3' SS-6B 20.3-21.2'
23	21.5					Backfilled with 5 bags of bentonite chips Asphalt Cold Patch installed
24						
25					Bottom of Boring at 21.5 ft below ground surface	
26						
27						
28						
29						
30						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
326918.DE.FD.GE	B-09	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : NW Corner of Front Ave and Oak St

ELEVATION : Approx. 210 ft DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, 140 lb Autohammer, HSA

WATER LEVELS : 18.8 ft below ground surface START : 9/6/07 11:00 END : 9/6/07 12:30 LOGGER : R. Lawrence

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1						Asphalt pavement at surface (1.5'), 1.5' AB under asphalt
2	2.5					
3		1.3	1-SS	3-5-8 (13)	SILT (ML): brown, moist, stiff, low plasticity, estimated 5% fine grained sand.	SS-1 @ 11:15
4	4.0					
5	5.0					
6		2.0	2-ST	push	Same as above (ML)	ST-2 @ 11:20 Push ST-2: 350 psi 5.0-6.0', 550 psi 6.0-7.0'
7	7.0					
8		1.4	3-SS	3-4-5 (9)	SILT (ML): grayish brown, moist, stiff, low plasticity, estimated 5% fine grained sand.	SS-3 @ 11:25
9	8.5					
10	10.0					
11		1.2	4-SS	4-13-26 (39)	10.0-10.4' Similar to above, except hard. 10.4-10.6' Sandy SILT (ML): brown, moist, hard, low plasticity, estimated 50% fine grained sand.	SS-4 SS-4A 10.0-10.4' SS-4B 10.6-11.2'
12	11.5				10.6-11.2' Silty GRAVEL with Sand (GM): brown, moist, dense, estimated 20-30% fine to coarse sand, estimated 15-25% fines, subrounded.	Driller notes gravel at 11.5'
13						
14						
15	15.0					
16		1.2	5-SS	11-24-28 (52)	Silty GRAVEL with Sand (GM): brown, moist, very dense, subangular to subrounded gravel, estimated 15-25% fine to coarse sand, estimated 15-20% fines, occasional weathered rock.	SS-5 @ 11:48 GWT @ 18.8'
17	16.5					
18						
19						
20	20.0					
21		1.1	6-SS	14-16-17 (33)	Well graded GRAVEL with Silt and Sand (GW-GM): brown, wet, dense, subangular to subrounded gravels, estimated 25-35% fine to coarse sand, estimated 5-15% fines.	SS-6 @ 12:00
22	21.5					Backfilled with 3 bags of bentonite chips Asphalt Cold Patch installed
23					Bottom of Boring at 21.5 ft below ground surface	
24						
25						
26						
27						
28						
29						
30						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326918.DE.FD.GE	B-10 SHEET 1 OF 2

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : N Side of Front Ave and Harrison

ELEVATION : Approx. 204 ft DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, 140 lb Autohammer, HSA

WATER LEVELS : START : 9/6/07 13:40 END : 9/6/07 17:30 LOGGER : R. Lawrence

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1						Asphalt pavement at surface (5"), 1.0' AB under asphalt
2	2.5					
3		1.0	1-SS	4-6-7 (13)	SILT (ML): light brown, moist, stiff, low plasticity, estimated 5% fine grained sand.	SS-1 @ 13:45
4	4.0					
5	5.0					
6		1.3	2-SS	3-6-8 (14)	Same as above.	SS-2 @ 13:50
7	6.5					
8	7.5					
9		1.4	3-SS	3-5-7 (12)	Same as above.	SS-3 @ 13:57
10	9.0					
11	10.0					
12		1.5	4-SS	4-8-32 (40)	10.0-11.1' Similar to above, except hard. 11.1-11.5' Well graded GRAVEL with Silt and Sand (GW-GM): brown, moist, dense, subangular to subrounded gravels, estimated 20-30% fine to coarse sand, estimated 5-15% fines, some weathered rock.	SS-4 @ 14:03 SS-4A 10.0-11.1' SS-4B 11.1-11.5 Driller notes gravel/weathered rock at 11.0'
13	11.5					
14						
15						
16	15.0					
17		1.3	5-SS	16-31-31 (62)	Similar to above (GW-GM), except very dense, estimated 25-35% fine to coarse sand, some gravels appear to have been fractured by SPT.	SS-5 @ 14:12
18	16.5					
19						
20						
21	20.0					
22		1.1	6-SS	15-26-37 (63)	Same as above.	SS-6 @ 14:25 Driller notes more gravels and less weathered rock from 20.0-25.0'
23	21.5					
24						
25						
26	25.0					
27		1.1	7-SS	30-34-28 (62)	Same as above.	SS-7 @ 14:45
28	26.5					
29						
30						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326918.DE.FD.GE	B-10 SHEET 2 OF 2

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : N Side of Front Ave and Harrison

ELEVATION : Approx. 204 ft DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, 140 lb Autohammer, HSA

WATER LEVELS : START : 9/6/07 13:40 END : 9/6/07 17:30 LOGGER : R. Lawrence

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
30.0					30.0-30.6' Silty GRAVEL with Sand (GM): brown, wet, loose, subangular to subrounded, estimated 25-35% fine to coarse sand, estimated 15-25% fines.	SS-8 @ 15:00 SS-8A 30.0-30.6' SS-8B 30.6-30.9' SS-8C 30.9-31.5'
31	30.0-31.5	1.5	8-SS	8-4-4 (8)		
32					30.6-30.9' Similar to above, except clayey GRAVEL with Sand (GC): gray, wet, firm, high plasticity, estimated 5% fine grained sand, more sand and gravels in shoe. Clayey GRAVEL with Sand (GC) at top of tube.	ST-9 @ 15:15 Push ST-9: 400 psi
33	33.5		9-ST	push		
34		1.4	10-SS	2-3-5 (8)	Lean CLAY (CL): gray, wet, firm, lost o medium plasticity, estimated 5% fine grained sand.	SS-10 @ 15:25
35	35.0					
36						
37						
38						
39						
40	40.0					
41	41.5	1.7	11-SS	3-7-9 (16)	Similar to above, except very stiff.	SS-11 @ 15:40 Driller notes stiffer at 42.0'
42						
43						
44						
45	45.0					
46	46.5	1.8	12-SS	4-9-11 (20)	45.0-45.9' Sandy Lean CLAY (CL): gray, wet, very stiff, low plasticity, estimated 30-40% fine grained sand.	SS-12 @ 15:58 Driller notes softer at 46.0'
47					45.9-46.8' Lean CLAY (CL): gray, wet, very stiff, no to low plasticity, estimated 5% fine grained sand.	SS-12A 45.0-45.9' SS-12B 45.9-46.8'
48						
49						
50	50.0					
51			13-ST	push	Similar to SS-14	ST-13 @ 16:20 Push ST-13: 300 psi 50.0-51.0', 450 psi 51.0-51.5', 550 psi 51.5-52.0'
52	52.0					
53	53.5	1.8	14-SS	3-3-5 (8)	Lean CLAY (CL): gray, wet, firm, low plasticity, estimated 5% fine grained sand.	SS-14 @ 16:30
54					Bottom of Boring at 53.5 ft below ground surface	Backfilled with 8 bags of bentonite chips Asphalt Cold Patch installed
55						
56						
57						
58						
59						
60						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326918.DE.FD.GE	B-11 SHEET 1 OF 2

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : Corner of Front Ave and Cleveland

ELEVATION : Approx. 209 ft DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, Mud rotary, Autohammer, SPT

WATER LEVELS : START : 9/13/07 08:00 END : 9/13/2007 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1						Asphalt pavement at surface Weather 55°F, overcast, light mist Arrive on site @ 07:35, Driller Arturo, Helper __, start drilling at 08:25
2						
3						
4						
5	5.0					
6	6.5	1.5	1-SS	3-8-11 (19)	Elastic SILT with Sand (MH): gray to brown, moist, stiff, estimated 5-10% fine sand, organics present.	SS-1 @ 08:33
7						
8						
9						
10	10.0					
11	11.5	1.5	2-SS	4-7-19 (26)	SILT (ML): tan with gray mottling and small (<1mm) brown inclusions, low to medium plasticity, very stiff, <5% sand, moist, bottom 2" contain gravels ±0.75" diameter, rounded.	Switch to drag bit SS-2 @ 08:43
12						
13						
14						
15	15.0					
16	16.5	1.2	3-SS	5-18-21 (39)	Well graded GRAVEL with Sand and Silt (GW-GM): brown to tan to orange, moist, gravels are rounded, basaltic, estimated 30% sand, 15% silt.	Switch to tri-cone button bit. 2.5' slough, hole is caving. SS-3 @ 08:53
17						
18						
19						
20	20.0					
21	21.5	1.5	4-SS	30-40-33 (73)	Similar to above (GW-GM), except more dense, gravels are round to subrounded, some are broken by sampler, maximum size is 3", estimated 30% well-graded sand, 10-15% silt.	SS-4 @ 10:09
22						
23						
24						
25	25.0					
26	26.5	1.4	5-SS	32-32-37 (69)	As above.	SS-5 @ 10:45
27						
28						
29						
30						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
326918.DE.FD.GE	B-11	SHEET 2 OF 2

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : Corner of Front Ave and Cleveland

ELEVATION : Approx. 209 ft DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, Mud rotary, Autohammer, SPT

WATER LEVELS : START : 9/13/07 08:00 END : 9/13/2007 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
30.0					As above, except brown to tan, moist, very dense, estimated 30% well-graded sand, 10-15% silt, gravels rounded, matrix is mottled.	SS-6 @ 11:13 Driller notes material change at 34.5'
31						
31.5	1.5	6-SS	34-30-28 (58)			
32						
33						
34						
35.0					Lean CLAY (CL): greenish gray, dry to moist, very stiff, dense form (?) resembles hardpan, sand content varies, estimated 5-20% fines.	SS-7 @ 11:35 Switch to 3 7/8" drag bit 11:56 hose blows 14:52 rig fixed, resume drilling
35						
36						
36.5	1.5	7-SS	6-11-13 (24)			
37						
38						
39						
40.0					As above, except stiff, estimated 5-15% fine sand.	SS-8 @ 15:00
40						
41						
41.5	1.5	8-SS	4-7-9 (16)			
42						
43						
44						
45.0					As above.	SS-9 @ 15:22
45						
46						
46.5	1.5	9-SS	5-8-11 (19)			
47						
48						
49						
50.0					As above, except much more dense (hard).	SS-10 @ 15:38
50						
51						
51.5	1.5	10-SS	8-23-26 (49)			
52					Bottom of Boring at 51.5 ft below ground surface	Backfilled with __ bags of bentonite chips Asphalt Cold Patch installed
53						
54						
55						
56						
57						
58						
59						
60						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326918.DE.FD.GE	B-12 SHEET 1 OF 2

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : SE Corner of Front Ave and Denver

ELEVATION : Approx. 215 ft DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, 140 lb Autohammer, HSA

WATER LEVELS : 20.0 ft below ground surface START : 9/7/07 14:30 END : 9/7/07 17:00 LOGGER : R. Lawrence

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1						Asphalt pavement at surface (2")
2	2.5					
3		0.7	1-SS	3-5-6 (11)	SILT (ML): brown, moist, stiff, low plasticity, 5% fine sand.	SS-1 @ 14:50
4	4.0					
5	5.0					
6		1.5	2-SS	3-5-7 (12)	Same as above.	SS-2 @ 14:55 TV = 0.45 kg/cm²
7	6.5					
8	7.5					
9		1.8	3-SS	3-4-6 (10)	Same as above.	SS-3 @ 15:01 TV = 0.4 kg/cm²
10	9.0					
11	10.0					
12		1.8	4-ST	push	Same as above.	ST-4 @ 15:10 Push ST-4: 125 psi 10.0-10.5', 225 psi 10.5-11.0', 450 psi 11.0-11.5', 600 psi 12.0-12.5' Driller notes gravel at 12.5'
13	12.0					
14		1.5	5-SS	7-45-50/5.5	12.0-12.5' Similar to above, except hard. 12.5-13.0' Transition from Silt to weathered rock and gravel.	SS-5 @ 15:20 SS-5A 12.0-12.5' SS-5B 13.0-13.5'
15	13.5					
16	15.0					
17		1.2	6-SS	14-28-33 (61)	13.0-13.5' Silty GRAVEL with Sand (GM): brown, moist, subangular gravels, estimated 20-30% fine to coarse sand, estimated 15-20% flow plasticity fines, lots of weathered rock. Silty GRAVEL with Sand (GM): various shades due to weathered rock, moist, very dense, subangular to subrounded gravels, estimated 20-30% fine to coarse sand, estimated 15-25% low plasticity fines, lots of weathered rock	SS-6 @ 15:32 Driller notes GWT @ 20.0'
18	16.5					
19						
20						
21	20.0					
22		1.2	7-SS	11-13-18 (31)	Silty GRAVEL with Sand (GM): brown, wet, dense, subrounded gravels, estimated 35-45% fine to coarse sand, estimated 15-25% low plasticity fines.	SS-7 @ 15:45
23	21.5					
24						
25						
26	25.0					
27		1.1	8-SS	9-28-40 (68)	Well graded GRAVEL with Silt and Sand (GW-GM): brown, moist, subrounded to subangular gravels, estimated 35-45% fine to coarse sand, estimated 5-15% fines.	SS-8 @ 16:03
28	26.5					
29						
30						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326918.DE.FD.GE	B-12 SHEET 2 OF 2

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : SE Corner of Front Ave and Denver

ELEVATION : Approx. 215 ft DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, 140 lb Autohammer, HSA

WATER LEVELS : 20.0 ft below ground surface START : 9/7/07 14:30 END : 9/7/07 17:00 LOGGER : R. Lawrence

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
31	30.0 31.5	1.1	9-SS	19-36-38 (74)	Silty GRAVEL with Sand (GM): brown, wet, angular to subrounded gravels (angular probably caused by SPT), estimated 25-35% fine to coarse sand, estimated 15-20% fines.	SS-9 @ 16:20
32					Bottom of Boring at 31.5 ft below ground surface	Backfilled with 7 bags of bentonite chips Asphalt Cold Patch installed
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326918.DE.FD.GE	B-13 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : Corner of Front and Geary (30' E on Geary)

ELEVATION : Approx. 211 ft DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, 140 lb Autohammer, HSA

WATER LEVELS : START : 9/14/07 08:00 END : 9/14/2007 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1						Asphalt pavement at surface Weather 55°F, overcast Arrive on site @ 07:45, Driller Arturo, Helper Adonis, start drilling at 08:00
2	2.5					
3		1.5	1-SS	11-40-33 (73)	2.5-3.0' SILT (ML): brown, dry, hard, roots present. 3.0-4.0' Well Graded GRAVEL (GW): brown to red to tan, dry, very dense, estimated 15% silt. Gravels are rounded and broken.	SS-1 @ 08:11
4	4.0					
5	5.0					
6		1.5	2-SS	11-24-24 (48)	Well graded GRAVEL with Silt (GW-GM): brown, dry, very dense, 3" layer of moist material, gravels rounded and broken, estimated 15% silt.	SS-2 @ 08:22
7	6.5 7.5					
8		1.5	3-SS	8-13-9 (22)	Similar to above, except moist.	SS-3 @ 08:31
9	9.0					
10	10.0					
11		1.5	4-SS	5-8-9 (17)	Same as above.	SS-4 @ 08:37
12	11.5					
13						
14						
15	15.0					
16		1.5	5-SS	8-25-38 (63)	Similar to above, except less silt (GW), moist to wet, estimated 5% fines.	SS-5 @ 08:48
17	16.5					
18					Bottom of Boring at 16.5 ft below ground surface	Backfilled with __ bags of bentonite chips Asphalt Cold Patch installed
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
326918.DE.FD.GE	B-14a	SHEET 1 OF 2

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : Gravel driveway W of Hwy 20

ELEVATION : Approx. 202 ft DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, 140 lb Autohammer, HSA

WATER LEVELS : 27.5 ft below ground surface START : 9/7/07 07:30 END : 9/7/07 13:00 LOGGER : R. Lawrence

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1						AB gravel at surface
2	2.5					
3		0.9	1-SS	4-6-7 (13)	Silty GRAVEL with Sand (GM): shades of brown and gray, moist, medium dense, estimated 20-30% fine to coarse sand, estimated 15-25% low plasticity fines.	SS-1 @ 07:35
4	4.0					
5	5.0					Driller notes Silt at 4.5'
6		0.7	2-SS	3-5-5 (10)	SILT (ML): reddish brown, moist, stiff, no to low plasticity, estimated 5% fine sand.	SS-2 @ 07:42
7	6.5 7.5					
8		1.9	3-ST	push	Same as above.	ST-3 @ 07:50 Push ST-3: 150 psi 7.5-8.0', 200 psi 8.0-9.0', 250 psi 9.0-9.5'
9	9.5					
10		0.7	4-SS	2-2-2 (4)	Similar to above, except soft.	SS-4 @ 07:55
11	11.0					
12						
13						
14						
15	15.0					
16		1.0	5-SS	2-3-4 (7)	Similar to above, except firm.	SS-5 @ 08:00 TV = 0.15 kg/cm² Driller notes Gravel at 19.0'
17	16.5					
18						
19						
20	20.0					
21		0.9	6-SS	12-22-23 (45)	Well graded GRAVEL with Silt and Sand (GW-GM): brown, moist, dense, subangular to subrounded gravel, estimated 20-30% fine to coarse sand, estimated 5-15% fines, angular gravels fractured by SPT, some weathered rock.	SS-6 @ 08:10
22	21.5					
23						
24						
25	25.0					
26		0.9	7-SS	9-11-11 (22)	Similar to above, except medium dense, estimated 25-35% fine to coarse sand.	SS-7 @ 08:20 Water on rod indicates GWT at 27.5'
27	26.5					
28						
29						
30						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
326918.DE.FD.GE	B-14a	SHEET 2 OF 2

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : Gravel driveway W of Hwy 20

ELEVATION : Approx. 202 ft DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, 140 lb Autohammer, HSA

WATER LEVELS : 27.5 ft below ground surface START : 9/7/07 07:30 END : 9/7/07 13:00 LOGGER : R. Lawrence

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
30.0					Well graded SAND with Silt and Gravel (SW-SM): brown, wet, very dense, fine to coarse grained sand, estimated 30-50% subangular gravels, estimated 5-15% fines. Transitions gradually from mostly fine grained sand at top to mostly gravel at bottom.	Sand heaved around drill bit and bit became stuck inside the casing. Drill bit was eventually freed. Drilled down to 35.0', material was still sand. Sand was heaving substantially and made it difficult and time-consuming to remove auger and rod. Western States advised that they could not continue to drill this hole with Hollow Step Auger, auger and rod were removed at 12:45. SS-8 @ 08:35
31	31.5	1.5	8-SS	8-31-29 (60)		
32						
33						
34						
35						
36					Bottom of Boring at 35.0 ft below ground surface	Backfilled with 11 bags of bentonite chips
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326918.DE.FD.GE	B-14b SHEET 1 OF 2

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : 8 ft NE of B-14a

ELEVATION : Approx. 202 ft DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, 140 lb Autohammer, HSA

WATER LEVELS : START : 9/14/07 09:50 END : 9/14/2007 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1						Gravel road through manicured lawn with oaks at surface Weather 60°F, overcast Driller Arturo, Helper Adonis, start drilling at 10:08
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
326918.DE.FD.GE	B-14b	SHEET 2 OF 2

SOIL BORING LOG

PROJECT : North Albany Pump Station & Interceptor Pipeline, Albany, OR LOCATION : 8 ft NE of B-14a

ELEVATION : DRILLING CONTRACTOR : Western States

DRILLING METHOD AND EQUIPMENT : CME 55, 140 lb Autohammer, HSA

WATER LEVELS : START : 9/14/07 09:50 END : 9/14/2007 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
30.0					Well graded GRAVEL with Silt (GW-GM): brown, moist to wet, very dense, estimated 15% fines, gravel is rounded and broken.	SS-1 @ 11:27
31						
31.5	1.5	1-SS	28-26-26 (52)			
32						
33						
34						
35.0						
35					As above, except lightly cemented and more dense.	SS-2 @ 11:55
36	1.5	2-SS	20-30-38 (68)			
36.5						
37						
38						
39						
40.0						
40						
41.0	1.0	3-SS	40-50/5		As above, except more dense.	SS-3 @ 12:23
41						
42						
43						
44						
45.0						
45						
46.5	1.5	4-SS	6-6-8 (14)		CLAY (CL): greenish gray, moist, stiff, estimated 10% fine sand, very uniform, low plasticity.	SS-4 @ 12:55
46						
47						
48						
49						
50.0						
50						
51.5	1.5	5-SS	5-8-10 (18)		As above.	SS-5 @ 13:27
51						
52					Bottom of Boring at 51.5 ft below ground surface	Backfilled with __ bags of bentonite chips
53						
54						
55						
56						
57						
58						
59						
60						

Attachment B – Existing 2006 Technical Memorandum (TM-1)

Albany WSIP Pump Station and Force Main Geotechnical Evaluation

PREPARED FOR: Jack Burnam/Carollo Engineers

PREPARED BY: Paul Davis/CH2M HILL

COPIES: Craig Massie/CH2MHILL

DATE: July 3, 2006

Introduction

The purpose of this memorandum is to present the findings of geotechnical explorations for the proposed new wastewater force main and pump station for the City of Albany and provide foundation and construction recommendations. The new pump station is to be located near the intersection of Montgomery Street and Water Avenue, approximately 20 feet south of the top of the riverbank. The new force main will run from the new pump station along Water Avenue to Davidson Street, and then from Willamette Avenue to the wastewater treatment facility. The new pump station will be approximately 20 foot square and about 25 feet deep. The new force main will be 24 inch-diameter, with a material yet to be determined. The force main will be installed approximately 6 feet deep along most sections of the alignment.

A geotechnical subsurface exploration has been performed at the pump station site as well as 6 borings along the force main alignment. These locations are shown in Attachment A.

Authorization for this work is provided under a Standard Agreement for Professional Services between the City of Albany and CH2M HILL. The tasks included the following items:

- Summarizing subsurface soil and groundwater conditions at the proposed pump station site and select location along the proposed pipeline.
- Perform laboratory testing on select samples to confirm soil types and engineering properties
- Assessing seismicity for the project site.
- Establishing foundation design considerations, consisting of subsurface conditions, relevant soil properties, liquefaction susceptibility and settlement.
- Providing earthwork and construction recommendations.
- Preparing this summary memorandum

Subsurface Soil Explorations

Field explorations conducted for the project consisted of seven soil borings designated B-1 through B-7 located approximately as shown on the figures in Attachment A. The purpose of the field explorations was to determine subsurface conditions and to collect soil samples for visual classification and laboratory testing to determine engineering properties.

The soil borings were drilled on March 9-10 and April 21, 2006 by Geotech Explorations, a division of Boart Longyear from Tualatin, Oregon. The soil borings were advanced using a Mobile B-59 rubber-tired drill rig using hollow-stem auger drilling techniques. CH2M HILL provided continuous observation and logging of the boreholes.

Soil samples were typically collected from borings generally at either 2.5 or 5-foot intervals using a standard 2-inch-outside-diameter split-spoon sampler in accordance with the standard procedures outlined in American Society for Testing Materials (ASTM) D 1586, *Penetration Test and Split-Barrel Sampling of Soils*. This test is used to characterize the consistency of fine-grained soil or the relative density of coarse-grained soil by measuring penetration resistance expressed as blow counts, or N-value. The blow count is the number of blows required to advance a standard split-spoon sampler 6 inches with a 140-pound hammer falling 30 inches. The sampler is driven 18 inches and the blow count is recorded for each 6-inch increment. The sum of the blow counts for the second and third increments (1 foot) is referred to as the N-value in blows per foot (bpf). Low N-values indicate soft or loose soil; high N-values are evidence of hard or dense materials. After the sampler is driven and the blow counts are recorded, the sampler is withdrawn from the boring to recover a disturbed soil sample.

Relatively undisturbed, soil samples were obtained in 30-inch long, 3-inch diameter, thin-walled seamless steel tubes in general accordance with the standard procedures outlined in ASTM D 1587 (*Thin-Walled Tube Sampling of Soils*). The steel tubes were pushed, in one continuous stroke, approximately 24 inches into undisturbed soil with the hydraulic drive head of the drill rig. The tube, together with the encased soil, was removed from the ground and sealed. Tube samples were sealed and stored for use in laboratory testing and additional soil classification.

Soil samples from the borings were examined and visually classified in accordance with ASTM D 2488, *Visual-Manual Procedure for Description of Soils*. The visual classification of soil samples allows convenient and consistent comparison of soil samples using a standard method for describing the soil. Soil classification systems attempt to group soil having similar engineering behavior (based on index tests). Several classification systems have been developed, usually for a specific application. The system most generally accepted for a wide range of engineering applications is the Unified Soil Classification System (USCS). This method of classification provides a basis for comparing soils from widespread geographic areas.

Samples collected from the borings were placed in sealable plastic baggies to retain natural moisture content. Sampling intervals and field classifications of the soil samples are recorded on the boring logs which are provided in Attachment B.

Laboratory Testing

A laboratory-testing program was conducted to measure index soil properties and to estimate engineering characteristics for use in the engineering analysis. The laboratory-testing program was conducted by FEI Testing and Inspection, from Corvallis Oregon and included the following testing:

- *ASTM D 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.*
- *ASTM D 422, Standard Test Method for Particle-Size Analysis of Soils*
- *ASTM D 4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*

A comprehensive report from FEI Testing and Inspection is included in Attachment C.

Regional Geology

The project site is located in the central Willamette Valley, near the banks of the Willamette River. The local geology is described by the Oregon Department of Geology and Mineral Industries (DOGAMI) as Linn Gravels, Willamette Silt, and overland-channel deposit clays. Linn Gravels consist of deeply weathered, stratified gravels that may be partially covered at low elevations by Willamette Silt above elevation 300 feet (DOGAMI, 1953). The overland clays are older deposits generally located below the Linn Gravel and Willamette Silt.

Baldwin (1992) suggests that the prior to deposition of the Willamette silt, up to 150 feet of gravel and sand from the Rowland Formation spread over a broad area in the southern Willamette Valley. These gravels and sands are glacial outwash from the Cascades that was flushed into the valley by the North Santiam, South Santiam, Calapooia, and McKenzie Rivers.

Seismicity

Seismic events in the Willamette Valley are generally believed to result from two primary source mechanisms. One is the active subduction zone, where the Juan de Fuca plate subducts beneath the North American plate along the west coast. The other is shallow crustal sources generating lower magnitude earthquakes within the North American plate.

The Cascadia subduction zone sources include the Juan de Fuca-North American plate *interface* earthquakes, and *intraslab* earthquakes. Interface earthquakes are usually thrust faults at depths of less than 30 miles and are associated with the largest earthquakes observed worldwide. Intraslab earthquakes occur within the subducting Juan de Fuca plate, are deeper than interface earthquakes, and typically occur along normal faults.

Crustal sources are shallow earthquakes occurring within the North American plate. Crustal earthquakes are further categorized as occurring on *discrete fault sources* where repeated earthquakes have occurred in the geologic past, or within *areal source zones* where

earthquakes have been observed and will likely occur again, but have not been associated with any specific geologic features.

Of the two primary source mechanisms, the highest risk to the project site results from the active subduction zone (USGS).

Subsurface Conditions

Subsurface conditions encountered in the borings generally consist of low plasticity silt or lean clay from 0 feet to as deep as 11 feet with underlying dense gravel. The silt/clay is generally firm to very stiff in consistency and in some cases included some fine sand. Atterberg limits test run on samples in this layer indicated liquid limits of 29 and 42 and plasticity indexes of 7 and 17. Natural moisture contents were 25 and 26 percent. This silt/clay layer was encountered primarily in borings B-3, B-4, B-5, and B-6. SPT N-values ranged from a low of 4 to a high of 25 blows per foot. Pocket penetrometer test estimated unconfined compressive strength of about 3000 pounds per square foot. The material in this layer is generally consistent with properties of Willamette Silt.

Underlying the silt/clay layer is well-graded to silty gravel with sand. This layer was encountered in all the borings. The gravel is generally subrounded, and in many cases the gravel is larger than the sampler head (about 1.5 inches), indicating larger sized gravels. SPT N-values ranged from a low of 26 to greater than 50 blows per 6-inches. Sieve analyses were performed on select samples. The result of these test are summarized in Attachment C. This layer is likely part of the Linn Gravel formation.

In boring B-1, lean to fat greenish gray clay was encountered at a depth of 30 feet. The clay is firm to stiff in consistency with SPT N-Values of 6 and 12 blows per foot. It is likely this is part of the Calapooia Clay formation.

No indication of hazardous waste contamination was found in any of the test borings.

Groundwater Conditions

Groundwater was only encountered in boring B-7 at a depth of 19 feet (approximate elevation 192 feet). Wet soil conditions were encountered in boring B-1 at a depth of 25 feet (approximate elevation 181 feet) however, caving of the boring prevented accurate measurement of groundwater. These groundwater levels are expected to fluctuate throughout the season with the changes in the Willamette River level during periods of high precipitation and seasonal rain.

Discussion and Analyses

Foundations

It is our recommendation that the pump station and force main can be supported on conventional shallow foundations. Maximum bearing pressures should be limited to no more than 2,800 pounds per square foot to limit total settlement to less 1-inch. It is likely that the pump station will be founded in the dense gravel layer previously described where the bearing capacity will be sufficient to support the structure and deep enough to likely be below normal scour depths.

Visual observations of the riverbank from the pump station site indicated that the riverbank does not currently have noticeable erosion protection in this location to prevent the natural recession of the Willamette Riverbank that frequently occurs along this stretch of the river. This recession can occur in a variety of ways including (i) undercutting from scour and sliding of oversteepened slopes, (ii) debris flows of vegetation and saturated overburden soil, (iii) rapid drawdown following flooding events, and (iv) deep seated failures from weak soils. The extent as to which these occur is beyond the scope of this evaluation and will require additional hydraulic, riverbank reconnaissance, and additional slope stability and riverbank protection studies. However, based on the visual observations during the exploration activities, no deep seated sliding or significant erosion of the riverbank was observed.

Current conceptual designs indicate the pump station and control building will be located at least 20 feet from the top of the river bank, which has an approximate slope of 1 horizontal to 1 vertical (1H:1V). Careful consideration should be given to the location of any ancillary structures such as the control building and auxiliary power generators that would be located near the ground surface and near the top of the riverbank where undermining could occur over time. These structures should be located a sufficient distance beyond the top of the riverbank to prevent undermining from erosion, scour, or land sliding. Additionally, sufficient slope protection systems should be installed to prevent erosion of the riverbank.

If the location of the control building is to be located as shown in Attachment A with a distance of 20 feet from the top of riverbank, a riverbank protection system must be installed (such as riprap) prior to construction along this section of riverbank to prevent the slope from receding and potentially undermining the control building. Our experience has shown that riverbank protection of the Willamette River with riprap between Corvallis-Albany has proven effective in preventing riverbank recession and erosion. Additionally, we have seen that natural vegetation such as blackberries and other small brush grow in with the riprap to provide a more aesthetic appearance and provide an added measure of erosion protection.

With an existing 1H:1V slope, riprap protection can be installed with relatively minimal subgrade preparation or earthwork, as well as minimizing the volume of riprap required. In-water work periods and permit requirements need to be considered so that the work can take place during summer/early fall with river levels should be low.

Seismic Design Criteria

The primary reference source used to establish the seismicity at the project site are the U.S. Geological Survey (USGS) internet site resources (listed in the References section at the end of this report). Seismic design criteria were developed according to procedures outlined in the 2003 International Building Code (IBC).

The ground acceleration for the project area is based on a 2,500-year level event in accordance with the IBC. The 0.2-second spectral acceleration will be approximately 0.74g, based on the USGS web site (http://geohazards.cr.usgs.gov/eq/index.html). According to the IBC, site coefficient amplifications and reduction factors should be applied to the 0.2-second spectral acceleration to determine the design level ground accelerations at the ground surface.

The site coefficient takes into account how local site geology can result in amplification or attenuation of the firm-ground acceleration, depending on soil conditions at the site and the level of firm-ground acceleration. Based on the IBC procedures, some ground motion amplification is expected to occur at the project site.

For this project, procedures given in the 2003 edition of the IBC were used to determine the design peak ground acceleration (PGA) at the ground surface. Based on the soil type and density of the material encountered during the geotechnical explorations for the project, the site was classified as a Soil Profile Type S_D. The seismic design criteria for structural consideration (spectral acceleration) and PGA at ground surface for geotechnical consideration is summarized in Table 1. MCE is the maximum considered earthquake, based on 2,500-year mapped spectral accelerations (USGS/IBC).

TABLE 1
Seismic Design Criteria
Albany FS/PS

Site Classification	***S_D***
Ss (mapped short period spectral acceleration)	0.74g
S_1 (mapped 1-second period spectral)	0.34g
F_a (site coefficient short period)	1.2
F_v (site coefficient 1-second period)	1.73
S_{MS} (adjusted MCE short period)	0.88g
S_{M1} (adjusted MCE 1-second period)	0.59g
S_{DS} (design spectral short period)	0.59g
S_{D1} (design spectral 1-second period)	0.39g
PGA at Ground Surface	0.24g

To determine the design seismic acceleration expected to occur at the ground surface (period of zero) based on 2003 IBC procedures, the PGA at the ground surface is equal to the product of the 0.2-second spectral acceleration (0.74g) times the site coefficient (1.2), and

applying IBC reduction factors of 2/3 and 0.4, giving a design acceleration of 0.23g (equation 16-42).

Considering the generally deep water level (about 20 feet) and the dense/stiff subsurface conditions, our analysis of the soils indicated that liquefaction of the material beneath the pump station and force main is unlikely.

Dewatering

Based on groundwater measurements taken from the borings, it is not likely that groundwater or dewatering will be a significant issue for construction of the wastewater force main. With trenching only expected to be about 10 to 12 feet maximum, groundwater should be below this depth unless construction is performed during a period of heavy rain or high river levels. Therefore, it is possible that dewatering efforts in the trench could be minimal. However at the pump station site it is anticipated that groundwater will be present in the lower 5 to 10 feet of the excavation, which will be in relatively permeable soils. If construction activities are performed during the late spring and summer, this level is likely to be minimized and construction "in the dry" may be possible. However it is recommended that construction procedures "in the wet" be considered as a possibility as a tremmie seal may be the only means to prevent significant groundwater flows.

Excavation and Trenching

It is anticipated that only uncontaminated soils will be encountered during excavation of the pump station and trenching for the pipeline. No rock formations are expected. It is anticipated that excavation and trenching can be accomplished by standard heavy-duty hydraulic construction equipment. Excavation support and excavation sloping should be designed and maintained by the general contractor with a licensed PE in Oregon retained. Extreme care should be taken when designing and installing excavation support or trench support systems to prevent movement of damage to existing facilities including the adjacent Portland and Western Railroad, and existing underground utilities. It is expected that a portion of the force main installation near B-3 will require jack and bore techniques as the pipeline will under cross the railroad. This will also require careful study to minimize disturbance to adjacent private properties.

Use of Excavated Material

It expected that material removed from the excavations for the new structures will be primarily low plasticity or granular soils that can be used for backfill around or above the new structures. The volume of the material removed will be much greater than that required for backfill and anticipated grading requirements, and therefore will either need to be removed offsite by the contractor, or the City will need to provide the means for use or local stockpiling of the material. Careful monitoring of compaction and relatively frequent sampling and testing of the excavation spoils will be required as material to be compacted will vary from sand and gravel to low plastic clays that will have noticeable different compaction requirements.

Limitations

This report has been prepared for the exclusive use of Carollo Engineers, and the City of Albany, for specific application to the proposed Albany Force Main and Pump Station project which is part of the wastewater treatment plant expansion project. This report has been prepared in accordance with generally accepted geotechnical engineering practice. No other warranty, express or implied, is made.

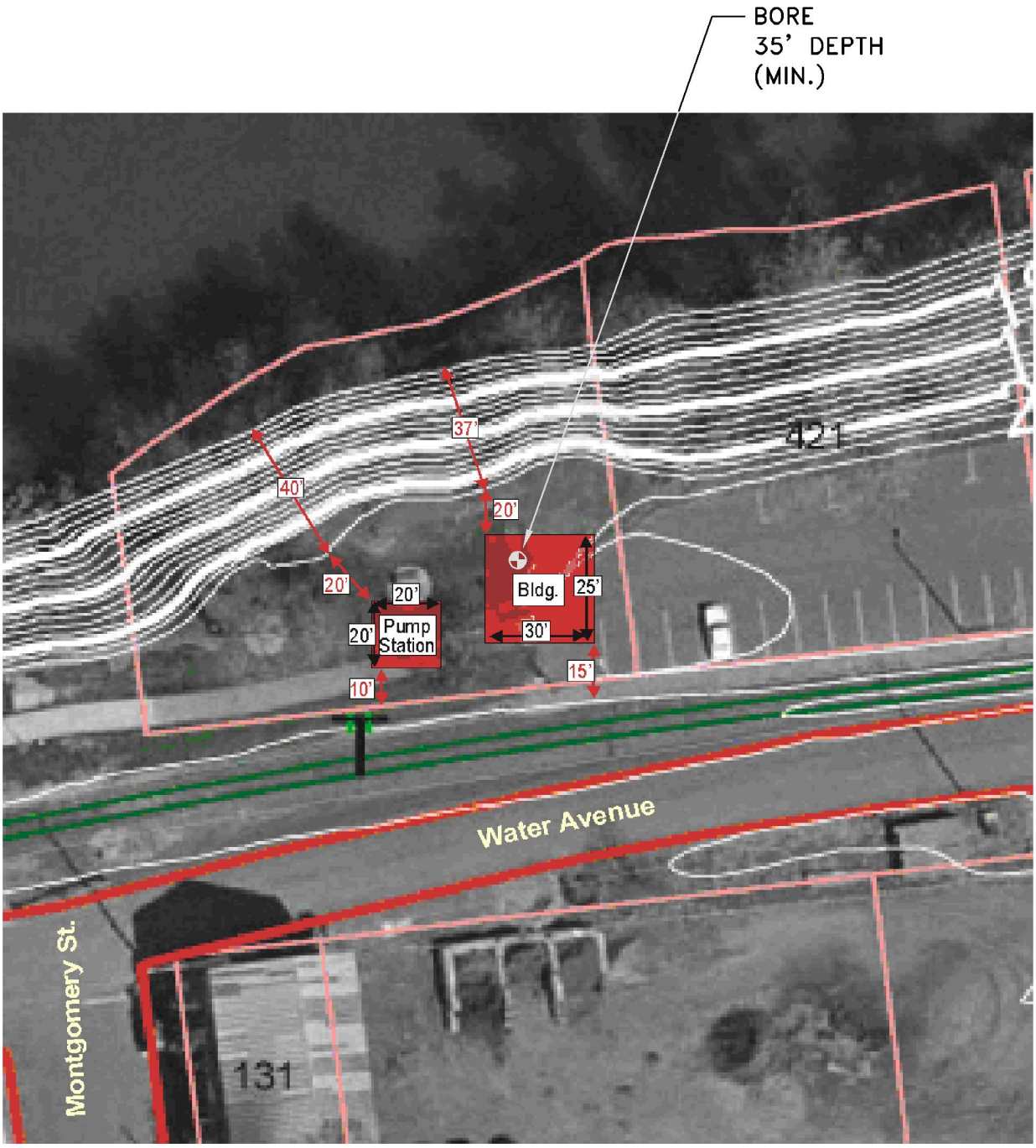
The information contained in this report is based on the data obtained from the field exploration described herein. The explorations indicate soil conditions and groundwater levels only at specific locations, and only to the depths penetrated. They do not necessarily reflect variations that may exist between exploration locations. Also, the passage of time may result in a change in the conditions at these locations.

In the event that any changes in the nature, design, or location of the facilities are planned, the information contained in this report should not be considered valid unless the changes are reviewed and the data verified in writing by CH2M HILL. CH2M HILL is not responsible for any claims, damages, or liability associated with interpretation of subsurface data, or for the reuse of subsurface data, without the express written authorization of CH2M HILL.

References

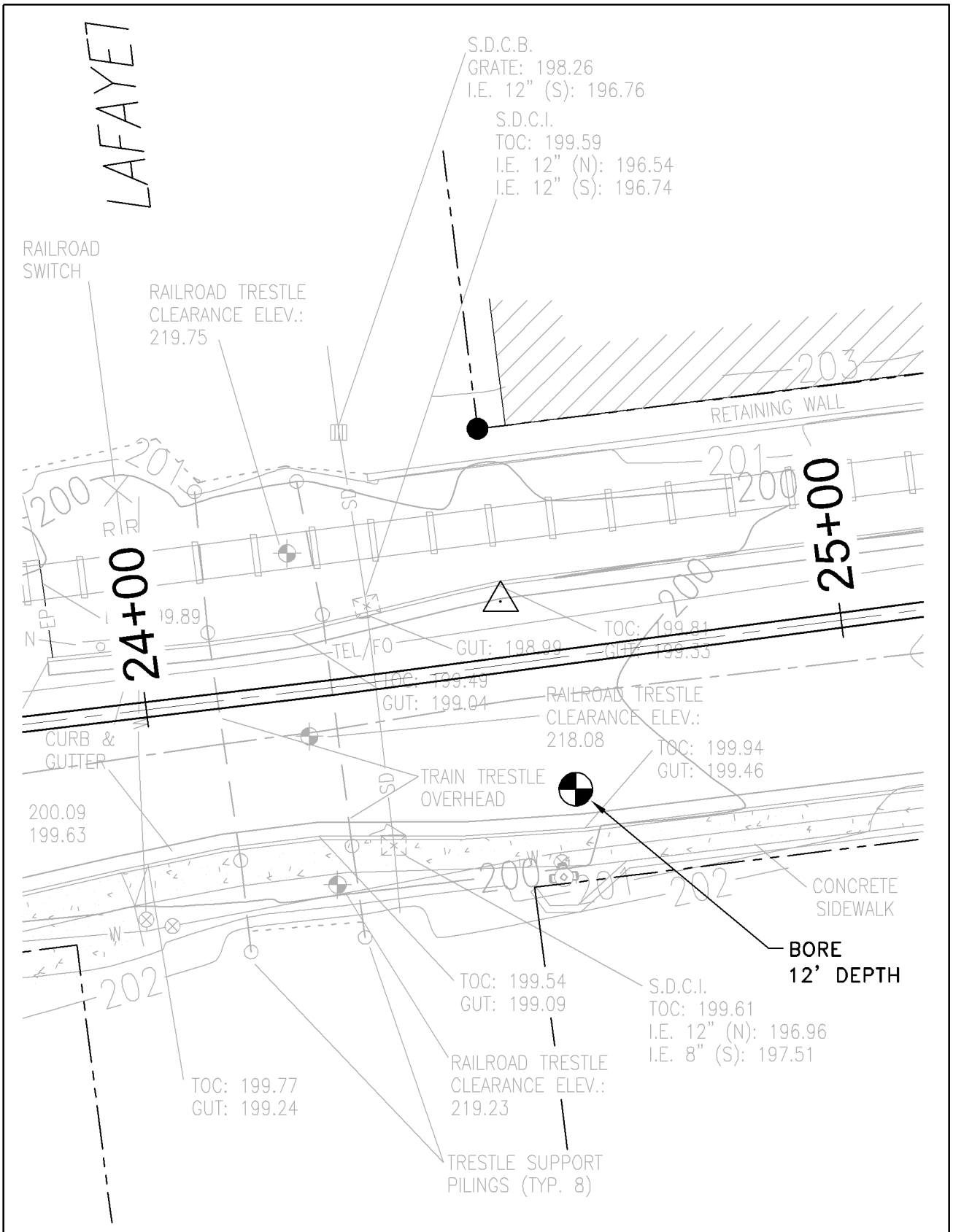
DOGAMI (1953). *Reconnaissance Geologic Map of the Albany Quadrangle.* Issued by State of Oregon Department of Geology and Mineral Industries. Geology by Ira S. Allison.

Baldwin (1992). Baldwin, Ewart M., Elizabeth L. Orr, and William N. Orr. *Geology of Oregon.* Fourth Edition.



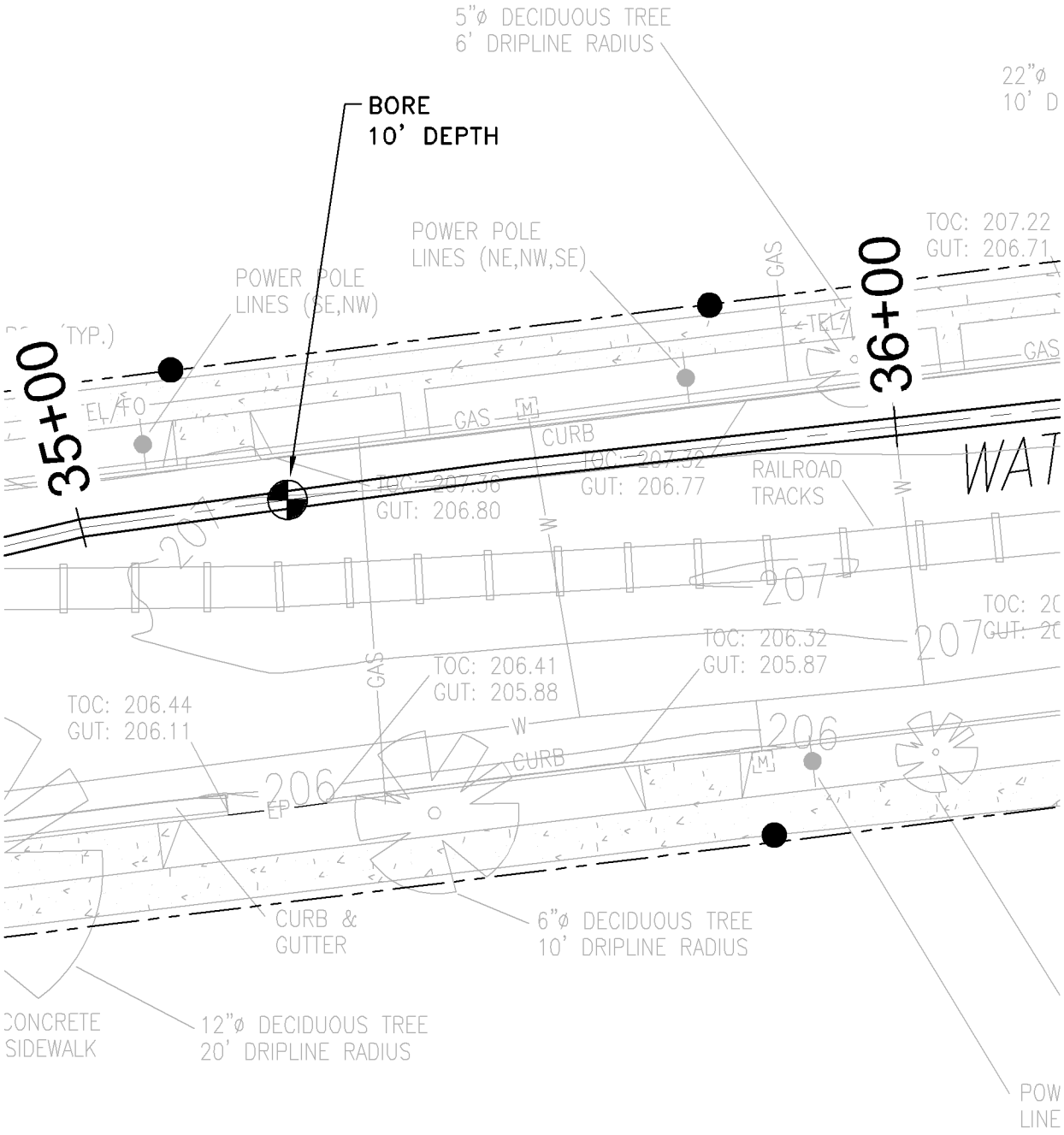
WWPS FORCE MAIN
BORE HOLE LOCATION NO. 1
CITY OF ALBANY

carollo engineers



WWPS FORCE MAIN
BORE HOLE LOCATION NO. 2
CITY OF ALBANY

carollo engineers



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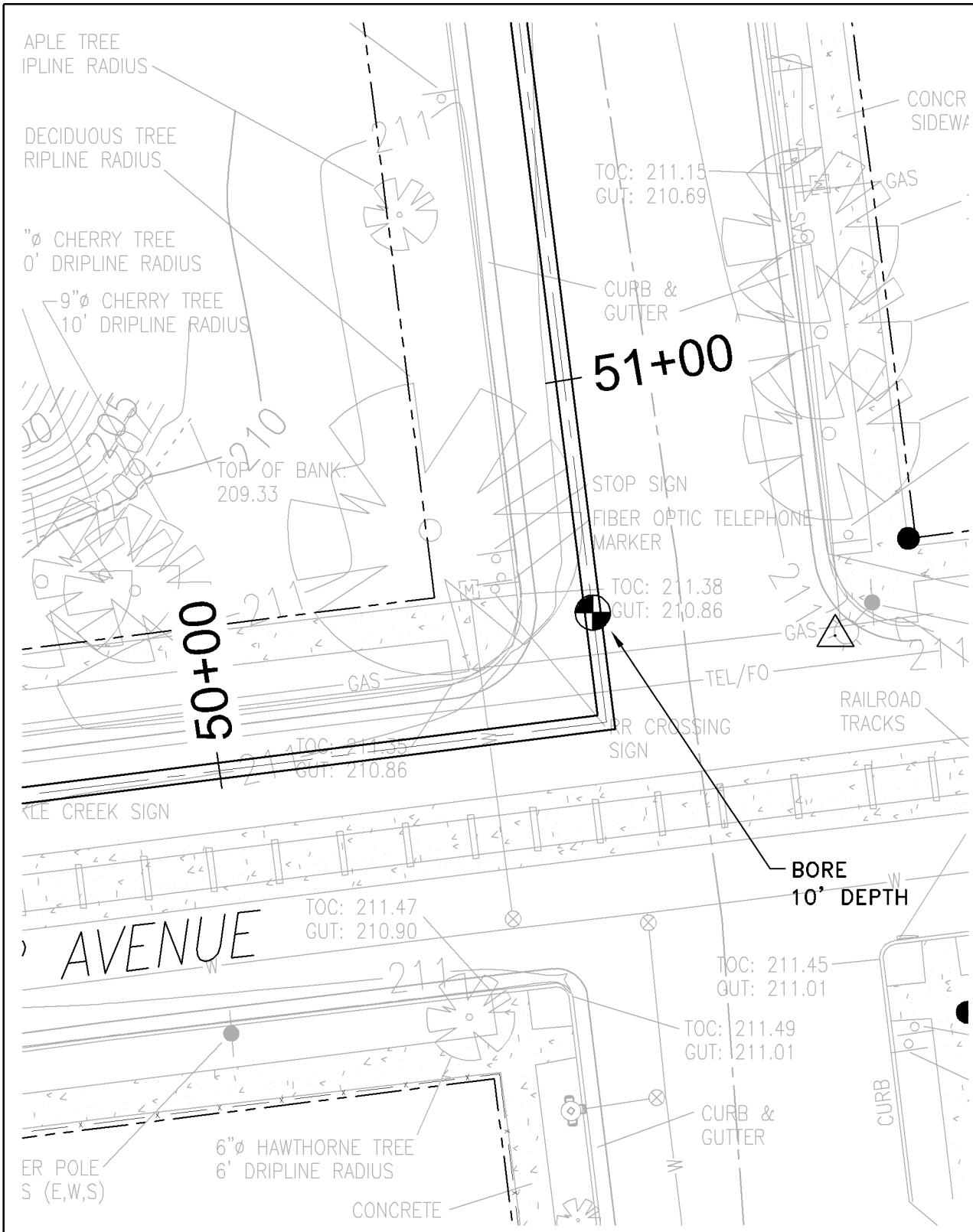
BORE HOLE LOCATION NO. 3
CITY OF ALBANY

carollo engineers



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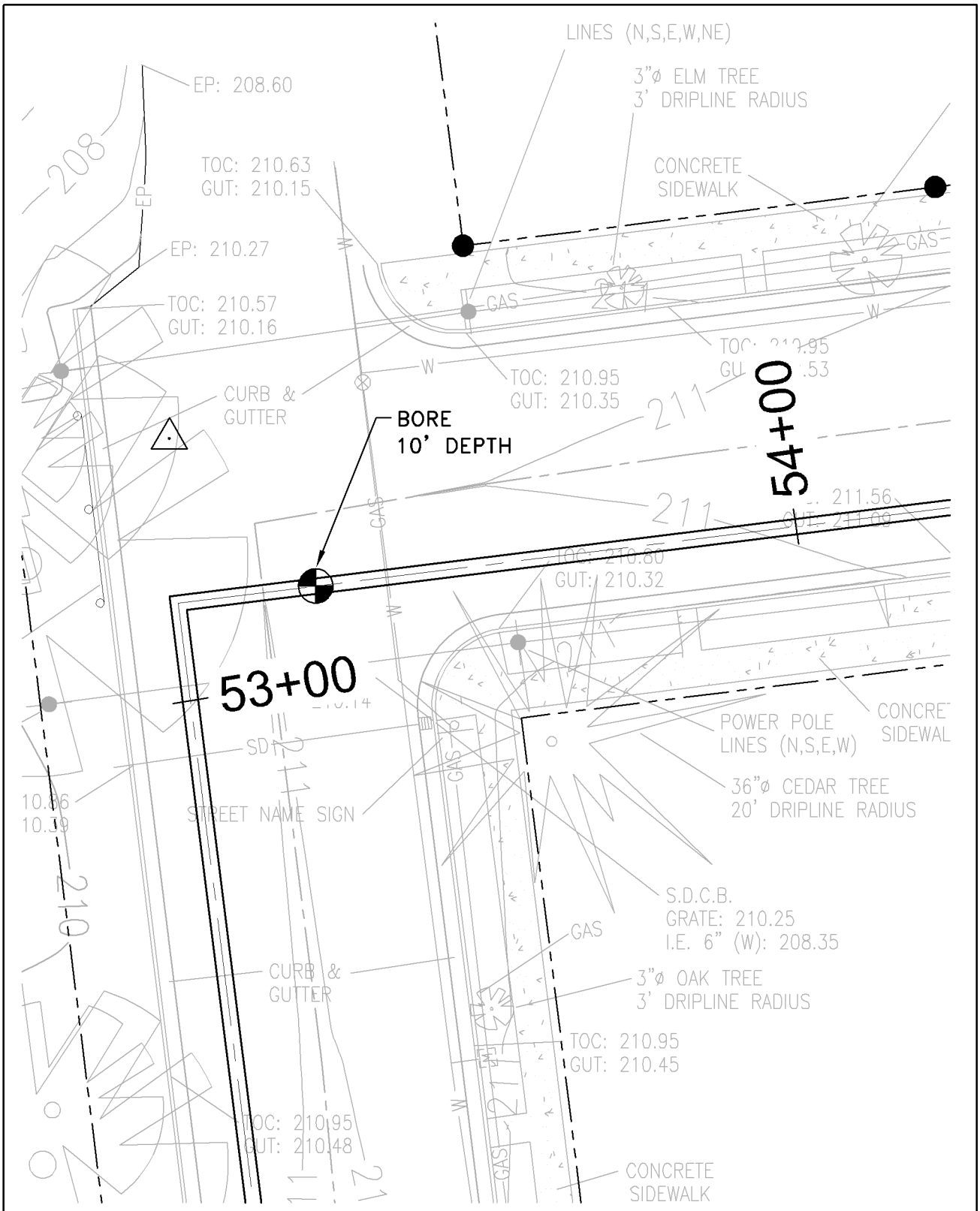
CITY OF ALBANY

carollo engineers



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BORE HOLE LOCATION NO. 5
CITY OF ALBANY

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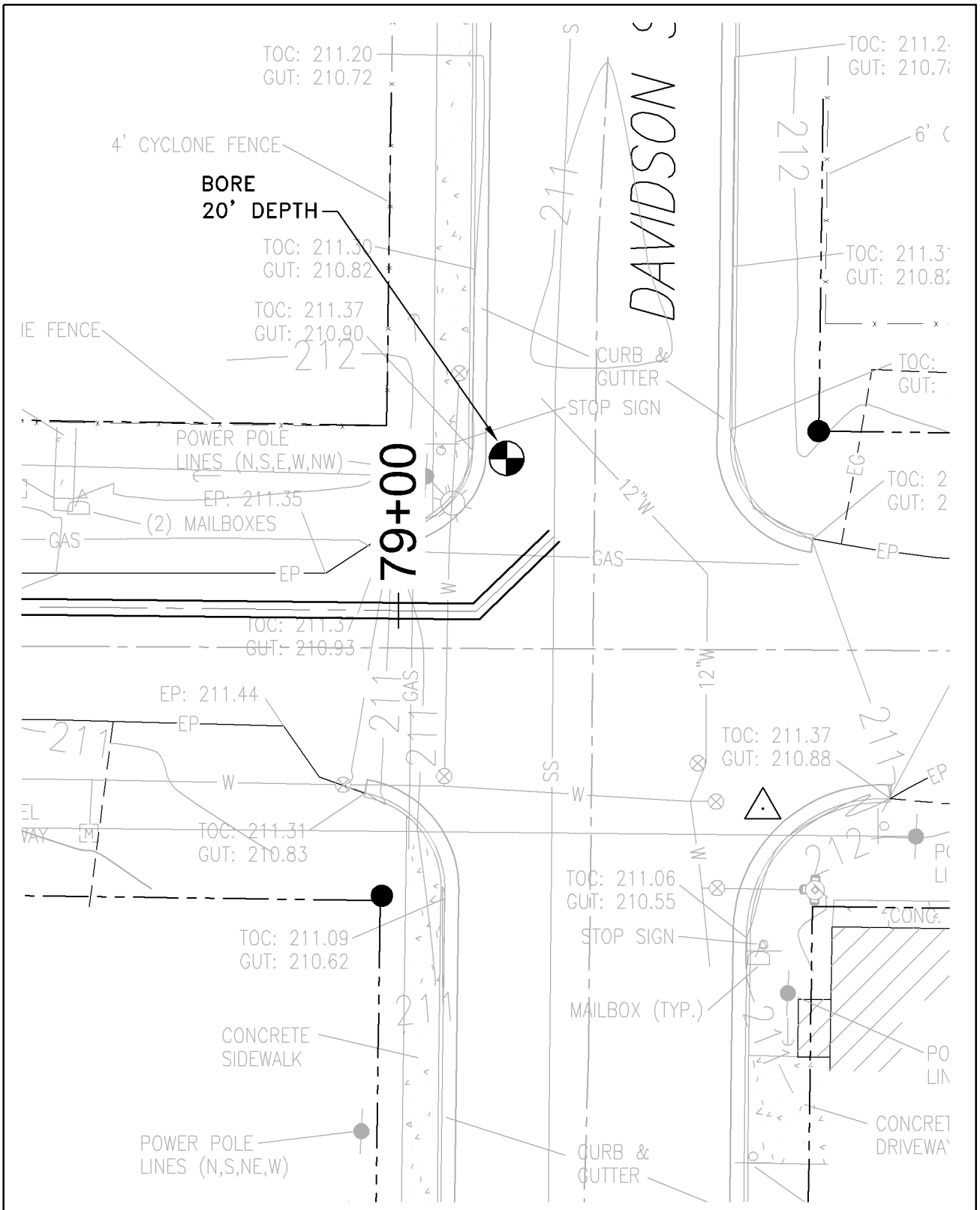

WWPS FORCE MAIN
BORE HOLE LOCATION NO. 6
CITY OF ALBANY

carollo engineers

Attachment A – 2006 Boring Logs

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326918.PE.GE	B-1 SHEET 1 OF 2

SOIL BORING LOG

PROJECT : Albany Pump Station and Force Main, Albany, Oregon LOCATION : Montgomery St/Water Avenue

ELEVATION : 206.0 ft DRILLING CONTRACTOR : Geotech Explorations, Eugene OR

DRILLING METHOD AND EQUIPMENT : CME 75, 4.25" I.D. HSA

WATER LEVELS : --- START : 4/21/06 08:40 END : 4/21/2006 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1					Organic topsoil with lush sod.	55°F, Rain, Calm. Dig out sod patch.
2	2.5					
3		0.8	1-SS	5-3-2 (5)	Silty GRAVEL (GM): brown to black with orange staining, moist, loose, about 60% angular to rounded gravel, fines are plastic, glass shards (Fill?).	
4	4.0					
5	5.0					
6		0.8	2-SS	3-2-2 (4)	Elastic SILT with GRAVEL (MH): brown to gray with orange staining, moist, soft, organics present, roots, gravel is angular to rounded, less than 15% gravel.	
7	7.5					
8		1.5	3-SS	7-3-4 (7)	Top 2": GRAVEL trending to medium silty SAND. Bot 13": Sandy SILT (ML): brown with orange staining and gray mottling, moist, soft, organic inclusions, about 15% fine to medium-grained sand.	PP = 1.5 to 1.75 tsf
9	9.0					
10	10.0	1.3	1-ST	push		
11		1.5	4-SS	17-13-13 (26)	Well-graded GRAVEL with SILT (GW-GM): brown to gray, hard, moist, about 55% subrounded to rounded gravel, 40% fine to coarse sand, 0.5% silt. Bot 4": Becomes silty sand, orange mottling.	Tube hits hard material at 10.0' bgs, 1000 psi. Remove tube, SPT follow.
12	11.5					
13						
14						
15	15.0					
16		0.4	5-SS	18-42-42 (84)	Silty GRAVEL (GM): brown, moist, very hard, coarse sand to broken gravel pieces near I.D. of sampler. About 55% gravel, 20% fine to coarse sand, 25% nonplastic silt.	Suspect larger gravels/cobbles at depth, broken to fit into sampler.
17	16.5					
18						
19						
20	20.0					
21		1.5	6-SS	13-26-33 (59)	Well-graded GRAVEL (GW): brown with some orange staining, dry to moist, very dense, about 60% gravel, 30% fine to coarse sand, 10% silt, gravel is subrounded to rounded, some pieces broken to fit I.D. of sampler, estimate less than 2" diameter in-situ.	Auger steaming, driller notes gravel is "tough stuff".
22	22.5					
23						
24						Rig chatter.
25	25.0					
26		1.3	7-SS	21-31-27 (58)	As above, except only top 6" are wet.	WET
27	26.5					
28						
29						
30						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326918.PE.GE	B-1 SHEET 2 OF 2

SOIL BORING LOG

PROJECT : Albany Pump Station and Force Main, Albany, Oregon LOCATION : Montgomery St/Water Avenue

ELEVATION : 206.0 ft DRILLING CONTRACTOR : Geotech Explorations, Eugene OR

DRILLING METHOD AND EQUIPMENT : CME 75, 4.25" I.D. HSA

WATER LEVELS : --- START : 4/21/06 08:40 END : 4/21/2006 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
31	30.0 – 31.5	1.5	8-SS	7-2-4 (6)	Fat CLAY (CH): greenish gray, dry to moist, soft, less than 5% sand.	PP = 1.5 to 2.5 tsf
35	35.0					
36	36.5	1.5	9-SS	5-5-7 (12)	Lean CLAY (CL): greenish gray, color similar to above except more green, dry to moist, firm to stiff.	PP = 2.5 to 3.5 tsf
37					Bottom of Boring at 36.5 ft below ground surface	Backfill hole with bentonite chips, 1.0' soil, and sod patch.

PROJECT NUMBER:	BORING NUMBER:
326918.PE.GE	B-2 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Albany Pump Station and Force Main, Albany, Oregon LOCATION : Corner of Water Street and Lafayette

ELEVATION : 199.5 ft DRILLING CONTRACTOR : Geotech Explorations, Tualatin OR

DRILLING METHOD AND EQUIPMENT : Mobile B-59 Truck Mounted, HSA

WATER LEVELS : --- START : 3/9/06 09:00 END : 3/9/06 10:15 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1					5" Asphalt Roadway	34°F, Rain/Snow.
2	2.5					SPT performed with rope and rotating cathead.
3	3.4	0.8	1-SS	41-50/5" (50/5")	Well-graded GRAVEL with SILT and SAND (GW-GM): brown, moist, very dense, 60% subrounded gravel, 30% sand, 10% silt.	
4						
5	5.0					
6		1.2	2-SS	12-49-27 (76)	As above, except gravel is subangular to subrounded, approximately 40% coarse sand.	
7	6.5					
8						
9						
10	10.0					
11	10.9	0.9	3-SS	21-50/5" (50/5")	Top 2": Medium SAND. Bot 10": Well-graded GRAVEL (GW): as above, gravel pieces subangular to subrounded.	Backfill hole with bentonite chips, asphalt sealed with cold-patch asphalt.
12					Bottom of Boring at 10.9 ft below ground surface	
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326918.PE.GE	B-3 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Albany Pump Station and Force Main, Albany, Oregon LOCATION : Corner of Water Street and Main St

ELEVATION : 206.0 ft DRILLING CONTRACTOR : Geotech Explorations, Tualatin OR

DRILLING METHOD AND EQUIPMENT : Mobile B-59 Truck Mounted, HSA

WATER LEVELS : --- START : 3/9/06 10:30 END : 3/9/06 11:15 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1					4" Asphalt Roadway	SPT performed with rope and rotating cathead.
2	2.5					
3		1.5	1-SS	1-2-4 (6)	Lean CLAY (CL): gray to brown, moist, firm, low to medium plasticity, trace organics.	PP = 1.25 to 1.75 tsf
4	4.0					
5	5.0					
6		1.5	2-SS	6-7-13 (20)	Lean CLAY with fine SAND (CL): moist, very stiff, low plasticity, 5 to 10% sand.	PP = 1.75 tsf
7	6.5 / 7.5					
8		1.5	3-SS	7-9-16 (25)	As above, except with some orange mottling.	
9	9.0					
10	10.0					Driller notes gravel encountered at 9.5' bgs.
11	11.0	0.8	4-SS	1-50/6" (50/6")	Well-graded GRAVEL with SAND (GP): brown, moist, very dense. Some pieces same size as I.D. of sampler, broken from larger pieces.	Backfill hole with bentonite chips, asphalt sealed with cold-patch asphalt.
12					Bottom of Boring at 11.0 ft below ground surface	
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
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29						
30						

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
326918.PE.GE	B-4 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Albany Pump Station and Force Main, Albany, Oregon LOCATION : Water St and Cleveland St

ELEVATION : 211.0 ft DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Mobile B-59 Truck Mounted, HSA

WATER LEVELS : --- START : 3/9/06 11:30 END : 3/9/06 12:30 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1					2" Asphalt Roadway, Gravel	34°F, Rain/Snow, Windy.
2	2.5					
3		1.1	1-SS	4-5-4 (9)	SILT (ML): brown with orange mottling, moist, firm, low plasticity, trace organics.	
4	4.0					
5	5.0					
6		1.5	2-SS	5-10-11 (21)	As above, except brown with some orange and gray mottling.	
7	6.5					
8						
9						
10	10.0					
11	11.0	0.8	3-SS	24-50/4" (50/4")	Well-graded GRAVEL with SAND and SILT (GP-GM): brown, moist, very dense, 60% subrounded gravel, 20% sand, 20% silt.	Backfill hole with bentonite chips, asphalt sealed with cold-patch asphalt.
12					Bottom of Boring at 11.0 ft below ground surface	
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
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25						
26						
27						
28						
29						
30						

PROJECT NUMBER:	BORING NUMBER:
326918.PE.GE	B-5 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Albany Pump Station and Force Main, Albany, Oregon LOCATION : Front St and Cleveland St

ELEVATION : 211.0 ft DRILLING CONTRACTOR : Boart Longyear

DRILLING METHOD AND EQUIPMENT : Mobile B-59 Truck Mounted, HSA

WATER LEVELS : --- START : 3/9/06 13:00 END : 3/9/06 13:45 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1					Asphalt Roadway	34°F, Rain/Snow, Wind.
2	2.5					
3		1.5	1-SS	5-10-16 (26)	SILT (ML): brown with some orange and gray mottling, moist, very firm, low plasticity.	
4	4.0					
5	5.0					
6	6.5	1.5	2-SS	7-11-16 (27)	As above, except no mottling.	
7						
8						
9						
10	10.0					
11	11.4	1.3	3-SS	8-39-50/4" (89/10")	Top 6": SILT (ML) as above. Mid 6": SILT with SAND (ML): brown, moist, very firm, low plasticity, with 30% sand. Bot 6": GRAVEL with SAND (GW): moist, very dense, subangular, broken to fit I.D. of sampler.	
12						Backfill hole with bentonite chips, asphalt sealed with cold-patch asphalt.
13					Bottom of Boring at 11.4 ft below ground surface	
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

PROJECT NUMBER:	BORING NUMBER:
326918.PE.GE	B-6 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Albany Pump Station and Force Main, Albany, Oregon LOCATION : Corner of Geary and Willamette

ELEVATION : DRILLING CONTRACTOR : Geotech Explorations, Tualatin OR

DRILLING METHOD AND EQUIPMENT : Mobile B-59 Truck Mounted, HSA

WATER LEVELS : --- START : 3/9/06 14:15 END : 3/9/06 15:15 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1					2" Asphalt Roadway	34°F, Rain/Snow, Wind.
2	2.5					
3		1.5	1-SS	4-9-10 (19)	SILT with SAND (ML): brown, moist, low plasticity, approximately 15% sand.	
4	4.0					
5	5.0					
6		0.8	2-SS	18-38-40 (78)	Well-graded GRAVEL with SILT (GW-GM): brown, moist, 60% subrounded gravel with angular pieces broken by sampler (estimated 1.5" to 2.5" intact), 25% coarse to medium sand, 15% silt. Bot 2": appears to be basaltic cobble.	Driller notes that gravel is reached at 5.0' bgs.
7	6.5					
8						
9						
10	10.0					
11		1.4	3-SS	20-32-50/5" (82/11")	Well-graded GRAVEL with SILT (GW-GM): brown with orange mottling and sapprolitic (?) decomposed pieces, moist, approximately 15% nonplastic fines, 65% subrounded gravel with angular faces broken by sampler, 20% sand. Gravel appears to be basalt.	
12	11.4				Bottom of Boring at 11.4 ft below ground surface	Backfill hole with bentonite chips, asphalt sealed with cold-patch asphalt.
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

PROJECT NUMBER:	BORING NUMBER:
326918.PE.GE	B-7 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Albany Pump Station and Force Main, Albany, Oregon LOCATION : Davidson and Willamette

ELEVATION : 211.0 ft DRILLING CONTRACTOR : Geotech Explorations, Tualatin OR

DRILLING METHOD AND EQUIPMENT : Mobile B-59 Truck Mounted, HSA

WATER LEVELS : 19.0 ft below ground surface START : 3/10/06 08:30 END : 3/10/2006 LOGGER : M. Kacmarcik

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
1					3" Asphalt Roadway	34°F, Light Rain/Snow, Wind 15 mph from South.
2	2.5					
3		0.1	1-SS	7-9-10 (19)	Well-graded GRAVEL with SILT and SAND (GP-GM): brown, moist, dense, gravel rounded, 20% sand, 15% silt, 65% gravel.	8:45 am only 1.5" recovery.
4	4.0					
5	5.0					
6	5.8	0.7	2-SS	12-50/3" (50/3")	Top 6": Silty SAND (SM): brown, moist, dense, medium to fine sand. Bot 2": Cobble, broken angular pieces.	8:54 am driller pauses 9:05 am initiate SPT
7						
8						
9						
10	10.0					
11		0.7	3-SS	12-20-35 (55)	Well-graded GRAVEL (GW): brown with orange mottling, moist, dense, angular pieces broken from subrounded gravel, estimate 2-3" diameter in-situ.	9:18 am
12	11.5					
13						
14						
15	15.0					
16		1.2	4-SS	6-21-25 (46)	Well-graded GRAVEL (GW): brown with orange mottling, moist, 50% fine to coarse sand, 50% subrounded gravel.	9:28 am
17	16.5					
18						
19						
20	20.0					Water encountered at 19.0' bgs.
21	20.1	0.3	5-SS	50/1" (50/1")	Poorly-graded SAND wih SILT (SLOUGH): brown, wet, very dense, subangular to subrounded.	9:42 am 1 wrap on cathead. Backfill hole with bentonite chips, asphalt sealed with cold-patch asphalt.
22					Bottom of Boring at 20.1 ft below ground surface	
23						
24						
25						
26						
27						
28						
29						
30						

Attachment B – Laboratory Test Results

FEI TESTING & INSPECTION, INC.

Geotechnical & Construction Services

LETTER OF TRANSMITTAL

Date: April 27, 2006

Project No.: 2066003-503
Report No. C-09125

Re: Albany PS & FM

To: CH2M Hill, Inc.
P.O. Box 428
Corvallis, OR 97339

Attn: Paul Davis

Enclosed are:

- ☐ Report
- ☐ Copy of Letter
- ☐ Other
- ☐ Drawings
- ☐ Specifications
- ☑ Test Results (4 Pages Total Incl. Cover)

These are transmitted as checked below:

- ☑ For your use
- ☑ As requested
- ☐ For your review/approval
- ☐ For your files

Remarks: Requested laboratory testing results attached. Please call if you have any questions.

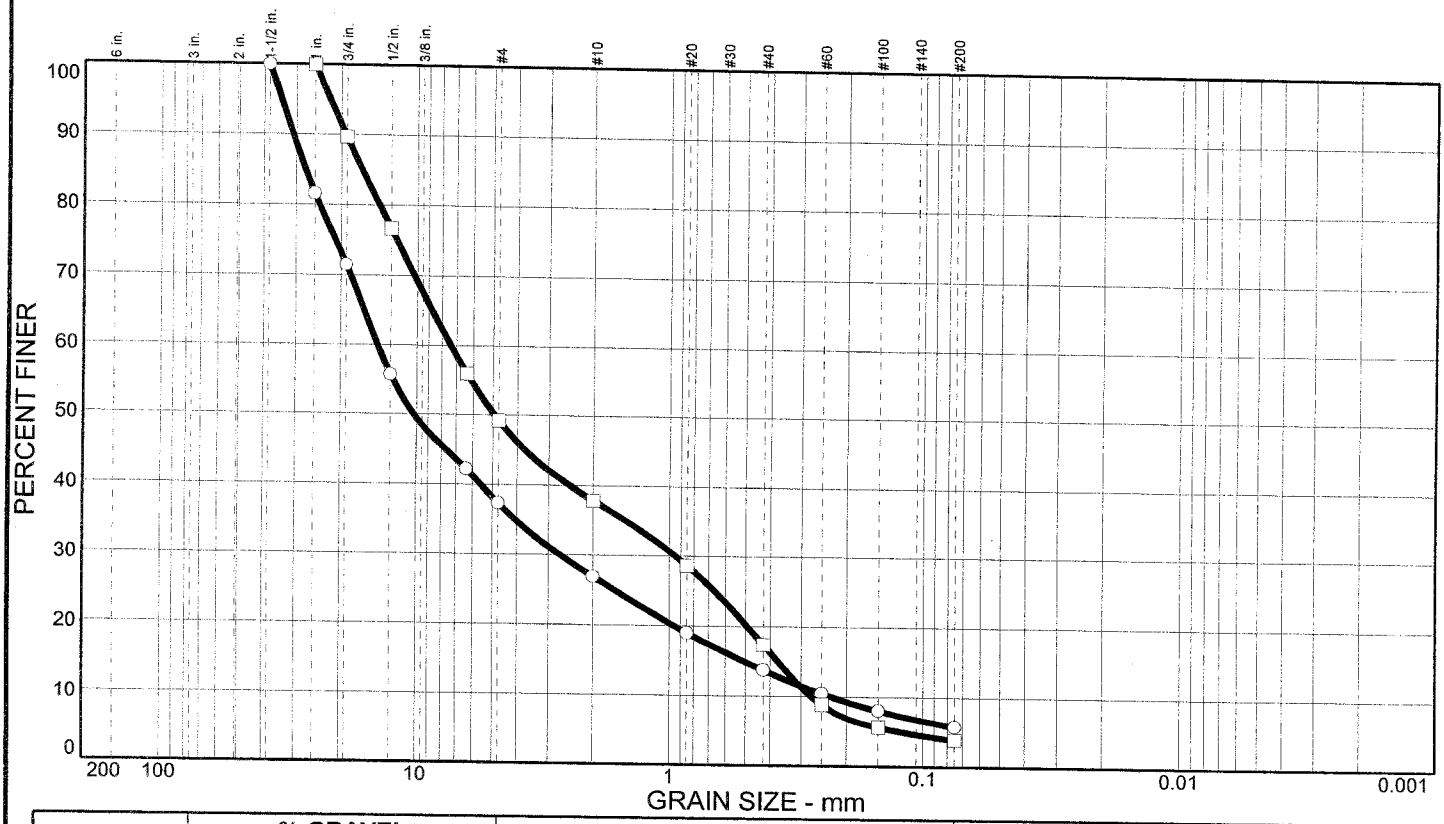
Copy to:

Signature:

Kevin C. Berklund
Laboratory Supervisor

750 NW Cornell Avenue · Corvallis, Oregon 97330 · phone (541) 757-4698 · fax (541) 757-2991
29540 B Airport Road · Eugene, Oregon 97402 · phone (541) 684-3849 · fax (541) 684-3851

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	28.5	34.1	10.5	13.1	8.0	5.8	
□	0.0	10.3	40.5	11.3	20.5	13.5	3.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			27.6	14.3	10.3	2.70	0.505	0.228	2.24	62.78
□			16.5	7.38	4.94	0.946	0.372	0.273	0.44	27.02

MATERIAL DESCRIPTION	USCS	AASHTO
○ Well-graded gravel with silt and sand	GW-GM	A-1-a
□ Poorly graded gravel with sand	GP	A-1-a

Project No. 326918.PE.GE **Client:** CH2M Hill

Project: Albany PS & FM

○ **Source:** 3170 **Sample No.:** B-2/2-SS **Elev./Depth:** 5.0-6.5

□ **Source:** 3170 **Sample No.:** B-7/4-SS **Elev./Depth:** 15.0-16.5

Remarks:

○ Water Content: 9.3%

□ Water Content: 8.8%

Particle Size Distribution Report

FEI Testing & Inspection, Inc.
Corvallis, OR

Figure 1

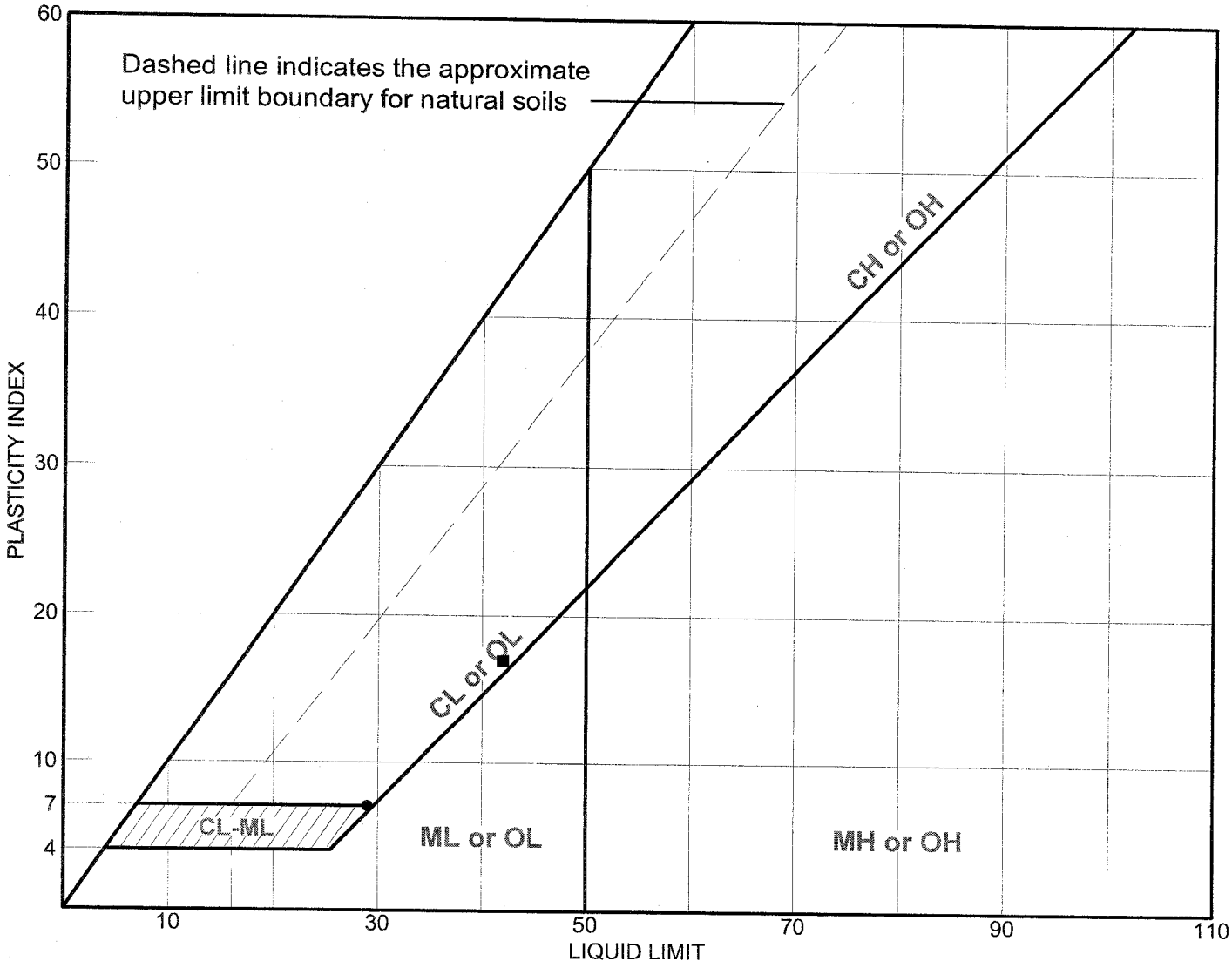
FEI Testing & Inspection, Inc.
Albany PS & FM
Project 2066003-503

Table 1. Sieve Analysis

Sieve Size	Percent Passing	
	B-2/2-SS*	B-7/4-SS*
1 1/2”	100.0	
1”	81.6	100.0
3/4”	71.5	89.7
1/2”	55.7	76.7
1/4”	42.2	55.9
#4	37.4	49.2
#10	26.9	37.9
#20	19.0	28.6
#40	13.8	17.4
#60	10.5	8.9
#100	8.1	5.7
#200	5.8	3.9

*FEI Sample No. 3170

ATTERBERG LIMITS REPORT - ASTM D4318



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	3170	B-3/3-SS	7.5-9.0	25.0	22	29	7	CL
■	3170	B-5/2-SS	5.0-6.5	26.2	25	42	17	CL

ATTERBERG LIMITS REPORT - ASTM D4318

FEI Testing & Inspection, Inc.
Corvallis, OR

Client: CH2M Hill
Project: Albany PS & FM
Project No.: 326918.PE.GE

Figure 2