Appendix 9
Landfill Gas Monitoring Plan

Landfill Gas Monitoring Plan for A-1 Sandrock CDLF
Solid Waste Permit #41-17 (Guilford County)

1.0 Introduction

The following plan has been prepared as a standalone document in accordance with current NCDENR Solid Waste Section (SWS) guidance, including the recent addition of hydrogen sulfide (H_2S) monitoring. The monitoring locations, methods, and thresholds for action have not changed, but the 2010 guidance document requires that attention be given specifically to well construction, equipment calibration, sampling procedures, and data keeping, in a plan that is organized in a standardized format. Landfill staff and monitoring personnel should view the SWS document "Landfill Gas Monitoring Guidance," November 2010, online at

http://portal.ncdenr.org/c/document_library/get_file?uuid=da699f7e-8c13-4249-9012-16af8aefdc7b&groupId=38361.

1.1 Background Information

Monitoring of landfill gas (LFG) is required at C&D landfills by Solid Waste Rule 15A NCAC 13B .0544. Landfill gas is a by-product from the decomposition of organic waste in a sanitary landfill, including certain C&D wastes. Landfill gas typically comprises about 50 percent methane, which can be explosive under certain conditions, as well as carbon dioxide, nitrogen, water, and small amounts of hydrogen sulfide. LFG has been known to promote the migration of contaminants into ground water. The Solid Waste Rules typically focus on the explosive properties from a public safety standpoint. Landfill gas migrates in soil above the ground water table and is restricted laterally by streams. Highly porous soils that tend to occur near the soil-rock interface within the Piedmont are considered to be a good pathway for gas migration.

Past experience suggests that up-gradient areas should be targeted for monitoring, especially if porous soils are present. In addition, this zone typically is an aquifer, thus fluctuations in the water table will affect the gas migration pattern or rate, as does surface saturation, frozen soils, and variation in barometric pressure. The Guidance suggests that the ideal time to sample for subsurface gas is during times of low barometric pressure. Pipelines and other utility trenches can serve as pathways for gas migration, with the potential to convey gas for considerable distances. Open landfills are not as likely to experience subsurface gas migration, but once a low permeability cover is installed, lateral migration into adjacent soils may be more likely if gas is present.

1.2 Current Site Conditions

The subject landfill is situated high on a ridge bounded on three sides by blue line streams, which act as natural barriers to gas migration. Potentiometric contours reflect the surface topography, which slopes moderately to the west but diverges sharply to the north and south (toward the streams) along the margins of the disposal area. Topographic relief near the streams is moderately steep to very steep, with elevation changes from the footprint to the streams on the order of 10 to 20 feet on the south side and 20 to 30 feet on the north and west sides. The landfill is unlined and is mostly excavated to the approved base grades. Onsite soils are mostly porous, weathered granite and extend 20 to 50 feet beneath the surface. The water table is approximately 25 to 40 feet deep over most of the site, except near the streams where water levels are 8 to 10 feet deep.

The approved base grades are a minimum of 8 to 12 feet above the level of the streams and a minimum of 4 feet above groundwater and/or bedrock. Lateral separation to the streams is 50 feet minimum; these dimensions provide little opportunity for gas to migrate beyond the facility boundary on the three sides bound by streams. On the up-gradient (southeast) side the topography increases by approximately 14 feet between the approved footprint and the nearest occupied structures, located approximately 750 feet from the approved disposal footprint. However, soils on this side of the site are derived from diorite, which results in a more clayey (less porous) soil type, and the landfill is mostly above-ground on the east side at this stage of development.

Back to the north, pipelines are present that could serve as potential conduits for off-site landfill gas migration – the nearest pipeline (sewer line) is a target for gas monitoring – although the pipelines are located across a deeply incised stream. The facility offices are also located across the stream, approximately 550 feet from the waste boundary. No occupied structures appear to be at risk for gas migration near this facility.

1.3 Regulatory Requirements

Thresholds that trigger responsive action are methane levels of 100 percent of the LEL, (the lower explosive limit, about 5 percent by volume) in soil-gas or air at the facility boundary; 25 percent of the LEL within onsite structures, not limited to just buildings but inclusive of drainage structures and utility vaults; zero in off-site structures. The contingency plan (**Section 5**) contains a summary of action required if a regulatory threshold is exceeded. Solid Waste Section guidance requires that LFG be monitored with a calibrated meter that is capable of detecting hydrogen sulfide, whereas the action limits are 4% by volume at 100% LEL and 1% by volume at 25% LEL.

1.4 Rationale for LFG Sampling Point Locations

Seven soil-gas monitoring points are located around existing Phase 1 and are relevant to the new Phase 2A (see **Drawing M1**). Points LFG-1 and LFG-2 are located on the up gradient side of the unlined landfill, opposite of ground water flow (refer to Section 1.1). Points LFG-3 through LFG-6 are strategically located relative to the sanitary sewer pipeline, albeit the topography of these locations and the water table make it unlikely that landfill gas would migrate in those directions (at least not very far). LFG-7 is so-located to provide uniform spacing, with the unlikelihood of any soil-gas migrating more than 50 feet from the landfill perimeter, though it is of interest to note that a small H_2S seep was observed at the far northwest corner of Phase 1, evidenced by the browning of vegetation and the characteristic "rotten egg" odor that persisted for a few weeks in 2013.

The gas seep area was mitigated by digging out the temporary soil cover and some of the underlying waste, in what amounted to two test pits that were allowed to vent for 2 to 3 weeks prior to replacing the excavated materials and enhancing the thickness of the soil cover. No trace of the gas seep has been observed since. However the Operator is alert to keeping an eye on that spot. It is known that sheetrock debris had been concentrated in that area. Continued reaction between the sheetrock and water is unlikely now that the soil cover is functional. With regard to this event, a new sampling point, LFG-8, had been added to the northwest corner (**Drawing M1**). The sampling point will be situated within 50 feet of the waste boundary, as are the other sampling locations.

2.0 LFG Monitoring

2.1 Locations and Logistics

LFG monitoring for this facility currently consists of sampling soil-gas adjacent to the landfill footprint via bar-hole punch test locations spaced approximately 500 foot apart (see **Drawing M1**). The monitored points reflect the emphasis on the up gradient side to the east, which is the only conceivable direction that gas could migrate offsite. The LFG monitoring points are situated along the nearest pipeline corridor, where the migration of gas (if present) could travel off-site; others focus on the up-gradient area where deep soils and ground water exist, and occupied structures are proximal. It is the facility's intent to implement monitoring at more points to the west and south as future phases are built. Tentative sampling points are shown as LFG-9 through LFG-12, with the understanding that these sampling points are to be activated during future expansion, and the logistics may be subject to revision for PTC applications for the future cells and phases.

The bar-hole punch test was prescribed and approved for the facility as it was brand new (opened in 2009) and had not received waste. This is a simple test of the soil-gas adjacent to the landfill, justified based on the presence of porous soils, topography, and natural barriers. The landfill has now received some 225,000 cubic yards of waste, comprised of mostly inert materials with paper, wood, and other potentially combustible materials – the same kind of materials that can degrade slowly to form landfill gas – so it is conceivable that at some time in the future, the Solid Waste Section may require permanent gas monitoring wells for this facility. Due to the age of the waste, it is likely that reactions leading to the production of landfill gas are becoming more active.

In anticipation of possible future requirements, this plan presents procedures for both bar-hole punch tests and sampling of monitoring wells. A SWS-endorsed well construction schematic is provided, which includes sealed construction and a specialized port at the top to facilitate sampling. Presumably, the monitoring wells would be located near the same points as currently monitored with the bar-hole punch test, for the same reasoning described above. This plan will be amended in the future to include data tables for the monitoring wells, if required. Data recording protocols will remain the same.

Landfill gas monitoring will be performed quarterly during the active life of the landfill, estimated at 20 years, and throughout the post-closure care period, 30 years unless future data warrant a schedule revision, which will be subject to approval by the SWS.

2.2 Structures and Ambient Sampling

Within the offices and any future buildings on-site, atmospheric sampling for methane shall be conducted. Methane is heavier than air and tends to accumulate in the lower zones with restricted circulations, i.e., crawlspaces, closets, and corners of rooms near the floor, cracks in walls, floor slabs, or foundations, crawlspace vents, drainage pipes, and utility vaults (excluding sanitary sewer manholes). Methane detection in and around the structures, though unlikely, would signify a problem such that the site manager should be notified – immediate action may be required – refer to the Contingency Plan (**Section 5**).

Ambient monitoring overlaps the building foundations and includes a "walk-around" at the toe of covered (vegetated) slopes to survey for gas that may be seeping through the cover. A key to potential side slope seepage includes stained soil, wetness with visible bubbling, or distressed (or absent) vegetation. Any detection of methane in the ambient monitoring should be noted on a site map and a special notation recorded in the monitoring report. Follow up sampling or close attention in future sampling events might be warranted. The site manager should be alerted to any ambient gas detection.

2.3 Sampling Schedule

Quarterly methane and hydrogen sulfide monitoring will be conducted at all subsurface gas detection locations and in all occupied structures located on the landfill property. In addition, enclosed structures, such as manholes, utility vaults, and buried drainage pipes should be checked for gas prior to servicing, in addition to the routine monitoring. The passive gas vents for the final cover, when installed, are not required to be monitored.

Monitoring times are also important when conducting landfill gas monitoring. Proper landfill gas monitoring should include sampling during times when landfill gas is most likely to migrate. LFG monitoring should be conducted when the barometric pressure is low and soils are saturated. During the winter season when snow cover is just beginning to melt or when the ground is frozen or ice covered, landfill gas monitoring should be conducted when the barometric pressure is low.

3.0 LFG Sampling Program

3.1 Equipment and Calibration

A-1 Sandrock enlists the services of an experienced third-party firm to conduct the monitoring. That firm utilizes a landfill gas instrument that meets the requirements of SWS Landfill Gas Monitoring Guidance with respect to detecting methane, oxygen, carbon dioxide, and hydrogen sulfide. Calibration shall occur prior to instrument use and according to the manufacturer's specifications. Should this element of the program change, this plan will be amended accordingly.

3.2 LFG Sampling Procedures

The following procedure is recommended for conducting landfill gas monitoring well sampling and/or bar-hole punch testing *(shown in italics).* The sampling equipment shall consist of a good-quality gas meter capable of detecting methane (LEL) and oxygen levels – most modern meters include carbon monoxide or carbon dioxide, depending on the meter and hydrogen sulfide readings. In deference to the professionals who have conducted the sampling for years, these procedures are guidelines; no changes to the current sampling program are warranted.

Step 1 Calibrate the instrument according to the manufacturer's specifications. In addition, prepare the instrument for monitoring by allowing it to properly warm up as directed by the manufacturer. Make sure the static pressure shows a reading of zero on the instrument prior to taking the first sample.

Step 2 Purge sample tube for at least one minute prior to taking reading. Connect the instrument tubing to the landfill gas monitoring well cap fitted with a stopcock valve or quick connect coupling.

Step 2 Alternate *Drive the bar into the ground to a depth of 3 feet at the sampling location using a hammer or backhoe bucket. Heavy gauge rebar is ideal for this task. The bar-hole needs to be near-vertical and free of obstructions. Drilling a hole with a modified concrete drill (an extension is required to reach the desired depth) has been demonstrated to expedite the making of a boring with less smearing of the side walls.*

Step 3 Open the valve and record the initial reading and then the stabilized reading. A stable reading is one that does not vary more than 0.5 percent by volume on the instrument's scale.

Step 3 Alternate *Cover the hole upon extraction of the drill to retain any gas present. Without completely lifting the cover, gently insert the sampling tube beneath the cover and obtain an initial reading. Allow time for a stabilized reading as described above.*

Step 4 Record the stabilized reading including the oxygen concentration and barometric pressure. A proper reading should have two percent oxygen by volume or less. If levels of oxygen are higher, it may indicate that air is being drawn into the system giving a false reading.

Step 5 Turn the stopcock valve to the off position and disconnect the tubing.

Step 5 Alternate *Backfill the hole with cuttings or native soil; tamp the backfill with a rod or equipment handle.*

Step 6 Proceed to the next landfill gas monitoring well and repeat Steps 2 – 5.

4.0 Record Keeping and Reporting

The sampling technician shall record the date, time, location, sampling personnel, calibration data, gas pump rate, barometric pressure (from local weather reports), ambient temperature, general weather conditions at the time of sampling, initial and stabilized concentrations of methane (see the **Landfill Gas Monitoring Data Form**) following this text). These monitoring records shall be maintained in the landfill operating record. Should methane be detected at any sampling location, the facility manager should be notified and, depending on the concentrations, a report to the Solid Waste Section might be warranted. In any event a qualified engineer should be consulted.

5.0 Contingency Plan

Solid Waste Rule .0544 (d) (3) requires the following responses in the event that methane and/or hydrogen sulfide concentrations are detected that exceed the regulatory limits:

A Immediately take all steps necessary to ensure protection of human health and notify the Division – at a minimum, occupied structures should be evacuated and ventilated until the methane concentrations subside; close monitoring of structures shall be implemented; for facility boundary violations, further evaluation is warranted, subject to notification and approval by the Division.

B Within seven days of detection, place in the operating record the methane or explosive gas levels detected and a description of the steps taken to protect human health;

C Within 60 days of detection, implement a remediation plan for the methane or explosive gas releases, place a copy of the plan in the operating record, and notify the Division that the plan has been implemented. The plan must describe the nature and extent of the problem and the proposed remedy.

D Based on the need for an extension demonstrated by the operator, the Division may establish alternative schedules for demonstrating compliance with the limits.

E "Lower explosive limit" means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at 25^{o} C at atmospheric pressure.

F Upon completion of mitigation activities, a thorough report shall be placed in the operating record to document the incident and outcome.

6.0 Professional Certification

The certification statement below must be signed and sealed by a North Carolina Professional Geologist or Professional Engineer and submitted with the Landfill Gas Monitoring Plan.

> The landfill gas monitoring plan for this facility has been prepared by a qualified geologist or engineer who is licensed to practice in the State of North Carolina. The plan has been prepared based on first-hand knowledge of site conditions and familiarity with North Carolina solid waste rules and industry standard protocol. This certification is made in accordance with North Carolina Solid Waste Regulations, indicating this Landfill Gas Monitoring Plan should provide early detection of any release of hazardous constituents to the uppermost aquifer, so as to be protective of public health and the environment. No other warranties, expressed or implied, are made.

Signed _____

Printed ___G. David Garrett, PG, PE_____

Date _____May 1, 2015_____

Not valid unless this document bears the seal of the above mentioned licensed professional.

If wells are installed in the future, the well locations shall be shown on a topographic map that is signed and sealed by a registered surveyor.

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BISHOP ROAD

SCALE HOUSE

COLONIAL PIPELINE

SANITARY SEWER

SW-1

APPROXIMATE LOCATION 50' EASEMENT FOR COLONIAL PIPELINE

LG-6

MW-5

LG-5

LG-7

MW-6

LG-8

SED. BASIN

MW-4

TEST PIT & WATER INFO

TEMP. SUMP

OLD GRADE STAKE FOR LOCATION REFENCE

HICKORY CREEK

PHASE 1

LG-4

SW-2

LG-3

LG-2

FUTURE LG-9

PHASE 2A
AREA 4.40 ACRES

PHASE 3

SOIL STOCKPILE AREA

MW-3

PHASE 2B
AREA 3.42 ACRES

MOSTLY ORIGINAL TOPOGRAPHY

LG-1

MW-1

FUTURE LG-10

MW-2

SW-4

FUTURE LG-11

LG-12 FUTURE

MONITORING WELLS (TYP.)
MW-1 IS THE BACKGROUND

LANDFILL GAS MONITORING POINT (TYP.)

SURFACE WATER SAMPLING LOCATION (TYP.)

FACILITY BOUNDARY

SW-3

N

300 0 300 600 900

Scale 1" = 300'

Bar is 1" on original drawing

LEGEND

PROPOSED

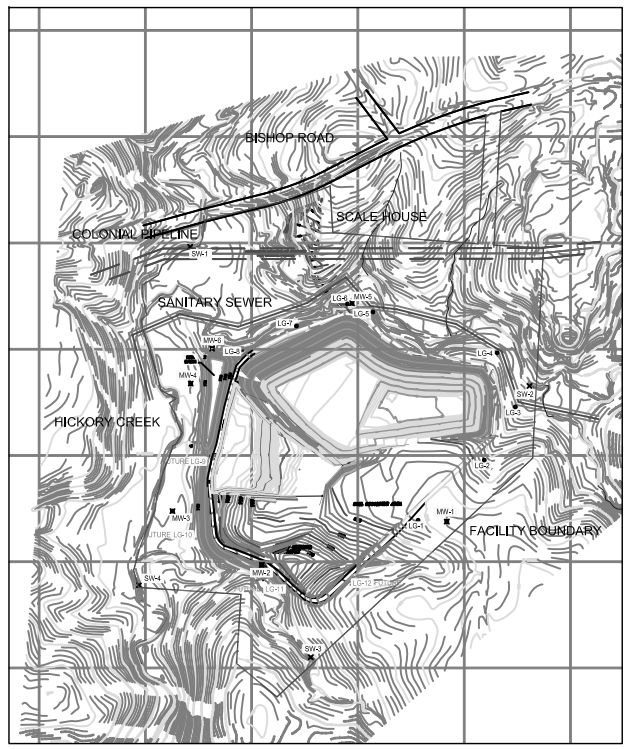
- 2 FOOT ELEVATION CONTOUR
280 - 10 FOOT ELEVATION CONTOUR
CELL AND WASTE LIMITS

NOTE:
CONTOURS SHOWN FOR CELLS 1A / 1B, 2A AND 2B REPRESENT FINAL TOP OF WASTE GRADES

EXISTING

- 2 FOOT ELEVATION CONTOUR
280 - 10 FOOT ELEVATION CONTOUR
FACILITY BOUNDARY
SANITARY SEWER
WATERCOURSE BUFFER ZONE
PROPERTY BUFFER ZONE
100 YR FLOODPLAIN
WATERCOURSE

BASE GRADE CONTOURS FOR PHASE 2 ARE AS SURVEYED IN APRIL 2015



FACILITY MAP

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 25462 DAVID GARRETT
4/20/2015
NC CORP. LICENSE NO. C-1837

NO.	REVISION	DATE

SHEET TITLE: WATER AND GAS MONITORING LOCATIONS

PROJECT TITLE: PERMIT RENEWAL APPLICATION
PHASE 2 PERMIT TO CONSTRUCT

CLIENT
A-1 SANDROCK, INC.
PERMIT NO. 41-17-CDLF-2008
2091 BISHOP ROAD
GREENSBORO, NC 27406

SCS ENGINEERS, PC
2520 WHITEHALL PARK DRIVE, SUITE 450
CHARLOTTE, NORTH CAROLINA 28273
PHONE: (704) 504-3107 FAX: (704) 504-3174

PROJ. NO. 02704.00 T3
DSN. BY: GDG
DWN. BY: GDG
CHK. BY: SCL
QA/QC BY:
APP. BY:

DATE: 3/30/2015

SCALE: AS SHOWN

DRAWING NO. M1

Sheet 8 of 8

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NC Division of Waste Management - Solid Waste Section

Landfill Gas Monitoring Data Form

Notice: This form and any information attached to it are "Public Records" as defined in NC General Statute 132-1. As such, these documents are available for inspection and examination by any person upon request (NC General Statute 132-6).

Facility Name: _____ Permit Number: _____

Date of Sampling: _____ NC Landfill Rule (.0500 or .1600): _____

Name and Position of Sample Collector: _____

Type and Serial Number of Gas Meter: _____ Calibration Date of Gas Meter: _____

Date and Time of Field Calibration: _____

Type of Field Calibration Gas (15/15 or 35/50): _____ Expiration Date of Field Calibration Gas Canister: _____

Pump Rate of Gas Meter: _____

Ambient Air Temperature: _____ Barometric Pressure: _____ General Weather Conditions: _____

Instructions: Under "Location or LFG Well" identify the monitoring wells or describe the location for other tests (e.g., inside buildings). A drawing showing the location of test must be attached. Report methane readings as both % LEL and % CH4 by volume. A reading in percent methane by volume can be converted to % LEL as follows: % methane by volume = % LEL/20

Location or LFG Well ID	Sample Tube Purge	Time	Time Pumped (sec)	Initial %LEL	Stabilized %LEL	%CH4 by volume	%O2	%CO2	%H2S	Notes

If your facility has more gas monitoring locations than there is room on this form, please attach additional sheets listing the same information as contained on this form.

Certification

To the best of my knowledge, the information reported and statements made on this data submittal and attachments are true and correct. I am aware that there are significant penalties for making any false statement, representation, or certification including the possibility of a fine and imprisonment.

_____ _____

SIGNATURE TITLE

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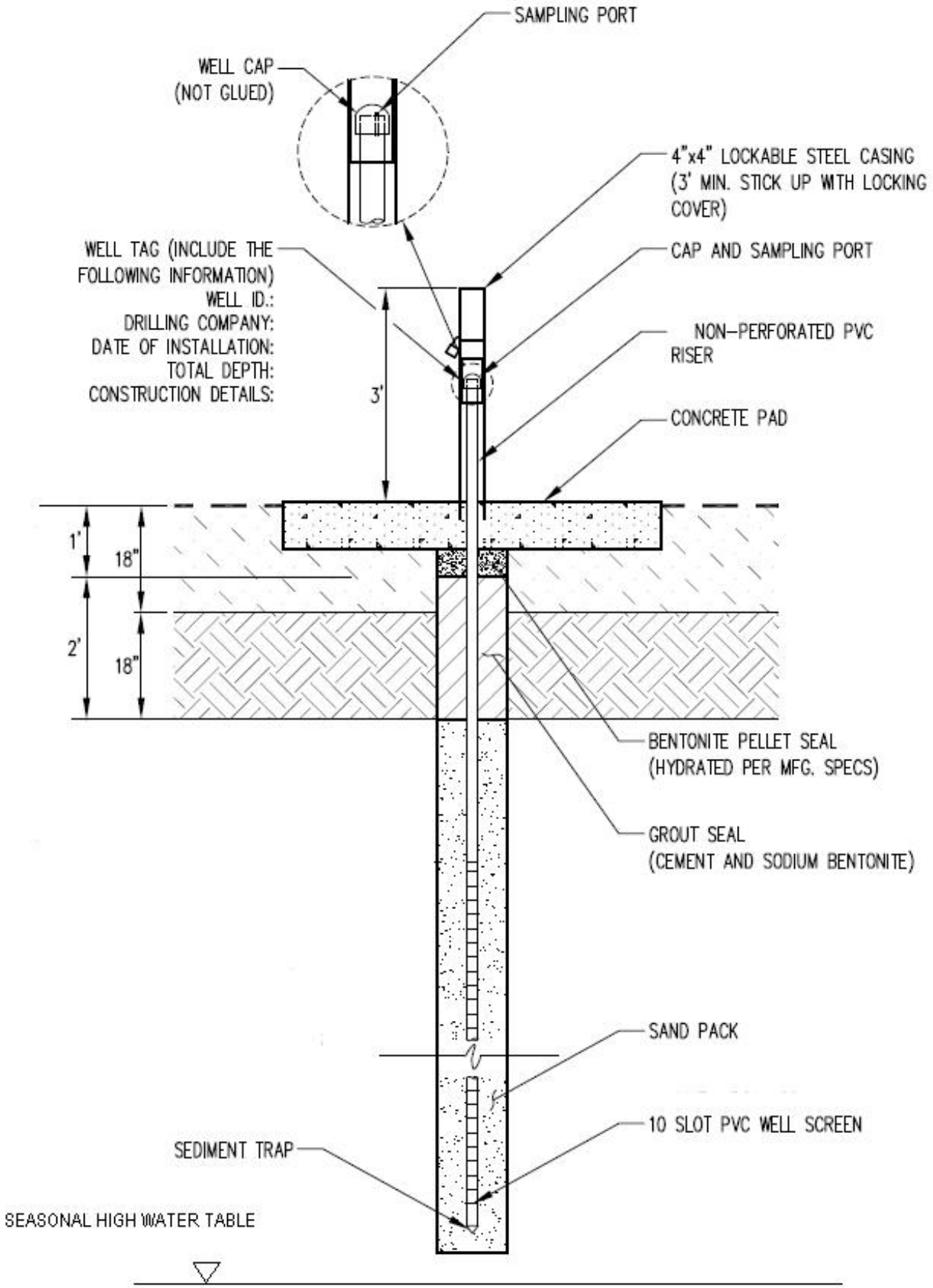
SAMPLING PORT
WELL CAP
(NOT GLUED)
4"x4" LOCKABLE STEEL CASING
(3' MIN. STICK UP WITH LOCKING
COVER)
WELL TAG (INCLUDE THE
FOLLOWING INFORMATION)
WELL ID.:
DRILLING COMPANY:
DATE OF INSTALLATION:
TOTAL DEPTH:
CONSTRUCTION DETAILS:
CAP AND SAMPLING PORT
NON-PERFORATED PVC
RISER
3'
CONCRETE PAD
1'
18"
2'
18"
BENTONITE PELLET SEAL
(HYDRATED PER MFG. SPECS)
GROUT SEAL
(CEMENT AND SODIUM BENTONITE)
SAND PACK
10 SLOT PVC WELL SCREEN
SEDIMENT TRAP
SEASONAL HIGH WATER TABLE