

**AQUIFER STORAGE RECOVERY
WELLHEAD AND CORE HANDLING PROCEDURES**

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CONTENTS

	Page
Introduction.....	1
Responsibilities of the Drilling Contractor.....	1
Maintain logs.....	1
Core and retrieve core.....	2
Place core on working table.....	3
Measure core length and recovery.....	3
Responsibilities of the SCWRC Geologist.....	3
Measure core length.....	4
Detach shoe from the core.....	4
Clean, describe, and sample core.....	5
Wrap core with transparent plastic (conventional cores only)...	6
Mark cores.....	6
Store cores.....	6
Selected samples.....	7
Freeze selected undisturbed samples.....	7
Core Freezing and Handling Procedures.....	8
Selected Undisturbed Core Samples.....	9
Packing and Shipping.....	11

CONTENTS (continued)

Appendices.....	12
Appendix A. Core logging forms.....	13
Appendix B. Suggested equipment.....	17

INTRODUCTION

The intention of this document is to outline and establish procedures involved in the drilling and coring operations at the Aquifer Storage Recovery Testing Site at Myrtle Beach, South Carolina.

Owing to special project requirements, some strata will be sampled by using a transparent inner sleeve or plastic inner barrel. These samples will be called undisturbed cores to differentiate them from conventional cores collected without a liner. Handling procedures vary, depending on the core type.

RESPONSIBILITIES OF THE DRILLING CONTRACTOR

It is the responsibility of the drilling contractor, as outlined in the Bid Document, to:

Maintain logs.-- The logs the driller must maintain include, but are not limited to, the following:

1. - record of daily activities;
2. - drillers log (type of material encountered in test hole);
3. - drilling time;
4. - coring time;
5. - core length and percentage of recovery.

Verification of the well construction should also be provided, including:

1. - depth and diameter of hole;
2. - diameter and depth of casing(s);
3. - diameter and depth of screen(s);
4. - depth and thickness of grout;

Bookkeeping should be approved by the SCWRC Geologist acting as a site representative for the Owner. Logs should be available for inspection at all times. At the end of the contract, the driller must furnish logs to the SCWRC Geologist.

Core and retrieve core.-- Upon retrieval, cores should be drained of excess drilling fluid by placing barrel across "sawhorses" with core shoe at the lower end, and subsequently transferred onto a 7-foot long, 4-inch ID, split PVC pipe (tray 1). This is done by placing one end of tray 1 under the lower end of the core barrel with the remainder of the tray extending out and away from the core barrel, and parallel to it.

The core shoe should be removed slowly from the core barrel, allowing the core to slide onto tray 2. One hand should be cupped over the core shoe to steady and slow the core as it may slide rapidly from the barrel. If the core fails to slide out, tapping the exterior of the inner core barrel may facilitate core movement or another method may be acceptable. Hydraulic extrusion of the core (pushing the core at one end, thereby forcing it out of the barrel) should be used only as the last resort.

Place core on working table.--- Once the core sample has been removed from the inner barrel and transferred to tray 1, it must be positioned on the working table.

Measure core length and recovery.--- After core has been positioned on the working table, the core length should be measured and the percent of recovery calculated using the following formula:

$$\text{percent recovery} = [\text{length recovered (ft)}/\text{length cored (ft)}] \times 100$$

RESPONSIBILITIES OF THE SCWRC GEOLOGIST

It is the responsibility of the SCWRC Geologist, once the core is on the working table, to log and prepare it for storing, freezing, or shipping:

- conventional cores will be stored in 5-foot long, 4-inch ID, PVC pipes;
- undisturbed samples should be cut to a maximum of 5-foot long sections, capped and stored in 5-foot long, 4-inch ID, PVC pipes
- selected undisturbed samples will be frozen in 3 to 5-foot lengths

All sample wrappers and containers must be appropriately marked with waterproof ink, noting depths to the nearest tenth of a foot (1/10 foot).

The following is a step-by-step procedure for core logging, handling, freezing, storing, and shipping:

Measure core length.-- Using a carpenter tape, measure the length of the core to the nearest 1/10 foot from the lower end of the core to the upper end of the core sample. Loose or broken pieces of core should be reassembled to the extent possible without disrupting remaining intact core. Material recovered at the upper end of the core sample that is suspected to be fill should be discarded and not included in percent recovery calculations.

If the length of core recovered exceeds the length of the interval cored, the additional recovery can be credited to the recovery for the previous cored interval provided: 1) the recovery for the previous interval is less than 100 percent; 2) the amount to be credited is less than or equal to the length of core not recovered in the previous interval; and 3) the material recovered appears in a natural condition with minimal distortion caused by coring operations.

An exception to this would occur when recovery exceeds the cored interval for a core consisting of significant amounts of clay, in which case, clay swelling resulting from a decrease of pressure or adsorption of water, should be suspected. Any recovery credits to the previous interval will be the judgement of the SCWRC Geologist, based on the probability and degree of clay swelling.

Detach shoe from the core.-- Remove core shoe so as to minimize core distortion. Insert a flathead screwdriver (or spatula) into the core shoe, along the core, and apply pressure to the core at tip of the screwdriver. Repeat this at other points around the core until the shoe breaks free of the core.

To remove the remaining core from the shoe, this procedure may be attempted from the opposite end of the shoe. If this is unsuccessful, the core may be hammered out of the shoe, or chipped out in small pieces with a screwdriver.

Clean, describe, and sample core.-- The core will be scrapped gently with a spatula or putty knife, or delicately wiped with a foam brush, to expose a thin strip of clean core. Water is not to be used to wash the core so as to minimize the introduction of foreign fluids into the core and to maintain the core as intact as possible.

Examine core first for the presence of any macroscopic features such as sand or clay sections, color, mottling, and sedimentary structures. Use the Core Logging Form included in Appendix A. Second, examine core more closely to determine major mineralogy, grain-size classifications, and any other details, time permitting. Supplement the description by inspecting the any samples taken from the core.

Core must be sampled at formation changes and at a minimum of every 2 1/2 feet, or every 5 feet for the undisturbed samples. One-half inch samples are sliced from the cores, allowing a 3-foot section of core to remain intact or unbroken, whenever possible. Another sample is obtained from the core removed from the core shoe. Styrofoam disks, labeled "sample" and the depth intervals, are placed between the sections of core wherever a sample is taken.

Wrap core with transparent plastic (conventional cores only).-- A second 4-inch PVC tray (tray 2) is lined with enough transparent plastic wrap (cellophane) to seal the sample, including the ends, and placed gently over the core. Where the core has been cut, two trays, with excess plastic wrapped around the ends of the trays, are placed end-to-end over the cut portion of the core. Gently rotate core and trays 180 degrees so that the core lies in tray 2 and tray 1 may be lifted up and away from the sample. Then carefully wrap and seal the core sample.

Mark cores.-- Beginning at the top of the core, two lines are drawn on the cellophane with waterproof markers, one black and one red, keeping the red line to the right of the black line. This enables the the top of the core to be determined at a glance without reading the specific depths. Use a waterproof, black marker to write the corresponding depth at the upper and lower ends of the core on duct tape adhered to the cellophane. Tray 2 is similarly marked with red and black lines along one edge with the appropriate core interval written on duct tape attached to the bottom. All depths must be marked to the nearest 1/10 foot.

Store cores.-- Conventional cores will be slid horizontally into a 5-foot length of 4-inch ID PVC pipe which must be capped. If less than five feet of core is to be stored in the PVC, styrofoam spacers must be placed in Tray 2 to prevent the core from sliding when transported.

The PVC pipes are also to be marked with a red line to the right of a black line from top to bottom. The core interval contained in the PVC is written along the side of the tube, next to the red line, and on the top

and bottom caps. Each PVC pipe will be numbered consecutively, reserving empty PVC pipes so that when the frozen cores are thawed, they may be stored, in order, with the rest of the cores.

These pipes are to be stored temporarily in a horizontal position on a wooden rack at the drilling site. At the end of the coring session, all cores will be removed and stored, numerical order, on racks in the nearby Water Treatment Plant.

Selected samples.-- There are 15 selected zones from which undisturbed core samples shall be taken (see section on Undisturbed Samples). From each of the zones choose the best 3-foot core section according to:

- 1.- percentage of recovery;
- 2.- integrity of sample;
- 3.- representation of stratum;

Freeze selected undisturbed samples.-- Selected undisturbed samples and conventional cores, with a minimum length of three feet and preferably of five feet, are to be frozen with dry ice in large ice boxes (see Core Freezing and Handling Procedures). Once frozen (after a minimum of 24 hours), they are to be transferred to a residential-type chest freezer for storage until they are prepared for shipping to the laboratory.

Numerous core intervals will be chosen for laboratory testing. Frozen cores from these zones will be cut into a minimum of three 1-foot samples, with one set of samples packed into ice chests containing dry ice for

shipment to the laboratory. The remaining two sets of samples will be returned to the freezer for later use in the permeameter tests or as backup samples in the laboratory.

Each individual piece of undisturbed core sample must have the upper and lower depths written directly onto the top, bottom, and cap of the liner as described above.

CORE FREEZING AND HANDLING PROCEDURES

The cores will be frozen with dry ice in wooden boxes (called ice coffins) specially prepared for this purpose. These boxes are 6 1/2 feet long, 1 1/2 feet wide and are lined with three layers of 3/4" styrofoam insulation, and were designed to transport six, 50 pound blocks of dry ice. Dry ice blocks, cut into slices, are to be obtained prior to freezing undisturbed cores. These blocks should remain whole and undisturbed until needed because it sublimates. Shortly after a core has been prepared for freezing, slices of dry ice are cut by using a circular saw, or broken with a hammer, into chunks (roughly 3 in. x 3 in.). Two portable dry ice machines and cylinders of liquid carbon dioxide (CO₂) are to be kept on-site for use only when the commercially prepared dry ice blocks are unavailable since the process is time-consuming and the dry ice obtained in this manner is less dense and more expensive.

When an undisturbed or conventional core sample is to be frozen, it is carefully slid into 5-foot long, 5-inch diameter tube of hardware cloth to prevent the core and lexan tubing from direct contact with dry ice. These

are gently placed into the ice coffins which contain a layer of dry ice chunks. A second layer of dry ice is added on top of the cores, followed by a second set of core samples, if needed, and covered with a third layer of dry ice. Each ice coffin can accommodate a maximum of 4 5-foot core samples and sufficient dry ice to freeze and maintain the samples for a 24-hour period. When the cores have frozen, they will be transferred to a residential-type chest freezer for storage until ready to be cut and shipped to a laboratory.

SELECTED UNDISTURBED CORE SAMPLES

There are 15 undisturbed core samples, 7 from the Black Creek Formation and 8 from the Middendorf Formation. The samples will be cored using a transparent inner core barrel or a plastic sleeve (liner).

Table 1 summarizes the information on the 15 zones. The depths listed are given as a guide and may have to be adjusted during drilling. Cuttings and available cores must be used to determine the correct depths of sampling. The desired strata for undisturbed sampling have been marked in the enclosed cross section.

Table 1. Coring Requirements

<u>Aquifer</u>	<u>Interval (ft/msl)</u>	<u>Inner Sleeve Length Required (ft)</u>	<u>Expected Material</u>			
			<u>Sand</u>	<u>Sand/Clay</u>	<u>Clay</u>	<u>Sandstone</u>
Black Creek						
	400 - 430	30	*			
	535 - 570	10	*			
	600 - 620	10	*			
	670 - 690	10	*			
	790 - 825	10			*	
	840 - 855	10				*
	930 - 945	10			*	
Middendorf						
	945-1,000	40	*			
	1,010-1,030	10			*	
	1,080-1,155	30		*		
	1,160-1,220	10			*	
	1,230-1,265	20	*			
	1,270-1,300	10			*	
	1,300-1,350	20	*			
	1,360-1,400	10			*	
		240	140	30	60	10

PACKING AND SHIPPING

There are two types of samples that are to be shipped. The first samples will be sent to a laboratory for hydrological testing, and the remaining will be sent to the Engineer for permeameter testing or as backup laboratory samples.

A 10 to 12-inch sample will be cut from the frozen cores, leaving a 10-inch or longer section of core both above and below it. The cuts will be made using a circular saw with a masonry blade. Samples from frozen conventional cores not encased in lexan will be fitted with two pieces of PVC tray to form a tube, then secured in place using duct tape. Each sample will be sealed at both ends with PVC caps.

The sealed samples will then be placed onto a 1- to 2- inch layer of dry ice inside a 68-quart ice chest lined with one layer of 3/4-inch styrofoam insulation. Pieces of insulation are to be inserted between the samples until they are snug and unable to move. The remaining space is to be filled with as much dry ice as possible. Another sheet of styrofoam insulation is placed on top of the samples. A note regarding the depth intervals of the samples and any other pertinent information is to be included. The ice chest is bound with nylon strapping tape or other approved material, then sent via overnight courier to the laboratory.

The remaining frozen samples will be returned to the freezer until needed, at which time they will be cut, packed and shipped as described.

APPENDICES

APPENDIX A. Core logging forms

APPENDIX B. Suggested equipment

SUGGESTED EQUIPMENT

DESCRIPTION	UNIT PRICE (approxiate)
Dry-ice machine (see attached information)	\$ 500.00
CO ₂ cylinders for dry ice. 14 @ \$20.00	280.00
Ice chest (Igloo 68). 7 @ \$68.00	476.00
Styrofoam 3" x 4'x 8' sheet. 2 @ \$37.00	74.00
Wooden racks. 5 (5 x 4 x 5) @ \$150.00	750.00
4-inch foam brushes. 12 @ \$ 0.50	6.00
2-inch brushes. 12 @ \$1.20	14.00
100-foot garden hose and pistol-type sprayer	30.00
4-inch wide putty knife. 3 @ \$5.00	15.00
2-inch wide putty knife. 3 @ \$3.00	9.00
Commercial grade transparent plastic (cellophane or food storage) wrap (2000-foot roll).....	50.00
Electric saw, 2-1/2 horsepower	60.00
Hammers. 2 @ \$19.00	40.00
Other.....	200.00
Shipping: 6 ice chests, max. weight 110 lb.	1,020.00
(Federal Express)	-----
TOTAL	\$3,600.00

CORE STORAGE MATERIALS (PVC)

4-inch ID PVC pipes (5-feet long). 540 feet @ \$0.70 per/foot	378.00
4-inch OD PVC half pipes (5-feet long). 270 feet @ \$0.70 per foot	189.00
4-inch ID PVC caps. 240 @ \$1.20 (non threaded).....	288.00
3.75-inch ID PVC caps. 260 @ 1.20 (non threaded).....	312.00
TOTAL	----- \$1,167.00