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APR 18 1994 <i>Station #12</i>	ENGINEERING DATA TRANSMITTAL	Page 1 of <u>1</u> 1. EDT 605116
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2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) ER	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Flow Sensor Installation	6. Cog. Engr.: D. J. Vaught	7. Purchase Order No.: N/A
8. Originator Remarks: <div style="text-align: center;">Release to file</div>		9. Equip./Component No.: N/A
11. Receiver Remarks: <div style="text-align: center;"> JUN 07 1994 OSTI </div>		10. System/Bldg./Facility: N/A
		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date:

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Impact Level	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-EN-AP-168 ✓		0	In Situ Permeable Flow Sensor Installation at 100-H Description of Work	NA	1/2	i	

16. KEY		
Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)									
(G)	(H)	(J) Name (K) Signature (L) Date				(G)	(H)	(J) Name (K) Signature (L) Date	
Reason	Disp.					Reason	Disp.		
1/2	1	Cog. Eng. D. J. Vaught 4/14/94 H6-05						ERC H6-07 3	
1/2	1	Cog. Mgr. R. P. Henckel 4/14/94 H6-02						IRA (2) H4-17 3	
1/2	1	QA G. Corrigan 4/14/94						Central Files (2) L8-04 3	
		Safety						EDMC (2) H6-08 3	
		Env.							
1	1	Ecology W. W. Soper 4-14-94							

18. Signature of EDT Originator <div style="text-align: center;"> 4/14/94 Date </div>	19. Authorized Representative Date for Receiving Organization <div style="text-align: center;"> 4-14-94 Date </div>	20. Cognizant/Project Engineer's Manager <div style="text-align: center;"> 4-14-94 Date </div>
21. DOE APPROVAL (if required) Ltr. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments		

BD-7400-172-2 (07/91) GEF097

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			ID Number (include revision, volume, etc.) WHC-SD-EN-AP-168, Rev. 0		
			List attachments.		
			Date Release Required <div style="text-align: right;">April 21, 1994</div>		
Title: In Situ Permeable Flow Sensor Installation at 100-H Description of Work				Unclassified Category UC-	
				Impact Level <div style="text-align: right;">NA</div>	
New or novel (patentable) subject matter? ☒ No ☐ Yes If "Yes", has disclosure been submitted by WHC or other company? ☐ No ☐ Yes Disclosure No(s).			Information received from others in confidence, such as proprietary data, trade secrets, and/or inventions? ☒ No ☐ Yes (Identify)		
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Title of Journal N/A

CHECKLIST FOR SIGNATORIES					
Review Required per WHC-CM-3-4	Yes	No	Reviewer - Signature Indicates Approval	Signature	Date
Classification/Unclassified	☐	☒			
Controlled Nuclear Information	☐	☒			
Patent - General Counsel	☒	☐	BD Williamson	<i>BD Williamson</i>	4/13/94
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Applied Technology/Export	☐	☒			
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Other Program/Project	☐	☒			

Information conforms to all applicable requirements. The above information is certified to be correct.		INFORMATION RELEASE ADMINISTRATION APPROVAL STAMP	
References Available to Intended Audience ☒ Yes ☐ No Transmit to DOE-HQ/Office of Scientific and Technical Information ☒ Yes ☐ No	Author/Requestor (Printed/Signature) D. J. Vaught <i>Douglas J. Vaught</i> Date 4/11/94
Intended Audience ☐ Internal ☐ Sponsor ☒ External Responsible Manager (Printed/Signature) R. P. Henckel <i>R. P. Henckel</i> Date 4-11-94			
		Date Cancelled	
		Date Disapproved	

SUPPORTING DOCUMENT		1. Total Pages 11
2. Title In Situ Permeable Flow Sensor Installation at 100-H Description of Work		3. Number WHC-SD-EN-AP-168
4. Rev No. 0		
5. Key Words groundwater, sonic drill, 3-D flow vector <div style="text-align: center;">APPROVED FOR PUBLIC RELEASE</div>		6. Author Name: D. J. Vaught Signature Organization/Charge Code 85910/PE73A
7. Abstract <div style="text-align: right;"><i>4/15/94 DJS</i></div> Vaught, D. J., 1994, In Situ Permeable Flow Sensor Installation at 100-H Description of Work, WHC-SD-EN-AP-168, Rev. 0, Westinghouse Hanford Company, Richland, Washington.		
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9. Impact Level <i>NA</i>		

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1.0 SCOPE OF WORK

1.1 SCOPE OF FIELD ACTIVITY

This description of work details field activities associated with drilling four boreholes in the 100-HR-3 Operable Unit for placement of four In Situ Permeable Flow Sensors near the 183-H Basin. A sonic drill rig funded under a Cooperative Research and Development Agreement (CRADA) will be employed to drill the boreholes.

This project includes installation of automatic data logging and telemetry equipment. Each Sensor will be supplied with a data logger at the surface which will be wired to a cellular phone on site or to an existing telemetry station to transmit data to a computer in 2440 Stevens Center. Power to operate the Sensors and data loggers will be supplied by a small gasoline or diesel generator. Processed data will be used to develop a three-dimensional flownet of the unconfined aquifer near and within the Columbia River influenced mixing zone.

This document should be used with *Environmental Investigations and Site Characterization Manual* (WHC 1992c) for specific procedures. Borehole locations are shown in Figure 1.

1.2 DESCRIPTION OF FLOW SENSOR

The In Situ Permeable Flow Sensor (Sensor) uses a thermal perturbation technique to directly measure the direction and magnitude of the three-dimensional groundwater flow velocity vector at a point in a permeable geologic medium as described by Ballard, et al (SNL 1994a). The Sensors have been satisfactorily tested at Savannah River, South Carolina and will soon enter commercial production. A planview of the Sensor is shown in Figure 2.

The Sensor consists of a thin, cylindrical heater encased in a water-proof olefin plastic shell. Placed just under the shell but radially out from the heating elements are 30 strategically placed thermistors. The Sensor is placed directly into the subsurface formation with no filter media and preferably with little drilling-induced formation damage (hence the need for the sonic drill rig) to ensure uncompromised data. Each Sensor requires 120 watts continuous AC power for the heating elements plus a separate automatic data logging and telemetry hookup.

A potential advantage of the In Situ Permeable Flow Sensor compared to flow measurement equipment used in existing monitoring wells is a more accurate assessment of groundwater flow through the formation. This results from the Sensor being in direct contact with the formation rather than inside a well screen and artificial gravel pack.

In addition, although existing methods also use thermal perturbation techniques, they can only measure the horizontal component of flow in any one well. The unique design of the Sensor allows a horizontal and vertical component of flow to be measured at a single location. This is especially valuable for the near-Columbia River Sensor location, where a detailed mea-

surement can be made of groundwater flow vector changes due to a rapidly fluctuating river level from upstream dam operations.

A disadvantage is the cost of drilling a borehole to install the Sensor compared with other groundwater flow measurement equipment which is transportable to and from existing monitoring wells. It is, though, certainly less expensive to bore and place a Sensor than to construct a new well. The Sensor cannot economically be recovered after removal of the drill stem and collapse of the surrounding formation and should be considered a permanent installation. Also, the quality of the contact between the Sensor and the formation cannot be directly observed, although some indication of the contact can be ascertained from the data.

2.0 GENERAL REQUIREMENTS

2.1 HEALTH AND SAFETY

All personnel working to this description of work will have completed the 40-hour hazardous waste site worker training program and will perform all work in accordance with the following:

- WHC, *Conduct of Operations Field Handbook* (WHC 1993)
- WHC-EP-0383, *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990)
- WHC-CM-4-3, *Industrial Safety Manual*, Vol. 1-3 (WHC 1992a)
- WHC-CM-7-5, *Environmental Compliance Manual* (WHC 1992b)
- WHC-CM-7-7, *Environmental Investigations and Site Characterization Manual* (WHC 1992c)
- Site-specific health and safety plan/job safety analysis.

2.2 PREREQUISITES

Each item on the Drilling Planning Form (A-6000-422) must be signed and dated by the cognizant engineer or field team leader prior to the start of work. A readiness review shall be conducted in accordance with EII 1.13, Environmental Readiness Review (WHC 1992c).

3.0 FIELD ACTIVITIES

3.1 SOIL SCREENING

Review of borehole logs from existing groundwater monitoring wells at the intended installation site of the Sensors indicates no chemical and radionuclide contamination in the soil column, although the underlying groundwater is contaminated with low levels of chromium, nitrates and gross alpha and beta (DOE-RL 1993). For this reason, and considering that the sonic drill rig does not produce drill spoils, the full time presence of a site

safety officer is not necessary. The designated site safety officer will inspect the site periodically throughout the project.

No continuous monitoring for volatile organics or radioactivity is planned, although the site safety officer may require periodic monitoring with a organic volatile monitor (OVM) to ensure compliance with breathing zone standards. Any instrumentation used will be maintained and calibrated consistent with EII 3.2, Calibration and Control of Monitoring Instruments (WHC 1992c).

3.2 WASTE GENERATION

All waste generated during drilling activities will be handled according to EII 4.3, Control of CERCLA and Other Past-Practice Investigation Derived Waste (WHC 1992c).

3.3 SENSOR INSTALLATION

Each Sensor will be placed approximately 50 feet below ground surface. Exact borehole depth for each Sensor will be specified by WHC Geosciences prior to start of work and the actual depth of installation will be recorded in the field logs.

At the deployment site, each Sensor will be laid on the ground and sufficient 1-inch diameter schedule 80 PVC pipe will be attached to the top of the Sensor in a manner which will not allow the Sensor to rotate relative to the PVC pipe. The PVC pipe will encase the power and data cables and must be of sufficient length to reach the ground surface after the Sensor is deployed. Marks are made along the PVC pipe so the horizontal orientation of the probe will be known after placement. This is required to determine the azimuth of the horizontal component of groundwater flow.

Placement and alignment of the Sensors will be conducted in the presence of Sandy Ballard of Sandia National Laboratories, Albuquerque, New Mexico (or a Sandia Labs technician) who will provide guidance and assistance. After placement of the Sensor, the hole casing will be slowly withdrawn with an applied low-amplitude resonance. This will induce formation collapse around the Sensor. If formation collapse does not occur, a field judgement will be made regarding the volume and composition of an added sand or gravel pack. At a point about five feet above the Sensor, a bentonite seal will be added as the drill stem is withdrawn. A concrete surface seal will be installed per WAC 173-160-510.

A separate data logger at ground level will be installed with each Sensor and all four data loggers will be connected via coaxial cable. Presently, the preferred method of data retrieval is to install a cellular telephone on site which will allow Sandia Labs (and later WHC Geosciences) to directly call and download the data loggers. An alternate method of data retrieval is to tie into an existing telemetry station onsite and transmit data to a computer located in 2440 Stevens Center. A third method of data retrieval would be to download the data loggers onsite into a notebook (portable) computer.

Due to the unique design and installation of the Sensors, it is anticipated that future abandonment per WAC 173-160-560 will not be feasible and is not desirable. The abandonment procedure will be to cut the PVC pipe and wires at a depth of two feet, pour bentonite pellets down the PVC pipe, then add a concrete cap.

3.4 LOCATION OF SENSORS

Shown in Figure 1 are the approximate locations of the four boreholes to be drilled for the Sensor installations. Actual field drill sites will be marked with wooden stakes by WHC Geosciences prior to start of work.

It should be noted that, although the Sensors will be co-located with existing RCRA groundwater monitoring wells, no impact to those wells are expected. The wells are sampled on a regular basis and any anomalous trends will be noted in the RCRA annual report. The RCRA groundwater organization is aware of this project through issuance of this report. Should an anomalous trend be noted, other appropriate organizations will be notified of the trend and its possible origin (installation of the Sensors). Due to this concern, the volume and quality of water added to the drill stem during the drilling operation (if more than several gallons) will be noted in the field logs.

4.0 DATA QUALITY OBJECTIVES

The Sensor installations are designed to produce data that pertain to the following:

- Measured values for horizontal groundwater flow velocity and direction from Sensors placed in the upper portion of the near-surface aquifer. Measurements will be made frequently to reveal changes in flow that are caused by daily river level fluctuations.
- Measured values for horizontal flow parameters at several locations to provide an indication of spatial variability with distance perpendicular to the river.
- Measured values for vertical flow velocity and direction.
- Flow velocity measurements that can be compared to measurements made simultaneously in nearby monitoring wells, where a different type of flow measuring device is operating.
- Measured values for flow changes induced by pumping a monitoring well, if that activity occurs during the life of the Sensors.

4.1 DATA ANALYSIS

After download, raw field data will be processed with a personal computer-based computer program (SNL, 1994b). The initial processing will result in time-dependent calculated values of flow velocity and direction at each Sensor.

4.2 DATA INTERPRETATION

Processed field data will be interpreted for several purposes:

- Provide horizontal and vertical flow characteristics for input to contaminant transport models for baseline risk assessments.
- Establish baseline conditions for potential pump and treat remediation activities.
- Provide data to further understand the influence of fluctuations in river levels on groundwater flow characteristics by correlating water level data from the river and nearby monitoring wells with flow vector measurements.
- Compare measurements made by Sensors with those made by monitoring well instruments to verify performance characteristics of each method. Results from both sets of measurements will be compared to estimates based on gradients and aquifer hydraulic properties.

Sandy Ballard of Sandia Labs will download data and provide computer analysis of the groundwater flow characteristics for two one-month test periods. The test periods are not yet defined, but will include a wet season and dry season evaluation. Additional data retrieval will be at the discretion of WHC, although data loggers would need to be provided as the initial set is the property of Sandia Labs. Risk assessment and remediation baseline evaluations and instrument comparison studies will be the responsibility of WHC.

4.3 QUALITY CONTROL

The two most significant quality control issues in the installation of the Sensors are the alignment and integrity of formation collapse around the Sensors. The establishment of correct Sensor alignment, as described in section 3.3, is most dependent upon eliminating the possibility of torsion in the PVC pipe as the Sensor is lowered into the ground. Use of 1 inch schedule 80 PVC and glued, not threaded, joints provide the necessary assurance of correct orientation. Note that the azimuth of the indicating mark on the PVC pipe after Sensor installation is not controlled; the controlling factor is to prevent twisting of the pipe.

The Sensor is designed to be in direct contact with either the formation or a gravel pack of similar size media as the surrounding formation. Given the unconsolidated, poorly sorted nature of the soils at the installation site and the use of the sonic drill rig, formation collapse is expected after withdrawal of the drill stem. If it is apparent to the field team leader that

formation collapse around the Sensor has not occurred after withdrawal of the drill stem above the instrument, a decision will be made on site whether to add a gravel pack. Formation contact quality problems, if they exist, will be apparent after data retrieval and analysis due to irregularities in the calculated flow and velocity values (SNL 1994a).

5.0 SCHEDULE

Installation of the Sensors with the sonic drill rig is slated for April 11 through 15 as shown in Figure 3 (note two week schedule slip). If this schedule slot is missed, future availability of the sonic drill rig will be after October, 1994. It is highly desirable to utilize the sonic drill rig for this project as the alternate drilling method, cable tool, will likely produce excessive formation damage thus compromising the integrity of the data.

6.0 CHANGES TO DESCRIPTION OF WORK

Major changes to this description of work will be submitted via an Engineering Change Notice and kept on file with the project manager. Copies will be submitted to the lead regulatory agency and appropriate field personnel.

7.0 REFERENCES

- DOE-RL, 1993, *Limited Field Investigation Report for the 100-HR-3 Operable Unit*, DOE/RL-93-43, Draft A, U.S. Department of Energy Richland Operations Office, Richland, Washington.
- SNL, 1994a, Ballard, Sanford, Glenn T. Barker, and Ralph L. Nichols, *The In Situ Permeable Flow Sensor: A Device for Measuring Groundwater Flow Velocity*, SAND93-2765, Sandia National Laboratories, Albuquerque, New Mexico.
- SNL, 1994b, Ballard, Sanford, *FLOW: A Computer Program for Processing In Situ Permeable Flow Sensor Data*, SAND93-2779, Sandia National Laboratories, Albuquerque, New Mexico.
- WAC 173-160, Washington Administrative Code, *Minimum Standards for Construction and Maintenance of Wells*.
- WHC, 1992a, *Industrial Safety Manual*, Vol. 1 through 3, WHC-CM-4-3, Uniform Publications System, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1992b, *Environmental Compliance Manual*, WHC-CM-7-5, Uniform Publications System, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1992c, *Environmental Investigations and Site Characteristics Manual*, WHC-CM-7-7, Uniform Publications System, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1993a, *Conduct of Operations Field Handbook*, Westinghouse Government Operations Business Unit.

Figure 2. In Situ Permeable Flow Sensor.

Figure 3. Sonic Schedule: Rev. G

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