

APPENDIX A

GROUTED-IN PIEZOMETER PROCEDURES

TECHNICAL MEMORANDUM



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TO: Mike Lemon, Scott Miller

DATE: 14 July 2005

FROM: John Wozniwicz

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RE: PROCEDURES FOR GROUTED-IN PIEZOMETER INSTALLATION

Introduction

This memorandum describes the procedure for grouted-in piezometer installation. Golder will be responsible for ordering the pressure gauges, programming the gauges and supervising their installation. A reference for grouted in piezometer installation is provided as an attachment.

The pressure gauges and single channel data loggers have been ordered from GEOKON (contact: Brian Brown) and scheduled to arrive on site on 8 August 2005. Mike Lemon needs to track the gauges and ensure their arrival in time for the installations.

Boreholes and Pressure Gauge Depths

The boreholes and installation depth for the pressure gauges are summarized in the table below.

Borehole	Recommended Gauge Depth [feet]	Recommended Pressure Range of Gauge
77	160	100 psi (0.7 MPA)
	630	290 psi (2 MPA)
74	100	50 psi (0.35 MPA)
	790	435 psi (3 MPA)
20	75	50 PSI (0.35 MPA)
	800	435 (3 MPA)



All depths are measured along the borehole. There is 20 feet of extra cable with each gauge.

Zero Reading for Gauges and Programming the Clock Time (prior o gauge installation)

The clock time of gauges should be programmed to Eastern Standard Time as shown on the web site “wwp.greenwichmeantime.com”. Typically, the gauges are programmed to the clock time of the computer. Therefore, the clock time of the computer should be set at the office to the same time as Eastern Standard Time shown on the web site. It is important that this time is within 1 or 2 seconds.

Once the clock time is set, take a zero reading and record the time and date. Clearly mark the gauge number and depth on the end of the electrical line for each gauge.

Lowering Gauges to Depth

Prior to running into the hole, the rods should be tripped to the bottom of the hole and freshwater circulated at the bottom of the hole to ensure there are no bridges in the hole. There are two possible methods to install. If the holes are stable, then the rods can be tripped out of the hole and the equipment can be installed in the open hole with PVC that can also be used as a tremie pipe for grouting. This is the simplest and most straightforward method.

However, if the borehole is unstable, the equipment will need to be installed through the core rods and then either grout and remove the core rods in stages or remove the core rods to the surface and grout through the PVC. For this case, there needs to be sufficient PVC rods to rest the string on the bottom of the borehole. Once the PVC is resting on the bottom of the borehole, the electrical line at the surface needs to be cut and strapped to the top of the PVC (the cut ends should be tapped so as not to expose bare wires) prior to removing the core pipe.

It is important to discuss the installation in advance with Andrew Ware as KMC only ordered enough PVC based on the deepest gauge in each hole which will not be sufficient for the latter installation. Mike Lemon needs to talk with Andrew on the week of July 25.

Two pressure gauges will be installed in each borehole. Select the appropriate gauges based on the table above. The gauges will be strapped to the PVC using duct tape (to be

provided by Golder) and the electrical line will be taped to the PVC every 5 feet. It is critical the gauges are installed to the correct depth. Therefore, each length of PVC pipe that is installed into the hole needs to be accurately measured (sometimes not provided in standard length of 10 feet) so that the gauge is landed on the correct depth. The depth measurement should be from the tip of the sensor.

Grouting Pressure Gauges

Data collection should start prior to grouting of the borehole. Set the data acquisition rate at 2 hour increments. Grouting should be performed so that there is continuous pour from the bottom of the hole to the surface. The holes may have to be topped up after the cement has had time to cure.

ATTACHMENT

Piezometers in Fully Grouted Boreholes

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1.1.1 P. Erik Mikkelsen

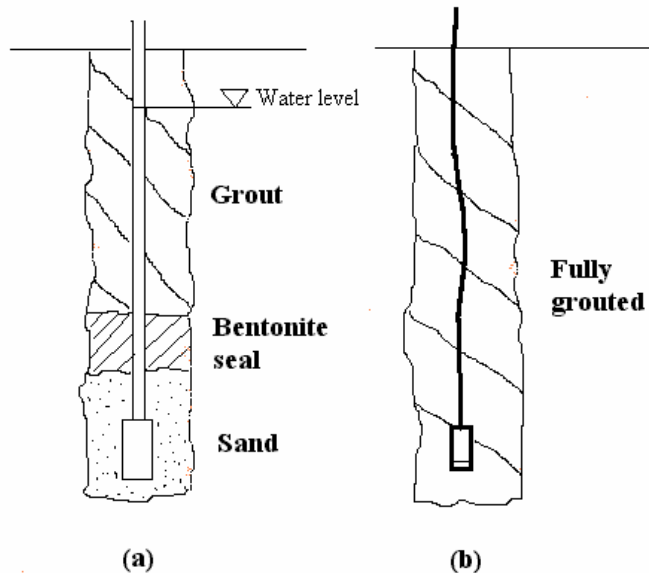
Gordon E. Green

Abstract

For decades it has been common practice in the geotechnical industry to install diaphragm piezometers (pore pressure sensors) in boreholes using methods developed for standpipe piezometers in saturated soil (Dunnicliff, 1988, 1993). Surrounding a diaphragm piezometer with a poured-in sand pocket and placing a bentonite seal above it is at best a laborious process and can in the worst case be so difficult that the installation becomes a total failure. This paper argues that traditional methods should be abandoned and that pneumatic and vibrating wire diaphragm piezometers can be more simply installed directly surrounding them with cement-bentonite grout in the borehole. The method is not only easier and faster, but has a much better chance of succeeding in measuring the correct ground water pressure. A review of key papers shows that this idea is not new, but that only recently have fully grouted diaphragm piezometers begun to be employed in practice. The fully grouted method also makes it feasible to install multiple piezometers and to install piezometers together with other instruments in a single borehole. Note that the proposed fully grouted method of installation only applies to diaphragm piezometers and generally excludes conventional standpipe piezometers. A review of traditional practice is provided as a background for understanding why it is time to change.

Why Use a Sand Pocket?

Open standpipe piezometers shown schematically in Figure 1(a) rely on a sizable intake volume and a narrow pipe diameter to obtain a reading of piezometric head without significant time-lag (Hvorslev, 1951). The volume of sand surrounding the intake filter is a necessary, integral part of the piezometer. The larger the sand volume, the more rapidly water can be delivered to the standpipe to equalize pressure changes. The smaller the standpipe diameter the faster equalization occurs. In contrast, when diaphragm piezometers are utilized to measure piezometric head, only an infinitely small volume of



diaphragm piezometers such as
socket normally specified
installation step of sand (and
simply and effectively be

of the borehole is necessary
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the borehole above the sand
ure 1(a). It is common
d. The bentonite is allowed

Figure 1. (a) Open standpipe piezometer. (b) Diaphragm piezometer

to partially hydrate before tremie-grouting the rest of the borehole. This practice should also be abandoned in order to simplify the installation procedure. The bentonite seal in Figure 1(a) is redundant, but is perceived to protect the sand from being disturbed during grouting and being grouted. Assuming the sand zone to be saturated, grout with a creamy consistency would penetrate the sand only a few inches. Grouting directly above the sand can be done provided excessive initial pump pressures are avoided and the tremie is prevented from acting like a jet nozzle directly into the sand. Side port exits from the tremie will prevent this. An extra few feet of sand can also help.

Forgotten Test Results.

In 1961 Penman demonstrated the vast difference in response times between open standpipe, twin-tube hydraulic and diaphragm type piezometers. Various piezometers were pressed into reconstituted London clay with a permeability of 3.4×10^{-8} cm/sec, essentially the same as bentonite clay. Theoretical and experimental results showed how little time was required to equilibrate diaphragm sensors during 20 and 30 psi loading steps and that they responded in a matter of minutes or less (Penman, 1961). The significance of this paper has been largely overlooked with respect to piezometer installation in boreholes. Whereas pushing or embedding piezometers directly into compacted or soft clay without a sand-pocket is an accepted procedure, a borehole piezometer is not normally installed without a substantial volume of sand around it. Current worldwide practice for installing standpipes and diaphragm piezometers are essentially identical. Penman's 1961 paper demonstrates that diaphragm sensors are clearly different from open standpipes and twin-tube hydraulic piezometers. His studies demonstrated that a vibrating wire piezometer responds extremely rapidly if embedded directly in a material similar to bentonite. Surrounding a diaphragm piezometer in the borehole with a cement-bentonite grout with a similar permeability is sound engineering.

Ignored Theory.

A diaphragm piezometer embedded directly in a low permeability saturated clay strata or a large mass of low permeability cement-bentonite grout should respond instantly to a pore water change. Effective stress principles and consolidation theory are well understood and accented in long-standing soil mechanics practice. A saturated clay layer

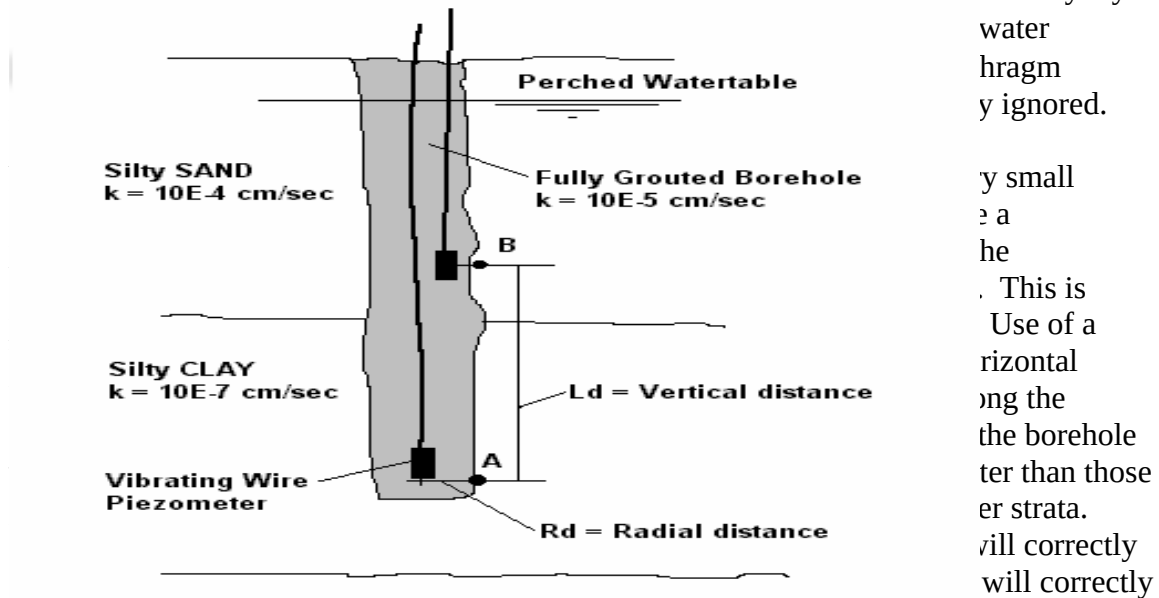


Figure 2. Multi-level piezometer installation

Cement-Bentonite Grouts

Basics. A bentonite grout backfill consisting of just bentonite and water may not be volumetrically stable and introduces uncertainty about locally introduced pore pressures caused by the hydration process (Mikkelsen, 2002). Introducing cement, even a small amount, neutralizes the expansive properties of the bentonite component once the cement-bentonite grout takes an initial set. The strength of the set grout can be designed to be similar to the surrounding ground by controlling the cement content and adjusting the mix proportions. Controlling the compressibility (modulus) and the permeability is not so easy. Weaker cementitious grouts tend to remain much stiffer than normally consolidated clays of similar strengths. The bentonite solids content has the greatest influence on the permeability of cement-bentonite grout, not the cement content.

Cement-bentonite grouts are easier to use than bentonite grouts, provide a long working time before set and are more forgiving should the user deviate from the design recipe or mixing equipment and method. It is easier to adjust the grout mix for variations in temperature, pH and cleanliness of the water. Pure bentonite grouts must be mixed and deployed by following measured quantities and procedures that are not common among drillers doing test borings.

Strength and Deformation Considerations. The general rule for grouting any kind of instrument in a borehole is to mimic the strength and deformation characteristics of the

surrounding soil rather than the permeability. However, while it is feasible to match strengths, it is unfeasible with the same mix design to match the deformation modulus of cement-bentonite to that of a clay for example. The practical thing to do is to approximate the strength and minimize the area of the grouted annulus. In this way the grout column would only contribute a weak force in the situation where it might be an issue.

Strength data collected informally from various sources over the years are summarized in Figure 3. A trend line drawn through the data points illustrates the decrease in strength with increasing water-cement ratio. The water-cement ratio controls the strength of the set grout (Marsland, 1973). Marsland's rule-of-thumb is to make the 7-day strength of the grout about one quarter that of the surrounding soil.

Water and cement in proportions greater than 0.7 to 1 by weight will segregate without the addition of bentonite or some other type of filler material (clay or lime) to suspend the cement uniformly. In all cases sufficient filler is added to suspend the cement and to provide a thick-creamy-but-pumpable grout consistency. The bentonite does not add significant strength to the grout. The background data for Figure 3 also suggests that the amount and type of bentonite or hydrated lime does not influence strength as long as the grout is non-bleeding and pumpable. If the grout bleeds the water-cement ratio decreases and strength increases. If fly ash were to be used as a substitute for cement the strength and modulus would be expected to drop. Fly ash has a smaller amount of cementing agents (calcium and gypsum).

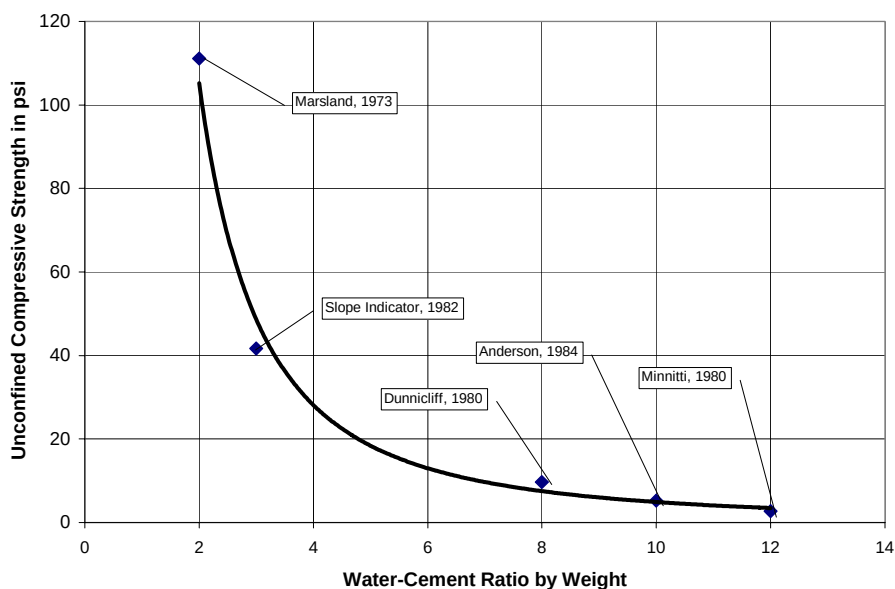


Figure 3. 28-day cement-bentonite grout strength vs. water-cement ratio. Data from authors personal files.

Mix Design Rules. In order to keep field procedures simple the emphasis should be on controlling the water-cement ratio. This is accomplished by mixing the cement with the water first. When water and cement are mixed first, the water-cement ratio stays fixed and the strength/modulus of the set grout is more predictable. If bentonite slurry is mixed first, the water-cement ratio cannot be controlled because the addition of cement must stop when the slurry thickens to a consistency that is still pumpable.

Making cement-bentonite grout in the field is a straightforward process. The most effective mixing is commonly done in a barrel or tub with the drill-rig pump, circulating the batch through the pump in 50 to 200 gallon quantities. The rig pump provides the kind of jet-mixing required to get the job done quickly. Any kind of bentonite powder used to make drilling mud combined with Type 1 or 2 Portland cement and water can be used, but the appropriate quantity of bentonite will vary somewhat depending on grade of bentonite, mixing sequence, mixing effort (agitation), water pH and temperature.

Grout mixes should be controlled by weight and proportioned to give the desired strength of the set grout. The conversion factors contained in Appendix H.10 in Dunnicliff (1988, 1993) are very helpful in mix design. Two mixes are given in Table 1 that varies in 28-day strength from 50 psi to 4 psi for water-cement ratios of 2.5 to 6.6 respectively.

Example Mixing Procedure. A rig pump with one suction hose and a return hose fitted with a jet nozzle in a 50-gallon barrel are the minimum requirements for circulation batch mixing of grout. Paddle or high shear mixers can also be used. A measured quantity of clean water goes into the mixing tub/barrel first and pumping and circulation starts. Then the cement is gradually added to the water and mixed thoroughly. At this stage the mix is like gray water. Next, bentonite powder is slowly added into the jetting area of the barrel, slowly enough so clumps of bentonite do not form. This should be constantly checked by scraping the bottom with a shovel. When clumps form, slow down and do not add any more powder until they are dissolved. Keep adding bentonite until the watery mix transitions to an oily/slimy consistency. Observe the consistency while mixing and let the grout thicken for another five to ten minutes. Generally, the mix thickens some more with added mixing time. Add more bentonite as required. When it is smooth and like thick cream or pancake batter, it is as heavy as is it feasible to pump. Drips of the grout should then barely come off a dipped finger and form "craters" in the fluid surface. That is the correct consistency for pumping the grout batch down the tremie-pipe. When possible, withdraw the tremie after each batch an amount corresponding to the grout level in the boring to keep the pumping pressures as low as possible. When pumping grout 100 feet or more from the borehole, thinner consistency would be required, but at the risk of some bleeding.

Application	Grout for Medium to Hard Soils		Grout for Soft Soils	
	Weight	Ratio by Weight	Weight	Ratio by Weight
Portland Cement	94 lbs. (1 sack)	1	94 lbs. (1 sack)	1
Water	30 gallons	2.5	75 gallons	6.6
Bentonite	25 lbs. (as required)	0.3	39 lbs. (as required)	0.4
Notes	The 28-day compressive strength of this mix is about 50 psi, similar to very stiff to hard clay. The modulus is about 10,000 psi.		The 28-day strength of this mix is about 4 psi, similar to very soft clay.	

2.0 TABLE 1. CEMENT-BENTONITE GROUT MIXES

Old habits die hard, so that some users will insist on mixing water and bentonite powder first as recommended by Dunnicliff (1988, 1993). This practice should be abandoned for instrument grouts. This is normally the way drilling mud is mixed and it yields more slurry per sack of bentonite than the above method. Also, use of hydrated bentonite with cement added last is common practice in grouting technology for ground improvement. Such mixes are highly thixotropic and rely on industrial type mixing plants and methods. The cement content is difficult to control under ordinary field instrument installation circumstances.

The amount of bentonite that is required for the above mixing procedure will vary due to factors mentioned earlier. The amount of bentonite shown in Table 1 should only be used as a guide and is also handy for estimating material quantities shipped to the site. With this method more bentonite is required than if water and bentonite was mixed first. This is an advantage from the standpoint of wanting a low permeability. When the bentonite solids content increases, the density increases and the permeability is lowered. It is another reason for mixing water and cement before adding cement. A lower permeability is generally preferred since cement-bentonites have a higher permeability than high-density bentonite grout or chip seals.

Diaphragm Piezometers in Fully Grouted Boreholes

Recent Experience. Increasingly, both single and multiple vibrating wire and pneumatic pressure sensors are being grouted directly into boreholes without sand pockets and bentonite seals. The idea is not new. Thirty years ago, Vaughan in London demonstrated that even grouted multiple small-diameter standpipes in clay were feasible (Vaughan, 1969). Tofani (2000) has used the procedure for 20 years in California for both pneumatic and vibrating wire piezometers. McKenna (1995) in Canada has adopted the fully grouted installation of piezometer sensors and McKenna and others (1994) adopted combined inclinometer casing and diaphragm piezometers directly grouted into the same borehole as standard procedures. The US Army Corps of Engineers, Omaha District adopted fully-grouted vibrating wire piezometer installations and included them with deep inclinometer casing installations based on recommendations by the first author (USACE, 1999). But, because the geotechnical community seems to be so rooted in traditional thinking when it comes to sealing a piezometer in a borehole, it is counter-intuitive to most engineers to simply grout the sensors in the hole. Grout is perceived as a sealant that would prevent the sensor from registering the correct pore pressure, should it get between the soil and the porous element on the piezometer tip. However, based on research 40 years ago (Penman, 1961), that perception is incorrect. Despite research in the 1960s that recognizes the feasibility of direct grouting, it remained largely unrecognized in 1988 when the “redbook” was first published (Dunnicliff, 1988).

Grout Permeability. Cement-bentonite grout is a porous solid with a permeability that lies somewhere in the cement and bentonite range mentioned above. Typical published values of permeability are listed in Table 2. Vaughan (1973) quotes a coefficient of permeability for a pumpable cement-bentonite grout mix on the order of 5×10^{-8} cm/sec. For low bentonite solid contents the permeability can be expected to be close to 10^{-6} cm/sec and for higher bentonite solids content it would be close to 10^{-8} cm/sec. So the issue is really not if this method works, but how well does it work and what, if any, are the limitations involved with the use of vibrating wire sensors or pneumatic sensors.

Grout Type	Characteristics	k (cm/sec)	Source
Neat cement	w/c = 0.53, γ = 112 pcf	10^{-7}	Baroid
Bentonite chips	hydrated	10^{-8}	Baroid
Bentonite slurry	6 % solids	10^{-5}	Baroid
Bentonite slurry	20 % solids	10^{-8}	Baroid
Cement-bentonite	water/solids = 4 to 1	10^{-6}	Vaughan, 1969

Cement-bentonite	w : c : b = 4 : 1 : 1	5×10^{-8}	Vaughan, 1973
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3.0 TABLE 2. PERMEABILITY OF SOME GROUTS

Vibrating Wire vs. Pneumatic Piezometers. Response tests (Penman, 1961; Tofani, 2000; McKenna, 1995; Mikkelsen and Slope Indicator Co., 2000) all show that both vibrating wire and pneumatic sensors stabilize after a pressure change in a matter of seconds to several minutes. Examples of recent response testing on a vibrating wire piezometer embedded in cement-bentonite grout are shown in Figures 4 and 5 (Mikkelsen and Slope Indicator Co., 2000). However, it should be recognized that vibrating wire and other electrical sensors have an advantage over pneumatic sensors. The volume of fluid displaced at a vibrating wire diaphragm during a pressure change is extremely small, so that system equilibrium is rapid. During reading, no actual displacement of the diaphragm occurs. In contrast, the diaphragm of a pneumatic sensor has to displace a small amount of pore-fluid every time the sensor is activated to take a reading. Experience demonstrates that a small amount of undissolved air must be present in the intake area of the sensor for it to work properly in low permeability clay. A fully saturated pneumatic sensor embedded in clay must overcome the total soil pressure for initial movement of the diaphragm. Obtaining a stable, reliable pore water pressure reading is not only time-consuming, but also often nearly impossible to get. A pneumatic piezometer should be installed without any special effort to remove all the air outside the diaphragm. It is a necessary compromise with an obvious sacrifice in response in low permeability clay. In contrast, a vibrating wire piezometer should be installed upside down, fastened to its cable and flooded with water to discourage air from collecting against the diaphragm.

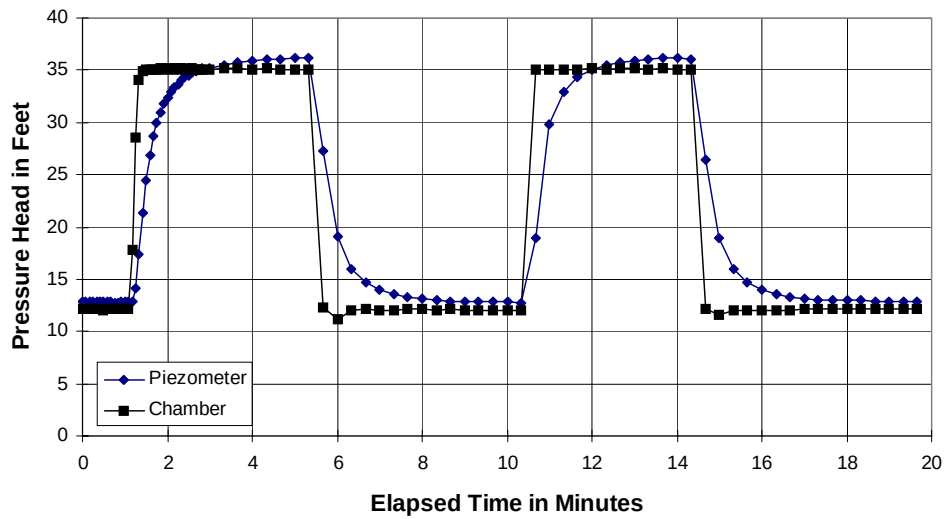


Figure 4. Vibrating wire piezometer response after 288 days grout cure. Piezometer embedded under 8 inches of cement-bentonite grout inside pressure chamber. Pressure applied above wet grout surface and piezometer response recorded.

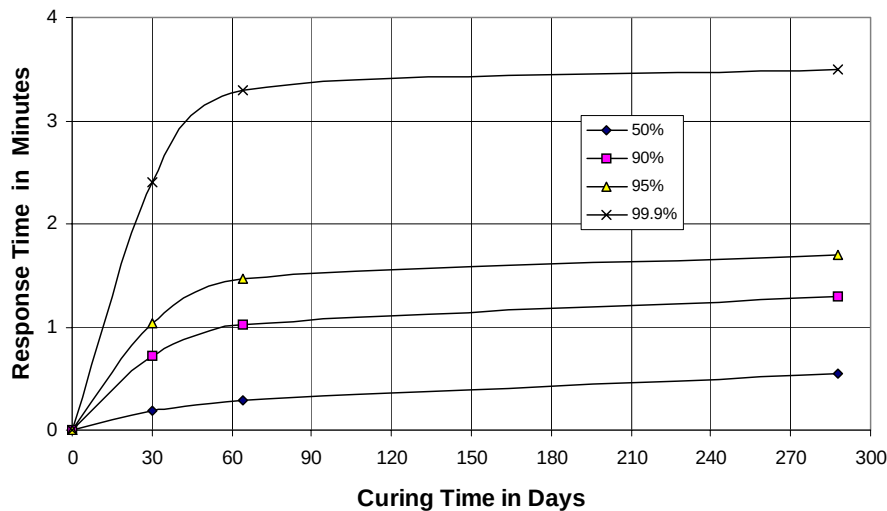


Figure 5. Vibrating wire piezometer response time vs. grout curing time

As a practical matter, lowering a diaphragm piezometer down a water or mud-filled borehole usually requires added weight to keep the cable or tube straight and counteract buoyancy and borehole stickiness. A short length of re-bar can be attached. A better method, especially for the pneumatic sensors, is to enclose the sensor in a 1.5 to 2-inch diameter, sand-filled geo-textile (or canvas) sock. This will encourage entrapment of a small amount of free air. Diaphragm piezometers can be directly attached to inclinometer casing during assembly without the re-bar or the sand-filled sock. As a final note, the pneumatic piezometers are generally unsuitable for measuring negative (sub-atmospheric) pressure whereas the vibrating wire piezometers are quite capable of measurements to 7 psi (50 kPa) below ambient atmospheric pressure.

Cement-Bentonite Grout as a High-Air Entry Filter

As a side issue, the cement-bentonite grout discussed herein also offers advantages of interest for pore water suction measurements in partially saturated soils. During the preparation of this article it was pointed out (Vaughan, 2001) that cement-based grouts have an air entry value up to about 100 psi, a property required for measurement of negative pore pressures. The grout, when set, becomes a perfectly saturated porous material, a far easier task than pre-saturating a high-air entry ceramic filter and deploying it down a borehole. A vibrating wire piezometer fully grouted within cement-bentonite grout can therefore be expected to measure negative pore water pressure or suction. Research is currently in progress in the UK on the role of grouts surrounding directly grouted-in piezometer tips designed to measure suction and the air entry value of grouts.

Multiple Piezometers in a Borehole

Simplicity and Reduced Cost. The borehole is the highest cost component of an instrument installation, so that there is a great incentive to put more than one sensor or more instrument types for that matter, in the same borehole. Debate has surrounded this topic in the past, because of the perceived lack of ability to seal around multiple cables,

pipes and tubes in one boring. It is the author's opinion that most difficulties arise from dealing with rigid standpipes and attempting to place multiple sand/bentonite seals. Elimination of multiple rigid pipes, poured-in sand-pockets, bentonite layers and opportunity for multiple down-hole measurements, are considerable benefits.

The ability to reliably install two, three or more piezometers in one borehole has enormous attractions. Vibrating wire piezometer sensors in fully grouted boreholes practically eliminates the risk of installation failure. The sensors should probably be spaced no closer than 10 to 20 feet apart. An option exists for users who remain skeptical about introducing grout between the soil and the porous piezometer filter. An enlarged porous pad directly attached to the piezometer sensor can be pressed directly against the borehole wall by springs (Green, 2000). Mechanical and hydraulic jacks have been used in Norway to achieve direct contact and a spring-actuated system was used successfully on a very deep installation in Canada. Pneumatically released spring-loaded multi-level piezometers are now available from Geokon for installation in fully grouted boreholes. Whether or not the spring-actuated system is used should not detract from the data quality; its use may encourage skeptics to go fully grouted.

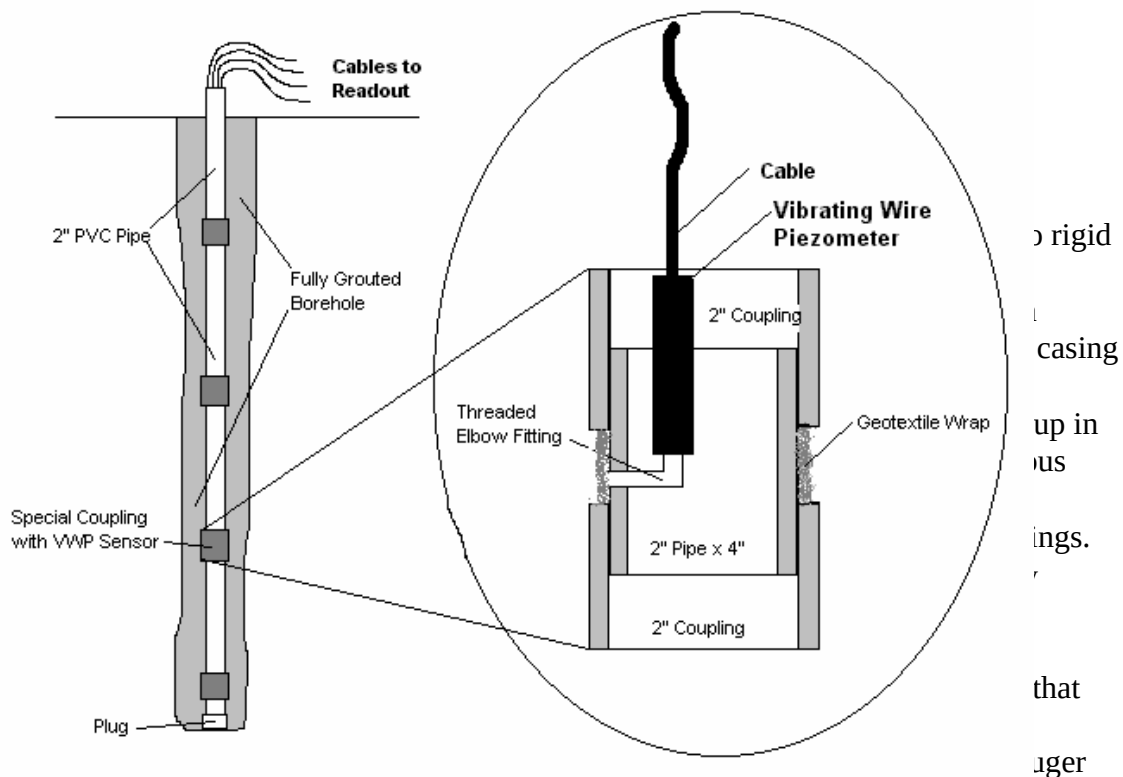


Figure 6. Multi-level piezometers in PVC pipe

Conclusions

1. Theoretically, fully grouted diaphragm piezometers should correctly measure the pore water pressure in the surrounding saturated soil. Effective stress concepts are well established and Darcy's Law helps us understand the significance of how the larger radial pressure gradient at a particular piezometer governs the measured pressure and that the smaller pressure gradients along a grouted borehole severely limits the effect of leakage along the borehole.
2. Empirical evidence from Penman (1961) and Vaughan (1969), and more recently by McKenna (1995), Tofani (2000) and the first author, clearly demonstrate that grouted-in diaphragm piezometers should and do work reliably. It is time for fully grouted diaphragm piezometers to be adopted in general without further delay or pending further testing.
3. A cement-bentonite grout mixture is the most reliable, versatile, easily mixed and readily pumpable grout for piezometer grouting seals. Poured in place sand pockets placed around the piezometer tip and sealed with compressed bentonite pellets or granular bentonite should be abandoned. Single component bentonite sealing grouts are too difficult to control during mixing, may set up too quickly and if thinned may remain too soft when set.
4. A fully grouted diaphragm piezometer is simpler and easier to install and therefore is more reliable. It saves considerable field installation time and is less costly.
5. Fully grouted installations facilitate placing multi-level piezometers in a single borehole and provide great savings in drilling and instrument installation cost. They are much simpler and less costly than other multi-level piezometer systems available (e.g. Westbay and Waterloo).
6. Fully grouted installations open up the opportunity to place multiple instrument types in a single borehole, e.g. inclinometers and piezometers.

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APPENDIX B
PUMPING TEST PROCEDURE

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RE: EAGLE PROJECT; PHASE III; BEDROCK CHARACTERIZATION PROGRAM; TECHNICAL PROCEDURES



General Work Sequence

Although the actual work sequence and test durations are likely to change, the proposal is based on the following schedule:

- Mob to Site;
- 10 day pumping test in Lower Bedrock in Borehole 04EA-84.;
- Demob and return after 10 days;
- Retrieve equipment and perform 5 day pumping test in Upper Bedrock in Borehole 04EA-84; and
- After 5 days of recovery, remove equipment and demob.

EQUIPMENT

The equipment will consist of the following:

- grouted-in vibrating wire pressure gauges installed in 3 boreholes to monitor pore pressure in the bedrock during the pumping test;
- pressure gauges that have been installed in two shallow alluvium wells to allow for evaluation of communication between the bedrock and the alluvium; and
- a packer and moyno pump to be installed in borehole 04EA-84 that will be used to isolate two test intervals and pump water from these intervals for water quality samples and for analysis of the response.

The packers will be external inflation type.

PACKER INSTALLATION AND INFLATION PROCEDURE

During installation, the inflation line and electrical line need to be tapped to be kept taut and tapped to the BQ rods every 5 feet. This is important as there is not much annulus between the BQ rods and the borehole walls. Teflon tape should be placed on all BQ rod joints. The inflation pressure should be the combination of the following:

- the vertical depth x 0.45 psi;

- 100 psi for stretching the packers to the borehole walls; and
- 400 psi for differential pressure.

The packer inflations spreadsheet has been attached.

MOYNO PUMP INSTALLATION INSTRUCTIONS

There are three main components to the pump: the pump housing (stator-blue), the rotor (silver corkscrew), the sucker rods (not shown) and the stop pin (bar at base of stator).



The test string will consist of packer(s), gauge carrier, stator and BQ rods. The general set-up is described below:

- packers
- x-over to gauge carrier;
- (2) 10 ft BQ rods
- Stator; and
- BQ rods to the surface.

The sucker rod instructions are as follows:

- Lower the rotor to the stop pin and pull up 12 inches;
- The first rod guide should be placed 20 feet above the pump;

- Thereafter, there should be one rod guide above each coupling.

The top sucker rod should be attached to the top drive of the rig. Fluid is produced by the rotation of the sucker rods. The rate is controlled by the rpm's of the top drive of the rig. The optimal rpm's will be somewhat experimental but start relatively low (100 to 200 rpm's) and then increase as needed to a maximum of 500 rpms.

Additional details are provided in Attachment A. The Weatherford contact is Ryan Orr (1-888-522-0252)

PACKER INTERVALS FOR BOREHOLE 04EA-84

The number of holes to be tested is likely to expand but the budgeted program includes the collection of water quality samples from two test intervals. The depth of the intervals and criteria for selection is provided in Table 1 below.

Table 1: Test Intervals in Borehole 04EA-84.

TOOL	DEPTH	HYDROSTRATIGRAPHIC UNIT	CRITERIA
Single Packer	250 m	Lower Bedrock	Collect water sample from the interval 257.74 to 260.29
Double Packer	55 to 85 m	Upper Bedrock	Collect sample from Upper Bedrock

INSTALLATION OF PRESSURE GAUGES IN MONITORING WELLS

Currently, pressure gauges are installed in two alluvium monitoring wells near the proposed pumping well. If there are more proximal alluvium wells or if tests are performed in other pumping wells that require re-installation of the gauges in other monitoring wells, the procedure for installation will be as follows:

- in the office, synchronize the clock time of the computer(s) you will use to program the gauges to Eastern Standard Time as shown on the web site "wpp.greenwichmeantime.com";

- synchronize the clock time on the gauges to the clock time of the computer;
- on site, measure water level in well from measuring point and note the relative position to ground surface;
- program gauge to start recording at 2 minute increments and to record pressure in psi units, start recording data and take some readings with gauge at surface;
- measure 20 feet from tip of the gauge and mark cable with tape;
- install gauge to 20 feet from the top of the casing, download data and document pressure reading once gauge is on the correct depth;
- tape electrical wire to casing so gauge can not move; and
- download data after 1 hour to make sure reading okay.

The installation procedure should be documented on the electronic field form.

TEST PROCEDURE

Moyno Pumping Test

Prior to start of the test all data loggers should be downloaded and the clock time should be set to Eastern Standard Time as shown on the web site “www.greenwichmeantime.com”. Each time data is downloaded the file name should be as follows: Borehole Number_Serial Number (if more than one gauge)_Time_Date. Also, the data loggers should be downloaded and the data should be plotted twice a day. The data collection should be set at 1 minute for all observation zones. For the pump well, the data collection will vary with time.

The aim will be to perform a constant rate test and recovery test. A target rate to start each test is 5 gpm. If the pressure change is less than half the available drawdown after 1 day, then the rate may be increased. Compute a specific capacity (flowrate/drawdown) and determine a more optimal rate. Alternatively, if the water level approaches the pump intake reduce the rate by 25 to 50 %. The goal is to have as few rate changes as possible. At completion of pumping, the sucker rods should not be removed as they form a seal inside the pump and acts as downhole shut-in tool.

The pumping rate, flow total and downhole pressure should be recorded twice an hour.

Double Packer Scan Tests

There is a possibility that additional testing will be required in other boreholes which will be decided upon arrival on site. One possibility is that double packer scan tests are performed to develop a profile along the borehole. For these tests, the equipment set-up would be the same except that diagnostic tests would be performed prior to installing the sucker rods to determine if the permeability is sufficient to obtain water quality samples.

The test procedure may be as follows:

- Install pressure gauge to below water table;
- 1 hour equilibration;
- Fill tubing for slug injection;
- If very little recovery after 15 minutes, continue for 1 hour, perform a slug withdrawal test with larger drawdown and monitor recovery for 1 hour (the problem with the slug injection test alone is the small magnitude of the pressure different due to proximity of the water level to the surface);
- If recovery is very rapid, pump at a low rate using Waterra pump lowered from surface and monitor both pressure and rate; and
- If relatively high transmissivity, there may be a chance that the sucker rods would be installed and pumping would continue for collection of water samples.

The procedure should be discussed with the project manager in advance of the testing.

WATER SAMPLING

The physical water quality parameters should be measured at the start of pumping and every hour thereafter. Prior to sampling, the minimum purge volume should be 10 x (the volume of the tubing and the volume of the interval), the physical parameters should have semi-stabilized, and received approval from project manager.

Two water quality sample should be collected from the single packer interval below 250 m in borehole 04EA-84 with one collected shortly after 10 volumes have been produced and a second sample should be collected just prior to turning the pump off. In addition, a

complete backup archive sample should be collected and labelled such that there is no analysis performed unless bottles were broken during transport of the main sample. A single sample should be collected from the interval 55 to 85 m in borehole 04EA-84 and a duplicate (label as different number for laboratory). The archive from the deep interval and the duplicate sample from the shallow interval should be sent in separate containers from the main samples.

Water sample collection and bottle supply will be coordinated by North Jackson.

DOCUMENTATION

The documentation should focus on electronic media. At a minimum, the following forms should be used to document test data:

- Golder Field Report – daily documentation of site activities. A new worksheet should be filled out for each day and emailed on a daily basis to Jon Cherry, Andrew Ware, John Wozniwicz and Scott Miller.
- Logbook – document pertinent information on logbook;
- Packer Inflation Form – computes the packer pressure;
- Pump Test Form – document pumping rate, field parameters and plots and straight line analysis.

These forms will need to be adapted to the job and best if performed prior to mobilization to the field.

Attachment A
Moyno Pump Operation Manual



Weatherford[®]

Progressing Cavity Pump Manual

*General Information
Version 1.2*



Weatherford®

Preface

Profile

This manual is intended as a guide for the selection, operation and routine maintenance of Weatherford Artificial Lift Systems progressing cavity pumps.

The information, specifications and illustrations in this publication are up to date at time of printing. Our policy is one of continued development and therefore we reserve the right to amend any of the information contained in this manual or binder without prior notice.

For more information about Weatherford progressing cavity pumping equipment, or technical assistance in evaluating your requirements, contact your nearest Weatherford representative.

PC Pump Manual

Table of Contents

Progressing Cavity Pump Generic Information

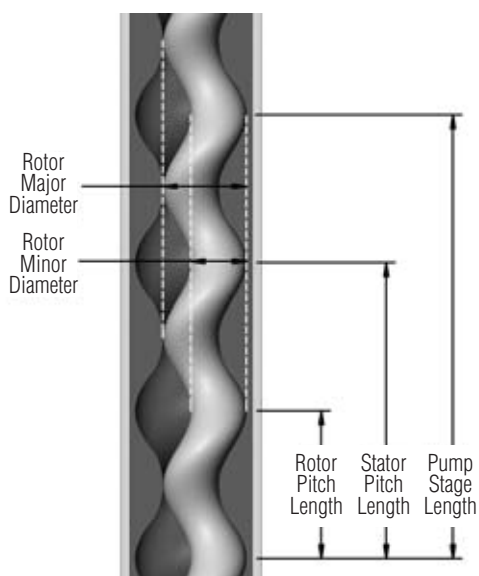
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Introduction

Progressing Cavity (PC) Pumps are a widely accepted means of artificial lift; with high production, lift capacity, and system efficiency being a few of the major benefits over other oil and water pumping systems. The ability for PC pumps to handle sand and viscous fluids make them the best solution for heavy oil production and the high gas oil ratio tolerance is beneficial in pumping mixtures of sand, oil, gas and water.

PC pumps are comprised of two parts - a helical shaped steel rotor and a stator. The rotor, which is the rotating internal component of the pump, is normally driven by a rod string. It is precision machined from high strength steel and coated with a wear resistance layer, such as chrome. The stator is attached to the production tubing string and remains stationary during normal operation. It consists of a molded elastomer permanently bonded to the inside of a steel tube.

As the PC pump operates, cavities formed between the stator and rotor move fluid upward in a non-pulsating action from the intake to the discharge of the pump. Pressure builds linearly from the inlet to the discharge of the pump providing the necessary lift to produce fluid to surface.



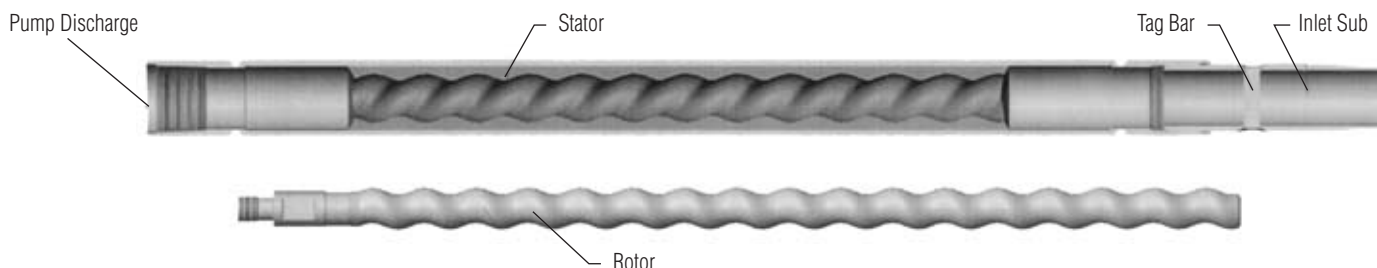
PUMP DISPLACEMENT

Displacement of any PC pump is a function of the rotor diameter, eccentricity, and the pitch length.

STAGE AND PRESSURE CONVENTIONAL DEFINITION

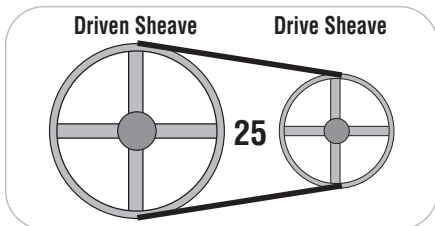
Pump pressure rating = 100 psi/pump stage

Pump stage = 3 rotor pitches
= 1.5 stator pitches



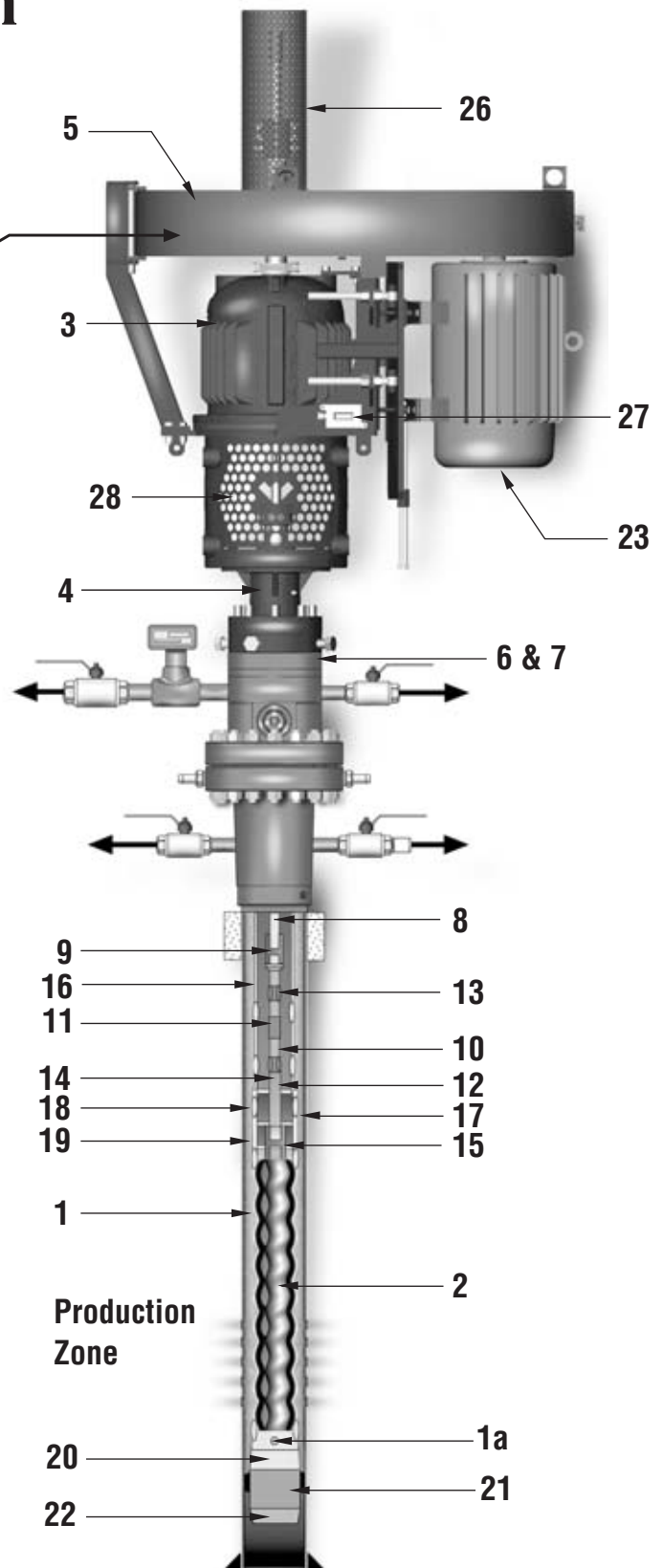
PC Pump Configuration

Typical Progressing Cavity Pump Set-up



EQUIPMENT LIST

1. Stator (includes Tagbar sub)
 - 1a. Tagbar Sub
2. Rotor
3. MG Direct Drive
4. Stuffing Box Wellhead Connection
5. Belt Guard
6. Flow-Tee (Composite Pumping Tree (CPT) Illustrated)
7. Rod BOP (Composite Pumping Tree (CPT) Illustrated)
8. Polished Rod
9. Polished Rod/Sucker Rod Change-Over Coupling
10. Sucker Rods
11. Sucker Rod Coupling
12. Shear Coupling
13. Rod Guides
14. Pony Rods
15. Sucker Rod/Rotor Change-Over Coupling
16. Tubing Drain
17. Pump Seating Nipple (PSN)
18. Tubing/Stator Swedge Adapter
19. Pup Joint
20. Torque Anchor/No-Turn Tool
21. Downhole Check Valve
22. Gas Separator/Tail Joints
23. Prime Mover
24. ePac VFD or Starter Box
25. Belts & Sheaves
26. Polished Rod Guard
27. Remote Tachometer
28. Booth Guard



Selection Considerations

PC pump selection is dependent on the following conditions:

- Production requirements.
- Pump landed depth.
- Tubing and casing pressures.
- Fluid conditions.
 - Density, viscosity, fluid level, sand and water content, aromatic content, CO₂ & H₂S presence, temperature, and gas oil ratio.
- Well equipment configuration.
- Tubing specifications.
- Casing specifications.
- Rod specifications.
- Drive capabilities.

An important factor to consider when selecting a PC pump is the experience gained from other wells in the area. Weatherford personnel are available to assist with well design and pump selection using our wide network of experience and a very powerful design program developed at C-FER. In order to complete a C-FER PC pump run, the following input sheet must be filled out completely. This program can predict all elements of a Downhole Progressing Cavity Pumping System including:

- Pump differential pressure.
- Pump speed.
- Total input power required.
- Polished rod drive torque.
- Rod axial and sidewall loading.
- Surface equipment loading.
- Tubing life and location of high tubing wear.

The program can then help determine the following:

- Pump size (volume and lift).
- Rod & tubing size.
- Drive system.
- Suggested rotor space out.
- Total system efficiency.

Note: Please ensure that all production and well data information is completed. This information is critical to the surface equipment design, PCP and elastomer selection. If key information is missing, designs cannot be completed accurately and delays will result. Please circle unit of measure where applicable.

To receive a C-FER design, return a completed input data sheet to one of the following:

For inquiries for Canada Fax: 780/875-0963

For United States or International Fax: 780/464-5198

Input Data Sheet

We offer the ability to predict all elements of a Downhole Progressing Cavity Pumping System including differential pressure, estimated pump speed, polished rod drive torque and total input power required for any given set of well parameters. From this information it is possible to correctly select the bottom hole pump based on volume and lift capabilities, sucker rod diameter and grade, prime mover horsepower and surface drive type most suitable for your application.



Company Name:		Country:	
Date:		Contact:	
E-mail:		Phone:	Fax:
Well Name:		Location:	
WELL DATA		PRODUCTION AND FLUID DATA	
Total Depth:	Ft - m	Current Production:	Bfpd - M ³ pd
Midpoint of Perforations:	Ft - m	Desired Production:	Bfpd - M ³ pd
Pump Landing Depth (TVD):	Ft - m	Water Cut:	%
TMD:	Ft - m	Abrasive Cut:	%
Producing Fluid Level From Surface (TVD)		Gas/Oil Ratio:	Scf/Bbl - M ³ /M ³
Current:	Ft - m	Total Fluid Viscosity:	Cp@ °F - °C
Projected:	Ft - m		Cp@ °F - °C
Flowline Pressure:	Psi - Kpa	Oil Gravity:	°API Aromatic Content Mole% Benzene, Toluene, Xylene:
Casing Pressure:	Psi - Kpa	Water Gravity:	Water Salinity:
Casing size:	Psi - Kpa	CO ₂ :	Ppm% H ₂ S: Ppm%
Tubing Size:	Inches -mm	Temperature at Pump:	°F - °C
Rod Size & Grade:	Inches -mm	Bottom Hole Temperature:	°F - °C
Coupling ☐ Slimhole ☐ Standard ☐		Treating Chemicals (list type and application):	
IPR DATA		SURFACE EQUIPMENT	
Static Reservoir Pressure:	Psi - Kpa	Primer Mover Type:	Gas ☐ Electric ☐
Bubble Point Pressure:	Psi - Kpa	Surface Drive:	Direct ☐ Hydraulic ☐
	Test Point #1	Operating Frequency:	Hz Line Voltage: Volts
Producing Pressure:		Specify Flow-Tee to Drive Head Connection:	
Fluid Rate (Bfpd-m ³ pd):			
Productivity Index:	Bbl/Psi - M ³ /Kpa		
Pertinent Information:			

To Receive this Data Information Sheet please contact your local Weatherford Distributor.
For an electronic copy please contact us at www.weatherford.com

Elastomer Swell Test Parameters

Elastomer swell tests and gas/fluid compositional analysis are completed to assist in determining gas and fluid affects on PC stator elastomers prior to running the pump. This testing can be conducted on any well or area but is predominantly completed on higher API oils and in areas with no previous PC pump experience.

The following are general instructions for elastomer testing:

1. Contact your Weatherford representative for information on elastomer testing labs in your area.
2. Contact the lab to discuss your objectives and to determine which tests will be completed (72 hour/240 hour tests).
3. Determine who will obtain the sample. (The customer or the lab).
4. Obtain a pressurized fluid sample at the well.
5. Complete a swell test request form. (Forms available from Weatherford PC Pump).
6. Fax the completed request form to the lab.
7. Discuss the results of the test with a Weatherford representative.

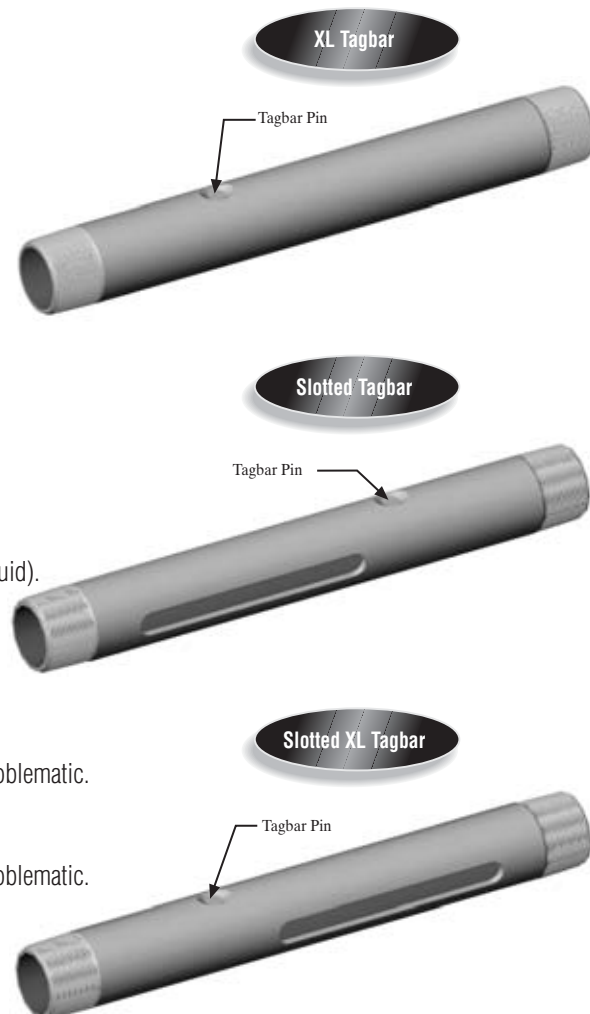
Tagbar Considerations & Selections

The tagbar is a bar or rod that is welded in high strength mechanical tubing and screwed or welded into the pump intake. The tagbar has 2 primary purposes:

1. Used as a reference point for landing the rotor.
2. Used as a safety stop to prevent the loss of the rotor and rods in the event of a failure to the drive string. It is not designed to support the rod string during continuous operation.

There are a few different styles of tagbars available:

1. **Standard Tagbar**
 - Used where pump inflow is not a problem (i.e. high H₂O cut fluid, high API fluid).
2. **XL Tagbar**
 - Used with an XL rotor to allow operator more flexibility during landing and the ability to adjust wear locations on the tubing caused by rod couplings.
 - Used in applications where optimum inflow is anticipated.
3. **Slotted Tagbar**
 - Used primarily in heavy oil applications where pump inflow is sometimes problematic.
 - Consists of two slots approximately 1" x 10".
4. **Slotted XL Tagbar**
 - Used primarily in heavy oil applications where pump inflow is sometimes problematic.
 - Allowing the rotor to stick out the bottom of the stator keeps the pump intake free of sludge.
5. **Custom Tagbars**
 - Custom tagbars can be built to suit specific applications as required.



Trouble Shooting Problems

There are many variables in any producing environment. These are a few of the more common problems that occur and possible actions that could be taken.

C O N D I T I O N		C O N S I D E R
Low or no production	> Normal torque	A,B,D,E,F,G,H,I
Low efficiency	> High torque	F,I,J,K,O,P,Q,
Polish rod will not turn	> High torque	F,K,L,N,O,P,Q,R,S,T
RPM increases not possible	> Low torque	R,S,T
RPM increases not possible	> High torque	F,J,K,L,O,P,Q,R,S,T
Uneven production		A,B,C,D,E,F,I,K,P,Q,S
Possible Cause of Problem		P o s s i b l e A c t i o n
A	Well pumped off	• Slow down PC pump RPM. • Lower casing gas pressure. • Down size PC pump.
B	Wellbore inflow problem	• Lift rotor out of stator and flush stator and tubing string cleaning the sand and sludge away from the perforations. • Lower casing gas pressure.
C	Wellbore inflow fluctuating	• Lower casing gas pressure. • Lift rotor out of stator and flush stator and tubing string cleaning the sand and sludge away from the perforations.
D	Pump intake partially plugged	• Lift rotor out of stator and flush stator and tubing string cleaning the sand and sludge away from the pump intake. • Use XL rotor and XL slotted tagbar to keep intake clean.
E	High fluid GOR (Gas oil ratio)	• Lower pump intake below perforations. • Use a gas separator on pump intake or change pump configuration.
F	Rotor landed incorrectly	• Refer to rotor landing procedure to ensure rotor is correctly landed. Note: landing procedures are only guidelines and changes may be required for certain applications.
G	Hole in tubing or stator	• Pressure test tubing (if possible) to see if a hole exists. • Pull equipment and repair as required. If problems occur at the same location, coated rod boxes, Corod or hardened tubing may be an option.
H	Tubing drain blown	• Pressure test tubing (if possible). • Use a drain with more pins.
I	Pump worn out	• Pressure test tubing (if possible). • Have pump test bench tested.
J	Pump operating at maximum lift	• Complete C-FER design module to confirm. • Replace with a pump with more lift. • Lower pump discharge pressure by: 1. Increasing tubing size or install Corod. 2. Continuously loading casing with a less viscous fluid. 3. Decreasing flowline pressure.
K	Stator / rotor interference fit increased due to elastomer swelling or hardening	• Insure proper elastomer has been used. • Use a looser fit pump to allow for swelling. • Complete fluid analysis.
L	High fluid viscosity	• Continuously load casing with a less viscous fluid. • Use viscosity reducing agents.
M	Broken rod or polished rod	• Insure proper sized rods are being used for torque velocities. • Insure torque setting limit is set correctly on drive unit.
N	Tubing string has backed off	• Install no-turn tool.
O	Debris has settled out above the stator	• Use smaller tubing to increase fluid velocities. • Lift rotor out of stator and flush tubing.
P	A large slug of wellbore debris has entered the pump intake	• Lift rotor out of stator and flush tubing and stator.
Q	Stator elastomer failed	• Insure proper elastomer has been used. • Complete C-FER design module to confirm pump is correctly sized for application. • Inspect pump to determine failure mode.
R	Drive head improperly sized	• Recalculate drive requirements.
S	Drive head or drive skid problems	• Repair as required or consult your local Weatherford service center.
T	VFD improperly sized or programmed	• Confirm all parameters are correct.

Installation Guidelines

The procedures listed below are intended to form a basic framework for a typical installation of a Weatherford Progressing Cavity Pumping System. Special applications or equipment may necessitate changes to these procedures. A Weatherford Artificial Lift representative can provide assistance in formulating modified installation procedures.

1-Stator Installation

2-Rotor Installation

3-Graphs & Charts

Stator Installation

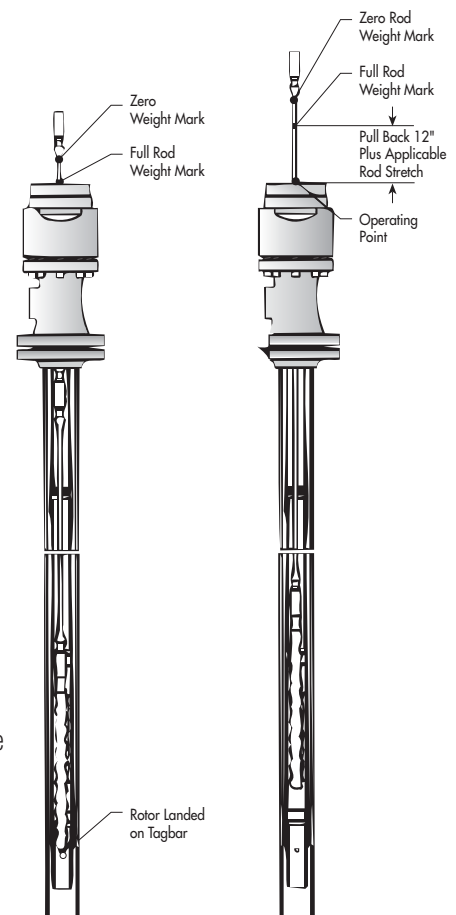
1-1 PRE-INSTALLATION

- Well cleanout procedures should be considered before running any progressing cavity pumping system. The removal of any solids (i.e. sand, coal fines) from the bottom of the wellbore is recommended with a minimum of two meters below the well perforations or two meters below the pump inlet sub.
- The rotor and stator are matched for optimum pump efficiency. Ensure the rotor serial number located on the rotor head (top) corresponds with the last set of numbers on the stator.
- Tighten all pump connections between optimum and maximum torque (According to API specifications outlined on page 17).
- If the inside diameter of the production string is less than the stator discharge connection diameter a tubing pup joint equivalent to the stator discharge connection diameter should be installed above the stator. DO NOT SWAGE DOWN AT PUMP DISCHARGE. Swage to smaller tubing size at least one full joint (if possible) above the stator (minimum of four feet acceptable).
- Consideration should be given to using a torque anchor in high speed and/or high torque applications or when production tubing cannot be made up to optimum makeup torque.
- If additional equipment is required for operation (i.e. PSN, no turn tools, tail joints) contact a Weatherford Artificial Lift Systems representative for additional landing procedures.

1-2 STATOR INSTALLATION

- The stator is run into the well on the end of the tubing string with the tagbar or inlet sub on the bottom of the stator.
- Run the stator and tubing into the well and tighten all connections between optimal and maximum torque (according to the API specifications outlined on page 17).
- Run the stator down to the recommended landing depth and set the tubing. The inlet sub of the pump is usually landed in or below the level of the perforations.

ROTOR LANDING:

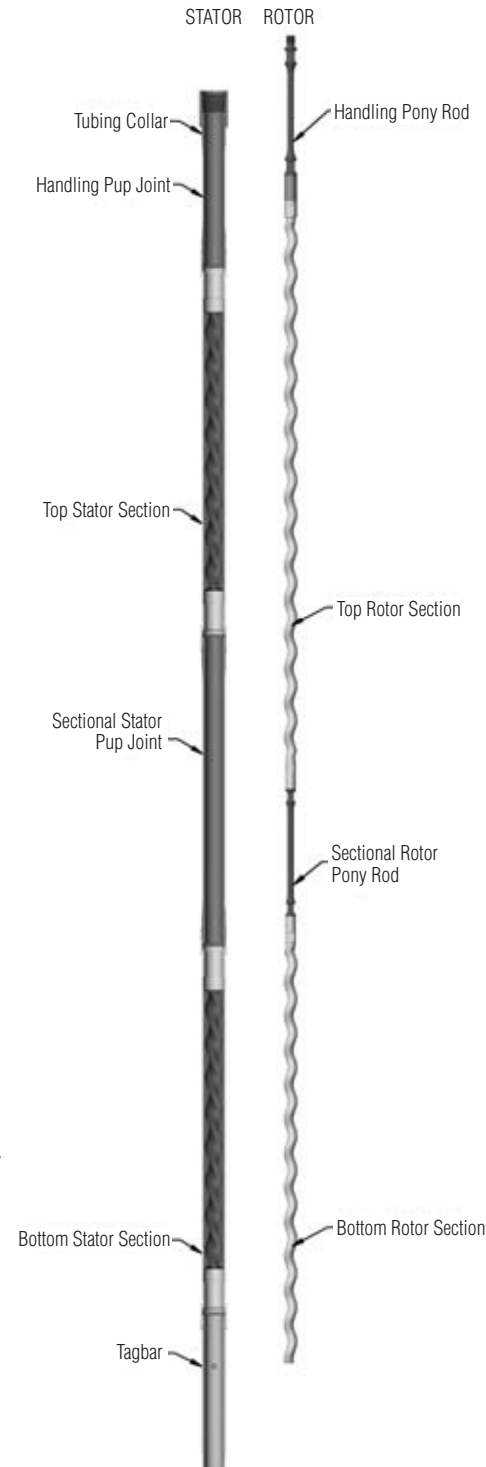


1-3 SECTIONAL PUMP INSTALLATION

Stator and Tubing String:

Tighten all connections between optimal and maximum API specified torques.

- Run all equipment below the PC pump (i.e. gas separator, tail joints, no-turn tool, etc.) into the well, if required. Hang the last connection on the wellhead using tubing elevators or a dog collar.
- Note: The stator is properly oriented when the serial numbers are towards the top or in the up-hole position.
- Make sure the tagbar is properly installed (if threaded tagbar) on the bottom stator section. Install the required sectional stator pup joint onto the top of the bottom stator section. Thread a tubing collar onto the other end of the sectional stator pup joint to prevent tubing elevators from slipping off.
- Tighten all connections and raise the assembly into rig's derrick, tagbar down. Connect the bottom of the tagbar onto the last connection if equipment is being used below the PC pump.
- Lower assembly into well and hang sectional stator pup joint on wellhead using a dog collar, remove the tubing collar leaving the pin end up.
- Connect a handling pup joint onto the top of the top stator section, add a tubing collar on the other end of the handling pup joint to prevent the tubing elevators from slipping off.
- Tighten all connections and raise the assembly into the rig's derrick, stator down. Connect bottom of top stator onto the top of the sectional stator pup joint. Lower the assembly into the well, hanging the handling pup joint on the wellhead with the tubing elevators.
- Connect the next joint of tubing onto the handling pup joint. Then continually add joints of tubing and other equipment (drain, burst joint, etc.) as normal until the sectional stator assembly reaches the required landing depth.



Rotor Installation

2-1 ROTOR LANDING

- The rotor is run into the well on the end of the sucker rod or continuous rod string.
- Care should be taken while handling the rotor on surface to avoid damaging the pin threads or the finished surface. The rotor should be supported in a manner as to prevent excessive bending that may cause permanent damage.
- Check the rods and couplings for excessive wear or other defects.
- Tighten all sucker rod couplings to API specifications as recommended by rod supplier.
- Prior to entering the stator with the rotor record the rod string weight.
- To prevent damage to the stator elastomer, SLOWLY lower the rotor into the stator. The rotor usually rotates to the right (clockwise).
- Lower the rods until the rotor rests on the tagbar (indicated when the rod string weight reaches zero).
- Mark the rod string and lift the rods ten to fifteen feet then lower to zero string weight again to ensure rotor is resting on the tagbar.
- Slowly pick the rods up until rod string weight is achieved.
- Pick up an additional 12".
- Pick up the rod string an additional amount for rod stretch.

Please refer to Tensile Rod Stretch charts on pages 19 to 22.

2-1 ROTOR LANDING (CONTINUED)

- If a tubing anchor catcher is used, difference in thermal expansion between the tubing and rod string may need to be considered.

***THIS IS ONLY A GUIDELINE. EACH FIELD HAS INDIVIDUAL AND UNIQUE CHARACTERISTICS THAT NEED TO BE MONITORED AND ANALYZED TO ESTABLISH THE PROPER ROTOR LANDING. THE CFER PC PUMP PROGRAM CALCULATES ROD STRETCH BASED ON ALL OPERATING PARAMETERS.**

- The rotor should now be in the operating position. Do not lift the rotor from this position. Landing with least amount of rotor sticking out of the top of the stator minimizes downhole vibration.
- Measure the height of the wellhead drive.
- Add the length of the well head drive assembly to the operating position. This becomes the clamping point. Allow an additional 6" to 12" for polished rod to stick up above the clamping point.
- DO NOT leave wrench marks on the polished rod.
- Install a polished rod clamp to support the polished rod on the well head drive.
A second rod clamp may be installed above the first clamp to prevent polished rod slippage.

WARNING:

Additional couplings at the stator discharge will restrict the fluid flow, also the orbiting motion of the rotor can cause increased tubing wear and/or possible rotor failure. Therefore whenever possible connect the first sucker rod directly to the rotor or the longest pony rod as possible.

2-2 ROTOR AND ROD STRING

Tighten all connections between optimal and maximum API specified torques.

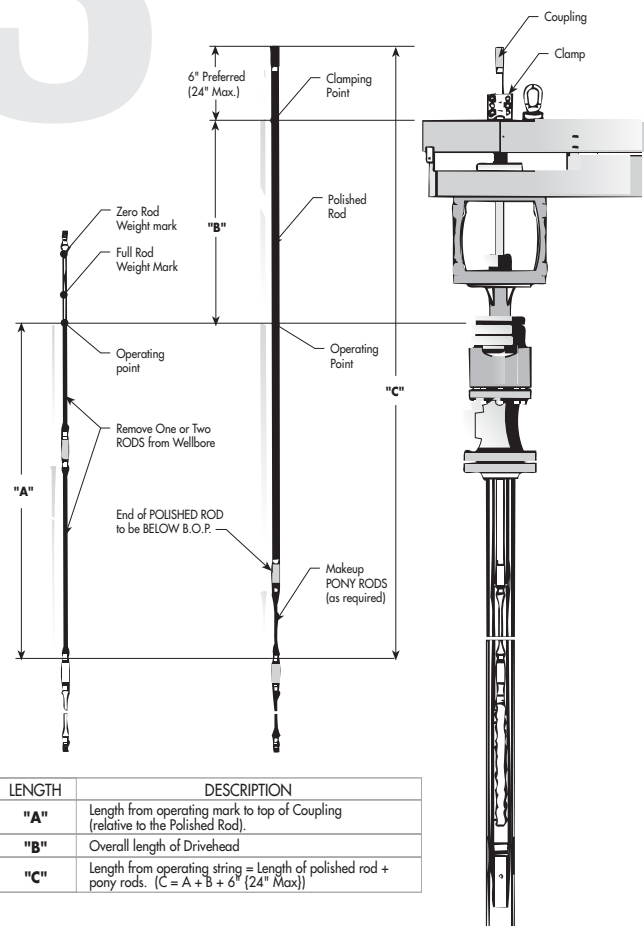
- Connect the required sectional rotor pony rod onto the top of the bottom rotor section (typically the API box end).
- Tighten the connection and raise the assembly into the rig's derrick, rotor down. Lower assembly into tubing, hanging the sectional rotor pony rod on the wellhead with the rod elevator.
- Connect a hanging pony rod onto the top of the top rotor section (typically the API pin end).
- Tighten the connection and raise the assembly into the rig's derrick, rotor down. Connect the bottom of the top rotor section onto the top of the sectional rotor pony rod.
- Lower assembly into the well, hanging the handling pony rod on the wellhead with the rod elevators.
- Connect the next rod onto the top of the handling pony. Continually add rods and other equipment (rod shear, etc.) as normal until the rotor tags out on the tagbar pin.
- Once the rotor tags out on the tag bar pin use conventional landing procedures to land the rotor.

Note: Sectional Pup Joint and Pony Rod are generally specific length combinations, but lengths can be adjusted for customer requests.

2-3 TO SUMMARIZE

- Record string weight before the rotor enters the stator.
- Land the rotor on the tagbar.
- Pull up string weight.
- Pull up an additional 12".
- Pull up to allow for rod stretch-operating position.
- Measure and allow for wellhead height-clamping position.
- Remove sucker rod(s) and replace with the polished rod and pony rods.
- Run the polish rod into the well and clamp off.

Polished Rod Measurement For Drive Installation:



Data Base System

The PC Solution Data Base was designed specifically for use with PC pumps. The system provides pump test and inspection results, inventory listings and pump life analysis reports. Every pump manufactured by Weatherford PC Pump is tested in-house and the results are recorded in the system.

Test Reports

- Test results for all new and used pumps.
- Documentation of pump serial numbers, elastomer type, rotor dimensions and performance parameters.

Installation Summary

- Summary of all PC pumps installed.
- Report can be summarized for each company and/or field for a specified date range.
- Sorted by installation date or location in each field.
- Includes a summary of the pump test report.

Inspection Reports

- Inspection summary for every pump returning from the field.
- Detailed analysis of rotor, stator and tagbar condition.
- Includes pump run time and the reason the pump was pulled.

Inspection Summary

- Summary of all PC pumps inspected.
- Report can be summarized for each company and/or field for a specified date range.
- Sorted by location and the date the pump was pulled for each field.
- Includes a summary of the pump type, condition, run time, and reason for being pulled.

PC Pump Evaluation

- 1 Test Temp:** shows the temperature of the fluid the PC pump is being tested with.
- 2 Test Speed:** Rotor speed during test.
- 3 Eff. (100 psi/stage):** Volumetric efficiency of the pump calculated based on the nominal pump displacement measured fluid rate and pump speed.
- 4 Diff Press:** Shows the simulated lift in psi at specific test points throughout the test.

- 5 Test Time:** Time in seconds recorded to determine time to fill a volumetric weight at specific test point throughout the test.
- 6 Hyd. Press:** Actual hydraulic or VFD torque reading taken at each specific test point.
- 7 Pump Eff. (%):** Pump efficiency determined by taking the test time and dividing by 60 seconds.
- 8 Torque (ft-lbs):** Total torque required to turn the pump. This includes both the friction and hydraulic components.



Weatherford PC Pump Test Report

Weatherford PC Pump Inc., Lloydminster, Alberta, Canada

Company:	ABC Company	Placed In Stock:	☐	Pump ID:	12
				W.O.#:	31113
Field:		Installed Into:	ABC Field One	1 Test Temp (C):	30.0
Location:			01-01-01-03 W3	Stator Run #:	35339
UWI:			Well # 1	Date Tested:	04-Sep-99
				Date Installed:	01-Jan-00

PC PUMP:	28	1200	XL	6481	32372	Type:	Standard
Stator Condition:	New	Elastomer Type:	N080	Top #			
Rotor Condition:	New	Rotor Coating:	Chrome	Bott. #			

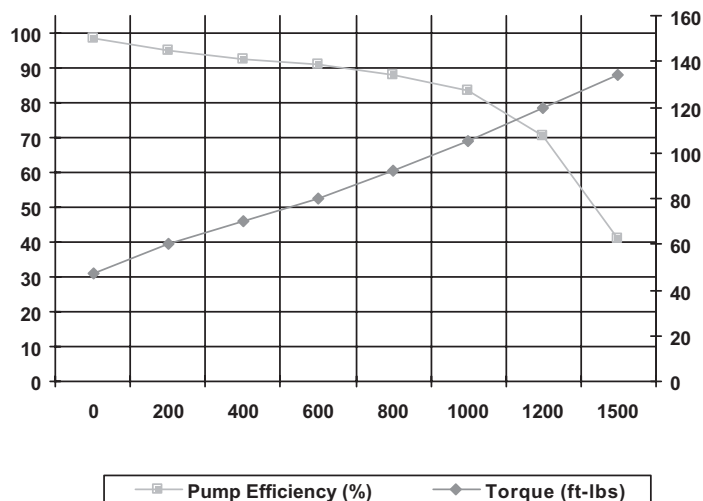
PC PUMP TEST DATA:

Distributor:	BMW Lloyd
Tested By:	JJ
Rotor Major Diameter:	2.265
Rotor Minor Diameter:	1.715
2 Test Speed RPM:	150
Torque (100 psi/stage):	120
3 Eff. (100 psi/stage):	70.6
Maximum Pressure:	2400
Test Bench:	BMW VFD1

4 Diff. Press. (psi)

5	6	7	8
Test Time (sec)	Hyd. Press. (psi)	Pump Eff. (%)	Torque (ft-lbs)
0	61	47	98.4
300	63	60	95.2
600	65	70	92.3
900	66	80	90.9
1100	68	92	88.2
1400	72	105	83.3
1800	85	120	70.6
2200	147	134	40.8
2600			

Efficiency & Torque VS Differential Pressure



Comments:

Identification of the Most Common Stator and Rotor Failures

Pump inspections performed by Weatherford pump shops provide the user with general pump conditions. The following provides information on identification, cause and possible solutions for each condition. For a more detailed pump analysis please contact your Weatherford technical support representative.

Stator Conditions: *Condition - Worn* ➡

Identification

The efficiency of the stator has decreased. The interference fit has been reduced due to the general operation of the pump.

Cause

- High rpm.
- Normal wear.
- Incorrect interference fit.
- Abrasive fluids.

Possible Solution

- Increase to a larger volume pump to lower rpm.
- Ensure pump efficiency is matched for application.
- Ensure correct elastomer.



Condition - Hardened (No photo)

Identification

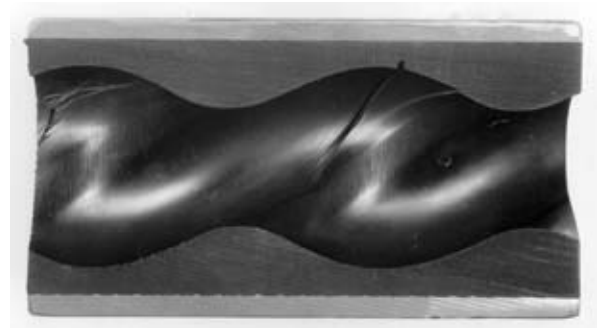
The stator elastomer surface is harder than it was originally.

Cause

- H₂S, heat and time.

Possible Solution

- Ensure correct elastomer is used for application.
- Ensure pump efficiency is matched for application.



Condition - Grooved ➡

Identification

Worm like holes or grooves in the elastomer in the opposite direction of fluid flow.

Cause

- Large particles of sand or other matter become lodged in the stator elastomer causing permanent rubber deformation. This produces a small orifice by which high pressure fluid passes, washing away the stator rubber. High GOR wells with low pump efficiency can also cause this type of failure.

Possible Solution

- Complete thorough wellbore cleanouts.
- Use a customized tagbar that will limit inflow of large debris.
- If pump efficiency is low make sure landing is correct.



Condition - Missing Rubber

Identification

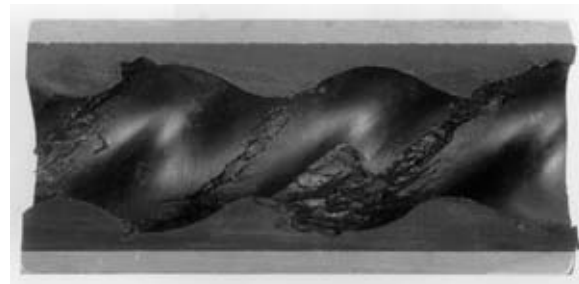
The areas of missing rubber are typically hard, shiny and irregular in shape.

Cause

- Excessive pressure per stage.
- Fatigue of the rubber due to cyclic stresses.
- High production fluid temperature.

Possible Solutions

- Increase to a larger volume pump to lower pump rotational speed.
- Ensure pump efficiency is matched for application.
- Ensure pump has enough lift.



Condition - Swollen

Identification

Cross-section of elastomer is swollen resulting in an altered geometry from new. Swollen stators may exhibit poor volumetric efficiencies and high rod string torque.

Cause

- Exposure to fluids that are not compatible with the elastomer

Possible Solutions

- Check elastomer/fluid compatibility.
- Review chemical treatment programs.



Normal



Swollen

Condition - Burnt Out

Identification

Rubber surface will be hard, brittle and extensively cracked.

Cause

Excessive heat due to:

- Poor inflow.
- Plugged intake.

Possible Solutions

- Ensure sufficient fluid level.
- Use slotted tagbar and insure wellbore is cleaned out.
- Wellbore perforations are open.



Condition - Mechanical Influence

Identification

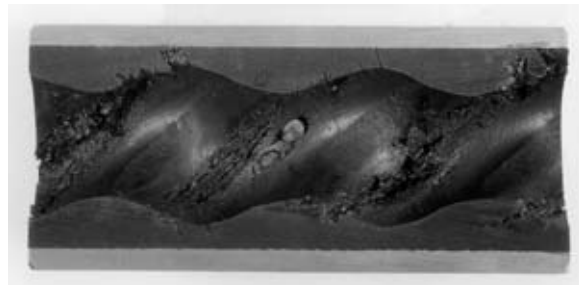
The rubber is torn or pitted.

Cause

- Production of large foreign particles.

Possible Solutions

- Complete thorough wellbore cleanouts.
- Use a customized tagbar that will limit inflow of large debris.
- Consider routine flush-by.
- Use a PC pump with large cavities.



Rotor Conditions:

Condition - Base Metal

Identification

Extreme abrasive wear through the chrome plating and into the rotor base metal on the major diameter of the rotor.

Cause

- Producing highly abrasive fluids.
- Incorrect landing procedure causing rotor/tubing contact.
- Production of large foreign particles.
- Excessively tight rotor/stator interference fit

Possible Solutions

- Insure proper landing procedures are followed.
- Complete thorough wellbore cleanouts.
- Use a customized tagbar that will limit inflow of large debris.
- Ensure correct rotor/stator interference fit for the application.



Condition - Broken

Identification

The rotor is in two pieces.

Cause

- Rotor breaks are usually caused by excessive torque or cyclic fatigue stresses.

Possible Solutions

Fatigue breaks:

- Ensure proper landing procedures are followed.
- Avoid landing stator in severe doglegs.

Torsional Breaks:

- Utilize high torque shutdown devices.



Torsional



Fatigue

Fracture surface is typically irregular with no distinctive pattern.

Fracture surface is typically flat with a half-moon shape pattern.

Condition - Checked

Identification

Chrome has fine cracks on the surface.

Cause

Excessive heat due to:

- Tight interference fit.
- Poor inflow or restricted intake.
- High operating temperatures.

Possible Solutions

- Complete thorough wellbore cleanouts.
- Ensure correct elastomer is used for application.
- Ensure sufficient fluid level.
- Ensure pump efficiency is matched for application.



Condition - General Wear ➡

Identification

The chrome surface is highly polished.

Cause

- Normal wear
- High rpm.
- Incorrect interference fit.
- Abrasive fluids.

Possible Solutions

- Increase to a larger volume pump to lower rpm.
- Ensure pump efficiency is matched for application.
- Ensure correct elastomer.



Condition - Pitting ➡

Identification

Small to large holes in the chrome surface that may or may not extend down into the base metal of the rotor. Pitting can be seen anywhere along or throughout the entire length of rotor in either the major or minor diameters.

Cause

- Corrosive elements such as H_2S , CO_2 within the wellbore fluid.

Possible Solutions

- Corrosion inhibitor.



Condition - Scored ➡

Identification

Wear lines on the chrome surface usually found on the major diameter.

Cause

- Due to normal wear and abrasion.
- Will be accelerated when pumping abrasive fluids or when rotating at high speeds.

Possible Solutions

- Increase to a larger volume pump to lower rpm.
- Ensure pump efficiency is matched for application.
- Ensure correct elastomer.



Downhole Accessories

Below is a list of the main downhole accessories used to enhance and lengthen the life of progressing cavity pumping systems. Please contact your local Weatherford Artificial Lift representative for more information.

1 *Corod® Continuous Rod*

Continuous sucker rod is unique because unlike conventional sucker rod it requires couplings only at the top and bottom of the rod string.

Advantages of Corod:

- Reduces pin and coupling failures.
- Prolongs life of tubing especially on directional and horizontal wells.
- Lowers torque and power requirements.
- Reduces flow losses through the tubing.

2 *Tubing Rotator*

The majority of tubing failures occur due to rod/tubing contact always at the same spot. A tubing rotator allows the operator to rotate the tubing to lengthen its life. The tubing rotator can be operated by:

- Manual.
- Hydraulic.
- Electric.

3 *Torque Anchor or Tubing Anchors*

The natural action of a PC pump on the tubing string connection is counterclockwise; therefore causing the potential for the tubing to be backed off. By installing a torque anchor/tubing anchor the chance of backed off tubing is greatly reduced.

4 *Open/Close Tagbar (OCT)*

The design of the OCT provides the producer with all of the benefits of a slotted and a non-slotted tagbar in one piece of equipment.

Advantages of the OCT:

- The ability to circulate the well through the tubing string.
- Reduce cost and shock loading associated with sand bailing.
- Allows for quick and easy location of pump intake.
- Easily adaptable to existing PC pumps.

5 *Downhole Gas Separators*

Downhole gas separators are used to help separate the gas from the oil at the pump intake.

By eliminating as much gas as possible from the intake, better pump efficiencies can be maintained therefore reducing pump rotational speeds & increasing pump run life.

6 *Coated/Spin Thru Rod Couplers and Rod Centralizers*

If high rod/tubing contact loads occur, premature wear to these components may require specialized rod couplings and centralizers. Specialized equipment helps to reduce rod/tubing contact loads and therefore extend rod/tubing run life. High contact loads typically occur in horizontal or directionally drilled wells.

Suggested Makeup Torque for Tubing

Recommended makeup torque is listed in the table below for common sizes, weights and grades of tubing. Note that PC pump stators should be treated as Grade J55. These values have been extracted from API Recommended Practice 5C1 "Recommended practice for Care and use of Casing and Tubing". The torque values listed below represent the optimum makeup torque. The minimum and maximum torque are 75% and 125% of the optimum value, respectively.

The joint life of tubing under repeated field makeup is inversely proportional to the makeup torque applied. Therefore, in wells where leak resistance is not a significant factor, minimum field makeup torque should be used to prolong joint life.

Size		Weight		Grade	Makeup Torque	
SI	Imperial	SI	Imperial		SI	Imperial
60.3 mm	2.375 in	7.0 kg/m	4.7 lbs/ft	H40	1340 N*m	990 ft*lbs
60.3 mm	2.375 in	7.0 kg/m	4.7 lbs/ft	J55	1750 N*m	1290 ft*lbs
60.3 mm	2.375 in	7.0 kg/m	4.7 lbs/ft	C75	2310 N*m	1700 ft*lbs
60.3 mm	2.375 in	7.0 kg/m	4.7 lbs/ft	L80	2390 N*m	1760 ft*lbs
60.3 mm	2.375 in	7.0 kg/m	4.7 lbs/ft	N80	2450 N*m	1800 ft*lbs
60.3 mm	2.375 in	7.0 kg/m	4.7 lbs/ft	C90	2610 N*m	1920 ft*lbs
60.3 mm	2.375 in	7.0 kg/m	4.7 lbs/ft	P-105	3080 N*m	2270 ft*lbs
73.0 mm	2.875 in	9.7 kg/m	6.5 lbs/ft	H40	1700 N*m	1250 ft*lbs
73.0 mm	2.875 in	9.7 kg/m	6.5 lbs/ft	J55	2230 N*m	1650 ft*lbs
73.0 mm	2.875 in	9.7 kg/m	6.5 lbs/ft	C75	2940 N*m	2170 ft*lbs
73.0 mm	2.875 in	9.7 kg/m	6.5 lbs/ft	L80	3050 N*m	2250 ft*lbs
73.0 mm	2.875 in	9.7 kg/m	6.5 lbs/ft	N80	3120 N*m	2300 ft*lbs
73.0 mm	2.875 in	9.7 kg/m	6.5 lbs/ft	C90	3340 N*m	2460 ft*lbs
73.0 mm	2.875 in	9.7 kg/m	6.5 lbs/ft	P-105	3940 N*m	2910 ft*lbs
88.9 mm	3.500 in	13.8 kg/m	9.3 lbs/ft	H40	2340 N*m	1730 ft*lbs
88.9 mm	3.500 in	13.8 kg/m	9.3 lbs/ft	J55	3090 N*m	2280 ft*lbs
88.9 mm	3.500 in	13.8 kg/m	9.3 lbs/ft	C75	4080 N*m	3010 ft*lbs
88.9 mm	3.500 in	13.8 kg/m	9.3 lbs/ft	L80	4240 N*m	3130 ft*lbs
88.9 mm	3.500 in	13.8 kg/m	9.3 lbs/ft	N80	4330 N*m	3200 ft*lbs
88.9 mm	3.500 in	13.8 kg/m	9.3 lbs/ft	C90	4650 N*m	3430 ft*lbs
88.9 mm	3.500 in	13.8 kg/m	9.3 lbs/ft	P-105	5490 N*m	4050 ft*lbs
101.6 mm	4.000 in	16.4 kg/m	11.0 lbs/ft	H40	2630 N*m	1940 ft*lbs
101.6 mm	4.000 in	16.4 kg/m	11.0 lbs/ft	J55	3470 N*m	2560 ft*lbs
101.6 mm	4.000 in	16.4 kg/m	11.0 lbs/ft	C75	4600 N*m	3390 ft*lbs
101.6 mm	4.000 in	16.4 kg/m	11.0 lbs/ft	L80	4780 N*m	3530 ft*lbs
101.6 mm	4.000 in	16.4 kg/m	11.0 lbs/ft	N80	4880 N*m	3600 ft*lbs
101.6 mm	4.000 in	16.4 kg/m	11.0 lbs/ft	C90	5250 N*m	3870 ft*lbs
114.3 mm	4.500 in	19.0 kg/m	12.8 lbs/ft	H40	2930 N*m	2160 ft*lbs
114.3 mm	4.500 in	19.0 kg/m	12.8 lbs/ft	J55	3870 N*m	2860 ft*lbs
114.3 mm	4.500 in	19.0 kg/m	12.8 lbs/ft	C75	5130 N*m	3780 ft*lbs
114.3 mm	4.500 in	19.0 kg/m	12.8 lbs/ft	L80	5340 N*m	3940 ft*lbs
114.3 mm	4.500 in	19.0 kg/m	12.8 lbs/ft	N80	5450 N*m	4020 ft*lbs
114.3 mm	4.500 in	19.0 kg/m	12.8 lbs/ft	C90	5870 N*m	4330 ft*lbs

Rod Specifications

Weatherford Rod

Rod Grade		Physical Properties		Maximum Recommended Torque					
Sucker Rod	COROD	Tensile Strength 1000 PSI	Yield Strength 1000 PSI	13/16"	7/8"	1"	1 1/8"	1 1/4" x 1"	1 1/4" x 1 1/8"
MD56	-	115-140	85 Min	-	675	1000	-	-	-
D	-	115-140	85 Min	-	735	1100	1570	-	-
KD63	-	115-140	85 Min	-	700	1000	1500	-	-
T66/XD	-	140-150	115 Min	-	800	1200	1700	*1600	*2500
S-67	-	120-140	110-125	-	780	1165	1660		
S-87	-	125-140	115-130	-	815	1220	1740		
S-88	-	140-155	130-145	-	920	1380	1965		
EL	-	N/A	N/A	-	*1000	*1000	2500	-	-
Weight, lbs / ft	-	-	-	-	2.22	2.90	3.68	-	-
-	D Carbon Steel	115 Min	85 Min	500	640	955	-	-	-
-	D Chrome Moly	115 Min	90 Min	-	640	955	-	-	-
-	D Chrome Moly Alloy	140 Min	110 Min	-	900	1300	-	-	-
-	Weight, lbs / ft	-	-	1.76	2.04	2.67	-	-	-

*Special High Torque Coupling and Makeup Procedures Required.

Norris Rod

Rod Grade		Physical Properties		Maximum Recommended Torque			
Sucker Rod		Tensile Strength 1000 PSI	Yield Strength 1000 PSI	7/8"	1"	1 1/8"	1 1/4"
54		115-140	90 Min	675	1010	-	-
75		120-140	90 Min	750	1110	1590	2100
78		120-140	90 Min	735	1100	1570	2000
96		135-150	115 Min	800	1200	1700	-
97		140-150	115 Min	800	1200	1700	2500
Weight, lbs / ft		-	-	2.22	2.9	3.68	4.17

* Available in 1" or 7/8" pin connections.

** Available in 1", 1 1/8" or 1 1/4" pin connections; The 1 1/4" rod is a non-API rod which is specifically designed for torsional applications.

Note: The Maximum Recommended Torque rating will remain the same regardless of pin connection.

All values are based on new rods, couplings and ideal operating conditions.

It is recommended to use a larger diameter rod to increase the allowable torque, rather than the next higher grade.

It is recommended to use a 0.8 safety factor to maximize rod fatigue life.

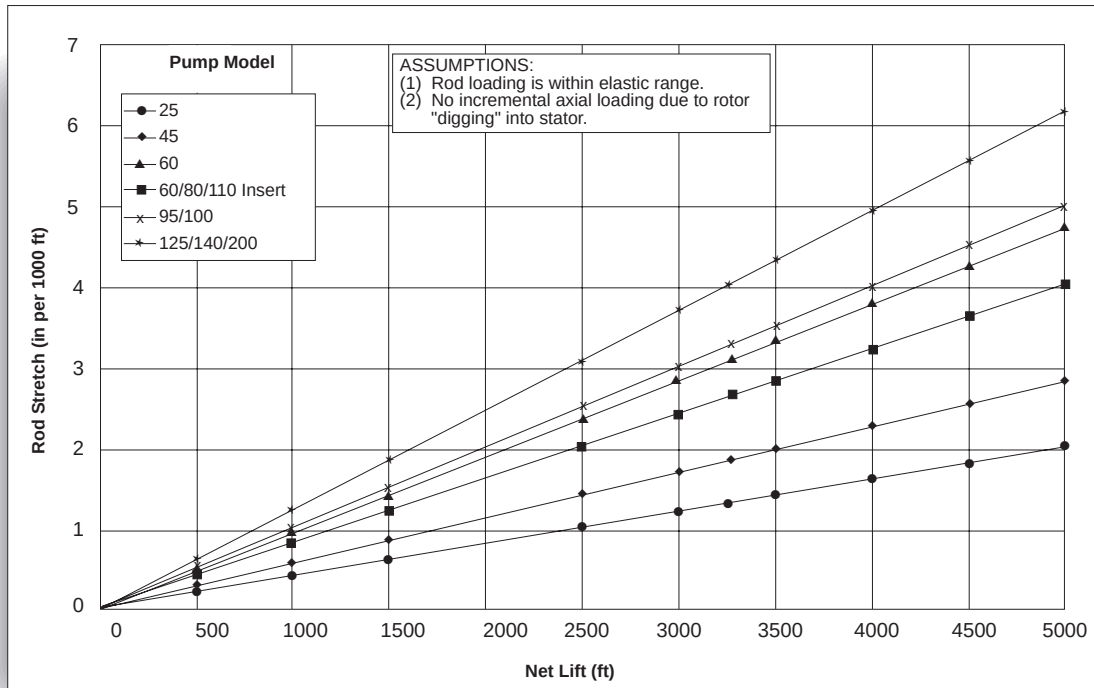
Norris Polished Rod Maximum Allowable Torque - ft-lbs.

Rod Size	Piston (C1045), Norloy (8620) 431 SS, 4140 Alloy
1 1/4"	1,800
1 1/2"	2,800

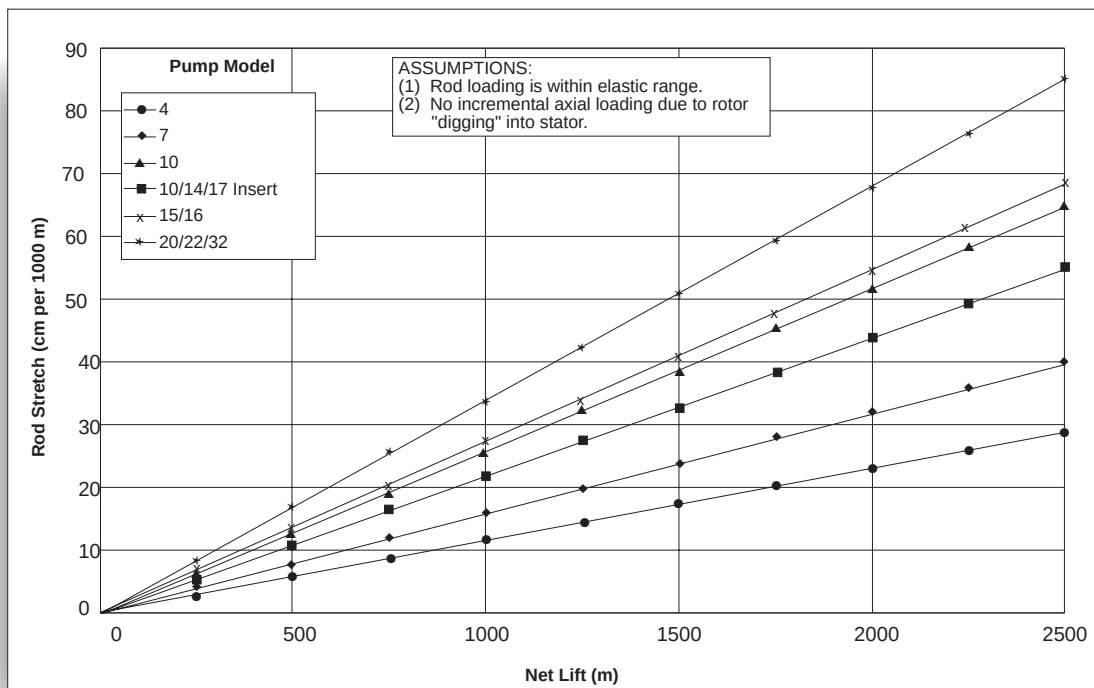
Specifications are subject to change without prior notice

Tensile Stretch for 7/8" or 22.225mm Rod String

Imperial

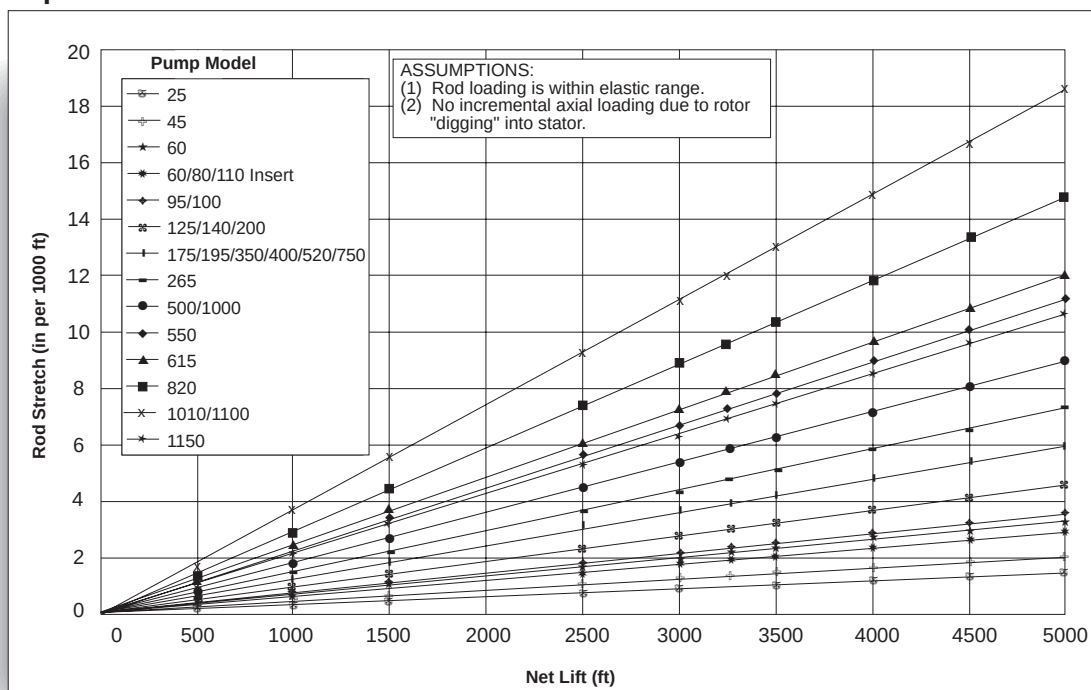


Metric

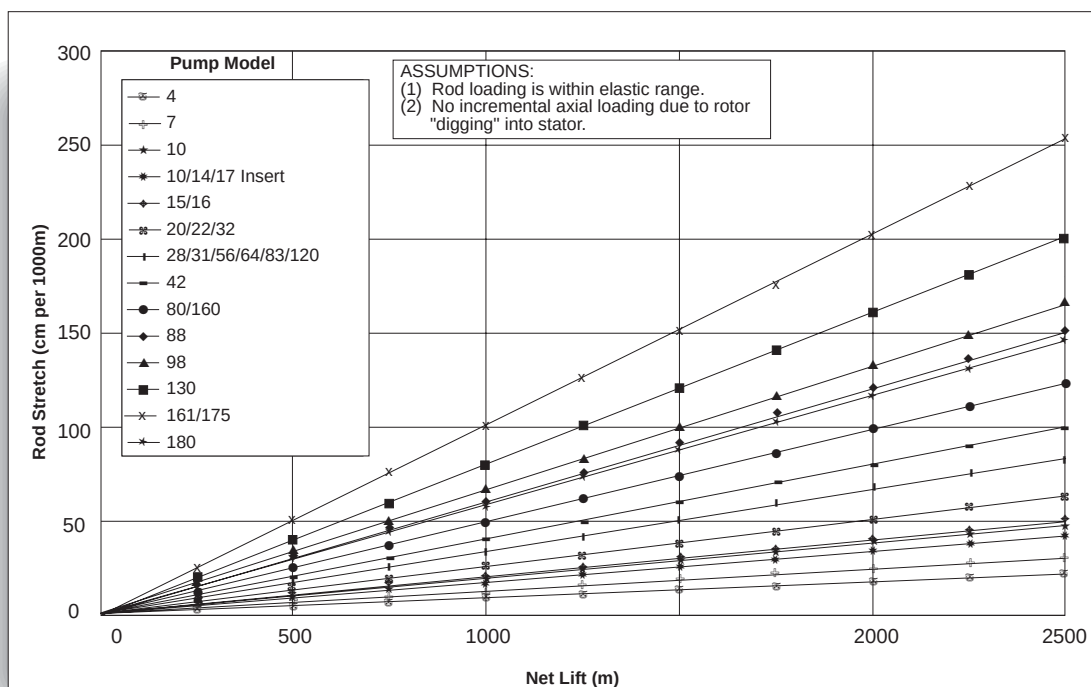


Tensile Stretch for 1" or 25.4mm Rod String

Imperial

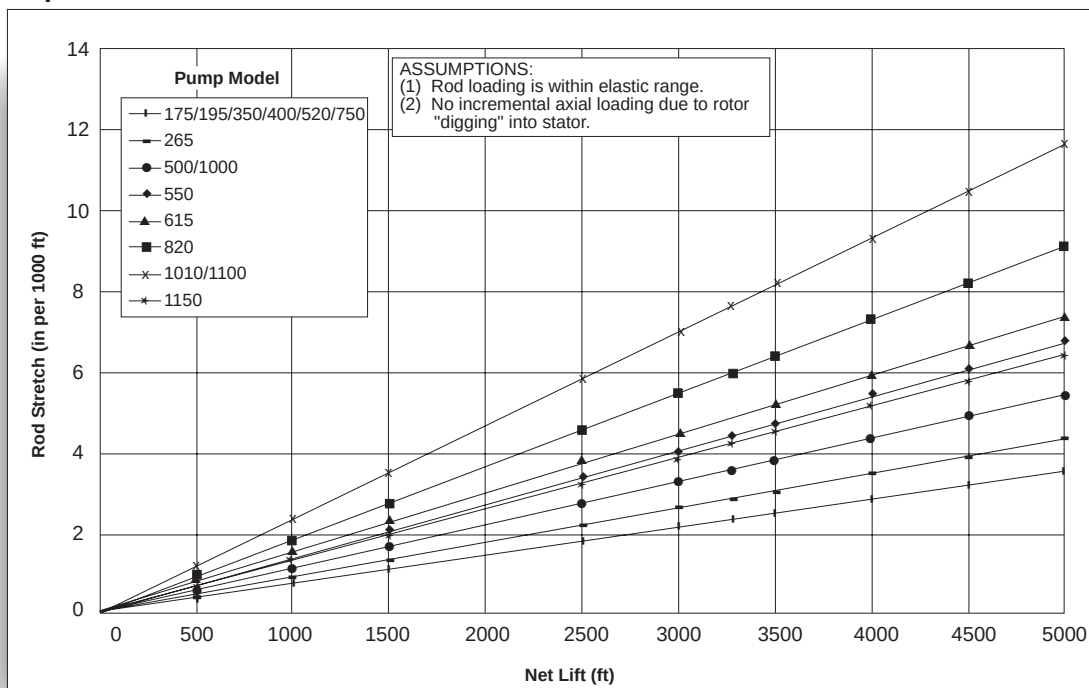


Metric

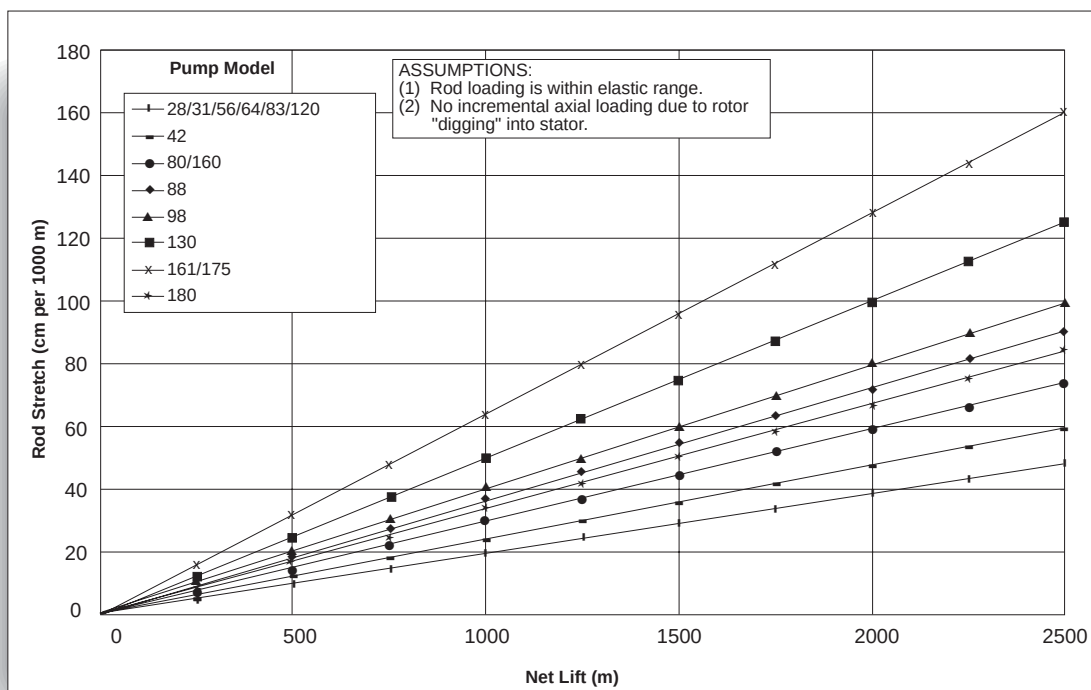


Tensile Stretch for 1 1/4" or 31.75mm Rod String

Imperial

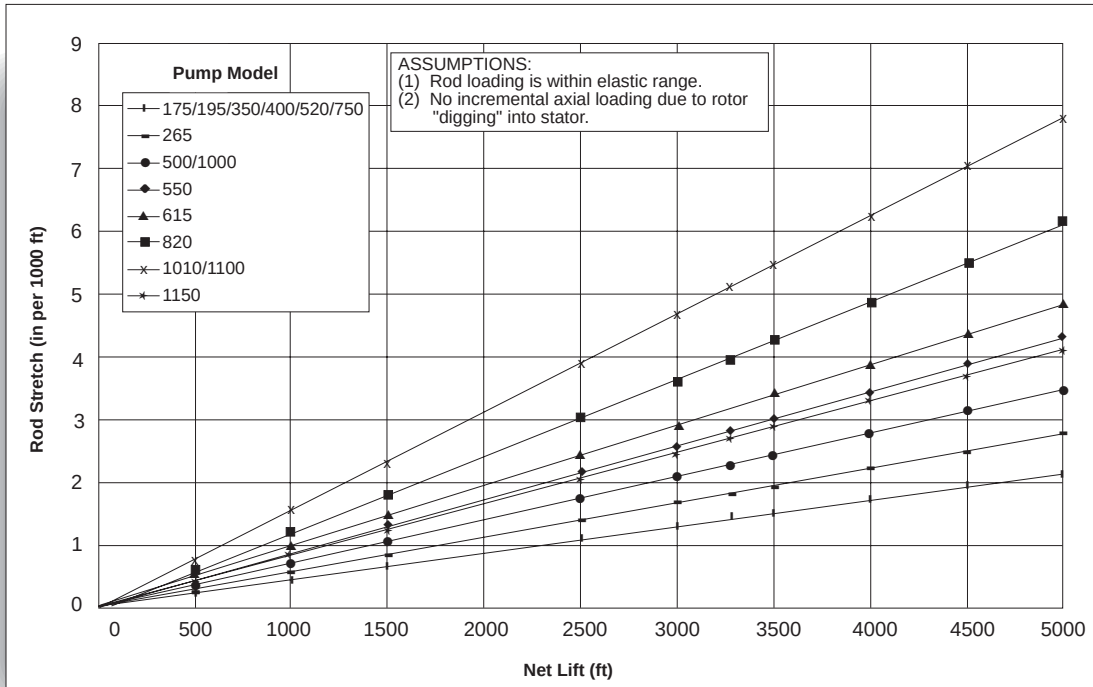


Metric

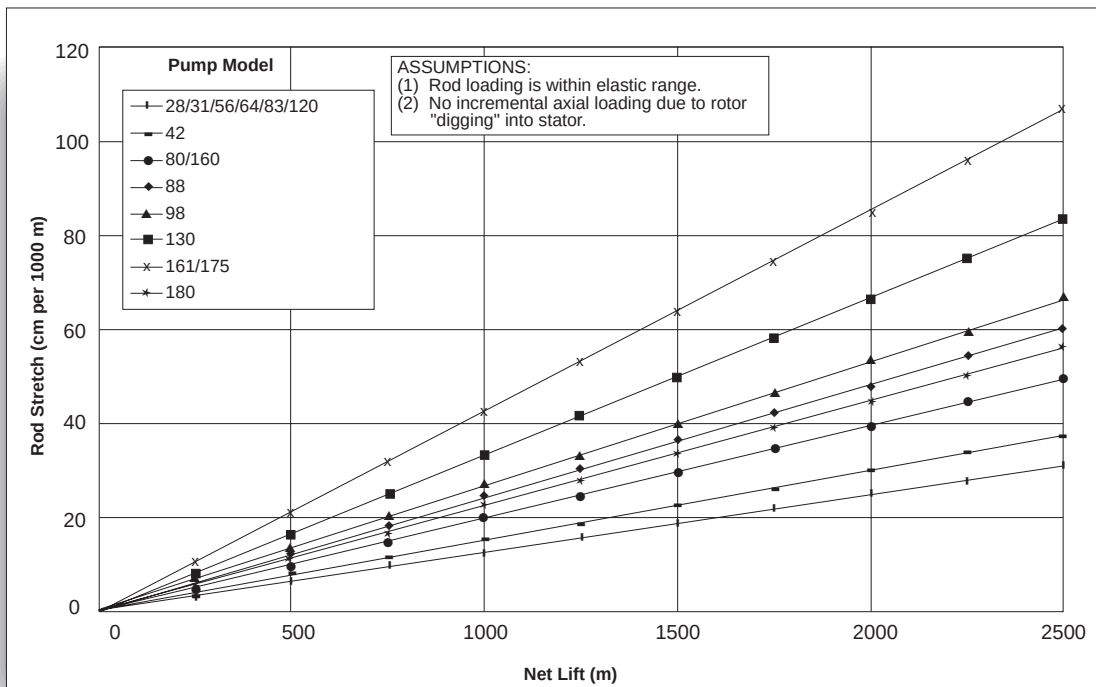


Tensile Stretch for 1 1/2" or 38.1mm Rod String

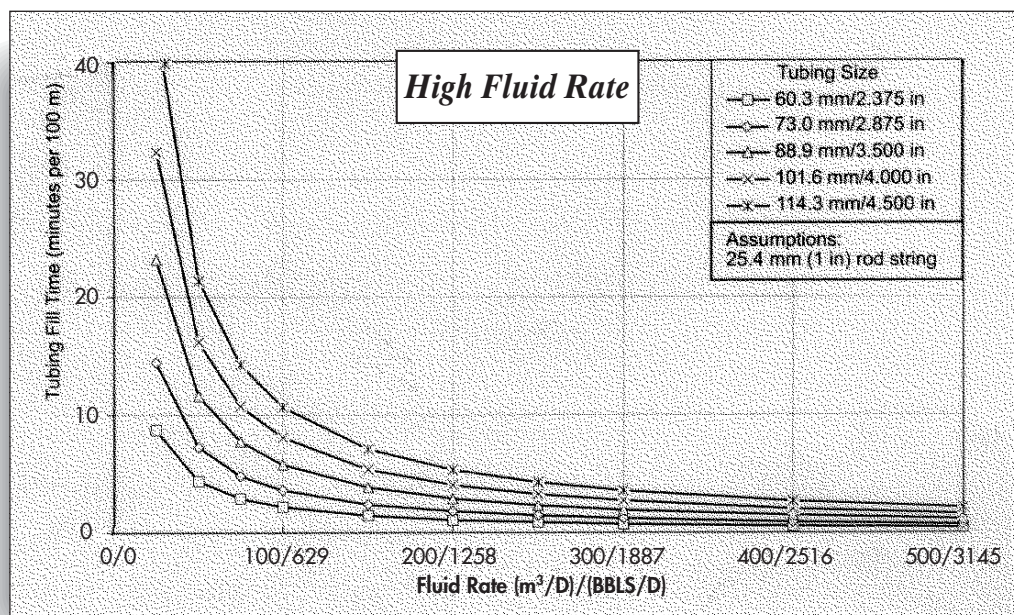
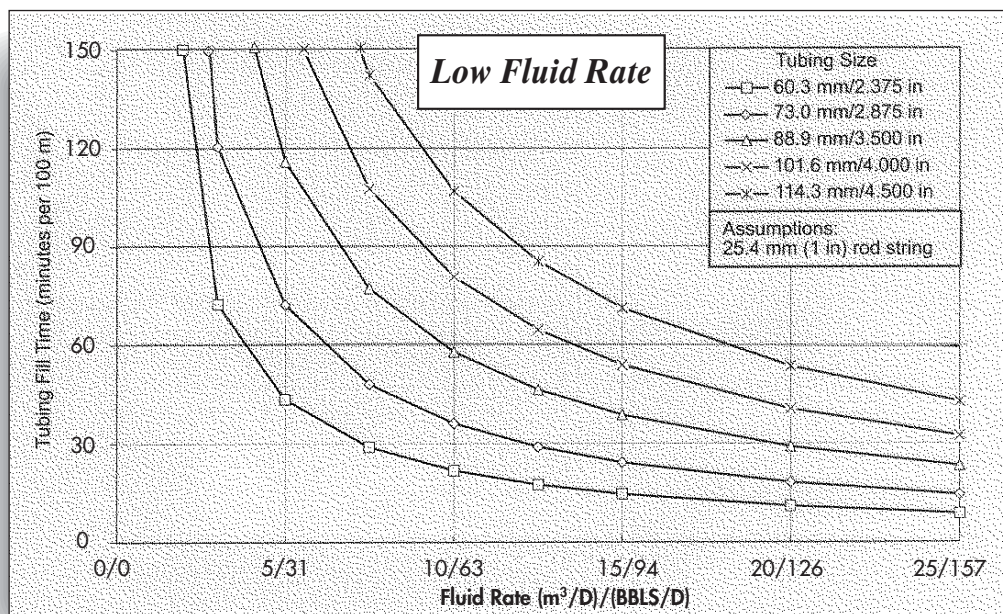
Imperial



Metric



Tubing Fill Times



Useful Formulas

- Electrical Output HP = $\frac{\text{RPM} \times \text{Torque (Ft - lbs)}}{5252}$
- Electrical Output Hp = $\frac{\text{Amps} \times \text{Volts} \times \text{Motor Eff.} \times \text{Motor P.F.} \times 1.73}{746}$
- Hydraulic Torque (Ft - lbs) = $\frac{\text{System Press. (psi)} \times \text{Hyd. Motor Displ. (in3)} \times \text{Sheave Ratio}}{2 \times 3.1416 \times 12 \text{ in/ft}}$
- Hydraulic Horse Power = $\frac{\text{System Press. (psi)} \times \text{Hyd. Pump Displ. (in3)} \times \text{Hyd. Pump rpm}}{395,934}$
- Specific Gravity = $\frac{141.5}{\text{API} + 131.5}$ 
- Fresh Water Gradient = .433 psi / foot
= 9.8 Kpa / meter
- Head Pressure (Kpa) = Fluid Density (kg/m3) x depth (meters) x .00981

Oil Density (kg/m3)	Specific Gravity	API
780	0.780	49.8
800	0.800	45.3
820	0.820	41.0
840	0.841	36.9
860	0.861	32.9
880	0.881	29.2
900	0.901	25.6
920	0.921	22.2
940	0.941	18.9
960	0.961	15.8
965	0.966	15.0
970	0.971	14.3
975	0.976	13.5
980	0.981	12.8
985	0.986	12.1
990	0.991	11.3
995	0.996	10.6
1000	1.001	9.9
1020	1.021	7.1
1040	1.041	4.5

Conversions

LENGTH	feet x 0.3048 = meters (m) meters x 3.281 = feet (ft)	TEMPERATURE	°F = (°C x 9 / 5) + 32 °C = (°F - 32) x 5 / 9
AREA	sq. feet x 0.0929 = meter ² (m ²) sq. meters x 10.764 = feet ² (ft ²)	PRESSURE	psi x 6.895 = kPa kPa x 0.145 = psi
VOLUME	cu. feet x 0.02832 = meter ³ (m ³) meter ³ x 35.31 = cu. feet (ft ³)	FLOWRATE	usgpm x 34.3 = Bpd usgpm x 5.451 = m ³ /d Bbls x 0.159 = m ³ m ³ x 6.29 = Bbls 1 Bbl = 42 US gal = 35 imp. gal
MASS	pounds (lbs) x 0.4536 = kilograms (kg) kg x 2.205 = pounds (lb)		
FORCE	pound force x 0.445 = decaNewtons (daN) daN x 2.25 = pound force (lb. f)		



Weatherford®

PC Pump Division of Weatherford Canada Partnership Warranty

This shall be the only warranty given by PC Pump Division of Weatherford Canada Partnership ("Partnership"), and no other warranty by Partnership, Express or Implied, shall be applicable, including any implied warrant of merchantability or any implied warranty of fitness for a particular purpose.

Subject to the limitations and conditions herein, Partnership warrants its products (with the exception of rotating stuffing boxes) to be free from defects in workmanship and material under normal use and service for a period of twelve (12) months from the date of installation or eighteen (18) months from the date of shipment, whichever occurs first. Partnership warrants rotating stuffing boxes to be free from defects in workmanship and material under normal use and service for a period of three (3) months from the date of installation or nine (9) months from the date of shipment, whichever occurs first.

Partnership's obligations under this warranty shall be limited to repairing, replacing or issuing credit for, at Partnership's option, any product or parts it finds to be defective in material or workmanship. Partnership must be given a reasonable opportunity to investigate. Shipping and handling in connection with this warranty will be at customer's expense. Products sold by Partnership, but manufactured by another company, will carry only the warranty of the manufacturer, and the customer will rely solely on that warranty. Services provided by Partnership are warranted for a period of ninety (90) days from the date the services are rendered. The liability of Partnership for any loss or damage resulting to the customer or user or any third party from any defect in any product or service will not, in any case, exceed the selling price that Partnership received from the customer for the product or service. The above shall be the customer's exclusive remedy with respect to products or services. **In no event will Partnership be liable for incidental, consequential, special, indirect or other damages of any nature.**

This warranty will not apply and will be void if the product fails as a result of downhole corrosion; non-compatibility of produced fluid with the stator and/or rotor; general wear and abrasion; incorrect installation, removal, use or maintenance; operation outside of the manufacturer's recommended guidelines; alteration; accident; abuse or negligence. Hydraulic wellhead drives, hydraulic power transmission units or rotating stuffing boxes sold individually for use with equipment not manufactured by Partnership will not be covered under this warranty.

Partnership does not warrant that any of the products sold by it, if used or sold in combination with other equipment or used in the practice of methods or processes, will not, by virtue of such combination or use, infringe patents of other, and Partnership shall not be liable for any patent infringement arising from, or by reason of, any such use or sale. Furthermore, Partnership shall not be liable for any patent infringement arising from, or by reason of, any use or sale of any materials, equipment or products not of Partnership's manufacture or for the use or sale of any materials, equipment or products, or other goods specially made, in whole or in part, to the customer's design specifications.

PROGRESSING CAVITY PUMPING SYSTEMS

Another Production Enhancement Solution from Weatherford



Manufacturing Facility

Weatherford Artificial Lift Systems Canada
PC Pump Products & Services
4604 - 62nd Avenue
Lloydminster, Alberta T9V 2G2
Canada
780/875-0103 Telephone
780/875-0963 Fax

Canada

Weatherford Artificial Lift Systems Canada
PC Pump Products & Services
2801 - 84th Avenue
Edmonton, Alberta T6P 1K1
Canada
780/417-4800 Telephone
780/464-5198 Fax

Worldwide Customer Service

Weatherford Artificial Lift Systems Inc.
515 Post Oak Blvd.
Houston, Texas 77027
United States
713/693-4800 Telephone
713/693-4323 Fax
als@weatherford.com



Weatherford®

www.weatherford.com

APPENDIX C

LOGBOOKS

GROUTED-IN PIEZOMETER INSTALLATION

**Kennecott Eagle Project
Grouted-In Piezometer
Installation**

Testing Logbook



Date	Time	Event	Comment
09.08.05	08:00	I (Mike Lemon) arrive at Negaunee office and meet with Andrew Ware. Begin Site-specific safety training and project review.	
	10:00	End training and review. Begin testing the 6 vibrating wire transducers (Geokon-4500 S) and data loggers (Geokon-AI-8001 Rev B).	
	14:00	I arrive on Site. Drillers are tripping rods down YD02-20 to flush borehole. I begin measuring each piece of 1" PVC pipe.	
	17:00	Borehole is flushed.	
	20:00	I leave Site.	
10.08.05	08:30	I arrive on Site while drillers move to 04EA-074. I continue measuring PVC pipe.	
	10:00	Drillers are set up on 04EA-074 and begin tripping BTW rods to flush borehole. Once completed the drillers move to 04EA-077 and trip rods to total depth to flush borehole with water.	
	13:00	Start lowering 1" PVC pipe down YD02-20 using a forklift and bail. Transducers 05-10383 (75 ft) and 05-8438 (800 ft) are taped to the PVC pipe to correspond to the projected depth.	
	14:45	PVC pipe reaches bottom of borehole. Total depth = 1137.5 ft. Water level = 22 ft bgs. Transducers and dataloggers are communicating properly.	
	16:00	Borehole is grouted through the 1" PVC pipe using a mixture of 1 part cement, 0.3 parts bentonite and 2.5 parts water.	
	18:30	Grouting completed and transducers are communicating properly. I begin measuring pipe for next installation.	
	20:00	I leave Site.	

**Kennecott Eagle Project
Grouted-In Piezometer
Installation**

Testing Logbook



Date	Time	Event	Comment
11.08.05	08:00	I arrive at Negaunee office. Remaining shipment of 1" PVC pipe is held up in shipping and should arrive around 10:00. Drillers begin flushing 04EA-077.	
	09:00	I return to Site and continue measuring PVC pipe.	
	12:00	A portion of the remaining PVC pipe arrives on Site. Start lowering 1" PVC pipe down 04EA-077 using Hagby drill rig. Transducers 05-9477 (160 ft) and 05-7644 (630 ft) were taped to the PVC pipe to correspond to the projected depth.	
	17:30	PVC pipe is lowered to base of borehole. Grout is tremied down 1" PVC pipe using a mixture of 1 part cement, 0.3 parts bentonite and 2.5 parts water.	
	18:30	Completed grouting. Transducers are communicating properly. I leave Site.	
12.08.05	08:00	Drillers move to grout open boreholes near 04EA-107. I arrive in Negaunee office and compile transducer data to date and wait for remaining PVC pipe shipment which was delayed.	
	10:00	Remaining PVC pipe arrives and I move to Site.	
	11:00	I measure PVC pipe while drill crew completes grouting of boreholes near 05EA-107.	
	14:00	Begin lowering 1" PVC pipe down 04EA-074 using a pulley and rope attached to a forklift. Transducers (05-10384 (100 ft) and 05-8437 (790 ft) were taped to the PVC pipe to correspond to the projected depths.	
	19:40	PVC pipe reaches total depth of 1250 ft bgs. Begin grouting with a mixture of 1 part cement, 0.3 parts bentonite and 2.5 parts water.	
	21:30	Completed grouting. Left Site.	

**Kennecott Eagle Project
Grouted-In Piezometer
Installation**

Testing Logbook



Date	Time	Event	Comment
13.08.05	08:00	I leave for Site after purchasing metal boxes to mount to surface casing to house data loggers.	
	10:00	Drillers help to drill and weld surfacing casing and mount metal boxes. I download dataloggers and program to record pressure and temperature every 2 hours.	
	13:00	Depart for St. Louis, MO.	

BOREHOLE 05EA-107 TESTING

Date	Time	Event	Comment
Borehole 05EA-107 was drilled at an inclination of -87. Prior to testing, the fluid in the borehole was displaced with freshwater. Total depth = 385.5 ft. Surface casing depth = 50 ft.			
All depths are measured along hole from ground surface unless otherwise noted.			
14.09.05 (257)	12:30	Start running in hole with packers, tools very tight in the hole, attributed partially to x-overs that were slightly bent, discuss with Andrew Ware, decision made to order smaller diameter packers and attempt to test with the tools on site	
	13:15	Tools on depth, measured static water level at 2.3 ft	Test A: 70.7 ft to 128.7 ft
	13:30	Inflate packers to 550 psi.	
	14:00	Add another rod as water flowing from top of tubing indicating flowing artesian conditions	
	14:15	Start slug withdrawal, relatively slow recovery indicating low permeability.	
	16:00	Deflate packers.	
	16:30	Tools on depth.	Test B: 121.3 ft to 179.3 ft
	16:45	Inflate packers to 500 psi.	
	17:03	Start slug withdrawal, relatively slow recovery indicating low permeability.	
	17:45	Leave Site for dinner.	
	22:00	Return to site, the pressure data shows anomalous recovery and attributed to gas leaking from packer which may have been damaged during installation, decide to remove tools and wait for new set of MD 2.4-inch packers which are smaller in diameter and scheduled to arrive in the morning	
15.09.05 (258)	12:00	Tools removed from hole and observed a "runny" cement in the bottom of the tool, decide to flush hole again before running in hole with smaller diameter packers.	
	13:00	Hole flushed. Begin tripping tool in hole.	
	16:25	Tools at depth.	Test 1: 70.0 ft to 124.8 ft

Date	Time	Event	Comment
	16:30	Inflated packers to 500 psi.	
	16:36	Lowered 0.5-inch tubing for airlifting.	
	16:45	Start slug withdrawal using compressed air.	
	17:25	Left Site for dinner.	
	19:15	Returned to Site. Deflated packers.	
	19:45	Tools on depth.	Test 2: 119.9 to 174.7 ft
	19:50	Inflated packers to 500 psi.	
	20:00	Lowered 0.5-inch tubing to airlift.	
	20:15	Start slug withdrawal using air compressor.	
	22:12	Deflated packers.	
	22:40	Tools on depth.	Test 3: 169.4 to 224.2 ft.
	22:45	Inflate packers to 500 psi.	
	22:54	Lowered 0.5-inch tubing for airlifting.	
	23:10	Start slug withdrawal using air compressor.	
	23:20	Leave Site.	
16.09.05 (259)	08:30	Deflate packers and move down to the next interval	
	09:00	Tools on new test interval	Test 4: 219.7 to 274.5 ft.
	09:20	Inflate packers to 520 psi.	
	09:25	Lower 0.5-inch tubing for airlifting.	
	10:00	Start slug withdrawal using air compressor.	
	12:00	Deflated packers.	
	12:20	Tools on new test interval.	Test 5: 269.4 to 324.2 ft.
	12:25	Inflate packers to 550 psi.	

Date	Time	Event	Comment
	12:30	Lower 0.5-inch tubing for airlifting.	
	12:44	Start slug withdrawal using air compressor.	
	14:45	Deflated packers.	
	15:00	Tools on new test interval.	Test 6: 320 to 374.8 ft.
	15:10	Inflate packers to 600 psi.	
	15:30	Lower 0.5-inch tubing for airlifting.	
	15:37	Start slug withdrawal using air compressor.	
	17:00	Perform analyses and decide to collect sample from this interval based on relatively high transmissivity.	
	18:00	Lowered low flow pump to 54 feet below ground surface.	
	18:19	Began pumping at 0.36 gpm.	
	18:32	Decide to use pump only for sampling due to uncertainty of pump not being cooled in small annulus of BTW rods over long pumping period. Decide to purge by airlifting. A 2" hose is connected to BTW rods to direct purged water to stock tank, which is then pumped to holding tanks.	
	19:00	Lower transducer and 0.5-inch tube for airlifting.	
	19:15	Start first air-lift. Air-lifting every 45 minutes. Field parameters collected are pH, conductivity, temperature, and turbidity.	Sampling Test 1: 320 ft to 374.8 ft.
	21:30	Leave site. Night shift drill crew continues air-lifting and collecting groundwater parameters every 45 minutes.	
17.09.05 (260)	07:45	Arrive on Site. Continue air-lifting and collecting groundwater parameters every 45 minutes.	

Date	Time	Event	Comment
	12:30	Began air-lifting every 30 minutes to increase purge rate.	
	20:30	Leave Site. Night shift drill crew continues air-lifting and collection groundwater parameters every 30 minutes.	
18.09.05 (261)	08:30	Arrive on Site and removed air-lift tubing and transducer from boring.	
	09:20	Pump lowered to approximately 60 feet below ground surface.	
	09:30	Began purging at approximately 570 ml/min and collecting pH, cond., turbidity, and temperature every 10 minutes.	
	11:40	Parameters stabilize and begin collecting groundwater sample.	Groundwater Sample: 05EA-107-320-374.8
	12:15	Completed sample collection.	
	12:30	Began tripping rods to target interval (59.7 to 114.5 ft)	
	13:00	Tools on interval for purging and groundwater sampling.	
	13:20	Inflate packers to 500 psi.	
	13:27	Start first air-lift. Continue air-lifting every 30 minutes. Field parameters collected include pH, conductivity, temperature, TDS, salinity, and turbidity.	05EA-107 Sampling Test 2: 60 ft – 114.8 ft.
	20:30	I leave Site. Drilling night crew continues air-lifting and collecting field parameters. John Wozniwicz and I agree to continue purging until morning of 20.09.05 to purge 10 well volumes.	
19.09.05 (262)	07:45	I arrive on Site and continue air-lifting and collecting field parameters every 30 minutes.	
	09:30	I leave Site for Kennecott's Negaunee office to ship groundwater samples and pick up field supplies. Drilling day crew continues air-lifting and collected field parameters every 30 minutes.	

Date	Time	Event	Comment
	15:30	I arrive on Site and continue air-lifting and collecting field parameters.	
	16:30	Heavy rain with severe lighting stopped air-lifting.	
	17:30	Storm subsides, continue air-lifting.	
	20:00	Golder leaves Site, drilling night crew continues air-lifting and collecting parameters every 30 minutes.	
20.09.05 (263)	07:45	Golder arrives on Site and lowers submersible pump for groundwater sampling. Groundwater parameters stabilized.	
	08:10	Begin purging with submersible pump at 0.5 gal/min.	
	09:15	Parameters stabilize. Collect groundwater sample and archive sample.	Groundwater Sample: 05EA-107-60-114.8
	10:00	Trip packers from borehole. IDEA mobes Hagby to 04EA-084. BTW rods are tripped to total depth and clean water is circulated through annulus. IDEA grouts 05EA-107 and 05EA-106? I build single packer tool for testing. All bedrock and alluvium transducers are downloaded and clocks synchronized with laptop, which was synchronized with www.greenwichmeantime.com at 06:00 – 20.09.05.	
	14:00	I leave for Negaunee to ship groundwater samples.	
	17:30	FedEx picks up samples for TriMatrix (48 hour hold on Sulfide). The remaining will ship out 21.09.05.	

BOREHOLE 04EA-084 TESTING

Date	Time	Event	Comment
Borehole 04EA-084 was drilled at an inclination of -60. Prior to testing, the fluid in the borehole was displaced with freshwater. Total depth = 991 ft.			
All depths are measured along hole from ground surface unless otherwise noted.			
21.09.05 (264)	08:15	Rick Booth (Golder) and I (Mike Lemon) arrive on Site and construct packer tool and Moyno pump.	
	09:00	Begin lowering tool and pump on BTW rods. Rotor is inside stator and sucker rods are lowered with the BTW rods.	
	11:30	Golder leaves Site to drop of 05EA-107 groundwater samples to FedEx for Brooks Rand and ISGS at the Big Bay Motel	
	13:30	Return to Site.	
	14:30	Tools and pump are on the target interval (820 ft bgs). IDEA constructs a stand with 2" pipe to support weight of string since head will not rotate with chucks closed.	
	17:10	Inflate packer to 500 psi.	
	17:20	Started Moyno pump at 300 rpm. Fill BTW rods with clean water to start measuring flowrate.	
	17:50	Stop Moyno to reconfigure discharge hose due to water spilling over top of BTW rods.	
	18:15	Start Moyno at 3.53 gpm at 300 rpm.	
	18:45	Stop Moyno to allow recovery overnight to obtain static water level. Rick Booth and I leave Site.	
22.09.05 (265)	08:00	Mike Lemon arrives on Site. Download downhole datalogger.	
	08:20	Start Moyno pump at 250 rpm, flow rate = 3.2 gpm. Groundwater field parameters collected on 60 minute intervals.	Pump Test: 04EA-084
	12:47	Reduced flowrate to 2.97 gpm (240 rpm) due to projected drawdown exceeding pump.	

Date	Time	Event	Comment
	16:00	Reduced flowrate to 2.16 gpm (180 rpm) due to projected drawdown exceeding pump.	
	16:50	Increased flowrate to 2.27 gpm (190 rpm) due to slight pressure recovery at 2.16 gpm.	
	17:00	Packer pressure increased to 700 psi.	
	17:17	Increased flowrate to 2.50 gpm since pressure is still recovering.	
	20:30	I leave Site. Drilling night crew continues collecting groundwater parameters and flow conditions.	
23.09.05 (266)	07:30	I pick up Fed Ex labels and sample port fittings in Marquette.	
	09:00	I arrive on Site and download all data loggers.	
	11:30	I phone John Wozniewicz and discuss data pressure data. We decide to lower pump rate after sample collection.	
	11:50	Collect groundwater sample from discharge pipe. Metal/cations and Mercury are collected both filtered and unfiltered.	Groundwater Sample: 04EA-084, 04EA-084-F, 04EA-084-U
	13:00	Reduce pump rpm to 144 = 1.6 gpm.	
	15:00	I leave Site to drop samples at Fed Ex and return air compressor to Midwest Rentals. Day drilling crew continues collecting parameters and flow conditions.	
	16:30	Samples to TriMatrix and Brooks Rand are delivered to Fed Ex for Saturday delivery. ISGS does not receive samples on Saturday. Tritium will be shipped on Monday.	
	20:00	Drilling night shift continues collecting parameters and flow conditions.	

Date	Time	Event	Comment
24.09.05 (267)	08:00	I arrive on Site and continue collecting parameters and flow conditions with the help of the drilling day shift. I also compile data from all transducers between hourly readings.	
	17:00	Download dataloggers.	
	19:00	Leave Site. Drilling day and night crew continue collecting parameters and monitoring flowrate.	
25.09.05 (268)	08:00	Arrive on Site and continue collecting parameters, monitoring flowrate and compiling data.	
	15:00	Downloaded dataloggers and compiled data.	
	18:30	Left Site. Drilling day and night shifts continue collecting purge data.	
26.09.05 (269)	08:00	Arrive on Site. Continue collecting parameters and monitoring flowrates. Dataloggers are downloaded and data compiled.	
	10:00	Collect general chemistry parameter sample at 11,000 gallons purged.	Groundwater Sample: 04EA-084 - 11000
	19:00	Left Site. Drilling day and night shifts continue collecting purge data.	
27.09.05 (270)	07:30	Drop groundwater samples off at FedEx in Marquette.	
	9:00	Arrive on Site. Continue collecting parameters and monitoring flowrate.	
	9:30	Representatives from MDEQ, MDNR, Kennecott (Jon Cherry and Andrew Ware), and a special interest group arrive on Site to observe pump test.	
	11:00	Parties leave Site.	
	16:00	Data loggers are downloaded and data compiled.	
	18:00	Leave Site. Drilling day and night shifts continue collecting purge data.	

Date	Time	Event	Comment
28.09.05 (271)	08:00	Arrive on Site. Continue collecting parameters and monitoring flow rate.	
	14:30	Download dataloggers and compile data.	
	20:00	Leave Site. Drilling night shift continue collection purge data.	
29.09.05 (272)	07:30	Arrive on Site. Download downhole datalogger and update purge data.	
	08:00	Begin collecting groundwater sample with a duplicate, field blank (metals collected through filter), and archive sample.	Groundwater Samples: • 04EA-084-817-981-2DUPF and U (filtered and unfiltered metals) ARCHIVE SAMPLE • 04EA-084-817-981-2F and U (filtered and unfiltered metals) • Blind Dup-F and U (filtered and unfiltered metals) • Field Blank F (metals analysis only)
	08:25	Stopped rotation of Moyno pump creating a pressure shut-in. Beginning of recovery test.	
	09:00	Downloaded dataloggers and compiled data. Collection interval set to 5 minutes at all monitoring points. Extra equipment is packed for return to St. Louis.	
	11:30	Leave Site for Fed Ex and airport.	
	18:00	Arrive in St. Louis.	
05.10.05 (278)		Travel to Marquette, MI.	
06.10.06 (279)	07:30	Arrive on Site. Download downhole datalogger and compile data.	
	09:00	Deflate packer and begin tripping tools and pump from 04EA-084.	
	15:30	Tools removed from 04EA-084. I begin packing tools for return to St. Louis and Burnaby. IDEA grouts 04EA-084. I remove Minitrols from alluvium wells and prepare for return.	
	19:30	Download data from YD02-20.	
	20:00	Leave Site.	

Date	Time	Event	Comment
07.10.05 (280)	09:00	Arrive on Site and finish packing equipment.	
	11:00	Download data from bedrock piezometers and set sample interval for 2 hrs and clear dataloggers.	
	13:30	Leave Site and return to Kennecott office in Negaunee to email data and pack Moyno sucker rods.	
	17:00	I return Minitroll from QAL-023 to Dan Wiitala of North Jackson.	
	17:30	I drop all equipment at Fed Ex for return to St. Louis.	
	19:30	Leave Marquette airport.	
	23:00	Arrive in St. Louis.	

APPENDIX D

PARAMETERS MEASURED DURING WATER SAMPLING

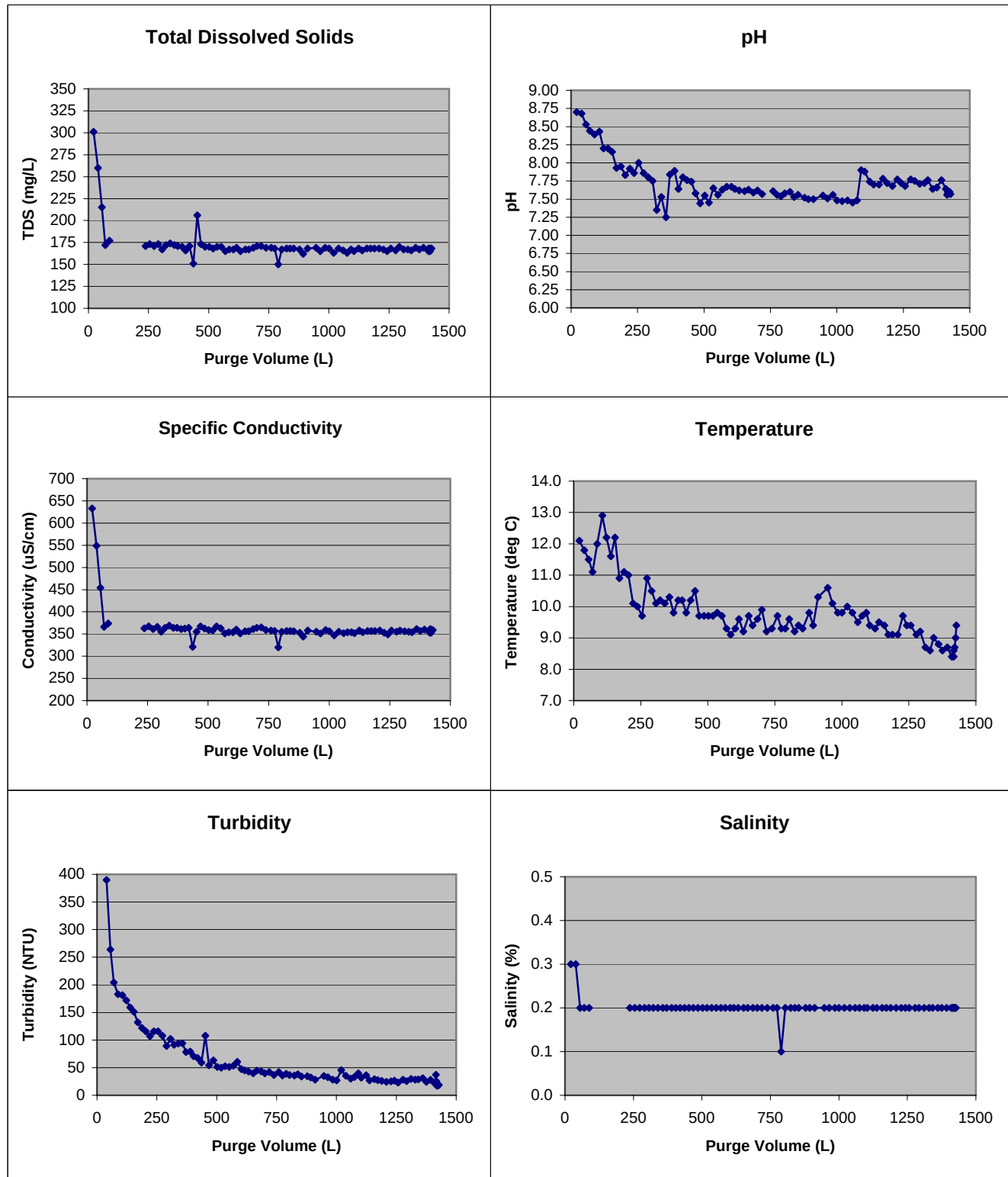
BOREHOLE 05EA-107

18.20 m – 34.90 m

18.17 mTVD – 34.85 mTVD

PARAMETERS MEASURED DURING WATER SAMPLING
BOREHOLE 05EA-107

INTERVAL: 18.20 m - 34.90 m (18.17 mTVD - 34.85 mTVD)



BOREHOLE 05EA-107 FIELD PARAMETERS
18.20 m to 34.90 m Sample Interval

Date	Time of Day	Purge Volume (gallons)	Temp (deg C)	pH (s.u.)	Conductivity (uS/cm)	Salinity (%)	TDS (mg/L)	Turbidity (NTU)
	13:27	5.5	12.1	8.70	633	0.3	301	--
	14:00	10.4	11.8	8.68	549	0.3	260	390
	14:30	14.7	11.5	8.53	454	0.2	215	264
	15:00	18.6	11.1	8.44	366	0.2	172	204
	15:30	23.2	12.0	8.39	374	0.2	177	183
	16:00	28.1	12.9	8.43	Not Measured	Not Measured	Not Measured	181
	16:30	32.3	12.2	8.20	Not Measured	Not Measured	Not Measured	172
	17:00	36.5	11.6	8.20	Not Measured	Not Measured	Not Measured	159
	17:30	40.8	12.2	8.15	Not Measured	Not Measured	Not Measured	151
	18:00	45.0	10.9	7.93	Not Measured	Not Measured	Not Measured	132
	18:30	49.6	11.1	7.95	Not Measured	Not Measured	Not Measured	122
	19:00	53.8	11.0	7.83	Not Measured	Not Measured	Not Measured	116
	19:30	58.4	10.1	7.92	Not Measured	Not Measured	Not Measured	107
	20:00	62.6	10.0	7.86	363	0.2	171	116
	20:30	67.2	9.7	8.00	367	0.2	173	116
	21:00	72.1	10.9	7.86	361	0.2	171	108
	21:30	76.7	10.5	7.80	366	0.2	173	89.3
	22:00	80.9	10.1	7.75	355	0.2	167	102
	22:30	85.2	10.2	7.35	364	0.2	172	91.7
	23:00	89.7	10.1	7.53	369	0.2	174	93.6
	23:30	94.3	10.3	7.25	364	0.2	172	94.2
	0:00	98.2	9.8	7.84	364	0.2	171	78.1
	0:30	102.8	10.2	7.89	361	0.2	170	79.3
	1:00	106.7	10.2	7.64	362	0.2	166	70.9
	1:30	111.0	9.8	7.80	364	0.2	171	67.7
	2:00	115.2	10.2	7.76	321	0.2	151	59.1
	2:30	119.5	10.5	7.74	355	0.2	206	108
	3:00	123.7	9.7	7.58	367	0.2	173	54.4
	3:30	128.3	9.7	7.44	362	0.2	170	63.3
	4:00	132.8	9.7	7.55	359	0.2	170	51.2
	4:30	137.1	9.7	7.45	358	0.2	168	49.9
	5:00	141.3	9.8	7.65	367	0.2	170	52.4
	5:30	145.9	9.7	7.56	363	0.2	170	51.3
	6:00	150.5	9.3	7.63	351	0.2	165	53.3
	6:30	154.7	9.1	7.67	354	0.2	167	60.7

BOREHOLE 05EA-107 FIELD PARAMETERS
18.20 m to 34.90 m Sample Interval

Date	Time of Day	Purge Volume (gallons)	Temp (deg C)	pH (s.u.)	Conductivity (uS/cm)	Salinity (%)	TDS (mg/L)	Turbidity (NTU)
	7:00	159.2	9.3	7.67	354	0.2	167	47.2
	7:30	162.8	9.6	7.64	360	0.2	169	45.1
	8:00	167.1	9.2	7.62	351	0.2	165	42.8
	8:30	172.3	9.7	7.61	356	0.2	167	40
	9:00	176.2	9.4	7.63	356	0.2	167	44.5
	9:30	181.1	9.6	7.59	361	0.2	169	43.2
	10:00	185.3	9.9	7.62	364	0.2	171	39.7
	10:30	189.9	9.2	7.57	365	0.2	171	42
	11:00	195.1	9.3	--	359	0.2	169	36.6
	11:30	200.7	9.7	7.61	358	0.2	169	42
	12:00	204.6	9.3	7.56	357	0.2	168	35.7
	12:30	208.5	9.3	7.54	320	0.1	150	38.8
	13:00	212.4	9.6	7.58	355	0.2	167	36.9
	13:30	217.6	9.2	7.60	357	0.2	168	35.6
	14:00	221.6	9.4	7.53	357	0.2	168	38.1
	14:30	225.5	9.3	7.56	356	0.2	168	33.9
	15:00	232.0	9.8	7.52	353	0.2	167	34.6
	15:30	235.9	9.4	7.50	344	0.2	162	32.4
	16:00	240.8	10.3	7.50	358	0.2	168	28.5
	17:30	250.2	10.6	7.55	355	0.2	169	35.1
	18:00	254.8	10.1	7.51	351	0.2	165	32.9
	18:30	260.2	9.8	7.56	359	0.2	169	28.3
	19:00	264.2	9.8	7.48	356	0.2	168	27
	20:00	269.5	10.0	7.47	347	0.2	163	45.4
	20:30	274.7	9.8	7.48	355	0.2	168	35.3
	21:00	279.9	9.5	7.45	352	0.2	166	30.2
	21:30	284.1	9.7	7.48	354	0.2	163	33.1
	22:00	288.4	9.8	7.90	354	0.2	167	40
	22:30	291.6	9.4	7.88	352	0.2	165	31.9
	23:00	296.9	9.3	7.74	358	0.2	168	36.4
	23:30	300.8	9.5	7.70	354	0.2	166	26.9
	0:00	306.0	9.4	7.70	357	0.2	168	29
	0:30	309.9	9.1	7.78	357	0.2	168	27.2
	1:00	314.1	9.1	7.72	357	0.2	168	26.2
	1:30	319.4	9.1	7.68	358	0.2	168	24.2

BOREHOLE 05EA-107 FIELD PARAMETERS
18.20 m to 34.90 m Sample Interval

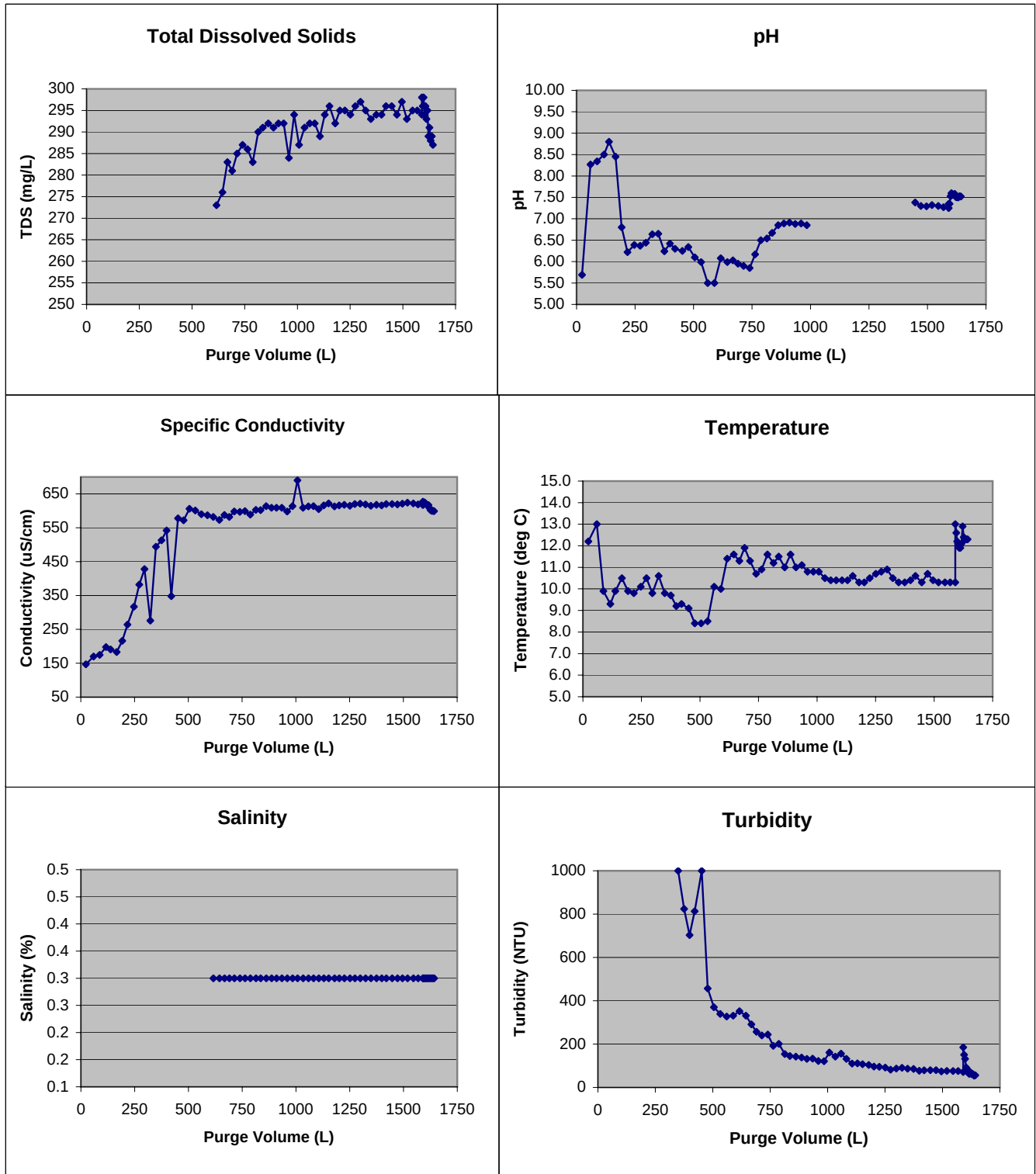
Date	Time of Day	Purge Volume (gallons)	Temp (deg C)	pH (s.u.)	Conductivity (uS/cm)	Salinity (%)	TDS (mg/L)	Turbidity (NTU)
	2:00	324.3	9.7	7.77	353	0.2	167	25.2
	2:30	328.2	9.4	7.72	349	0.2	165	26.4
	3:00	332.1	9.4	7.68	358	0.2	168	22.8
	3:30	337.6	9.1	7.77	355	0.2	166	28.2
	4:00	341.5	9.2	7.75	358	0.2	170	25.8
	4:30	346.5	8.7	7.71	356	0.2	167	29.5
	5:00	351.0	8.6	7.72	355	0.2	167	28.3
	5:30	354.6	9.0	7.76	354	0.2	166	28.6
	6:00	359.5	8.8	7.64	361	0.2	169	31.1
	6:30	363.4	8.6	7.66	357	0.2	167	24.4
	7:00	368.0	8.7	7.76	360	0.2	169	27.9
	7:30	372.6	8.4	7.64	357	0.2	167	21.6
	8:19	373.8	8.4	7.56	353	0.2	165	37.3
	8:28	374.4	8.4	7.58	361	0.2	168	25.4
	8:34	374.4	8.6	7.61	358	0.2	168	18.6
	8:40	375.3	8.7	7.58	353	0.2	165	17.2
	8:50	376.2	9.0	7.60	359	0.2	168	18.1
	9:00	377.1	9.4	7.57	359	0.2	168	18.5

BOREHOLE 05EA-107

97.52 m - 114.22 m
97.34 mTVD – 113.99 mTVD

PARAMETERS MEASURED DURING WATER SAMPLING
BOREHOLE 05EA-107

INTERVAL: 97.52 m - 114.22 m (97.34 mTVD - 113.99 mTVD)



BOREHOLE 05EA-107 FIELD PARAMETERS
97.52 m to 114.22 m Sample Interval

Date	Time of Day	Purge Volume (gallons)	Temp (deg C)	pH (s.u.)	Conductivity (uS/cm)	Salinity (%)	TDS (mg/L)	Turbidity (NTU)
9/16/2005	19:15	6.2	12.2	5.69	147	not measured	not measured	not measured
	19:45	15.7	13.0	8.27	170	not measured	not measured	not measured
	20:30	23.2	9.9	8.34	175	not measured	not measured	not measured
	21:15	31.0	9.3	8.50	198	not measured	not measured	not measured
	22:00	36.5	9.9	8.80	191	not measured	not measured	not measured
	22:45	44.0	10.5	8.45	183	not measured	not measured	not measured
	23:30	50.9	9.9	6.80	216	not measured	not measured	not measured
9/17/2005	0:15	57.4	9.8	6.22	264	not measured	not measured	not measured
	1:00	65.3	10.1	6.39	317	not measured	not measured	not measured
	1:45	71.8	10.5	6.37	382	not measured	not measured	not measured
	2:30	78.3	9.8	6.44	428	not measured	not measured	not measured
	3:15	85.5	10.6	6.64	276	not measured	not measured	not measured
	4:00	92.3	9.8	6.65	494	not measured	not measured	1000
	4:45	99.2	9.7	6.24	513	not measured	not measured	824
	5:30	105.4	9.2	6.42	542	not measured	not measured	703
	6:15	111.3	9.3	6.30	348	not measured	not measured	813
	7:00	119.4	9.1	6.25	578	not measured	not measured	1000
	7:45	126.3	8.4	6.34	572	not measured	not measured	457
	8:30	133.4	8.4	6.10	606	not measured	not measured	370
	9:15	140.6	8.5	5.99	601	not measured	not measured	339
	10:20	148.1	10.1	5.50	590	not measured	not measured	327
	11:00	155.6	10.0	5.50	587	not measured	not measured	331
	11:45	162.8	11.4	6.08	582	0.3	273	352
	12:30	170.3	11.6	5.99	573	0.3	276	331
	13:00	176.5	11.3	6.03	588	0.3	283	291
	13:30	182.3	11.9	5.95	582	0.3	281	257
	14:00	188.6	11.3	5.90	598	0.3	285	240
	14:30	195.4	10.7	5.85	597	0.3	287	244
	15:00	201.6	10.9	6.17	599	0.3	286	192
	15:30	208.1	11.6	6.50	589	0.3	283	201
	16:00	215.0	11.2	6.54	603	0.3	290	154
	16:30	220.9	11.5	6.67	602	0.3	291	145
	17:00	227.7	11.0	6.85	614	0.3	292	142
	17:30	234.2	11.6	6.89	609	0.3	291	138
	18:00	240.4	11.0	6.91	609	0.3	292	132
	18:30	247.0	11.1	6.88	609	0.3	292	133

BOREHOLE 05EA-107 FIELD PARAMETERS
97.52 m to 114.22 m Sample Interval

Date	Time of Day	Purge Volume (gallons)	Temp (deg C)	pH (s.u.)	Conductivity (uS/cm)	Salinity (%)	TDS (mg/L)	Turbidity (NTU)
	19:00	253.5	10.8	6.89	598	0.3	284	122
	19:30	260.0	10.8	6.85	614	0.3	294	121
	20:00	266.2	10.8	not measured	690	0.3	287	161
	20:30	273.1	10.5	not measured	609	0.3	291	142
	21:00	279.6	10.4	not measured	613	0.3	292	156
	21:30	285.8	10.4	not measured	614	0.3	292	132
	22:00	292.3	10.4	not measured	605	0.3	289	110
	22:30	298.5	10.4	not measured	616	0.3	294	111
	23:00	304.4	10.6	not measured	622	0.3	296	107
	23:30	311.6	10.3	not measured	613	0.3	292	104
9/18/2005	0:00	317.4	10.3	not measured	616	0.3	295	96.1
	0:30	323.6	10.5	not measured	618	0.3	295	95.4
	1:00	330.5	10.7	not measured	615	0.3	294	91.5
	1:30	336.7	10.8	not measured	620	0.3	296	82
	2:00	343.2	10.9	not measured	621	0.3	297	87.2
	2:30	349.7	10.5	not measured	619	0.3	295	90.6
	3:00	356.2	10.3	not measured	615	0.3	293	86.4
	3:30	363.1	10.3	not measured	618	0.3	294	85.3
	4:00	369.6	10.4	not measured	616	0.3	294	76.6
	4:30	375.2	10.6	not measured	620	0.3	296	79.1
	5:00	382.4	10.3	not measured	620	0.3	296	79.4
	5:30	388.9	10.7	not measured	619	0.3	294	79.9
	6:00	395.1	10.4	not measured	621	0.3	297	73.7
	6:30	401.3	10.3	not measured	624	0.3	293	76.4
	7:00	408.5	10.3	not measured	622	0.3	295	75.6
	7:30	414.3	10.3	not measured	619	0.3	295	75.5
	8:00	420.2	10.3	7.25	627	0.3	294	71
	9:41	420.2	13.0	7.35	617	0.3	298	185
	9:50	421.2	12.6	7.35	619	0.3	296	151
	10:00	422.3	12.2	7.53	625	0.3	298	132
	10:10	423.4	12.1	7.60	621	0.3	294	92.2
	10:20	424.6	11.9	7.56	619	0.3	296	85.5
	10:30	425.9	11.9	7.57	617	0.3	293	68.4
	10:40	427.1	12.1	7.58	617	0.3	295	62.5
	10:50	428.4	12.9	7.51	608	0.3	289	70
	11:00	429.7	12.4	7.50	602	0.3	291	61.1

BOREHOLE 05EA-107 FIELD PARAMETERS
97.52 m to 114.22 m Sample Interval

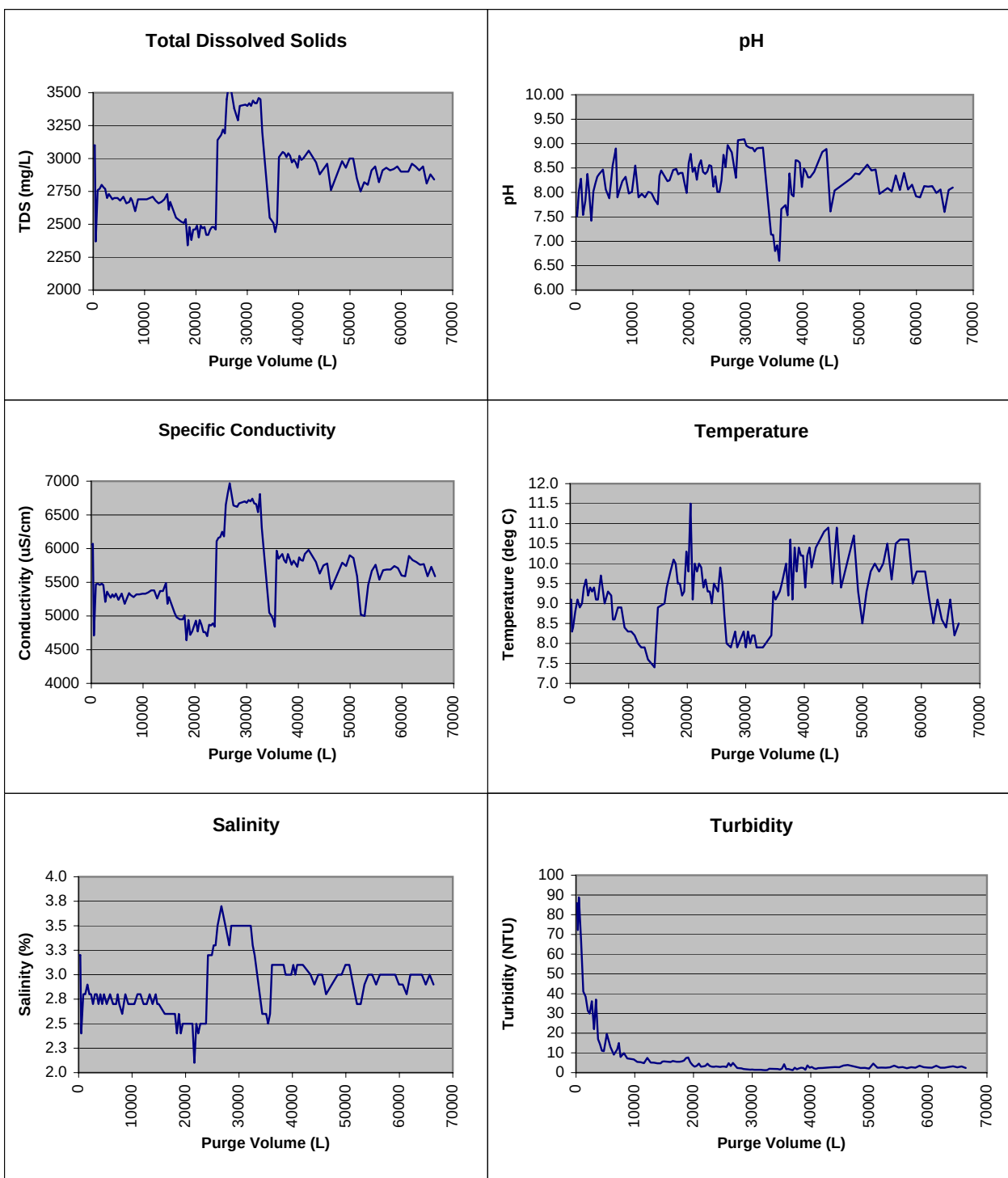
Date	Time of Day	Purge Volume (gallons)	Temp (deg C)	pH (s.u.)	Conductivity (uS/cm)	Salinity (%)	TDS (mg/L)	Turbidity (NTU)
	11:10	431.2	12.3	7.50	600	0.3	288	61.7
	11:20	432.6	12.3	7.53	600	0.3	289	54.4
	11:30	434.0	12.3	7.52	599	0.3	287	56

BOREHOLE 04EA-084

**249.05 m – 302.05 m
217.61 mTVD – 264.57 mTVD**

PARAMETERS MEASURED DURING WATER SAMPLING
BOREHOLE 04EA-084

INTERVAL: 249.05 m - 302.05 m (217.61 mTVD - 264.57 mTVD)



BOREHOLE 04EA-084 FIELD PARAMETERS
249.05 m to 302.08 m Sample Interval

Date	Time (hr)	(min)	Purge Volume (gallons)	Temp (deg C)	pH (s.u.)	Conductivity (uS/cm)	Salinity (0/00)	TDS (mg/L)	Turbidity (NTU)
9/22/2005	8	35	48.4	9.1	7.51	6060	3.2	3100	85.9
	8	45	80.6	8.3	7.69	6070	3.2	3100	72.3
	9	0	129.6	8.4	8.03	4710	2.4	2370	88.8
	9	30	229.6	8.8	8.28	5470	2.8	2760	66.7
	10	0	325.3	9.1	7.54	5480	2.8	2770	41.1
	10	35	433.6	8.9	7.83	5460	2.9	2800	38.5
	11	4	529.2	9.0	8.38	5480	2.8	2780	31.4
	11	30	613.0	9.4	7.99	5460	2.8	2770	29.9
	12	0	709.8	9.6	7.42	5210	2.7	2700	36.2
	12	30	807.6	9.2	8.02	5360	2.8	2730	22
	13	0	897.6	9.4	8.18	5310	2.8	2710	37
	13	30	986.7	9.3	8.32	5270	2.7	2690	17
	14	0	1075.8	9.4	8.38	5320	2.8	2700	14.4
	14	30	1164.1	9.1	8.42	5280	2.7	2700	11.1
	15	0	1252.3	9.1	8.47	5330	2.8	2700	10.9
	15	45	1384.7	9.7	8.06	5240	2.7	2680	19.6
	17	0	1550.3	9.0	7.88	5333	2.8	2710	13
	18	0	1702.2	9.3	8.55	5180	2.7	2660	9.13
	19	0	1853.4	9.2	8.90	5290	2.7	2670	11.7
	19	30	1929.1	8.6	7.90	5340	2.8	2700	15
	20	0	2004.1	8.6	8.02	5310	2.7	2680	7.95
	21	0	2155.3	8.9	8.23	5280	2.6	2600	9.89
	22	0	2305.4	8.9	8.32	5320	2.8	2690	7.24
	23	0	2454.7	8.4	7.98	5320	2.7	2690	6.97
9/23/2005	0	0	2604.1	8.3	8.01	5330	2.7	2690	6.67
	1	0	2755.4	8.3	8.55	5330	2.7	2690	5.47
	2	0	2906.0	8.2	7.90	5350	2.8	2700	5.29
	3	0	3057.9	8.0	7.97	5380	2.8	2710	4.78
	4	0	3207.9	7.9	7.90	5380	2.7	2680	7.45
	5	0	3359.2	7.9	8.01	5260	2.7	2660	5.1
	6	0	3508.6	7.6	7.99	5370	2.8	2670	5.03
	7	0	3659.2	7.5	7.85	5370	2.7	2690	4.71
	8	0	3808.6	7.4	7.76	5490	2.8	2730	4.73
	8	30	3884.8	8.2	8.34	5180	2.7	2610	5.55
	9	0	3960.5	8.9	8.45	5280	2.7	2670	5.73

BOREHOLE 04EA-084 FIELD PARAMETERS
249.05 m to 302.08 m Sample Interval

Date	Time		Purge Volume (gallons)	Temp (deg C)	pH (s.u.)	Conductivity (uS/cm)	Salinity (0/00)	TDS (mg/L)	Turbidity (NTU)
	(hr)	(min)							
	11	0	4255.6	9.0	8.23	5040	2.6	2550	5.35
	11	40	4354.7	9.4	8.25	4980	2.6	2540	5.92
	13	35	4523.8	9.8	8.46	4950	2.6	2520	5.51
	15	0	4664.0	10.1	8.48	4950	2.6	2510	5.51
	16	0	4759.7	10.0	8.37	5010	2.6	2540	5.69
	17	0	4856.0	9.5	Not Measured	Not Measured	Not Measured	Not Measured	6.11
	18	0	4953.8	9.5	Not Measured	Not Measured	Not Measured	Not Measured	7.42
	19	0	5049.0	9.2	Not Measured	Not Measured	Not Measured	Not Measured	7.64
	20	0	5146.3	9.3	Not Measured	Not Measured	Not Measured	Not Measured	5.18
	21	0	5242.6	10.3	Not Measured	Not Measured	Not Measured	Not Measured	3.79
	22	0	5336.8	9.8	Not Measured	Not Measured	Not Measured	Not Measured	3.03
	23	0	5431.6	11.5	Not Measured	Not Measured	Not Measured	Not Measured	3.5
9/24/2005	0	0	5527.3	9.1	Not Measured	Not Measured	Not Measured	Not Measured	4.57
	1	0	5625.1	10.0	Not Measured	Not Measured	Not Measured	Not Measured	3.04
	2	0	5722.4	9.8	Not Measured	Not Measured	Not Measured	Not Measured	3.17
	3	0	5818.2	10.0	Not Measured	Not Measured	Not Measured	Not Measured	3.43
	4	0	5914.9	9.9	Not Measured	Not Measured	Not Measured	Not Measured	4.52
	5	0	6012.8	9.4	Not Measured	Not Measured	Not Measured	Not Measured	3.4
	6	0	6109.0	9.6	Not Measured	Not Measured	Not Measured	Not Measured	3.02
	7	0	6204.8	9.3	Not Measured	Not Measured	Not Measured	Not Measured	2.95
	8	0	6299.0	9.3	Not Measured	Not Measured	Not Measured	Not Measured	3.13
	9	0	6392.3	9.0	Not Measured	Not Measured	Not Measured	Not Measured	3.03
	10	0	6487.5	9.5	Not Measured	Not Measured	Not Measured	Not Measured	2.9
	11	0	6582.2	9.4	Not Measured	Not Measured	Not Measured	Not Measured	3.05
	12	0	6675.5	9.3	Not Measured	Not Measured	Not Measured	Not Measured	3.06
	13	0	6770.8	9.9	Not Measured	Not Measured	Not Measured	Not Measured	2.79
	14	0	6865.5	9.5	Not Measured	Not Measured	Not Measured	Not Measured	4.77
	15	0	6962.8	8.7	Not Measured	Not Measured	Not Measured	Not Measured	3.35
	16	0	7059.0	8.0	Not Measured	Not Measured	Not Measured	Not Measured	4.91
	18	0	7252.6	7.9	Not Measured	Not Measured	Not Measured	Not Measured	2.36
	19	0	7347.3	7.9	Not Measured	Not Measured	Not Measured	Not Measured	2.17
	20	0	7443.6	8.3	Not Measured	Not Measured	Not Measured	Not Measured	2.17
	21	0	7539.8	7.9	Not Measured	Not Measured	Not Measured	Not Measured	1.85
	22	0	7637.1	8.3	Not Measured	Not Measured	Not Measured	Not Measured	1.92
	23	0	7734.4	7.9	Not Measured	Not Measured	Not Measured	Not Measured	1.89

BOREHOLE 04EA-084 FIELD PARAMETERS
249.05 m to 302.08 m Sample Interval

Date	Time (hr)	(min)	Purge Volume (gallons)	Temp (deg C)	pH (s.u.)	Conductivity (uS/cm)	Salinity (0/00)	TDS (mg/L)	Turbidity (NTU)
9/25/2005	0	0	7831.7	8.3	Not Measured	Not Measured	Not Measured	Not Measured	1.51
	1	0	7928.0	7.9	Not Measured	Not Measured	Not Measured	Not Measured	1.56
	2	0	8024.8	8.3	Not Measured	Not Measured	Not Measured	Not Measured	1.44
	3	0	8121.0	8.0	Not Measured	Not Measured	Not Measured	Not Measured	1.44
	4	0	8218.8	8.2	Not Measured	Not Measured	Not Measured	Not Measured	1.41
	5	0	8316.1	8.2	Not Measured	Not Measured	Not Measured	Not Measured	1.41
	6	0	8411.9	7.9	Not Measured	Not Measured	Not Measured	Not Measured	1.31
	7	0	8508.7	7.9	Not Measured	Not Measured	Not Measured	Not Measured	1.27
	8	0	8603.4	7.9	Not Measured	Not Measured	Not Measured	Not Measured	1.3
	9	0	8698.6	7.9	Not Measured	Not Measured	Not Measured	Not Measured	1.96
	10	0	8794.4	7.9	Not Measured	Not Measured	Not Measured	Not Measured	4.68
	11	0	8890.6	7.9	Not Measured	Not Measured	Not Measured	Not Measured	2.63
	12	0	8984.9	7.9	Not Measured	Not Measured	Not Measured	Not Measured	1.98
	13	0	9079.6	8.2	7.14	Not Measured	Not Measured	Not Measured	1.82
	14	0	9174.4	9.3	7.13	Not Measured	Not Measured	Not Measured	1.59
	15	0	9269.1	9.1	6.80	Not Measured	Not Measured	Not Measured	2.03
	16	0	9362.8	9.2	6.92	Not Measured	Not Measured	Not Measured	4.29
	17	0	9458.1	9.3	6.60	5970	2.6	2510	1.74
	18	0	9554.3	9.5	7.66	5850	3.1	3010	1.85
	19	0	9651.6	9.4	7.62	5830	3.0	2040	1.8
	20	0	9747.4	10.0	7.74	5920	3.1	3050	1.22
	21	0	9842.6	9.2	7.53	5830	3.1	3040	2.48
	22	0	9938.4	10.6	8.39	5790	3.1	3010	1.69
	23	0	10033.6	9.1	7.96	5920	3.1	3040	2.19
9/26/2005	0	0	10128.8	10.4	7.92	5840	3.1	3020	2.46
	1	0	10224.1	9.8	8.66	5760	3.0	2970	2.36
	2	0	10320.3	10.4	8.65	5820	3.0	2990	1.45
	3	0	10415.6	10.2	8.61	5780	3.0	2970	3.67
	4	0	10511.3	10.2	8.11	5730	3.0	2930	2.47
	5	0	10608.6	9.4	8.49	5870	3.1	3020	2.88
	6	0	10703.8	10.2	8.42	5830	3.0	2990	2.14
	7	0	10800.1	10.4	8.31	5820	3.1	3000	1.87
	8	0	10896.4	9.9	8.31	5920	3.1	3020	2.3
	10	0	11085.3	10.4	8.42	5980	3.1	3060	2.35
	12	0	11272.8	10.7	8.95	4970	2.5	2480	2.53

BOREHOLE 04EA-084 FIELD PARAMETERS
249.05 m to 302.08 m Sample Interval

Date	Time (hr)	(min)	Purge Volume (gallons)	Temp (deg C)	pH (s.u.)	Conductivity (uS/cm)	Salinity (0/00)	TDS (mg/L)	Turbidity (NTU)
	14	0	11462.3	10.8	8.83	5800	3.0	2970	2.68
	16	0	11654.8	10.9	8.89	5630	2.9	2880	2.81
	18	0	11844.3	9.5	7.61	5750	3.0	2920	2.75
	20	0	12034.8	10.9	8.04	5780	3.0	2960	3.61
	22	0	12227.8	9.4	8.10	5400	2.8	2760	3.87
9/27/2005	0	0	12421.4	11.1	8.27	3770	1.9	1880	2.12
	2	0	12613.4	9.0	8.39	4580	2.3	2790	2.53
	4	0	12805.9	10.7	8.29	5790	3.0	2980	2.36
	6	0	12997.9	9.3	8.39	5740	3.0	2930	2.45
	8	0	13187.4	8.5	8.37	5900	3.1	3000	2.03
	10	0	13376.4	9.3	8.47	5860	3.1	3000	4.59
	12	0	13562.9	9.8	8.57	5590	2.9	2850	2.47
	14	0	13752.9	10.0	8.45	5020	2.7	2750	2.55
	16	0	13942.9	9.8	8.47	5000	2.7	2820	2.52
	18	0	14128.9	10.0	7.97	5460	2.9	2800	2.68
	20	0	14316.9	10.5	8.03	5670	3.0	2910	3.52
	22	0	14507.9	9.6	8.09	5760	3.0	2940	2.62
9/28/2005	0	0	14698.4	10.5	8.02	5540	2.9	2820	2.79
	2	0	14887.9	10.6	8.35	5680	3.0	2910	2.25
	4	0	15079.9	10.6	8.05	5690	3.0	2930	2.74
	6	0	15270.4	10.6	8.40	5690	3.0	2910	2.51
	8	0	15459.9	9.5	8.06	5740	3.0	2920	3.47
	10	0	15645.5	9.8	8.16	5710	3.0	2940	2.72
	12	0	15833.0	9.8	7.92	5600	2.9	2900	2.56
	14	0	16020.0	9.8	7.90	5590	2.9	2900	2.5
	16	0	16207.5	9.1	8.13	5890	2.8	2900	3.47
	18	0	16396.0	8.5	8.12	5830	3.0	2960	2.5
	20	0	16583.5	9.1	8.13	5800	3.0	2940	2.49
	22	0	16774.5	8.6	7.99	5760	3.0	2910	2.88
9/29/2005	0	0	16966.0	8.4	8.06	5770	3.0	2940	3.23
	2	0	17157.5	9.1	7.60	5590	2.9	2810	2.7
	4	0	17348.5	8.2	8.05	5730	3.0	2880	3.13
	6	0	17539.0	8.5	8.10	5590	2.9	2840	2.35

APPENDIX E

WATER QUALITY RESULTS FROM LABORATORIES

05EA-107

SAMPLE INTERVAL: 97.52 m – 114.22 m (97.34 mTVD – 113.99 mTVD)

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **05EA-107-320-374.8**
 Lab Sample ID: **0509300-01**
 Matrix: Water

Work Order: **0509300**
 Description: Laboratory Services
 Sampled: 09/18/05 11:40
 Sampled By: Michael Levon
 Received: 09/20/05 08:45

Dissolved Metals by EPA 6000/7000 Series Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Aluminum	<50	50	ug/L	1	USEPA-6010B	09/29/05	KLV	0508916
Antimony	<5.0	5.0	ug/L	1	USEPA-6020	10/01/05	DSC	0508915
Arsenic	<2.0	2.0	ug/L	1	USEPA-6020	10/01/05	DSC	0508915
Barium	<20	20	ug/L	1	USEPA-6020	10/01/05	DSC	0508915
Beryllium	<1.0	1.0	ug/L	1	USEPA-6020	10/03/05	DSC	0508915
Boron	4100	100	ug/L	1	USEPA-6010B	09/28/05	KLV	0508916
Cadmium	<0.50	0.50	ug/L	1	USEPA-6020	10/01/05	DSC	0508915
Calcium	3.1	0.50	mg/L	1	USEPA-6010B	09/28/05	KLV	0508916
Chromium	<5.0	5.0	ug/L	1	USEPA-6020	10/01/05	DSC	0508915
Cobalt	<10	10	ug/L	1	USEPA-6010B	09/28/05	KLV	0508916
Copper	<5.0	5.0	ug/L	1	USEPA-6020	10/01/05	DSC	0508915
Iron	79	20	ug/L	1	USEPA-6010B	09/28/05	KLV	0508916
Lead	<1.0	1.0	ug/L	1	USEPA-6020	10/01/05	DSC	0508915
Lithium	16	8.0	ug/L	1	USEPA-6010B	09/28/05	KLV	0508916
Magnesium	0.98	0.50	mg/L	1	USEPA-6010B	09/28/05	KLV	0508916
Manganese	<20	20	ug/L	1	USEPA-6010B	09/28/05	KLV	0508916
Molybdenum	<10	10	ug/L	1	USEPA-6020	10/01/05	DSC	0508915
Nickel	<25	25	ug/L	1	USEPA-6020	10/01/05	DSC	0508915
Selenium	<1.0	1.0	ug/L	1	USEPA-6020	10/01/05	DSC	0508915
Silver	<0.20	0.20	ug/L	1	USEPA-6020	10/01/05	DSC	0508915
Sodium	80	10	mg/L	20	USEPA-6010B	09/29/05	KLV	0508916
Strontium	91	50	ug/L	1	USEPA-6010B	09/28/05	KLV	0508916
Zinc	12	10	ug/L	1	USEPA-6020	10/01/05	DSC	0508915
Potassium	1.7	0.50	mg/L	1	USEPA-6010B	09/28/05	KLV	0508916

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **05EA-107-320-374.8**
 Lab Sample ID: **0509300-01**
 Matrix: Water

Work Order: **0509300**
 Description: Laboratory Services
 Sampled: 09/18/05 11:40
 Sampled By: Michael Levon
 Received: 09/20/05 08:45

Physical/Chemical Parameters by EPA/APHA/ASTM Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Alkalinity, Bicarbonate	70	2.0	mg/L	1	USEPA-310.1	09/23/05	VAS	0509016
Alkalinity, Carbonate	28	2.0	mg/L	1	USEPA-310.1	09/23/05	VAS	0509017
Alkalinity, Total	98	2.0	mg/L	1	USEPA-310.1	09/23/05	VAS	0509015
Chloride	97	1.0	mg/L	1	USEPA-325.2	09/28/05	JLB	0509156
Fluoride	0.85	0.10	mg/L	1	APHA 4500-F C	09/29/05	VAS	0509205
Nitrogen, Ammonia	0.093	0.020	mg/L	1	USEPA-350.1	09/27/05	GEH	0509143
* Nitrogen, Nitrate	<0.050	0.050	mg/L	1	USEPA-353.2	09/20/05	HLB	0509333
Phosphorus, Total	0.0330	0.0100	mg/L	1	USEPA-365.1	09/22/05	INR	0508996
Residue, Dissolved @ 180° C	278	50	mg/L	20	USEPA-160.1	09/22/05	GEH	0509024
Sulfate	<5.0	5.0	mg/L	1	USEPA-375.4	09/28/05	JLB	0509157
Sulfide	<1.0	1.0	mg/L	1	USEPA-376.1	09/20/05	JSS	0509192

*See Statement of Data Qualifications



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Phone (616) 975-4500 Fax (616) 942-7463
www.trimatrixlabs.com

Chain of Custody Record

COC No.

110014

For Lab Use Only

Cart	Client Name	Project Name
VOA Rack/Tray	Address	Client Project No. / P.O. No.
Receipt Log No.	447 Dunes Ave, Ste 300	053-9362-003
Project Chemist	Phone	Invoice To ☐ Client ☐ Other (comments)
Laboratory Project No.	Fax	Contact/Report To

Page 1 of 1

Analyses Requested

← PRESERVATIVES	
A NONE pH<7	
B HNO ₃ pH<2	
C H ₂ SO ₄ pH<2	
D 1+1 HCl pH<2	
E NaOH pH>12	
F ZnAc/NaOH pH>9	
G MeOH	
H Other (note below)	

Test Group	Matrix Code	Laboratory Sample Number	Sample ID	Cooler ID	Sample Date	Sample Time	C O M P	G R A B	Matrix	Container Type (corresponds to Container Packing List)										Total	Sample Comments
1			0524-107-320-374.8		9-18-05	11:40			X W 1											4	
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					

Sampled By (print)	How Shipped? Hand Carrier				Comments							
	Tracking No.											
Sampler's Signature	1. Relinquished By				2. Relinquished By				3. Relinquished By			
Company	1. Received By				2. Received By				3. Received For Lab By			



BROOKSRAND
TRACE METALS ANALYSIS & PRODUCTS

October 13, 2005

Golder Associates, Inc.
Attn.: Scott H. Miller, P.G.
44 Union Blvd., Suite 300
Lakewood, CO 80228

RE: Brooks Rand Project: NJC003; Tracking #: 05BR1391
Client Project: Eagle Bedrock Pump Test, 053-2362

Dear Mr. Miller:

This report is for the mercury analysis of one (1) water sample collected on 9/18/05 and was received at Brooks Rand LLC (BRL) on 9/20/05. The sample has been assigned the BRL internal tracking number 05BR1391.

These samples were received, stored, prepared and analyzed according to BRL standard operating procedures (SOPs) and EPA Method 1631E. All results were blank corrected, as outlined in the calculations section of EPA Method 1631E. All QA criteria were met and no qualification of the data was required. BRL certifies that the reported test results meet all requirements of NELAC. BRL is a NELAC Accredited laboratory (NYS ELAP ID 11688).

If there are any questions please feel free to contact us.

Sincerely,

Mariah Berry
Project Coordinator
mariah@brooksrand.com

Elizabeth Madonick
Project Manager
elizabeth@brooksrand.com

Reported by**Brooks Rand LLC****Contact:** Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for**Golder Associates****Contact:** Scott H. Miller, P.G.

44 Union Blvd, Suite 300

Lakewood

CO

80228

Tel: (303) 980-0540

Lab Project # NJC003**Lab Tracking #** 05BR1391**Verbal**

EAM 9/13/05

Client Project ID

Eagle Bedrock Pump Tes

Sample/Sampling/Receiving Info

Golder Associates**BRL****Sample****Identification**

05EA-107-320-374.8

Sampling Date

9/18/2005

Sample Number

05BR1391 - 1

Receiving Date

9/20/2005

Thursday, October 13, 2005


Project Manager

Reported by**Brooks Rand LLC****Contact:** Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for**Golder Associates****Contact:** Scott H. Miller, P.G.

44 Union Blvd, Suite 300

Lakewood CO 80228

Tel: (303) 980-0540

Lab Project # NJC003**Lab Tracking #** 05BR1391**Verbal**

EAM 9/13/05

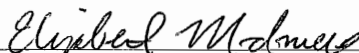
Client Project ID

Eagle Bedrock Pump Tes

Hg, dissolved

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
05EA-107-320-374.8	05BR1391 - 1	9/27/2005	9/29/2005	05-0734	3.510	ng/L	

Thursday, October 13, 2005


Project Manager

QUALITY ASSURANCE REPORT

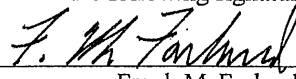
Batch: 05-0734
Analysis: Mercury by EPA 1631.E (CVAFS)
Tracking: 05BR1388, 05BR1400, 05BR1391, 05BR1405, 05BR1392 & 05BR1374
Project: LAF001, LOV001, NJC003, TEK001 & USG007
Matrix: Water
Batch Size: 20 samples
Analysis Date: September 29, 2005

- 1 SAMPLE PREPARATION** – Acceptable
- 2 CALIBRATION** – Acceptable
- 3 CALIBRATION VERIFICATION** – Acceptable
- 4 QUALITY CONTROL SAMPLES** – Acceptable
- 5 BLANKS** – Acceptable
- 6 METHOD DUPLICATE ANALYSIS** – Not Applicable
- 7 SPIKE / SPIKE DUPLICATE ANALYSIS** – Acceptable
- 8 LIMITS OF DETECTION** – Acceptable, see section 9
- 9 OVERALL DATA QUALITY** – Acceptable

Sample results have been evaluated using sample specific or client requested detection limits that may have been adjusted to account for sample aliquot size. Refer to the QA Summary for detection limits for affected samples.

No qualification of the data is required based on this review.

I certify that, to the best of my knowledge and belief, the data are reported as true and accurate. The Laboratory Director, or her designee, has authorized release of data contained in this Quality Assurance Report as verified by the following signature(s).

 10/12/05
Frank McFarland
Quality Assurance Manager

BRL QA Summary

Batch #: 05-0734

Method #: EPA 1631.E

Analyte: Hg

Matrix: Water

BIAS Criteria: Recovery = 77-123%
Continuing Calibration Verification (CCV)

QCS ID	Certified Value ng/L	Measured Value ng/L	Recovery %
CCV1	5.00	4.95	99.0%
CCV2	5.00	5.05	101.1%
CCV3	5.00	5.07	101.4%
CCV4	5.00	5.00	99.9%
CCV5	5.00	5.01	100.1%
CCV6	5.00	4.99	99.9%

BIAS Criteria: Recovery = 85-115%
Independent Calibration Verification (ICV)

QCS ID	Certified Value ng/L	Measured Value ng/L	Recovery %
ICV*	16.01	15.36	95.9%

* Preparation of the CRM NIST 1641d.

BIAS Criteria: Recovery = 71-125%, RPD < 24%
Matrix Spikes/Matrix Spike Duplicates (MS/MSD)

Sample ID	Sample Value ng/L	Matrix Spike			Matrix Spike Duplicate			Duplicate RPD
		Spiked Value ng/L	Measured Value ng/L	MS Recovery %	Spiked Value ng/L	Measured Value ng/L	MSD Recovery %	
05BR1388-1	1.15	4.01	5.14	99.6%	4.01	5.36	105.0%	4.2%
05BR1374-7	0.18	1.01	1.35	115.3%	1.01	1.23	103.3%	9.4%

0.5% BrCl Method Blanks (MB)

Criterion: MB < 0.5 ng/L

Detection Limits				
MB1	MB2	MB3	Average	StDev
ng/L	ng/L	ng/L	ng/L	ng/L
0.04	0.05	0.03	0.04	0.01

0.5% BrCl MB analyzed in triplicate.

Average MB result multiplied by appropriate factor to produce correction factor for each sample preservation BrCl level.

Sample Specific Detection Limits

Sample	MDL	PQL
ID	ng/L	ng/L
05BR1388-1	0.20	0.50

10/7/2005


Project Manager

Brooks Rand LLC Sample Receiving Log

Tracking # 05BR1391 Customer: Golder Associates Contact: Scott Miller Project Ref. #: NJC003 Collection Date 9/18/2005 QA Level Standard Sample Condition Intact Shipping container intact? Yes Shipping container type: Cooler Shipping container temp: 6.2 C Shipping container coolant: Ice Sample preservation: none Acid lab # Hg Concentration: Sample storage area: Cabinet #5 Sample Turnaround Time: Contract Turnaround Time: 28 days	Due Date: 10/18/2005 Receiving Date: 9/20/2005 Receiving Time: 9:55 AM Logged-in by: Stuart Brown Log-in Date: 9/20/2005 Log-in Time: 10:26 AM Airbill present? Yes Airbill # 792530117439 Carrier: Fedex Custody seal present? Yes Custody seal intact? Yes COC Present? Yes COC Number: N/A Analysis request form? Yes COC/Sample tag agree? No
---	--

See SOW No

See Mem No

Consult MSDS No

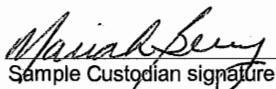
See Project Manage No

See Lab Manage No

See Contract Inf No

Comments:

Lab ID:	Sample Tag #	Container #	Size:	pH	Matrix/Sub-Matrix	Comments:
1	05EA-107-320-374.8	FPE 05-215	250 mL Bottle		Water,	
Analysis / Method:		Hg, dissolved	EPA 1631			



Sample Custodian signature

updated 10/3/05

Date

Brooks Rand LLC Chain Of Custody Record

Page 1 of 1

Client: <u>GOLDER / KEMURCO</u>		Email address:		Ship to: Brooks Rand LLC	
Contact: <u>SCOTT MILLER</u>		PO #:		3958 6 th Avenue NW	
Address: <u>44 UNION BLVD, STE 300</u>		Sampler's signatures: <u>Michael J. Jensen</u>		Seattle, WA 98107	
<u>LAKEWOOD, CO 80228</u>		Fax COC for receipt confirmation? <u>(Y/N)</u>		Phone: 206-632-6206	
Phone #: <u>303-980-0540</u>		Client project ID: <u>053-236Z</u>		Fax: 206-632-6017	
Fax #: <u>303-985-2080</u>		BRL project ID: <u>NJCND3</u>		Email: <u>brl@brooksrnd.com</u>	
BRL project ID: <u>NJCND3</u>		www.brooksrand.com			
For BRL use only		Cooler temp (°C):		Custody seals intact? (Y/N)	
				Date:	
				Initials:	

Sample ID	Collection		Miscellaneous			Field Preservation			Analyses required			Comments
	Date	Time	Sampler (initials)	Matrix type	# of containers	Sample field filtered, Y/N	Unpreserved or ice only	HNO ₃	HCl	BrCl	Other (specify)	
1	05EA-107-320-374.8	9/18/05 1140	MSL	W	1	Y	X				Hg (1631)	
2												
3												
4												
5												
6												
7												
8												
9												
10												

Shipping carrier: <u>FEDEX</u>		# of coolers: <u>1</u>	
Relinquished by: <u>Michael J. Jensen</u>		Received by: <u>[Signature]</u>	
Date: <u>9/19/05</u>	Time: <u>1400</u>	Date: <u>9-20-05</u>	Time: <u>9:58</u>
Date: <u>9/19/05</u>	Time: <u>1400</u>	Date: <u>9-20-05</u>	Time: <u>9:58</u>

White: LAB COPY Yellow: CUSTOMER COPY

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **05EA-107-60-114.8**
 Lab Sample ID: **0509312-01**
 Matrix: Water

Work Order: **0509312**
 Description: Laboratory Services
 Sampled: 09/20/05 09:15
 Sampled By: Michael Levon
 Received: 09/21/05 08:45

Dissolved Metals by EPA 6000/7000 Series Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Aluminum	<50	50	ug/L	1	USEPA-6010B	09/28/05	KLV	0508946
Antimony	<5.0	5.0	ug/L	1	USEPA-6020	10/01/05	JMF	0508945
Arsenic	<2.0	2.0	ug/L	1	USEPA-6020	10/01/05	JMF	0508945
Barium	<20	20	ug/L	1	USEPA-6020	10/01/05	JMF	0508945
Beryllium	<1.0	1.0	ug/L	1	USEPA-6020	10/01/05	DSC	0508945
Boron	940	100	ug/L	1	USEPA-6010B	09/29/05	KLV	0508946
Cadmium	<0.50	0.50	ug/L	1	USEPA-6020	10/01/05	JMF	0508945
Calcium	5.9	0.50	mg/L	1	USEPA-6010B	09/28/05	KLV	0508946
Chromium	<5.0	5.0	ug/L	1	USEPA-6020	10/01/05	JMF	0508945
Cobalt	<10	10	ug/L	1	USEPA-6010B	09/28/05	KLV	0508946
Copper	<5.0	5.0	ug/L	1	USEPA-6020	10/06/05	DSC	0509407
Iron	88	20	ug/L	1	USEPA-6010B	09/28/05	KLV	0508946
Lead	<1.0	1.0	ug/L	1	USEPA-6020	10/01/05	JMF	0508945
Lithium	13	8.0	ug/L	1	USEPA-6010B	09/28/05	KLV	0508946
Magnesium	2.4	0.50	mg/L	1	USEPA-6010B	09/28/05	KLV	0508946
Manganese	22	20	ug/L	1	USEPA-6010B	09/28/05	KLV	0508946
Molybdenum	<10	10	ug/L	1	USEPA-6020	10/01/05	JMF	0508945
Nickel	<25	25	ug/L	1	USEPA-6020	10/01/05	JMF	0508945
Selenium	<1.0	1.0	ug/L	1	USEPA-6020	10/01/05	JMF	0508945
Silver	<0.20	0.20	ug/L	1	USEPA-6020	10/01/05	JMF	0508945
Sodium	21	2.5	mg/L	5	USEPA-6010B	09/29/05	KLV	0508946
Strontium	170	50	ug/L	1	USEPA-6010B	09/29/05	KLV	0508946
* Zinc	<10	10	ug/L	1	USEPA-6020	10/01/05	JMF	0508945
Potassium	2.9	0.50	mg/L	1	USEPA-6010B	09/28/05	KLV	0508946

*See Statement of Data Qualifications

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **05EA-107-60-114.8**
 Lab Sample ID: **0509312-01**
 Matrix: Water

Work Order: **0509312**
 Description: Laboratory Services
 Sampled: 09/20/05 09:15
 Sampled By: Michael Levon
 Received: 09/21/05 08:45

Physical/Chemical Parameters by EPA/APHA/ASTM Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Alkalinity, Bicarbonate	39	2.0	mg/L	1	USEPA-310.1	09/23/05	VAS	0509016
Alkalinity, Carbonate	<2.0	2.0	mg/L	1	USEPA-310.1	09/23/05	VAS	0509017
Alkalinity, Total	83	2.0	mg/L	1	USEPA-310.1	09/28/05	VAS	0509150
Chloride	1.2	1.0	mg/L	1	USEPA-325.2	09/28/05	JLB	0509156
Fluoride	0.53	0.10	mg/L	1	APHA 4500-F C	09/29/05	VAS	0509205
Nitrogen, Ammonia	0.076	0.020	mg/L	1	USEPA-350.1	09/27/05	GEH	0509143
Nitrogen, Nitrate	<0.050	0.050	mg/L	1	USEPA-353.2	09/21/05	HLB	0509071
Phosphorus, Total	<0.0100	0.0100	mg/L	1	USEPA-365.1	09/22/05	INR	0508996
Residue, Dissolved @ 180° C	76	50	mg/L	20	USEPA-160.1	09/22/05	GEH	0509024
Sulfate	<5.0	5.0	mg/L	1	USEPA-375.4	09/28/05	JLB	0509157
Sulfide	<1.0	1.0	mg/L	1	USEPA-376.1	09/26/05	JSS	0509311



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www.trimatrixlabs.com

Chain of Custody Record

COC No.

110016

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TAI MATRAX

Page 1 of 1

Analyses Requested

← PRESERVATIVES

- A NONE pH<7
- B HNO₃ pH<2
- C H₂SO₄ pH<2
- D 1+1 HCl pH<2
- E NaOH pH>12
- F ZnAc/NaOH pH>9
- G MeOH
- H Other (note below)

ANALYSES REQUESTED
ANALYSES, CHEMISTRY
AMMONIA
SULFIDE

Client Name	Project Name
COLSER/KENNEDY	FAIR
Address	Client Project No. / P.O. No.
44 UNION BLVD, STE 300	053-2362
Phone	Invoice To
303-980-0540	☐ Client
Fax	☐ Other (comments)
303-985-2080	Contact/Report To
	SCOTT MILLER

Sample ID	Cooler ID	Sample Date	Sample Time	Matrix	Number of Containers Submitted										Total	Sample Comments
					A	B	C	D	E	F	G	H	I	J		
1	05EA-107-100-914.8	9-20-05	0915	X W	1	1	1	1								
2																
3																
4																
5																
6																
7																
8																
9																
10																

Comments

Shipped By (print)

MAURICE LEMMON

Shipped By (signature)

MAURICE LEMMON

Company

COLSER

How Shipped? Hand Carrier

Tracking No.

1. Relinquished By

MAURICE LEMMON

2. Received By

MAURICE LEMMON

Date

Time

Date

Time

3. Relinquished By

Date

Time

Date

3. Received By

PINK COPY - FIELD



BROOKSRAND
TRACE METALS ANALYSIS & PRODUCTS

October 20, 2005

Golder Associates, Inc.
Attn.: Scott H. Miller, P.G.
44 Union Blvd., Suite 300
Lakewood, CO 80228

RE: Brooks Rand Project: NJC003; Tracking #: 05BR1405
Client Project: Eagle Bedrock Pump Test, 053-2362

Dear Mr. Miller:

This report is for the mercury analysis of one (1) water sample collected on 9/20/05 and was received at Brooks Rand LLC (BRL) on 9/22/05. The sample has been assigned the BRL internal tracking number 05BR1405.

The sample was received, stored, prepared and analyzed according to BRL standard operating procedures (SOPs) and EPA Method 1631E. All results were blank corrected, as outlined in the calculations section of EPA Method 1631E. All QA criteria were met and no qualification of the data was required. BRL certifies that the reported test results meet all requirements of NELAC. BRL is a NELAC Accredited laboratory (NYS ELAP ID 11688).

If there are any questions please feel free to contact us.

Sincerely,

Mariah Berry
Project Coordinator
mariah@brooksrand.com

Elizabeth Madonick
Project Manager
elizabeth@brooksrand.com

Reported by**Brooks Rand LLC****Contact:** Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for**Golder Associates****Contact:** Scott H. Miller, P.G.

44 Union Blvd. Suite 300

Lakewood CO 80228

Tel: (303) 980-0540

Lab Project # NJC003**Lab Tracking #** 05BR1405**Quote****Client Project ID**

NJC003b

Eagle Bedrock Pump Test

Sample/Sampling/Receiving Info

Golder Associates**BRL****Sample****Identification**

05EA-107-60-114.8

Sampling Date

9/20/2005

Sample Number

05BR1405 - 1

Receiving Date

9/22/2005

Tuesday, October 25, 2005


Project Manager

Reported by**Brooks Rand LLC**

Contact: Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for**Golder Associates**

Contact: Scott H. Miller, P.G.

44 Union Blvd, Suite 300

Lakewood CO 80228

Tel: (303) 980-0540

Lab Project # NJC003

Lab Tracking # 05BR1405

Quote

NJC003b

Client Project ID

Eagle Bedrock Pump Test

Hg, dissolved

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
05EA-107-60-114.8	05BR1405 - 1	9/27/2005	9/29/2005	05-0734	0.810	ng/L	

Tuesday, October 25, 2005


Project Manager

QUALITY ASSURANCE REPORT

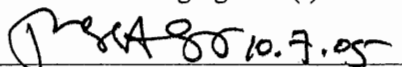
Batch: 05-0734
Analysis: Mercury by EPA 1631.E (CVAFS)
Tracking: 05BR1388, 05BR1400, 05BR1391, 05BR1405, 05BR1392 & 05BR13745
Project: LAF001, LOV001, NJC003, TEK001 & USG006
Matrix: Water
Batch Size: 20 samples
Analysis Date: September 29, 2005

- 1 **SAMPLE PREPARATION** – Acceptable
- 2 **CALIBRATION** – Acceptable
- 3 **CALIBRATION VERIFICATION** – Acceptable
- 4 **QUALITY CONTROL SAMPLES** – Acceptable
- 5 **BLANKS** – Acceptable
- 6 **METHOD DUPLICATE ANALYSIS** – Not Applicable
- 7 **SPIKE / SPIKE DUPLICATE ANALYSIS** – Acceptable
- 8 **LIMITS OF DETECTION** – Acceptable, see section 9
- 9 **OVERALL DATA QUALITY** – Acceptable

Sample results have been evaluated using sample specific or client requested detection limits that may have been adjusted to account for sample aliquot size. Refer to the QA Summary for detection limits for affected samples.

No qualification of the data is required based on this review.

I certify that, to the best of my knowledge and belief, the data are reported as true and accurate. The Laboratory Director, or her designee, has authorized release of data contained in this Quality Assurance Report as verified by the following signature(s).



Tressa K. Pearson-Franks
Quality Assurance Associate

BRL QA Summary

Batch #: 05-0734

Method #: EPA 1631.E

Analyte: Hg

Matrix: Water

BIAS Criteria: Recovery = 77-123%			
Continuing Calibration Verification (CCV)			
QCS ID	Certified Value ng/L	Measured Value ng/L	Recovery %
CCV1	5.00	4.95	99.0%
CCV2	5.00	5.05	101.1%
CCV3	5.00	5.07	101.4%
CCV4	5.00	5.00	99.9%
CCV5	5.00	5.01	100.1%
CCV6	5.00	4.99	99.9%

BIAS Criteria: Recovery = 85-115%			
Independent Calibration Verification (ICV)			
QCS ID	Certified Value ng/L	Measured Value ng/L	Recovery %
ICV*	16.01	15.36	95.9%

* Preparation of the CRM NIST 1641d.

BIAS Criteria: Recovery = 71-125%, RPD<24%								
Matrix Spikes/Matrix Spike Duplicates (MS/MSD)								
Sample ID	Sample Value ng/L	Matrix Spike			Matrix Spike Duplicate			Duplicate RPD
		Spiked Value ng/L	Measured Value ng/L	MS Recovery %	Spiked Value ng/L	Measured Value ng/L	MSD Recovery %	
05BR1388-1	1.15	4.01	5.14	99.6%	4.01	5.36	105.0%	4.2%
05BR1374-7	0.18	1.01	1.35	115.3%	1.01	1.23	103.3%	9.4%

0.5% BrCl Method Blanks (MB) Criterion: MB < 0.5 ng/L					Detection Limits	
MB1	MB2	MB3	Average	StDev	MB MDL	MB PQL
ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
0.04	0.05	0.03	0.04	0.01	0.10	0.25

0.5% BrCl MB analyzed in triplicate.

Average MB result multiplied by appropriate factor to produce correction factor for each sample preservation BrCl level.

Sample Specific Detection Limits		
Sample	MDL	PQL
ID	ng/L	ng/L
05BR1388-1	0.20	0.50

10/7/2005


Project Manager

Brooks Rand LLC Sample Receiving Log

Tracking # **05BR1405**

Customer: Golder Associates

Contact: Scott Miller

Project Ref. #: NJC003

Collection Date 9/20/05

QA Level Standard

Sample Condition Intact

Shipping container intact? Yes

Shipping container type: Cooler

Shipping container temp: Ambient

Shipping container coolant: None

Sample preservation:

Acid lab #

Hg Concentration:

Sample storage area: Cabinet #1

Sample Turnaround Time:

Contract Turnaround Time: 28 days

Due Date: 10/20/2005

Receiving Date: 9/22/2005

Receiving Time: 8:19 AM

Logged-in by: Jennell Simpson

Log-in Date: 9/22/2005

Log-in Time: 10:24 AM

Airbill present? Yes

Airbill # 852819500838

Carrier: Fed Ex

Custody seal present? Yes

Custody seal intact? Yes

COC Present? Yes

COC Number:

Analysis request form? No

COC/Sample tag agree? Yes

See SOW No See Project Manage No

See Mem No See Lab Manage No

Consult MSDS No See Contract Inf No

Comments:

Lab ID:	Sample Tag #	Container #	Size:	pH	Matrix/Sub-Matrix	Comments:
1	05EA-107-60-114.8	FPE #05-215	250 mL Bottle		Water,	
Analysis / Method:		Hg, dissolved	EPA 1631			

Manual Review updated 10/3/05
 Sample Custodian signature Date

Brooks Rand LLC Chain Of Custody Record

Page 1 of 1

Client: <u>COOPER / KENNEDY</u>		Email address:		Ship to: Brooks Rand LLC	
Contact: <u>Scott Miller</u>		PO #: <u>053-2362</u>		3958 6 th Avenue NW	
Address: <u>44 Union Blvd. Ste 300</u>		Sampler's signatures:		Seattle, WA 98107	
<u>LAKEWOOD, CO 80228</u>		Fax COC for receipt confirmation? <u>(Y/N)</u>		Phone: 206-632-6206	
Phone #: <u>303-480-0540</u>		Client project ID: <u>053-2362</u>		Fax: 206-632-6017	
Fax #: <u>303-485-2080</u>		BRL project ID: <u>NJ (003)</u>		Email: <u>br@brooksrnd.com</u>	
For BRL use only		Cooler temp (°C): <u>Ambient</u>	Custody seals present? <u>(Y/N)</u>	Custody seals intact? <u>(Y/N)</u>	Date: <u>9/22/05</u> Initials: <u>gja</u>

Sample ID	Collection		Miscellaneous			Field Preservation			Analyses required			Comments
	Date	Time	Sampler (initials)	Matrix type	# of containers	Sample field filtered, Y/N	Unpreserved or ice only	HNO ₃	HCl	BrCl	Other (specify)	
1	05EA-107-160-114.8	9/22/05 0915	MSL	W	1	Y	X					
2												
3												
4												
5												
6												
7												
8												
9												
10												

Shipping carrier: <u>Expdx</u>		# of coolers: <u>1</u>	
Relinquished by: <u>[Signature]</u>	Date: <u>9/22/05</u> Time: <u>1300</u>	Received by:	Date: <u>9/22/05</u> Time: <u>8:19</u>
Relinquished by:	Date:	Received at BRL: <u>[Signature]</u>	Date: <u>9/22/05</u> Time: <u>8:19</u>

White: LAB COPY Yellow: CUSTOMER COPY

05EA-107

SAMPLE INTERVAL: 18.20 m – 34.90 m (18.17 mTVD – 34.85 mTVD)

04EA-084

SAMPLE INTERVAL: 249.05 m – 302.05 m (217.61 mTVD – 264.57 mTVD)

VOLUME PURGED: 16,480 LITERS

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **04EA-084**
 Lab Sample ID: **0509374-01**
 Matrix: Water

Work Order: **0509374**
 Description: Laboratory Services
 Sampled: 09/23/05 11:50
 Sampled By: Michael Levon
 Received: 09/24/05 08:40

Dissolved Metals by EPA 6000/7000 Series Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Aluminum	<50	50	ug/L	1	USEPA-6010B	10/07/05	KLV	0509108
Antimony	<5.0	5.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509107
* Arsenic	23	2.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509107
* Barium	24	20	ug/L	1	USEPA-6020	10/11/05	JMF	0509107
Beryllium	<1.0	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509107
Boron	5800	100	ug/L	1	USEPA-6010B	10/07/05	KLV	0509108
* Cadmium	<5.0	5.0	ug/L	10	USEPA-6020	10/13/05	JMF	0509107
Calcium	83	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509108
Chromium	<5.0	5.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509107
Cobalt	<10	10	ug/L	1	USEPA-6010B	10/07/05	KLV	0509108
* Copper	<5.0	5.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509107
Iron	2200	20	ug/L	1	USEPA-6010B	10/07/05	KLV	0509108
Lead	<1.0	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509107
Lithium	140	8.0	ug/L	1	USEPA-6010B	10/07/05	KLV	0509108
Magnesium	67	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509108
Manganese	83	20	ug/L	1	USEPA-6010B	10/07/05	KLV	0509108
* Molybdenum	<10	10	ug/L	1	USEPA-6020	10/11/05	JMF	0509107
* Nickel	<25	25	ug/L	1	USEPA-6020	10/11/05	JMF	0509107
* Selenium	21	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509107
Silver	<0.20	0.20	ug/L	1	USEPA-6020	10/11/05	JMF	0509107
Sodium	1100	100	mg/L	200	USEPA-6010B	10/07/05	KLV	0509108
Strontium	5300	1200	ug/L	25	USEPA-6010B	10/07/05	KLV	0509108
* Zinc	18	10	ug/L	1	USEPA-6020	10/11/05	JMF	0509107
Potassium	9.2	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509108

*See Statement of Data Qualifications

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **04EA-084**
 Lab Sample ID: **0509374-01**
 Matrix: Water

Work Order: **0509374**
 Description: Laboratory Services
 Sampled: 09/23/05 11:50
 Sampled By: Michael Levon
 Received: 09/24/05 08:40

Total Metals by EPA 6000/7000 Series Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
* Aluminum	<50	50	ug/L	1	USEPA-6010B	10/13/05	DSC	0509149
Antimony	<5.0	5.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509101
Arsenic	3.7	2.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509101
Barium	23	20	ug/L	1	USEPA-6020	10/08/05	JMF	0509101
Beryllium	<1.0	1.0	ug/L	1	USEPA-6020	10/13/05	JMF	0509101
* Boron	5700	100	ug/L	1	USEPA-6010B	10/14/05	JLT	0509149
* Cadmium	<5.0	5.0	ug/L	10	USEPA-6020	10/13/05	JMF	0509101
* Calcium	79	0.50	mg/L	1	USEPA-6010B	10/13/05	DSC	0509149
Chromium	<5.0	5.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509101
* Cobalt	<10	10	ug/L	1	USEPA-6010B	10/13/05	DSC	0509149
* Copper	<5.0	5.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509101
* Iron	2500	20	ug/L	1	USEPA-6010B	10/13/05	DSC	0509149
Lead	<1.0	1.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509101
* Lithium	130	8.0	ug/L	1	USEPA-6010B	10/13/05	DSC	0509149
* Magnesium	66	0.50	mg/L	1	USEPA-6010B	10/13/05	DSC	0509149
Manganese	81	20	ug/L	1	USEPA-6010B	10/13/05	DSC	0509149
Molybdenum	<10	10	ug/L	1	USEPA-6020	10/08/05	JMF	0509101
Nickel	<25	25	ug/L	1	USEPA-6020	10/08/05	JMF	0509101
Potassium	8.8	0.50	mg/L	1	USEPA-6010B	10/13/05	DSC	0509149
* Selenium	<1.0	1.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509101
Silver	<0.20	0.20	ug/L	1	USEPA-6020	10/08/05	JMF	0509101
* Sodium	1000	50	mg/L	100	USEPA-6010B	10/13/05	ICP	0509149
* Strontium	4700	500	ug/L	10	USEPA-6010B	10/14/05	JLT	0509149
Zinc	26	10	ug/L	1	USEPA-6020	10/08/05	JMF	0509101

*See Statement of Data Qualifications

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **04EA-084**
 Lab Sample ID: **0509374-01**
 Matrix: Water

Work Order: **0509374**
 Description: Laboratory Services
 Sampled: 09/23/05 11:50
 Sampled By: Michael Levon
 Received: 09/24/05 08:40

Physical/Chemical Parameters by EPA/APHA/ASTM Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Alkalinity, Bicarbonate	36	2.0	mg/L	1	USEPA-310.1	09/28/05	VAS	0509153
Alkalinity, Carbonate	<1.0	1.0	mg/L	1	USEPA-310.1	09/28/05	VAS	0509154
Alkalinity, Total	34	2.0	mg/L	1	USEPA-310.1	09/28/05	VAS	0509150
Chloride	2000	40	mg/L	40	USEPA-325.2	10/03/05	JLB	0509266
Fluoride	0.95	0.10	mg/L	1	APHA 4500-F C	09/29/05	VAS	0509205
Nitrogen, Ammonia	0.29	0.020	mg/L	1	USEPA-350.1	09/29/05	GEH	0509243
Nitrogen, Nitrate	<0.050	0.050	mg/L	1	USEPA-353.2	09/24/05	HLB	0509577
Phosphorus, Total	<0.0100	0.0100	mg/L	1	USEPA-365.1	10/03/05	INR	0508996
Residue, Dissolved @ 180° C	3990	50	mg/L	20	USEPA-160.1	09/27/05	GEH	0509144
Sulfate	<5.0	5.0	mg/L	1	USEPA-375.4	10/03/05	JLB	0509268
Sulfide	<1.0	1.0	mg/L	1	USEPA-376.1	09/26/05	JSS	0509311

For Lab Use Only

Page 1 of 1

Analyses Requested

← PRESERVATIVES
 A NONE pH<7
 B HNO₃ pH<2
 C H₂SO₄ pH<2
 D 1+1 HCl pH<2
 E NaOH pH>12
 F ZnAc/NaOH pH>9
 G MeOH
 H Other (note below)

ANALYSES, CHEMISTRY
AMMONIA
SULFIDE

METALS, IONIC

Container Type (corresponds to Container Packing List)

Client Name Colato/Kennecott
Project Name EAGLE
Client Project No. / P.O. No. 053-2362
Address 44 Union Blvd, Ste 300
Invoice To ☐ Client ☐ Other (comments)
Phone 303-980-0540
Contact/Report To SCOTT MILLER
Fax 303-985-2080

Sample ID	Cooler ID	Sample Date	Sample Time	Matrix	Number of Containers Submitted	Total	Sample Comments
1 0454-084-F		9/23/05	1150	X W	1		FILTERED
2 0454-084-U		9/23/05	1150	X W	1		UNFILTERED
3 0454-084		9/23/05	1150	X W	1		
4							
5							
6							
7							
8							
9							
10							

Comments * 48 hr HOLD ON WINTER

How Shipped? Hand Carrier *Ex*

Tracking No.

1. Relinquished By *Michael A. Jones* **Date** 9/23/05 **Time** 1130

2. Received By *Colato* **Date**

3. Relinquished By

4. Received By



BROOKSRAND
TRACE METALS ANALYSIS & PRODUCTS

October 20, 2005

Golder Associates, Inc.
Attn.: Scott H. Miller, P.G.
44 Union Blvd., Suite 300
Lakewood, CO 80228

RE: Brooks Rand Project: NJC003; Tracking #: 05BR1414
Client Project: Eagle Bedrock Pump Test, 053-2362

Dear Mr. Miller:

This report is for the total and dissolved mercury (Hg) analysis of two (2) water samples collected on 9/23/05 and received at Brooks Rand LLC (BRL) on 9/24/05. The samples have been assigned the BRL internal tracking number 05BR1414 and were received, stored, prepared and analyzed according to BRL standard operating procedures (SOPs) and EPA Method 1631E.

During analysis of batch 05-0760, the initial calibration of the instrument failed due to the high recovery of the 100-pg Hg standard. The instrument was recalibrated and all acceptance criteria were met. No client samples were affected.

All results were blank corrected, as outlined in the calculations section of EPA Method 1631E. All QA criteria were met and no qualification of the data was required. BRL certifies that the reported test results meet all requirements of NELAC. BRL is a NELAC Accredited laboratory (NYS ELAP ID 11688).

If there are any questions please feel free to contact us.

Sincerely,

Mariah Berry
Project Coordinator
mariah@brooksrand.com

Elizabeth Madonick
Project Manager
elizabeth@brooksrand.com

Reported by**Brooks Rand LLC****Contact:** Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for**Golder Associates****Contact:** Scott H. Miller, P.G.

44 Union Blvd, Suite 300

Lakewood CO 80228

Tel: (303) 980-0540

Lab Project # NJC003**Lab Tracking #** 05BR1414**Quote****Client Project ID**

NJC003b

Eagle Bedrock Pump Test

Sample/Sampling/Receiving Info

Golder Associates**BRL****Sample****Identification**

04EA-084-F

04EA-084-U

Sampling Date

9/23/05

9/23/05

Sample Number

05BR1414 - 1

05BR1414 - 2

Receiving Date

9/24/2005

9/24/2005

Tuesday, October 25, 2005


Project Manager

Reported by**Brooks Rand LLC****Contact:** Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for**Golder Associates****Contact:** Scott H. Miller, P.G.

44 Union Blvd, Suite 300

Lakewood CO 80228

Tel: (303) 980-0540

Lab Project # NJC003**Lab Tracking #** 05BR1414**Quote**

NJC003b

Client Project ID

Eagle Bedrock Pump Test

Hg

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
04EA-084-U	05BR1414 - 2	10/5/2005	10/17/2005	05-0760	0.600	ng/L	

Tuesday, October 25, 2005


Project Manager

Reported by**Brooks Rand LLC****Contact:** Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for**Golder Associates****Contact:** Scott H. Miller, P.G.

44 Union Blvd, Suite 300

Lakewood CO 80228

Tel: (303) 980-0540

Lab Project # NJC003**Lab Tracking #** 05BR1414**Quote**

NJC003b

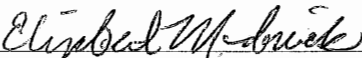
Client Project ID

Eagle Bedrock Pump Test

Hg, dissolved

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
04EA-084-F	05BR1414 - 1	10/5/2005	10/17/2005	05-0760	0.440	ng/L	

Tuesday, October 25, 2005


Project Manager

QUALITY ASSURANCE REPORT

Batch: 05-0760
Analysis: Mercury by EPA 1631.E (CVAFS)
Tracking: 05BR1425, 05BR1417, 05BR1411, 05BR1414 & 05BR1413
Project: BSK001, CFM001, DWQ002, NJC003 & URS014
Matrix: Water
Batch Size: 20 samples
Analysis Date: October 17, 2005

- 1 **SAMPLE PREPARATION** – Acceptable
- 2 **CALIBRATION** – Acceptable, see section 9
- 3 **CALIBRATION VERIFICATION** – Acceptable
- 4 **QUALITY CONTROL SAMPLES** – Acceptable
- 5 **BLANKS** – Acceptable, see section 9
- 6 **METHOD DUPLICATE ANALYSIS** – Not Applicable
- 7 **SPIKE / SPIKE DUPLICATE ANALYSIS** – Acceptable
- 8 **LIMITS OF DETECTION** – Acceptable, see section 9
- 9 **OVERALL DATA QUALITY** – Acceptable

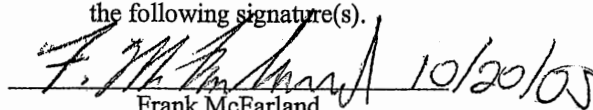
Initial calibration failed due to the unacceptable recovery of the 100 pg standard. The instrument was recalibrated, and all criteria were met. No client samples were affected.

Due to elevated calibration blanks, the method blanks analyzed with this batch produced negative results. The absolute value of the average method blank result was less than the MDL. The true value was used to blank correct sample results. The use of a negative value for blank correction ensures sample results are not overcorrected by the high calibration blank result that may have declined after repeated use of the bubblers.

Sample results have been evaluated using sample specific or client requested detection limits that may have been adjusted to account for sample aliquot size. Refer to the QA Summary for detection limits for affected samples.

No qualification of the data is required based on this review.

I certify that, to the best of my knowledge and belief, the data are reported as true and accurate. The Laboratory Director, or her designee, has authorized release of data contained in this Quality Assurance Report as verified by the following signature(s).


Frank McFarland
Quality Assurance Manager

BRL QA Summary

Batch #: 05-0760

Method #: EPA 1631.E

Analyte: Hg

Matrix: Water

BIAS Criteria: Recovery = 77-123%			
Continuing Calibration Verification (CCV)			
QCS ID	Certified Value ng/L	Measured Value ng/L	Recovery %
CCV1	5.00	5.21	104.3%
CCV2	5.00	5.33	106.5%
CCV3	5.00	5.43	108.7%

BIAS Criteria: Recovery = 85-115%			
Independent Calibration Verification (ICV)			
QCS ID	Certified Value ng/L	Measured Value ng/L	Recovery %
ICV*	16.01	17.28	107.9%

* Preparation of the CRM NIST 1641d.

BIAS Criteria: Recovery = 71-125%, RPD < 24%								
Matrix Spikes/Matrix Spike Duplicates (MS/MSD)								
Sample ID	Sample Value ng/L	Matrix Spike			Matrix Spike Duplicate			Duplicate RPD
		Spiked Value ng/L	Measured Value ng/L	MS Recovery %	Spiked Value ng/L	Measured Value ng/L	MSD Recovery %	
05BR1413-28	2.20	6.04	9.32	117.8%	6.09	9.42	118.4%	1.1%
05BR1413-30	0.55	2.01	2.66	105.4%	2.02	2.76	109.3%	3.5%

0.5% BrCl Method Blanks (MB) Criterion: MB < 0.5 ng/L					Detection Limits	
MB1	MB2	MB3	Average	StDev	MB MDL	MB PQL
ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
0.02	-0.02	-0.02	-0.01	0.02	0.10	0.25

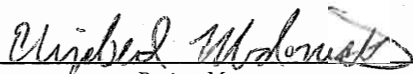
0.5% BrCl MB analyzed in triplicate.

Average MB result multiplied by appropriate factor to produce correction factor for each sample preservation BrCl level.

Sample Specific Detection Limits		
Sample ID	MDL ng/L	PQL ng/L
05BR1413-28	0.20	0.51
05BR1413-36	0.10	0.26
05BR1413-38	0.10	0.26
05BR1414-1	0.10	0.26
05BR1417-1	0.21	0.52

Sample Specific Detection Limits		
Sample ID	MDL ng/L	PQL ng/L
05BR1417-2	1.1	2.6
05BR1417-3	0.20	0.51
05BR1417-4	0.21	0.53
05BR1417-5	0.10	0.26
05BR1417-6	1.1	2.6

10/20/2005


Project Manager

Brooks Rand LLC Sample Receiving Log

Tracking # **05BR1414**

Customer: Golder Associates

Contact: Scott Miller

Project Ref. #: NJC003

Collection Date 9/23/05

QA Level Standard

Sample Condition Intact

Shipping container intact? Yes

Shipping container type: Cooler

Shipping container temp: Ambient

Shipping container coolant: None

Sample preservation: None

Acid lab #

Hg Concentration:

Sample storage area: Cabinet #1

Sample Turnaround Time:

Contract Turnaround Time: 28 days

Comments:

Due Date: 10/22/2005

Receiving Date: 9/24/2005

Receiving Time: 10:15 AM

Logged-in by: Joseph Roberts

Log-in Date: 9/24/2005

Log-in Time: 11:26 AM

Airbill present? Yes

Airbill # 853172916777

Carrier: FedEx

Custody seal present? Yes

Custody seal intact? Yes

COC Present? Yes

COC Number: N/A

Analysis request form? No

COC/Sample tag agree? Yes

See SOW No See Project Manage No

See Mem No See Lab Manage No

Consult MSDS No See Contract Inf No

Lab ID:	Sample Tag #	Container #	Size:	pH	Matrix/Sub-Matrix	Comments:
1	04EA-084-F	FPE:05-215	250 mL Bottle		Water,	Sample was filtered by client.
Analysis / Method:		Hg, dissolved	EPA 1631			
2	04EA-084-U	FPE:05-215	250 mL Bottle		Water,	
Analysis / Method:		Hg	EPA 1631			

Maisha Berry updated 10/3/05
 Sample Custodian signature Date

Brooks Rand LLC Chain Of Custody Record

Page 1 of 1

Client: <u>COOPER / SEWARD</u>		Email address:		Ship to: Brooks Rand LLC	
Contact: <u>Scott Miller</u>		PO #: <u>053-2362</u>		3958 6 th Avenue NW	
Address: <u>44 Union Blvd. SE 300</u>		Sampler's signatures:		Seattle, WA 98107	
<u>LAKEWOOD, CO 80228</u>		Fax COC for receipt confirmation? (Y/N)		Phone: 206-632-6206	
Phone #: <u>303-980-0540</u>		Client project ID: <u>053-2362</u>		Fax: 206-632-6017	
Fax #: <u>303-985-2080</u>		BRL project ID: <u>NJ (003)</u>		Email: <u>brl@brooksrnd.com</u>	
For BRL use only		Cooler temp (°C): <u>4</u>		Custody seals present? (Y/N)	
		Custody seals intact? (Y/N)		Date: <u>9/24/05</u> Initials: <u>RL</u>	

For BRL use only		Cooler temp (°C)	Andrew	Custody seals present? (Y/N)	Custody seals intact? (Y/N)	Date: 9/24/05	Initials: JL						
Sample ID	Collection		Miscellaneous			Field Preservation		Analyses required		Comments			
	Date	Time	Sampler (initials)	Matrix type	# of containers	Sample field filtered, Y/N	Unpreserved or ice only	HNO ₃	HCl		BrCl	Other (specify)	
1	0424-084-F	9/23/05 11:50 AM	W	W	1	Y	X					Hg 1631	STANDARD
2	0424-084-U	9/23/05 11:50 AM	W	W	1	N	X						TURNAROUND TIME
3													
4													
5													
6													
7													
8													
9													
10													

Shipping carrier: <u>Fed Ex</u>		# of coolers: <u>1</u>	
Relinquished by: <u>[Signature]</u>	Date: <u>9/23/05</u>	Time: <u>16:30</u>	Received by: <u>[Signature]</u>
Relinquished by: <u>[Signature]</u>	Date: <u>9/24/05</u>	Time: <u>10:15</u>	Received at BRL: <u>[Signature]</u>

White: LAB COPY Yellow: CUSTOMER COPY

04EA-084

SAMPLE INTERVAL: 249.05 m – 302.05 m (217.61 mTVD – 264.57 mTVD)

VOLUME PURGED: 41,960 LITERS

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **04EA-084-11000**
 Lab Sample ID: **0509419-01**
 Matrix: Water

Work Order: **0509419**
 Description: Laboratory Services
 Sampled: 09/26/05 10:00
 Sampled By: Michael Lemon
 Received: 09/28/05 08:40

Physical/Chemical Parameters by EPA/APHA/ASTM Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Alkalinity, Bicarbonate	37	2.0	mg/L	1	USEPA-310.1	10/06/05	INR	0509420
Alkalinity, Carbonate	<2.0	2.0	mg/L	1	USEPA-310.1	10/06/05	INR	0509422
Alkalinity, Total	37	2.0	mg/L	1	USEPA-310.1	10/06/05	INR	0509423
Chloride	2000	40	mg/L	40	USEPA-325.2	10/03/05	JLB	0509266
Fluoride	0.99	0.10	mg/L	1	APHA 4500-F C	10/07/05	MSM	0509483
Nitrogen, Nitrate	<0.050	0.050	mg/L	1	USEPA-353.2	09/28/05	HLB	0509733
Residue, Dissolved @ 180° C	3980	50	mg/L	20	USEPA-160.1	10/03/05	GEH	0509339
Sulfate	<5.0	5.0	mg/L	1	USEPA-375.4	10/03/05	JLB	0509268

For Lab Use Only

Tai MAT 225

Analyses Requested

Page 1 of 1

➡ PRESERVATIVES

Client Name	COLASER / KENNEDY	Project Name	FAHLE
Address	44 UNION BLVD, STE 300	Client Project No. / P.O. No.	053-2362
	LAKEWOOD, CO 80228	Invoice To	☐ Client ☐ Other (comments)
Phone	303-980-0540	Contact/Report To	SCOTT MILLER
Fax	303-985-2080		

[illegible]

Completed By (print)		How Shipped?		Hand	Carrier	Comments							
Shipper's Signature		Tracking No.				1. Relinquished By		Date	Time	2. Relinquished By		Date	Time
						1. Received By		Date	Time	2. Received By		Date	Time
<i>MICHAEL S. LEMON</i>		<i>Fed Ex</i>				<i>Michael D. Jones</i>		<i>9/18/75</i>		<i>0730</i>			
<i>GOLDER</i>													

PINK COPY - FIELD

VERI TOW COPY - LABORATORY

SECRET

04EA-084

SAMPLE INTERVAL: 249.05 m – 302.05 m (217.61 mTVD – 264.57 mTVD)

VOLUME PURGED: 66,750 LITERS

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **04EA-084-817-981-2**
 Lab Sample ID: **0509454-01**
 Matrix: Water

Work Order: **0509454**
 Description: Laboratory Services
 Sampled: 09/29/05 08:00
 Sampled By: Michael Lemon
 Received: 09/30/05 08:45

Physical/Chemical Parameters by EPA/APHA/ASTM Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Alkalinity, Bicarbonate	37	2.0	mg/L	1	USEPA-310.1	10/06/05	INR	0509420
Alkalinity, Carbonate	2.9	2.0	mg/L	1	USEPA-310.1	10/06/05	INR	0509422
Alkalinity, Total	79	2.0	mg/L	1	USEPA-310.1	10/06/05	INR	0509423
Chloride	2000	20	mg/L	20	USEPA-325.2	10/11/05	JLB	0509573
Fluoride	1.0	0.10	mg/L	1	APHA 4500-F C	10/07/05	MSM	0509483
Nitrogen, Ammonia	0.26	0.020	mg/L	1	USEPA-350.1	10/04/05	GEH	0509359
Nitrogen, Nitrate	<0.050	0.050	mg/L	1	USEPA-353.2	09/30/05	HLB	0509743
Phosphorus, Total	0.0148	0.0100	mg/L	1	USEPA-365.1	10/05/05	INR	0509273
Residue, Dissolved @ 180° C	3560	50	mg/L	20	USEPA-160.1	10/03/05	GEH	0509339
Sulfate	<5.0	5.0	mg/L	1	USEPA-375.4	10/03/05	JLB	0509268
Sulfide	<1.0	1.0	mg/L	1	USEPA-376.1	10/03/05	JSS	0509728

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **04-EA-084-817-981-2F**
 Lab Sample ID: **0509454-02**
 Matrix: Water

Work Order: **0509454**
 Description: Laboratory Services
 Sampled: 09/29/05 08:00
 Sampled By: RE/AM
 Received: 09/30/05 08:45

Dissolved Metals by EPA 6000/7000 Series Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Aluminum	<50	50	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Antimony	<5.0	5.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Arsenic	19	2.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Barium	<20	20	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Beryllium	<1.0	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Boron	5900	100	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
* Cadmium	<5.0	5.0	ug/L	10	USEPA-6020	10/13/05	JMF	0509313
Calcium	76	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509314
Chromium	<5.0	5.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Cobalt	<10	10	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
* Copper	<5.0	5.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Iron	1800	20	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Lead	<1.0	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Lithium	130	8.0	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Magnesium	61	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509314
Manganese	68	20	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Molybdenum	<10	10	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Nickel	<25	25	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
* Selenium	17	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Silver	0.46	0.20	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Sodium	970	100	mg/L	200	USEPA-6010B	10/07/05	KLV	0509314
Strontium	4800	1200	ug/L	25	USEPA-6010B	10/07/05	KLV	0509314
Zinc	19	10	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Potassium	9.2	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509314

*See Statement of Data Qualifications

ANALYTICAL REPORT

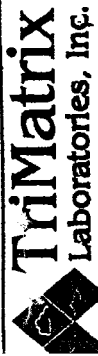
Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **04EA-084-817-2U**
 Lab Sample ID: **0509454-03**
 Matrix: Water

Work Order: **0509454**
 Description: Laboratory Services
 Sampled: 09/29/05 08:00
 Sampled By: RE/AM
 Received: 09/30/05 08:45

Total Metals by EPA 6000/7000 Series Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Aluminum	<50	50	ug/L	1	USEPA-6010B	10/17/05	KLV	0509325
Antimony	<5.0	5.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Arsenic	18	10	ug/L	5	USEPA-6020	10/08/05	JMF	0509326
Barium	<100	100	ug/L	5	USEPA-6020	10/08/05	JMF	0509326
Beryllium	<1.0	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509326
Boron	5000	100	ug/L	1	USEPA-6010B	10/13/05	DSC	0509325
* Cadmium	<5.0	5.0	ug/L	10	USEPA-6020	10/13/05	JMF	0509326
Calcium	72	0.50	mg/L	1	USEPA-6010B	10/13/05	DSC	0509325
Chromium	<5.0	5.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Cobalt	<10	10	ug/L	1	USEPA-6010B	10/17/05	KLV	0509325
* Copper	<5.0	5.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Iron	2600	20	ug/L	1	USEPA-6010B	10/13/05	DSC	0509325
Lead	<1.0	1.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Lithium	120	8.0	ug/L	1	USEPA-6010B	10/13/05	DSC	0509325
Magnesium	61	0.50	mg/L	1	USEPA-6010B	10/13/05	DSC	0509325
Manganese	68	20	ug/L	1	USEPA-6010B	10/13/05	DSC	0509325
Molybdenum	<10	10	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Nickel	<25	25	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Potassium	8.5	0.50	mg/L	1	USEPA-6010B	10/13/05	DSC	0509325
* Selenium	3.6	1.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Silver	<1.0	1.0	ug/L	5	USEPA-6020	10/08/05	JMF	0509326
Sodium	1200	5.0	mg/L	10	USEPA-6010B	10/14/05	JLT	0509325
Strontium	4700	500	ug/L	10	USEPA-6010B	10/14/05	JLT	0509325
Zinc	39	10	ug/L	1	USEPA-6020	10/08/05	JMF	0509326

*See Statement of Data Qualifications



5560 Corporate Exchange Court SE Grand Rapids, MI 49512
Phone (616) 975-4500 Fax (616) 942-7463
www.trimatrixlabs.com

Chain of Custody Record

COC No.

110016

For Lab Use Only

TAIMATRIX

Analyses Requested

Page 1 of 1

- ← PRESERVATIVES
- A NONE pH-7
 - B HNO₃ pH<2
 - C H₂SO₄ pH<2
 - D 1+1 HCl pH<2
 - E NaOH pH>12
 - F ZnAc/NaOH pH>9
 - G MeOH
 - H Other (note below)

ANALYSES, CHEMISTRY
AMMONIA
SULFIDE

Client Name	COLLIER/KENNEDY	Project Name	FACE
Address	44 UNION BLVD, STE 300	Client Project No. / P.O. No.	053-2362
Phone	303-980-0540	Invoice To	☐ Client ☐ Other (comments)
Fax	303-985-2080	Contact/Report To	SCOTT MILLER

Sample ID	Cooler ID	Sample Date	Sample Time	Number of Containers Submitted				Total	Sample Comments
				A	C	F			
1 04EA-084-817-981-2		9/29/05	800	X	W			3	
2 04EA-084-817-981-2F		9/29/05	800	X	W			1	FIELD FILTERED
3 04EA-084-817-981-2U		9/29/05	800	X	W			1	UN-FILTERED
4									
5									
6									
7									
8									
9									
10									

Comments

How Shipped?	Hand	Carrier	FED EX
Tracking No.			

Prepared By (print)
MICHAEL S. LEMON
Prepared By (Signature)
MICHAEL S. LEMON

1. Relinquished By	Date	Time	2. Relinquished By	Date	Time
Michael S. Lemon	9/29/05	1300			
1. Received By	Date	Time	2. Received By	Date	Time
GROVER					

PINK COPY - FIELD



BROOKSRAND
TRACE METALS ANALYSIS & PRODUCTS

October 25, 2005

Golder Associates, Inc.
Attn.: Scott H. Miller, P.G.
44 Union Blvd., Suite 300
Lakewood, CO 80228

RE: Brooks Rand Project: NJC003; Tracking #: 05BR1466
Client Project: Eagle Bedrock Pump Test, 053-2362

Dear Mr. Miller:

This report is for the total and dissolved mercury (Hg) analysis of two (2) water samples collected on 9/29/05 and received at Brooks Rand LLC (BRL) on 9/30/05. These samples have been assigned the BRL internal tracking number 05BR1466 and were received, stored, prepared and analyzed according to BRL standard operating procedures (SOPs) and EPA Method 1631E.

During analysis, these samples produced irregular peak shapes, potentially resulting in poor integration and a low bias for the Hg results. The samples were exhausted after reanalysis, and sample results from the diluted volume yielded Hg concentrations below the dilution-adjusted method detection limit (MDL). For this reason, sample results from the full volume analyses have been reported and qualified "J". These results should be considered estimates.

All results were blank corrected, as outlined in the calculations section of EPA Method 1631E. All QA criteria were met and no additional qualification of the data was required. BRL certifies that the reported test results meet all requirements of NELAC. BRL is a NELAC Accredited laboratory (NYS ELAP ID 11688).

If there are any questions, please feel free to contact us.

Sincerely,

Mariah Berry
Project Coordinator
mariah@brooksrand.com

Elizabeth Madonick
Project Manager
elizabeth@brooksrand.com

Reported by

Brooks Rand LLC

Contact: Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for

Golder Associates

Contact: Scott H. Miller, P.G.

44 Union Blvd. Suite 300

Lakewood CO 80228

Tel: (303) 980-0540

Lab Project # NJC003

Lab Tracking # 05BR1466

Quote

NJC003b

Client Project ID

Eagle Bedrock Pump Test

Sample/Sampling/Receiving Info

Golder Associates

BRL

Sample

Identification

04EA-084-817-981-2F

04EA-084-817-981-2U

Sampling Date

9/29/2005

9/29/2005

Sample Number

05BR1466 - 1

05BR1466 - 2

Receiving Date

9/30/2005

9/30/2005

Tuesday, October 25, 2005


Project Manager

Reported by

Brooks Rand LLC

Contact: Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for

Golder Associates

Contact: Scott H. Miller, P.G.

44 Union Blvd, Suite 300

Lakewood CO 80228

Tel: (303) 980-0540

Lab Project # NJC003

Lab Tracking # 05BR1466

Quote

NJC003b

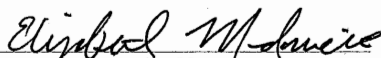
Client Project ID

Eagle Bedrock Pump Test

Hg

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
04EA-084-817-981-2U	05BR1466 - 2	10/7/2005	10/10/2005	05-0783	0.660	ng/L	J

Tuesday, October 25, 2005


Project Manager

Reported by**Brooks Rand LLC****Contact:** Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for**Golder Associates****Contact:** Scott H. Miller, P.G.

44 Union Blvd, Suite 300

Lakewood CO 80228

Tel: (303) 980-0540

Lab Project # NJC003**Lab Tracking #** 05BR1466**Quote**

NJC003b

Client Project ID

Eagle Bedrock Pump Test

Hg, dissolved

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
04EA-084-817-981-2F	05BR1466 - 1	10/7/2005	10/10/2005	05-0783	0.210	ng/L	J

Tuesday, October 25, 2005


Project Manager

QUALITY ASSURANCE REPORT

Batch: 05-0783
Analysis: Mercury by EPA 1631.E (CVAFS)
Tracking: 05BR1321, 05BR1412, 05BR1429, 05BR1466, 05BR1484, 05BR1489,
05BR1496, & 05BR1499
Project: IDQ002, URS014, LAF001, NJC003, AAK005, LOV001, BCT001 &
NEL002
Matrix: Water
Batch Size: 17 samples
Analysis Date: October 10, 2005

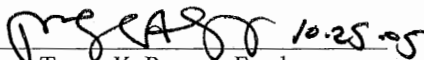
- 1 **SAMPLE PREPARATION** – Acceptable
- 2 **CALIBRATION** – Acceptable
- 3 **CALIBRATION VERIFICATION** – Acceptable
- 4 **QUALITY CONTROL SAMPLES** – Acceptable
- 5 **BLANKS** – Acceptable
- 6 **METHOD DUPLICATE ANALYSIS** – Not Applicable
- 7 **SPIKE / SPIKE DUPLICATE ANALYSIS** – Acceptable
- 8 **LIMITS OF DETECTION** – Acceptable, see section 9
- 9 **OVERALL DATA QUALITY** – Acceptable

Analysis of samples **05BR1466-1** and **05BR1466-2** produced peaks with abnormal shapes. Reanalysis of the samples at a reduced volume produced results below the dilution adjusted PQL. The results from the analyses of the samples at full volume have been reported and have been qualified "J" as estimates.

Sample results have been evaluated using sample specific or client requested detection limits that may have been adjusted to account for sample aliquot size. Refer to the QA Summary for detection limits for affected samples.

No qualification of the data is required based on this review.

I certify that, to the best of my knowledge and belief, the data are reported as true and accurate. The Laboratory Director, or her designee, has authorized release of data contained in this Quality Assurance Report as verified by the following signature(s).


Tressa K. Pearson-Franks
Quality Assurance Associate

BRL QA Summary

Batch #: 05-0783

Method #: EPA 1631.E

Analyte: Hg

Matrix: Water

BIAS Criteria: Recovery = 77-123%			
Continuing Calibration Verification (CCV)			
QCS ID	Certified Value ng/L	Measured Value ng/L	Recovery %
CCV1	5.00	4.61	92.1%
CCV2	5.00	5.05	101.1%
CCV3	5.00	5.06	101.2%
CCV4	5.00	5.00	100.0%

BIAS Criteria: Recovery = 85-115%			
Independent Calibration Verification (ICV)			
QCS ID	Certified Value ng/L	Measured Value ng/L	Recovery %
ICV*	16.01	16.09	100.5%

* Preparation of the CRM NIST 1641d.

BIAS Criteria: Recovery = 71-125%, RPD < 24%								
Matrix Spikes/Matrix Spike Duplicates (MS/MSD)								
Sample ID	Sample Value ng/L	Matrix Spike			Matrix Spike Duplicate			Duplicate RPD
		Spiked Value ng/L	Measured Value ng/L	MS Recovery %	Spiked Value ng/L	Measured Value ng/L	MSD Recovery %	
05BR1321-1	3018	6061	9492	106.8%	6061	9652	109.5%	1.7%
05BR1489-1	26.03	61.14	89.38	103.6%	60.58	88.86	103.7%	0.6%

1.0% BrCl Method Blanks (MB) Criterion: MB < 0.5 ng/L					Detection Limits	
MB1 ng/L	MB2 ng/L	MB3 ng/L	Average ng/L	StDev ng/L	MB MDL ng/L	MB PQL ng/L
0.08	0.21	0.07	0.12	0.08	0.10	0.25

1.0% BrCl MB analyzed in triplicate.

Average MB result multiplied by appropriate factor to produce correction factor for each sample preservation BrCl level.

Sample Specific Detection Limits		
Sample ID	MDL ng/L	PQL ng/L
05BR1321-1	10	25
05BR1321-2	1.0	2.5
05BR1412-47	0.10	0.26
05BR1429-5	0.10	0.26

Sample Specific Detection Limits		
Sample ID	MDL ng/L	PQL ng/L
05BR1484-2	0.10	0.26
05BR1489-1	0.20	0.50

10/25/2005


 Project Manager

Brooks Rand LLC Sample Receiving Log

Tracking # **05BR1466**

Customer: Golder Associates

Contact: Scott Miller

Project Ref. #: NJC003

Collection Date 9/29/2005

QA Level Standard

Sample Condition Intact

Shipping container intact? Yes

Shipping container type: Cooler

Shipping container temp: ambient

Shipping container coolant: none

Sample preservation: none

Acid lab #

Hg Concentration:

Sample storage area: Cabinet #1

Sample Turnaround Time:

Contract Turnaround Time: 28 days

Comments:

Due Date: 10/28/2005

Receiving Date: 9/30/2005

Receiving Time: 7:00 AM

Logged-in by: Stuart Brown

Log-in Date: 9/30/2005

Log-in Time: 8:25 AM

Airbill present? Yes

Airbill # 853172916870

Carrier: Fedex

Custody seal present? Yes

Custody seal intact? Yes

COC Present? Yes

COC Number: N/A

Analysis request form? No

COC/Sample tag agree? Yes

See SOW No See Project Manage No

See Mem No See Lab Manage No

Consult MSDS No See Contract Inf No

Lab ID:	Sample Tag #	Container #	Size:	pH	Matrix/Sub-Matrix	Comments:
1	04EA-084-817-981-2F	FPE 05-215	250 mL Bottle		Water,	
Analysis / Method:		Hg, dissolved	EPA 1631			
2	04EA-084-817-981-2U	FPE 05-215	250 mL Bottle		Water,	
Analysis / Method:		Hg	EPA 1631			

Maiah Berry updated 10/3/05
 Sample Custodian signature Date

Brooks Rand LLC Chain Of Custody Record

Page 1 of 1

Client: <u>COOLER / SCIENCE CO</u>	Email address:	Ship to: <u>Brooks Rand LLC</u>
Contact: <u>SCOTT MILLER</u>	PO #: <u>053-2362</u>	<u>3958 6th Avenue NW</u>
Address: <u>44 UNION BLVD. STE 300</u>	Sampler's signatures: <u>[Signature]</u>	<u>Seattle, WA 98107</u>
<u>LAKEWOOD, CO 80228</u>	Fax COC for receipt confirmation? <u>(Y/N)</u>	Phone: <u>206-632-6206</u>
Phone #: <u>303-980-0540</u>	Client project ID: <u>053-2362</u>	Fax: <u>206-632-6017</u>
Fax #: <u>303-985-2080</u>	BRL project ID: <u>N3 (003)</u>	Email: <u>brl@brooksrnd.com</u>
		<u>www.brooksrand.com</u>

For BRL use only	Cooler temp (°C): <u>Amber</u>	Custody seals present? <u>(Y/N)</u>	Custody seals intact? <u>(Y/N)</u>	Date: <u>9/30/05</u>	Initials: <u>FK</u>
------------------	--------------------------------	-------------------------------------	------------------------------------	----------------------	---------------------

Sample ID	Collection		Miscellaneous			Field Preservation			Analyses required			Comments
	Date	Time	Sampler (Initials)	Matrix type	# of containers	Sample field filtered, Y/N	Unpreserved or ice only	HNO ₃	HCl	BrCl	Other (specify)	
1	04EA-084-817-981-2E	9/29/05 800	MSL W	W	1	Y	X					
2	04EA-084-817-981-2U	9/29/05 800	MSL W	W	1	N	X					
3												
4												
5												
6												
7												
8												
9												
10												

Shipping carrier: <u>FEDEX</u>	# of coolers: <u>1</u>
Relinquished by: <u>[Signature]</u>	Received by: <u>[Signature]</u>
Date: <u>9/29/05</u>	Date: <u>9/30/05</u>
Time: <u>1300</u>	Time: <u>0700</u>
Relinquished by: <u>[Signature]</u>	Received at BRL: <u>[Signature]</u>
Date: <u>9/30/05</u>	Date: <u>9/30/05</u>
Time: <u>0700</u>	Time: <u>0700</u>

White: LAB COPY Yellow: CUSTOMER COPY

TRITIUM ANALYSES

TABLE E-1

SAMPLE ID INFORMATION

Borehole	Sample ID	Sample Interval (m along borehole)	Volume Purged (liters)
05EA-107	05EA-107-60-114-8	18.20 to 34.90	1410
	05EA-107-320-374-8	97.52 to 114.22	1590
04EA-084	04EA-084	249.05 to 302.08	16480
	Not Analyzed		41960
	04EA-084-817-951-2		66750



Illinois State Geological Survey

Natural Resources Building
615 East Peabody Drive
Champaign, IL 61820-6964
217/333-5111
FAX 217/244-7004



Isotope Analysis Report

TO: Scott Miller
Golder Associates
44 Union Blvd., STE 300
Lakewood, CO 80228

FROM: Keith C. Hackley, PhD.
Illinois State Geological Survey
615 E. Peabody
Champaign, IL 61820

Date: 11/30/05

Sample ID	ISGS No.	Tritium (TU)*	std dev. (± TU)
05EA-107-320-374-8	1495	0.60	0.17
05EA-107-60-114-8	1496	<0.80	
04EA-084	1497	<0.69	
04EA-084-817-951-2	1498	<0.71	
Blind dup	1499	<0.83	

* TU = Tritium Unit. One TU is defined as one tritium atom per 10^{18} hydrogen atoms, or 7.088 dpm/ kg H₂O, or 3.193 pCi/ kg H₂O. Less than values are calculated for those samples whose measured tritium concentration is less than three times the standard deviation. The calculated "< value" is 2.5 times the standard deviation plus the measured tritium concentration. For example, if the measured tritium concentration was 0.26, and the std dev. was 0.18, then the < value would be calculated as $2.5 \cdot 0.18 + 0.26 = 0.71$, and reported as < 0.71 TU.

For Lab Use Only

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Analyses Requested

Page 1 of 1

Client Name	Project Name
COUSER / KENNEDY	FAIR
Address	Client Project No. / P.O. No.
44 UNION BLVD, STE 300	053-2362
LAKEWOOD, CO 80228	Invoice To ☐ Client ☐ Other (comments)
Phone 303-980-0540	Contact/Report To
Fax 303-985-2050	SCOTT MILLER

Lab Matrix	Lab Sample Number	Sample ID	Cooler ID	Sample Date	Sample Time	Matrix	Container Type (corresponds to Container Packing List)	Number of Containers Submitted	Total	Sample Comments
1	DHEA-084			9/21/05	1150	X W I				
2										
3										
4										
5										
6										
7										
8										
9										
10										

Sampled By (print)	How Shipped?	Hand	Carrier	Time	Comments
MICHAEL S. LEMOND	Tracking No.		FEDEX		
Sampler's Signature	1. Relinquished By	Date	Time	2. Relinquished By	Date
Michael S. Lemond	Michael S. Lemond	9/21/05	1630		
Company	1. Received By	Date	Time	2. Received By	Date
COUSER					



Exchange Court SE Grand
975-4500 Fax (616)
www.trimatrixlabs.com

COC No.

110016

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Page of

PRESERVATIVES		A		B		C		D		E		F		G		H	
NONE pH-7		HNO ₃ pH<2		H ₂ SO ₄ pH<2		1+1 HCl pH<2		NaOH pH>12		ZnAc/NaOH pH>9		MeOH		Other (note below)			
Project Name FAULT Client Project No. / P.O. No. 053-8362 Invoice To ☐ Client ☐ Other (comments) Contact/Report To SCOTT MILLER																	
Client Name CROWER / KENNEDY Address 44 UNION BLVD, STE 300 LAKEWOOD, CO 80228 Phone 303-980-0540 Fax 303-985-2050																	
Sample ID 04EA-084-817-981-2 Cooler ID Sample Date 9/29/05 Sample Time 0800 Matrix W																	
Number of Containers Submitted 1 Total																	
Comments																	
How Shipped? Hand Carrier FEDEX Tracking No.																	
Relinquished By Michael S. Jensen Date 9/29/05 Time 1300																	
Relinquished By Date Time																	
Relinquished By Date Time																	

QA/QC ANALYSES

04EA-084 – DUPLICATE

SAMPLE INTERVAL: 249.05 m – 302.05 m (217.61 mTVD – 264.57 mTVD)

VOLUME PURGED: 66,750 LITERS



BROOKSRAND
TRACE METALS ANALYSIS & PRODUCTS

October 25, 2005

Golder Associates, Inc.
Attn.: Scott H. Miller, P.G.
44 Union Blvd., Suite 300
Lakewood, CO 80228

RE: Brooks Rand Project: NJC003; Tracking #: 05BR1469
Client Project: Eagle Bedrock Pump Test, 053-2362

Dear Mr. Miller:

This report is for the total and dissolved mercury (Hg) analysis of three (3) water samples collected on 9/29/05 and received at Brooks Rand LLC (BRL) on 9/30/05. These samples have been assigned the BRL internal tracking number 05BR1469.

The chain-of-custody (COC) form accompanying these samples indicated that samples "04EA-084-817-981-2FDUP" and "04EA-084-817-981-2UDUP" should be archived. These samples have also been assigned the BRL internal tracking number 05BR1469 and have not been included in this report.

All samples were received, stored, prepared and analyzed according to BRL standard operating procedures (SOPs) and EPA Method 1631E. All results were blank corrected, as outlined in the calculations section of EPA Method 1631E. Sample results below the method detection limit (MDL) were qualified "U" for non-detect and have been reported at the MDL. All QA criteria were met and no additional qualification of the data was required. BRL certifies that the reported test results meet all requirements of NELAC. BRL is a NELAC Accredited laboratory (NYS ELAP ID 11688).

If there are any questions, please feel free to contact us.

Sincerely,

Mariah Berry
Project Coordinator
mariah@brooksrand.com

Elizabeth Madonick
Project Manager
elizabeth@brooksrand.com

Reported by

Brooks Rand LLC

Contact: Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for

Golder Associates

Contact: Scott H. Miller, P.G.

44 Union Blvd, Suite 300

Lakewood CO 80228

Tel: (303) 980-0540

Lab Project # NJC003

Lab Tracking # 05BR1469

Quote

Client Project ID

NJC003b

Eagle Bedrock Pump Test

Sample/Sampling/Receiving Info

Golder Associates

BRL

Sample

Identification

Sampling Date

Sample Number

Receiving Date

Field Blank-F

9/29/2005

05BR1469 - 1

9/30/2005

Blind DUP-F

9/29/2005

05BR1469 - 2

9/30/2005

Blind DUP-W

9/29/2005

05BR1469 - 3

9/30/2005

04EA084-817-981-2FDUP

9/29/2005

05BR1469 - 4

9/30/2005

04EA-084-817-981-2WDUP

9/29/2005

05BR1469 - 5

9/30/2005

Tuesday, October 25, 2005


Project Manager

Reported by

Brooks Rand LLC

Contact: Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for

Golder Associates

Contact: Scott H. Miller, P.G.

44 Union Blvd, Suite 300

Lakewood CO 80228

Tel: (303) 980-0540

Lab Project # NJC003

Lab Tracking # 05BR1469

Quote

NJC003b

Client Project ID

Eagle Bedrock Pump Test

Hg

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
Blind DUP-W	05BR1469 - 3	10/17/2005	10/19/2005	05-0815	0.270	ng/L	

Tuesday, October 25, 2005

Elizabeth Madonick
Project Manager

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **Blind Dup.**
 Lab Sample ID: **0509453-01**
 Matrix: Water

Work Order: **0509453**
 Description: Laboratory Services
 Sampled: 09/29/05 00:00
 Sampled By: Michael Lemon
 Received: 09/30/05 08:45

Physical/Chemical Parameters by EPA/APHA/ASTM Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Alkalinity, Bicarbonate	38	2.0	mg/L	1	USEPA-310.1	10/06/05	INR	0509420
Alkalinity, Carbonate	<2.0	2.0	mg/L	1	USEPA-310.1	10/06/05	INR	0509422
Alkalinity, Total	38	2.0	mg/L	1	USEPA-310.1	10/06/05	INR	0509423
Chloride	2000	20	mg/L	20	USEPA-325.2	10/11/05	JLB	0509573
Fluoride	0.99	0.10	mg/L	1	APHA 4500-F C	10/07/05	MSM	0509483
Nitrogen, Ammonia	0.27	0.020	mg/L	1	USEPA-350.1	10/04/05	GEH	0509359
Nitrogen, Nitrate	<0.050	0.050	mg/L	1	USEPA-353.2	09/30/05	HLB	0509743
Phosphorus, Total	0.0136	0.0100	mg/L	1	USEPA-365.1	10/05/05	INR	0509273
Residue, Dissolved @ 180° C	3690	50	mg/L	20	USEPA-160.1	10/03/05	GEH	0509339
Sulfate	<5.0	5.0	mg/L	1	USEPA-375.4	10/03/05	JLB	0509268
Sulfide	<1.0	1.0	mg/L	1	USEPA-376.1	10/03/05	JSS	0509728

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **Blind Dup.-F**
 Lab Sample ID: **0509453-02**
 Matrix: Water

Work Order: **0509453**
 Description: Laboratory Services
 Sampled: 09/29/05 00:00
 Sampled By: Michael Lemon
 Received: 09/30/05 08:45

Dissolved Metals by EPA 6000/7000 Series Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Aluminum	<50	50	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Antimony	<5.0	5.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Arsenic	23	2.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Barium	<20	20	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Beryllium	<1.0	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Boron	5800	100	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
* Cadmium	<5.0	5.0	ug/L	10	USEPA-6020	10/13/05	JMF	0509313
Calcium	75	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509314
Chromium	<5.0	5.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Cobalt	<10	10	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
* Copper	<5.0	5.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Iron	1600	20	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Lead	<1.0	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Lithium	140	8.0	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Magnesium	61	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509314
Manganese	67	20	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Molybdenum	<10	10	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Nickel	<25	25	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
* Selenium	21	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Silver	1.1	0.20	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Sodium	960	100	mg/L	200	USEPA-6010B	10/07/05	KLV	0509314
Strontium	4700	1200	ug/L	25	USEPA-6010B	10/07/05	KLV	0509314
Zinc	19	10	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Potassium	9.3	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509314

*See Statement of Data Qualifications

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **Blind Dup. U**
 Lab Sample ID: **0509453-03**
 Matrix: Water

Work Order: **0509453**
 Description: Laboratory Services
 Sampled: 09/29/05 00:00
 Sampled By: Michael Lemon
 Received: 09/30/05 08:45

Total Metals by EPA 6000/7000 Series Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Aluminum	67	50	ug/L	1	USEPA-6010B	10/17/05	KLV	0509325
Antimony	<5.0	5.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Arsenic	18	10	ug/L	5	USEPA-6020	10/08/05	JMF	0509326
Barium	<100	100	ug/L	5	USEPA-6020	10/08/05	JMF	0509326
Beryllium	<1.0	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509326
Boron	5600	100	ug/L	1	USEPA-6010B	10/13/05	DSC	0509325
* Cadmium	<5.0	5.0	ug/L	10	USEPA-6020	10/13/05	JMF	0509326
Calcium	81	0.50	mg/L	1	USEPA-6010B	10/13/05	DSC	0509325
Chromium	<5.0	5.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Cobalt	<10	10	ug/L	1	USEPA-6010B	10/17/05	KLV	0509325
* Copper	<5.0	5.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Iron	2900	20	ug/L	1	USEPA-6010B	10/13/05	DSC	0509325
Lead	<1.0	1.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Lithium	130	8.0	ug/L	1	USEPA-6010B	10/13/05	DSC	0509325
Magnesium	65	0.50	mg/L	1	USEPA-6010B	10/13/05	DSC	0509325
Manganese	73	20	ug/L	1	USEPA-6010B	10/13/05	DSC	0509325
Molybdenum	<10	10	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Nickel	<25	25	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Potassium	9.0	0.50	mg/L	1	USEPA-6010B	10/13/05	DSC	0509325
Selenium	7.7	1.0	ug/L	1	USEPA-6020	10/08/05	JMF	0509326
Silver	<1.0	1.0	ug/L	5	USEPA-6020	10/08/05	JMF	0509326
Sodium	1200	5.0	mg/L	10	USEPA-6010B	10/14/05	JLT	0509325
Strontium	5100	500	ug/L	10	USEPA-6010B	10/14/05	JLT	0509325
Zinc	40	10	ug/L	1	USEPA-6020	10/08/05	JMF	0509326

*See Statement of Data Qualifications

FIELD BLANK
IN-LINE FILTER

ANALYTICAL REPORT

Client: **Golder Associates, Inc. - CO**
 Project: Eagle Groundwater
 Client Sample ID: **Field Blank-F**
 Lab Sample ID: **0509453-04**
 Matrix: Water

Work Order: **0509453**
 Description: Laboratory Services
 Sampled: 09/29/05 08:00
 Sampled By: Michael Lemon
 Received: 09/30/05 08:45

Dissolved Metals by EPA 6000/7000 Series Methods

Analyte	Analytical Result	RL	Unit	Dilution Factor	Method	Date Analyzed	By	QC Batch
Aluminum	<50	50	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Antimony	<5.0	5.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Arsenic	<2.0	2.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Barium	<20	20	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Beryllium	<1.0	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Boron	110	100	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Cadmium	<0.50	0.50	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Calcium	<0.50	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509314
Chromium	<5.0	5.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Cobalt	<10	10	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Copper	<5.0	5.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Iron	<20	20	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Lead	<1.0	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Lithium	<8.0	8.0	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Magnesium	<0.50	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509314
Manganese	<20	20	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Molybdenum	<10	10	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Nickel	<25	25	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
* Selenium	<1.0	1.0	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Silver	1.3	0.20	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Sodium	0.77	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509314
Strontium	<50	50	ug/L	1	USEPA-6010B	10/07/05	KLV	0509314
Zinc	<10	10	ug/L	1	USEPA-6020	10/11/05	JMF	0509313
Potassium	<0.50	0.50	mg/L	1	USEPA-6010B	10/07/05	KLV	0509314

*See Statement of Data Qualifications



Chain of Custody Record
COC No. 110016

COC No.

110016

For Lab Use Only

Tamarak

Analyses Requested

Page 7 of 7

DA Rack/Trey	Client Name <i>COLAER/KENNEDY</i>	Project Name <i>FACE</i>
Order Log No.	Address <i>44 UNION BLVD, STE 300</i>	Client Project No. / P.O. No. <i>053-136Z</i>
Order Client		Invoice To ☐ Client ☐ Other (comments)
Security Project No.	Phone <i>303-980-0540</i>	Contact/Report To <i>SCOTT MILLER</i>
	Fax <i>303-985-2083</i>	

[illegible]

Completed By (Print)

Michael S. Lemon

**_____
Supplier's Signature**

How Shipped?	Hand	Carrier	Ex
Tracking No.			

~~Proprietary~~

100

1. Relinquished By

Date	Time
------	------

Time

2. Relinquished By

Date	Time
------	------

3. Relinquished By

Time

***** COMPANY REPORT

Reported by**Brooks Rand LLC****Contact:** Elizabeth Madonick

3958 6th Avenue NW

Seattle, WA 98107

Tel: 206-632-6206 Fax: 206-632-6017

Summary of Results for**Golder Associates****Contact:** Scott H. Miller, P.G.

44 Union Blvd, Suite 300

Lakewood CO 80228

Tel: (303) 980-0540

Lab Project # NJC003**Lab Tracking #** 05BR1469**Quote**

NJC003b

Client Project ID

Eagle Bedrock Pump Test

Hg, dissolved

Sample Identification	BRL Number	Preparation date	Analysis date	Batch #	Result	Units	Qualifier (Q)
Field Blank-F	05BR1469 - 1	10/17/2005	10/19/2005	05-0815	0.100	ng/L	U
Blind DUP-F	05BR1469 - 2	10/17/2005	10/19/2005	05-0815	0.100	ng/L	U

Tuesday, October 25, 2005


Project Manager

QUALITY ASSURANCE REPORT

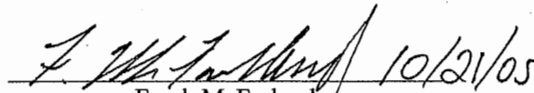
Batch: 05-0815
Analysis: Mercury by EPA 1631.E (CVAFS)
Tracking: 05BR1469, 05BR1483, 05BR1497, 05BR1498, & 05BR1520
Project: NJC003, IDQ002, INT007, CIT002, & DWQ002
Matrix: Water
Batch Size: 20 samples
Analysis Date: October 19, 2005

- 1 **SAMPLE PREPARATION** – Acceptable
- 2 **CALIBRATION** – Acceptable
- 3 **CALIBRATION VERIFICATION** – Acceptable
- 4 **QUALITY CONTROL SAMPLES** – Acceptable
- 5 **BLANKS** – Acceptable
- 6 **METHOD DUPLICATE ANALYSIS** – Not Applicable
- 7 **SPIKE / SPIKE DUPLICATE ANALYSIS** – Acceptable
- 8 **LIMITS OF DETECTION** – Acceptable, see section 9
- 9 **OVERALL DATA QUALITY** – Acceptable

Sample results have been evaluated using sample specific or client requested detection limits that may have been adjusted to account for sample aliquot size. Refer to the QA Summary for detection limits for affected samples.

No qualification of the data is required based on this review.

I certify that, to the best of my knowledge and belief, the data are reported as true and accurate. The Laboratory Director, or her designee, has authorized release of data contained in this Quality Assurance Report as verified by the following signature(s).


Frank McFarland
Quality Assurance Manager

BRL QA Summary

Batch #: 05-0815

Method #: EPA 1631.E

Analyte: Hg

Matrix: Water

BIAS Criteria: Recovery = 77-123% Continuing Calibration Verification (CCV)			
QCS ID	Certified Value ng/L	Measured Value ng/L	Recovery %
CCV1	5.00	5.08	101.7%
CCV2	5.00	5.28	105.6%
CCV3	5.00	5.21	104.1%
CCV4	5.00	4.49	89.9%
CCV5	5.00	5.24	104.7%
CCV6	5.00	5.39	107.8%

BIAS Criteria: Recovery = 85-115% Independent Calibration Verification (ICV)			
QCS ID	Certified Value ng/L	Measured Value ng/L	Recovery %
ICV*	16.01	15.91	99.4%

* Preparation of the CRM NIST 1641d.

BIAS Criteria: Recovery = 71-125%, RPD<24% Matrix Spikes/Matrix Spike Duplicates (MS/MSD)								
Sample ID	Sample Value ng/L	Matrix Spike			Matrix Spike Duplicate			Duplicate RPD
		Spiked Value ng/L	Measured Value ng/L	MS Recovery %	Spiked Value ng/L	Measured Value ng/L	MSD Recovery %	
05BR1469-3	0.27	1.98	2.60	117.5%	1.98	2.44	109.7%	6.4%
05BR1498-2	0.72	3.83	4.56	100.2%	3.74	4.58	103.4%	0.5%

1.0% BrCl Method Blanks (MB) Criterion: MB < 0.5 ng/L					Detection Limits	
MB1	MB2	MB3	Average	StDev	MB MDL	MB PQL
ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
0.24	0.24	0.28	0.25	0.02	0.10	0.25

1.0% BrCl MB analyzed in triplicate.

Average MB result multiplied by appropriate factor to produce correction factor for each sample preservation BrCl level.

Sample Specific Detection Limits		
Sample ID	MDL ng/L	PQL ng/L
05BR1483-6	2.0	5.0
05BR1483-7	2.0	5.0
05BR1483-8	2.0	5.0

Sample Specific Detection Limits		
Sample ID	MDL ng/L	PQL ng/L
05BR1483-9	2.0	5.0
05BR1498-1	0.87	2.16
05BR1498-2	0.19	0.47

10/21/2005


Project Manager

Brooks Rand LLC Sample Receiving Log

Tracking # **05BR1469**

Customer: North Jackson Company

Contact: Peter Sabee

Project Ref. #: NJC003

Collection Date 9/29/2005

QA Level Standard

Sample Condition Intact

Shipping container intact? Yes

Shipping container type: Cooler

Shipping container temp: ambient

Shipping container coolant: none

Sample preservation: 0.5% BrCl

Acid lab #

Hg Concentration:

Sample storage area: Cabinet #2

Sample Turnaround Time:

Contract Turnaround Time: 28 days

Due Date: 10/28/2005

Receiving Date: 9/30/2005

Receiving Time: 8:30 AM

Logged-in by: Stuart Brown

Log-in Date: 9/30/2005

Log-in Time: 11:17 AM

Airbill present? Yes

Airbill # 853172916869

Carrier: Fedex

Custody seal present? Yes

Custody seal intact? Yes

COC Present? Yes

COC Number: N/A

Analysis request form? No

COC/Sample tag agree? No

See SOW No See Project Manage No

See Mem No See Lab Manage No

Consult MSDS No See Contract Inf No

Comments:

Lab ID:	Sample Tag #	Container #	Size:	pH	Matrix/Sub-Matrix	Comments:
1	Field Blank-F	FPE 05-215	250 mL Bottle		Water,	
Analysis / Method:		Hg, dissolved	EPA 1631			
2	Blind DUP-F	FPE 05-215	250 mL Bottle		Water,	
Analysis / Method:		Hg, dissolved	EPA 1631			
3	Blind DUP-W	FPE 05-251	500 mL Bottle		Water,	
Analysis / Method:		Hg	EPA 1631			
4	04EA084-817-981-2FDUP	FPE 05-215	250 mL Bottle		Water,	
Analysis / Method:					HOLD	
5	04EA-084-817-981-2WDUP	FPE 05-215	250 mL Bottle		Water,	
Analysis / Method:					HOLD	

Lab ID: Sample Tag # Container # Size: pH Matrix/Sub-Matrix Comments:

Mariah Perry Rev. 10/25/05
Sample Custodian signature Date

Brooks Rand LLC Chain Of Custody Record

Page 1 of 1

Client: <u>COLEMAN / SENNICK CO PT</u>		Email address:		Ship to: <u>Brooks Rand LLC</u>	
Contact: <u>SCOTT MILLER</u>		PO #: <u>053-2362</u>		3958 6 th Avenue NW	
Address: <u>44 UNION BLVD. SEASIDE, WA 98107</u>		Sampler's signature: <u>Michael A. Jensen</u>		Seattle, WA 98107	
Phone #: <u>303-980-0540</u>		Fax COC for receipt confirmation? <u>(Y/N)</u>		Phone: 206-632-6206	
Fax #: <u>303-985-2080</u>		Client project ID: <u>053-2362</u>		Fax: 206-632-6017	
For BRL use only		Cooler temp (°C): <u>20</u>		Email: <u>brl@brookstrand.com</u>	
Custody seals present? <u>(Y/N)</u>		Custody seals intact? <u>(Y/N)</u>		Date: <u>9/30/05</u> Initials: <u>MR</u>	

Sample ID	Collection		Miscellaneous			Field Preservation				Analyses required				Comments
	Date	Time	Sampler (Initials)	Matrix type	# of containers	Sample field filtered, Y/N	Unpreserved or ice only	HNO ₃	HCl	BrCl	Other (specify)			
1	9/29/05	0800	MSL	W	1	Y	X							
2	9/29/05	—	MSL	W	1	Y	X							
3	9/29/05	—	MSL	W	1	Y	X							
4	04EA-084-817-981-2F01P4/29/05	800	MSL	W	1	Y	X							*ARCHIVE*
5	04EA-084-817-981-2F01P4/29/05	800	MSL	W	1	Y	X							*ARCHIVE*
6														
7														
8														
9														
10														

Shipping carrier: <u>FEA-Ex</u>		# of coolers: <u>1</u>	
Relinquished by: <u>Michael A. Jensen</u>	Date: <u>9/29/05</u>	Time: <u>1300</u>	Received by:
Relinquished by:	Date:	Time:	Received at BRL: <u>9/30/05</u>
			Time: <u>8:30</u>

White: LAB COPY Yellow: CUSTOMER COPY

QUALITY CONTROL REPORT

Dissolved Metals by EPA 6000/7000 Series Methods

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Aluminum/USEPA-6010B

QC Batch: 0508916 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Laboratory Control Sample		1250	1210	ug/L	97	86-120		100	

QC Batch: 0508946 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<100	ug/L				100	
Laboratory Control Sample		1250	1140	ug/L	91	86-120		100	

QC Batch: 0508916 (3010A Digestion)					Analyzed: 09/29/2005 By: KLV				
Method Blank			<50	ug/L				50	
Laboratory Control Sample		1250	1150	ug/L	92	86-120		50	

Analyte: Antimony/USEPA-6020

QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<5.0	ug/L				5.0	

QC Batch: 0508945 (3010A Digestion)					Analyzed: 10/01/2005 By: JMF				
Method Blank			<5.0	ug/L				5.0	
Laboratory Control Sample		100	89.0	ug/L	89	83-129		5.0	

QC Batch: 0509107 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	43.1	ug/L	108	83-129		1.0	

QC Batch: 0509313 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	43.1	ug/L	108	83-129		1.0	

Analyte: Arsenic/USEPA-6020

QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<2.0	ug/L				2.0	

Continued on next page

QUALITY CONTROL REPORT

Dissolved Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Arsenic/USEPA-6020 (Continued)

QC Batch: 0508945 (3010A Digestion)					Analyzed: 10/01/2005 By: JMF				
Method Blank			<2.0	ug/L				2.0	
Laboratory Control Sample		100	95.6	ug/L	96	83-111		2.0	

QC Batch: 0509107 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	40.3	ug/L	101	83-111		1.0	

QC Batch: 0509313 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	40.3	ug/L	101	83-111		1.0	

Analyte: Barium/USEPA-6020

QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<20	ug/L				20	

QC Batch: 0508945 (3010A Digestion)					Analyzed: 10/01/2005 By: JMF				
Method Blank			<5.0	ug/L				5.0	
Laboratory Control Sample		100	96.0	ug/L	96	86-119		5.0	

QC Batch: 0509107 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	42.4	ug/L	106	86-119		1.0	

QC Batch: 0509313 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	42.4	ug/L	106	86-119		1.0	

Analyte: Beryllium/USEPA-6020

QC Batch: 0508945 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<1.0	ug/L				1.0	

Continued on next page

QUALITY CONTROL REPORT

Dissolved Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Beryllium/USEPA-6020 (Continued)

QC Batch: 0508945 (Continued) (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Laboratory Control Sample		100	95.7	ug/L	96	81-116		1.0	
QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/03/2011 By: DSC				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		100	99.2	ug/L	99	81-116		1.0	
QC Batch: 0509107 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	43.5	ug/L	109	81-116		1.0	
QC Batch: 0509313 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	43.5	ug/L	109	81-116		1.0	

Analyte: Boron/USEPA-6010B

QC Batch: 0508916 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<100	ug/L				100	
Laboratory Control Sample		250	267	ug/L	107	78-122		100	
QC Batch: 0508946 (3010A Digestion)					Analyzed: 09/29/2005 By: KLV				
Method Blank			<100	ug/L				100	
Laboratory Control Sample		250	262	ug/L	105	78-122		100	

Analyte: Cadmium/USEPA-6020

QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<0.50	ug/L				0.50	
QC Batch: 0508945 (3010A Digestion)					Analyzed: 10/01/2005 By: JMF				
Method Blank			<0.50	ug/L				0.50	

Continued on next page

QUALITY CONTROL REPORT

Dissolved Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Cadmium/USEPA-6020 (Continued)

QC Batch: 0508945 (Continued) (3010A Digestion)					Analyzed: 10/01/2005 By: JMF				
Laboratory Control Sample		100	97.0	ug/L	97	83-112		0.50	

QC Batch: 0509107 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<0.20	ug/L				0.20	
Laboratory Control Sample		40.0	39.0	ug/L	98	83-112		0.20	

QC Batch: 0509313 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<0.20	ug/L				0.20	
Laboratory Control Sample		40.0	39.0	ug/L	98	83-112		0.20	

Analyte: Calcium/USEPA-6010B

QC Batch: 0508916 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<1.0	mg/L				1.0	
Laboratory Control Sample		12.5	12.9	mg/L	103	88-121		1.0	

QC Batch: 0508946 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<1.0	mg/L				1.0	
Laboratory Control Sample		12.5	12.6	mg/L	101	88-121		1.0	

Analyte: Chromium/USEPA-6020

QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<5.0	ug/L				5.0	

QC Batch: 0508945 (3010A Digestion)					Analyzed: 10/01/2005 By: JMF				
Method Blank			<5.0	ug/L				5.0	
Laboratory Control Sample		100	110	ug/L	110	84-122		5.0	

QC Batch: 0509107 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	

Continued on next page

QUALITY CONTROL REPORT

Dissolved Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Chromium/USEPA-6020 (Continued)

QC Batch: 0509107 (Continued) (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Laboratory Control Sample		40.0	41.1	ug/L	103	84-122		1.0	
QC Batch: 0509313 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	41.1	ug/L	103	84-122		1.0	

Analyte: Cobalt/USEPA-6010B

QC Batch: 0508916 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<15	ug/L				15	
Laboratory Control Sample		250	253	ug/L	101	84-117		15	
QC Batch: 0508946 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<15	ug/L				15	
Laboratory Control Sample		250	240	ug/L	96	84-117		15	

Analyte: Copper/USEPA-6020

QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<5.0	ug/L				5.0	
QC Batch: 0509407 (General Metals Prep)					Analyzed: 10/06/2005 By: DSC				
Method Blank			<5.0	ug/L				5.0	
Laboratory Control Sample		100	90.0	ug/L	90	86-123		5.0	
QC Batch: 0509107 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	40.0	ug/L	100	86-123		1.0	
QC Batch: 0509313 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	

Continued on next page

QUALITY CONTROL REPORT

Dissolved Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Copper/USEPA-6020 (Continued)

QC Batch: 0509313 (Continued) (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Laboratory Control Sample		40.0	40.0	ug/L	100	86-123		1.0	

Analyte: Iron/USEPA-6010B

QC Batch: 0508916 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<20	ug/L				20	
Laboratory Control Sample		250	257	ug/L	103	83-118		20	

QC Batch: 0508946 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<20	ug/L				20	
Laboratory Control Sample		250	238	ug/L	95	83-118		20	

Analyte: Lead/USEPA-6020

QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<1.0	ug/L				1.0	

QC Batch: 0508945 (3010A Digestion)					Analyzed: 10/01/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		100	100	ug/L	100	87-118		1.0	

QC Batch: 0509107 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	42.3	ug/L	106	87-118		1.0	

QC Batch: 0509313 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	42.3	ug/L	106	87-118		1.0	

Analyte: Lithium/USEPA-6010B

QC Batch: 0508916 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<10	ug/L				10	

Continued on next page

QUALITY CONTROL REPORT

Dissolved Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Lithium/USEPA-6010B (Continued)

QC Batch: 0508916 (Continued) (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Laboratory Control Sample		250	258	ug/L	103	86-115		10	

QC Batch: 0508946 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<10	ug/L				10	
Laboratory Control Sample		250	252	ug/L	101	86-115		10	

Analyte: Magnesium/USEPA-6010B

QC Batch: 0508916 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<1.0	mg/L				1.0	
Laboratory Control Sample		12.5	12.8	mg/L	102	87-115		1.0	

QC Batch: 0508946 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<1.0	mg/L				1.0	
Laboratory Control Sample		12.5	12.6	mg/L	101	87-115		1.0	

Analyte: Manganese/USEPA-6010B

QC Batch: 0508916 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<20	ug/L				20	
Laboratory Control Sample		250	252	ug/L	101	83-118		20	

QC Batch: 0508946 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<20	ug/L				20	
Laboratory Control Sample		250	247	ug/L	99	83-118		20	

Analyte: Molybdenum/USEPA-6020

QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<10	ug/L				10	

QC Batch: 0508945 (3010A Digestion)					Analyzed: 10/01/2005 By: JMF				
Method Blank			<10	ug/L				10	

Continued on next page

QUALITY CONTROL REPORT

Dissolved Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Molybdenum/USEPA-6020 (Continued)

QC Batch: 0508945 (Continued) (3010A Digestion)					Analyzed: 10/01/2005 By: JMF				
Laboratory Control Sample		100	94.7	ug/L	95	88-114		10	
QC Batch: 0509107 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	41.7	ug/L	104	88-114		1.0	
QC Batch: 0509313 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	41.7	ug/L	104	88-114		1.0	

Analyte: Nickel/USEPA-6020

QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<25	ug/L				25	
QC Batch: 0508945 (3010A Digestion)					Analyzed: 10/01/2005 By: JMF				
Method Blank			<25	ug/L				25	
Laboratory Control Sample		100	109	ug/L	109	84-117		25	
QC Batch: 0509107 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	39.6	ug/L	99	84-117		1.0	
QC Batch: 0509313 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	39.6	ug/L	99	84-117		1.0	

Analyte: Potassium/USEPA-6010B

QC Batch: 0508916 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<0.50	mg/L				0.50	

Continued on next page

QUALITY CONTROL REPORT

Dissolved Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Potassium/USEPA-6010B (Continued)

QC Batch: 0508916 (Continued) (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Laboratory Control Sample		12.5	13.4	mg/L	107	87-125		0.50	
QC Batch: 0508946 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<0.50	mg/L				0.50	
Laboratory Control Sample		12.5	13.5	mg/L	108	87-125		0.50	

Analyte: Selenium/USEPA-6020

QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<1.0	ug/L				1.0	
QC Batch: 0508945 (3010A Digestion)					Analyzed: 10/01/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		100	88.5	ug/L	88	75-110		1.0	
QC Batch: 0509107 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	40.2	ug/L	100	75-110		1.0	
QC Batch: 0509313 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	40.2	ug/L	100	75-110		1.0	

Analyte: Silver/USEPA-6020

QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<0.20	ug/L				0.20	
QC Batch: 0508945 (3010A Digestion)					Analyzed: 10/01/2005 By: JMF				
Method Blank			<0.20	ug/L				0.20	
Laboratory Control Sample		100	101	ug/L	101	86-114		0.20	

Continued on next page

QUALITY CONTROL REPORT

Dissolved Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Silver/USEPA-6020 (Continued)

QC Batch: 0509107 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<0.20	ug/L				0.20	
Laboratory Control Sample		40.0	42.5	ug/L	106	84-117		0.20	

QC Batch: 0509313 (General Metals Prep)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<0.20	ug/L				0.20	
Laboratory Control Sample		40.0	42.5	ug/L	106	84-117		0.20	

Analyte: Sodium/USEPA-6010B

QC Batch: 0508946 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<1.0	mg/L				1.0	
Laboratory Control Sample		12.5	11.8	mg/L	94	86-117		2.0	

QC Batch: 0508916 (3010A Digestion)					Analyzed: 09/29/2005 By: KLV				
Method Blank			<1.0	mg/L				1.0	
Laboratory Control Sample		12.5	12.5	mg/L	100	86-117		1.0	

Analyte: Strontium/USEPA-6010B

QC Batch: 0508916 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<50	ug/L				50	
Laboratory Control Sample		250	264	ug/L	106	91-113		50	

QC Batch: 0508946 (3010A Digestion)					Analyzed: 09/28/2005 By: KLV				
Method Blank			<50	ug/L				50	
Laboratory Control Sample		250	261	ug/L	104	91-113		50	

QC Batch: 0508946 (3010A Digestion)					Analyzed: 09/29/2005 By: KLV				
Method Blank			<50	ug/L				50	
Laboratory Control Sample		250	253	ug/L	101	91-113		50	

Analyte: Zinc/USEPA-6020

QC Batch: 0508915 (3010A Digestion)					Analyzed: 10/01/2005 By: DSC				
Method Blank			<10	ug/L				10	

Continued on next page

QUALITY CONTROL REPORT

Dissolved Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Zinc/USEPA-6020 (Continued)

QC Batch: 0508945 (3010A Digestion) Analyzed: 10/01/2005 By: JMF

Method Blank			7.5	ug/L				4.0	
*Laboratory Control Sample		100	101	ug/L	101	80-137		4.0	

QC Batch: 0509107 (General Metals Prep) Analyzed: 10/11/2005 By: JMF

Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	40.3	ug/L	101	80-137		1.0	

QC Batch: 0509313 (General Metals Prep) Analyzed: 10/11/2005 By: JMF

Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		40.0	40.3	ug/L	101	80-137		1.0	

QUALITY CONTROL REPORT

Total Metals by EPA 6000 / 7000 Series Methods

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Aluminum/USEPA-6010B

QC Batch: 0509149 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<50	ug/L				50	
Laboratory Control Sample		1250	1240	ug/L	99	86-120		50	

QC Batch: 0509325 (3010A Digestion)					Analyzed: 10/17/2005 By: KLV				
Method Blank			<50	ug/L				50	
Laboratory Control Sample		1250	1220	ug/L	98	86-120		50	

Analyte: Antimony/USEPA-6020

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<5.0	ug/L				5.0	
Laboratory Control Sample		100	96.2	ug/L	96	83-129		5.0	

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<5.0	ug/L				5.0	
Laboratory Control Sample		100	98.3	ug/L	98	83-129		1.0	

Analyte: Arsenic/USEPA-6020

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<5.0	ug/L				5.0	
Laboratory Control Sample		100	90.2	ug/L	90	83-111		5.0	

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<25	ug/L				25	
Laboratory Control Sample		100	91.0	ug/L	91	83-111		1.0	

Analyte: Barium/USEPA-6020

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<100	ug/L				100	
Laboratory Control Sample		100	91.9	ug/L	92	86-119		100	

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<500	ug/L				500	

Continued on next page

QUALITY CONTROL REPORT

Total Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Barium/USEPA-6020 (Continued)

QC Batch: 0509326 (Continued) (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Laboratory Control Sample		100	96.6	ug/L	97	86-119		1.0	

Analyte: Beryllium/USEPA-6020

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/11/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		100	91.6	ug/L	92	81-116		1.0	

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/13/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		100	88.5	ug/L	88	81-116		1.0	

Analyte: Boron/USEPA-6010B

QC Batch: 0509325 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<100	ug/L				100	
Laboratory Control Sample		250	255	ug/L	102	78-122		100	

QC Batch: 0509149 (3010A Digestion)					Analyzed: 10/14/2005 By: JLT				
Method Blank			<100	ug/L				100	
Laboratory Control Sample		250	255	ug/L	102	78-122		100	

Analyte: Cadmium/USEPA-6020

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		100	93.7	ug/L	94	83-112		1.0	

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		100	93.5	ug/L	94	83-112		0.20	

Analyte: Calcium/USEPA-6010B

QC Batch: 0509149 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<0.50	mg/L				0.50	

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QUALITY CONTROL REPORT

Total Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Calcium/USEPA-6010B (Continued)

QC Batch: 0509149 (Continued) (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Laboratory Control Sample		12.5	13.4	mg/L	107	88-121		0.50	

QC Batch: 0509325 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<0.50	mg/L				0.50	
Laboratory Control Sample		12.5	13.5	mg/L	108	88-121		0.50	

Analyte: Chromium/USEPA-6020

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<10	ug/L				10	
Laboratory Control Sample		100	97.0	ug/L	97	84-122		10	

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<10	ug/L				10	
Laboratory Control Sample		100	98.4	ug/L	98	84-122		1.0	

Analyte: Cobalt/USEPA-6010B

QC Batch: 0509149 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<10	ug/L				10	
Laboratory Control Sample		250	255	ug/L	102	84-117		10	

QC Batch: 0509325 (3010A Digestion)					Analyzed: 10/17/2005 By: KLV				
Method Blank			<10	ug/L				10	
Laboratory Control Sample		250	253	ug/L	101	84-117		10	

Analyte: Copper/USEPA-6020

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<4.0	ug/L				4.0	
Laboratory Control Sample		100	95.5	ug/L	96	86-123		4.0	

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<4.0	ug/L				4.0	

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QUALITY CONTROL REPORT

Total Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Copper/USEPA-6020 (Continued)

QC Batch: 0509326 (Continued) (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Laboratory Control Sample		100	99.7	ug/L	100	86-123		1.0	

Analyte: Iron/USEPA-6010B

QC Batch: 0509149 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<20	ug/L				20	
Laboratory Control Sample		250	268	ug/L	107	83-118		20	

QC Batch: 0509325 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<20	ug/L				20	
Laboratory Control Sample		250	276	ug/L	110	83-118		20	

Analyte: Lead/USEPA-6020

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<3.0	ug/L				3.0	
Laboratory Control Sample		100	99.6	ug/L	100	87-118		3.0	

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<3.0	ug/L				3.0	
Laboratory Control Sample		100	101	ug/L	101	87-118		1.0	

Analyte: Lithium/USEPA-6010B

QC Batch: 0509149 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<8.0	ug/L				8.0	
Laboratory Control Sample		250	242	ug/L	97	86-115		8.0	

QC Batch: 0509325 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<8.0	ug/L				8.0	
Laboratory Control Sample		250	266	ug/L	106	86-115		8.0	

Analyte: Magnesium/USEPA-6010B

QC Batch: 0509149 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<0.50	mg/L				0.50	

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QUALITY CONTROL REPORT

Total Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Magnesium/USEPA-6010B (Continued)

QC Batch: 0509149 (Continued) (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Laboratory Control Sample		12.5	12.8	mg/L	102	87-115		0.50	

QC Batch: 0509325 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<0.50	mg/L				0.50	
Laboratory Control Sample		12.5	13.0	mg/L	104	87-115		0.50	

Analyte: Manganese/USEPA-6010B

QC Batch: 0509149 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<20	ug/L				20	
Laboratory Control Sample		250	256	ug/L	102	83-118		20	

QC Batch: 0509325 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<20	ug/L				20	
Laboratory Control Sample		250	255	ug/L	102	83-118		20	

Analyte: Molybdenum/USEPA-6020

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<10	ug/L				10	
Laboratory Control Sample		100	98.1	ug/L	98	88-114		10	

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<10	ug/L				10	
Laboratory Control Sample		100	99.6	ug/L	100	88-114		1.0	

Analyte: Nickel/USEPA-6020

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<25	ug/L				25	
Laboratory Control Sample		100	93.6	ug/L	94	84-117		25	

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<25	ug/L				25	

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QUALITY CONTROL REPORT

Total Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Nickel/USEPA-6020 (Continued)

QC Batch: 0509326 (Continued) (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Laboratory Control Sample		100	96.2	ug/L	96	84-117		1.0	

Analyte: Potassium/USEPA-6010B

QC Batch: 0509149 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<0.50	mg/L				0.50	
Laboratory Control Sample		12.5	12.3	mg/L	98	87-125		0.50	

QC Batch: 0509325 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<0.50	mg/L				0.50	
Laboratory Control Sample		12.5	13.5	mg/L	108	87-125		0.50	

Analyte: Selenium/USEPA-6020

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<5.0	ug/L				5.0	
Laboratory Control Sample		100	81.3	ug/L	81	75-110		5.0	

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<5.0	ug/L				5.0	
Laboratory Control Sample		100	81.4	ug/L	81	75-110		1.0	

Analyte: Silver/USEPA-6020

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<0.20	ug/L				0.20	
Laboratory Control Sample		100	98.7	ug/L	99	84-117		0.20	

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<1.0	ug/L				1.0	
Laboratory Control Sample		100	102	ug/L	102	84-117		0.20	

Analyte: Sodium/USEPA-6010B

QC Batch: 0509149 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<0.50	mg/L				0.50	

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QUALITY CONTROL REPORT

Total Metals by EPA 6000/7000 Series Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Sodium/USEPA-6010B (Continued)

QC Batch: 0509149 (Continued) (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Laboratory Control Sample		12.5	12.0	mg/L	96	86-117		1.0	

QC Batch: 0509325 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<0.50	mg/L				0.50	
Laboratory Control Sample		12.5	12.9	mg/L	103	86-117		1.0	

Analyte: Strontium/USEPA-6010B

QC Batch: 0509149 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<50	ug/L				50	
Laboratory Control Sample		250	255	ug/L	102	91-113		50	

QC Batch: 0509325 (3010A Digestion)					Analyzed: 10/13/2005 By: DSC				
Method Blank			<50	ug/L				50	
Laboratory Control Sample		250	267	ug/L	107	91-113		50	

Analyte: Zinc/USEPA-6020

QC Batch: 0509101 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<50	ug/L				50	
Laboratory Control Sample		100	87.0	ug/L	87	80-137		50	

QC Batch: 0509326 (3010A Digestion)					Analyzed: 10/08/2005 By: JMF				
Method Blank			<50	ug/L				50	
Laboratory Control Sample		100	86.5	ug/L	86	80-137		1.0	

QUALITY CONTROL REPORT

Physical/Chemical Parameters by EPA/APHA/ASTM Methods

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Alkalinity, Bicarbonate/USEPA-310.1

QC Batch: 0509420 (General Inorganic Prep)					Analyzed: 10/06/2005 By: INR				
Method Blank			<2.0	mg/L				2.0	
Laboratory Control Sample		238	228	mg/L	96	89-111		2.0	

QC Batch: 0509016 (General Inorganic Prep)					Analyzed: 09/23/2005 By: VAS				
Method Blank			<2.0	mg/L				2.0	
Laboratory Control Sample		238	226	mg/L	95	89-111		2.0	

QC Batch: 0509153 (General Inorganic Prep)					Analyzed: 09/28/2005 By: VAS				
Method Blank			<5.0	mg/L				5.0	
Laboratory Control Sample		238	236	mg/L	99	89-111		5.0	

Analyte: Alkalinity, Carbonate/USEPA-310.1

QC Batch: 0509422 (General Inorganic Prep)					Analyzed: 10/06/2005 By: INR				
Method Blank			<2.0	mg/L				2.0	
Laboratory Control Sample		377	335	mg/L	89	0-200		2.0	

QC Batch: 0509017 (General Inorganic Prep)					Analyzed: 09/23/2005 By: VAS				
Method Blank			<2.0	mg/L				2.0	
Laboratory Control Sample		377	322	mg/L	85	0-200		2.0	

QC Batch: 0509154 (General Inorganic Prep)					Analyzed: 09/28/2005 By: VAS				
Method Blank			<5.0	mg/L				5.0	
Laboratory Control Sample		377	330	mg/L	88	87-110		5.0	

Analyte: Alkalinity, Total/USEPA-310.1

QC Batch: 0509423 (General Inorganic Prep)					Analyzed: 10/06/2005 By: INR				
Method Blank			<2.0	mg/L				2.0	
Laboratory Control Sample		238	228	mg/L	96	0-200		2.0	

QC Batch: 0509015 (General Inorganic Prep)					Analyzed: 09/23/2005 By: VAS				
Method Blank			<2.0	mg/L				2.0	

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QUALITY CONTROL REPORT

Physical/Chemical Parameters by EPA/APHA/ASTM Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Alkalinity, Total/USEPA-310.1 (Continued)

QC Batch: 0509015 (Continued) (General Inorganic Prep)						Analyzed: 09/23/2005 By: VAS			
Laboratory Control Sample		238	226	mg/L	95	0-200		2.0	

QC Batch: 0509150 (General Inorganic Prep)						Analyzed: 09/28/2005 By: VAS			
Method Blank			<2.0	mg/L				2.0	
Laboratory Control Sample		238	236	mg/L	99	0-200		2.0	

Analyte: Chloride/USEPA-325.2

QC Batch: 0509266 (General Inorganic Prep)						Analyzed: 10/03/2005 By: JLB			
Method Blank			<1.0	mg/L				1.0	
Laboratory Control Sample		49.7	49.6	mg/L	100	92-109			

QC Batch: 0509573 (General Inorganic Prep)						Analyzed: 10/11/2005 By: JLB			
Method Blank			<1.0	mg/L				1.0	
Laboratory Control Sample		49.7	49.4	mg/L	99	92-109			

QC Batch: 0509156 (General Inorganic Prep)						Analyzed: 09/28/2005 By: JLB			
Method Blank			<0.50	mg/L				0.50	
Laboratory Control Sample		49.7	50.2	mg/L	101	92-109			

Analyte: Fluoride/APHA 4500-F C

QC Batch: 0509483 (Method-Specific Preparation)						Analyzed: 10/07/2005 By: MSM			
Method Blank			<0.10	mg/L				0.10	

QC Batch: 0509205 (General Inorganic Prep)						Analyzed: 09/29/2005 By: VAS			
Method Blank			<0.10	mg/L				0.10	
Laboratory Control Sample		2.00	1.97	mg/L	98	88-116		0.10	

Analyte: Nitrogen, Ammonia/USEPA-350.1

QC Batch: 0509359 (Method-Specific Preparation)						Analyzed: 10/04/2005 By: GEH			
Method Blank			<0.020	mg/L				0.020	

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QUALITY CONTROL REPORT

Physical/Chemical Parameters by EPA/APHA/ASTM Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Nitrogen, Ammonia/USEPA-350.1 (Continued)

QC Batch: 0509359 (Continued) (Method-Specific Preparation)						Analyzed: 10/04/2005 By: GEH			
Laboratory Control Sample		0.810	0.765	mg/L	94	90-110		0.020	
QC Batch: 0509143 (General Inorganic Prep)						Analyzed: 09/27/2005 By: GEH			
Method Blank			<0.050	mg/L				0.050	
Laboratory Control Sample		0.810	0.789	mg/L	97	90-110		0.050	
QC Batch: 0509243 (Method-Specific Preparation)						Analyzed: 09/29/2005 By: GEH			
Method Blank			<0.020	mg/L				0.020	
Laboratory Control Sample		0.810	0.804	mg/L	99	90-110		0.020	

Analyte: Nitrogen, Nitrate/USEPA-353.2

QC Batch: 0509333 (Method-Specific Preparation)						Analyzed: 09/20/2005 By: HLB			
Method Blank			<0.050	mg/L				0.050	
Laboratory Control Sample		0.510	0.518	mg/L	102	90-110		0.050	
QC Batch: 0509071 (Method-Specific Preparation)						Analyzed: 09/21/2005 By: HLB			
Method Blank			<0.050	mg/L				0.050	
Laboratory Control Sample		0.510	0.541	mg/L	106	90-110		0.050	
QC Batch: 0509577 (Method-Specific Preparation)						Analyzed: 09/24/2005 By: HLB			
Method Blank			<0.050	mg/L				0.050	
Laboratory Control Sample		0.510	0.523	mg/L	103	90-110		0.050	
QC Batch: 0509733 (Method-Specific Preparation)						Analyzed: 09/28/2005 By: HLB			
Method Blank			<0.050	mg/L				0.050	
Method Blank			<0.050	mg/L				0.050	
Laboratory Control Sample		0.510	0.517	mg/L	101	90-110			
Laboratory Control Sample			0.517	mg/L		90-110		0.050	
QC Batch: 0509743 (Method-Specific Preparation)						Analyzed: 09/30/2005 By: HLB			
Method Blank			<0.050	mg/L				0.050	

Continued on next page

QUALITY CONTROL REPORT

Physical/Chemical Parameters by EPA/APHA/ASTM Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Nitrogen, Nitrate/USEPA-353.2 (Continued)

QC Batch: 0509743 (Continued) (Method-Specific Preparation)					Analyzed: 09/30/2005 By: HLB				
Method Blank			<0.050	mg/L				0.050	
Laboratory Control Sample		0.510	0.529	mg/L	104	90-110		0.050	
Laboratory Control Sample		0.510	0.529	mg/L	104	90-110		0.050	

Analyte: Phosphorus, Total/USEPA-365.1

QC Batch: 0508996 (365.1 Digestion)					Analyzed: 10/03/2005 By: INR				
Method Blank			<0.0100	mg/L				0.0100	
Laboratory Control Sample		0.400	0.409	mg/L	102	90-110		0.0100	

QC Batch: 0509273 (365.1 Digestion)					Analyzed: 10/05/2005 By: INR				
Method Blank			<0.0100	mg/L				0.0100	
Laboratory Control Sample		0.400	0.408	mg/L	102	90-110		0.0100	

QC Batch: 0508996 (365.1 Digestion)					Analyzed: 09/22/2005 By: INR				
Method Blank			<0.0100	mg/L				0.0100	
Laboratory Control Sample		0.400	0.420	mg/L	105	90-110		0.0100	

QC Batch: 0508996 (365.1 Digestion)					Analyzed: 09/27/2005 By: INR				
Method Blank			<0.0100	mg/L				0.0100	
Laboratory Control Sample		0.400	0.419	mg/L	105	90-110		0.0100	

Analyte: Residue, Dissolved @ 180° C/USEPA-160.1

QC Batch: 0509339 (General Inorganic Prep)					Analyzed: 10/03/2005 By: GEH				
Method Blank			<50	mg/L				50	
Laboratory Control Sample		1000	996	mg/L	100	0-200		50	
Laboratory Control Sample		1000	972	mg/L	97	0-200		50	
Laboratory Control Sample		200	208	mg/L	104	0-200		50	
Laboratory Control Sample		200	198	mg/L	99	0-200		50	

QC Batch: 0509024 (General Inorganic Prep)					Analyzed: 09/22/2005 By: GEH				
Method Blank			<2	mg/L				2	

Continued on next page

QUALITY CONTROL REPORT

Physical/Chemical Parameters by EPA/APHA/ASTM Methods (Continued)

QC Type	Sample Conc.	Spike Qty.	Result	Unit	Spike % Rec.	Control Limits	RPD	RPD Limits	RL
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Analyte: Residue, Dissolved @ 180° C/USEPA-160.1 (Continued)

QC Batch: 0509024 (Continued) (General Inorganic Prep)						Analyzed: 09/22/2005 By: GEH			
Laboratory Control Sample		200	198	mg/L	99	0-200		50	
Laboratory Control Sample		1000	968	mg/L	97	0-200		50	

QC Batch: 0509144 (General Inorganic Prep)						Analyzed: 09/27/2005 By: GEH			
Method Blank			<2	mg/L				2	
Laboratory Control Sample		200	194	mg/L	97	0-200		50	
Laboratory Control Sample		1000	928	mg/L	93	0-200		50	

Analyte: Sulfate/USEPA-375.4

QC Batch: 0509268 (General Inorganic Prep)						Analyzed: 10/03/2005 By: JLB			
Method Blank			<5.0	mg/L				5.0	
Laboratory Control Sample		23.8	23.7	mg/L	100	85-113			

QC Batch: 0509157 (General Inorganic Prep)						Analyzed: 09/28/2005 By: JLB			
Method Blank			<2.0	mg/L				2.0	
Laboratory Control Sample		23.8	23.7	mg/L	100	85-113			

Analyte: Sulfide/USEPA-376.1

QC Batch: 0509728 (Method-Specific Preparation)						Analyzed: 10/03/2005 By: JSS			
Method Blank			<1.0	mg/L				1.0	
Laboratory Control Sample		13.2	13.0	mg/L	98	80-120		1.0	

QC Batch: 0509192 (Method-Specific Preparation)						Analyzed: 09/20/2005 By: JSS			
Method Blank			<1.0	mg/L				1.0	
Laboratory Control Sample		11.6	11.0	mg/L	95	80-120		1.0	

QC Batch: 0509311 (Method-Specific Preparation)						Analyzed: 09/26/2005 By: JSS			
Method Blank			<1.0	mg/L				1.0	
Laboratory Control Sample		13.6	13.8	mg/L	101	80-120		1.0	

STATEMENT OF DATA QUALIFICATIONS

Dissolved Metals by EPA 6000/7000 Series Methods

Qualification: Analyte detected in the method blank

Analysis: USEPA-6020

0508945-BS1 Zinc

0508945-MS1 Zinc

0508945-MSD1 Zinc

0508945-PS1 Zinc

Sample/Analyte: 0509312-01 05EA-107-60-114.8 Zinc

Qualification: The CRL for Potassium fell outside of the 50-150% window.

Analysis: USEPA-6010B

5092802-CRL1 Potassium

Qualification: The % difference in results between the sample and a serial dilution of the sample exceeded the control limit. Sample matrix interference is suspected and the reported result is considered estimated.

Analysis: USEPA-6020

Sample/Analyte: 0509374-01 04EA-084 Barium

Qualification: The % difference between the values of the isotopes monitored for this analyte exceeded 25%; the lower of the two results has been reported.

Analysis: USEPA-6020

Sample/Analyte: 0509374-01 04EA-084 Copper

0509374-01 04EA-084 Selenium

0509453-02 Blind Dup.-F Copper

0509453-02 Blind Dup.-F Selenium

0509453-04 Field Blank-F Selenium

0509454-02 04-EA-084-817-981-2F Copper

0509454-02 04-EA-084-817-981-2F Selenium

Qualification: This analyte was not present in this sample at a concentration greater than 100 times the MDL, therefore serial dilution is not required.

Analysis: USEPA-6020

Sample/Analyte: 0509374-01 04EA-084 Arsenic

0509374-01 04EA-084 Molybdenum

0509374-01 04EA-084 Nickel

0509374-01 04EA-084 Zinc

Qualification: The RL for this analyte has been elevated due to sample matrix interference.

Analysis: USEPA-6020

Sample/Analyte: 0509374-01 04EA-084 Cadmium

0509453-02 Blind Dup.-F Cadmium

0509454-02 04-EA-084-817-981-2F Cadmium

STATEMENT OF DATA QUALIFICATIONS

Total Metals by EPA 6000/7000 Series Methods

Qualification: The % difference between the values of the isotopes monitored for this analyte exceeded 25%; the lower of the two results has been reported.

Analysis: USEPA-6020

Sample/Analyte:	0509374-01 04EA-084	Copper
	0509374-01 04EA-084	Selenium
	0509453-03 Blind Dup. U	Copper
	0509454-03 04EA-084-817-2U	Copper
	0509454-03 04EA-084-817-2U	Selenium

Qualification: This analyte was not present in this sample at a concentration greater than 50 times the MDL, therefore serial dilution is not required.

Analysis: USEPA-6010B

Sample/Analyte:	0509374-01 04EA-084	Lithium
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Qualification: The RPD between the MS and MSD results exceeded the control limit. The non-spiked sample result is considered estimated.

Analysis: USEPA-6010B

Sample/Analyte:	0509374-01 04EA-084	Aluminum
	0509374-01 04EA-084	Cobalt

Qualification: The MS and/or MSD recovery was outside the control limit. The non-spiked sample concentration for the same analyte was greater than or equal to 4 times the spiked amount; the non-spiked sample result is not qualified.

Analysis: USEPA-6010B

Sample/Analyte:	0509374-01 04EA-084	Boron
	0509374-01 04EA-084	Calcium
	0509374-01 04EA-084	Iron
	0509374-01 04EA-084	Magnesium

Qualification: Matrix QC results are not available due to sample dilution.

Analysis: USEPA-6010B

Sample/Analyte:	0509374-01 04EA-084	Sodium
	0509374-01 04EA-084	Strontium

Qualification: The RL for this analyte has been elevated due to sample matrix interference.

Analysis: USEPA-6020

Sample/Analyte:	0509374-01 04EA-084	Cadmium
	0509453-03 Blind Dup. U	Cadmium
	0509454-03 04EA-084-817-2U	Cadmium

STATEMENT OF DATA QUALIFICATIONS**Physical/Chemical Parameters by EPA/APHA/ASTM Methods**

Qualification: The EPA hold time for analysis was exceeded and the sample result(s) are considered estimated.

Analysis: USEPA-353.2

Sample/Analyte: 0509300-01 05EA-107-320-374.8

Nitrogen, Nitrate

APPENDIX F

CALIBRATION CERTIFICATES FOR INSTRUMENTATION

TABLE F-1
INSTRUMENTATION SUMMARY

Borehole ID	Borehole Inclination	Measured Gauge Depth	True Vertical Gauge Depth	Transducer Serial Number	Datalogger Serial Number	Transducer Pressure Range
	(degrees)	(meters)	(meters)			(kPa)
YD02-20 Upper Bedrock Lower Bedrock	90	23.38	23.38	05-10383	3563	350
		244.45	244.40	05-8438	3579	3000
04EA-074 Upper Bedrock Lower Bedrock	56	30.45	25.22	05-10384	3580	350
		240.76	192.00	05-8437	3564	3000
04EA-077 Upper Bedrock Lower Bedrock	70	49.14	46.34	05-9447	3578	700
		192.45	182.46	05-7644	3565	2000
QAL-023	90	9.03	9.03	11987	11987	206
QAL-043	90	5.48	5.48	3420	3420	103
QAL-044	90	6.16	6.16	18010	18010	103
04EA-084	60	246.90	215.71	46261	3617	5171
05EA-107	87	15.91 to 28.79	15.89 to 28.74	46261	3617	5171
Barometer	NA	NA	NA	66465	214	17

All transducers measure "gauge pressure"



48 Spencer St Lebanon, NH 03766 USA

YD02-20 Upper Bedrock Transducer

Vibrating Wire Pressure Transducer Calibration Report

Type: SDate of Calibration: July 22, 2005Serial Number: 05-10383Temperature: 21.4 °CPressure Range: 350 kPa†Barometric Pressure: 993.0 mbarCal. Std. Cntrl. #(s): 524, 529, 511, 506, 069, 309, 080, 081Technician: K. Bellavance

Applied Pressure (kPa)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	8791	8792	8792	-0.092	-0.03	0.115	0.03
70.0	8159	8159	8159	70.03	0.01	70.00	0.00
140.0	7529	7529	7529	139.9	-0.04	139.8	-0.07
210.0	6894	6894	6894	210.3	0.08	210.2	0.04
280.0	6263	6264	6264	280.2	0.05	280.2	0.06
350.0	5636	5636	5636	349.7	-0.07	349.9	-0.03

(kPa) Linear Gage Factor (G): 0.1109 (kPa/ digit) Regression Zero: 8791Polynomial Gage Factors: A: 1.142E-07 B: -0.1125 C: 980.4Thermal Factor (K): -0.1180 (kPa/ °C)(psi) Linear Gage Factor (G): 0.01608 (psi/ digit)Polynomial Gage Factors: A: 1.65566E-08 B: -0.01632 C: 142.19Thermal Factor (K): -0.01711 (psi/ °C)

Calculated Pressures:

$$\text{Linear, } P = G(R_0 - R_1) + K(T_1 - T_0) - (S_1 - S_0)**$$

$$\text{Polynomial, } P = AR_1^2 + BR_1 + C + K(T_1 - T_0) - (S_1 - S_0)**$$

†Barometric pressures are absolute. Barometric compensation is not required with vented and differential pressure transducers.

Factory Zero Reading:

GK-401 Pos. B or F(R₀): 8794 Temp(T₀): 22.2 °C †Baro(S₀): 987.4 mbar Date: July 27, 2005

*Initial zero readings must be established in the field following the procedures described in the Instruction Manual. If the Polynomial equation is used the field value of C must be calculated by plugging the initial zero reading into the polynomial equation with the value of P set to zero

The above instrument was found to be in tolerance in all operating ranges

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1

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8001 Calibration Data Sheet

Customer: Golder Associates, Inc. Job Number: 203672Calibration Date: August 03, 2005 Calibration Recall August 03, 2006

Calibration Instruction: AI-8001 Rev: B

Serial Number 3563 Calibration Technician Shirley M. Zocchi

TRANSOMER BOREHOLE
05-10383 DHEA-20 (75')

Frequency (HZ)	Actual Freq. Counter Reading (HZ) F	Computed Reading in Digit $F^2 \times 10^{-3}$	Actual 8001 Reading	Error in Digits *. C-A	Maximum Error
750.00	750.08	562.62	562.50	0.12	± 4
1500.00	1500.17	2250.51	2249.80	0.71	± 4
3000.00	3000.34	9002.04	8999.20	2.84	± 4

*Error = Computed Reading - Actual Reading

Calibration Standards:

Control Number 017 Calibration recall date: January 12, 2006

This certifies the above named instrument has been calibrated by comparison with standards traceable to the National Institute of Standards and Technology (NIST) in compliance with ANSI/NCSL Z540-1 and is in tolerance as found.

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48 Spencer St. Lebanon, N.H. 03766 USA

YD02-20 Lower Bedrock Transducer

Vibrating Wire Pressure Transducer Calibration Report

Type: SDate of Calibration: July 22, 2005Serial Number: 05-8438 04EA-30 (200')Temperature: 22.6 °CPressure Range: 3 MPa DATA LOGGER 3579†Barometric Pressure: 991.9 mbarCal. Std. Cntrl. #(s): 524, 529, 511, 506, 069, 309, 080, 081Technician: Y. Bellavance

Applied Pressure (MPa)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	8832	8833	8833	0.005	0.18	0.000	0.01
0.6	8153	8153	8153	0.600	-0.02	0.601	0.02
1.2	7473	7472	7473	1.195	-0.18	1.199	-0.05
1.8	6785	6784	6785	1.796	-0.12	1.800	0.01
2.4	6095	6096	6096	2.399	-0.04	2.400	0.01
3.0	5402	5402	5402	3.005	0.18	3.000	0.00

(MPa) Linear Gage Factor (G): 0.0008745 (MPa/ digit) Regression Zero: 8839Polynomial Gage Factors: A: -3.450E-09 B: -0.0008254 C: 7.5594Thermal Factor (K): 0.0005718 (MPa/ °C)(psi) Linear Gage Factor (G): 0.1267 (psi/ digit)Polynomial Gage Factors: A: -5.00012E-07 B: -0.1196 C: 1095.6Thermal Factor (K): 0.0829 (psi/ °C)Calculated Pressures: Linear, $P = G(R_0 - R_1) + K(T_1 - T_0) - (S_1 - S_0)**$ Polynomial, $P = AR_1^2 + BR_1 + C + K(T_1 - T_0) - (S_1 - S_0)**$ †Barometric pressures are absolute. Barometric compensation is not required with vented and differential pressure transducers.

Factory Zero Reading:

GK-401 Pos B or F(R₀): 8829 Temp(T₀): 22.4 °C †Baro(S₀): 987.4 mbar Date: July 27, 2005

*Initial zero readings must be established in the field following the procedures described in the Instruction Manual. If the Polynomial equation is used the field value of C must be calculated by plugging the initial zero reading into the polynomial equation with the value of P set to zero.

The above instrument was found to be in tolerance in all operating ranges
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1

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**8001 Calibration Data Sheet**Customer: Golder Associates, Inc. Job Number: 203672Calibration Date: August 03, 2005 Calibration Recall August 03, 2006

Calibration Instruction: AI-8001 Rev: B

Serial Number 3579 Calibration Technician Sheree M. Zocchi

04EA-80 (800)
05-8438

Frequency (HZ)	Actual Freq. Counter Reading (HZ) F	Computed Reading in Digit $F^2 \times 10^{-3}$	Actual 8001 Reading	Error in Digits *. C-A	Maximum Error
750.00	750.08	562.62	562.40	0.22	±4
1500.00	1500.17	2250.51	2249.70	0.81	±4
3000.00	3000.34	9002.04	8999.10	2.94	±4

*Error = Computed Reading - Actual Reading

Calibration Standards:

Control Number 017 Calibration recall date: January 12, 2006

This certifies the above named instrument has been calibrated by comparison with standards traceable to the National Institute of Standards and Technology (NIST) in compliance with ANSI/NCSL Z540-1 and is in tolerance as found.

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48 Spencer St. Lebanon, N H. 03766 USA

04EA-074 Upper Bedrock Transducer

Vibrating Wire Pressure Transducer Calibration Report

Type: SDate of Calibration: July 22, 2005Serial Number: 05-10384 [04EA-74 000]
(DATA LOGGER 3580)Temperature: 21.4 °CPressure Range: 350 kPa†Barometric Pressure: 993.0 mbarCal. Std. Cntrl. #(s): 524, 529, 511, 506, 069, 309, 080, 081Technician: Kil Belkance

Applied Pressure (kPa)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	8717	8717	8717	-0.526	-0.15	-0.013	0.00
70.0	7957	7956	7957	70.12	0.04	69.97	-0.01
140.0	7199	7200	7200	140.4	0.13	140.1	0.02
210.0	6447	6448	6448	210.3	0.09	209.9	-0.01
280.0	5695	5696	5696	280.2	0.05	280.1	0.03
350.0	4949	4950	4950	349.5	-0.15	350.0	0.01

(kPa) Linear Gage Factor (G): 0.0929 (kPa/ digit) Regression Zero: 8711Polynomial Gage Factors: A: 2.703E-07 B: -0.0966 C: 821.4Thermal Factor (K): -0.1688 (kPa/ °C)(psi) Linear Gage Factor (G): 0.01347 (psi/ digit)Polynomial Gage Factors: A: 3.91971E-08 B: -0.01401 C: 119.14Thermal Factor (K): -0.02448 (psi/ °C)Calculated Pressures: Linear, $P = G(R_0 - R_1) + K(T_1 - T_0) - (S_1 - S_0)^{**}$ Polynomial, $P = AR_1^2 + BR_1 + C + K(T_1 - T_0) - (S_1 - S_0)^{**}$ †Barometric pressures are absolute. Barometric compensation is not required with vented and differential pressure transducers

Factory Zero Reading:

GK-401 Pos B or F(R₀): 8713 Temp(T₀): 23.5 °C †Baro(S₀): 987.4 mbar Date: July 27, 2005

*Initial zero readings must be established in the field following the procedures described in the Instruction Manual. If the Polynomial equation is used the field value of C must be calculated by plugging the initial zero reading into the polynomial equation with the value of P set to zero

The above instrument was found to be in tolerance in all operating ranges

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1

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**8001 Calibration Data Sheet**Customer: Golder Associates, Inc. Job Number: 203672Calibration Date: August 03, 2005 Calibration Recall August 03, 2006

Calibration Instruction: AI-8001 Rev: B

Serial Number 3580 Calibration Technician Shrese M. Zocchi

05-10384

04EA-74 (100')

Frequency (HZ)	Actual Freq. Counter Reading (HZ) F	Computed Reading in Digit $F^2 \times 10^{-3}$	Actual 8001 Reading	Error in Digits *. C-A	Maximum Error
750.00	750.08	562.62	562.50	0.12	± 4
1500.00	1500.17	2250.51	2249.80	0.71	± 4
3000.00	3000.34	9002.04	8999.40	2.64	± 4

*Error = Computed Reading - Actual Reading

Calibration Standards:

Control Number 017 Calibration recall date: January 12, 2006

This certifies the above named instrument has been calibrated by comparison with standards traceable to the National Institute of Standards and Technology (NIST) in compliance with ANSI/NCSL Z540-1 and is in tolerance as found.

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04EA-074 Lower Bedrock Transducer

Vibrating Wire Pressure Transducer Calibration Report

Type: SDate of Calibration: July 22, 2005Serial Number: 05-8437

04EA-74(790')

Temperature: 22.6 °CPressure Range: 3 MPa

3564 DATA LOGGER

†Barometric Pressure: 991.9 mbarCal. Std. Cntrl. #(s): 524, 529, 511, 506, 069, 309, 080, 081Technician: J. Bellavance

Applied Pressure (MPa)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	8854	8855	8855	0.007	0.22	0.000	0.01
0.6	8146	8147	8147	0.599	-0.02	0.601	0.03
1.2	7437	7436	7437	1.194	-0.22	1.199	-0.05
1.8	6718	6718	6718	1.795	-0.17	1.800	0.01
2.4	5996	5997	5997	2.399	-0.04	2.401	0.02
3.0	5270	5271	5271	3.007	0.22	3.000	0.01

(MPa) Linear Gage Factor (G): 0.0008370 (MPa/ digit) Regression Zero: 8862Polynomial Gage Factors: A: -3.956E-09 B: -0.0007811 C: 7.2267Thermal Factor (K): 0.0007291 (MPa/ °C)(psi) Linear Gage Factor (G): 0.1213 (psi/ digit)Polynomial Gage Factors: A: -5.73326E-07 B: -0.1132 C: 1047.3Thermal Factor (K): 0.1057 (psi/ °C)Calculated Pressures: Linear, $P = G(R_0 - R_1) + K(T_1 - T_0) - (S_1 - S_0)**$ Polynomial, $P = AR_1^2 + BR_1 + C + K(T_1 - T_0) - (S_1 - S_0)**$ †Barometric pressures are absolute. Barometric compensation is not required with vented and differential pressure transducers.

Factory Zero Reading:

GK-401 Pos. B or F(R₀): 8854 Temp(T₀): 22.2 °C †Baro(S₀): 987.4 mbar Date: July 27, 2005

*Initial zero readings must be established in the field following the procedures described in the Instruction Manual. If the Polynomial equation is used the field value of C must be calculated by plugging the initial zero reading into the polynomial equation with the value of P set to zero.

The above instrument was found to be in tolerance in all operating ranges
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1

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**8001 Calibration Data Sheet**Customer: Golder Associates, Inc. Job Number: 203672Calibration Date: August 03, 2005 Calibration Recall August 03, 2006

Calibration Instruction: AI-8001 Rev: B

Serial Number 3564 Calibration Technician Sheree M. ZocchiTRANSDUCER
05-8437BORING
04EA-74(790')

Frequency (HZ)	Actual Freq. Counter Reading (HZ) F	Computed Reading in Digit $F^2 \times 10^{-3}$	Actual 8001 Reading	Error in Digits *. C-A	Maximum Error
750.00	750.08	562.62	562.40	0.22	±4
1500.00	1500.17	2250.51	2249.70	0.81	±4
3000.00	3000.34	9002.04	8999.00	3.04	±4

*Error = Computed Reading - Actual Reading

Calibration Standards:

Control Number 017 Calibration recall date: January 12, 2006

This certifies the above named instrument has been calibrated by comparison with standards traceable to the National Institute of Standards and Technology (NIST) in compliance with ANSI/NCSL Z540-1 and is in tolerance as found.

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48 Spencer St. Lebanon, N.H. 03766 USA

04EA-077 Upper Bedrock Transducer

Vibrating Wire Pressure Transducer Calibration Report

Type: SDate of Calibration: July 25, 2005Serial Number: 05-9447Temperature: 21.3 °CPressure Range: 700 kPa†Barometric Pressure: 986.0 mbarCal. Std. Cntrl. #(s): 524, 529, 511, 506, 069, 309, 080, 081Technician: J. Bellavance

Applied Pressure (kPa)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	8704	8704	8704	0.768	0.11	0.038	0.01
140.0	7868	7868	7868	139.8	-0.04	139.9	-0.02
280.0	7027	7028	7028	279.5	-0.07	280.2	0.02
420.0	6186	6185	6186	419.5	-0.08	420.0	0.00
560.0	5342	5341	5342	559.8	-0.03	559.8	-0.02
700.0	4493	4494	4494	700.8	0.11	700.1	0.01

(kPa) Linear Gage Factor (G): 0.1662 (kPa/ digit)Regression Zero: 8709Polynomial Gage Factors: A: -3.098E-07 B: -0.1622 C: 1434.9Thermal Factor (K): -0.0573 (kPa/ °C)(psi) Linear Gage Factor (G): 0.02411 (psi/ digit)Polynomial Gage Factors: A: -4.49293E-08 B: -0.02352 C: 208.12Thermal Factor (K): -0.00831 (psi/ °C)

Calculated Pressures:

Linear, $P = G(R_0 - R_1) + K(T_1 - T_0) - (S_1 - S_0)**$ Polynomial, $P = AR_1^2 + BR_1 + C + K(T_1 - T_0) - (S_1 - S_0)**$ †Barometric pressures are absolute. Barometric compensation is not required with vented and differential pressure transducers

Factory Zero Reading:

GK-401 Pos B or F(R₀): 8702 Temp(T₀): 23.1 °C †Baro(S₀): 986.2 mbar Date: July 27, 2005

*Initial zero readings must be established in the field following the procedures described in the Instruction Manual. If the Polynomial equation is used the field value of C must be calculated by plugging the initial zero reading into the polynomial equation with the value of P set to zero.

The above instrument was found to be in tolerance in all operating ranges

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1

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**8001 Calibration Data Sheet**Customer: Golder Associates, Inc. Job Number: 203672Calibration Date: August 03, 2005 Calibration Recall August 03, 2006

Calibration Instruction: AI-8001 Rev: B

Serial Number 3578 Calibration Technician Shereen M Zocchi

TRANSQUAR

BORING

05-9447

04EA-77(160')

Frequency (HZ)	Actual Freq. Counter Reading (HZ) F	Computed Reading in Digit $F^2 \times 10^{-3}$	Actual 8001 Reading	Error in Digits *. C-A	Maximum Error
750.00	750.08	562.62	562.40	0.22	±4
1500.00	1500.17	2250.51	2249.70	0.81	±4
3000.00	3000.34	9002.04	8999.00	3.04	±4

*Error = Computed Reading - Actual Reading

Calibration Standards:

Control Number 017 Calibration recall date: January 12, 2006

This certifies the above named instrument has been calibrated by comparison with standards traceable to the National Institute of Standards and Technology (NIST) in compliance with ANSI/NCSL Z540-1 and is in tolerance as found.

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48 Spencer St. Lebanon, N.H. 03766 USA

04EA-077 Lower Bedrock Transducer

Vibrating Wire Pressure Transducer Calibration Report

Type: SDate of Calibration: July 22, 2005Serial Number: 05-7644DATALOGGER 3565
BORING 04EA-77(630')Temperature: 22.1 °CPressure Range: 2 MPa†Barometric Pressure: 992.5 mbarCal. Std. Cntrl. #(s): 524, 529, 511, 506, 069, 309, 428, 028Technician: K. Bellavance

Applied Pressure (MPa)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	8734	8734	8734	0.004	0.19	0.000	0.00
0.4	8024	8023	8024	0.399	-0.05	0.400	-0.02
0.8	7308	7308	7308	0.797	-0.15	0.800	0.00
1.2	6589	6589	6589	1.197	-0.15	1.200	0.00
1.6	5867	5865	5866	1.599	-0.04	1.599	-0.03
2.0	5139	5138	5139	2.004	0.19	2.000	-0.01

(MPa) Linear Gage Factor (G): 0.0005562 (MPa/ digit)Regression Zero: 8741Polynomial Gage Factors: A: -2.209E-09B: -0.0005256C: 4.7591Thermal Factor (K): 0.0003941 (MPa/ °C)(psi) Linear Gage Factor (G): 0.08061 (psi/ digit)Polynomial Gage Factors: A: -3.20118E-07B: -0.07617C: 689.72Thermal Factor (K): 0.05711 (psi/ °C)

Calculated Pressures:

$$\text{Linear, } P = G(R_0 - R_1) + K(T_1 - T_0) - (S_1 - S_0)^{**}$$

$$\text{Polynomial, } P = AR_1^2 + BR_1 + C + K(T_1 - T_0) - (S_1 - S_0)^{**}$$

†Barometric pressures are absolute. Barometric compensation is not required with vented and differential pressure transducers.

Factory Zero Reading:

GK-401 Pos. B or F(R₀): 8732Temp(T₀): 22.4 °C†Baro(S₀): 987.4 mbarDate: July 27, 2005

*Initial zero readings must be established in the field following the procedures described in the Instruction Manual. If the Polynomial equation is used the field value of C must be calculated by plugging the initial zero reading into the polynomial equation with the value of P set to zero.

The above instrument was found to be in tolerance in all operating ranges

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1

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**8001 Calibration Data Sheet**Customer: Golder Associates, Inc. Job Number: 203672Calibration Date: August 03, 2005 Calibration Recall August 03, 2006

Calibration Instruction: AI-8001 Rev: B

Serial Number 3565 Calibration Technician *Shereese M. Zecchi*TRANSDUCER BORING
05-7644 04EA-77 (630')

Frequency (HZ)	Actual Freq. Counter Reading (HZ) F	Computed Reading in Digit $F^2 \times 10^{-3}$	Actual 8001 Reading	Error in Digits *. C-A	Maximum Error
750.00	750.08	562.62	562.40	0.22	±4
1500.00	1500.17	2250.51	2249.70	0.81	±4
3000.00	3000.34	9002.04	8999.00	3.04	±4

*Error = Computed Reading - Actual Reading

Calibration Standards:

Control Number 017 Calibration recall date: January 12, 2006

This certifies the above named instrument has been calibrated by comparison with standards traceable to the National Institute of Standards and Technology (NIST) in compliance with ANSI/NCSL Z540-1 and is in tolerance as found.

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Downhole Testing Transducer
05EA-107 and 04EA-084

Vibrating Wire Pressure Transducer Calibration

Model Number: 4500H-750 Pressure Range: 750 psi
Serial Number: 46261 Mfg. Number: 4-801
Customer: Golder Associates, Inc. Temperature: 22 °C
Cust. I.D. #: n/a Barometric Pressure: 1001 mbar
Job Number: 12356 Date: Dec. 22, 1994
Cal. Std. Control #(s): 177 Technician: DB

Pressure (psi)	Reading 1st Cycle	Pressure (psi)	Reading 2nd Cycle	Average Pressure	Average Reading	Change	Linearity (%FS)	Polynomial Fit (%FS)
0	9354	0	9354	0	9354		0.21	-0.04
150	8567	150	8571	150	8569	785	0.04	0.09
300	7785	300	7790	300	7788	782	-0.23	-0.03
450	6996	450	6996	450	6996	792	-0.24	-0.03
600	6197	600	6196	600	6197	800	-0.05	0.00
750	5391	750	5393	750	5392	805	0.26	0.01

Linear Gage Factor (G): 0.18939 (psi/digit) Regression Zero: 9362

Polynomial Gage Factors: A: -9.13E-07 B: -0.17592 C:* 1725.22142

Thermal Factor (K): -0.038691 (psi/°C)

Calculated Pressures: Linear, $P = G(R_0 - R_1) + K(T_1 - T_0) - (S_1 - S_0)**$

Polynomial, $P = AR_1^2 + BR_1 + C + K(T_1 - T_0) - (S_1 - S_0)**$

***Barometric compensation is not required with vented transducers.*

Factory Zero Reading:

GK-401 Pos. B or F(R₀): 9350 Temp(T₀): 22.1 °C Baro(S₀): 991.2 mbar Date: August 18, 1998

**The user is advised to establish zero conditions in the field by recording the reading at a known temperature and barometric pressure.*

Wiring Code: Red and Black: Gage White and Green: Thermistor Bare: Shield

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.



48 Spencer St. Lebanon, N.H. 03766 USA

Barometer Transducer

Vibrating Wire Pressure Transducer Calibration Report

Type: DDate of Calibration: September 1, 2005Serial Number: 01-6193 / 66465Temperature: 23.6 °CPressure Range: 17 kPa†Barometric Pressure: 986.0 mbarCal. Std. Cntrl. #(s): 524, 529, 511, 506, 069, 309, 402, 428Technician: K. Bellavance

Applied Pressure (kPa)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	4736	4736	4736	-0.034	-0.20	-0.005	-0.03
3.4	5525	5522	5524	3.417	0.10	3.418	0.10
6.8	6298	6301	6300	6.818	0.10	6.788	-0.07
10.2	7076	7077	7077	10.22	0.13	10.20	-0.02
13.6	7848	7848	7848	13.60	0.02	13.60	-0.01
17.0	8617	8617	8617	16.97	-0.16	17.00	0.01

(kPa) Linear Gage Factor (G): -0.004382 (kPa/ digit)Regression Zero: 4744Polynomial Gage Factors: A: 1.437E-08 B: 0.004190 C: -20.172Thermal Factor (K): -0.009125 (kPa/ °C)(psi) Linear Gage Factor (G): -0.0006356 (psi/ digit)Polynomial Gage Factors: A: 2.08424E-09 B: 0.0006077 C: -2.9257Thermal Factor (K): -0.0013235 (psi/ °C)

Calculated Pressures:

Linear, $P = G(R_0 - R_1) + K(T_1 - T_0) - (S_1 - S_0)^{**}$ Polynomial, $P = AR_1^2 + BR_1 + C + K(T_1 - T_0) - (S_1 - S_0)^{**}$ †Barometric pressures are absolute. Barometric compensation is not required with vented and differential pressure transducers.

Factory Zero Reading:

GK-401 Pos. B or F(R₀): 4744 Temp(T₀): 23.0 °C †Baro(S₀): 986.8 mbar Date: September 01, 2005

*Initial zero readings must be established in the field following the procedures described in the Instruction Manual. If the Polynomial equation is used the field value of C must be calculated by plugging the initial zero reading into the polynomial equation with the value of P set to zero.

The above instrument was found to be in tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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QAL-023

Calibration Report

Report Number: 20041221093311897

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miniTROLL

Calibration Result:

PASSED

Instrument Type:	miniTROLL
Calibration Date:	2004-12-21
Model Number:	SSP-100
Full Scale Pressure Range:	206.8427 kPa (30 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	11897

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 41014
2. Instrulab model 832 s/n 12070(RTD-03)
3. Ruska model 7215xi s/n 53144
4. Automated software calibration procedures used.

Range of Applied Temperature:

-5.18 C to 49.77 C

Range of Applied Pressure:

0.0002 kPa (0.0000 PSI) to 206.8525 kPa (30.0014 PSI)

Temperature Calibration:

Temperature Accuracy Specification:

+/- 0.25 C

Temperature Calibration Results:

PASSED

Pressure Calibration: Range For 30psig: 21.1m, 69.20ft.

Pressure Accuracy Specification:

At 15.0 C
 +/- 0.050 %FS

Over entire temperature range

+/- 0.100 %FS

Pressure Calibration Result:

PASSED

PASSED

Post-Calibration Check:

Temperature

Applied
 35.26 C

Reported
 35.25 C

Pressure

Applied
 0.0001 PSI

Reported
 0.0012 PSI

9.9002 PSI

9.9993 PSI

20.0996 PSI

20.0990 PSI

29.9995 PSI

29.9981 PSI

20.1000 PSI

20.0975 PSI

9.9005 PSI

9.9026 PSI

0.0002 PSI

0.0028 PSI

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Test Performed By: JB

Test Verified By:

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QAL-043

Calibration Report

Report Number: 2005102615533420

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QAMiniTROLL

Calibration Result:

PASSED

Instrument Type:	miniTROLL
Calibration Date:	2005-10-26
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	3420

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 41014
2. Instrulab model 832 s/n 12068(RTD-04)
3. Ruska model 7215xi s/n 53143
4. Automated software calibration procedures used.

Range of Applied Temperature:

-5.17 C to 49.77 C

Range of Applied Pressure:

0.0003 kPa (0.0000 PSI) to 103.4240 kPa (15.0004 PSI)

Temperature Calibration:

Temperature Accuracy Specification:

+/- 0.25 C

Temperature Calibration Results:

PASSED

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

Pressure Accuracy Specification:

At 15.0 C
 +/- 0.100 %FS

Over entire temperature range

+/- 0.200 %FS

Pressure Calibration Result:

PASSED

PASSED

Post-Calibration Check:

Temperature

Applied	Reported
35.27 C	35.27 C

Pressure

Applied	Reported
0.0001 PSI	0.0010 PSI
4.9492 PSI	4.9494 PSI
10.0496 PSI	10.0515 PSI
15.0009 PSI	14.9992 PSI
10.0498 PSI	10.0500 PSI
4.9490 PSI	4.9504 PSI
0.0001 PSI	0.0020 PSI

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Test Performed By: LLL

Test Verified By:

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QAL-044

Calibration Report

Report Number: 20050723164118010

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miniTROLL

Calibration Result:

PASSED

Instrument Type:	miniTROLL
Calibration Date:	2005-07-23
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	18010

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 41014
2. Instrulab model 832 s/n 12068(RTD-04)
3. Ruska model 7215xi s/n 53143
4. Automated software calibration procedures used.

Range of Applied Temperature:

-5.17 C to 49.74 C

Range of Applied Pressure:

-0.0001 kPa (-0.0000 PSI) to 103.4258 kPa (15.0007 PSI)

Temperature Calibration:

Temperature Accuracy Specification:

+/- 0.25 C

Temperature Calibration Results:

PASSED

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

Pressure Accuracy Specification:

At 15.0 C
 +/- 0.100 %FS

Over entire temperature range

Pressure Calibration Result:

PASSED

+/- 0.200 %FS

PASSED

Post-Calibration Check:

Temperature

Applied
 35.25 C

Reported
 35.23 C

Pressure

Applied
 0.0002 PSI

Reported
 -0.0024 PSI

4.9501 PSI

4.9438 PSI

10.0493 PSI

10.0471 PSI

14.9997 PSI

14.9966 PSI

10.0501 PSI

10.0490 PSI

4.9498 PSI

4.9488 PSI

0.0002 PSI

-0.0019 PSI

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Test Performed By: LLL

Test Verified By:

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