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Best Environmental Subsurface Sampling Technologies

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H2-Vape™

Written SOPs

BESST, INC.
16 Diane Lane, Suite 100, Larkspur, CA 94939
866.298.8701 / 415.453.2501 / 415.453.2509 (fax)
email: besstprobes@aol.com
www.besstinc.com

STANDARD OPERATING PROCEDURES FOR THE H2-Vape Probe™

(Collecting Continuous Soil Gas With Cone Penetrometer and Then Collecting Groundwater – In One Push)

1.0 Introduction:

The following SOP reviews the assembly, and operational procedures for the H2-Vape Probe™ in the continuous soil gas mode, using a CPT rig; including the option of collecting a groundwater sample in the same push – after the soil gas samples have been collected. One point of note is that there are four O-Rings used with the H2-Vape Probe™ in all operations and are described in detail in the assembly instructions below. It is important to realize that the H2-Vape Probe™ is not limited to use with CPT. It has been successfully used with the following drill methods:

- CPT
- Mud Rotary (94mm) and others (covered in this SOP)
- Air Rotary Casing Hammer
- Dual Wall Percussion
- Inside Sonic Pipe
- Hollow Stem Auger (Covered in this SOP)

2.0 General Description of Drive and Sniff with the H2-Vape Probe™:

2.1 Introduction

Drive and Sniff is a unique concept that was originated by SimulProbe® Technologies in 1995, and is now being applied to the H2-Vape Probe™. Drive and Sniff (D&S) works by using the following ingredients:

2.1.1 Up-hole Vacuum Pump
2.1.2 Soil Gas Line from the Vacuum Pump to the top of the H2-Vape Probe™.
2.1.3 The H2-Vape Probe™ Circumferential Seam
2.1.4 The H2-Vape Probe™ Sliding Drive Shoe

2.2 Fundamentals

The H2-Vape Probe™ is a unique sampling device in that it can collect soil gas continuously with a CPT rig as it is pushed deeper and deeper through the vadose zone. This is made possible by the Circumferential Seam technology that is incorporated into the device.

The Circumferential Seam (the seam) is a leaky and very thin (0.5mm) soil gas entrance to the inside of the device; where the soil gas sample can be sucked to the ground surface. The seam is formed when the

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16 Diane Lane, Suite 100, Larkspur, CA 94939
866.298.8701 / 415.453.2501 / 415.453.2509 fax / besstprobes@aol.com

sliding drive shoe on the down hole side of the tool is in the closed position – abutting against the lower end of the main body of the device.

Figure 1 shows the H2-Vape Probe™ with the sliding shoe in the closed and open position. Note that when the sliding shoe is open, that there is a stainless steel wire mesh screen exposed. This is simply a filter that keeps out dust and fine sediments from the soil gas path – if any was to slip through the seam when it is in the closed position.

However, the slide shoe need not be open when collecting any of the soil gas samples in the same push. This is because the air molecules in the sediment pore spaces are very small compared to the thinness of the seam (0.5mm). So, it is easy for gas phase pore molecules to slide through the seam when it is closed. We call this a leaky seam. The reason why the seam is leaky is because during the machining process, micron sized ridges and valleys are formed on the metal surface as the part is being cut. Even after the part is polished, these ridges and grooves remain. It is through the micron-sized grooves that the pore gas molecules travel when a soil gas sample is collected under vacuum. The wire mesh screen can be changed easily after each CPT hole is completed.

From a mechanical and practical point of view, the seam has proven to be difficult to plug off with sediment when using a CPT rig – so this is a good thing. This is because soil is swiped past the seam continuously as the tool is pushed with the CPT rig; and forms essentially a self cleaning process where the new soil cleans or wipes away the old soil as each sediment layer comes into contact with the seam. Therefore, every stratigraphic horizon during the D&S push is a potential monitoring point.

As the soil gas is pulled in through the seam, the gas molecules rise internally through the tool to the vacuum line connected to the top of the probe. The gas then travels through the vacuum line to the pump at the ground surface, where soil gas samples can be collected, and soil gas concentrations monitored and measured in various ways.

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2.3 General Drive and Sniff Procedure

2.3.1 CPT drives H2-Vape Probe™ to target soil gas sampling point

2.3.2 Stop drive

2.3.3 Turn on vacuum pump

2.3.4 Purge the Soil Gas Line and monitor vacuum, flow, and VOC discharge with an FID, PID, or portable GC; from vacuum pump discharge, through a syringe port, vacuum box with Tedlar bag or Summa canister prior to the pump intake. A single purge volume of the H2-Vape Probe™ is 730ml when using the 1/3-liter Water Canister and 1,400ml when using the 1-liter Water Canister. The purge volume of the Soil Gas Line for a 3/16" ID tube is 5.43ml/ft. Therefore, a 100ft. line has a single purge volume of 543ml. The total single purge volume for this example is 1,243ml when using the 1/3-liter Water Canister. If the flow meter on the vacuum pump reads a flow rate of 1-litre (1,000ml) per minute, then it will take approximately 75 seconds to complete one total purge volume (line + tool). When using the 1-liter Canister and 100 feet of tubing, the total purge volume would be 1,943ml and the total purge time for a single volume would be about 2 minutes.

Note: When applying a vacuum, soil gas is able to move through the one-way Reed Valve at the bottom of the Water Canister. Since the groundwater canister is attached, its volume has been included in the total for a single purge volume.

2.3.5 As the purging proceeds, PID and/or FID readings should be recorded. BESST, Inc. recommends 2 to 6 total purge volumes in most situations before collecting a final PID and/or FID reading and soil gas sample. A Tedlar bag, syringe, or Summa canister sample can be used to collect soil gas samples for lab analysis. Also, a Tedlar bag could be filled with soil gas and then connected directly to the sniffer tube of the PID or FID for a fixed volume semi quantitative analysis for TVOC (total volatile organic compounds). The Tedlar bag, Soil Gas Line and H2-Vape Probe ™ can be purged under positive pressure with nitrogen gas (or helium) between each sampling event – if required by site specific protocol.

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3.0 Assembly:

3.1 O-rings:

3.1.1 Fat 1-Inch O-ring x 1/8-Inch cross section. This O-ring is used on two places. The first is around the Drive Cone and the second is around the Perforated Washer. Both parts are part of the 15-Inch PVC Screen Extension.

3.1.2 1-Inch O-ring x 1/16-Inch cross section. This O-ring is used near the bottom of the AW thread on the Water Canister Base.

3.1.3 2-Inch O-ring x 1/16-Inch cross section. This O-ring is used in two places on the H2-Vape Probe™. The first place is in the O-ring groove on the Water Canister Base and the second is the O-ring groove on the Water Canister Top. Each one of these two O-rings faces the bottom and top rim of the Water Canister, respectively.

3.1.4 Fat 1.5-Inch O-ring x 1/8-Inch cross section. This O-ring is used in two places. The first is at the base of the tapered thread of the Water Canister Base, and the second place is at the base of the tapered thread of the Water Canister Top. Therefore, each of these two O-rings resides very close to each of the 2-Inch O-rings.

3.2 Place a Conical Screen over the intake ports on the lower end of the H2-Vape Probe™.

3.3 Screw the Teflon Screen Retention Ring onto the bottom end of the H2-Vape Probe™ to hold the Conical Screen in place. The Teflon ring only has to be hand-snug. Do not over tighten.

3.4 Slide the Cover Sleeve over the Teflon Ring and the Conical Screen.

3.5 Insert the threaded end of the Shoe Sleeve through the Cover Sleeve and screw it onto the bottom end of the H2-Vape Probe™; until it screws up against the Teflon Ring. The Shoe Sleeve will trap the Cover Sleeve onto the H2-Vape Probe™ and creates the mechanism for the leaky circumferential seam.

3.6 Assemble the Groundwater 15-Inch PVC Screen Extension.

3.6.1 First, take a fat 1-inch O-ring and place it over and onto the O-ring groove along the shaft of the Drive cone.

3.6.2 Take the steel Drive Cone and screw it onto the ½-inch thread of the Support Rod.

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3.6.3 Take either end of the 15-Inch PVC Screen and slide it over the Support Rod. Then seat it over the top ledge of the Drive Cone.

3.6.4 Take the Drive Shoe and slide it over the 15-Inch PVC Screen, and then force (by twisting and pushing) the conical end of the Drive Shoe over the fat 1-Inch O-ring around the shaft of the Drive Cone. Note: It is recommended that Teflon paste be smeared onto the outside of the O-ring to allow the Drive Shoe to easily slide over the O-ring. The Teflon paste also helps the Drive Cone release easily from the Drive Shoe when retracting the H2-Vape Probe™ back to expose the Screen.

3.6.5 Take the second fat 1-inch O-ring and place it around and over the O-ring groove on the Perforated Washer.

3.6.6 Screw the Perforated Washer onto the ¼-inch thread at the top of the Support Rod. The conical side of the Perforated Washer should be facing the top of the PVC Screen.

3.7 Attach the assembled 15-Inch Screen Assembly and Drive Shoe. Push the Perforated Washer end of the Screen Assembly through the opening of the Shoe Sleeve and slide it in as far as it will go. Then screw the Drive Shoe onto the Cover Sleeve thread and hand tighten.

3.8 Assemble the Water Canister.

3.8.1 Place the remaining O-rings (described above) onto the Water Canister Base and Top.

3.8.2 Very Important: Attach a Reed Valve onto the single hose barb; pointing upward at the top of the Water Canister Base. Make sure to press the Reed Valve firmly onto the hose barb.

3.8.3 Screw the Water Canister Base and Top onto the Water Canister.

3.8.4 Attach the brass Swage-lok Connector to the top of the Water Canister Top. This is accomplished by screwing the NPT thread of the Swage connector into the female thread at the top of the Water Canister Top. It is required to first place Teflon tape around the NPT thread before screwing it into the Water Canister Top since this will create an air tight seal. The top of the Swage connector is a ¼-Inch compression fitting (for ¼-inch OD tubing). The compression fitting is formed by a Two Part Ferrule that sits inside a 9/16-Inch Hex-Nut that screws onto the main body of the Swage connector. The Two Part Ferrule seats inside the 9/16-Inch Hex Nut – the conical end of the Ferrule facing the H2-Vape Probe™.

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3.9 Attach the assembled Water Canister by screwing the bottom of the Water Canister Base onto the top of the bottom portion of the H2-Vape Probe™.

3.10 Slide a Gooch tube over the circumferential seam between the top of the Cover Sleeve and the bottom of the main body of the H2-Vape Probe™.

3.11 Insert ¼-inch OD tubing into the 9/16-inch Hex Nut at the top of the Swage-lok Connector. Make sure that a brass ferrule set (top and bottom) is first placed on the inside of the 9/16-Inch Hex Nut – the conical end of the ferrule facing the H2-Vape Probe. Tighten the nut on the Swage-lok connector by hand until it is only hand tight. Then, with a 9/16-inch wrench tighten the Hex Nut by exactly one and one-quarter turns to crush its ferrules onto the ¼-inch OD tubing.

3.12 Pre-thread the ¼-inch tubing through the CPT rod and prepare for tool deployment and penetration through the floor of the CPT truck.

4.0 H2-Vape Probe™ Operation: Drive and Sniff

4.1 Assemble the H2-Vape Probe™ as per the assembly instructions in Section 3.0

4.2 Attach the up hole end of the ¼-inch OD tubing to a vacuum pump – preferably equipped with a vacuum gauge and flow meter.

4.3 Begin driving the H2-Vape Probe™ with the CPT rig.

4.4 If you are using the Drive and Sniff method, the first sniff can take place once the H2-Vape Probe™ has been driven at least 6 inches into the new soil. The sniff samples can be pulled at any sample frequency desired.

4.5 To collect a sniff sample, stop the drive, purge 2 to 6 total volumes, screening the vacuum pump discharge for total volatile organic compounds (TVOC) with the appropriate screening device or devices. Do not pull the H2-Vape Probe™ back for a sniff sample, as this would likely clog the wire mesh screen below the circumferential seam. The sniff sample is collected through the circumferential seam only.

4.6 When purging consider the following:

- Typically purge 2 to 6 Soil Gas Line volumes (5.43 ml/ft for 3/16” ID tubing)
- Typically purge 2 to 6 H2-Vape Probe™ volumes

5.0 H2-Vape Probe™ Operation: Groundwater Sampling -

<u>Sampling At The Capillary Fringe And Just Below First Groundwatter</u>

5.1 The CPT rig can perform as many Drive and Sniff sampling events as necessary or perform none. In other words, the game plan might be to

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drive directly to ground water. In either case, the procedure for groundwater sampling is the same.

5.2 Confirmation of the ground water table interface with the vadose zone (capillary fringe) can be detected by observing the vacuum pressure gauge on the pump. A good indication is when the vacuum gauge needle abruptly changes to near full vacuum (25 to 28 inches Hg) – unless of course you know that you are in a tight clay. If you are sure that the H2-Vape Probe™ is not in a tight clay, the vacuum gauge is reading close to full vacuum, and there is a significant increase in water condensation in the line, then this is a strong indication that the H2-Vape Probe™ has either entered the capillary fringe or the saturated zone.

5.3 Being that the PVC Screen length of the H2-Vape Probe™ is 15-inches long, and the stainless steel housing that shields the PVC Screen (as the tool is driven) is about 20-inches long it is important to consider the following:

- When the 15-Inch PVC Screen is fully extended, the H2-Vape Probe™ must be at least 4-feet under the water table. This means that the top of the H2-Vape Water Canister can be just below or above the water table to receive at least 300ml of fluid when using the 1/3-liter Water Canister (Figure 2).

- When using a fully extended 15-Inch PVC Screen with a 1-liter Water Canister, the H2-Vape Probe must be about 6-feet below the top of first groundwater to receive about 1-liter of groundwater.

5.4 The fill rate and volume of the Water Canister can be monitored through the gas line (plastic tube – Teflon, poly etc.). This is accomplished by placing the plastic line in a bucket of water and indirectly observing the fill of the Water Canister with groundwater via a bubble stream from the plastic tube into the bucket water.

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5.5 Since the volume of the PVC Screen area is about 150ml and the volume of the stainless steel Screen Shield is about 400ml, the H2-Vape Probe™ requires about 550ml of air displacement before groundwater starts to enter the Water Canister - through the one-way Reed Valve.

5.6 The fill volume can be measured with a clear plastic 1-liter bottle that is immersed inside the water bucket and filled with its water. The mouth of the plastic bottle faces the bottom of the water bucket and the plastic tube that is connected to the H2-Vape Probe™ is inserted into the mouth of the plastic bottle.

5.7 As the air bubbles that are displaced from the H2-Vape Probe™ are displaced into the plastic bottle, the water in the bottle is pushed out by the air-bubbles. When 1-liter of water has been pushed out of the bottle, approximately 1-liter of groundwater has entered the H2-Vape Probe. At this point, there would be a small volume of groundwater covering the Reed Valve inside the Water Canister. Remember, the H2-Vape Probe™ has to be filled with about 700ml of fluid before the fluid starts to rise above the Reed Valve inside the Water Canister.

5.8 To monitor the volume of groundwater that is inside the Water Canister the displacement technique is repeated with the plastic bottle.

5.9 After sufficient groundwater is collected inside the Water Canister, the Water Canister can then be pressurized with inert gas (nitrogen, helium, etc.) before returning the H2-Vape Probe™ to the ground surface.

5.10 The use of inert gas pressure accomplishes two goals:

- The inert gas pressure over powers the organic vapor pressure of VOC molecules that are in dissolved aqueous phase in the water sample – therefore preventing VOC loss and maintaining dissolved organic equilibrium in the groundwater sample as the tool is retrieved to the ground surface.

- The inert gas pressure is transferred to the Reed Valve through the groundwater sample inside the Water Canister, therefore sealing the Reed Valve shut. This aspect of the operation uses the groundwater sample as a hydraulic line and prevents any of the bore hole fluids in the CPT hole from cross contaminating the ground water sample inside the Water Canister as the tool is retrieved to the ground surface.

5.11 The inert gas pressure that is required is simple to calculate. For the sake of ease, BESST, Inc. recommends always using 75 PSI for the first 100 feet of groundwater, and an additional 75 PSI for every additional 100 foot interval. So as an example, any sampling point between 4 feet below the water table to 100 feet below the water table – use 75 PSI. Any sampling point between 101 feet below the water table to 200 feet

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below the water table – use 150 PSI. Any sampling point between 201 feet below the water table to 300 feet below the water table – use 225 PSI. The Reed Valve is rated for an inert gas pressure of up to 500 PSI. For pressures greater.

5.12 At the ground surface, the H2-Vape Probe™ inert gas pressure is bled off.

5.13 After the pressure is released, the stainless steel Shield portion of the tool is disconnected from the bottom of the Water Canister- and set off to the side.

5.14 A plastic drain tube is inserted through the bottom of the Water Canister and pushed up into the Reed Valve. This action spreads the rubber Reed Valve so that the water sample can enter the drain tube and then gravity drain into the sample vials. Before inserting the drain tube, it is important to crimp the tube at the bottom so the water in the Water Canister does not suddenly squirt from the Canister – loosing precious water to the ground.

5.15 If your sure that there is water in the Water Canister, but there is no water entering the drain tube, then unscrew the Hex Nut at the top of the Water Canister. This will allow air from the atmosphere to push the sample into the drain tube. This phenomenon is called an air lock.

6.0 Vertically Profiling Below First Water With The H2-Vape Probe™

6.1 The H2-Vape Probe™ use is not restricted to just below first groundwater. It can be pushed deep into the saturated zone to vertically profile groundwater contamination.

6.2 Therefore, the end user has the option to push far below the top of ground water for the fist ground water sample after the vertical soil gas survey is completed. At other times, when the a vertical soil gas survey is not needed, the operator can push directly to any depth from 4-feet below first groundwater.

6.3 When pushing deeper than 4-feet from below first water, the operation of the H2-Vape Probe™ is procedurally somewhat different. The tool is still set up the same way as described above when being used with CPT, but the key difference is that the H2-Vape Probe™ is pressurized with inert gas (most of the time N2) before hole entry. In this manner, as the tool drives deeper and deeper below first water to its sampling target, the Reed Valve in the Water Canister is pressurized and therefore, pressure compensated against the fluid pressure of the saturated formation.

6.4 When pressurizing the Water Canister before hole entry, a simple assumption can be made about the pressure needed in the Water Canister for the trip down hole. Always assume the worst case pressure for every 100 feet below groundwater. Treat the pore water as if it was as heavy as thick drilling mud (about 14lbs/gallon that equals about 0.75

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PSI for every foot below the top of the water table. Therefore, if the tool is to be pushed 100 feet below first water, then pressure the water canister to 75 PSI. For any interval between 101 and 200 feet below first water pressurize the Water Canister to 150 PSI. For any interval between 201 and 300 PSI, pressurize the Water Canister to 225 PSI.

6.5 When the tool is driven to the target depth, the pressure is released from the Water Canister. The tool is pulled back to expose the 15-Inch PVC Screen. The fill rate and volume is monitored with the same line that was used for the back pressurization; by placing the line in a bucket of water and monitoring the bubble action (see Section 5.6 through 5.8 for details). After the sample is collected, the tool is re-pressurized for return to the ground surface.

6.6 Follow sections 5.12 through 5.15 for collecting the groundwater sample from the Water Canister at the ground surface.

7.0 Using the H2-Vape Probe for Soil Gas Sampling with Hollow Stem Auger

7.1 The H2-Vape Probe™ can be used with hollow stem auger (HSA) for continuous soil gas sampling in the vadose zone.

7.2 The tool is assembled and operated in the same way as described for CPT application in sections 3.0 and 4.0.

7.3 Although, the HAS method does not offer the continuous extended push capabilities of a CPT rig, the H2-Vape Probe™ can be used in conjunction with AW or AW type rods for long increment sampling. So as an example, the driller could drive the H2-Vape Probe™ 5- to 10-feet at a time ahead of the auger bit by using an up-hole hammer to pound on the top of the rod. The soil density below the auger bit will determine how far ahead the H2-Vape Probe™ can be driven each time. In soft soils, the H2-Vape Probe™ could be driven as much as10 feet at a time. The field scientist could screen the soil gas every two feet within this drive, and therefore end up with 5 soil gas sampling events in one drive.

7.4 After the soil gas sampling events are completed, the tool is retrieved to the ground surface, cleaned and reloaded for the next extended sampling interval.

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16 Diane Lane, Suite 100, Larkspur, CA 94939
866.298.8701 / 415.453.2501 / 415.453.2509 fax / besstprobes@aol.com

8.0 Using the H2-Vape Probe for Soil Gas Sampling with Mud Rotary

8.1 Soil gas sampling and mud rotary drilling are normally thought of as mutually exclusive operations. Assembly and Operation of the H2-Vape Probe™ for groundwater sampling is very similar to the instructions provided in Sections 3.0, 4.0 and 5.0. However, use of the H2-Vape Probe™ for soil gas sampling the vadose zone is feasible provided that the following guidelines are adhered to.

8.1.1 The H2-Vape Probe™ Condom must be used around the outside of the tool. The Condom is made of latex and is approximately 2-feet long when it is completely rolled over the outside of the tool. The Condom serves as a protective sheath, preventing the possibility of any mud drilling fluid from entering the any part of the H2-Vape Probe™.

8.1.2 Two The H2-Vape Gooch Tubes must be placed over the Condom. The Lower Gooch Tube is placed over the Condom in the area of the Circumferential Seam. The Upper Gooch Tube is placed over the top of the rolled out Condom. The Lower Gooch Tube serves as a baby bumper to protect the Condom during transit of the Probe to the bore hole bottom. The Upper Gooch Tube serves to seal off the top of Condom.

8.1.3 When using sampling rod to deploy the Probe into the borehole, nylon tie wraps must be used to strap the plastic back pressurization tubing to the rod every 20-feet.

8.1.4 When using sampling rod to deploy the H2-Vape Probe™ the lower most rod must have an exit hole for the plastic tubing which is connected to the top of the H2-Vape Probe™ Hex Nut. The exit hole for the plastic tubing should be at least ½-inch diameter, and angled at 45 degrees –dipping into the pipe at the bottom of the exit hole. When the plastic tubing exits the hole on the sampling rod, a Swage-lok female Union should be used to connect the short section of tubing coming off the top of the H2-Vape Probe™ and the main length of the tube around the hose spool. The hammer or rod sub should be screwed onto the top of the Probe's AW- Pin before the female Swage connector ties the short line and the main line together. This will prevent the plastic tubing from getting twisted as the rod or hammer sub is screwed onto the AW Pin at the top of the H2-Vape Probe™.

8.1.5 The exit hole on the sampling rod should be at least 2-feet above the landing ring when using 94mm mud systems.

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Additionally, and this is very important, the extra Female Swage Union just outside the exit hole cannot be used with a 94mm system. This is because there will not be enough annular space between the sampling rod and the inside of the mud rotary drill pipe to accommodate the width of the Union. Therefore, the main body of the plastic tubing must be continuous from the hose spool to the Swage connector at the top of the H2-Vape Probe™. Care must be taken when attaching the hammer or rod sub to not twist the plastic tubing.

8.1.6 When using a down hole wire-line hammer with mud rotary drilling, the hammer weight should be at least 300lbs in order to compensate for the bore hole fluid buoyancy against the hammer.

8.1.7 When using a down-hole wire-line hammer with mud rotary, the top of the hammer must always have a swivel and the wire-line must be non-rotating cable. These tow items are a must – particularly the non-rotating cable.

9.0 Using the H2-Vape Probe for Groundwater Sampling with Hollow Stem Auger

9.1 The assembly and operation of the H2-Vape Probe™ with HSA is very similar that of CPT when vertically profiling the saturated zone. The following instruction should be adhered to.

9.1.1 The H2-Vape Probe™ Condom must be used around the outside of the tool. The Condom is made of latex and is approximately 2-feet long when it is completely rolled over the outside of the tool. The Condom serves as a protective sheath, preventing the possibility of any mud drilling fluid from entering the any part of the H2-Vape Probe™.

9.1.2 Two The H2-Vape Gooch Tubes must be placed over the Condom. The Lower Gooch Tube is placed over the Condom in the area of the Circumferential Seam. The Upper Gooch Tube is placed over the top of the rolled out Condom. The Lower Gooch Tube serves as a baby bumper to protect the Condom during transit of the Probe to the bore hole bottom. The Upper Gooch Tube serves to seal off the top of Condom.

9.1.3 When using sampling rod to deploy the Probe into the borehole, nylon tie wraps must be used to strap the plastic back pressurization tubing to the rod every 20-feet.

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9.1.4 When using sampling rod to deploy the H2-Vape Probe™ the lower most rod must have an exit hole for the plastic tubing which is connected to the top of the H2-Vape Probe™ Hex Nut. The exit hole for the plastic tubing should be at least ½-inch diameter, and angled at 45 degrees –dipping into the pipe at the bottom of the exit hole. When the plastic tubing exits the hole on the sampling rod, a Swage-lok female Union should be used to connect the short section of tubing coming off the top of the H2-Vape Probe™ and the main length of the tube around the hose spool. The hammer or rod sub should be screwed onto the top of the Probe's AW- Pin before the female Swage connector ties the short line and the main line together. This will prevent the plastic tubing from getting twisted as the rod or hammer sub is screwed onto the AW Pin at the top of the H2-Vape Probe™.

9.1.5 When using a down hole wire-line hammer with HSA, the hammer weight should be at least 300lbs in order to compensate for the bore hole fluid buoyancy against the hammer.

9.1.6 When using a down-hole wire-line hammer with HSA, the top of the hammer must always have a swivel and the wire-line must be non-rotating cable. These tow items are a must – particularly the non-rotating cable.

10.0 Using the H2-Vape Probe for Groundwater Sampling with Mud Rotary Drilling

10.1 The following instruction should be adhered to.

10.1.1 The H2-Vape Probe™ Condom must be used around the outside of the tool. The Condom is made of latex and is approximately 2-feet long when it is completely rolled over the outside of the tool. The Condom serves as a protective sheath, preventing the possibility of any mud drilling fluid from entering the any part of the H2-Vape Probe™.

10.1.2 Two The H2-Vape Gooch Tubes must be placed over the Condom. The Lower Gooch Tube is placed over the Condom in the area of the Circumferential Seam. The Upper Gooch Tube is placed over the top of the rolled out Condom. The Lower Gooch Tube serves as a baby bumper to protect the Condom during transit of the Probe to the bore hole bottom. The Upper Gooch Tube serves to seal off the top of Condom.

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16 Diane Lane, Suite 100, Larkspur, CA 94939
866.298.8701 / 415.453.2501 / 415.453.2509 fax / besstprobes@aol.com

10.1.3 When using sampling rod to deploy the Probe into the borehole, nylon tie wraps must be used to strap the plastic back pressurization tubing to the rod every 20-feet.

10.1.4 When using sampling rod to deploy the H2-Vape Probe™ the lower most rod must have an exit hole for the plastic tubing which is connected to the top of the H2-Vape Probe™ Hex Nut. The exit hole for the plastic tubing should be at least ½-inch diameter, and angled at 45 degrees –dipping into the pipe at the bottom of the exit hole. When the plastic tubing exits the hole on the sampling rod, a Swage-lok female Union should be used to connect the short section of tubing coming off the top of the H2-Vape Probe™ and the main length of the tube around the hose spool. The hammer or rod sub should be screwed onto the top of the Probe's AW- Pin before the female Swage connector ties the short line and the main line together. This will prevent the plastic tubing from getting twisted as the rod or hammer sub is screwed onto the AW Pin at the top of the H2-Vape Probe™.

10.1.5 The exit hole on the sampling rod should be at least 2-feet above the landing ring when using 94mm mud systems. Additionally, and this is very important, the extra Female Swage Union just outside the exit hole cannot be used with a 94mm system. This is because there will not be enough annular space between the sampling rod and the inside of the mud rotary drill pipe to accommodate the width of the Union. Therefore, the main body of the plastic tubing must be continuous from the hose spool to the Swage connector at the top of the H2-Vape Probe™. Care must be taken when attaching the hammer or rod sub to not twist the plastic tubing.

10.1.6 When using a down hole wire-line hammer with HSA, the hammer weight should be at least 300lbs in order to compensate for the bore hole fluid buoyancy against the hammer.

10.1.7 When using a down-hole wire-line hammer with HSA, the top of the hammer must always have a swivel and the wire-line must be non-rotating cable. These tow items are a must – particularly the non-rotating cable.

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