THE KRYDON GROUP

Engineers and Environmental Scientists

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STANDARD OPERATING PROCEDURE

FOR

GROUNDWATER RECOVERY SYSTEM

REVISION 1

THE KRYDON GROUP, INC.
221 WEST CLEMENTS BRIDGE ROAD
BARRINGTON, NEW JERSEY 08007

BUILDING 699

FORT MONMOUTH, NEW JERSEY

REVISION 1 : FEBRUARY 1994

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THE KRYDON GROUP, INC.
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PART A INTRODUCTION

A.1 BACKGROUND

On October 19, 1989, The Main Post Gasoline Station at Fort Monmouth, New Jersey, contacted the New Jersey Department of Environmental Protection and Energy (NJDEPE) to report an apparent release of gasoline from the piping system. Approximately 11,000 gallons of gasoline were discharged into the soils surrounding the underground tanks and piping.

Since the gasoline release, The Main Post Gasoline Station has replaced the piping system connecting the underground storage tanks and the fuel pumps with equipment fully compliant with the NJDEPE Bureau of Underground Storage Tanks regulations. Since this station is the only facility of its kind on the Fort where non-military vehicles may refuel, the Main Post Station has remained operational.

However, in response to this substantial discharge, a number of remediation action have taken place. One of the required actions was the installation of monitoring wells so that an assessment of the impact to groundwater could be made. In all, twelve (12) monitoring wells were installed in the vicinity of the site including several on adjacent lots. The wells were installed in a pattern that encompassed the source of the contamination, the area of the former piping system, and the estimated down gradient plume of contamination. In conjunction with these monitoring wells, a product recovery pump system was installed in the monitoring well immediately down gradient of the source in an attempt to recover remaining liquid phase free product.

The recovery system consisting of a small diameter dual pump system and its appurtenant support mechanisms, was manufactured and installed in monitoring well No. 11 by Groundwater Recovery Systems, 299B National Road, Exton, PA 19341.

A.2 PRESENT CONDITION

The Krydon Group, Inc., under subcontract agreement with Serv-Air, Inc. to render services for the Environmental Branch of the United States Army Directorate of Public Works (DPW), was engaged to manage this network of monitoring wells and the recovery system. Included in the scope of work is the weekly measurement of the water and product levels in each monitoring well, removal of free product within the wells, operation and maintenance of the recovery pump system and reporting the results of data collection. Managing the recovery system consists of effluent sampling, system maintenance, system troubleshooting, and rain-gauge monitoring. Additionally, field monitoring reports and groundwater isopleth maps are produced and submitted to Serv-Air, Inc.

At present, The Krydon Group has been completing this work for approximately five months.

PART B THEORY OF HYDROCARBON REMOVAL

B.1 PRODUCT RECOVERY - GENERAL

The release of gasoline, a petroleum hydrocarbon compound, into the soil resulted in the hydrocarbon contamination of the local groundwater table. As a result of this contamination, a remediation plan was designed in an attempt to recover the gasoline, a light, nonaqueous phase liquid free product from the uppermost layer of the saturated zone of the surface aquifer. The remediation plan contemplated two elements: design and installation of a groundwater recovery system and; implementation of a periodic monitoring and maintenance program

The specific gravity of gasoline being less than water and its general tendency toward insolubility in water cause it to "float" on the surface of the groundwater at the point of the free product interface with the groundwater table. In this specific case, the depth at which this occurs is approximately 12 feet - 8 inches below the ground surface. This scenario exists between the groundwater and the released product although it occurs in a soil media. The installation of monitoring wells allows access to the liquid phase, free product, the product/groundwater interface, and the groundwater. In these wells, the product and groundwater separate into two distinct layers with a slight diffusion zone in-between. The diffusion zone consists of varying concentrations of dissolved product in the water. However, the bulk of the product "floats" on the surface of the water as a free phase liquid. To effectively and efficiently remove the bulk of the free product from the groundwater surface, a dual pumping system was employed.

B.2 DUAL PUMP RECOVERY SYSTEM - PRINCIPAL OF OPERATION

To efficiently recover the hydrocarbon product from the groundwater surface, a dual pumping system is used. The system consists of pumps located at different elevations in the well. The product pump is located uppermost in the well while the water pump is located at a depth below the product pump. The distance separating the two pump is conditioned on the quantity of product estimated to exist at the groundwater surface. By taking advantage of the differences in specific gravities of gasoline and water, the product pump, activated by a configuration of floats which float on the respective surfaces of the product and the water, is able to remove free product from the groundwater. When the product float is lifted to a pre-determined level, corresponding with an anticipated product thickness, the pump is activated. Once activated, this pump skims the bulk product from the water surface through an intake screen located adjacent to the product float. Complementary water floats prevent the emulsification of the product and water, by activating a water pump which controls and limits the level of water in relation to the product float and intake screen. As a result, two separate liquids are recovered simultaneously yet separately.

The second of the two pumps is a water pump. The water pump is regulated to draw water at a pre-determined rate and discharge it to a treatment facility. Removal of the groundwater is essential for the effective removal of hydrocarbon products from the groundwater surface. As the groundwater is drawn into the system, a cone of depression in the groundwater surface is produced. This cone of depression effectively lowers the contour of the groundwater surface surrounding the recovery well. As a result, a positive gradient is produced on the groundwater surface. This gradient causes the groundwater and any product within the surrounding vicinity of the well to be drawn towards the recovery well. As a result, the hydrocarbon product floating on the water surface will become concentrated over time at the point of removal, in this case the recovery well. This allows the product pump to remove the free phase product and control the spread of the contamination plume.

This dual pump system discharges the two liquids into two separate recovery systems. The product pump discharges directly into a storage or recovery drum. Recovered product may be recycled or disposed as a hazardous waste. The water pump discharges directly into the sewer system for treatment at the waste water treatment plant. It is essential that the water pump never draw product because of the likelihood of spreading contamination. Likewise, the product pump must not draw water so as to avoid unnecessary disposal costs.

Further, pumping rates must be closely monitored since a rate that is too great may reduce the transport of the product through the surrounding soil. Additionally, an excessive rate may jeopardize the integrity of the foundations supporting surrounding structures. Empirical data indicates the optimum rate is approximately 2.0 to 3.0 gallons per minute (GPM).

B.3 DUAL PUMP RECOVERY SYSTEM - SYSTEM OPERATION

The recovery pump system which consists of a small diameter dual pump, a control panel, a sensor probe containing three density floats, a tank full probe, sensor probe wiring, power cords, a flow meter, a sampling spigot, and a gate valve, was manufactured and installed by Groundwater Recovery Systems, Inc. This system was installed adjacent to Building 699 in monitoring well No. 11 (see site map). The pumps are attached to a cable winch and are lowered down the well to an operating depth of approximately 12'-8".

The dual pump is designed to collect both free product and potentially contaminated ground water from different elevations within the well and discharge into their respective storage/treatment networks. A storage drum, packed in an adjacent hazardous waste bin receives any product discharged from the product pump. PVC pipe delivers the water collected from the well into the base sanitary sewer system located next to Building 699.

The system's pumps are activated and deactivated by control panel signals which are elicited by the positioning of the density float system. The float system consists of three floats (from top to bottom): a product float, a water float, and an over-ride float. Each float in the system functions as an on/off switch for its affiliated pump.

Activation of the product pump occurs when the product float, or the top float, is elevated to its uppermost limit, approximately one inch above the lower limit. Once activated, pumping continues until the product float drops to its lower limit, at which time the pump is deactivated. However the product pump may also be deactivated if the water float reaches its uppermost position. This deactivation is designed to preclude the pumping of water into the free product storage system.

Water is removed for the recovery well when the water, or middle float, is elevated to its uppermost limit. Water collection continues until the water level in the well falls to the float's lower limit, at which time the float sensors alert the control panel to deactivate the water pump.

The over-ride float, or the lowest float in the system, controls the overall activation of the pumps by indicating the elevation of the groundwater in relation to the float system. Its purpose is to prevent the inadvertent dry operation of either of the pumps. Thus, it performs the function of preventing system damage. When the over-ride float reaches its lower limit, the entire system is shut down to prevent damage to the pumps. Once the over-ride float reaches its uppermost limit, the system may operate freely. However, should the over-ride

be activated, a signal is displayed on the control panel. This signal indicates to the operator that the system must be reset by turning the power off and then on before the pumps will operate again. The manual resetting of the system is necessary regardless of the current position of the over-ride float.

A tank full probe is located on the top of the storage drum into which recovered product is pumped. The probe incorporates a float which indicates the level of product in the drum. When the float is at its lower limit, its sensor signals the control panel to allow the pumps to operate normally. However, if the float is elevated from its lower limit, the Tank Full status light will be turned on and the entire system is deactivated to prevent overfill of the storage drum.

The system control panel, located adjacent to the well, controls the functions of the system and records specific system performance data. The control panel also regulates power to the pumps, activates the specific response mechanisms, and records data generated from the flow meter. Pump activation is dictated by the floats which send electronic signals through probe sensor cords between the floats and control panel. Data generated by the flow meter is relayed to the control panel through a separate sensor cord running directly to the flow meter. Additionally, wiring between the product storage tank and the control panel allows display of the storage tank's status.

Instrumentation on the control panel provides the data necessary for the proper operation, maintenance, sampling, and overall analysis of the recovery process. System status generated by the density floats and the tank full probe are displayed by status lights on the control panel. There are four status lights on the control panel: Product pump, Water pump, Tank Full, and Over-ride. When the product or water floats are being elevated from their respective lower limits, the status light will flash or blink. When either pump is activated, its respective status light remains on steadily. When the tank probe, which is located at the top of the storage drum, is elevated to any degree, the status light will be on steadily while deactivating the two pumps. Similarly, when the over-ride float reaches its lower limit, the light will be on steadily while deactivating the two pumps. When the over-ride status light is on steadily, a manual reset of the system is required to allow the pumps to operate normally.

Additional displays on the control panel include the effluent flow rate and total recovery volume (gallons) from the water pump. This information is relayed by the flow meter, and is displayed numerically on the LCD display. The average water discharge rate into the sewer is displayed numerically in gallons per minute while the cumulative total is indicated in gallons. As per specifications provided by the flow meter manufacturer, the flow meter records and displays on the control panel an average rate of discharge for the flucuating effluent flow.

For the purpose of maintaining the system, a voltmeter and ammeter for both the product and water pump are included on the control panel. These meters display the voltage provided to and the amperage drawn by each pump. Additionally, the on/off switch for the system and the respective pumps are included on the control panel. For each pump, the on/off switch also incorporates an "auto" and "hand" position. The auto position allows the pumps to work in accordance with the positioning of the floats. The hand position activates the pumps regardless of the positioning of the floats.

The flow meter employs a paddle wheel and an adjustable gate valve which produce and adjust the rate of flow for the water effluent. The adjustable feature of the gate valve permits the operator to limit the flow to a specific rate. The paddle wheels within the flow meter produce an electronic response which is relayed to the control panel. At the control panel, a calibrated micro-processor converts the signal to a "gallons per minute" rate display. The micro-processor simultaneously records and displays the cumulative volume of water discharged through the flow meter. Adjacent to the gate valve is a sampling spigot, from which effluent samples may be collected.

A rain-gauge apparatus complements the system. The mechanism consists of an electronic rain-gauge and a rainfall catch basin. Both are situated adjacent to the well and pump system. The processor unit of the rain-gauge is mounted within a weatherproof box and records in a tabular format the amount of rainfall in inches that has been collected in the catch basin.

PART C STANDARD OPERATING PROCEDURE

C.1 MONITORING SCHEDULE

To produce valid, consistent and replicable results, the well monitoring and the sample collection must conform to a designated schedule. The contract specifications, required the following monitoring scheme be followed:

Well Monitoring:	Monitoring, as specified in the Operating Procedure and consisting of measuring depths to groundwater and product, removing free phase product, observing well condition, and recording relevant well, product, and groundwater data to be performed a minimum of once a week.
System Maintenance:	Operation and maintenance to be performed a minimum of once a week, or as required. Additional maintenance may be required due to the condition of the system or at the request of Serv-Air.
Sampling:	Effluent sampling for TPHC to occur weekly. Effluent sampling for BTEX to occur monthly and to be collected during the first week of each month. Additional sampling may be required as per instructions from Serv-Air. Analysis of the samples collected is performed by Fort Monmouth Environmental Laboratory.
Rain-gauge Monitoring:	To be recorded and maintained weekly. The gauge is to be reset, or rezeroed, as field conditions warrant. If maintenance is required, the gauge shall be rezeroed.
Report Schedule:	As depicted within the specifications.
Contract Duration:	Original contract length was five(5) months. At the request of Serv-Air, the original scope of work was extended an additional five (5) months. Future work should be performed in blocks of time no less than twelve(12) months in duration to allow project continuity.

C.2 STANDARD OPERATING PROCEDURE

In order to monitor and sample the groundwater accurately and consistently, a Standard Operating Procedure (SOP) must be implemented and employed consistently. The SOP is described in chronological order.

1. Upon arrival at Fort Monmouth, the technician shall sign in at the Environmental Testing Laboratory (see site map for building location). Equipment required for the day's work is to be checked out of the laboratory. The technician shall also check out the No. 12 key, an ORS meter, the appropriate sampling bottles, a cooler, a chain of custody, and product recovery canisters. The technician shall also ascertain whether the director of the Environmental Laboratory has any concerns that need to be addressed during the site visit. Finally, before departing the laboratory, the technician shall notify the laboratory director of the samples that are to be collected and delivered to the lab for analysis.

2. Upon departure from the Laboratory, the technician shall proceed to Building 699. At Building 699, the technician shall unlock the gate surrounding the recovery pump system and check the status of the system at the control panel. The system status and any other relevant information shall be recorded since it will provide an indication of the product levels to be anticipated in each monitoring well.

3. The field technician shall prepare for the monitoring by donning an orange, reflective safety vest as to increase his visibility to vehicle operators. A hammer, a prying device (or a screw driver), a 9/16 inch socket, and the No. 12 key are necessary to access the wells.

4. Prior to accessing a well, the technician shall secure the monitoring well area by erecting orange safety cones around the well. This will allow the technician to work safely while preventing any vehicles from damaging the well.

5. The technician will visually inspect the well upon arrival at each monitoring well. Any distinct odors or characteristics of the well and water shall be noted and, if serious in nature, reported to the director of the laboratory upon completion of the monitoring.

6. The technician shall access the well by removing the external cover and the well casing cap.

   Once the well has been accessed, the technician shall begin the process of monitoring as follows:

Decontaminate the ORS probe with a detergent which has been provided or approved by the Laboratory director and a water rinse. Ensure that the probe is clear of any obstructions and functioning properly. The monitoring process shall be started by attaching the grounding cord of the ORS to the external well cover and lowering the probe into the well. Lower the ORS until a beeping sound is heard. The probe will produce a beeping sound when it is in water and a steady alarm when it is in product. Once the beeping sound is heard, the technician shall slowly raise the probe while constantly observing the depth as depicted by the ORS's measuring cord. Raise the probe until the beeping sound stops or becomes a steady alarm at which time the technician shall record the corresponding depth, in centimeters. This depth shall be recorded as the depth to the groundwater. The measurement shall be taken to the top of the PVC well casing at the point marked by the well installer as the well casing elevation reference point. If the steady alarm is heard, continue to slowly raise the probe until the alarm stops and record the corresponding depth, in centimeters. This depth shall be recorded as the depth to product. If the beeping alarm stops and no steady alarm is heard, then no product is present in the well. In this case, the depth to product shall be recorded as "Not Detected". If product was detected, the product thickness is determined by subtracting the depth to product from the depth to water. Measuring in metric units allows more accurate readings; however, conversion will be required for the necessary reports.

7. Once the well monitoring has been completed, the technician shall remove the ORS sensor probe from the monitoring well. Once the ORS is clear of the well, it may be decontaminated. Begin by wiping off excess water with a clean paper towel. The probe shall be decontaminated with a detergent, which has been provided or approved by the Laboratory director, and a water rinse, or a suitable substitute. Paper towels and any decontamination waste shall be disposed in the designated waste container.

8. If during the monitoring, the technician determines that the product thickness exceeds 1 inch, the product must be removed. The technician will employ a hydrophobic filter type of product recovery canister, an "oil snake", or a suitable substitute approved by the Director of Public Works Project Manager. Inspect the canister or "oil snake" to ensure it is clean and free of obstructions. Begin by lowering the canister or "oil snake" into the well until it contacts the groundwater surface. Once the standing liquid in the well has been reached, collection of the product shall take place by slowly raising and lowering the canister or "oil snake" throughout the thickness of the product to allow proper adsorption of the

product. After sufficient time, retrieve the canister or "oil snake" from the well and empty the product into a temporary product recovery canister. The technician shall repeat this process until all product from the well is removed. The total volume of product retrieved from the well shall be recorded prior to disposing of the recovered product into the designated storage drum. The "oil snake" shall be disposed of in designated waste container, or decontaminate and clean the canisters prior to reuse.

9. The technician shall complete the well monitoring by securing the well by replacing the well casing cap and the external cover.

10. Steps 4 through 9 shall be repeated for each monitoring well. The wells shall be monitored in the following order:
    - A. MW# 4
    - B. MW-RW#2
    - C. MW#14
    - D. MW#13
    - E. MW#2
    - F. MW#3
    - G. MW#5
    - H. MW#6
    - I. MW#9
    - J. MW#12
    - K. MW#8
    - L. MW#1
    - M. MW#11 **(Location of Recovery Pump)

Note: Monitoring wells #7 and #10 have been decommissioned and are not included in the order of monitoring.

10. The last monitoring well to be inspected is MW#11, which contains the recovery pump system. Upon the completion of the well monitoring, the pump system must be maintained, cleaned, and monitored. The following steps are to be implemented upon arrival to monitoring well #11:

A. The technician shall measure the depths to groundwater and product as previously described in steps 5 through 7. All relevant data must be recorded.

B. The control panel shall be opened. The technician must then record the status of the system as displayed by the control panel instrumentation. Record the flow rate, the total volume pumped, the current condition of the status lights, and the voltage/amperage

meter readings. The following are typical readings which predict normal system operation:

1. Flow rate= 2.5 to 2.6 gpm
2. Total Volume= variable and cumulative

Water pump data:

3. DC voltage= 12 volts
4. AC amperage= 9.4 amps

Product pump data:

5. AC voltage= 120 volts
6. DC amperage= 2.5 amps

The technician shall also observe the condition of the well and all piping/connections associated with the system. Note any leaks, obstructions, or damage and report them immediately to the Laboratory Director and the Project Manager from the DPW. If any leaks, obstructions or damage is observed, the system shall be shut down immediately.

C. In the event the system is not operating properly, turned off, or shut down by the over-ride float, consult the Troubleshooting Manual and/or the Laboratory Director. The technician shall attempt to determine the cause of the shut down and amend the condition if possible.

D. While the system is operating, the technician shall record the cycle times of the system by noting the time the water pump is on and off. Record the total volume pumped before and after the period during which the water pump operated. Also noted shall be the amount of time which the product pump operated. Having made those observations, if the rate of flow is not approximately 2 to 3 gpm, the technician shall adjust the gate valve until the flow rate falls in the range of 2 to 3 gpm. The gate valve is adjusted by turning the gate valve handle clockwise to lower the rate or counter-clockwise to increase the rate.

E. While the water pump is activated, the technician shall open the sampling spigot and sample the effluent in accordance with the appropriate NJDEPE sampling protocol and sampling schedule, contained in Monitoring Schedule section of this document. Adjust the spigot to slowly fill the sampling jars so as not to aerate the sample. The spigot should be closed tightly after sampling and the technician shall inspect it for leaks. If leakage

occurs, re-tighten the spigot until the leak stops. Samples shall be stored in a cooler and relevant data corresponding to that sample shall be recorded on a chain of custody form. If the system has been shut down prior to sampling, the effluent must not be sampled until the system has been reactivated for the completion of three cycles.

F. Once samples have been collected, the technician shall turn the pumps and the entire system off. Raise the pumps from the well and secure them to allow cleaning. The cleaning shall begin by checking the system for any visible problems. Using cloths or paper towels, the technician shall remove all excess sludge, water, and product from the pumps. The entire system shall be cleaned with a degreaser and water. The degreaser shall be provided by or approved by the Laboratory Director. Scour pads and heavy-duty cloth have proven useful in the cleaning.

G. Once the outer surface of the pumps is clean, the technician must disconnect the float assembly and remove it from the float cylinder. Clean the float assembly with degreaser, water, and a scour pad/heavy-duty cloth. Then clean the inside of the float cylinder with degreaser and a heavy duty cloth. Ensure that the floats are free of any obstructions and have the proper operational mobility. With the float assembly still disconnected, turn the system on to check the responses of the control panel and pumps to the location of each respective float. This float response check begins by moving each float across their respective ranges and observing the response of the pumps and the control panel instrumentation. First, move the over-ride float to its uppermost limit to allow the system to run properly. Then move the water float from its lower limit. The status light for the water pump should begin to flash. When the float reaches the upper limit, the status light should be on steadily and the water pump should begin to run. Lower the water float from its upper limit to a point in the middle of its range and then move the product float up from its lower limit. The product status light should begin to flash while the water pump stays activated. Once the product float reaches it upper limit, the status light will become steady and the product pump should turn on. Keeping the product float at its upper limit, move the water float to its upper limit. At this time, the product pump should become deactivated and its status light should begin to flash. At this point turn the system's power off so as to prevent damage to the pumps and harm to the technician. If the floats do not work properly, consult the System Troubleshooting Manual and inform

the Laboratory Director. If the system appears to be working properly, reconnect the float assembly within the float cylinder.

H. The technician shall then proceed to clean the remainder of the pump configuration, including the wiring harnesses and pipes, using the approved degreaser, water, and a heavy-duty cloth.

I. The technician shall then inspect the Product Intake Assembly for any obstructions and cleanliness. If the intake screen appears to be obstructed or dirty, remove the screen and flush with water. Flush the screen from the inside out to effectively remove any obstructions. Once the screen is clean, reattach it to the intake assembly.

J. The technician will then inspect the Tank Full float as follows: Disconnect the Tank Full float assembly from the storage drum. With the system turned back on briefly, raise the float from its lower limits. This should turn the Tank Full status light on and deactivate the remainder of the system. If this does not occur, consult the System Troubleshooting Manual. If this appears to be working properly, turn the system's power off and reconnect the float assembly to the storage drum.

K. With the system now completely cleaned and inspected, the technician shall: Lower the pump configuration back into the well until the respective check marks on the winch pole and the winch cord align. The pump is now set at the depth of 12'-8" within the well.

L. Before activating the system, conduct the System Troubleshooting checklist as provided by the manufacturer in the Operation Manual. Perform each step of the troubleshooting checklist and record each result. An ohm-meter will be required to perform this task.

M. Once the Troubleshooting is complete and the system is determined to be operational, turn the system's power on. Activate the product and water pumps by adjusting their power switch to the "auto" position. At this time, the water pump status light should be on steadily and the product status light should flash. The water pump will be activated for several minutes before any water is drawn due to air being in the system. Although the normal operating amperage for the water pump is approximately 9.4 amps, the amperage during this period of warm up shall be approximately 11 to 12 amps. This is caused by the water pump

having to draw all the air from the system before any water will be drawn.

N. The technician shall ensure the system is working properly by observing the system cycle a few times and pumping at a desired flow rate.

O. Finally, inspect the rain-gauge. Record the current readout and ensure that the catch basin is clear of obstructions. If a problem exists with the rain-gauge, consult the operation manual. Reset, or re-zero, the rain-gauge as conditions warrant or if the system fails. During the cold weather, ensure that the batteries are working properly and that the catch basin is not iced over.

P. Prior to departure, ensure that every tool used has been cleaned properly before returning to storage. Properly dispose of all debris generated during the maintenance and cleaning of the pump system.

Q. Lock the fence surrounding the recovery system and monitoring well No. 11.

R. Return to the Environmental Laboratory. Return borrowed equipment and the No. 12 key, and sign out on the time sheet. List the samples on a chain of custody and release them to a laboratory technician. Place the samples in the designated refrigerator and leave a copy of the chain of custody with the samples.

S. Consult with the Laboratory Director regarding the amount of product recovered and the maintenance/operation of the recovery system. Any problems or concerns with the system and any unusual characteristics of the wells or system should be brought to the Director's attention prior to departure.

T. Leave the site with all necessary data required to prepare the weekly report.

U. Within 30 days of the site visit, the technician shall prepare a weekly report containing the following:

1. Progress statement
2. A copy of the field notes
3. A groundwater isopleth map depicting groundwater contours, product thicknesses, elevations of both

groundwater and product within the wells, rain-gauge readings, and the analytical results of the sampling.

4. A copy of the chain of custody
5. Summary
6. Recommendations
7. Schedule of continuing activities and date of the next report submission.
8. Any information or data relevant to the operation/ maintenance of the recovery system or the integrity of the monitoring wells.
9. A sample data form is enclosed.

V. Submit the reports on a monthly basis.

W. Submit all reports, data, and maps as dictated by the project's specifications.

C.3 RECOMMENDATIONS / ADDITIONAL INFORMATION

During the period which The Krydon Group was under contract to perform this scope of work, important observations and characteristics were noted and investigated. This additional information is a result of practical experience in performing the tasks for which this Standard Operating Procedure was written. The Krydon Group presents the following suggestions and recommendations.

The recovery pump system experienced many technical difficulties and obstructions during the period which The Krydon Group maintained the system. It was determined that the system needs to be cleaned thoroughly every week since sludge readily accumulated on the floats, the pumps, and the wiring. The accumulated sludge obstructed the floats' proper mobility and the product pump's intake screen. Cleaning the floats, the pumps, and the system's piping and wiring, along the sections which are near the pump, proved to help remove the accumulated sludge from the well and thus aid in the prevention of float and intake screen obstructions. If the floats and the product intake screen were not cleaned weekly, both would predictably be obstructed and the system would not be working properly, if at all.

A recurring condition that periodically impacted the data collection was the level of the groundwater dropping below the float system and thus deactivating the entire system. After investigating this problem, it was determined that the local tidal action may have influenced the groundwater table at the site. Two bodies of water which are influenced by tidal action are located within 1/2 to 1 mile from the site. During the periods of substantial low tides, the groundwater at the site would drop below the float configuration.

Should it be necessary to consult the system manufacturer, Larry Roy of Groundwater Recovery Systems should be contacted.

The rain-gauge occasionally has difficulties. During periods of heavy precipitation, the gauge will overload and shut down. In this case, simply resetting the rain-gauge will solve the problem. Ice and snow may accumulate within catch basin and prevent the system from registering the proper rainfall. During the cold weather, there is no easy solution to this problem. One solution to this problem would be to attach a heating element to the catch basin so as to melt any precipitation, prevent blockage, and allow continuous readings. Additionally, the life of batteries in the rain-gauge must be checked constantly during the cold weather. History has shown that these batteries have a shorter life than would be normally expected during the cold periods of the year. An expected life span for the batteries during these cold periods is approximately three to four weeks.

A disposable "oil snake" proved to be extremely versatile in the quick removal of any residual product from within the monitoring wells. The "snakes" would quickly skim the product from the water surface and allow easy disposal. After wringing the "snake" of the product, it could be reused or disposed of in the designated waste container.

In regards to the flow data displayed on the control panel, the analysis of the total volume discharged into the sewer system must incorporate flow fluctuation. The flow meter displays on the control panel a flow rate of the effluent for the period of time in which the water pump is activated. The total volume of water pumped is also displayed on a cumulative basis, thus allowing the determination of the volume of water discharged during a cycle period. However, if the rate of flow is multiplied by the amount of time in which the pump was activated during a cycle, a particular volume of discharged water is calculated. This calculated volume will always be larger than the difference in total volume over the equivalent time period. After consulting the manufacturer and investigating the system, it was determined that the total gallonage gauge was more accurate since it incorporated, in its calculations, the fluctuations in the effluent flow. The calculations involving the rate of flow and time in which the system was on did not account for these fluctuations and thus generated a larger number. Therefore, the readings from the total volume gauge, in gallons, are to be considered valid and accurate.

As per the site visit by Groundwater Recovery Systems (GRS), it was observed that the product pump was considered "tight" during the activation of the pump. GRS recommended at that time that the product pump was in need of being rebuilt for more effective and efficient use in the future. The Krydon Group supports this recommendation and further recommends a maintenance program in which GRS visits the site annually to diagnose any system problems.

During cold and adverse weather, the effluent water pipes which lie on the ground surface often freeze, although heat tape is presently installed around the piping. Frequently during snowy weather, the effluent pipes are damaged by the snow plows during the snow removal at Building 699. Covered by a rubber bumper, the effluent pipes are not presently secured to the ground. Therefore, the piping is prone to be moved and subsequently broken when hit by a snow-plow or by a vehicle. The combination of ice accumulation and pipe damage has interrupted the continuity of the system's operation for substantial periods of time. Since the control of the contamination migration is lost during the periods in which the system is inoperable, The Krydon Group strongly recommends that efforts to control damage and freezing be investigated and implemented. These problems will continue to occur unless preventive measures are implemented.

Construction and installation of an elevated well cover on monitoring well No. 11 will prevent rainfall runoff and ice from directly entering the well.

C.4 QUALITY CONTROL/QUALITY ASSURANCE

In order to generate valid sampling data, a strict quality control/quality assurance program is to be formulated and implemented. An acceptable program consists of a designated schedule of monitoring and sampling, sound decontamination procedures, and a method of sampling and monitoring.

Consistency is essential in obtaining valid samples and collecting site data. Therefore, monitoring and sampling are to be performed on a regular basis. The weekly monitoring of the wells and the effluent sampling should occur exactly a week apart (i.e. on every Wednesday). This will minimize any variations in the data that would result from an inconsistent schedule. Additionally, the well monitoring should occur in the designated order, as outlined in the Standard Operating Procedure section.

Sampling of the effluent shall occur on a weekly basis with an equal interval between sampling times (e.g.. on every Wednesday). This consistency in schedule will minimize the variation in data that results from groundwater fluctuations and the inconsistent concentrations of product that results from fluctuating mobility within the soil. Additionally, the samples collected to be analyzed for BTEX should be taken during the first week of every month. This will minimize any effects that the pump's fluctuating operating condition will have on the analytical results.

Samples shall be collected from the effluent in accordance with the sampling procedures outlined in the NJDEPE sampling regulations. Each aqueous sample shall be taken from a slow stream of effluent from the system sampling spigot to prevent aeration of the sample. BTEX samples must be collected and contained with zero head-space. Additionally, as per NJDEPE protocol regulations, sampling of the effluent may only occur after the pump system has cycled three times. This will produce a valid, representative sample of the groundwater since stagnated water and/or product will be removed by the cycling.

Holding time for the samples shall be minimized as much as possible and limited in accordance with NJDEPE regulations. No sample will be analyzed or considered valid if the holding time is exceeded. In conjunction, the samples shall be transported in a cooler and stored in a refrigerator as to preserve the integrity of the sample. Quality control and assurance policies of the Laboratory shall be followed during the analysis of the samples.

In order to prevent cross-contamination from monitoring operations, the ORS probe shall be decontaminated between the monitoring of each well. The probe shall be wiped free of any sludges or excess water with a single use

paper towel or single use clean cloth. A degreaser, which has been provided or approved by the Laboratory Director, and a water rinse shall be employed as the decontamination agents to be used at the site of each well. A suitable substitute, as approved by the Laboratory Director, may also be used. Rinseate from this decontamination shall be contained and disposed of properly as to prevent the spread of contamination into the soil surrounding the well. In no case should the ORS probe be introduced into a well without first being decontaminated.

A quality control and assurance policy shall be formulated and implemented prior to beginning any work related to this Standard Operating Procedure.

PART D APPENDIX

D.1 RECOVERY PUMP SYSTEM OPERATING MANUAL

OPERATING MANUAL

SMALL DIAMETER DUAL PUMP SYSTEM

Updated 8/22/89

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THEORY OF HYDROCARBON REMOVAL

The problem of hydrocarbon removal from the groundwater is best solved with a dual pump system: one for product, one for water in-situ. Large surface separators are avoided; product and water are not mixed in pumping, therefore, they do not emulsify. The water may, or may not, be treated before discharging. Product is pumped into a recovery tank and may be used or blended without further separation and processes. The water pump is the key to this process. Operating the water pump produces a cone of depression which increases the amount of product collected and controls the contaminant plume. The following terms are used to define the process:

Static Water Level:	The depth from ground surface to the water table.
Drawdown:	The amount of drop in the water table when the well is pumped.
Cone of Depression:	The form of the surface of the water in the ground around a pumped well.
Radius of Influence:	The distance from the center of the well to the limit of the cone of depression.
Hydraulic Conductivity:	A measure of the ease with which water can be transmitted through the ground.

The theory of water flow in wells has been studied for years. A generalized rule is Darcy's Law which relates flow rates, drawdown, radius of influence, etc.

Basically, a few generalizations can be made about pulling water from wells.

1. The radius of influence is proportional to the drawdown.
2. The water must be maintained at a constant level for maximum effect.
3. Too great a pumping rate can cause serious foundation problems on the surface and leaves product in the soil.

If possible, put the water back into the ground beyond the circumference of the cone of depression. Ideally this will increase the effective cone and amounts to using the same water to transport the product to the well. Be careful that this water returns to the well and does not go into an undesired area. A Hydrogeologist should be consulted before doing this.

When there is product on top of the water it flows with the water and builds up in the well. The Water Pump must pump only water and never pump product.

As the product builds up in the well and the Water Pump continues to pump, the product/water interface gradually moves down. This is because the increasing product head is pushing down on water. Likewise, if the product were to be removed, the product/water interface rises.

SYSTEM DETAILS

The Small Diameter Dual Pump System was designed to utilize 4" O observation wells for the recovery of free floating hydrocarbons. This has been accomplished by utilizing a central axis for the development of both the water and oil pumps (Drawing 1).

PUMP ASSEMBLY

Located directly above the water pump is the oil pump assembly canister. This canister serves the dual function of both housing the oil pump assembly and serving as a linear bypass for the water flow. The oil pump assembly has been secured in the center of the canister to allow for minimum flow loss (CV=35GPM) as well as to utilize the flowing water as a coolant. The canister, as well as the oil pump assembly, are constructed of 304 stainless steel with stationary, viton, and o-ring seals.

INTAKE ASSEMBLY

Most systems currently available rely on a fixed position intake assembly for recovering hydrocarbons. Therefore, any adjustments of the intake level must be accomplished by physically moving the whole pump assembly either up or down within the well.

The Dual Pump System utilizes a special Nycoil intake assembly to remedy this situation. The Nycoil assembly is a pre-stressed, extruded, nylon II, coiled hose assembly. The advantage of this hose assembly lies in its ability to extend up to 24' from it's original compact coiled length of 8". The nominal O.D. (4") of the coil assembly allows for unrestricted expansion and recoiling within the well. The intake assembly has been fitted with a specially designed, 316 stainless steel intake strainer. For deployment in the recovery well, the intake strainer is attached to the sensing probe. Now adjustments to the intake level are easily accomplished by simply raising or lowering the sensing probe cable to the desired level. An additional advantage of the intake assembly is that the pump system can be hard piped into place in a stationary position within the recovery well, effectively eliminating the cumbersome, cost restrictive, large diameter discharge hose assembly.

At certain times the product pump intake may become clogged with debris or biomass (usually present at the oil/water interface). This will cause the magnetic coupling of the product pump to de-couple the pump from the motor. If stopping and restarting the pump does not rectify this situation, simply reverse the polarity of the pump leads (eg: ' + ' to ' - ' and ' - ' to ' + ') and run the pump in reverse for a few seconds. This should clear most debris from the intake. (Make sure that the check valve has been disconnected before running the pump in reverse to prevent damage).

The intake assembly comes pre-attached to the probe and needs only to be hooked up to the coiled intake hose. The intake hose, in turn, is attached to the 1/4" NPT fitting at the top of the pump.

A 1/2" black polypropylene discharge tubing (75') is supplied for the output of the pump. It attaches to the 1/2" compression fitting at the top of the pump canister. A check valve has been included and may be installed at the well head.

SENSING PROBE

Both the water and oil pump systems are controlled by a single sensing probe. Because this single probe is attached to the oil pump intake assembly it allows the operator an excellent degree of control over the interface (oil/water) within the well. As previously mentioned, adjustments of this level are easily accomplished by simply raising or lowering the probe cable to the desired height within the recovery well.

The Dual Pump sensing probe is also unique in that it utilizes density floats for sensing the presence of oil/water rather than conductivity. Our experience has shown that conductivity sensors, which rely on passing an external signal through the liquid being sensed, tend to require a high degree of maintenance. Whenever direct current (D.C.) is passed between two electrodes within a liquid a certain degree of galvanic action takes place. Within a recovery well, there is also the added problem of a higher degree of mineral deposits being leached into the water due to the natural reduced oxygen conditions. This occurs due to the presence of hydrocarbon utilizing oxygen consuming bacteria (i.e. arthrobactor and pseudomonis) which naturally occur and proliferate at the hydrocarbon/water interface.

Over time, as galvanic pitting takes place and a greater degree of deposits collect on the electrodes, a much more intensive cleaning maintenance program is necessary. While increasing the sensitivity of the electrodes may provide a temporary solution to the problem, it is usually only a stop-gap measure until total failure occurs.

The Dual Pump System, by utilizing density floats (approximately .95 for water .45 for hydrocarbon) has overcome this problem. The density floats are arranged to travel up and down a stainless steel tube. Located inside the tube are pre-wired, magnetic (Hall effect) reed switches. As the float(s) rise to within proximity of the switches the pump(s) are activated, allowing for the smooth, continuous removal of hydrocarbon and water. The sensing probe can also be pre-set at the factory to maintain a pre-determined hydrocarbon thickness within the recovery well down to approximately 1".

The probe comes complete with 75' of polyurethane coated, multi-conductor cable. The cable has been marked numerically every foot by a 7 digit system. To find the depth, record the first number, lower the probe and when a reading is taken, subtract the first number from the last number (e.g. xxxxx88 - xxxxx50 = 38 feet).

The probe contains four (4) independent sensing switches which are: (Ref. Drawing #2).

Oil: Activates oil pump when on.

High water: Activates the water pump when on and shuts down the oil pump.

Low water: Holds the water pump on once activated until the water falls below this level.

Override: If activated, this will shut down the water pump if the water falls below this level.

The probe for this system has been further modified in that the High and Low water probe hysterisis (separation) has been increased from the expanded dynamics of a small diameter well (high flow situation). Additionally, a time delay has also been added so that when the High sensor is activated, the system must time out a pre-set delay of up to 15 minutes before the water pump will start. This delay is so that the pump may not be cycled too rapidly as the rise time from high to low in a small diameter, high flow well is only several seconds.

The low probe will function as usual; keeping the water pump on until the water falls below it.

OIL/WATER PUMPS

The water pump supplied with the system is a Grundfos series, 304 stainless steel nominal flow, fitted with carbon impregnated Teflon seals and bearings. The motor is 230Vac, single phase, 304 stainless steel, complete with 75' of 14/7 direct burial THHN cable.

The oil pump is 316 stainless steel with carbon impregnated and/or viton wetted parts. The flow rate is factory pre-set at 1 GPM at 30 PSI max. This flow rate allows for smooth continuous removal of product from the well rather than pumping in slugs. The motor is a 12Vdc, magnetically coupled system, environmentally sealed in a 3" 304 stainless steel case, utilizing the power cable described above.

The power cable assembly has been modified to reduce the overall diameter, and subsequent flow restrictions in the riser pipe.

The cable supplied with the system is a 7 conductor/14 gauge THHN, direct burial type cable with a semi-rigid PVC outer jacket. This cable supplies powered to both the water and oil pump as follows. (Ref. Drawing #3).

	Motors Under 2HP	Motors Larger Than 2HP
Black	- main winding water pump	- main winding, water pump
Orange	- ground	- start winding, water pump
Yellow	- main winding water pump	- power return, water pump
Red	- +12Vdc, oil pump	- +12Vdc, oil pump
Blue	- -12Vdc oil pump	- -12Vdc, oil pump
Brown	- not used	- ground, oil/water pump

The appropriate leads have been split from the cable and routed to their respective pumps inside of a potted fitting directly above the oil pump in the oil pump assembly can.

SYSTEM OPERATION

Control Panel

The Control Panel contains the central processing and drive controls for both the oil and water pumps.

Unlike other systems, the Control Panel for the Small Diameter Dual Pump System has the capability of driving both pumps from a single logic controller circuit. This Controller has been designed around a specifically programmed memory driven by a microprocessor system.

Basically, the Controller monitors all external signals from the Sensing Probe and Tank Full assemblies and directs the pumping and light drive systems accordingly.

* The water pump drive system consists of a single mechanical relay which drives a Power Interrupting System. The power interrupter consists of an inductive load contacter block where the coil has been wired in series with a solid state programmable, on-delay, timer (0-15 minutes). When the mechanical relay receives a signal to run (ie: Hi probe on) the time delay is activated and must then count through it's time delay. When T=0 the contact block coil is then energized closing the contact and powering the water pump. The pump will then run until a stop pumping signal is received (ie: the Lo float falls).

The time delay has been added to the system in order to prevent rapid cycling of the water pump.

* Note: Time delay is utilized only for systems driving a 1.5 HP or larger Water Table Depression Pump the standard systems use dual solid state relays directly coupled to the water pump power leads.

The Oil Pump drive system consists of a single mechanical relay which drives a 12Vdc signal from a power transformer. When the mechanical relay receives a turn on signal the 12Vdc transformer is activated powering the oil pump.

The Oil Pump will stay powered until the mechanical relay receives a signal to stop pumping (ie: oil float falls).

The following function descriptions regarding the Hand/Off/Auto switches will further explain the systems response to external input from the Tank Full and Sensing Probe.

POWER SWITCH

ON - supplies power to the Logic Controller Circuit
OFF - no low voltage *
OFF - no low voltage *

* CAUTION: When the power switch is in the OFF position the control panel is still supplied with high voltage. Extreme caution should be taken before working on any internal components.

WATER SWITCH

HAND - manually activates the water pump, providing the system is not in an override mode (check O-Ride light).

OFF - water pump is disabled.

AUTO - system will respond according to the external sensing signals.

See Drawing #2 For Steps 1-4.

1. Check override float status, if activated, then pump will not run and override light will be on (Red light marked O-Ride).

   Note: The power switch must be turned to OFF to reset the override.

*2. If the Low Float is down, the water pump is OFF.

3. When the Low Float rises the water run light flashes and the pump is in a standby mode.

4. When the High Float is activated the water run light comes on steady and the water pump turns on.

   Note: The Water ON light flashes only when the Low float is rising.

OIL PUMP

Hand - Check Tank Full status - if it is on then the Tank Full light is on and the pump will not run. If the Tank Full light is OFF, then pump will turn on.

Off - Product pump is disabled.

Auto - System responds according to external sensing signals: See Drawing #2 for Steps 1-3.

*1. Check the Tank Full status - if it is on then the Tank Full light is on and the pump will not run.

2. If the Tank Full is OFF then oil float status is checked. If the oil float is up then the *time delay count down is started.

* Time delay is only applicable if the time delay control is activated.

3. Check the high water status. If it is not activated, the oil pump will enable float at T=0 seconds. If it is activated, then the oil pump will stay off until the high water float falls.

Note: The time delay is activated when the oil float rises after T=0 the delay will reset when the oil float falls or the water float rises.

* The system has been designed so that the Tank Full must be connected in order for the oil system to operate. Consequently, in the event that the Tank Full cable has been damaged, the oil pump cannot operate properly.

TANK FULL SENSING INPUT

Tank Full sensing is accomplished via the TANK FULL ASSEMBLY. It has both a 2" bushing for large tanks and 3/4" bushing for 55 gallon drums. When the recovery tank is full, the float on the TANK FULL rises shutting off the oil pump functions. The TANK FULL is supplied with 25' of cable. Connection to the CONTROL PANEL is accomplished by a 5 pin bayonet connector that couples to a 5 pin bayonet receptacle located at the bottom of the CONTROL PANEL.

SYSTEM TEST

- Set the control panel on a bench and connect to a 230Vac power source (unless the system is marked 115Vac).

- Connect the TANK FULL and SENSING PROBE to their respective 5 pin and 9 pin receptacles (Note: in some cases an extra "twist" is needed to lock the connectors into place. When locked in place, the connectors are listed as drip and moisture proof. Make sure all floats are located in the down position).

- Set both product and water control switches on AUTO and the power switch to ON. The system should now be powered. Within 5 to 15 seconds the override light should come on. This means that the override float is in a down position in the probe (the time delay is simply a safety feature to avoid nuisance trips). Under this condition, the water pump will NOT run, because the override sensor is located below the Lo water sensor (and the water pump should shut off when the water level falls below the Lo sensor). The Override Float should always be in the UP position under normal operation conditions. Therefore, if the Override Float should fall and remain down, a failure in the water pump control has occurred so the water pump has been shut down. In order to restart the water pump, the power switch must be reset by turning to OFF then back to ON.

- Now, place the Oil/Water sensing probe into a bucket of water with approximately 2-3" of kerosene on top and reset the power switch.

- The water pump run light should go on.

- Slowly raise the probe until the Oil run light begins to flash.

- The Oil Pump run light should go on.

- Keep raising the probe until both the Oil and Water run lights go out. Make sure to stop as soon as the Water run lights goes out to avoid activation the override sequence. Now, lower the probe 2-3".

- The water run light should begin flashing. This indicates that the Lo water sensor has been activated and the Water float is raising.

- Lower the probe until the Oil run light begins to flash and wait until the Oil pump run light goes on. Now raise the Tank Full float.

- The Tank Full light goes on and inhibits the Oil pump only from running.

- Lower the Tank Full float and the oil pump light will begin flashing and go through it's cycle again.

- Keep lowering the probe until the Water pump run light goes on solid and the Oil run light flashes. Note that the High Water sensor both activates the Water Pump and de-activates the Oil pump system.

WELL DEPLOYMENT

Attach one end of the Nycoil tubing to the bottom of the oil/water sensing probe. Now attach the other end to the top of the product pump assembly (1/4" NPT fitting).

Couple the 1/2" polypropylene discharge tubing to the 1/2" compression fitting at the top of the water jacket can.

Now, carefully put the power cable through the first section of the riser pipe while guiding the pipe through the center of the Nycoil assembly (we highly recommend 10' sections as they are much easier to handle).

Keep adding sections (using care not to damage the power cord) as the system is deployed within the well. As the system goes in, we recommend tying the discharge tubing to the riser pipe. Note: the probe cable must remain free and untangled.

Keep adding pipe sections on until the water pump is 10-15' below the ESTIMATED PUMPING LEVEL. The supplied "tee" fitting at the top of the riser pipe will allow exiting of the power cable from the discharge pipe.

Attach the Sensing Probe and Tank Full to the control panel using the bayonet connectors on the cable ends and deploy the Tank Full into the recovery tank making sure that the float has unobstructed movement.

Next, bring the 14/7 AWG power cable into the Splice Box through the fitting supplied. Using wire nuts, attach the 5 power cord wires to the pre-marked color coded wires in the Splice Box.

Hook the panel up to a 220Vac power source as previously described and turn both control switches to AUTO and the power switch to ON. The Water pump should now start. Utilizing the foot markers on the probe cable set the probe level to the required pumping level.

When the water pump begins to cycle, valve down the flow rate until the pump cycles no more than once every 5 minutes. Note: You can only control the on-time of the pump as the off time is dependent on water recharge to the pumping well.

SYSTEM DEPLOYMENT

Before the Dual Pump System is deployed, it should be tested in order to familiarize yourself with the system. There are three distinct parts to the Dual Pump System.

1. Control Panel (housed in a NEMA 4 cabinet).
2. External Sensing Probes (Oil/Water Probe and Tank Full).
3. Pump Assembly (Oil/Water)

It is best to first familiarize yourself with the Control Panel:

CONTROL PANEL

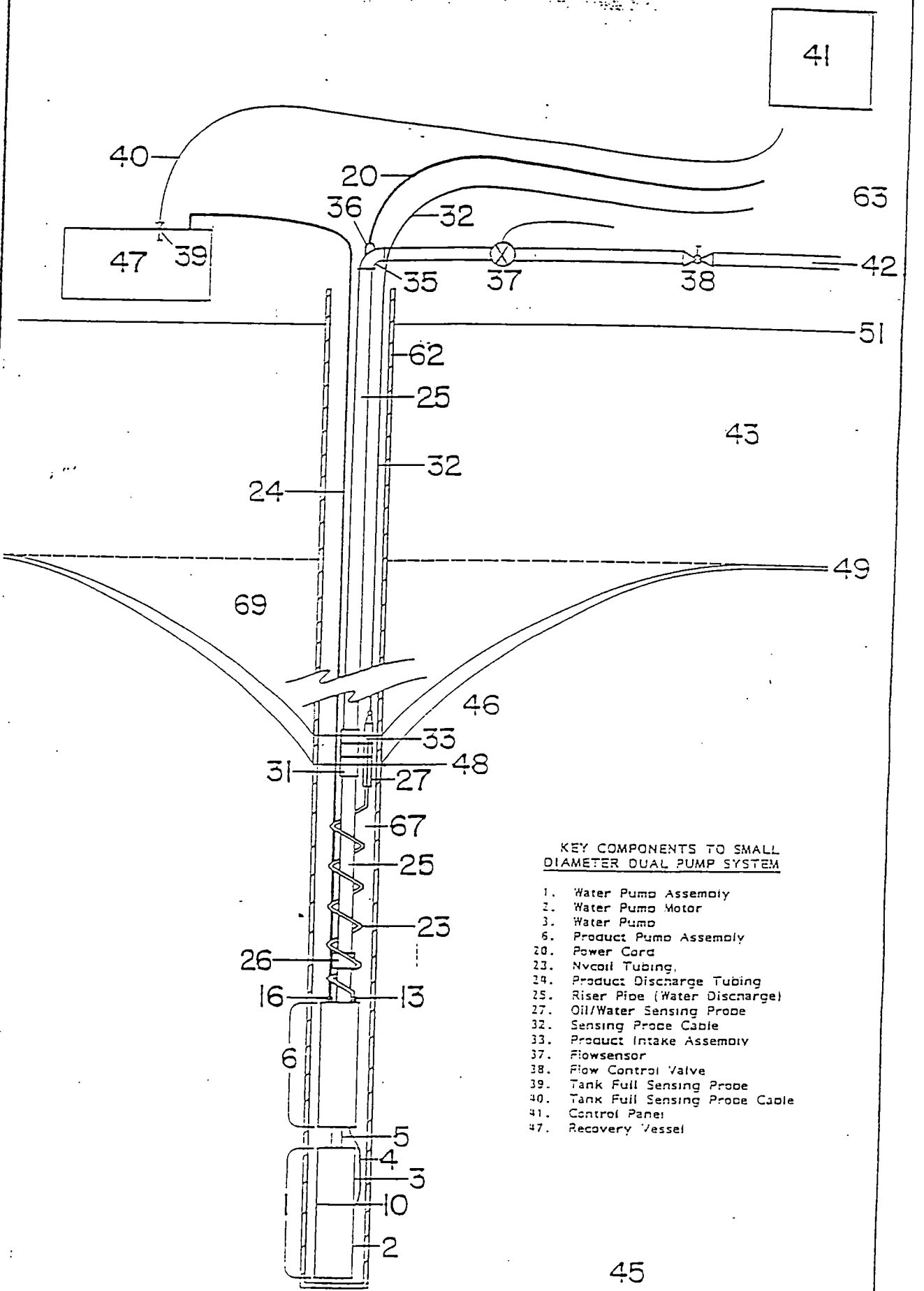
Although the Control Panels can be supplied in several different versions, the operational characteristics are relative. The systems all contain some form of:

- Power input (115 / 230Vac)
- Power output (115 / 230Vac, 12Vdc)
- Oil/Water Sensing Input
- Tank Full Sensing Input

POWER INPUT: Is accomplished in one of two ways. Either the system has been supplied with a power cable or the end user hard wires the power supply to the wires exiting the bottom left cable conduit on the panel. In most cases, a 230Vac/15Amp power supply is required although oil pump only and some special fracticnal horsepower water systems require a 115Vac/20Amp power supply.

POWER OUTPUT: Is accomplished by utilizing a Splice Box located under the panel. For connection instructions see the wiring instructions located inside the front door of the control panel, or see the chart on page 6 of this manual.

OIL/WATER SENSING INPUT - Is accomplished by utilizing the Oil/Water probe described earlier. The Probe is approximately 1.23" in diameter and is supplied in three standard lengths; 24" and 36". A general rule of thumb is that the higher the water flow the longer the probe (e.g. 50 GPM = 36" Probe). The probe is supplied with a 75' multi-conductor, numerically marked, cable. Connection to the CONTROL PANEL is accomplished by a 9 pin, bayonet connector that couples to a 9 pin bayonet receptacle located at the bottom of the CONTROL PANEL.



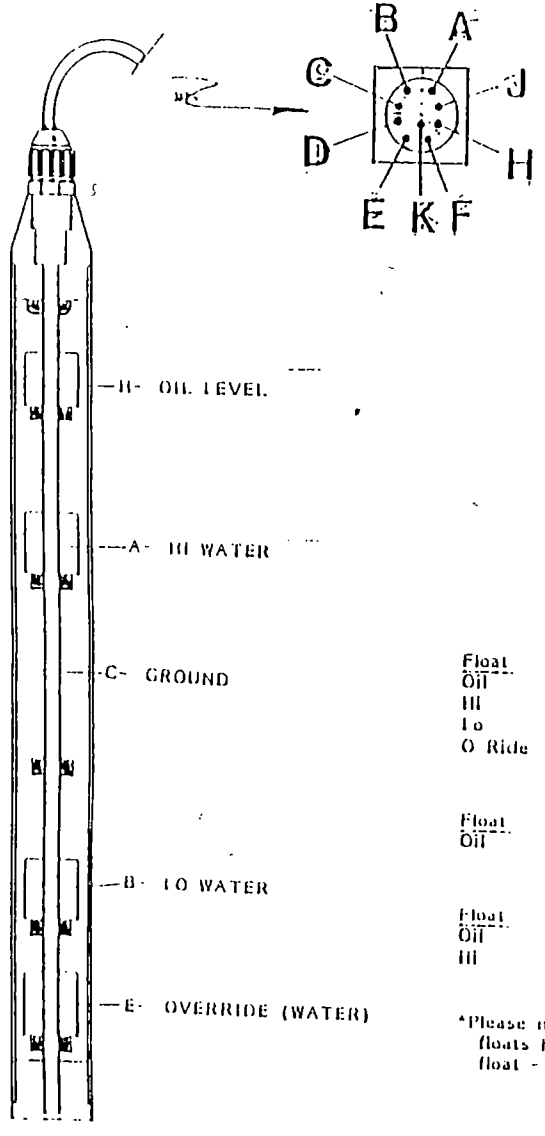
KEY COMPONENTS TO SMALL DIAMETER DUAL PUMP SYSTEM

1. Water Pump Assembly
2. Water Pump Motor
3. Water Pump
6. Product Pump Assembly
20. Power Cord
23. Nycoil Tubing,
24. Product Discharge Tubing
25. Riser Pipe (Water Discharge)
27. Oil/Water Sensing Probe
32. Sensing Probe Cable
33. Product Intake Assembly
37. Flowsensor
38. Flow Control Valve
39. Tank Full Sensing Probe
40. Tank Full Sensing Probe Cable
41. Control Panel
47. Recovery Vessel

FIG. 1

GROUNDWATER RECOVERY SYSTEMS, INC.

FIG 2



DUAL PUMP PROBE

Float Position Up - X
Float Position Down - -

Float	Pins	X	-
Oil	H-C	5-20Ω	open
HI	A-C	5-20Ω	open
Lo	B-C	5-20Ω	open
O Ride	E-C	open	5-20Ω

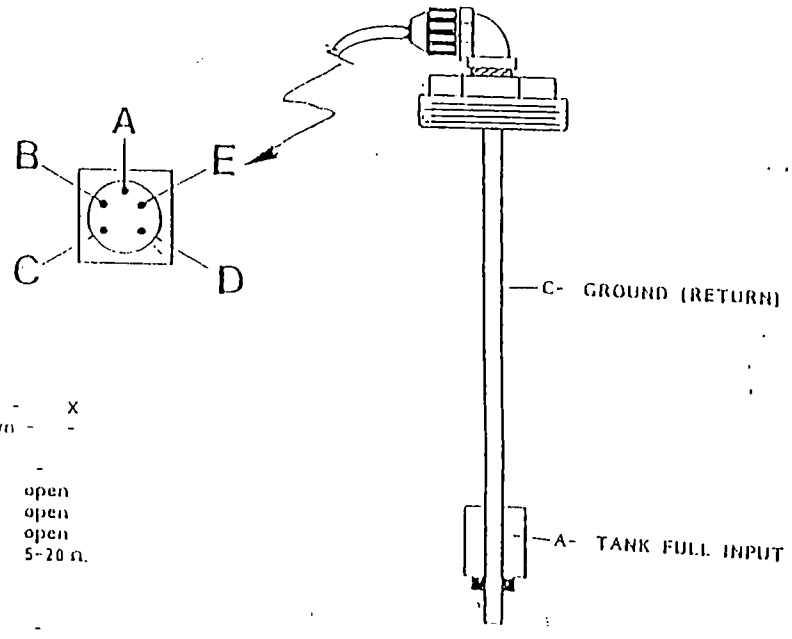
Tank Full

Float	Pins	X	-
Oil	A-C	open	5-20Ω

Portable Oil Pump

Float	Pins	X	-
Oil	H-C	5-20Ω	open
HI	A-C	open	5-20Ω
	B-C	5-20Ω	open

*Please note In newer probes, high/lo floats have been combined into a single float - All functions remain the same.



TANK FULL

GROUNDWATER RECOVERY SYSTEMS, INC.
Box 1901 • RD #4 Strasburg Road
Romansville, PA 19320-1901

SCALE —
DATE —
APPROVED BY
DRAWN BY
REVISED: —

TYPICAL DUAL PUMP PROBE
AND
TANK FULL WIRING

DRAWING NUMBER

GRS
Groundwater Recovery Systems, Inc.

January 1, 1989

TERMS AND CONDITIONS/DISTRIBUTORS

1. Minimum order amount is $45.00 (retail price).

2. Payment terms are:

   All invoices, must be paid within 30 days of shipping/invoice date.

   Invoices entitled to trade discounts must be paid within thirty days. Shipping costs and/or technician's time are not subject to trade discounts. Invoices paid after thirty days are not entitled to any trade discount.

   There will be an interest charge of 1 1/2% per month applied to invoices that are more than 60 days old.

   Accounts with a balance in excess of $15,000.00 which are over 60 days old, will be placed on a C.O.D. status.

3. All orders must be in writing to the Romansville, PA sales office. Telephone orders will be accepted, but must be accompanied by a Purchase Order number, and must be confirmed by a written Purchase Order or letter. Verbal and P.O.'s referencing the date only will not be accepted.

4. Prices are subject to change upon 30 days notice.

5. Groundwater Recovery Systems, Inc. (Manufacturer) warrants its products to be free from defect in material and workmanship under normal use and service, the remedy under this warranty being exclusively limited to making good at Manufacturer's factory any part or parts thereof which shall be returned to it with transportation charges prepaid; and which its examination shall disclose to its satisfaction to have been thus defective, except for pumps and motors, provided that such part or parts shall be so returned to it no later than 12 months after delivery of its product to the purchaser. Pumps and motors are warranted X months after delivery of its product to the original purchaser. THIS LIMITED WARRANTY IS BEING MADE IN PLACE OF ALL OTHER EXPRESS WARRANTIES AND IN PLACE OF ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS. THIS LIMITED WARRANTY IS IN LIEU OF ALL OBLIGATIONS OR LIABILITIES ON THE PART OF THE MANUFACTURER FOR DAMAGES INCLUDING, BUT NOT LIMITED TO, CONSEQUENTIAL AND INCIDENTAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH THE USE OF THE PRODUCT.

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6100 Ulmerton Rd. • #17 • Clearwater, FL 34620 • 813-572-6326 • 813-572-6326

CABLE CONNECTOR WIRING DIAGRAMS

STANDARD PROBE
(9 Pin)

A - Black - Hi H20
B - White - Lo H20
C - Green - Ground
D - Blue - Lo/Lo H20 (3' only)
E - Orange - Override
F
H - Red - Oil
J

TANK FULL
(5 Pin)

A - Black - Hi Oil
B
C - Green - Ground
D
E

TOWER PROBE
(5 Pin)

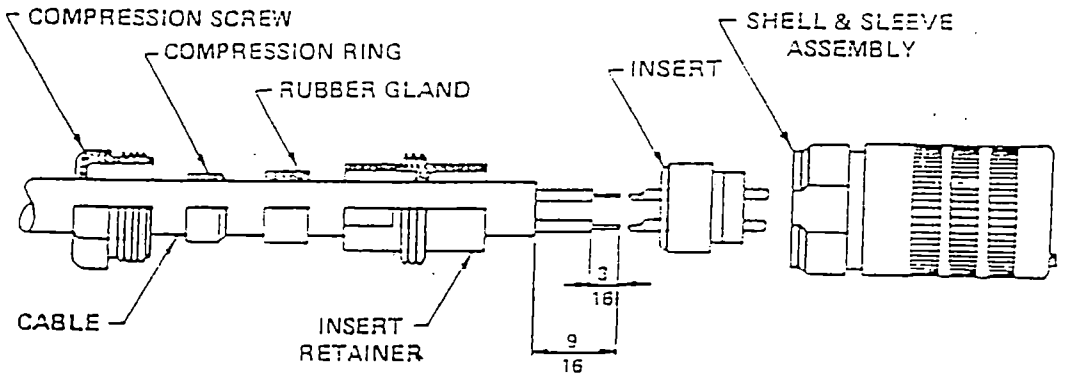
A - Red - Hi ICU
B - Blue - Lo ICU
C - Green - Ground
D - Black - Blower shutdown
E - Orange - Trans Pump

PORTABLE OIL PROBE
(9 Pin)

A - Black - H20 Low
B - Blue - H20 Up
C - Green - Ground
D
E
F
H - Red - Oil
J

WATER ONLY/ICU SYSTEM
(9 Pin)

A - Black - Hi H20
B - White - Lo H20
C - Green - Ground
D - Blue - Lo/Lo H20
E - Orange - Override



WIRING TECHNIQUE:

Prepare the cable for assembly by stripping the outer cable jacket to expose 3/16 inch of insulated leads and inner conductor insulation to expose 3/16 inch of bare wire. The conductors can be tinned before they are soldered into the contact solder cups. This will permit easy entrance into the solder cups and will eliminate the possibility of loose strands.

1. Slip the compression screw, the compression ring, the rubber gland and then the insert retainer onto the cable in this order.
2. Fill solder pockets with solder.
3. For easy soldering, start with the lowest and work toward the top.
4. Slip wired insert assembly into the shell and sleeve assembly. Be sure to align keyway on the insert with the key in the shell.
5. Thread the insert retainer into the shell and sleeve assembly behind the insert.
6. Slide the rubber gland and compression ring into the insert retainer.
7. Slide the compression screw into place and tighten to affect a complete moisture seal.

Groundwater Recovery Systems, Inc.

TROUBLESHOOTING GUIDE

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SYSTEM TROUBLESHOOTING

CONTROL PANEL

1. Check input voltage by looking at the AC volt meter (should be 230 Vac). Actual reading:_____.

2. If power is not present, check input breaker.

3. Check to see if power switch on the panel is in the ON position.

4. Check if product pump operates in the HAND position. If so, record the current draw of pump:_____.

5. Check if water pump operates in the HAND position. If so, record the current draw of pump:_____.

7. Record status of lights on (ON, OFF, FLASHING) the panel with both switches in the AUTO position, and power switch on.

_____	_____	_____	_____
Oil Run Light	Tank Full	Water Run Light	Override

8. Record the pump status (running or not running) for both product & water. Product Pump:_____ Water Pump:_____.

9. If pump not operating in AUTO position, check output voltage from panel at the junction box. Actual reading:_____.

Voltage readings should be:

Water Pump: Black to Yellow; 230V AC. Actual reading:_____.

Product Pump: Red to Blue; 12V DC. Actual reading:_____.

If these output voltages are not present, or are incorrect, the problem may be in the control panel.

PUMP TROUBLESHOOTING

WATER PUMP

1. Check & record motor winding resistance with power off and pump cable disconnected from panel, check:

	1/2 HP	Actual	3/4 HP	Actual
Black to Yellow; should be	4.2 - 5.2 ohms	_____	2.7 -3.4 ohms	_____
Black to Orange; should be	Infinity	_____	Infinity	_____
Yellow to Orange; should be	Infinity	_____	Infinity	_____

(For other motor sizes, refer to Grundfos manual in the rear of your GRS operation manual. If readings are not correct, the problem may be in the pump or pump power cable).

PRODUCT PUMP

1. Check & record motor winding resistance with power off and pump cable disconnected at Junction Box.

	Actual Reading
Red/Black - blue should be: 10 ohms - 15 ohms	_____
Red/Black - Orange should be: Infinity	_____
Blue - Orange should be: Infinity	_____

2. If winding resistance is correct, the pump may be jammed. Run the pump with a car battery. This will allow the pump to clear itself of any debris by running at a higher level. Run both forward and reverse by reversing the polarity of the leads (Red is (+) and Blue is (-)).

   CAUTION: DO NOT RUN FOR MORE THAN 30 SECONDS IN EITHER DIRECTION!

TROUBLESHOOTING DUAL PUMP SENSING PROBE

1. Continuity check of the probe (see fig. 1, 1A).
   On the 9 pin plug check continuity from:

   Pin H - Pin C with Float #1 up on collar W approximately 0 ohms.
   Actual Reading:_____

   Pin H - Pin C with Float #1 down on collar X approximately infinity ohms. Actual Reading:_____

   Pin A - Pin C with Float #2 up on collar X approximately 0 ohms.
   Actual Reading:_____

   Pin A - Pin C with Float #2 down on collar Y approximately infinity ohms. Actual Reading:_____

   Pin B - Pin C with Float #2 up on collar X approximately 0 ohms.
   Actual Reading:_____

   Pin B - Pin C with Float #2 down on collar Y approximately infinity ohms. Actual Reading:_____

   Pin E - Pin C with Float #3 up on collar Y approximately infinity ohms. Actual Reading:_____

   Pin E - Pin C with Float #3 down on collar Z approximately 0 ohms.
   Actual Reading:_____

If any of these readings are incorrect, the problem may be in the probe, probe cable, or connecting plug.

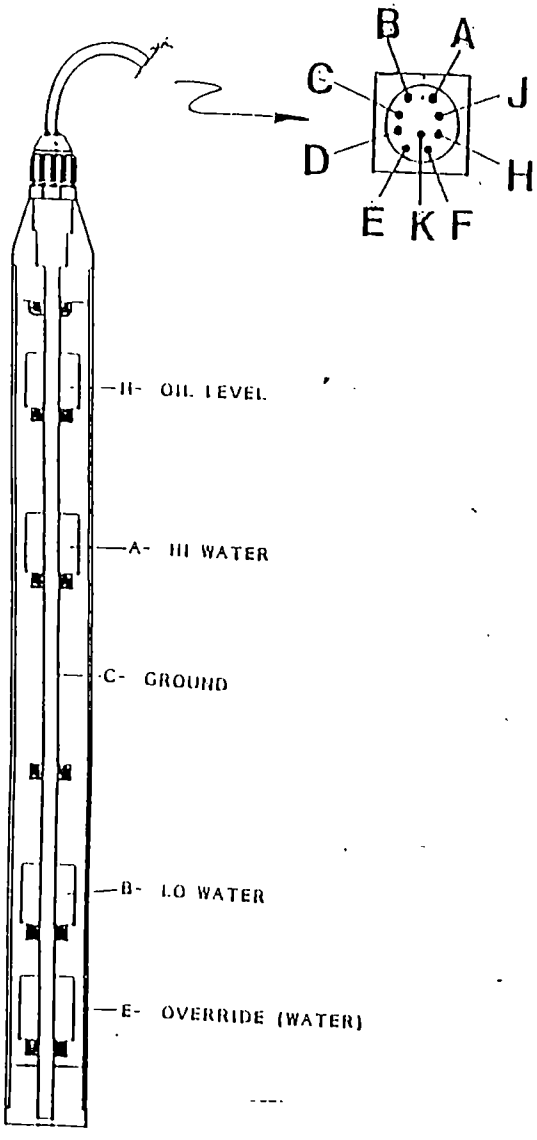
TROUBLESHOOTING TANK FULL PROBE

1. Continuity check of Tank Full Probe (see fig. 2,2A)
   On the 5 pin plug check continuity from:

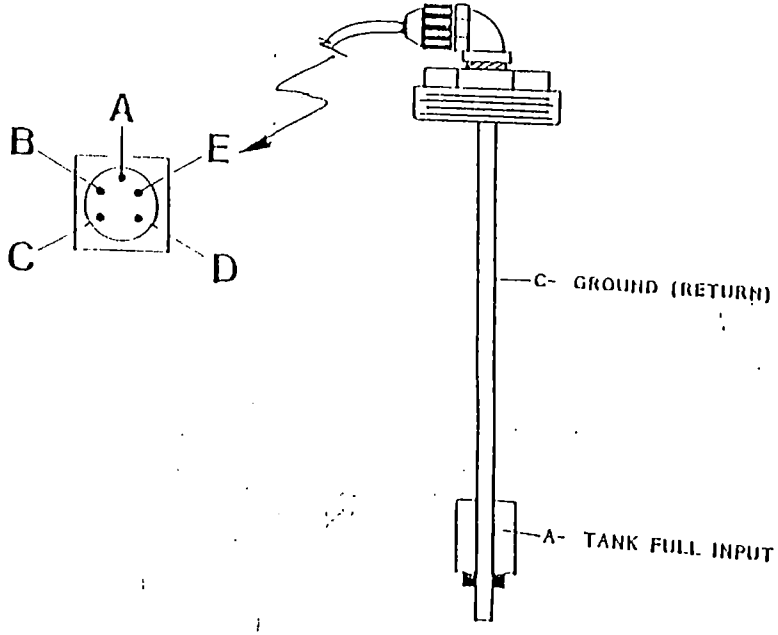
   Pin A - Pin C with the Float down on collar X approximately 0 ohms.
   Actual Reading:_____

   Pin A - Pin C with the Float 1" above collar X approximately infinity ohms. Actual Reading:_____

If any of these readings are incorrect, the problem may be in the Tank Full probe, the Tank Full cable, or the connecting plug.



DUAL PUMP PROBE



TANK FULL

GROUNDWATER RECOVERY SYSTEMS, INC.
Box 1901 • RD #4 Strasburg Road
Romansville, PA 19320-1901

SCALE:
DATE:
APPROVED BY:
DRAWN BY:
REVISED:

TYPICAL DUAL PUMP PROBE
AND
TANK FULL WIRING

DRAWING NUMBER

D.2 RAIN-GAUGE OPERATING MANUAL

WEATHERLOG RECORDING RAIN GAUGE INSTRUCTIONS

1. Hold the narrow end of the black collector in one hand and remove the base, prying it off with the fingertips of the other hand.

2. Remove the hardware package from the base of the collector.

3. Mount the collector base above ground on a flat level surface in an open area (on a fence post, roof, deck, tree stump, etc.). Avoid mounting to a steel or iron table. Place the long flat stainless steel hold down strips between the base and the mounting surface. The mounting screws go thru the small holes in the base, thru the stainless strip and finally into the mounting surface. Leave the collector off for now.

4. Run the wire from the collector thru a window or other wall opening to the indoor location where you wish to place the recorder. Be careful not to cut the wire.

5. Install 4 AA alkaline batteries into the back of the recorder. Install 3 AA alkaline batteries into the black box attached to the recorder.

6. Plug the wire from the collector into the black box connected to the recorder.

7. Feed the paper into the recorder and pull out enough to wind it onto the spring loaded take-up reel.

____ 8. Press the ON button. Press the [P] or [PRT] key. PRT should now be shown on the display.

9. To setup the recorder for:

To setup the recorder for:	Press the following keys in this order:
English - Inches.	.01, ÷, ÷. Press [RND] The display should read 5/4.
Metric - Millimeters . . .	.254, ÷, ÷. Press [RND] The display should read F.

The K and ÷ signs should now show on the display if set up properly.

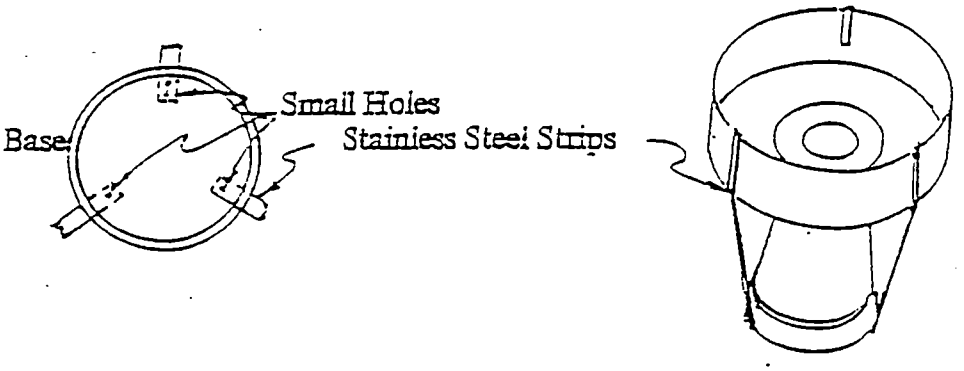
10. Press the [0] key followed by the [P/#] key. This resets and marks the beginning of the print count. Press the [P] key (PRT now should not show on the display.) The system is ready to operate. No keys should be pressed from this point on except the [0] key. If other keys are pressed, go back to step #8.

11. To check the sytem, tip the measuring dipper back and forth and observe the LCD readout in the recorder. This should show one count ampunt for each tip of the dipper. THE PRINTER WILL NOT PRINT UNTIL ITS TIME INTERVAL COMES UP, WHEN IT WILL PRINT THE TOTAL SHOWN IN THE DISPLAY. Pressing the [=] key is equivalent to tipping the dipper.

12. Now replace the collector on the rain gauge, making sure the wires do not interfere with the operation of the dipper. Push the cover firmly down onto its base. Bend the stainless strips up and over the top of the stainless collector ring to secure the assembly against the wind.

13. Repeat step #10 if you need to reset the system.

RECORDING RAIN GAUGE INSTRUCTIONS - PAGE 2



PAPER TAKE-UP REEL INSTRUCTIONS

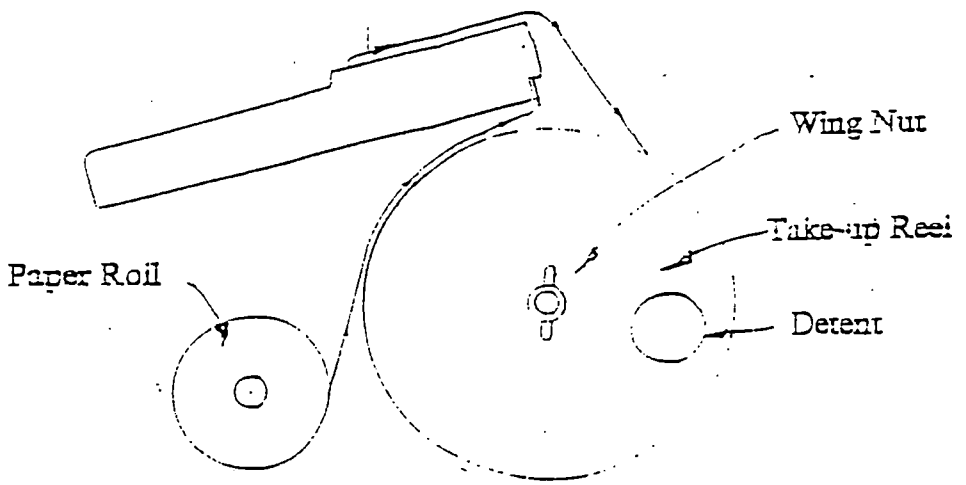
1. Place a new roll of paper on the post beneath the recorder and feed the paper up and into the recorder as shown below. Press the paper advance button (↑) until the paper is fed out of the recorder.

2. Using your finger in the detent provided, wind the take-up reel COUNTER CLOCKWISE until "STOP" appears on the spring. Do not wind past this point.

3. Tape the end of the paper onto the reel and carefully release it allowing the spring force to take up the slack. The unit is now ready to use.

4. To remove paper that is wound onto the take-up reel, unscrew the wingnut and pull the reel off the post. The two halves of the reel will then separate for removal of the printed tape.

5. Place the black box connected to the recorder in the clip provided at the side of the take-up reel frame.



D.3 SAMPLE FIELD NOTES REPORT

Serv-Air Environmental Laboratory
Site Information

Bldg. #699 DICAR #: 89-10-19-1329

Date: 12/22/93 Discharge Approved:

Project Manager: C. Appleby, DEH Personnel on-site: Teal S. Jeffries

Time Arrived: 8:20am Time Departed: 10:30am

Work Performed:

( ) MW's

MW#	Depth to product feet	Depth to water feet	Elevation of Wellhead (ft)	Product feet
1	4.47	4.48	15.81	.01
2	—	3.13	16.64	—
3	4.50	4.51	15.80	.01
4	4.57	4.58	15.92	.01
5	3.83	3.84	15.48	.01
6	4.35	4.36	15.78	.01
8	—	4.66	16.20	—
9	—	4.34	15.96	—
11	—	6.22	17.14	—
12	—	5.17	16.66	—
13	—	2.82	16.21	—
14	2.67	2.68	15.98	.01
RW2	4.77	4.78	16.09	.01

( ) Bail Product

MW#	Liters bailed
	Ø

(✓) Check Product Fill Switch
(✓) Check System
(✓) System Start-up
(✓) Troubleshoot
Describe: Over-ride light was on & system was not running. System was cleared and placed on line. No apparent problems with the system.

Flow Rate: 2.59 gpm
Total Gallons: 24891

Bailed Product Disposed to: N/A

Sample Requirements: (Attach COC and Results)
( ) BTEX (✓) TPH

General Notes/Observations: Rain gauge = .48 inches. Observation: Local extreme tidal action noted during the week of Dec. 20, 1993; may have caused over-ride to be activated.

Previous Total Gallonage:

Current Total Gallonage Reading: 24,891

Signed: Teal S. Jeffries

THE KRYDON GROUP
221 W. CLEMENTS BRIDGE RD.
BARRINGTON, N.J. 08007
(609) 546-5305

DAILY CONSTRUCTION REPORT

DATE 12/22/93

DAY | S | M | T | W | TH | F | S |

PROJECT Ft. Monmouth
JOB No. 93018.01
CLIENT
CONTRACTOR
PROJECT MANAGER Greg Lupinski

WEATHER	BRITE SUN	CLEAR	OVERCAST	RAIN	SNOW
TEMP.	TO 32	32-50	50-70	70-85	85 UP
WIND	STILL	MODER.	HIGH	REPORT No.	
HUMIDITY	DRY	MODER.	HUMID		

AVERAGE FIELD FORCE

NAME OF CONTRACTOR	NON-MANUAL	MANUAL	REMARKS
TKG - Ted			

VISITORS

TIME	REPRESENTING	REPRESENTING	REMARKS

EQUIPMENT AT THE SITE

CONSTRUCTION ACTIVITIES

8:20 am - TKG arrives on site
8:40 am - TKG arrives @ Bldg 699 and begins well Monitoring
#6 W: 132.9 cm Corrosion sheen (heavy)
P: 132.8 cm
#5 W: 117.0 cm No sheen present.
P: 116.9 cm
#3 W: 137.3 cm sheen & odor
P: 137.2 cm
#2 W: 95.4 cm
P: ND
#13 W: 86.1 cm
P: ND
#14 W: 91.7 slight sheen
P: 91.6
#4 W: 139.6 cm sheen
P: 139.5 cm water & sheen in bailer
RW#2 W: 145.7 cm sheen & odor
P: 145.4 cm

DISTRIBUTION: 1. PROJ. MGR.
2. FIELD OFFICE
3. FILE
4. CLIENT

BY [signature] TITLE Proj. Engineer

THE KRYDON GROUP
221 W. CLEMENTS BRIDGE RD.
BARRINGTON, N.J. 08007
(609) 546 - 5305

DAILY CONSTRUCTION REPORT
(CONTINUATION SHEET)

PROJECT Ft. Monmouth REPORT No. _____

JOB No. 9301A.01 DATE 12/22/93

CONSTRUCTION ACTIVITIES (CONTINUED)

#7 W: 132.4 cm
P: ND

#12 W: 157.6 cm
P: ND

#8R W: 142.1 cm
P: ND

#1 W: 150.4 cm steam @ 0.3 cm
P: 130.3 cm

#11 W: 189.5 cm steam observed.
P: ND

9:25 am - MW #11 Pump system is not running. The green light is on thus indicating the system from working properly. 2488 and 3.
30 AC Volts
17 DC Volts
System was turned off and then back on to reset the system.
Running @ 2.69 gpm
Water level was high due to pump being off. Hydrocarbon sample was taken after the well was purged through 2 cycles.
R: gauge = 0.2 inches (Petroleum stuck to paper towel around)

Cycle Time: ON: 2 min 30 sec Cycle through cycle: 2487 gal through to
OFF: 2 hr 45 min 2487 gal
GPM: 2.59
TPHC sample taken @ 4:55 am
System cleaned thoroughly.

10:35 am - TK6 leaves Bldg 699. TK6 goes to lab & C. Applebaum's office for information.
11:30 am - TK6 leaves Ft. Monmouth

DISTRIBUTION: 1. PROJ. MGR. 2. FIELD OFFICE 3. FILE 4. CLIENT

SHEET 2 OF 2

BY [signature] TITLE Proj Engineer

SERV-AIR, INC.
An E-SYSTEMS Company

P.O. #:

Chain of Custody

Project #: 23018.01

Customer: Krydon

Phone: (609) 546-5305

Sampler: Ted Jeffers

Site Name: Bldg. 699 - Pump Eff. Mw#11

Date / Time: 12/22/93 | 9:55a

Analysis Parameters: TPH

Start:

Finish:

Lab Sample ID Number	Date/Time		Customer Sample Location/ID Number	Sample Matrix	# of Bottles	Preservation Method	Remarks
	12/22/93	9:55a	Sx01 Mw#11 Pump Eff.	aqueous	3	✓	

Relinquished By (signature): Ted Jeffers — Date / Time: 12/22/93 | 10:30a

Received By (signature): Mark Hubbard

Shipped By:

Relinquished By (signature): — Date / Time:

Received For Lab by (signature): — Date / Time:

Note: A drawing depicting sample location should be attached or drawn on the reverse side of this chain of custody.

SAI-ENV COC Form 01 — Page 1 of 1 Pages — Rev. A Date: 02 Apr 93

FT. MONMOUTH OFFICE
E-SYSTEMS, INC • P. O. BOX 369, BUILDING 1209 • FT. MONMOUTH, NEW JERSEY 07703-5000 • (201) 544-0995

12/22/93

Groundwater Recovery
Systems, Inc.

TROUBLESHOOTING GUIDE

Box 1901 • R.D. #4 • Strasburg Road • Pomansville, PA 19320-1901 • 215-486-6722 • FAX 215-486-6723
5100 Ulmerton Rd. • #17 • Clearwater, FL 34620 • 813-572-6325 • 813-572-6326

SYSTEM TROUBLESHOOTING

CONTROL PANEL

1. Check input voltage by looking at the AC volt meter (should be 230 Vac). Actual reading: 120.
2. If power is not present, check input breaker.
3. Check to see if power switch on the panel is in the ON position.
4. Check if product pump operates in the HAND position. If so, record the current draw of pump: ϕ.
5. Check if water pump operates in the HAND position. If so, record the current draw of pump: 2.59.
7. Record status of lights on (ON, OFF, FLASHING) the panel with both switches in the AUTO position, and power switch on.

Oil Run Light	Tank Full	Water Run Light	Override
OFF	OFF	OFF	ON

8. Record the pump status (running or not running) for both product & water. Product Pump: Not Running Water Pump: Not Running.
9. If pump not operating in AUTO position, check output voltage from panel at the junction box. Actual reading: 12.

Voltage readings should be:

Water Pump: Black to Yellow; 230V AC. Actual reading: 120.

Product Pump: Red to Blue; 12V DC. Actual reading: 12.

If these output voltages are not present, or are incorrect, the problem may be in the control panel.

PUMP TROUBLESHOOTING

WATER PUMP

1. Check & record motor winding resistance with power off and pump cable disconnected from panel, check:

	1/2 HP	Actual	3/4 HP	Actual
Black to Yellow; should be	4.2 - 5.2 ohms	_____	2.7 -3.4 ohms	1.6
Black to Orange; should be	Infinity	_____	Infinity	∞
Yellow to Orange; should be	Infinity	_____	Infinity	∞

(For other motor sizes, refer to Grundfos manual in the rear of your GRS operation manual. If readings are not correct, the problem may be in the pump or pump power cable).

PRODUCT PUMP

1. Check & record motor winding resistance with power off and pump cable disconnected at Junction Box.

	Actual Reading
Red/Black - blue should be: 10 ohms - 15 ohms	.8
Red/Black - Orange should be: Infinity	∞
Blue - Orange should be: Infinity	∞

2. If winding resistance is correct, the pump may be jammed. Run the pump with a car battery. This will allow the pump to clear itself of any debris by running at a higher level. Run both forward and reverse by reversing the polarity of the leads (Red is (+) and Blue is (-)).

   CAUTION: DO NOT RUN FOR MORE THAN 30 SECONDS IN EITHER DIRECTION!

TROUBLESHOOTING DUAL PUMP SENSING PROBE

N/A

1. Continuity check of the probe (see fig. 1, 1A).
   On the 9 pin plug check continuity from:

   Pin H - Pin C with Float #1 up on collar W approximately 0 ohms.
   Actual Reading:_____

   Pin H - Pin C with Float #1 down on collar X approximately infinity ohms. Actual Reading:_____

   Pin A - Pin C with Float #2 up on collar X approximately 0 ohms.
   Actual Reading:_____

   Pin A - Pin C with Float #2 down on collar Y approximately infinity ohms. Actual Reading:_____

   Pin B - Pin C with Float #2 up on collar X approximately 0 ohms.
   Actual Reading:_____

   Pin B - Pin C with Float #2 down on collar Y approximately infinity ohms. Actual Reading:_____

   Pin E - Pin C with Float #3 up on collar Y approximately infinity ohms. Actual Reading:_____

   Pin E - Pin C with Float #3 down on collar Z approximately 0 ohms.
   Actual Reading:_____

If any of these readings are incorrect, the problem may be in the probe, probe cable, or connecting plug.

TROUBLESHOOTING TANK FULL PROBE

1. Continuity check of Tank Full Probe (see fig. 2,2A)
   On the 6 pin plug check continuity from:

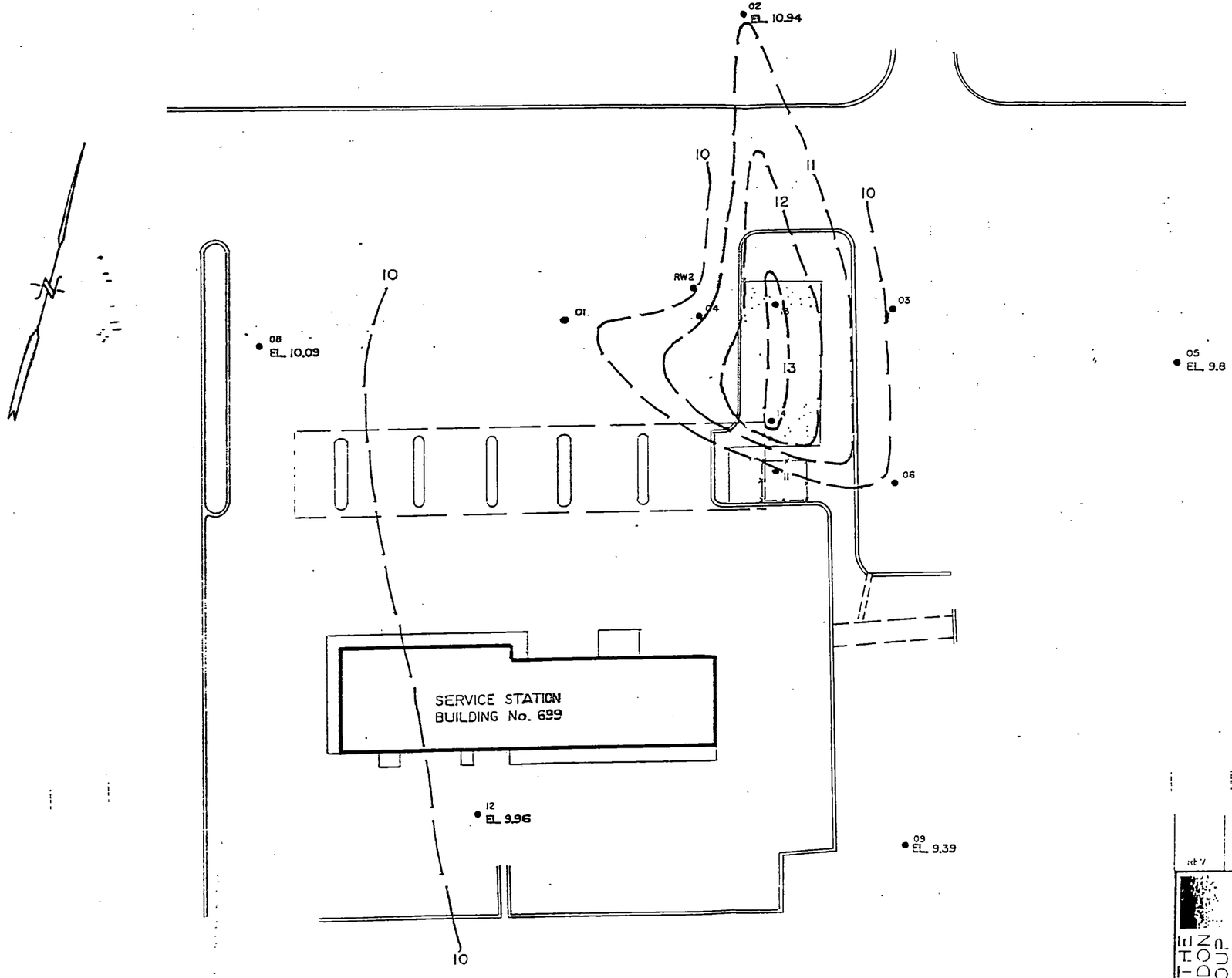
   Pin A - Pin C with the Float down on collar X approximately 0 ohms.
   Actual Reading: 0

   Pin A - Pin C with the Float 1" above collar X approximately infinity ohms. Actual Reading: ∞

If any of these readings are incorrect, the problem may be in the Tank Full probe, the Tank Full cable, or the connecting plug.

D.4 SAMPLE ISOPLETH MAP

M.W. #	GROUNWATER ELEVATION	DEPTH TO PRODUCT FEET	DEPTH TO WATER FEET	ELEVATION OF WELLHEAD (FT.)
1	9.84	5.95	5.97	15.81
2	10.94	——	5.70	16.64
3	9.7	——	6.10	15.80
4	——	——		15.92
5	9.8	——	5.68	15.48
6	9.63	——	6.15	15.78
8	10.09	——	6.11	16.20
9	9.39	——	6.57	15.96
11	4.25	12.87	12.89	17.14
12	9.96	——	6.70	16.66
13	13.24	——	2.97	16.21
14	13.16	——	2.82	15.98
RW2	9.87	——	6.22	16.09



ANALYTICAL RESULTS

M.W. # 11	TPHC	20.8	MG/L
	B	3500	UG/L
	T	1500	UG/L
	E	1800	UG/L
	X	3100	UG/L

RAIN GAUGE READING

2.07 In.

REV	DATE	DWN BY	CHK'D BY	DESCRIPTION

THE KRYDON GROUP

ENGINEERS SCIENTISTS & PLANNERS
221 W. CLEMENTS BRIDGE RD., BARRINGTON, N. 08007
(609) 546-5305

GROUNDWATER ISOPLETH

"SERVICE STATION BLDG. No 699"

FORT MONMOUTH, MONMOUTH COUNTY, NEW JERSEY

DANIEL T. DRISCOLL
NJ PROFESSIONAL ENGINEER LIC #GE31990
PA PROFESSIONAL ENGINEER LIC #034564-E

DATE: 8-25-93
DRAWN BY: R.A.H.
CHK'D BY: D.T.D.
SCALE: 1" = 40'
Comm. No: 93018.01
Sheet 2 of