ATTACHMENT C

OPERATION AND MAINTENANCE MANUAL FOR SVE SYSTEM

Manual Revised April 2013
(submitted May 16, 2013)

OPERATION AND MAINTENANCE MANUAL
SOIL VAPOR EXTRACTION SYSTEM

Page-Trowbridge Ranch Landfill

Pinal County, Arizona

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April 2013

This report was originally prepared in 2008 on behalf of the University of Arizona by Hydro Geo Chem, Inc. to support operation and maintenance of the soil vapor extraction system installed at Page Trowbridge Ranch Landfill. As part of the Post Closure Permit Renewal process for the site, AMEC Environment and Infrastructure, Inc. (AMEC) updated the report with current information and made modifications to address regulatory requirements. A summary of changes made to the document by AMEC is included in Section 1.0 of this report.

Although AMEC has performed an inspection of associated equipment for general accordance with this plan and adherence to standard operation and maintenance procedures commonly employed for soil vapor extraction systems, AMEC did not develop the technical approach presented herein and thus makes no warranty regarding the information provided in documentation prepared by Hydro Geo Chem, Inc.

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1. INTRODUCTION

This Operations and Maintenance (O&M) Manual is intended to act as a guide for the operation and maintenance of the solar-powered soil vapor extraction (SVE) system installed at the Page-Trowbridge Ranch Landfill (PTRL) in Pinal County, Arizona (Attachment A, Drawing 1). The SVE system is located between landfill units A and B at the PTRL (Attachment A, Drawing 2).

The purpose of this document is to provide operating personnel with the basic knowledge necessary to start, operate, troubleshoot, and maintain the SVE system and identify the sampling activities necessary to evaluate system performance. This document is based on Revision 2 of the O&M Manual originally prepared by Hydro Geo Chem, Inc. (HGC), which outlines O&M procedures based on conditions at the time of report preparation, after the system was in operation for 12 months. Revisions made by AMEC Environment & Infrastructure, Inc. in this document include: updating the air permit status in Section 1.1, adding detail regarding extraction well construction in Section 2.2, revising the SVE operating strategy in Section 3.1, removing photoionization detection (PID) monitoring from the operating procedure in Section 6, adding a new Section 6.3 on operational parameters for the SVE system, and revising reporting requirements in Section 8.

Operation of a treatment system is an evolving process. The user should evaluate the document for errors, make corrections, and suggest improvements or modifications to operating procedures or performance monitoring descriptions included herein. This document should be reviewed periodically for changes and modified in accordance with the findings of that review.

1.1 Background and General System Description

The SVE system consists of two, solar-powered, positive displacement blower units (SVE-1 and SVE-2) connected to associated SVE wells. SVE-1 is designed to extract soil gas from Well SGS (Soil Gas Shallow) at a rate of 85 standard cubic feet per minute (scfm). SVE-2 is designed to extract soil gas from Well SGD (Soil Gas Deep) at a design rate of 40 scfm, or the flow can be reversed to inject air into this well at 40 scfm. The extracted soil gas streams from the two SVE units are combined at a total design rate of 125 scfm when SVE-2 is in extraction mode. The extracted soil gas stream is then passed through two granular activated carbon (GAC) adsorbers in series for removal of VOCs prior to atmospheric discharge.

Based on influent concentrations measured from 2010 through 2011, the rated capacity of the blowers, and the maximum hours of operation per day, the remediation system does not exceed the 5.5 pound per day or the one ton per year potential to emit permit threshold limit (Pinal County Rule 1-1-140). An air quality permit for this system is therefore not required based on the current system configuration and influent concentrations. During the operation of the SVE system, the VOC concentrations and extraction rates will continue to be used to verify that an air quality permit is not required.

1.2 Key Project Contacts

Key project contacts for the SVE system O&M are presented in Table 1 with their affiliation, role, telephone, and e-mail contacts.

1.3 Contaminants of Concern

The contaminants of concern (COCs) consist of the following VOCs present in soil gas at PTRL that were identified and collectively evaluated as a potential threat to groundwater or human health via inhalation pathways (HGC, 2005a):

- Carbon tetrachloride
- Chloroform
- Dichlorodifluoromethane (Freon 12)
- 1,1-Dichloroethene (1,1-DCE)
- Methylene chloride
- Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- Trichlorofluoromethane (Freon 11)
- Trichlorotrifluoroethane (Freon 113)

1.4 SVE System Components

The SVE system consists of the following components, as detailed in the as-built drawings included as Attachment A (Drawings 2, 3, 4, and E-2A):

- SVE wells SGS and SGD
- Solar-powered, skid-mounted, vacuum blower package identified as SVE-1:
    - belt-driven, positive displacement (rotary lobe type) blower configured for 85 scfm;
    - 2-horsepower (hp), 120 volt alternating current (VAC), totally-enclosed fan cooled (TEFC) motor;
    - condensate separator;
    - seven 185-watt photovoltaic (PV) panels and one 170-watt PV panel on common support rack mounted above vacuum blower unit skid;
    - four 175-watt PV panels on common support rack and post;
    - a 3900-watt, 24 volt direct current (VDC) to 120 VAC inverter with remote control for programming;
    - electrical control panels for enclosure of solar power operating, control and monitoring equipment, and instrumentation;
    - flow rate sensor and vacuum gauge; and
    - branch valve ports for soil gas sampling or pressure monitoring
- Solar-powered, skid-mounted, vacuum blower package identified as SVE-2:
    - Belt-driven, positive displacement (rotary lobe type) blower configured for 40 scfm;
    - 1-hp, 24 VDC, brushed, TEFC motor;
    - condensate separator;
    - three 185-watt PV panels and five 175-watt PV panels on common support rack mounted above vacuum blower unit skid;
    - four 175-watt PV panels on common support rack and post;
    - electrical control panels for enclosure of solar power operating, control and monitoring equipment, and instrumentation;

  - flow rate sensor and vacuum gauge; and
  - branch valve ports for soil gas sampling or pressure monitoring
- 55-gallon, buried condensate sump along the pipeline from Well SGS to SVE-1;
- 16 each, 6-volt, 224 ampere-hours (AH) at standard 24-hour duration, absorbed gel mat (AGM) batteries within electrical panel enclosures, arranged as four parallel sets of four batteries in series for 24 VDC output;
- interconnecting piping and valving from SVE wells to SVE system and GAC absorbers; and
- two 2,000-pound capacity GAC adsorbers with interconnecting pipes/hoses.

2. EQUIPMENT DESCRIPTION

The SVE system consists of two, skid-mounted, solar-powered vacuum blower units, SVE-1 and SVE-2, attached to Wells SGS and SGD, respectively (Attachment A, Drawing 2). The larger capacity unit, SVE-1, is designed to extract up to 85 scfm of soil gas from the shallow vadose zone via Well SGS. The smaller capacity unit, SVE-2, is designed to extract up to 40 scfm of soil gas from the deep vadose zone via Well SGD or inject fresh air into the same zone at roughly the same rate. The vacuum blower discharge stream from SVE-1 (and SVE-2 if operating in SVE service) is passed through two GAC adsorbers, connected in series, for removal of VOCs prior to atmospheric discharge.

2.1 Equipment Compound

The aboveground components of the SVE system are located south of the service road between landfill units A and B (Attachment A, Drawing 2). This equipment compound is unfenced, allowing access to all aboveground system components. These components consist of two, skid mounted SVE units, each with eight PV panels attached to support racks; two sets of four PV panels attached to support poles independent of the SVE unit skids; interconnecting piping and hoses attached to a support framework near the two 2,000-pound GAC adsorbers. The adsorbers are located near the service road, permitting easy access for periodic carbon replacement. All above ground process piping is painted white for protection from solar degradation. Additionally, the white finish serves to minimize temperature increases within the process gas stream prior to reaching the GAC adsorbers, since adsorber efficiency increases with decreasing process temperatures.

2.2 Wells, Vaults, and Laterals

Well SGS is located near the southeast corner of landfill unit A (Attachment A, Drawing 2). As depicted on the lithologic log and well completion diagram provided in Attachment B, the well is constructed of 4-inch diameter, polyvinyl chloride (PVC) casing to a depth of 255 feet below ground surface (bgs) with slotted screen casing from 100 to 220 feet bgs (pea gravel filter pack extends from 98 to 255 feet bgs) for extracting soil gas. Additionally, a ½-inch diameter PVC soil-vapor monitoring probe, SGS-SP, is installed adjacent to the 4-inch well casing, enabling soil gas to be monitored from a slotted screen interval occurring at 75 to 80 feet bgs (sand filter pack extends from 73 to 83 feet bgs). The annular space around of the well between the sand packs surrounding the 4-inch well screen and ½-inch vapor probe screen, and from the ½-inch vapor probe screen to land surface (well vault), is sealed with 30-percent high-solids bentonite.

Well SGD is located between landfill units A and B (Attachment A, Drawing 2). As depicted on the lithologic log and well completion diagram (Attachment B), the well is constructed of 2-inch PVC casing to a depth of 605 feet bgs with slotted screen casing from 408 to 540 feet bgs and 560 to 600 feet bgs (pea gravel filter pack extends from 435 to 605 ft bgs). The well is accompanied by two ½-inch diameter PVC soil-vapor monitoring probes, SGD-SP and SGD-MP, enabling soil gas to be monitored from slotted screen intervals occurring at 100 to 120 feet bgs (sand filter pack extends from 98 to 123 feet bgs) and 195 to 215 feet bgs (sand filter pack extends from 193 to 217 feet bgs), respectively. The annular space around the well between the filter packs surrounding the 2-inch well screen and ½-inch vapor probe screens is sealed with 30percent high-solids bentonite.

An additional ½-inch PVC soil-vapor monitoring probe, SGD-DP (or SGD-2), is located just west of Well SGD within a separate borehole with soil gas monitoring enabled via a slotted screen interval occurring at 330 to 350 feet bgs (sand filter pack extends from 325 to 355 feet bgs).

Both extraction well heads, with sampling ports and connected lateral lines with isolation ball valves (BV-1 and BV-2), are enclosed within traffic-rated vaults made of composite materials. The vault lids can be lifted with a lid hook hanging on the pipe support rack adjacent to the GAC adsorbers.

From the SVE well heads, the respective lateral lines extend below grade to their respective SVE system skids (Attachment A, Drawing 2). The lateral line from Well SGS is sloped downward at a minimum of one percent to the condensate sump (Section 2.3), both from the well head and skid. Any condensed soil gas moisture within this 4-inch lateral line should flow by gravity into the sump for subsequent removal on a periodic basis. From SVE-2, the respective lateral line slopes approximately one percent toward the well to permit drainage of condensate back to the well. Within each pipe trench previously advanced for lateral line installation, a 12-gauge tracer wire exists above the pipeline for pipeline location purposes, should nearby excavation be necessary in the future (Attachment A, Drawing 4).

2.3 Well SGS Condensate Sump

A condensate sump, consisting of a 55-gallon drum, is installed at the low point in the 4-inch lateral line from Well SGS to SVE-1 (Attachment A, Drawing 4). As indicated on Detail 4, condensate enters the top of the sump through a bulkhead fitting from a low-point branch tee within the 4-inch lateral line. Another bulkhead fitting on the top of the sump provides access from the surface through a 2-inch PVC standpipe or riser stub. Upon removing a 2-inch threaded plug from the end of this standpipe, the condensate level within the sump can be measured, and the condensate removed by a bailer or a suitable pump.

2.4 Common Battery Array

The solar arrays and associated control panels of SVE-1 and SVE-2 are connected to a common battery array located between the two skids. The battery array consists of sixteen, 6-volt, AGM, 224 AH batteries manufactured by Concorde Battery Corporation. The batteries are connected as four parallel sets of four batteries in series for 24 VDC service at a combined electrical storage capacity of 896 AH. This electrical storage capacity serves as an electrical energy buffer between the fluctuating rate of solar power production and the nearly constant rate of DC power draw by the vacuum blower motors. The battery array receives solar power simultaneously from both charge controllers. Electrical power is discharged from the battery array to SVE-1 and SVE-2, upon demand, for blower operation.

The load controllers are programmed to 1) allow battery array charging from the charge controllers without blower operation when the battery voltage decreases to 24.2 volts and 2) limit further battery array charging (or overcharging) when the battery voltage increases to 27.2 volts. The battery rest voltages when fully charged and fully discharged (100% and 0% states-of-charge) are 26.5 and 22.8 volts, respectively. The above programming is intended to maintain the battery state-of-charge above 65% (minimum rest voltage of 25.2 volts) and the depth-of-discharge above 50%, resulting in at least 1000 charge/discharge life cycles at one cycle per day.

2.5 SVE-1 Equipment Skid and Auxiliary Solar Panel Array

As depicted on Drawings E-2A and 3 (Attachment A), the SVE-1 equipment skid features a condensate separator, vacuum blower and motor with associated belt drive, interconnecting PVC piping, instruments, control panel, and 8-panel PV array mounted to an overhead support rack. An auxiliary, pole-mounted, 4-panel PV array is provided near the SVE-1 skid. SVE-1 is interconnected to Well SGS and the GAC absorbers (Section 2.7) via field-limit piping connection points located on the north side of the skid.

2.5.1 Condensate Separator

The condensate separator or "knockout tank" (KO-1) removes any free aqueous condensate from the extracted soil gas stream not collected in the condensate sump (usually from October through April) prior to this gas stream passing through the SVE-1 vacuum blower and downstream equipment. KO-1 consists of a vertical, cylindrical steel vessel with tangential inlet and top center outlet. The lateral line from Well SGS extends above grade and enters this vessel at the tangential inlet for removal of any entrained soil gas moisture (mist) by centrifugal forces and impingement against the vessel sidewall. A pressure gauge (0 to 30 inches water column (WC) vacuum) is provided on this inlet riser pipe for monitoring vacuum pressure at this point. The top outlet piping conveys the moist soil gas stream, less the free moisture, to the inlet port of the vacuum blower.

Any aqueous condensate that impinges against the sidewall of KO-1 falls to the bottom of and accumulates in this vessel. A clear plastic sight gauge is provided on the side of KO-1 for inspection of liquid level. Within this site gauge, a high level switch (LSH-1) is installed for automatic shut down of the vacuum blower. Should the liquid level within KO-1 reach a maximum operating level, LSH-1 would actuate to prevent water from being drawn into the outlet pipe and potentially damaging the blower. While SVE-1 is down for routine maintenance, condensate is removed from KO-1 by opening a drain valve at the bottom of the vessel (see Section 4.3).

2.5.2 Extraction Blower, Motor, and Belt Drive

The extraction blower, PDB-1, consists of a Dresser-Roots Model URAI 42 rotary-lobe type, positive displacement blower. PDB-1 serves as the prime mover for the extraction of soil gas from Well SGS at an extraction rate of 85 scfm and subsequent conveyance through the GAC adsorbers (Section 2.7). The blower is dual-belt driven from a 2-hp Dayton motor (M-1) using 120 VAC power from the Magnum RD3924 DC-to-AC Inverter which uses 24 VDC power from the common battery array (Section 2.4) and solar power system (Sections 2.5.3 and 2.6.4). Manufacturer's specifications for the motor and blower are provided in Attachment C. The motor is thermally protected; if the motor exceeds the temperature rating, the motor will need to be manually reset.

Within the 2-inch diameter inlet pipe to the blower, an averaging Pitot tube (FE-1) is installed for local indication of soil gas flow rate by an associated Dwyer Magnehelic® flow velocity indicator (FM-1) located on the side of the control panel. Alternatively, the differential pressure across the

Pitot tube may be measured directly from the interconnecting tubing to FM-1, along with the discrete line pressure, for calculation of flow rate using the Pitot tube equation.

At the inlet and discharge ports of the blower, branch valve ports are provided for periodic gas pressure measurements directly across the blower for calculation of brake horsepower draw by gas compression.

2.5.3 Solar Panel Arrays

An 8-panel PV array is mounted above the SVE-1 skid, consisting of seven 185-watt Sharp ® single-crystal silicon PV panels and one 170-watt Sharp polycrystalline silicon PV panel. Additionally, an auxiliary PV array, consisting of four 175-watt BP Solar polycrystalline silicon nitride PV panels, is mounted to a support rack and pole located adjacent to SVE-1. The tilt angle on both PV arrays can be periodically adjusted (twice per year) for proper alignment of the arrays relative to the azimuth of the sun. Tilt angle adjustment is accomplished by reworking the guy wires that extend from the support racks to concrete anchors.

Collectively, the 8-panel and 4-panel arrays (24 VDC nominal output per panel) are cabled together as six sets of two panels in series for nominal 48 VDC solar power output to control panel CP-1. The positive cable from each panel set extends to a 10 amp circuit breaker within CP-1. The negative cable from each panel set extends to a common negative bus bar within CP-1.

2.5.4 Control Panel and Electrical System

Control panel CP-1, mounted on the north side of SVE-1, contains the electrical controls and circuitry necessary to deliver solar (direct current) power from the six-set PV array to the common battery array (Section 2.4) and the DC-to-AC inverter which provides power to the blower motor (M-1).

The six 10-amp circuit breakers for the positive cables of the PV array are connected to a common bus bar. The positive cable from this bus bar is routed through a main disconnect switch (mounted on the side of CP-1) and then to the charge controller.

The Outback FLEXmax 80 charge controller (SC-1) is state-of-the-art relative to the control of solar power from the PV array to the common battery array and blower motor. The Outback charge controller has a digital display screen with a menu of settings and display options for the various operating parameters. On the PV array side, the controller features Maximum Power Point Tracking (MPPT) capability, which automatically and continually extracts the optimum or maximum DC power output from the nominal 48-volt PV array. On the charge side, the controller transmits up to 97.5% of the solar power to the common battery array and blower motor at the required voltage (nominal 24-volts) while increasing (more than doubling) the current at the reduced voltage, thereby eliminating any electrical power loss resulting from a loss of voltage through the controller. The voltage output from the controller is programmed for battery array charging in three modes: bulk, absorb, and float. In bulk mode, the output power (voltage and current) is maximized for quick recharging of the batteries. If and when the charge voltage reaches a programmed set-point value, the absorb mode begins for a programmed duration, which may be extended by the controller if the charge voltage is not maintained at or above the programmed set-point value. If and when the absorb mode ends, the float mode begins. During the float mode, the charge voltage is programmed at a lower set-point value that matches the battery array voltage at 100% state-of-charge or fully charged state. Considering the variable solar power input to the controller during the day and the operation of the blower motor, the actual voltage output to the battery array and blower motor will be generally less than the programmed voltage set-points for bulk and absorb modes.

From the charge controller, the positive cable passes through an 80-amp circuit breaker and then splits to the blower motor start circuit, including the Magnum RD3924 3900 watt 24 VDC to120 VAC inverter and common battery array (Section 2.4) after passing through the main disconnect switch. The blower motor start circuit features an "On/Off" selector switch (HS-1) located on the face of CP-1 for enabling blower operation. Downstream of this switch, the start circuit passes through normally-closed, high level switch LSH-1; the positive side of the load controller (LC-1), and then through the control side of a solenoid relay (SS-1) to the negative side of the common battery array. At the load side of SS-1, a positive cable from the charge controller and common battery array passes through SS-1, followed by a 30-amp fuse, the load controller, and to the blower motor. Upon switching HS-1 to the "On" position, the blower motor start circuit becomes energized to the load controller, unless this leg of the circuit is opened by a high level condition (LSH-1 actuated). When the battery array voltage increases to a set-point value programmed within the load controller, the load controller will close an internal switch, thereby closing the blower motor start circuit to energize relay SS-1, which closes the DC power circuit to the DC-to-AC inverter and blower motor. When the battery array voltage decreases to a set-point value programmed within the load controller, the load controller will open the internal switch to de-energize the blower motor start circuit. Switching HS-1 to the "Off" position will disable SS-1, thereby also disabling DC power to the blower motor. Power from the PV and battery arrays can be interrupted by moving the main disconnect switch (KS-1) to the "Off" position.

The load controller (LC-1), consisting of a Morning Star Tri-Star 60 Solar System Controller, senses the battery array voltage at the battery array. This controller functions only as a high and low voltage switch for proper operation of the battery array and blower motor as described above.

The inverter is a Magnum 3924, 3900 watt, 24 VDC-to-120 VAC inverter capable of handling 30 amps continuous and a 93% efficiency rating. The inverter has the ability to handle 1 millisecond of surge current at 150 amps AC, and 100 milliseconds of surge current at 90 amps AC in order to handle the start-up current draw of the motor. The inverter is housed in a separate box to protect it from the elements. The box, previously used to house the batteries in the initial electrical configuration, has been retrofitted with air vents allowing for airflow to cool the inverter. The inverter features a modified sine wave output, remote control port, and thermal protection.

The inverter operating parameters are set with the Magnum ME-RC remote control. The remote control is located in CP-1, and is connected to the inverter via a standard phone cable. This remote control is used to set the low battery cut-out which is presently set to ensure that the load controller shuts off the motor as opposed to the inverter shutting of the motor. Other parameters that can be set by the remote control are necessary only if the inverter is also being used to charge the batteries. Since the battery charging is controlled by the FLEXmax 80 charge controller, these settings do not need to be changed. The remote control is also used to determine system status and fault mode messages via the LCD screen. This last feature is useful to determine what caused the inverter to shut off if it is found in such a state upon arrival at the site for maintenance. Possible conditions that may cause the inverter to shut off include:

1. Exceeding the temperature rating of the internal components. The inverter does include thermal protection and the inverter should restart once the unit has cooled down;
2. Exceeding the current ratings of the inverter. If the current overload condition occurs for less than 3 seconds, the inverter will restart. If the current overload lasts for more than 10 seconds, the unit will shut down and the inverter will need to be restarted manually;
3. Exceeding the internal field effect transistor's (FET) safe operating condition. If this occurs then the system will require a manual restart;
4. Unknown fault: if this message is displayed, then technical support will need to be contacted.

CP-1 is also equipped with an hour meter to better facilitate monitoring of system performance. The hour meter is connected to the motor circuit and energized when the blower motor is in operation. The amperage drawn by the 2 hp 120 VAC motor is monitored via the use of a multi-meter with an ammeter probe.

2.6 SVE-2 Equipment Skid

The SVE-2 equipment skid features a condensate separator, vacuum blower and motor with associated belt drive, interconnecting PVC piping, instruments, control panel, and 8-panel PV array mounted to an overhead support rack (Drawings E-2A and 3 [Attachment A]). An auxiliary, pole-mounted, 4-panel PV array is provided near to the SVE-2 skid. SVE-2 is interconnected to Well SGD and the GAC adsorbers (Section 2.7) via field-limit piping connection points located on the north side of the skid.

2.6.1 Condensate Separator

The condensate separator or "knockout tank" (KO-2) removes any free aqueous condensate from the extracted soil gas stream or ambient air prior to this gas stream passing through the SVE-2 vacuum blower and downstream equipment. KO-2 consists of a vertical, cylindrical steel vessel with tangential inlet and top center outlet. The lateral line from Well SGD extends above grade and enters this vessel at the tangential inlet for removal of any entrained soil gas moisture (mist) by centrifugal forces and impingement against the vessel sidewall. A pressure gauge (0 to 30 inches WC vacuum) is provided on this inlet riser pipe for monitoring vacuum pressure at this point. The top outlet piping conveys the moist soil gas stream, less the free moisture, to the inlet port of the vacuum blower.

Any aqueous condensate that impinges against the sidewall of KO-2 falls to the bottom of this vessel and accumulates. A sight gauge, constructed of clear plastic, is provided on the side of KO-2 for inspection of liquid level within. Within this site gauge, high level switch (LSH-2) is installed for automatic shut down of the vacuum blower. Should the liquid level within KO-2 reach a maximum operating level, LSH-2 would actuate to prevent water from being drawn into the outlet pipe and potentially damaging the blower. While SVE-2 is down for routine maintenance, condensate is removed from KO-2 by opening a drain valve at the bottom of the vessel (see Section 4.3).

2.6.2 Extraction Blower, Motor, and Belt Drive

The Dresser-Roots Model URAI 42 rotary-lobe type, positive displacement blower, PDB-2, serves as the prime mover for the extraction of soil gas from Well SGD and subsequent conveyance through the GAC adsorbers (Section 2.7), or injection of ambient air into Well SGD, at a rate of 40 scfm at 25 inches WC vacuum. The blower is dual-belt driven from a 1-hp Leeson motor (M-2) using 24 VDC power from the common battery array (Section 2.4) and solar power system (Sections 2.6.4 and 2.6.5). Manufacturer's specifications for the motor and blower are provided in Attachment C.

Within the 2-inch diameter inlet pipe to the blower, an averaging Pitot tube (FE-2) is installed for local indication of soil gas flow rate by an associated Dwyer Magnehelic® flow velocity indicator (FM-2) located on the side of the control panel. Alternatively, the differential pressure across the Pitot tube may be measured directly from the interconnecting tubing to FM-2, along with the discrete line pressure, for calculation of flow rate using the Pitot tube equation.

At the inlet and discharge ports of the blower, branch valve ports are provided for periodic gas pressure measurements directly across the blower for calculation of brake horsepower draw by gas compression.

2.6.3 Air Inlet and Filter

SVE-2 is also equipped to inject air into the subsurface through Well SGD. During air injection mode, ambient air is drawn into SVE-2 through a 2-inch air inlet filter and isolation valve (BV3) located at a branch point just upstream of KO-2. The filter removes particulate matter from the air stream prior to injection into the vadose zone soil via Well SGD. Just upstream of the air filter branch point, another isolation valve, B-4, is closed to direct air flow through KO-2 to the vacuum blower inlet. On the 2-inch PVC discharge line from the blower (downstream of the discharge hose), a 2-inch PVC branch line with isolation valve, BV-6, is connected to the Well SGD lateral line (2-inch PVC) where extending above grade. Another isolation valve, BV-5, is provided just downstream of this branch point to isolate SVE-2 from the GAC adsorbers. With BV-6 open and BV-5 closed, the air stream from PDB-2 is directed into the Well SGD lateral line for injection into Well SGD.

2.6.4 Solar Panel Arrays

An 8-panel PV array is mounted above the SVE-2 skid, consisting of three 185-watt Sharp single-crystal silicon PV panels and five 175-watt BP Solar polycrystalline silicon nitride PV panels. Additionally, an auxiliary PV array, consisting of four 175-watt BP Solar polycrystalline silicon nitride PV panels, is mounted to a support rack and pole located adjacent to SVE-2. The tilt angle on both PV arrays can be periodically adjusted (twice per year) for proper alignment of the arrays relative to the azimuth of the sun. Tilt angle adjustment is accomplished by reworking the guy wires that extend from the support racks to concrete anchors.

Collectively, the 8-panel and 4-panel arrays are cabled together as six sets of two panels in series for nominal 48 VDC solar power output to control panel CP-2. The positive cable from each panel set extends to a 10 amp circuit breaker within CP-2. The negative cable from each panel set extends to a common negative bus bar within CP-2.

2.6.5 Control Panel and Electrical System

Control panel CP-2, mounted on the north side of SVE-2, contains the electrical controls and circuitry necessary to deliver solar power from the six-set PV array to the common battery array (Section 2.4) and blower motor (M-2).

As a continuation of Section 2.6.4, the six 10-amp circuit breakers for the positive cables of the PV array are connected to a common bus bar. The positive cable from this bus bar is routed through a main disconnect switch (mounted on the side of CP-2) and then to the charge controller.

The Outback FLEXmax 80 charge controller (SC-2) is described in Section 2.5.4. From the charge controller, the positive cable passes through an 80-amp circuit breaker and then splits to the motor controller and common battery array (Section 2.4) after passing through the main disconnect switch. Power supply to the PDB-2 motor start circuit originates from the PDB-1 motor start circuit at SS-1 within CP-1. As a subsurface performance provision, this configuration enables PDB-2 to start only when PDB-1 is in operation. Power is supplied to the PDB-2 motor start circuit from an "On/Off" selector switch (HS-2) located on the face of CP-2. Downstream of this switch, the start circuit passes through normally-closed, high level switch LSH-2; the positive side of the load controller (LC-2), and then through the control side of a solenoid relay (SS-1) to the negative side of the common battery array. At the load side of SS-1, a positive cable from the charge controller and common battery array passes through SS-1, followed by a 60-amp fuse, the load controller, and the motor controller, to the blower motor. Upon switching HS-2 to the "On" position, the blower motor start circuit is enabled to the load controller (from SVE-1), unless this leg of the circuit is opened by a high liquid level condition (LSH-2 actuated). When the battery array voltage increases to a set-point value programmed within the load controller, the load controller will close an internal switch to further enable the blower motor start circuit to relay SS-1. When PDB-1 is in operation, SS-1 then becomes energized, thereby closing the DC power circuit to the motor controller and blower motor. When the battery array voltage decreases to a set-point value programmed within the load controller, the load controller will open the internal switch to de-energize the blower motor start circuit. Switching HS-2 to the "Off" position will disable SS-1, thereby also disabling DC power to the blower motor. Power from the PV and battery arrays can be interrupted by moving the main disconnect switch (KS-2) to the "OFF" position.

The load controller (LC-2), consisting of a Morning Star Tri-Star 45 Solar System Controller, senses the battery array voltage at a terminal block located within CP-2. This controller functions only as a high and low voltage switch for proper operation of the battery array and blower motor as described above. The set-point value for this switch is identical to that for LC-1, resulting in PDB-1 and PDB-2 starting and stopping together.

The motor controller (MC-2) consists of a Minarek DC 60-12/24, pulse-width modulated, adjustable speed drive for DC brush motors. MC-2 features a speed-adjust potentiometer that fixes the normal voltage output to the blower motor to realize the desired blower speed and throughput. Other variable controls are provided for smooth start-up and operation of the blower motor, as well as for current limit protection.

CP-2 is also equipped with an hour meter and ammeter to better facilitate monitoring of system performance. The hour meter is connected to the motor circuit and energized when the blower motor is in operation. The ammeter is connected to the motor circuit at a shunt to measure the DC amperage drawn by the motor.

2.7 GAC Adsorbers and Piping / Hose Connections

The 3-inch PVC blower discharge lines from SVE-1 and 2-inch PVC discharge line from SVE-2 are connected to a common 3-inch PVC line. Near this connection, both discharge lines contain a flapper-type check valve to prevent the reverse flow. The soil gas stream passes through a 3-inch PVC riser pipe (R-INF) attached to a steel support framework, followed by a 6-foot long, heavy-duty hose with Camlock couplers (inlet hose 1 – IH1), to the top, or inlet, of lead GAC adsorber. From the bottom of the lead adsorber, the treated soil gas stream is conveyed through outlet hose 1 (OH1) connected to the bottom of an adjoining section of 3-inch PVC riser pipe (R1) that is also mounted to the steel support framework. The top of R1 is connected to inlet hose 2 (IH2) which connects to the inlet (top) of the lag GAC adsorber for continued soil gas flow through this vessel, in series. From the lag adsorber, the treated soil gas stream is discharged to the atmosphere through an outlet hose 2 (OH2) and 3-inch PVC vent pipe (R2), also mounted to the steel support framework.

Each GAC adsorber contains 2,000 pounds of activated carbon for removal of VOCs from the combined soil gas stream by the process of activated carbon adsorption. The VOC loading within the lead adsorber is monitored to predict when the GAC will become spent or requires replacement with fresh carbon. When the carbon within the lead adsorber is replaced, the roles of the two adsorbers are to be switched by reconfiguring the hoses. The canister with the clean carbon should always be the lag GAC adsorber.

3. OPERATION PROCEDURES

The SVE system is composed of two units, SVE-1 and SVE-2, which are connected to a common battery array. SVE-1 extracts soil gas from the 98 to 255-feet bgs interval via shallow Well SGS at a flow rate of approximately 85 scfm. SVE-2 can either extract soil gas from or inject fresh ambient air into the 435 to 605-feet bgs interval through deep Well SGD at a flow rate of 40 scfm. SVE-1 can be operated independently of SVE-2. Through an electrical interlock provision, SVE-2 cannot be operated in soil gas extraction or air injection mode unless SVE-1 is in operation. Operation of both units in soil gas extraction mode is referred to as "extraction-extraction" mode. Operation of SVE-1 in extraction mode and SVE-2 in injection mode is referred to as "extraction-injection" mode. Under normal conditions, SVE-1 and SVE-2 should be operated in the "extraction-injection" mode.

Prior to operation of SVE-1 only or SVE-1 and SVE-2 together, certain isolation valves must be properly configured as further described in the following sections.

3.1 Operating Strategy

SVE-2 should be operated in air injection mode along with SVE-1 operation in extraction mode, since the injection of fresh air into the deep zone will displace soil gas with any contaminants radially outward and then upward through Well SGS to the surface, as induced by the SVE process driven by SVE-1. Otherwise, if SVE-2 were in extraction mode under the same operating condition, soil gas with higher concentrations of contaminant vapor (at shallower depths) would be drawn towards the screened interval of Well SGD, having the undesirable effect of drawing contaminants deeper into the vadose zone and closer to groundwater.

As stated above, SVE-2 is electrically interlocked to prevent operation in injection mode (or extraction mode) without SVE-1 operating in extraction mode. This forbidden operation prevents the potential displacement of contaminant vapor radially outward toward the property boundaries and eventually into the atmosphere, as well as downward to the aquifer.

When preparing SVE-2 for operation in injection mode, the respective isolation valves should be configured as indicated in the table below. **All system valves must be checked when restarting SVE-2 after an extended period of inactivity to ensure that they are in the proper configuration.**

SVE-2 Injection Configuration

Valve Number	Injection Configuration
BV-3	Open
BV-4	Closed
BV-5	Closed
BV-6	Open

For reference purpose only, the configuration of isolation valves for operating SVE-2 in extraction mode are listed below. **However, SVE-2 should normally be operated in injection mode.**

SVE-2 Extraction Configuration

Valve Number	Extraction Configuration
BV-3	Closed
BV-4	Open
BV-5	Open
BV-6	Closed

3.2 GAC Adsorber Lead-Lag Configuration

The SVE system is intended to operate with the soil gas stream passing through the GAC adsorbers in series. Series flow enables the carbon within the lead adsorber to become "loaded" by adsorbing most of the VOCs from the soil gas flow stream, while the "lag" adsorber captures any VOCs that may pass through the "lead" adsorber. When the carbon within the lead adsorber can no longer capture all the VOCs from the soil gas stream, the carbon within the lead adsorber is to be replaced with fresh activated carbon. This former lead adsorber then becomes the lag adsorber by reconfiguring the hose connections. In this way, a bed of "fresh" carbon is maintained within the lag adsorber as an effective "polishing" provision for removal of any VOCs that pass through the lead adsorber.

3.3 Normal Start-up of SVE Units

Prior to start-up of SVE-1 with SVE-2 in injection or extraction mode, the following conditions are to be verified:

1. The isolation valve on the lateral line near the associated wellhead (BV-1 or BV-2) is open and wellhead port valves are closed.
2. Relative to SVE-2, valves BV-3 through BV-6 are properly positioned according to the intended operating mode, either extraction or injection.
3. The associated condensate separator is drained of any accumulated condensate.

4. The associated blower is checked for appropriate level of gear-case oil and proper greasing of drive bearings. Also, the belt cage is installed.
5. At SVE-2, the inlet air filter is cleaned.
6. All process piping is inspected for any cracks or other failures and repaired as necessary.
7. At the GAC adsorbers, the interconnecting hoses/pipes are properly configured and securely connected.
8. The main disconnect switches on the respective control panels are in the "Off" position.
9. On the respective control panels, HS-1 and HS-2 are switched to the "Off" position. Also, the respective charge, load, and motor controllers are properly configured/programmed (see Section 3.5).
10. All personnel are clear of equipment.

After the above conditions are verified, rotate the main disconnect switch on the SVE-1 control panel to the "On" position and then enable SVE-1 (PDB-1) operation by switching HS-1 to the "Start" position. The system may not start in the early morning if the battery array does not have sufficient charge. When the battery array voltage reaches a set-point value of 27.2 volts, the SVE-1 load controller will initiate DC power to the motor controller and blower motor, thereby causing PDB-1 to start automatically.

Once PDB-1 is in operation, SVE-2 (PDB-2) is then enabled to operate. After rotating the main disconnect switch to the "On" position, start PDB-2 by switching HS-2 to the "Start" position. Thereafter, PDB-2 will automatically start and stop along with PDB-1. Initiate operations monitoring as described under Section 6.

3.4 Shutdown of SVE Units

To shut down the SVE units, disable PDB-1 and PDB-2 by switching HS-1 and HS-2 to the "Off" position and then rotating the main disconnect switches on the respective control panels to the "Off" position. At this point, DC power continues to be "live" within each main disconnect switch on the "hot" side. Further, DC power from the solar arrays continues to be "live" within each control panel across the 10-amp circuit breakers to the "hot" side of the main disconnect switch. Any maintenance work on the electrical system should only be performed by a qualified electrician to avoid possible electrocution.

3.5 Normal Operation of SVE Units

Both SVE units, SVE-1 and SVE-2, feature the following three operating subsystems: 1) solar power production and control, 2) battery array discharge and voltage control, and 3) blower motor control. Each subsystem operates automatically and in concert with each other for unattended operation. Operating efficiencies relative to solar power production, battery array power and life cycle, and blower operating time may be further optimized (maximized) by reprogramming, adjusting, and/or configuring of the various electronic equipment components, given the time of year and other external conditions.

In the following sections, operating descriptions and initial control set-points are presented for each subsystem to provide the operator with a general understanding of SVE system function and operation. Such understanding is intended to eventually result in the optimization of operating efficiencies and the prompt identification and troubleshooting of abnormal operating conditions. Considering that normal operating conditions vary with the time of day and year, as well as the prevailing extent of atmospheric occlusion, an Excel spreadsheet is presented in Attachment E as a prime reference for the identification of any abnormal operating conditions.

3.5.1 Solar Power Production and Control

The solar arrays are comprised of twenty-four (24) individual photovoltaic (PV) panels, each having a nameplate rating for solar power output (watts) and maximum operating voltage and current at a standard solar flux or insolation value of 1,000 watts per square meter. Nameplate ratings for the three different PV panels employed within the solar arrays (Sharp 185 Watt, Sharp 170 Watt, and BP Solar 175 Watt) are presented in the manufacturer's specification sheets (Attachment D). As indicated, the nameplate ratings are rather similar, resulting in a satisfactory degree of compatibility relative to solar power production efficiency.

Solar power output from a given PV panel, consisting of DC power at a variable voltage output and current, is dependent upon the magnitude of the insolation (time of day, time of year, and extent of atmospheric occlusion), the operating life of the PV panel (integrity of panel surface), the temperature of the PV panel, the cleanliness of the PV panel surface, the use of diodes for prevention of reverse flow of electricity back to the panel, and the solar power output from the mating PV panel connected in series. Each of these factors is modeled within an Excel spreadsheet, which calculates predicted values of average solar power production from the solar arrays for each month of the year. A printout of this spreadsheet is provided in Attachment E for reference.

On average, a single PV panel will produce nearly 5 amps of DC power with a voltage output of 36 volts, while the PV panel temperature is at 25 degrees Celsius (C) or 77 degrees Fahrenheit (F) and the insolation is 1,000 watts per square meter (high noon). With two PV panels connected in series, the panel set will produce nearly 5 amps of DC power with a voltage output of 72 volts under the same conditions. The twelve sets of PV panel pairs that comprise the four solar arrays will produce nearly 60 amps of DC power (30 amps to each SVE unit) with a voltage output of 72 volts under the same conditions.

As may be concluded above, the PV panels have an insolation conversion efficiency of about 14% at the rated conditions, meaning that only 14% of the solar radiation is actually converted to solar DC power. The remaining 86% of the solar radiation is absorbed by the PV panels (black body absorbers) as sensible heat gain, causing the bulk temperature of the PV panels to increase above the surrounding ambient temperature. As the PV panel temperature increases, the internal resistance of the panel to the flow of electricity increases, resulting in a proportional decrease in the voltage (and solar DC power) output. For every one degree Celsius (C) increase in PV panel temperature above 25 degrees C, the rated maximum voltage output of the panel will decrease by ½ %, which has the effect of decreasing the insolation conversion efficiency to as low as 11.5% (hottest days of the year).

During each day, as the sun traverses across the sky, the insolation available for solar DC production will vary from zero to nearly 1,000 watts per square meter (high noon) and then back to zero. The voltage output across each PV panel will vary proportionally with the magnitude of the insolation at a steady current of nearly 5 amps, and then reach a maximum inflection point (see Sharp 185 Watt performance chart in Attachment D). Maximum solar DC output from the PV panels is realized when the output voltage is able to be controlled either at, or near to, the maximum rated value.

The charge controllers employed for SVE-1 and SVE-2 each control the solar DC power production from six parallel sets of two PV panels connected in series (see OutBack Power Systems Flexmax 80 User's Manual in Attachment D). Each (identical) controller features Maximum Power Point Tracking capability, which automatically controls the overall output voltage across the two solar arrays (8 panel and 4 panel) at the maximum value at the prevailing conditions (72 volts maximum at PV panel temperature of 25 degrees C). The controllers modulate this output voltage by regulating the solar DC power passing through the unit to the battery array. Through this modulation, the maximum output voltage is continually sensed and then converged upon, thereby maintaining maximum solar DC power production from the solar arrays.

Within the charge controllers, approximately 96.8 % of the solar DC power production passes through to the battery array and load controllers. On this downstream side, the charge controllers have the capability of stepping down the voltage for proper charging of the 24-volt battery array and operation of the 24-volt blower motors while also conserving solar DC power by stepping up the current proportionally (from approximately 30 to over 70 amps).

The charge controllers have LCD displays for monitoring and recording of the following solar DC power parameters: instantaneous solar DC input voltage and current, instantaneous charge voltage and current, instantaneous DC power (watts), daily accumulated DC power (kilowatt-hours), and daily peak input voltage.

3.5.2 Battery Array Charging / Discharging and Voltage Control

To realize a battery array life of nearly three years (1,000 charge cycles), the battery array is comprised of sixteen, 6-volt, AGM batteries that are to be maintained at a state-of-charge ranging from approximately 75 to 100%, which corresponds to an approximate maximum depth-of-discharge of 50% for the site-specific conditions (see Technical Manual for Sun Xtender® Batteries, Attachment D). This state-of-charge range corresponds to a battery rest voltage range of 25.2 to 26.5 volts @ 25 degrees C. At a 50% depth-of-discharge, the battery discharge voltage approaches 24.2 volts. As discussed below, the battery discharge voltage is limited to 24.2 volts as a control parameter. However, the battery rest voltage may exceed 26.5 volts, potentially reaching 28.0 volts, if the blowers are manually shut down (HS-1 and HS-2 switched to "Off") while the solar arrays continue to charge the battery arrays (main disconnect switches still in the "On" position).

During battery charging, the charge voltage (charge controller output voltage) is greater than the rest voltage, since current is flowing into the batteries and overcoming the resistance to current flow imposed by the battery internals. The greater the current flow into the batteries, the greater the charge voltage relative to the prevailing battery array rest voltage. The difference in the charge and rest voltages represents a proportional loss of DC power during charging. This loss of power exists in the form of internal heat gain and resulting temperature increase within the batteries.

Conversely, during battery discharging, the discharge voltage is less than the rest voltage, since current is flowing out of the batteries and overcoming the resistance to current flow imposed by the battery internals. The greater the current flow out of the batteries, the lesser the discharge voltage relative to the prevailing battery array rest voltage. The difference in the discharge and rest voltages represents a proportional loss of DC power during discharging. This loss of power also exists in the form of internal heat gain and temperature rise within the batteries.

At the beginning of each operating day (sunrise to about 9:00 AM), the battery array is charged by the solar arrays via the charge controllers at an increasing current (up to 130 amps) and charge voltage. When the charge voltage reaches 26.6 volts, the blower motors will start (see Section 3.5.3), thereby diverting a portion of the charge current (approximately 80 amps) from the battery array to the blower motors. As a result, the charge voltage may not further increase with increasing current output from the charge controllers. When the charge current from the charge controllers becomes no longer great enough to power the blower motors, the battery array begins to discharge current to the blower motors, thereby causing the charge voltage to decrease below the prevailing rest voltage of the battery array.

The charge controllers at SVE-1 and SVE-2 are programmed for proper control of charge voltage to the battery array and blower motors (when in operation), as sensed at the controllers. This voltage control only pertains to maximum voltage (and current) limits for three-stage, battery array charging. In the bulk (first) stage, which begins each morning with the vacuum blowers shut down and the battery arrays in need of charging, DC power is applied to the battery array at a current limit set-point of 80 amps and maximum voltage set-point of 28.0 to 28.7 volts, depending on the time of year (battery temperature). The actual charge voltage during the day will increase from an initial value of approximately 25.2 volts to a maximum value that may reach the maximum voltage set-point value. Should the charge voltage reach the maximum voltage set-point, then the absorb (second) stage will begin. The absorb stage will continue over a duration set-point of one hour or longer, depending on the estimated time duration in which the actual charge voltage could potentially exceed the maximum voltage set-point. During this absorb period (continuation of bulk charge period), the charge controller will attempt to maintain the charge voltage at the maximum voltage set-point. Should this charge voltage set-point be reached during the absorb period, then the float (third) stage will begin. During the float stage, the charge controller will reduce the maximum charge voltage to a set-point of 26.0 to 26.7 volts, depending on the time of year (battery temperature), which corresponds to the battery array being fully charged at rest (no current flow to or from the battery array). The float stage continues until the charge controller senses the end of the solar day. During the next morning, the charge controller senses the beginning of the next solar day and initiates the bulk charging stage once again.

On the following table, set-point values for maximum charge voltages under bulk / absorb and float modes, as well as absorb durations, are given for each month of the year. For optimal battery array performance, the following set point values can be programmed into each charge controller during the midpoint of each month.

Monthly Set-point Values for Charge Controllers

Month	Bulk / Absorb Voltage Set-point (V) (in ppbv)	Float Voltage Set-point (volts)	Absorb Duration (hours)
January	28.7	26.7	1
February	28.6	26.6	1
March	28.6	26.6	1
April	28.4	26.4	1
May	28.2	26.2	1
June	28.0	26.0	1
July	28.0	26.0	1
August	28.1	26.1	1
September	28.1	26.1	1
October	28.3	26.3	1
November	28.4	26.4	1
December	28.6	26.6	1

The LCD displays on the charge controllers also indicate the daily accumulated absorb and float times for monitoring and recording.

3.5.3 Blower Motor Control

The source of DC power to the SVE-1 and SVE-2 blower motors is shared by the common battery array and the respective solar arrays via the respective charge controllers. DC power is enabled to the DC-to-AC inverter for SVE-1 and the motor controller for SVE-2, and blower motors via respective load controllers only when the charge voltage to the battery array increases to 26.6 volts, as sensed by the load controllers. Later in the day, when the discharge voltage from the battery array decreases to 24.2 volts, DC power is disabled to the blower motors, as sensed again by the load controllers. This load control provision 1) prevents the depth-of-discharge of the battery array from decreasing below 50% and 2) protects the blower motors from a potentially damaging overload (high current) condition at the reduced voltage.

The load controllers are programmed to energize and de-energize relay SS-1 upon actuation of internal high and low voltage switches, respectively, resulting in the starting and stopping of the respective blower motors (see Morningstar Tri-Star Solar System Controller Installation and Operation Manual in Attachment D). Only the low voltage switch set-point (24.2 volts) is programmed within the load controller (by configuring the DIP switches). The high voltage switch set-point (26.6 volts) is programmed into the load controller via associated software.

The AC power to the SVE-1 blower motor is controlled through the Magnum RD3924 DC-to-AC inverter (see Magnum RD Series Inverter/Chargers Operators Manual in Attachment D). The operating parameters for the inverter are set with the Magnum ME-RC Remote Control (see Magnum ME-RC Remote Control Owner's Manual in Attachment D). Normal operating parameters have been set for the inverter, and changes are not anticipated to be necessary. The remote control is also used to diagnose faults that may occur.

The DC power to the SVE-2 blower motor is controlled through a motor controller (see Minarik Automation & Control User's Manual in Attachment D). The motor controller features a speed-adjust potentiometer that limits motor (and blower) speed, as well as several dashpots for adjustable control of motor starting and stopping characteristics and current draw limitation. The appropriate adjustments have been applied to the motor controller. Further adjustments are not anticipated to be necessary.

4. ROUTINE MAINTENANCE PROCEDURES

Routine inspection and maintenance of the SVE units are to be performed on an intermittent to periodic basis, concurrently with operations monitoring activities. As described below and summarized in Table 2, inspection and maintenance activities are to be conducted for PDB-1 and PDB-2 and associated belt drives, the air filter at SVE-2, Well SGS condensate sump, both condensate separators, and both GAC adsorbers. Each maintenance activity may be initiated after completing the proper shutdown of the SVE units, if necessary, as described under Section 3.4. Upon completion of a given maintenance activity with the SVE units shut down, the SVE units are to be restarted as described under Section 3.3.

Usually, inspection and maintenance activities may be performed by one technician. However, two technicians are required when the maintenance activity poses an undue risk of injury, as discussed under Section 5.

4.1 Routine Inspection and Maintenance

4.1.1 Weekly Inspections and Maintenance

During operation, the following inspections and maintenance tasks are to be conducted on a weekly basis along with operations monitoring activities:

- Check Pitot tubes for proper orientation (dynamic port on axis with pipe). If Pitot tube reading does not appear to be normal, then disconnect tubing from Pitot tube to allow any condensate within Pitot tube to be drawn out by vacuum pressure. Also, drain any condensate from connecting tubes and reconnect to Pitot tube. Also check for any cracking in the nylon Pitot tubes as cracks will allow leakage, resulting in erroneous readings. Cracked tubing should be repaired or replaced.
- Usually from October through April, measure and record condensate levels within condensate separators and Well SGS condensate sump.
- Apply grease to all blower shaft bearings at zerk fittings using No. 2, high-temperature grease, as specified in the blower manufacturer's instructions (Attachment C).

While in operation, extraction blowers PDB-1 and PDB-2 are to be observed for any of the following conditions:

- unusual or excessive noise or vibration;
- leaking oil;
- overheating;
- reduced throughput (SVE rate);
- oscillating blower / motor speed; and
- excessive inlet vacuum or discharge pressure.

In the unlikely event of an excessive blower inlet vacuum or discharge pressure, check upstream and downstream piping segments, respectively, for cause of apparent flow restriction and resolve. Such condition would cause blower overheating and reduced throughput, and possibly cause unusual or excessive noise or vibration. If excessive inlet or discharge pressure is not observed, then any unusual or excessive noise or vibration, along with reduced throughput, would likely indicate a failing blower fluid end (e.g., rotary lobes out of alignment or worn shaft bearings), unless the blower gear box was unlikely overfilled with oil. In response to this observation, the blower must be immediately shut down. The blower is to be removed and delivered to a qualified blower repair specialist for repair, adjustment, and/or replacement. Consult the blower manufacturer's maintenance and parts manual in Attachment C for further information and instructions. Should the blower exhibit an oscillating speed, check the respective charge and motor controllers for proper adjustments (see Section 3.5).

4.1.2 Quarterly Inspections and Maintenance

On a quarterly basis, with SVE-1 and SVE-2 in operation, check all process piping for any apparent leakage. Repair any leaks, as appropriate.

Check vacuum gauges for proper function by measuring vacuum pressure with water or oil-filled manometer as calibration device. Adjust zero or span on gauge as necessary.

If any issues had been noted with blower operation during the quarter, measure the blower and motor shaft speeds with a tachometer before and after quarterly maintenance activities are performed. Record indicated speeds on field data sheets (Attachment F) for subsequent transfer into an Excel spreadsheet.

With extraction blowers PDB-1 and PDB-2 shut down and with the associated belt guards removed, inspect belt drives for proper alignment and any worn or frayed belts. Realign belt drive and replace belts, as necessary. As a final preventative maintenance measure, change blower gear box oil (after each 1,000 hours of operation or approximately every three months) as instructed within the blower manufacturer's instructions (Attachment C). Check the brushes on the 1-hp 24 VDC motor on SVE-2 for wear and replace as per manufacturer's instructions (usually when 5/8 inches or less of the brush is remaining). Restart PDB-1 and PDB2 as described under Section 3.4, after cleaning the inlet air filter at SVE-2 (if previously operating in injection mode).

Check surface of solar arrays for presence of dust of other foreign matter (e.g., bird droppings). If dust or other matter is apparent, attempt to clean surface of solar array first with dry mop and squeegee (for bird droppings). Clean water may be used to help dislodge certain foreign matter. Immediately remove excess water with squeegee before any streaks or mineral scaling occurs upon drying.

4.2 GAC Adsorbers Maintenance

As discussed under Section 2.7, GAC adsorbers ACF-1 and ACF-2 are operated in series to remove VOCs from the extracted soil gas stream prior to atmospheric discharge. When the "lead" adsorber can no longer remove VOCs from the soil gas stream, the resulting "breakthrough" condition (to the "lag" adsorber) requires SVE system shut down and replacement of the 2,000-pound carbon bed within the lead adsorber. During operation, potential breakthrough of VOCs from the lead adsorber to the lag adsorber is monitored at a frequency no less than twice annually by collecting process stream vapor samples. When the concentrations of Freon 11 and chloroform in the sample taken from in-between the lead and the lag adsorbers exceeds 65% of the respective concentrations in the influent sample, the carbon in the lead canister is to be replaced. Because the air quality permit potential to emit thresholds in Pinal County are based on mass flux of total organics, the criteria for carbon change out are based on the concentrations of the two most abundant VOCs in the extracted soil vapor, Freon-11 and chloroform, which account for approximately 80% to 90% of the total VOC mass in extracted soil vapor.

Carbon replacement within the lead adsorber requires removal of the "spent" carbon and replacement with 2,000 pounds of fresh (reactivated) carbon by a GAC services firm (e.g., Siemens Water Technologies). Spent carbon removal is accomplished by vacuuming the material out of the adsorber via the top manway and into a dust collector for continued recovery within bulk bags. The spent carbon within the bulk bags is transported to an off-site carbon reactivation facility (e.g., the Siemens facility in Parker, Arizona) for recycling. The fresh carbon, delivered within bulk bags, is charged to the adsorber from the top manway.

Once the adsorber is refilled with fresh carbon, the "lead" and "lag" configuration of the two canisters is reversed by changing the configuration of the hoses from the SVE blowers to the outlet stack. This requires the hoses are switched on the inlets and outlets of both canisters such that the old "lead" canister becomes the new "lag" canister (filled with new carbon) and the old "lag" canister becomes the new "lead canister (see Section. 2.7)

4.3 Soil Gas Condensate Management

During the cool season from approximately October through April, soil gas moisture will condense within the lateral lines from Wells SGS and SGD to associated condensate separators. The condensate sump within the 4-inch lateral line between Well SGS and SVE-1 will accumulate condensate at the rate of about 6 to 8 inches (10 to 13 gallons) per week during operation in the cool season. At least once per month during operation, with the SVE system inactive during the early morning hours, condensate should be removed from this sump with a bailer or small electric pump to a nearby 55-gallon drum. Failure to remove condensate from this sump could result in the flow of soil gas being restricted within the Well SGS lateral, causing excessive vacuum pressures at PDB-1 and potential blower damage.

When a few inches of condensate are observed within the sight glass of condensate separator KO-1 or KO-2, condensate should be drained from the separator and transferred into a 55-gallon drum (see below). To drain each separator, shut down the respective SVE unit and place a container below the drain valve of the separator and open the valve. When the flow of liquid stops or the container nearly fills, close the valve, empty the container into the drum and repeat, as necessary. Restart the SVE system.

If condensate is observed from the drain valve of a GAC adsorber, then drain the condensate into a container and transfer into a 55-gallon drum.

Condensate removed from the Well SGS condensate sump, KO-1 and KO-2, and GAC adsorbers is placed within the open-top, 55-gallon drums (located near to the condensate sump) and allowed to evaporate. The drums are covered with metal screen to prevent wildlife from entering.

4.4 Solar Array Adjustment

Twice per year, the planar angle of the solar arrays relative to horizontal is to be adjusted to increase the effective area available for solar energy capture. These adjustments should be made near the time of the equinox (approximately April and October). The technicians can discuss the need for this adjustment. The present capacity of the solar arrays (4295 watts) is considerably greater than the power needed to run both blower motors (approximately 2200 to 2300 watts). The SVE components receive more protection from the sun with the panels set at 48 degrees relative to horizontal. If the system operating time starts to decrease as the summer months approach, then the planar angle of the solar arrays can then be adjusted.

4.4.1 Spring Adjustment

4.4.1.1 SVE-1and SVE-2 Solar Arrays and Auxiliary Arrays

- At the SVE-1 solar array, unclip the guy wires from the concrete anchors on the south side of the array.
- Tilt the array back (down on the north side) and remove the lowest section of chain on the north side of the array until the planar angle of the array relative to horizontal is 18 degrees.
- Insert the sections of chains removed from the north side of the array and insert on the south side of the array; reattach to the concrete anchors. Adjust the turnbuckles to remove the slack in the wires.
- On each auxiliary array, loosen the wing nuts on the side of the support rack mounting collar and the nuts on the pivot point of the panel array where it connects to the support pole. Adjust the solar array to an angle of 18 degrees from horizontal, as indicated on the collar. Tighten all nuts.

4.4.2 Fall Adjustment

4.4.2.1 SVE-1and SVE-2 Solar Arrays and Auxiliary Arrays

- At the SVE-1 solar array, unclip the guy wires from the concrete anchors on the north side of the array.
- Tilt the array forward (up on the north side) and remove the lowest section of chain from the south side of the array until the planar angle of the array relative to horizontal is 48 degrees.
- Insert the chain removed from the south side into the north side of the array and reattach to the concrete anchors. Adjust the turnbuckles to remove the slack in the wires.
- On each auxiliary array, loosen the wing nuts on the side of the support rack mounting collar and the nuts on the pivot point of the panel array where it connects to the support pole. Adjust the solar array to an angle of 48 degrees from horizontal, as indicated on the collar. Tighten all nuts.

5. SITE HEALTH AND SAFETY

A number of potential health hazards are present on site, as there are in any industrial process operation. Operations at the site will be accomplished in accordance with established health and safety guidelines. In addition to the general health and safety concerns for work at the site, specific potential hazards associated with the SVE system are outlined below. Please note that other hazards not listed below may be present at the site.

5.1 Electrical

Direct human contact with DC electricity could result in severe injury or death. **Any servicing, modification or rewiring of the electrical system must be performed by a qualified electrician.** Before servicing any electrical systems (e.g., control panels, motors, solar panels), the source of electrical power to the system (i.e., solar and battery arrays) must first be isolated and then verified by the use of a voltmeter.

Electrical power to a given control panel is isolated by rotating the respective main disconnect switch to the "Off" position. **Be aware that power from the solar panels to the "hot" side of the 10-amp circuit breakers is still present even if the circuit breakers are off, provided the panels are receiving solar radiation. Electrical power to the "hot" side of the circuit breakers can only be isolated by disconnecting the positive cables at the disconnect fittings located directly beneath the solar arrays.**

The battery array, consisting of 16 each, 6-volt AGM batteries, interconnected as four parallel sets of four batteries in series, is a source of 24-volt DC power to each control panel, in addition to the solar arrays. DC power from the battery array is isolated at each main disconnect switch. The battery array has an electrical rating of 896 AH over a 24-hour duration, and is capable of delivering over 100 amps of DC power. For this reason, the battery array is housed within two, grounded electrical cabinets for personnel protection. The battery array does not require routine maintenance, as each battery is sealed. Eventually, the batteries will require replacement (after roughly 1,000 cycles or three years), which must be performed only by a qualified electrician.

With each main disconnect switch in the "off" position, the "hot" side of each switch will continue to be "hot" where connected to the battery array. For this reason, servicing of each main disconnect switch must be performed by a qualified electrician.

5.2 Blower Belt Drives

SVE blowers PDB-1 and PDB-2 are driven by the electric motors via belt drives that transfer torsional power from the motors to the blowers. Belt guards enclose the belt and sheave assemblies to prevent possible injury. The blowers must not be operated without the belt guards in place, unless the shaft rotational speeds of the blowers and motors are being measured. **During shaft rotational speed measurement, a second technician must be present to shut down the SVE system should the first technician inadvertently come in contact with the rotating belt drive.**

5.3 Biological Hazards

The SVE system is located in an unpaved, rural setting with arid climate. Rattlesnakes, poisonous insects, and arachnids may be present around and beneath system components. Personnel should use caution when approaching system components and when placing hands and other unprotected skin in concealed areas.

5.4 Lifting

Back strain and other injuries can occur when lifting heavy objects. Use proper lifting techniques and lift with the legs, keeping the back straight. Heavy objects, such as blowers, motors, and other equipment may require two people or mechanical assistance, such as a forklift.

5.5 Slipping, Tripping, and Falling

Personnel may encounter muddy or uneven walking surfaces during operating and maintenance activities. Proper footwear and vigilance will help prevent injury. All work areas should be maintained in a neat, orderly fashion. All tools and supplies must be properly stored and secured when not in use.

Ladders used to access the GAC adsorbers, solar arrays, or other system equipment must be used as intended by the manufacturer. Place ladders on stable, solid ground that will not shift or enable slippage. Under no circumstances shall anyone stand on the top rung of a ladder.

6. OPERATING PERFORMANCE MONITORING AND SAMPLING PLAN

When the SVE system is in operation, on a weekly, monthly, and quarterly basis, in combination with routine inspection / maintenance activities, the SVE system (SVE-1 and SVE-2) is to be monitored for proper performance by recording applicable operating parameters indicated by local instruments, measuring and recording other operating parameters with hand-held instruments (Section 6.1), and collecting process gas samples for laboratory analysis (Section 6.2), as described below. Performance monitoring and inspection/maintenance activities may not be performed when the SVE system is not operating.

6.1 Operating Performance Monitoring

Various operating parameters are to be monitored on a regular basis to ensure proper system function and performance. These operating parameters are characterized as either process or electrical parameters. The process parameters (Section 6.1.1) apply to the flow of soil gas and VOCs through the SVE system. The electrical parameters (Section 6.1.2) apply to the flow of DC and AC power through the SVE system, from the solar and battery arrays to the blower motors.

6.1.1 Process Parameters

From the process parameters identified below, daily and cumulative soil gas extraction volumes and VOC recoveries are to be calculated for SVE-1 and SVE-2 (if operating in extraction mode) within an Excel spreadsheet. Additionally, daily and cumulative air injection volumes are to be calculated for SVE-2, if operating in air injection mode. Respective AC or DC power requirements are also to be calculated for air compression through the blowers, enabling the calculation of blower mechanical efficiencies from certain electrical parameters.

Weekly Process Data Collection during Operation

During operation, the following process parameters are to be recorded on a weekly basis on field data sheets (Attachment F) for subsequent transfer into the Excel spreadsheet:

- Hour meter reading on each SVE system control panel;
- Well SGS and SGD wellhead pressures as measured by a portable pressure gauge or manometer;
- Vacuum pressure at inlet to each condensate separator as indicated by a portable vacuum pressure gauge or manometer;
- Differential pressure across Pitot tube within each vacuum blower inlet pipe as indicated from the dedicated Magnehelic® gauge or a portable, digital differential manometer;
- Blower inlet and discharge pressures as measured by respective, portable pressure gauges or a manometer; and
- Water level within condensate separator as indicated within associated site glass;
- Pressures at inlet and outlet of lead GAC adsorber as measured by a portable pressure gauge or manometer.

Monthly Process Data Collection during Operation

During operation, on a monthly basis, soil gas (process stream) samples are to be collected from the valve port at Lead GAC adsorber inlet, and valve port between GAC adsorbers and the valve port on the outlet stack prior to atmospheric discharge, and analyzed for the presence of VOCs using EPA Method TO-15 (see Section 6.2.2). The laboratory results are to be applied to the Excel spreadsheet for use in calculating daily VOC recoveries from the extracted soil gas streams, as well as for confirming whether VOC breakthrough is occurring from the lead GAC adsorber.

6.1.2 Electrical Parameters

From the electrical parameters identified below, the collective electrical performances of the four solar arrays, SVE-1 and SVE-2 control panels, common battery array, and blower motors are monitored with time to identify changes that may require operating or maintenance actions. The following electrical parameters are to be recorded on a weekly basis during operation on field data sheets (Attachment F) for subsequent transfer into an Excel spreadsheet:

- From the status screen of each charge controller, the instantaneous input voltage and current, instantaneous output (charge) voltage and current, the instantaneous DC power (watts), and the daily accumulated DC power (kilowatt-hours);
- From the end of day summary screen of each charge controller, the peak input voltage and DC power (kilowatt-hours), the maximum and minimum output (charge) voltage, the peak output current, the accumulated amp-hours and DC power (kilowatt-hours), and the accumulated absorb and float times.
- Instantaneous motor current readings as indicated by the ammeter mounted on the control panel CP-2 and via a hand-held multi-meter with an ammeter probe for SVE-1.

6.2 Process Gas Sampling

The following procedures are to be followed for collecting soil gas samples for laboratory analysis (Section 6.2.2). Soil gas samples shall be collected from the valve port at Lead GAC adsorber inlet, the valve port between GAC adsorbers, and the valve port on the outlet stack prior to atmospheric discharge.

Gas samples are to be collected in sample containers provided by the analytical laboratory in accordance with analytical method and sampling protocol. Sample containers shall be prepared by the laboratory and certified as being clean. Sample containers are to be ordered from the laboratory a few days prior to a sampling event.

Gas samples are to be collected in the following order: from 1) the valve port on the outlet stack prior to atmospheric discharge, 2) the valve port between GAC adsorbers, and 3) the valve port at Lead GAC adsorber inlet using the following procedure:

1. Ensure SVE system has been operating normally for at least one-half hour prior to sample collection and that the system has been operational during normal operating hours for at least 30 days.
2. Collect gas sample from valve port to be sampled.

3. Purging is not necessary. Connect short length of Teflon or PVC tubing from flow control valve of canister to hose barb on sampling port.
4. Open sample valve and then open canister valve. Leave canister valve open for duration stipulated on flow control valve or as specified by the Analytical Laboratory. Then close sample and canister valves.
5. Remove tubing from valve port and canister.
6. Label canister with sample number (provided by laboratory), date, and time of collection; enter information on chain-of-custody form.

Sample containers are to be stored in a container in accordance with laboratory requirements and kept under chain of custody until transferred to the laboratory. Collected samples are to be expeditiously transferred to the designated laboratory for analysis of VOCs by EPA Method TO-15.

6.3 Operational Parameters for the SVE System

The operational parameters for the SVE system are summarized below..

- The SVE system shall operate for a minimum of three months within a twelve-month period. Annual average extraction and injection rates (total extraction/injection volume divided by total elapsed time) shall be at or above 9.2 and 3.75 scfm, respectively.
- The SVE system may be operated in a pulsed operation mode to assist in detecting potential threats to groundwater quality.

7. WASTE MANAGEMENT

Wastes generated during O&M of the SVE system consist primarily of soil gas condensate and spent carbon, as addressed in the following sections. Paper towels, rags, product packaging, and other incidental trash generated during the course of O&M activities are to be removed from the site and deposited in a trash receptacle. Used blower oil is to be contained, removed from the site, and recycled. Old grease expelled during blower shaft bearing lubrication is to be scraped from the blower floor plate, contained, and deposited in a trash receptacle.

7.1 Spent Carbon

As discussed in Section 4.2, when "breakthrough" of VOCs occurs from the lead GAC adsorber, the spent carbon within this adsorber is to be replaced with fresh carbon by a GAC services firm. Prior to transporting the spent carbon to an off-site reactivation facility for recycling, the carbon must be sampled, analyzed, and profiled for acceptance by the reactivation facility and proper waste identification for over-the-road transport. Previously, a sample of the spent carbon was analyzed in the laboratory and found not to exceed the toxicity characteristic leaching procedure (TCLP) criteria for any regulated VOC. Accordingly, the spent carbon does not need to be manifested for shipping as a hazardous waste.

The current approved profile number for the spent carbon is W70096NH-2 which is valid through August 23, 2013. Reprofiling of the spent carbon is to be conducted as necessary to ensure proper management of this waste.

7.2 Condensate Disposal

As discussed in Section 4.3, soil gas condensate is recovered to 55-gallon drums from the Well SGS condensate sump, condensate separators, and GAC adsorbers. Based on the anticipated rate of generation (approximately 10 to 13 gallons per week for about 12 weeks of the year), up to 160 gallons may be generated in a year. Waterproof gloves (e.g., latex) are to be worn to limit exposure when handling condensate. Previously, the condensate has been sampled, analyzed, and found to contain low concentrations of VOCs (concentrations are significantly less than the 700 µg/L Toxicity Characteristic Leaching Procedure regulatory threshold for tetrachloroethene). Accordingly, the condensate is not characterized as a RCRA waste. For this reason, the aqueous condensate and any dissolved VOCs are allowed to evaporate to the atmosphere from within the drums, as the selected disposal option. Additional sampling and analysis of the drummed condensate should not be necessary, unless the disposal option is changed.

8. DATA MANAGEMENT AND REPORTING

Operating performance monitoring and sampling data collected from the SVE system (Section 6) are to be assembled during each month when the system is in operation, along with a description of any extraordinary maintenance activities. Operating performance monitoring data are to be transferred into an Excel spreadsheet from completed field data sheets and project field notebook entries. In addition, soil gas analytical laboratory reports are recorded electronically with laboratory data also entered into the Excel spreadsheet for calculation of VOC recovery and carbon spending rates. A comparison of the calculated rate of VOCs recovered from the subsurface to the 5.5 pound per day or the one ton per year potential to emit permit thresholds will be conducted on a semi-annual basis during the routine reporting cycle. Reporting to the regulatory agency will be performed in accordance with the most current version of the Expanded Groundwater Detection Monitoring Plan.

9. REFERENCES

HGC, 2005a, Preliminary Screening Risk Assessment, University of Arizona Page-Trowbridge Ranch Landfill, Pinal County, Arizona. January 20, 2005

HGC, 2005b, Page-Trowbridge Ranch Interim Measures Package Description Document, Page-Trowbridge Ranch Interim Measures—Issue for Construction. September 30, 2005.

TABLES

TABLE 1

SVE System Contact List

Page-Trowbridge Ranch Landfill

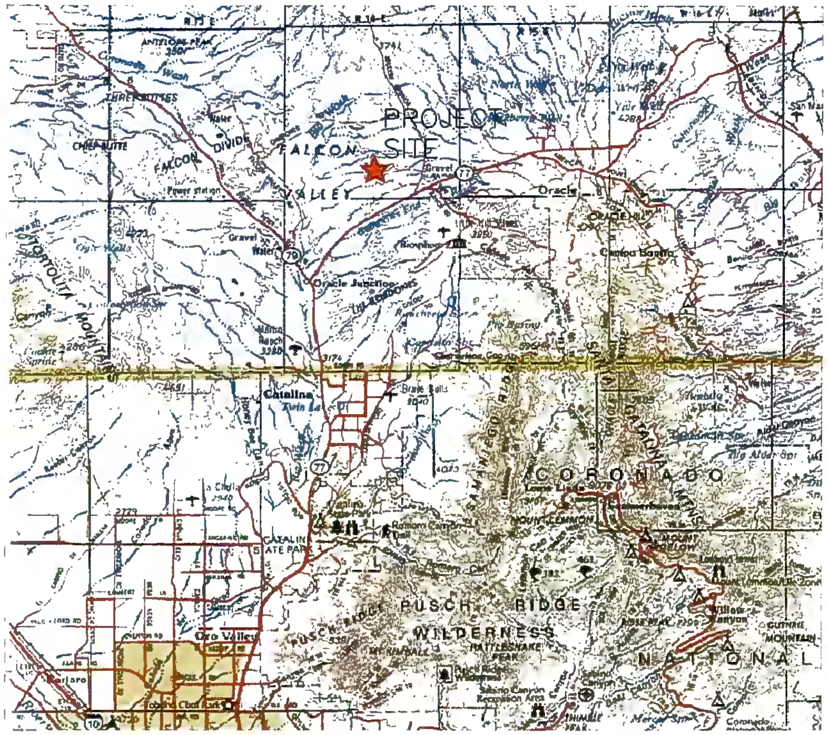
Contact	Affiliation	Role	Phone Numbers	E-mail Address
Steve Holland	University of Arizona	Risk Manager	(520) 621-1790	sholland@email.arizona.edu
Lloyd Wundrock	University of Arizona	Site Manager	(520) 621-1590	lloydw@email.arizona.edu
Jeff Christensen	University of Arizona	Hazardous Waste Supervisor	(520) 621-5861	jgchrist@email.arizona.edu
Scott Winegarden	Siemens Water Technologies	Carbon Vendor	(602) 421-8305	scott.winegarden@siemens.com
Gilbert Preciado	Sunstate Equipment	Rental Equipment	(520) 623-6121	
	Solberg Mfg	Air Filter	(630) 773-1363	

TABLE 2
Maintenance Schedule
Page-Trowbridge Ranch Landfill

Task	Weekly	Quarterly	As Required
Record date and time of site visit	X		
Check Pitot tubes	X		
Check for condensate accumulations - transfer to drums	X		
Observe PDB-1 and PDB-2 for any abnormal conditions	X		
Inspect belt drives - realign or replace belts		X	
Lubricate PDB-1 and PDB-2 - change gear oil		X	
Inspect process piping for leakage		X	
Check accuracy of vacuum gauges		X	
Check / clean surface of PV panels		X	
Adjust tilt angle of solar arrays			X
Carbon replacement			X

ATTACHMENT A

AS-BUILT DRAWINGS	
Drawing 1	Cover Sheet
Drawing 2	Overall Site Plan & Compound Plan
Drawing 3	Process Flow Diagram
Drawing 4	Details
Drawing E-2A	Electrical Single-Line Diagram



LOCATION MAP

NORTH

0 4 8

SCALE IN MILES

DRAWING INDEX

DWG NO.	TITLE
1	COVER SHEET
2	OVERALL SITE PLAN & COMPOUND PLAN
3	PROCESS FLOW DIAGRAM
4	DETAILS
E-2A	ELECTRICAL SINGLE-LINE DIAGRAM

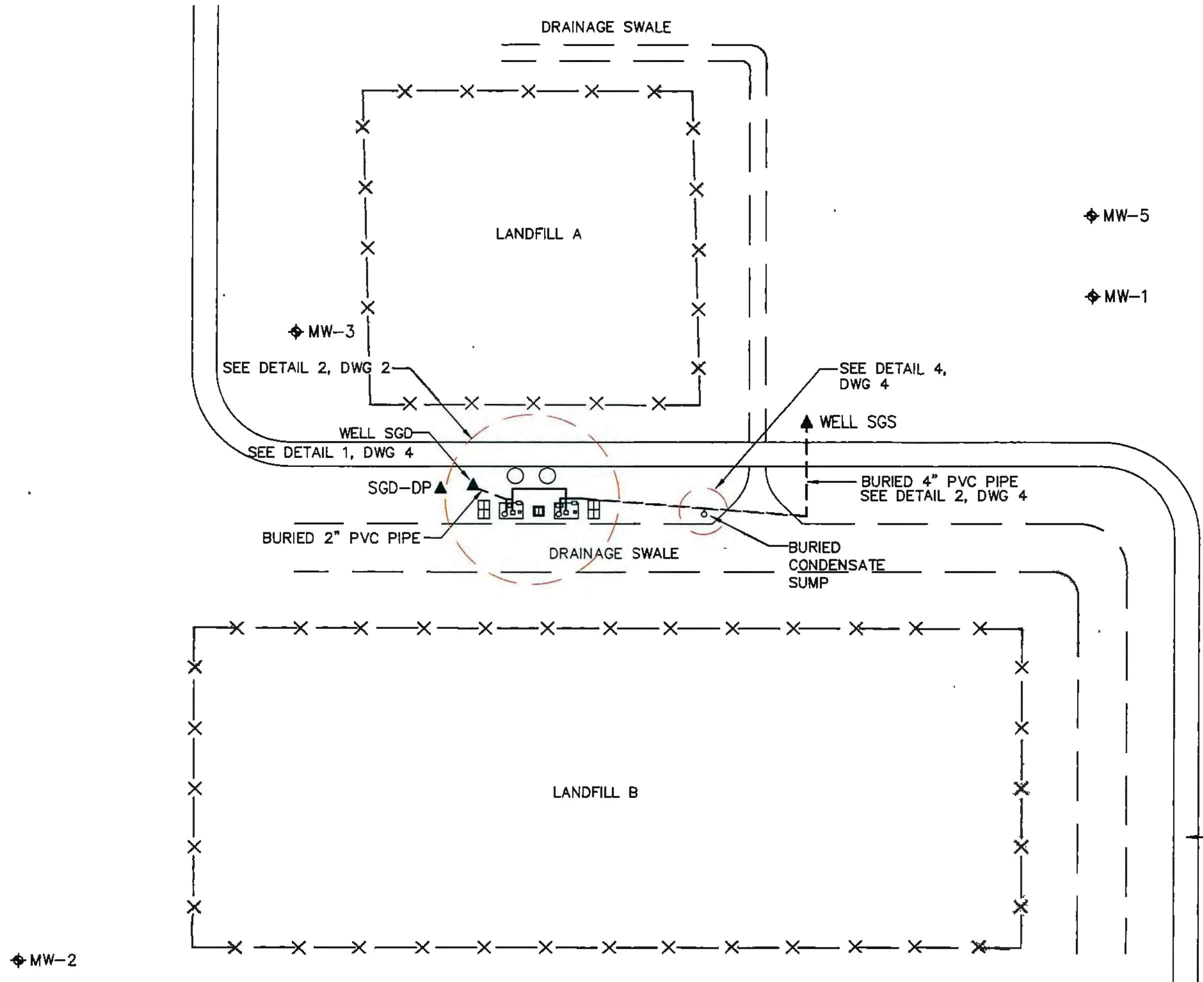
DRAWINGS FOR:

STATE OF ARIZONA DEPT. OF ADMINISTRATION PAGE-TROWBRIDGE RANCH LANDFILL INTERIM MEASURES

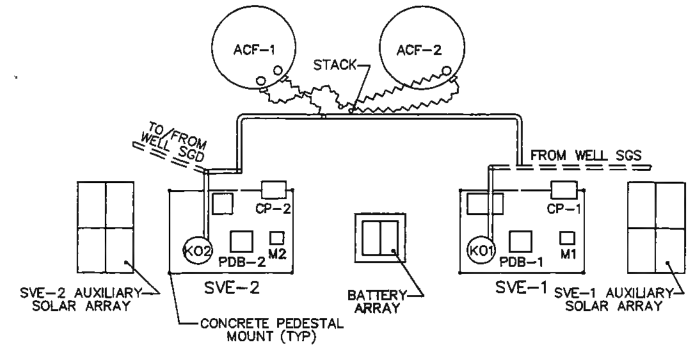
BY:

HYDRO GEO CHEM, INC.

HYDRO GEO CHEM, INC.	PAGE RANCH LANDFILL INTERIM MEASURES COVER SHEET					
	Approved: DAD	Date: 12/04/08	Revised:	Date:	Reference: 7934004A	Figure: 1



1 OVERALL SITE PLAN



2 COMPOUND PLAN

NTS

NOTES:

A. SVE-1 SOLAR ARRAY CONSISTS OF SEVEN 185 WATT PANELS AND ONE 170 WATT PANEL.

B. SVE-2 SOLAR ARRAY CONSISTS OF THREE 185 WATT PANELS AND FIVE 175 WATT PANELS.

C. SVE-1 AND SVE-2 AUXILIARY SOLAR ARRAYS EACH CONSIST OF FOUR 175 WATT PANELS.

D. PAINT ALL EXPOSED PVC PIPES WITH WHITE LATEX PAINT, 2 COATS.

ACF-1, ACF-2	GAC ADSORBERS
PDB-1, PDB-2	POSITIVE DISPLACEMENT BLOWERS
CP-1, CP-2	CONTROL PANELS
KO1, KO2	KNOCKOUT TANKS
M1, M2	24 VOLT DC MOTORS

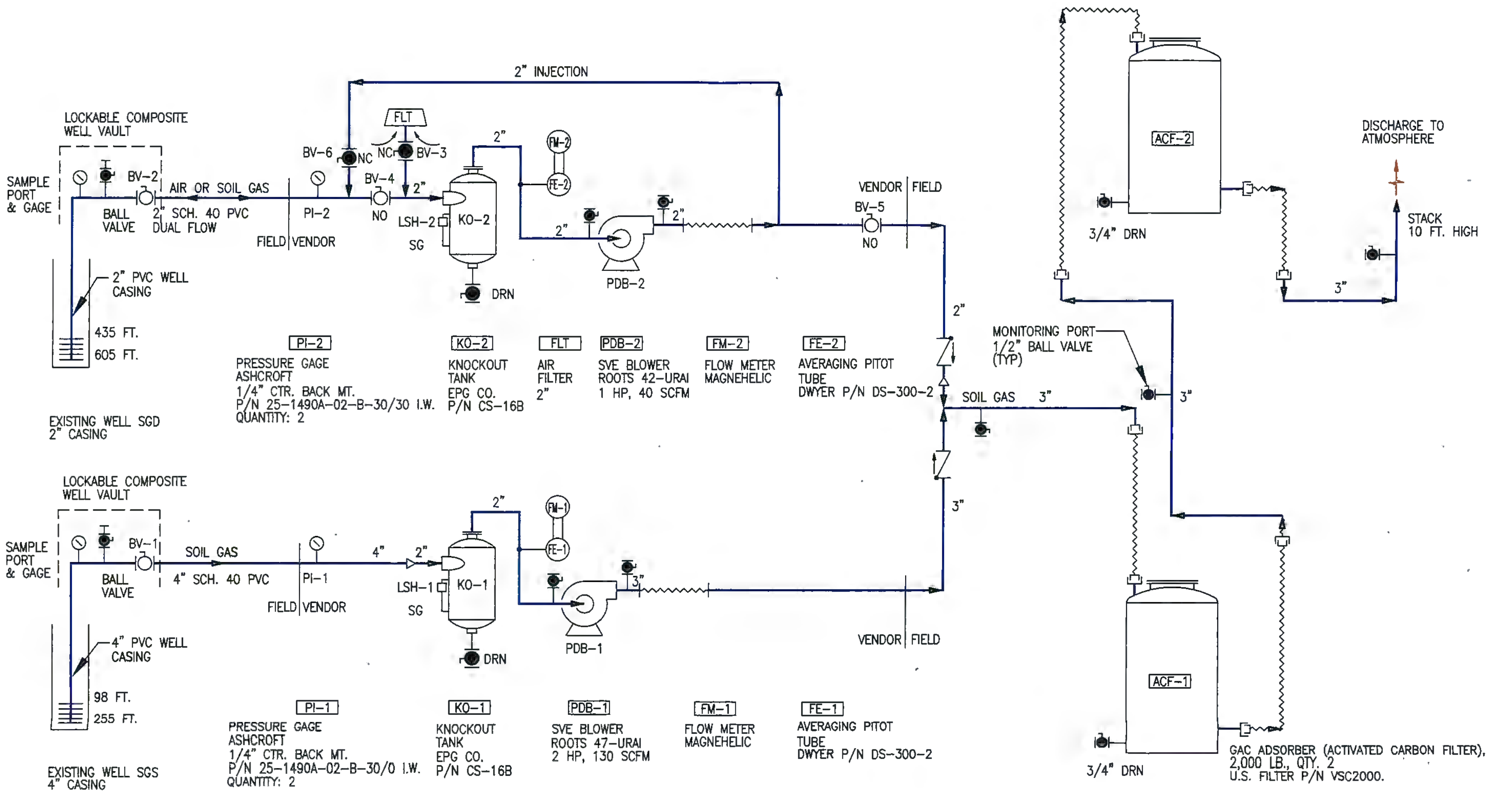
EXPLANATION

- ◆ EXISTING MONITORING WELL
- ▲ SOIL VAPOR MONITORING WELL

HYDRO GEO CHEM, INC.

PAGE RANCH LANDFILL INTERIM MEASURES
OVERALL SITE PLAN & COMPOUND PLAN

Approved	Date	Revised	Date	Reference	Figure
DAD	12/04/08			7934005A	2

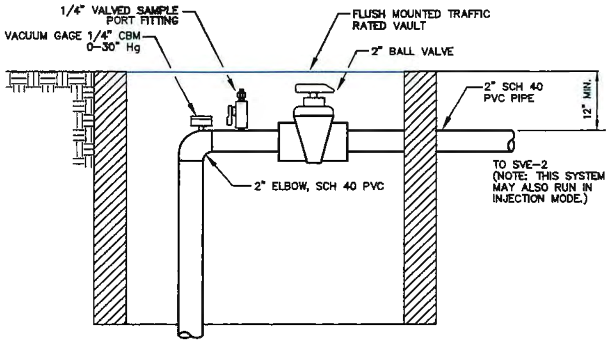


NC = NORMALLY CLOSED
NO = NORMANLLY OPEN
PIPE MATERIALS:
ALL FIELD PIPING IS PVC, SCH. 40, SOLVENT JOINTS.
SKID PIPING IS PVC, SCH. 40, SOLVENT JOINTS.

HYDRO GEO CHEM, INC.

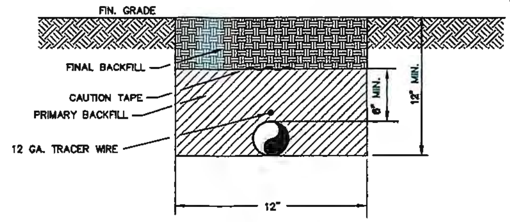
PAGE RANCH LANDFILL INTERIM MEASURES
PROCESS FLOW DIAGRAM

Approved	Date	Revised	Date	Reference	Figure
DAD	12/04/08			7934006A	3



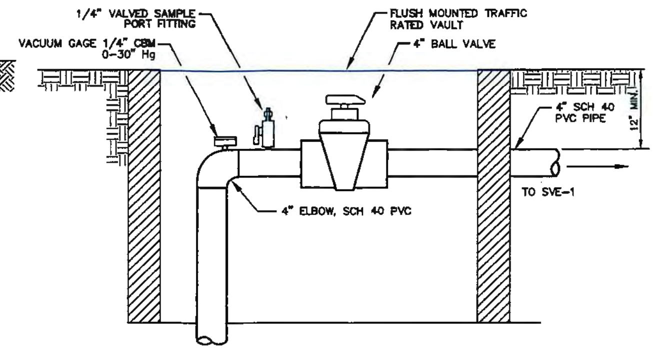
NOTE: SLOPE PIPE MIN. 1% TOWARD WELLHEAD FOR CONDENSATE MANAGEMENT.

① 2" DEEP SVE EXTRACTION WELLHEAD ASSEMBLY
NTS



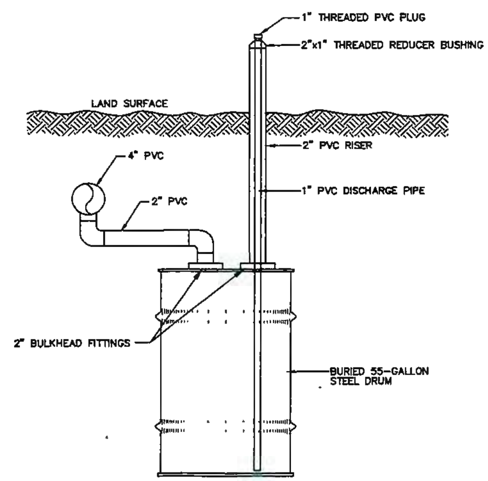
NOTE: TRENCH DEPTH VARIES DUE TO SLOPE GRADIENT TOWARD WELL HEAD OR CONDENSATE SUMP AS PART OF CONDENSATE MANAGEMENT SYSTEM

② TRENCH SECTION - SINGLE PIPE
NTS



NOTE: SLOPE PIPE MIN. 1% TOWARD SUMP FOR CONDENSATE MANAGEMENT.

③ 4" SHALLOW SVE EXTRACTION WELLHEAD ASSEMBLY
NTS

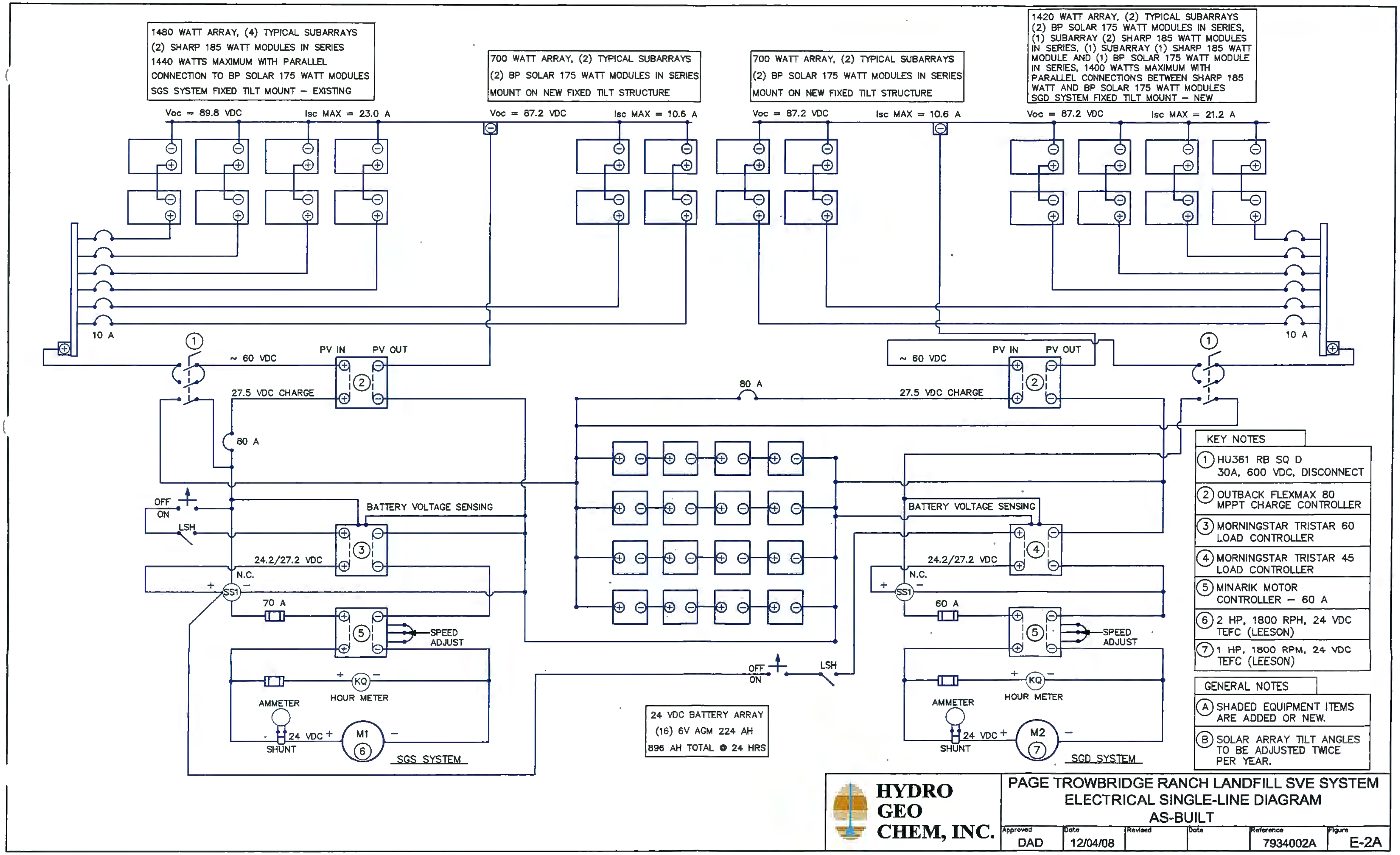


④ BURIED CONDENSATE SUMP
NTS

HYDRO GEO CHEM, INC.

PAGE RANCH LANDFILL INTERIM MEASURES
DETAILS

Approved	Date	Revised	Date	Reference	Figure
DAD	12/04/08			7934003A	4


1480 WATT ARRAY, (4) TYPICAL SUBARRAYS
(2) SHARP 185 WATT MODULES IN SERIES
1440 WATTS MAXIMUM WITH PARALLEL
CONNECTION TO BP SOLAR 175 WATT MODULES
SGS SYSTEM FIXED TILT MOUNT – EXISTING
700 WATT ARRAY, (2) TYPICAL SUBARRAYS
(2) BP SOLAR 175 WATT MODULES IN SERIES
MOUNT ON NEW FIXED TILT STRUCTURE
700 WATT ARRAY, (2) TYPICAL SUBARRAYS
(2) BP SOLAR 175 WATT MODULES IN SERIES
MOUNT ON NEW FIXED TILT STRUCTURE
1420 WATT ARRAY, (2) TYPICAL SUBARRAYS
(2) BP SOLAR 175 WATT MODULES IN SERIES,
(1) SUBARRAY (2) SHARP 185 WATT MODULES
IN SERIES, (1) SUBARRAY (1) SHARP 185 WATT
MODULE AND (1) BP SOLAR 175 WATT MODULE
IN SERIES, 1400 WATTS MAXIMUM WITH
PARALLEL CONNECTIONS BETWEEN SHARP 185
WATT AND BP SOLAR 175 WATT MODULES
SGD SYSTEM FIXED TILT MOUNT – NEW
Voc = 89.8 VDC
Isc MAX = 23.0 A
Voc = 87.2 VDC
Isc MAX = 10.6 A
Voc = 87.2 VDC
Isc MAX = 10.6 A
Voc = 87.2 VDC
Isc MAX = 21.2 A
10 A
10 A
~ 60 VDC
PV IN
PV OUT
27.5 VDC CHARGE
80 A
80 A
~ 60 VDC
PV IN
PV OUT
27.5 VDC CHARGE
OFF
ON
LSH
BATTERY VOLTAGE SENSING
24.2/27.2 VDC
N.C.
SS1
70 A
SPEED ADJUST
AMMETER
HOUR METER
KQ
24 VDC
SHUNT
M1
SGS SYSTEM
OFF
ON
LSH
BATTERY VOLTAGE SENSING
24.2/27.2 VDC
N.C.
SS1
60 A
SPEED ADJUST
AMMETER
HOUR METER
24 VDC
SHUNT
M2
SGD SYSTEM
24 VDC BATTERY ARRAY
(16) 6V AGM 224 AH
896 AH TOTAL @ 24 HRS
KEY NOTES
1 HU361 RB SQ D 30A, 600 VDC, DISCONNECT
2 OUTBACK FLEXMAX 80 MPPT CHARGE CONTROLLER
3 MORNINGSTAR TRISTAR 60 LOAD CONTROLLER
4 MORNINGSTAR TRISTAR 45 LOAD CONTROLLER
5 MINARIK MOTOR CONTROLLER – 60 A
6 2 HP, 1800 RPH, 24 VDC TEFC (LEESON)
7 1 HP, 1800 RPM, 24 VDC TEFC (LEESON)
GENERAL NOTES
A SHADED EQUIPMENT ITEMS ARE ADDED OR NEW.
B SOLAR ARRAY TILT ANGLES TO BE ADJUSTED TWICE PER YEAR.
HYDRO GEO CHEM, INC.
PAGE TROWBRIDGE RANCH LANDFILL SVE SYSTEM
ELECTRICAL SINGLE-LINE DIAGRAM
AS-BUILT
Approved DAD
Date 12/04/08
Revised
Date
Reference 7934002A
Figure E-2A

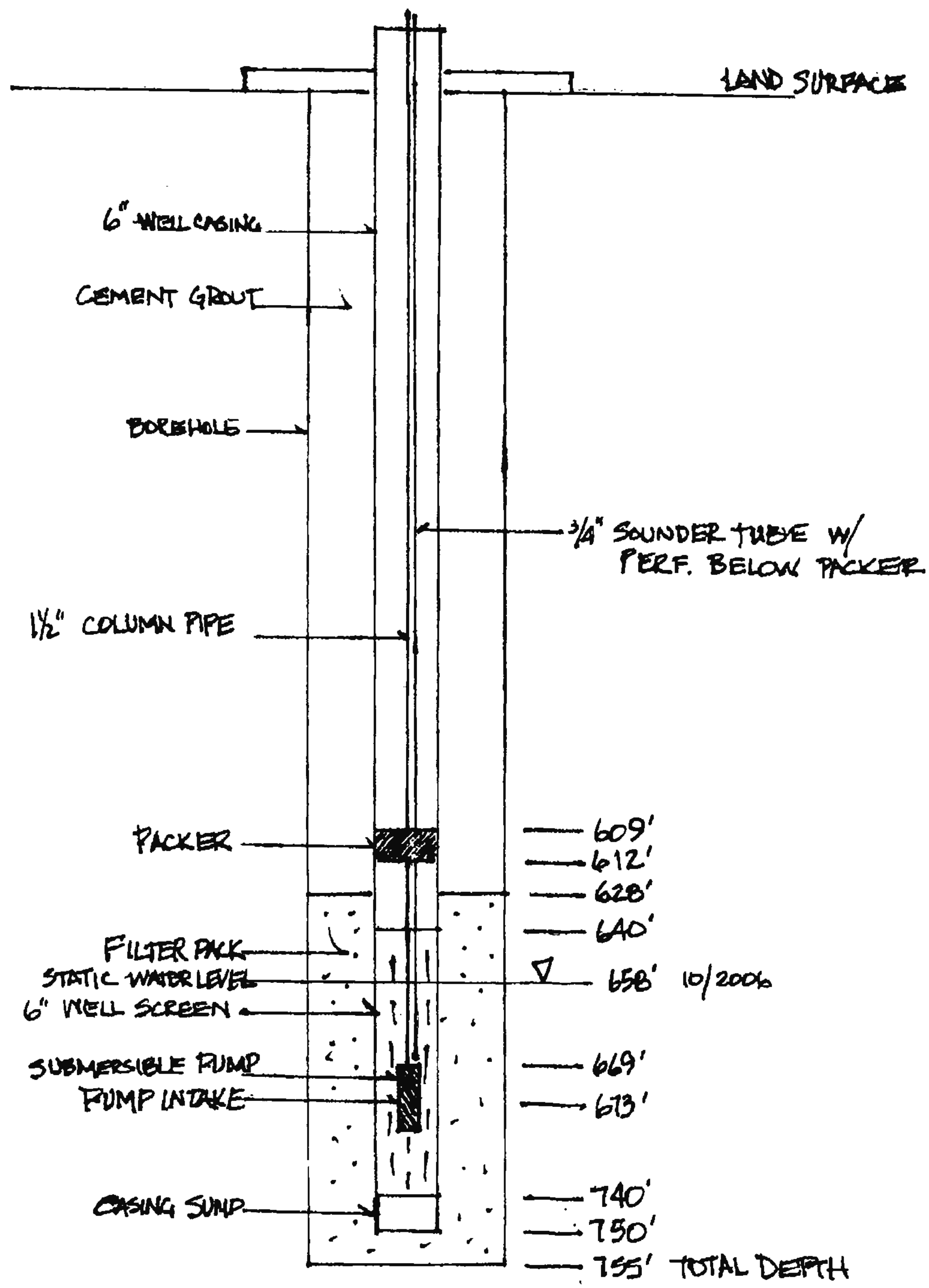
ATTACHMENT B

LITHOLOGIC LOGS AND WELL CONSTRUCTION DETAILS

MW-5
MW-2
Well SGS with SGS-SP
Well SGD with SGD-SP and SGD-MP
SGD-2 (SGD-DP)

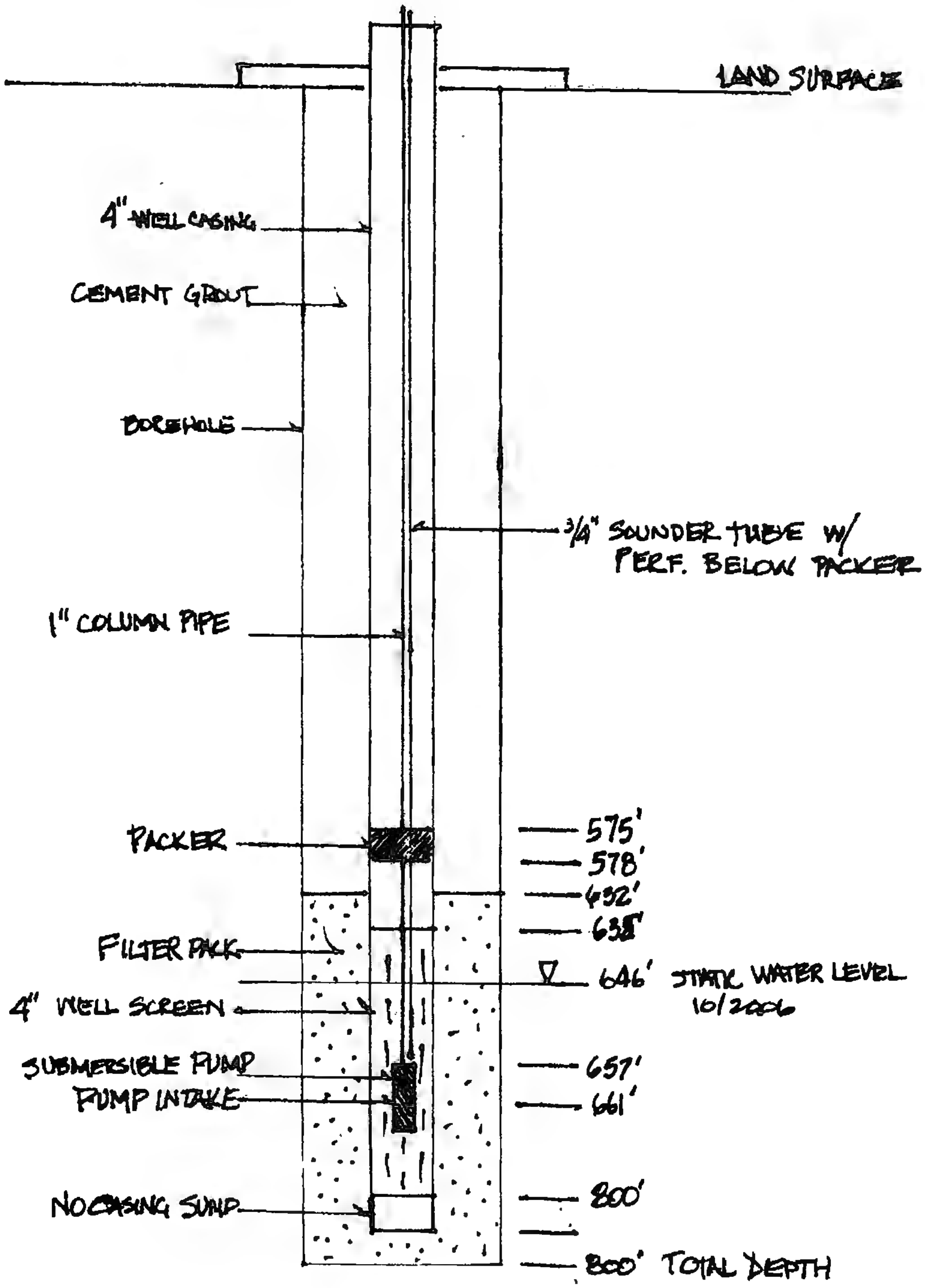
PAGE-TROWBRIDGE RANCH

MONITOR WELL MW-5



PAGE-TROWBRIDGE RANCH

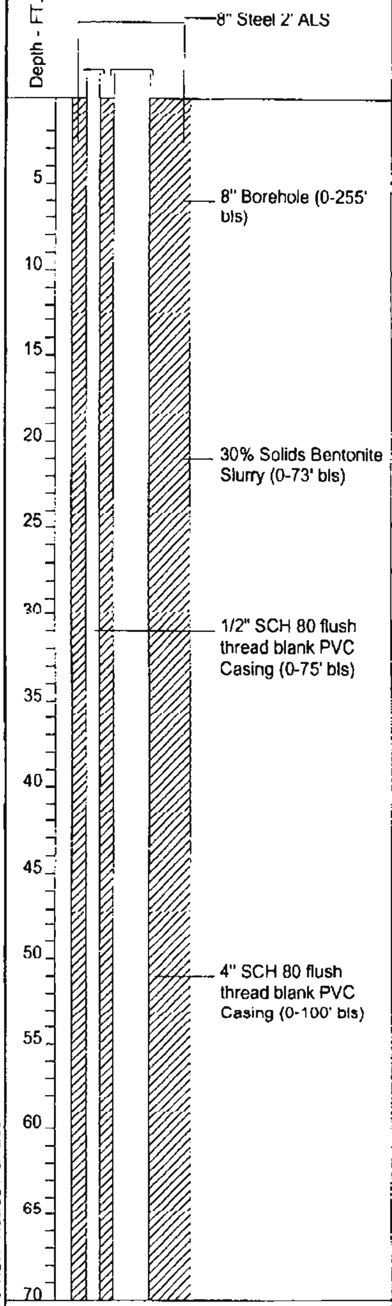
MONITOR WELL MW-2



Project: Page-Trowbridge Ranch Landfill | **Boring:** SGS | Pg. 1 of 4

Drilling Co:	Water Development Corp.	Drilling Method:	Air Rotary
Date Started:	12/2/03	Location:	Between Cells A&B 20' North of Access Road
Sampler:		Date Completed:	12/5/03
Desc. of Meas Pt:	Land Surface Elev.	Logged by:	W.Thompson
Land Surf. Elev:		Meas. Pt. Elev:	
Reviewed by:	B. Anderson		

WELL COMPLETION



Depth - FT.	DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
0	SILTY SAND, very pale brown (10YR 7/3); Sand fraction is fine to very fine grained with a few small fractions (less than 5%) up to 2mm in diameter; generally poorly graded; loose; strong reaction to HCl; dry	SM	0	75	25	D
7	SILTY SAND; pinkish gray (7.5 YR 6/2); as described above, few sand clasts to 3/4" max diameter, subangular to to well rounded, crystalline, quartz, granite; considerable CaCO3 cementaion as caliche; very strong reaction to HCl; dry.	SM	2	68	30	D
20	Silt with Sand; light brown (7.5YR 6/4); sand fraction is very fined grained; calcareous; soft, loose; very strong reaction to HCl; dry.	ML	0	10	90	
45	SILT with SAND; light brown (7.5YR 6/4); cuttings are very consistent. Sand fraction is very fined grained; some fine gravel clasts; quartz to 1/2" max diameter; some calcareous cementation; very strong reaction to HCl; (no moisture given)	ML	2	13	85	
51	SANDY SILT; pink (7.5YR 7/4);sand fraction is coarse through very fine grained, overall poorly graded; soft, loose, some cementation; very strong reaction to HCl; damp.	ML	0	20	80	M
56	SILT; light brown (7.5YR 6/4); soft, loose, flour-like texture;very strong reaction to HCl; slightly damp.	ML	0	5	95	M

Columns also printed (blank): Blow Count, % Recovery, PID (ppm), Samples (G), Graphic Log. ESTIMATED % OF: GR, SA, FI.

HYDRO GEO CHEM, INC.

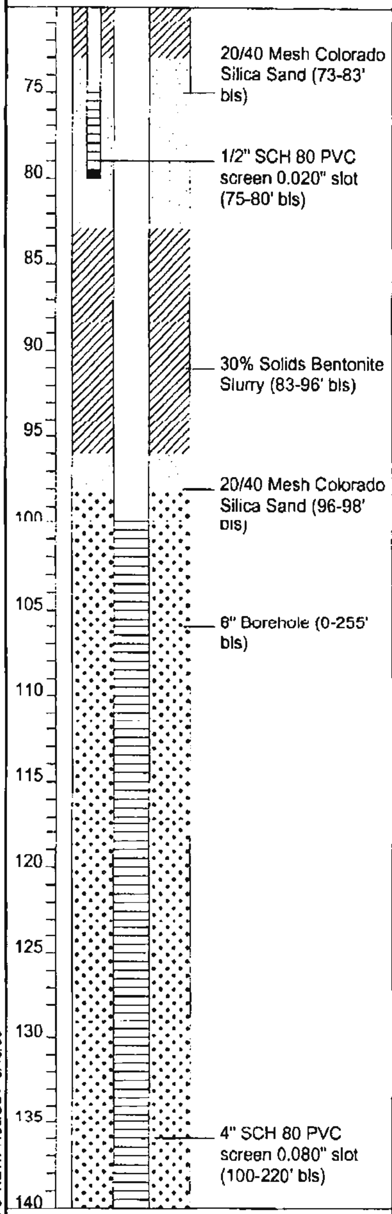
Lithologic Log and Well Construction Details of SGS

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/26/04			793100	1a

Project: Page-Trowbridge Ranch Landfill | **Boring:** SGS | Pg. 2 of 4

Drilling Co:	Water Development Corp.	Drilling Method:	Air Rotary
Date Started:	12/2/03	Location:	Between Cells A&B 20' North of Access Road
Sampler:		Date Completed:	12/5/03
Desc. of Meas Pt:	Land Surface Elev.	Logged by:	W.Thompson
Land Surf. Elev:		Meas. Pt. Elev:	
Reviewed by:	B. Anderson		

WELL COMPLETION



Depth - FT.	DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
73–76	SILT; light brown (7.5YR 6/4); soft, loose, flour-like texture;very strong reaction to HCl; slightly damp.*(continued)*					
76–81	SAND with SILT; pinkish gray (7.5 YR 6/2): sand fraction is very coarse through very fine grained; quartz, crystalline aphenites, hues range from white to pink and light through dark gray, fairly well graded; strong reaction to HCl; slightly damp.	SW-SM	0	90	10	M
81–91	SILTY SAND; as above except for an increase in silt fraction.	SM	0	75	25	M
91–101	SANDY SILT; light yellowish brown (10 YR 6/4);sand fraction is fine to very fine grained, well graded to silt fraction; loose, soft; strong reaction ot HCl; slightly damp.	ML	0	30	70	M
101–111	SILTY SAND with GRAVEL; very pale brown (10 YR 7/3); gravel to 1.5" max diameter, subangular to well rounded, crystalline gray aphenite quartz; sand fraction is coarse through very fine grained but is primarily fine grained, loose mix; strong reaction to HCl; dry.	SM	20	60	20	D
111–116	SILT with SAND; brown (7.5 Y5/4): sand fraction is fine to very fine grained; loose, soft; strong reaction to HCl; slightly damp.	ML	0	10	90	M
116–121	SILTY SAND; very pale brown (10 YR 7/3); sand fraction is very fine grained; loose, soft; strong reaction to HCl; slightly damp.	SM	0	60	40	M
121–126	SILT with SAND; brown (7.5 Y5/4); sand fraction is fine to very fine grained; loose, soft; strong reaction to HCl; damp.	ML	0	10	90	M
126–136	SILT; brown (7.5 YR 5/3); soft flour-like texture; very strong reaction to HCl; slightly damp.	ML	0	0	100	M
136–140	SILT with SAND; as above except for trace amount of very fine grained sand.	ML	0	5	95	M

HYDRO GEO CHEM, INC.

Lithologic Log and Well Construction Details of SGS

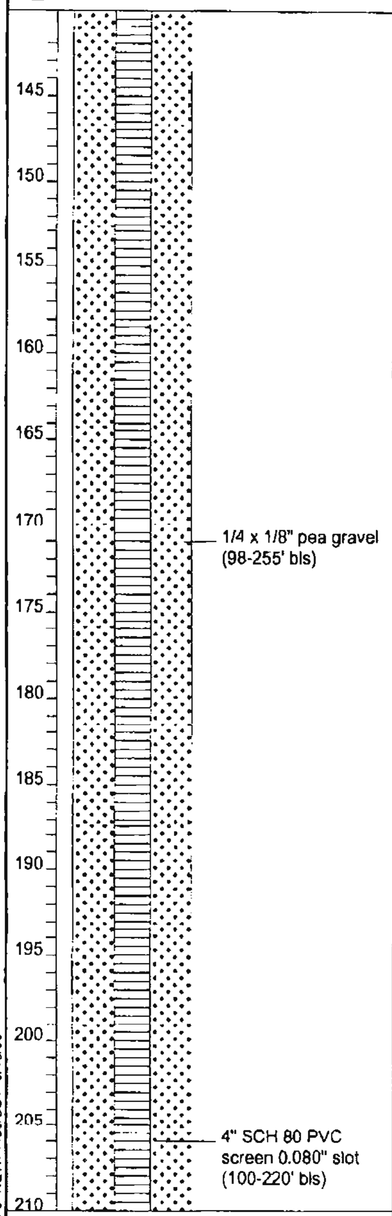
Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/26/04			793100	1b

HGC-WELL 793100.GPJ NEWPROJ.GDT 9/18/06

Project: Page-Trowbridge Ranch Landfill | **Boring:** SGS | Pg. 3 of 4

Drilling Co:	Water Development Corp.	Drilling Method:	Air Rotary
Location:	Between Cells A&B 20' North of Access Road	Sampler:	
		Desc. of Meas Pt:	Land Surface Elev.
Land Surf. Elev:		Meas. Pt. Elev:	
Date Started:	12/2/03	Date Completed:	12/5/03
Logged by:	W.Thompson	Reviewed by:	B. Anderson

WELL COMPLETION



DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
SILT with SAND; as above except for trace amount of very fine grained sand. *(continued)*					
SILT with SAND; light yellowish brown (10 YR 6/4); sand fraction is very fine grained; loose, soft, gritty; strong reaction to HCl; damp.	ML	0	10	90	M
WELL GRADED SAND with SILT; light yellowish brown (10 YR 6/4); sand fraction is coarse through very fine grained, subangular to rounded, faily well graded through to silt fraction; loose;strong reaction to HCl; slightly damp.	SW-SM	0	90	10	M
SANDY SILT; light yellowish brown (10 YR 6/4); sand fraction is medium through very fine grained-primarily fine grained; soft, gritty texture; strong reaction to HCl; slightly damp.	ML	0	40	60	M
SANDY SILT; as above except sand fraction is fine to very fine grained and silr fraction has increased.	ML	0	20	80	M
SILTY SAND; pale brown (10 YR 6/3); sand fraction is fine to very fine grained, homogeneous; loose; strong reaction to HCl; slightly damp.	SM	0	80	20	M
SILTY GRAVEL with SAND; pale brown (10 YR 6/3);gravel fraction is fine graded to 1/2" max diameter, subangular to well rounded, dark through light gray cyrstalline aphentites and quartz; sand fraction is coarse through very fined grained, fairly well graded throughout; loose; strong reaction to HCl; damp.	GM	60	20	20	M
SANDY SILT; very pale brown (10 YR 7/3); sand fraction is very fine grained; soft, gritty, loose; Strong reaction to HCl; damp.	ML	0	40	60	M
SILT with SAND; as above with much less sand; soft; slightly damp.	ML	0	10	90	M
SILTY SAND; very pale brown (10 YR 7/3); sand fracrion is very fined grained; very loose; strong reaction to HCl; slightly damp	SM	0	60	40	M

HYDRO GEO CHEM, INC.

Lithologic Log and Well Construction Details of SGS

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/26/04			793100	1c

Project: Page-Trowbridge Ranch Landfill — **Boring:** SGS — Pg. 4 of 4

Drilling Co: Water Development Corp. — Drilling Method: Air Rotary — Date Started: 12/2/03

Location: Between Cells A&B 20' North of Access Road — Sampler: — Date Completed: 12/5/03

Desc. of Meas Pt: Land Surface Elev. — Logged by: W.Thompson

Land Surf. Elev: — Meas. Pt. Elev: — Reviewed by: B. Anderson

WELL COMPLETION: 1/4 x 1/8" pea gravel (98-255' bls)

Depth - FT.	Samples	DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
210–215	G	SANDY SILT; as above except that the silt fraction has ?increased?	ML	0	30	70	M
215–220	G	SILTY SAND; pinkish gray (7.5 YR 7/3); trace gravels, gravel fraction is fine to 1/2" max diameter and is ?tomb?; sand fraction is fine to very fine grained; loose; strong reqaction to HCl; damp.	SM	5	55	40	M
220–255	G	SANDY SILT; very pale brown (10 YR 7/3); sand fraction is very fine grained; soft; loose; very strong reaction to HCl; slightly damp.	ML	0	25	75	M
255		TD @ 255' bls	ML	0	25	75	M

HYDRO GEO CHEM, INC.

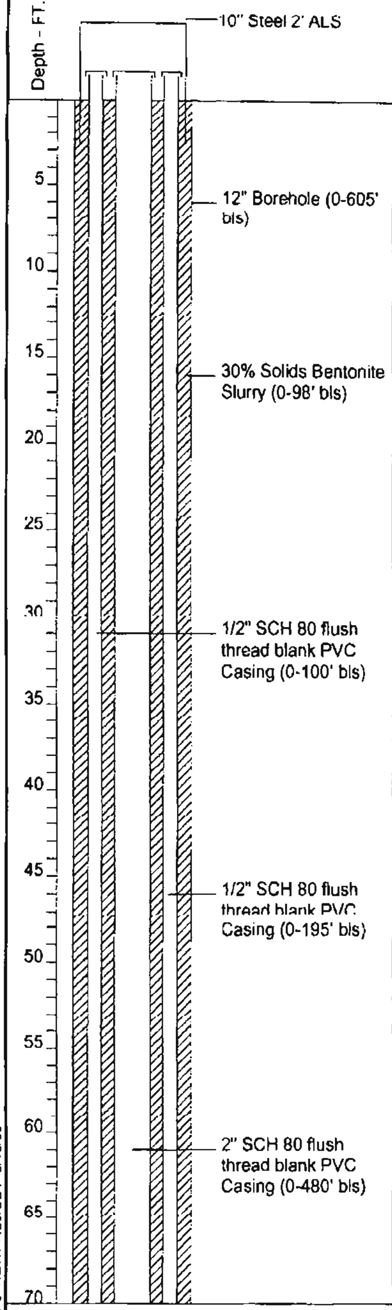
Lithologic Log and Well Construction Details of SGS

Approved	Date	Revised	Date	Reference.	FIG.
T.Schrauf	1/26/04			793100	1d

Project: Page-Trowbridge Ranch Landfill — **Boring:** SGD-1 — Pg. 1 of 9

Drilling Co:	Water Development Corp.	Drilling Method:	Air Rotary
Location:	Between Cells A&B South of Access Road	Sampler:	
Date Started:	12/5/03	Date Completed:	12/9/03
Desc. of Meas Pt:	Land Surface Elev.	Logged by:	W.Thompson
Land Surf. Elev:		Meas. Pt. Elev:	
Reviewed by:	B. Anderson		

WELL COMPLETION



Depth - FT.	DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
0	SILT, pink (7.5YR 7/4); trace sand, sand fraction is fine to very fine grained; slightly cemented, easily broken up; soft; strong reaction to HCl; dry	ML	0	5	95	D
12	SILT, as above except for very small amount of gravel, subangular to rounded, crystalline aphentites, dark through light gray, some quartz; loose; strong reaction to HCl; dry	ML	2	5	93	D
20	SILT; light brown (7.5 YR 6/4); soft, powdery, flour-like texture; very strong reaction to HCl; dry	ML	0	0	100	D
25	SILT; with trace sand; light brown (7.5 YR 6/4); sand fraction coarse through very fine grained; weekly cemented; strong reaction to HCl; dry.	ML	0	5	95	D
31	SILT; light brown (7.5 YR 6/4); soft, powdery, flour-like texture; slight cementation; strong reaction to HCl; dry.	ML	0	0	100	D
40	SILTY SAND; light brown (7.5 YR 6/4): sand fraction is medium to very fine grained; minor cementation, fairly loose; strong reaction to HCl; dry.	SM	0	65	35	D
45	SANDY SILT; light brown (7.5 YR 6/4); sand fraction as described above; moderate cementation; strong reaction to HCl; dry.	ML	0	25	75	D
50	SANDY SILT; as above, less sand, more silt.	ML	0	10	90	D
55	SILT; light brown (7.5 YR 6/4); soft, powdery, flour-like texture; strong reaction to HCl; dry.	ML	0	0	100	D
60	SILT with SAND; light brown (7.5 YR 6/4); sand fraction is fine to very fine grained; soft, gritty texture; strong reaction to HCl; moist.	ML	0	10	90	M
65		SM	10	50	40	M

Columns also shown: Blow Count, % Recovery, PID (ppm), Samples (G), Depth - FT., Graphic Log.

HYDRO GEO CHEM, INC.

Lithologic Log and Well Construction Details of SGD-1

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/27/04			793100	2a

Project: Page-Trowbridge Ranch Landfill | Boring: **SGD-1** | Pg. 2 of 9

Drilling Co: Water Development Corp. | Drilling Method: Air Rotary | Date Started: 12/5/03

Location: Between Cells A&B South of Access Road | Sampler: | Date Completed: 12/9/03

Desc. of Meas Pt: Land Surface Elev. | Logged by: W.Thompson

Land Surf. Elev: | Meas. Pt. Elev: | Reviewed by: B. Anderson

Well completion (Depth - FT.):

- 1/2" SCH 80 PVC Screen 0.020" slot (100-120' bls)
- 20/40 Mesh Colorado Silica Sand (98-123' bls)
- 30% Solids Bentonite Slurry (123-193' bls)

Depth - FT.	DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
73-77	SILTY SAND with GRAVEL; light brown (7.5 YR 6/4); gravel fraction to 1" max diameter, subangular to rounded, crystalline; sand fraction is coarse to very fine grained but is primarily fine grained; loose mix; strong reaction to HCl; moist. *(continued)*					
77-83	SAND with SILT; light brown (7.5 YR 6/4); sand fraction is fine to very fine grained; soft; strong reaction to HCl; moist.	ML	0	10	90	M
83-90	SILTY SAND with GRAVEL; brown (7.5 YR 5/4); gravel clast to 1" max diameter, subangular to rounded, crystalline aphentites; sand fraction coarse to very fine grained; loose; strong reaction to HCl; moist.	SM	35	50	15	M
90-95	SILT with SAND; light brown (7.5 YR 6/4); trace gravel to 1/2" max diameter, subangular to rounded; sand fraction is very fine grained; soft; strong reaction to HCl; moist.	ML	5	10	85	M
95-100	SILT; light brown (7.5 YR 6/4); soft, flour-like texture; strong reaction to HCl; moist.	ML	0	0	100	M
100-105	SILTY SAND; light yellowish brown (10 YR 6/4); sand fraction is fine to very fine grained; soft, loose mix; strong reaction to HCl; moist.	SM	0	60	40	M
105-115	WELL-GRADED SAND with GRAVEL; light yellowish brown (10 YR 6/4); gravel fraction is fine grained to 1/2" max diameter, subangular to rounded; sand fraction is coarse to very fine grained, fairly well graded; loose; strong reaction to HCl; moist.	SW	10	85	5	M
115-120	SILTY SAND; with trace gravel; yellowish brown (10 YR 5/4), as described above except for decrease in gravel fractions and increase in silt fraction.	SM	5	75	20	M
120-125	SANDY SILT; light yellowish brown (10 YR 6/4); sand fraction is very fine grained; soft, gritty texture; strong reaction ot HCl; moist.	ML	0	25	75	M
125-135	SILT; light yellowish brown (10 YR 6/4); soft, flour-like texture; strong reaction to HCl; moist.	ML	0	5	95	M
135-140	SILT; with gravel and sand; yellowish brown (10 YR 5/6); gravel fraction to 1" max diameter, subangular to rounded; soft, loose; strong reaction to HCl; moist.	ML	10	10	80	M

Samples (G) at approx. 74, 80, 87, 93, 98, 103, 110, 118, 123, 131, 138 ft.

HYDRO GEO CHEM, INC.

Lithologic Log and Well Construction Details of SGD-1

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/27/04			793100	2b

Project: Page-Trowbridge Ranch Landfill | **Boring:** SGD-1 | Pg. 3 of 9

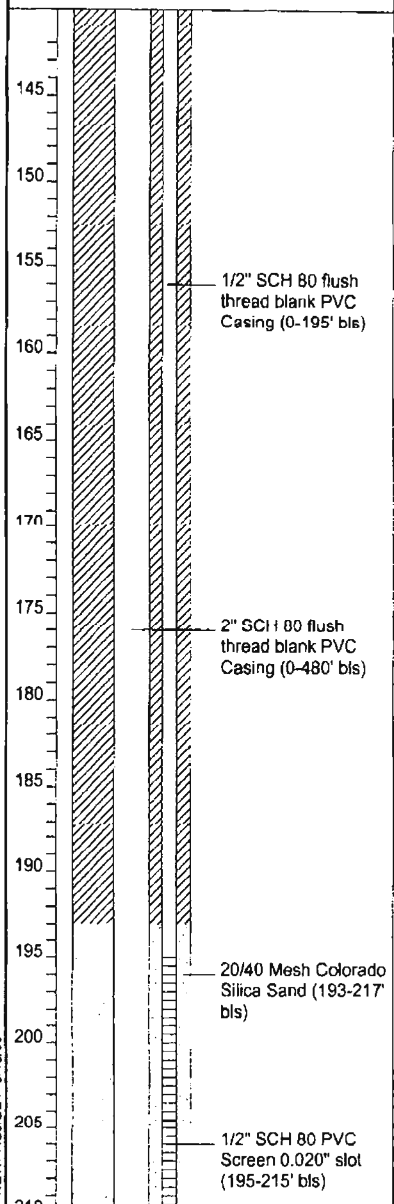
Drilling Co: Water Development Corp. | Drilling Method: Air Rotary | Date Started: 12/5/03

Location: Between Cells A&B South of Access Road | Sampler: | Date Completed: 12/9/03

Desc. of Meas Pt: Land Surface Elev. | Logged by: W.Thompson

Land Surf. Elev: | Meas. Pt. Elev: | Reviewed by: B. Anderson

WELL COMPLETION



Depth - FT.	Description	USCS Symbol	GR	SA	FI	Moisture
145–150	SANDY SILT; light yellowish brown (10 YR 6/4); sand fraction is fine to very fine grained; soft, flour-like texture; strong reaction to HCl; moist.	ML	0	15	85	M
150–155	SANDY SILT; as described above except for increase in sand fraction.	ML	0	40	60	M
155–163	GRAVELLY SILT with SAND; yellowish brown (10 YR 5/4); gravel fraction to 1" max diameter, subangular to rounded, crystalline aphentites, dark through light gray, quartz; sand fraction is coarse through fine grained but primarily fine grained; loose mix; strong reaction to HCl; moist.	SM	30	40	30	M
163–175	SANDY SILT; yellowish brown (10 YR 5/4); sand fraction is fine to very fine grained; soft, powdery, gritty texture; strong reaction to HCl; moist.	ML	0	20	80	M
175–180	GRAVELLY SILT; light yellowish brown (10 YR 6/4); gravel fraction to 1/2" max diameter, subangular to rounded; sand fraction is coarse through very fine grained, well graded to silt fraction; loose; strong reaction to HCl; moist.	SM	20	65	15	M
180–185	SILTY SAND; brown (7.5 YR 5/4); sand fraction is fine to very fine grained; loose; strong reaction to HCl; moist.	SM	0	80	20	M
185–190	SILT with SAND; brown (7.5 YR 5/4); sand fraction is fine to very fine grained; soft, gritty, flour-like texture; strong reaction to HCl; moist.	ML	0	10	90	M
190–195	SILT with SAND; as describe above except for a small amount of gravel to 1" max diameter, subangular to rounded, crystalline.	ML	5	10	85	M
195–200	SILTY SAND with GRAVEL; brown (7.5 YR 5/4); gravel fraction is fine grained to 1/2" max diameter, subangular to rounded; sand fraction is coarse to very fine grained, fairly well graded; loose; strong reaction to HCl; moist.	SM	10	65	25	M
200–210	as above except for increase in silt fraction.	ML	0	60	40	M

(Columns Blow Count, % Recovery, PID (ppm) blank; samples "G" at intervals.)

HYDRO GEO CHEM, INC.

Lithologic Log and Well Construction Details of SGD-1

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/27/04			793100	2c

Project: Page-Trowbridge Ranch Landfill | Boring: **SGD-1** | Pg. 4 of 9

Drilling Co: Water Development Corp. | Drilling Method: Air Rotary | Date Started: 12/5/03

Location: Between Cells A&B South of Access Road | Sampler: | Date Completed: 12/9/03

Desc. of Meas Pt: Land Surface Elev. | Logged by: W.Thompson

Land Surf. Elev: | Meas. Pt. Elev: | Reviewed by: B. Anderson

WELL COMPLETION

30% Solids Bentonite Slurry (217-433' bls)

2" SCH 80 flush thread blank PVC Casing (0-480' bls)

Depth - FT.	DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
215	as above except for increase in silt fraction. *(continued)*					
216	SANDY SILT; brown (7.5 YR 5/4); sand fraction is fine to very fine grained; soft, gritty texture; strong reaction to HCl; moist.	ML	0	30	70	M
231	SANDY SILT; brown (7.5 YR 5/4); as above except for increase in silt fraction.	ML	0	20	80	M
251	SILTwith SAND; brown (7.5 YR 5/4); sand fraction is very fine grained, flour-like texture; strong reaction to HCl; moist.	ML	0	10	90	M

Lithologic Log and Well Construction Details of SGD-1

HYDRO GEO CHEM, INC.

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/27/04			793100	2d

HGC-WELL 793100.GPJ NEWPROJ.GDT 9/18/06

Project: Page-Trowbridge Ranch Landfill — **Boring:** SGD-1 — Pg. 5 of 9

Drilling Co: Water Development Corp. — Drilling Method: Air Rotary — Date Started: 12/5/03

Location: Between Cells A&B South of Access Road — Sampler: — Date Completed: 12/9/03

Desc. of Meas Pt: Land Surface Elev. — Logged by: W.Thompson

Land Surf. Elev: — Meas. Pt. Elev: — Reviewed by: B. Anderson

Depth - FT.	WELL COMPLETION	Samples	DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
(continued)–290		G (285)	SILTwith SAND, brown (7.5 YR 5/4); sand fraction is very fine grained, flour-like texture; strong reaction to HCl; moist. *(continued)*					
290–298		G (295)	SAND with SILT; very pale brown (10 YR 7/3); sand fraction is medium through very fine grained, fairly well graded to silt fraction; loose; strong reaction to HCl; moist.	SW-SM	0	90	10	M
298–331	30% Solids Bentonite Slurry (217-433' bls)	G (315)	SANDY SILT; brown (7.5 YR 5/4); sand fraction is fine to very fine grained; soft, gritty flour-like texture; strong reaction to HCl; moist.	ML	0	20	80	M
331–336	2" SCH 80 flush thread blank PVC Casing (0-480' bls)	G (333)	SAND with SILT; yellowish brown (10 YR 5/4); sand fraction is medium through very fine grained, fairly well graded through to the silt fraction; loose strong reaction to HCl; moist.	SW-SM	0	90	10	M
336–346		G (340)	SILTY SAND; dark yellowish brown (10 YR 4/4); sand fraction is very fine grained; soft; strong reaction to HCl; moist.	SM	0	60	40	M
346–350		G (348)	SANDY SILT with minor clay; dark yellowish brown (10 YR 4/4); sand fraction is very fine grained; soft, slightly ?cohesive?, slightly sticky; strong reaction to HCl; moist.	ML	0	40	60	M

Columns also printed: Blow Count, % Recovery, PID (ppm), Graphic Log, ESTIMATED % OF

Lithologic Log and Well Construction Details of SGD-1

HYDRO GEO CHEM, INC.

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/27/04			793100	2e

Project: Page-Trowbridge Ranch Landfill | **Boring:** SGD-1 |

Drilling Co: Water Development Corp. | Drilling Method: Air Rotary | Date Started: 12/5/03

Location: Between Cells A&B South of Access Road | Sampler: | Date Completed: 12/9/03

Desc. of Meas Pt: Land Surface Elev. | Logged by: W.Thompson

Land Surf. Elev: | Meas. Pt. Elev: | Reviewed by: B. Anderson

WELL COMPLETION: 30% Solids Bentonite Slurry (217-433' bls); 2" SCH 80 flush thread blank PVC Casing (0-480' bls)

Depth - FT.	Samples	DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
~352-361	G (355)	SANDY SILT; as describe above except that clay fraction is absent and silt fraction has increased.	ML	0	30	70	M
361-406	G (382)	SILTY SAND; dark brown (7.5 YR 4/?)???doesn't match; sand fraction is coarse through very fine grained but, is primarily fine grained; soft, gritty texture; weak reaction to HCl; moist.	SM	0	70	30	M
406-416	G (410)	SANDY SILT; dark brown (10 YR 4/3??doesn't match???); sand fraction is very fine graded; soft; strong reaction to HCl; moist.	SM	0	20	80	M
416-420	G (418)	SILTY SAND; brown (10 YR 5/3); sand fraction is medium through very fine grained; soft, gritty texture; weak reactiuon to HCl; moist.	SM	0	75	25	M

Depth scale: 355, 360, 365, 370, 375, 380, 385, 390, 395, 400, 405, 410, 415, 420

HYDRO GEO CHEM, INC.

Lithologic Log and Well Construction Details of SGD-1

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/27/04			793100	2f

Project: Page-Trowbridge Ranch Landfill | Boring: **SGD-1** | Pg. 7 of 9

Drilling Co: Water Development Corp. | Drilling Method: Air Rotary | Date Started: 12/5/03

Location: Between Cells A&B South of Access Road | Sampler: | Date Completed: 12/9/03

Desc. of Meas Pt: Land Surface Elev. | Logged by: W.Thompson

Land Surf. Elev: | Meas. Pt. Elev: | Reviewed by: B. Anderson

WELL COMPLETION

- 20/40 Mesh Colorado Silica Sand (433-435' bls)
- 1/4 x 1/8" pea gravel (435-605' bls)
- 2" SCH 80 PVC Screen 0.080" slot (480-540' bls)

Depth - FT.	DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
421-435	SILTY SAND; brown (10 YR 5/3); sand fraction is medium through very fine grained; soft, gritty texture; weak reactiuon to HCl; moist.*(continued)*					
435-453	WELL-GRADED SAND with SILT; yellowish brown (10 YR 5/4); very minor gravel to 1/2" max diameter, subangular to rounded; sand fraction is coarse to very fine grained, fairly well graded; loose; strong reaction to HCl; moist.	SW	2	88	10	M
453-476	WELL-GRADED SAND with GRAVEL; yellowish brown (10 YR 5/4); gravel fraction is fine grained to 1/2" max diameter, sub angular to rounded, dark through light gray aphentiss with quartz; sand fraction is verycoarse through fine grained, well graded throughout, fairly clean, loose, weak reaction to HCl; ???moisture???	SW	30	65	5	
476-490	SILTY SAND; yellowish brown (10 YR 5/4); sand fraction is coarse through very fine grained, fairly well graded through to the silt fraction; loose; weak reaction to HCl; moist.	SM	0	85	15	M

Samples: G (approx. 428', 445', 465', 483')

Lithologic Log and Well Construction Details of SGD-1

HYDRO GEO CHEM, INC.

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/27/04			793100	2g

Project: Page-Trowbridge Ranch Landfill | **Boring:** SGD-1 |

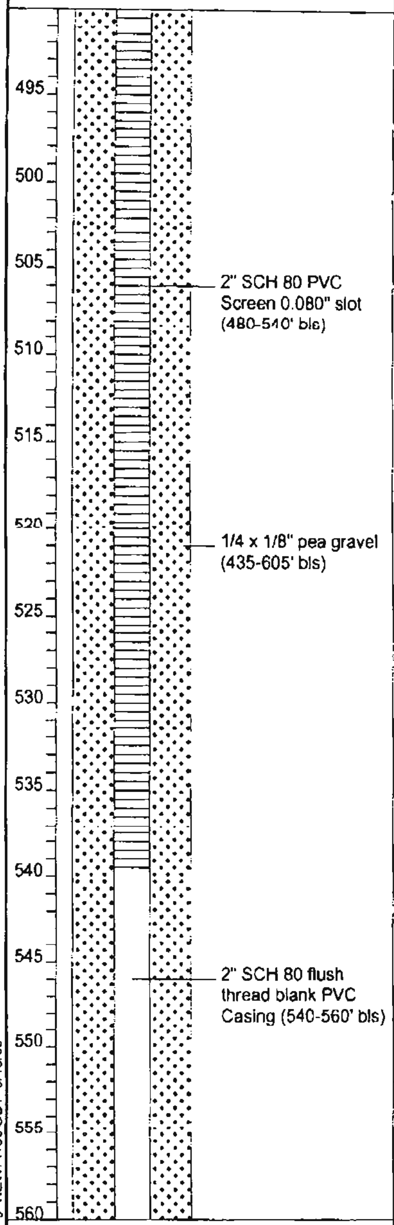
Drilling Co: Water Development Corp. | Drilling Method: Air Rotary | Date Started: 12/5/03

Location: Between Cells A&B South of Access Road | Sampler: | Date Completed: 12/9/03

Desc. of Meas Pt: Land Surface Elev. | Logged by: W.Thompson

Land Surf. Elev: | Meas. Pt. Elev: | Reviewed by: B. Anderson

WELL COMPLETION



Depth - FT.	Samples	DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
490–495	G						
495–505	G	WELL-GRADED SAND with SILT; brown (10 YR 5/3); gravel fraction to 1/2" max diameter, subangular to rounded; sand fraction is coarse through very fine grained, fairly well graded to silt fraction; loose weak reaction to HCl; moist.	SW-sm	5	85	10	M
505–515	G	WELL-GRADED SAND with GRAVEL; light yellowish brown (10 YR 6/4); gravel fraction is fine grained to 1/2" max diameter, subangular to rounded; sand fraction is coarse through fine grained, well graded, fairly clean; loose; weak reaction to HCl; moist.	SW	20	75	5	M
515–525	G	SILTY SAND; light yellowish brown (10 YR 6/4); gravel fraction to 1/4" max diameter very minor; sand fraction is coarse through very fine grained, fairly well graded throughout, loose, strong reaction to HCl; moist.	SM	3	82	15	M
525–540	G	WELL-GRADED SAND with SILT(???or is this SP-SM???); brown (10 YR 5/3); sand fraction is medium through very fine grained, well graded to silt fraction; loose; weak reaction to HCl; moist.	SW-sm	0	90	10	M
540–555	G	SILT with SAND; yellowish brown (10 YR 5/6); sand fraction is fine to very fine grained; soft, gritty texture; strong reaction to HCl; moist.	ML	0	40	60	M
555–560	G	SILTY SAND; yellowish brown (10 YR 5/4); sand fraction is fine to very fine grained; soft, gritty texture; strong reaction to HCl; moist.	SM	0	70	30	M

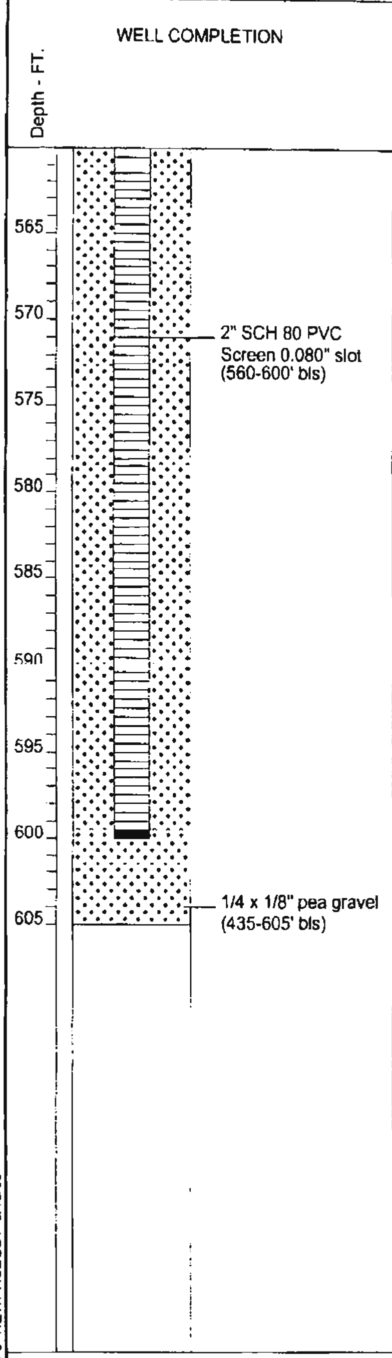
(Blow Count, % Recovery and PID (ppm) columns are empty.)

HYDRO GEO CHEM, INC.

Lithologic Log and Well Construction Details of SGD-1

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/27/04			793100	2h

Project: Page-Trowbridge Ranch Landfill		Boring: **SGD-1**	Pg. 9 of 9
Drilling Co: Water Development Corp.	Drilling Method: Air Rotary	Date Started: 12/5/03	
Location: Between Cells A&B South of Access Road	Sampler:	Date Completed: 12/9/03	
	Desc. of Meas Pt: Land Surface Elev.	Logged by: W.Thompson	
Land Surf. Elev:	Meas. Pt. Elev:	Reviewed by: B. Anderson	



Blow Count	% Recovery	PID (ppm)	Samples	Depth - FT.	Graphic Log	DESCRIPTION	USCS Symbol	ESTIMATED % OF GR	SA	FI	Moisture
			G	565–575		WELL-GRADED SAND; brown (10 YR 5/3); sand fraction is coarse through very fine grained, well graded through to the silt fraction; loose; weak reaction to HCL; moist.	SW	0	95	5	M
			G	575–605 (labels: 575, 580, 585, 600, 595, 600, 605)		WELL-GRADED SAND with GRAVEL; brown (10 YR 5/3); gravel fraction is minor to 1/4" max diameter, subangular to rounded; sand fraction is coarse through very fine grained, well graded; loose; weak reaction to HCl; moist.	SW	10	85	5	M
				605		TD @ 605' bls	SW	10	85	5	M

Lithologic Log and Well Construction Details of SGD-1

HYDRO GEO CHEM, INC.

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/27/04			793100	2i

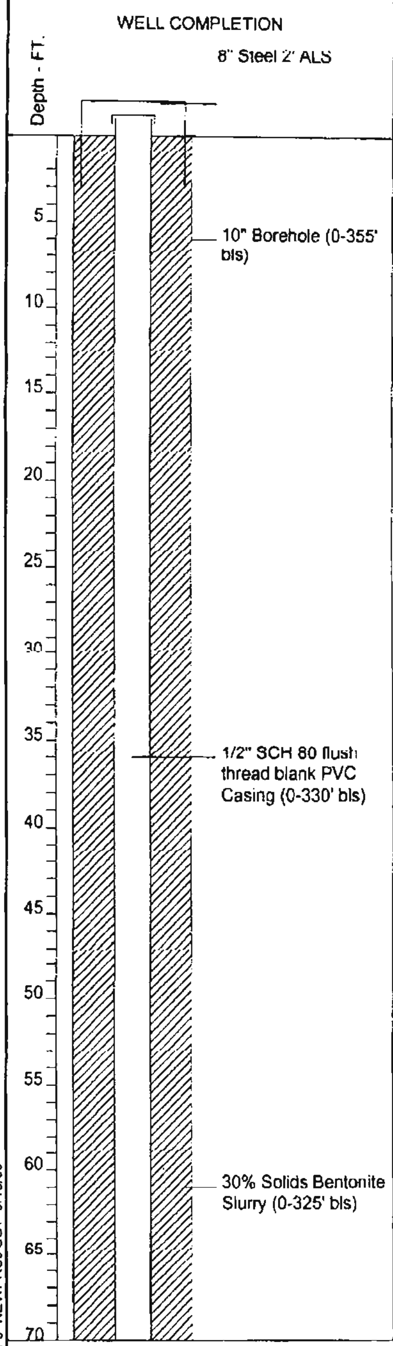
Project: Page-Trowbridge Ranch Landfill **Boring:** SGD-2 Pg. 1 of 6

Drilling Co: Water Development Corp. Drilling Method: Air Rotary Date Started: 12/12/03

Location: 10' West of SGD (Deep) Sampler: Date Completed: 12/13/03

Desc. of Meas Pt: Logged by: W.Thompson

Land Surf. Elev: Meas. Pt. Elev: Reviewed by: B. Anderson



DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
SILT; pink (7.5YR 7/4); trace sand-sand fraction is fine to very fine grained; slightly cemented-easily broken up; soft; strong reaction to HCl; dry	ML	0	5	95	D
SILT, as above except for very small amount of gravel clast, subangular to rounded, crystalline aphentiss, dark through light gray, some quartz; loose; strong reaction to HCl; dry	ML	2	5	93	D
SILT; light brown (7.5 YR 6/4); soft, powdery, flour-like texture; very strong reaction to HCl; dry	ML	0	0	100	D
SILT; with trace sand; light brown (7.5 YR 6/4); sand fraction coarse through very fine grained; slightly cemented; strong reaction to HCl; dry.	ML	0	5	95	D
SILT; light brown (7.5 YR 6/4); soft, powdery, flour-like texture; slight cementation; strong reaction to HCl; dry.	ML	0	0	100	D
SILTY SAND; light brown (7.5 YR 6/4); sand fraction is medium to very fine grained; minor cementation, fairly loose; strong reaction to HCl; dry.	SM	0	65	35	D
SANDY SILT; light brown (7.5 YR 6/4); sand fraction as described above, moderate cementation; strong reaction to HCl; dry.	ML	0	25	75	D
SANDY SILT; as above, less sand, more silt.	ML	0	10	90	D
SILT; light brown (7.5 YR 6/4); soft powder, flour-like texture; strong reaction to HCl; dry.	ML	0	0	100	D
SILT with SAND; light brown (7.5 YR 6/4); sand fraction is fine to very fine grained; soft, gritty texture; strong reaction to HCl; moist.	ML	0	10	90	M
	SM	10	50	40	M

Columns: Blow Count; % Recovery; PID (ppm); Samples (G); Depth - FT.; Graphic Log; ESTIMATED % OF (GR, SA, FI)

Lithologic Log and Well Construction Details of SGD-2

HYDRO GEO CHEM, INC.

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/29/04			793100	3a

Project: Page-Trowbridge Ranch Landfill | **Boring:** SGD-2 |

Drilling Co:	Water Development Corp.	Drilling Method:	Air Rotary
Location:	10' West of SGD (Deep)	Sampler:	
		Desc. of Meas Pt:	
Land Surf. Elev:		Meas. Pt. Elev:	
Date Started:	12/12/03	Date Completed:	12/13/03
Logged by:	W.Thompson	Reviewed by:	B. Anderson

WELL COMPLETION

- 1/2" SCH 80 PVC screen 0.020" slot (330-350' bls)
- 30% Solids Bentonite Slurry (0-325' bls)

Depth - FT.	Samples	DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
72–76	G	SILTY SAND with GRAVEL; light brown (7.5 YR 6/4); gravel fraction to 1" max diameter, subangular to rounded, crystalline; sand fraction is coarse ot very fine grained but is primarily fine grained; loose mix; strong reaction to HCl: moist.*(continued)*					
76–84	G	SAND with SILT; light brown (7.5 YR 6/4); sand fraction is fine to very fine grained; soft; strong reaction to HCl; moist.	ML	0	10	90	M
84–91	G	SILTY SAND with GRAVEL; brown (7.5 YR 5/4); gravel clast to 1" max diameter, subangular to rounded, crystalline aphentiss; sand fraction coarse to very fine grained; loose: strong reaction to HCl; moist.	SM	35	50	15	M
91–95	G	SILT with SAND; light brown (7.5 YR 6/4); trace gravel to 1/2" max diameter, subangular to rounded; sand fraction is very fine grained; soft; strong reaction to HCl; moist.	ML	5	10	85	M
95–100	G	SILT; light brown (7.5 YR 6/4); soft, flour-like texture; strong reaction to HCl; moist.	ML	0	0	100	M
100–105	G	SILTY SAND; light yellowish brown (10 YR 6/4); sand fraction is fine to very fine grained; soft, loose mix;Strong reaction to HCl; moist.	SM	0	60	40	M
105–115	G	WELL-GRADED SAND with GRAVEL; light yellowish brown (10YR 6/4); gravel fraction is fine grained to 1/2" max diameter, subangular to rounded; sand fraction is coarse to very fine grained, fairly well graded; loose: strong reaction to HCl; moist.	SW	10	85	5	M
115–120	G	SILTY SAND; with trace gravel; yellowish brown (10 YR 5/4), as described above except for decrease in gravel fraction and increase in silt fraction.	SM	5	75	20	M
120–125	G	SANDY SILT; light yellowish brown (10 YR 6/4); sand fraction is very fine grained; soft, gritty texture; strong reaction ot HCl; moist.	ML	0	25	75	M
125–135	G	SILT; light yellowish brown (10 YR 6/4); soft, flour-like texture; strong reaction to HCl; moist.	ML	0	5	95	M
135–140	G	SILT; with gravel and sand; yellowish brown (10 YR 5/6); gravel fraction to 1" max diameter, subangular to rounded; soft, loose; strong reaction to HCl; moist.	ML	10	10	80	M

HYDRO GEO CHEM, INC.

Lithologic Log and Well Construction Details of SGD-2

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/29/04			793100	3b

HGC-WELL 793100.GPJ NEWPROJ.GDT 9/18/06

Project: Page-Trowbridge Ranch Landfill | **Boring:** SGD-2 | Pg. 3 of 6

Drilling Co: Water Development Corp. | Drilling Method: Air Rotary | Date Started: 12/12/03

Location: 10' West of SGD (Deep) | Sampler: | Date Completed: 12/13/03

Desc. of Meas Pt: | Logged by: W.Thompson

Land Surf. Elev: | Meas. Pt. Elev: | Reviewed by: B. Anderson

WELL COMPLETION (Depth - FT. 145–210)

- 1/2" SCH 80 flush thread blank PVC Casing (0-330' bls)
- 30% Solids Bentonite Slurry (0-325' bls)

DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
SANDY SILT; light yellowish brown (10 YR 6/4): sand fraction is fine to very fine grained; soft, flour-like texture; strong reaction to HCl; moist.	ML	0	15	85	M
SANDY SILT; as described above except for increase in sand fraction.	ML	0	40	60	M
GRAVELLY SILT with SAND; yellowish brown (10 YR 5/4); gravel fraction to 1" max diameter, subangular to rounded, crystalline aphentiss, dark through light gray, quartz; sand fraction is coarse through fine grained but, primarily fine grained; loose mix; strong reaction to HCl; moist.	SM	30	40	30	M
SANDY SILT; yellowish brown (10 YR 5/4), sand fraction is fine to very fine grained; soft, powdery, gritty texture; strong reaction to HCl; moist.	ML	0	20	80	M
GRAVELLY SILT; light yellowish brown (10 YR 6/4); gravel fraction to 1/2" max diameter, subangular to rounded; sand fraction is coarse through very fine grained, well graded to silt fraction; loose; strong reaction to HCl; moist.	SM	20	65	15	M
SILTY SAND; brown (7.5 YR 5/4); sand fraction is fine to very fine grained; loose; strong reaction to HCl; moist.	SM	0	80	20	M
SILT with SAND; brown (7.5 YR 5/4); sand fraction is fine to very fine grained, soft, gritty, flour-like texture; strong reaction to HCl; moist.	ML	0	10	90	M
SILT with SAND; as describe above except for a small amount of gravel to 1" max diameter, sub???? to rounded, crystalline.	ML	5	10	85	M
SILTY SAND with GRAVEL; brown (7.5 YR 5/4): gravel fraction is fine graded to 1/2" max diameter, subangular to rounded: sand fraction is coarse to very fine grained, fairly well graded; loose; strong reaction to HCl; moist.	SM	10	65	25	M
as above except for increase in silt fraction.	ML	0	60	40	M

HYDRO GEO CHEM, INC.

Lithologic Log and Well Construction Details of SGD-2

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/29/04			793100	3c

HGC-WELL 793100.GPJ NEWPROJ.GDT 9/18/06

Project: Page-Trowbridge Ranch Landfill | Boring: **SGD-2** | Pg. 4 of 6

Drilling Co:	Water Development Corp.	Drilling Method:	Air Rotary
Location:	10' West of SGD (Deep)	Sampler:	
		Desc. of Meas Pt:	
Land Surf. Elev:		Meas. Pt. Elev:	
Date Started:	12/12/03	Date Completed:	12/13/03
Logged by:	W.Thompson	Reviewed by:	B. Anderson

WELL COMPLETION

- 30% Solids Bentonite Slurry (0-325' bls)
- 1/2" SCH 80 flush thread blank PVC Casing (0-330' bls)

Depth - FT.	Blow Count	% Recovery	PID (ppm)	Samples	Description	USCS Symbol	GR	SA	FI	Moisture
212–215				G	as above except for increase in silt fraction.*(continued)*					
215–230				G	SANDY SILT; brown (7.5 YR 5/4); sand fraction is fine to very fine grained; soft, gritty texture; strong reaction to HCl; moist.	ML	0	30	70	M
230–250				G	SANDY SILT; brown (7.5 YR 5/4); as above except for increase in silt fraction.	ML	0	20	80	M
250–280				G	SILTwith SAND; brown (7.5 YR 5/4); sand fraction ism very fine grained, flour-like texture; strong reaction to HCl; moist.	MI	0	10	90	M

HYDRO GEO CHEM, INC.

Lithologic Log and Well Construction Details of SGD-2

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/29/04			793100	3d

HGC-WELL 793100.GPJ NEWPROJ.GDT 9/18/06

Project: Page-Trowbridge Ranch Landfill　　Boring: **SGD-2**　　Pg. 5 of 6

Drilling Co: Water Development Corp.　　Drilling Method: Air Rotary　　Date Started: 12/12/03

Location: 10' West of SGD (Deep)　　Sampler:　　Date Completed: 12/13/03

Desc. of Meas Pt:　　Logged by: W.Thompson

Land Surf. Elev:　　Meas. Pt. Elev:　　Reviewed by: B. Anderson

WELL COMPLETION:
- 30% Solids Bentonite Slurry (0-325' bls)
- 1/2" SCH 80 flush thread blank PVC Casing (0-330' bls)
- 20/40 Mesh Colorado Silica Sand (325-355' bls)
- 1/2" SCH 80 PVC screen 0.020" slot (330-350' bls)

Samples (G) at approx. 285, 295, 315, 333, 340, 348 ft.

Depth - FT.	DESCRIPTION	USCS Symbol	GR	SA	FI	Moisture
283–290	SILT with SAND; brown (7.5 YR 5/4); sand fraction ism very fine grained, flour-like texture; strong reaction to HCl; moist. *(continued)*					
290–298	SAND with SILT; very pale brown (10 YR 7/3); sand fraction is medium through very fine grained, fairly well graded to silt fraction; loose; strong reaction to HCl; moist.	SW-SM	0	90	10	M
298–330	SANDY SILT; brown (7.5 YR 5/4); sand fraction is fine to very fine grained; soft, gritty flour-like texture; strong reaction to HCl; moist.	ML	0	20	80	M
330–335	SAND with SILT; yellowish brown (10 YR 5/4); sand fraction is medium through very fine grained, fairly well graded through to the silt fraction; loose strong reaction to HCl; moist.	SW-SM	0	90	10	M
335–345	SILTY SAND; dark yellowish brown (10 YR 4/4); sand fraction is very fine grained; soft; strong reaction to HCl; moist.	SM	0	60	40	M
345–350	SANDY SILT with minor clay; dark yellowish brown (10 YR 4/4); sand fraction is very fine grained; soft, slightly ?cohesive?, slightly sticky; strong reaction to HCl; moist.	ML	0	40	60	M

Lithologic Log and Well Construction Details of SGD-2

HYDRO GEO CHEM, INC.

Approved	Date	Revised	Date	Reference:	FIG.
T.Schrauf	1/29/04			793100	3e

Project: Page-Trowbridge Ranch Landfill | Boring: **SGD-2** | Pg. 6 of 6

Drilling Co: Water Development Corp. | Drilling Method: Air Rotary | Date Started: 12/12/03

Location: 10' West of SGD (Deep) | Sampler: | Date Completed: 12/13/03

Desc. of Meas Pt: | Logged by: W.Thompson

Land Surf. Elev: | Meas. Pt. Elev: | Reviewed by: B. Anderson

Depth - FT.	WELL COMPLETION	Blow Count	% Recovery	PID (ppm)	Samples	Depth - FT.	Graphic Log	DESCRIPTION	USCS Symbol	ESTIMATED % OF GR	SA	FI	Moisture
355					G	355		SANDY SILT; as describe above except that clay fraction is absent and silt fraction has increased.	ML	0	30	70	M
								TD @ 355' bls	ML	0	30	70	M

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HYDRO GEO CHEM, INC.

Lithologic Log and Well Construction Details of SGD-2

Approved	Date	Revised	Date	Reference	FIG.
T.Schrauf	1/29/04			793100	3f

ATTACHMENT C

PROCESS EQUIPMENT SPECIFICATIONS AND MANUFACTURERS' USER MANUALS

(on CD)

Roots Universal RAI Rotary Positive Blowers Brochure
Leeson DC Motors, Low Voltage, NEMA Frame, Spec Sheet
Dayton 2-hp 120vac Motor

ATTACHMENT D

SOLAR POWER PRODUCTION AND CONTROL EQUIPMENT SPECIFICATIONS AND MANUFACTURERS' USER MANUALS

(on CD)

Sharp 185 Watt (NT-185U1) Spec Sheet
Sharp 170 Watt (NT-170U1) Spec Sheet
Bp Solar 175 Watt (SX 3175) Spec Sheet, Warranty, and Installation Instructions
Outback FLEXmax 80 User's Manual
Technical Manual for Sun Xtender Batteries (Concorde Battery Corporation)
TriStar Solar System Controller Installation and Operation Manual
Minarik Automation & Control User's Manual, DC Series (DC60-12/24)
Magnum ME-RC Owners Manual
Magnum RD Series Inverter Manual

ATTACHMENT E

(on CD)

EXCEL SPREADSHEETS

ATTACHMENT F

(on CD)

FIELD DATA SHEETS