Sandia National Laboratories, New Mexico
Environmental Restoration Operations

Aboveground Injection System
Mechanical Integrity Test Results Report

December 2017

United States Department of Energy
Sandia Field Office

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SANDIA NATIONAL LABORATORIES, NEW MEXICO

ABOVEGROUND INJECTION SYSTEM MECHANICAL INTEGRITY

TEST RESULTS REPORT

Contract No.: 1806318

Site Location: Sandia National Laboratories, New Mexico (SNL/NM), Albuquerque, New Mexico

The Aboveground Injection System Mechanical Integrity Test Results Report presented in this document has been developed specifically for SNL/NM activities in Albuquerque, New Mexico. For this contract, Banda Group International, LLC (Banda) is the prime subcontractor providing consulting services and Amec Foster Wheeler Environment & Infrastructure Inc. (Amec Foster Wheeler) is the secondary subcontractor providing consulting services. Project personnel referenced below have reviewed and approved this report for implementation during the duration of this contract. Procedures to be followed for document submission, approval, integration and implementation of changes to this report are discussed within the body of the report.

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LIST OF ACRONYMS

®	Registered Trademark
ABC	Air-Bleed Cap
AIS	Aboveground Injection System
Amec Foster Wheeler	Amec Foster Wheeler Environment and Infrastructure, Inc.
Banda	Banda Group International, LLC
BGI Team	Banda Group International and Amec Foster Wheeler
COCs	Constituents of Concern
DOE	Department of Energy
e.g.	exempli gratia
GPM	Gallons per Minute
ISB	In-situ Bioremediation
KAFB	Kirtland Air Force Base
MIT	Mechanical Integrity Test
NM	New Mexico
NPT	National Pipe Thread
ORP	Oxidation/Reduction Potential
PCO	Pest Control Operator
PSID	Pounds per Square Inch Differential Pressure
SNL/NM	Sandia National Laboratories, New Mexico
TA-V	Technical Area-V
TCE	Trichloroethene

1.0 Introduction

An In-Situ Bioremediation (ISB) Pilot Test Treatability Study is planned at Sandia National Laboratories, New Mexico (SNL/NM) Technical Area-V (TA-V) Groundwater Area of Concern. The Treatability Study is designed to gravity inject an electron-donor substrate and bioaugmentation bacteria into groundwater using an injection well. The constituents of concern (COCs) are nitrate and trichloroethene (TCE). The Pilot Test Treatability Study will evaluate the effectiveness of bioremediation and COC treatment over a prescribed period of time. Results of the pilot test will provide data that will be used to evaluate the cost and effectiveness of a full-scale system.

2.0 Purpose

This Aboveground Injection System (AIS) Mechanical Integrity Test (MIT) Results Report describes the activities, procedures, and results of the mechanical integrity tests. This Report with the As-built AIS Engineered Drawings (submitted together) provides the results of the AIS construction and testing. The MIT was conducted on the AIS components to insure they do not leak when operated as designed; and, to ensure that the mechanical components of the AIS function as designed.

3.0 Gravity Feed Piping/Metering/Regulating Components

A series of gravity feed piping assemblies and manifolds were constructed and installed to meter and regulate the injection of bioamendment into the test wells. During operation, the assemblies and manifolds will be positioned below the level of the deoxygenation tanks, and above the injection casing wellhead. The chief material used in the fabrication of the assemblies and manifolds was stainless steel piping and fittings. The components were assembled and tested at the Amec Foster Wheeler shop prior to installation at the site.

3.1 General Construction Description

The gravity feed piping manifold consists of valves, pressure gauges, and a totalizing flow meter. It connects the various injection sources to the injection wellhead. The main manifold will be used to control and monitor the injection stream before it reaches the injection wellhead.

3.2 Sampling Ports

Stainless steel lab cock sampling ports will be mounted in a tee fitting with reducer as shown in the Engineered Drawings. Each sample port reduces the 2-inch diameter main line piping to ¼-inch diameter tubing connector. The sample ports facilitate a point of connection for clean, new sample tubing to a barbed connection at select point along the AIS. The AIS contains five sample ports; one on each of the four deoxygenation tank connection assemblies and one on the main manifold.

3.3 Support and Racking

Weldless metal framing with integral channels (e.g., Unistrut®) to attach pipe clamps was used to fabricate the supports and racking of the AIS components. The metal framing for the deoxygenation tank connection and filling-manifold assemblies were integrated into the deck of the steel platforms so that the associated valves and sample ports will be supported, relieving stress on the deoxygenation tank bulkhead fittings. The main manifold and injection wellhead connection assembly were racked on free-standing metal frames with legs and stabilizers so that they can be positioned as desired in the field. The main manifold racking frame was field fitted so that the manifold sits level and as close to the ground surface as practical so that the gravity feed from the deoxygenation tanks is maximized. The injection wellhead connection assembly was fitted with a steel frame that is adjustable so that assembly can be supported and sturdy while connecting to the injection well casing.

3.4 Deoxygenation Tank Connection Assemblies

Four deoxygenation tank connection assemblies, one for each of the tanks were constructed as designed and shown in the Engineered Drawings. These assemblies connect the 2-inch tank bulkhead fitting and the aboveground injection line that leads to the main manifold.

Two deoxygenation tank assemblies were constructed prior to the pilot test. Four deoxygenation tank assemblies (two additional) will be built for the full-scale implementation of the project.

3.5 Main Manifold

The main manifold is the principal plumbing section that connects injection streams from the deoxygenation tanks and the bioaugmentation assembly, into one central line leading to the injection wellhead. The main manifold includes means of controlling and measuring total flow and flow rates, sampling the combined injection flow stream, and monitoring injection line pressures.

The main manifold was built as detailed in the AIS Engineered Drawings. The main manifold consists of couplings, check valves, tees, nipples, barbs, meters and gauges to control and monitor the AIS.

3.6 Injection Wellhead Assembly

The injection wellhead assembly is comprised of the aboveground injection line, which conveys injectate from the main manifold to the injection wellhead via connection to the injection casing wellhead. At the top of the injection well casing, a compression fitting collar with Camlok® connector is used to connect the aboveground injection line to the wellhead. It forms a seal at the top-of-casing.

The compression fitting allows for the fitting to be removed to allow the well vault lid to close properly when the injection line is not connected to the injection casing.

A one-hole well seal will facility a data logging field cable and the wire rope safety cable connected to the downhole multi-parameter sonde. An 18-inch x 18-inch traffic-rate steel manhole will house the well and allow access to the wellhead assembly. The wellhead assembly was constructed as shown in the Engineered Drawings.

An air-bleed assembly was installed on the top of the Injection Wellhead Assembly. The air-bleed assembly will be used to collect and release air displaced by injection and flowing upwards from the injection casing. Without this assembly air displaced during the initialization of injection could flow through the main manifold, disrupting the totalizer, and end up in the deoxygenation tanks.

4.0 Premix/Chase-water Tank and Sump Pump

A premix/chase-water tank and sump pump was incorporated as part of the AIS. The premix/ chase-water tank and sump pump will be used for mixing injectate solution with potable water prior to transferring the solution into the deoxygenation tanks via use of a sump pump; and, to flush the injection line and injection well following amendment addition. The design drawings show detail of the premix/chase-water tank and sump pump configuration. Brief descriptions of the system components are provided below.

4.1 Premix/Chase-water Tank Description

The premix/chase-water tank is a Norwesco® 150 gallon White Ribbed Pest Control Operator (PCO) Tank. The tank is translucent white, 48-inches in length, 37-inches wide, and 29-inches high. It is fabricated from rugged, impact-resistant, one-piece, seamless, UV-resistant polyethylene, which are compatible with the chemicals that will be used during the ISB treatability study.

The manway centered at the top of the tank is 16-inches in diameter which will facilitate placing and removing the sump pump. The premix/chase-water tank will have a low enough profile to allow easy access to top opening while standing on the ground.

4.2 Sump Pump

A Little Giant® ½ horsepower sump pump is used to transfer injectate solution between the premix/chase-water tank and deoxygenation tanks or main manifold. The sump pump will also be used to consolidate and empty residual water from tanks.

4.2.1 Pump Description

The Little Giant® ½-horsepower stainless steel sump pump operates using a 115 electric voltage connection and has a 20-foot long tree-pronged power cord. The pump is rated for a discharge capacity greater than 20 gallons per minute through a 2-inch NPT fitting.

The sump pump will be powered via a connection to a portable gasoline powered generator.

4.2.2 Pump Discharge Setup

The sump pump discharge setup consist of a 2-inch female to male Camlok® fitting attached to a 2-inch diameter Camlok® connector and PVC hose. The PVC hose will be custom manufactured to the required length between the premix/chase-water tank and deoxygenation tanks.

4.2.3 Adapter/Connectors

2-inch female/male Camlok® fittings will be used to attach the sump pump the transfer hose and deoxygenation tank or main manifold.

4.2.4 Hose

2-inch diameter aluminum cam and 1.5-inch diameter PVC hose will be used to transfer injectate solution between tanks. The hose will be custom manufactured to the required length.

4.2.5 Electrical

The sump pump will be hardwired with a 120 volt electrical power cord and plug by the manufacturer. Electrical power will be supplied using a gasoline-powered generator.

5.0 Mechanical Integrity Tests

Upon completion of the AIS piping construction, including the deoxygenation tank connection assemblies, the tank emptying and filling manifolds, the main manifold, and the wellhead connection assembly, the mechanical integrity tests were conducted at the offsite construction/fabrication shop.

During the MIT, a test-run to simulate the gravity-injection through the main manifold and the "side-stream" of another liquid flow until the system is stabilized was performed. The MIT demonstrated the following:

- Each piping manifold and assembly of the AIS pass a hydrostatic leak detection.

- The side-stream process from the KB-1 ® dispenser to the main manifold. The volume of the side-stream for the test-run period shall be such that it can be extrapolated to complete the planned daily injection volume of the dechlorinator.
- The side-stream process from the chase water tank to the main manifold.

The hydrostatic pressure and side-stream tests and results are described in detail in the subsections below.

5.1 Procedures of Hydrostatic Pressure Tests on AIS Components

Hydrostatic pressure tests on each AIS component were completed on November 1, 2017. Hydrostatic pressure tests on each AIS component were accomplished using test adapters that facilitated the following:

- Filling of the AIS component with water;
- Removing air from the AIS component as it is filled with water;
- Pressurizing and shutting in the pressured water within the AIS component; and
- Monitoring the shut-in pressure.

Two test adapters were fabricated to accomplish the hydrostatic pressure tests: a filling and air-bleed cap (ABC) adapter. The filling test adapter was fabricated to connect to the upstream end (per check valve orientation) Camlock® connection of the AIS component being tested; and, it included a check-valve, pressure gauge, isolation valve, and tap-water connection (e.g., ¾-inch diameter threaded, swivel water hose connector). The air-bleed cap adapter was fabricated to connect to the downstream end Camlock® connection of the AIS component being tested; and, it included an isolation valve and an air-bleed valve assembly. The ABC adapter was fitted with tubing above the air-bleed valve so that the relative elevation of the air-bleed line was positioned at least 4 feet above the highest pipe or valve on the AIS component being tested. Prior to hydrostatic pressure testing the filling and ABC assemblies were joined and tested to assure that they are functioning properly and do not leak.

Hydrostatic pressure tests were accomplished by first fully opening any valves on the AIS component being tested and connecting the filling- and ABC-test adapters. Some of the AIS components include additional open ports (e.g., chase-water connection on the Main Manifold), which were capped/plugged prior to hydrostatic testing. Camlock® caps/plugs were used to seal off these open ports that are not fitted with a test adapter. The valves on sample port stopcocks and the KB-1 connection point on the main manifold were left open prior to hydrostatic testing. The valves at these ports/connection points were closed during filling of the AIS component once air was displaced and water flowed from them.

Prior to filling the AIS component with water, the air-bleed valve on the ABC test adapter was fully opened. Initially, water was introduced by slowly filling the assembly through the filling test adapter to displace air through the air-bleed cap test adapter. The valves on sample port stopcocks and the KB-1 connection point on the main manifold were left open prior to hydrostatic testing. The valves at these ports/connection points were closed during filling of the AIS component once air was displaced and water began flowing from them. Once air stopped and water started flowing from the air-bleed valve on the ABC test adapter the flow of water into the filling test adapter was stopped. The AIS component being tested was moved/agitated and the water flow was turned back on and off quickly to liberate trapped air. Once satisfied that the AIS component being tested was filled with water and air was removed to extent practical, the air-bleed valve was closed and the flow of water slowly turned on to increase hydrostatic pressure in the AIS component being tested.

During the pressurization phase of the hydrostatic pressure test, the pressure in the AIS component being tested was raised to 9.0 pounds per square inch differential (PSID) pressure plus. The pressure was monitored on the filling test adapter pressure gauge and the gauges on the main manifold. Once raised to the desired pressure the isolation valve on the filling test adapter was closed and the hydrostatic pressure monitoring began.

During the hydrostatic pressure monitoring phase, the pressure on the filling test adapter pressure gauge was recorded from the beginning of the test at 5-minute intervals for 20 minutes.

5.2 Results of Hydrostatic Pressure Tests on AIS Components

A successful test was recorded on all AIS components. The two conditions met for successful test results were as follows:

1. the pressure during testing is maintained within 10% of the starting pressure; and,
2. no visible leaks are observed.

During testing no pressure reading was observed to vary more than 10% from the start of the 20-minute test. Also, no leaks were observed from the fittings or piping that comprise the AIS components. Appendix A provides the field forms used to record the hydrostatic pressure tests conducted on October 31 and November 1, 2017.

Once all AIS components pass the hydrostatic pressure testing, a simulation of field operations was conducted. Field conditions were simulated using the sump pump and premix/chase-water tank to reproduce gravity flow from the deoxygenation tanks through the deoxygenation tank connection assemblies, emptying manifold, main manifold, and injection wellhead connection assembly. The set up was a closed circuit with water pumped from the premix/chase-water tank, through the AIS components, and back into the premix/chase-water tank at the discharge from the injection wellhead connection assembly.

5.3 Procedures for Field Condition Simulation and Side-stream Tests

Prior to the start of the field-condition simulation test, the premix/chase-water tank was filled approximately half full of tap water, and the sump pump with discharge line attached was lowered into the tank. The water flow from the sump pump was throttled down to achieve a flow rate of 5 gallons per minute (GPM). This was done so that the simulated flow rates are within the specified flow rates desired in the field from the gravity draining of the deoxygenation tanks.

The field-condition simulation test setup consisted of attaching the sump pump discharge line to the main manifold, connecting the main manifold to the injection wellhead connection assembly and routing the discharge back to the premix/chase-water tank. The set up was laid out on the ground surface with all AIS components on the ground and in the approximate pattern anticipated during field conditions. The reading on the totalizer on the main manifold was recorded at the completion of the field-condition simulation test setup.

Once the setup was completed, the sump pump was turned on to start the recirculation of water from the premix/chase-water tank through the AIS components and back to the tank. Air trapped in sample ports and the air-bleed valve was flushed, and a stopwatch was used with the totalizer to measure the recirculated flow rate for the first 15 minutes of recirculation.

Once the recirculation through the field-condition simulation test setup was established at 5.1 GPM, the side-stream tests were conducted. Table 1 summarizes the data collected and results of the flow tests conducted during the field condition simulation setup phase.

TABLE 1. FLOW TEST RESULTS SUMMARY

FLOW TEST	TOTALIZER READING START (GAL)	TOTALIZER READING STOP (GAL)	TOTAL FLOW (GAL)	TIME (MIN:SEC)	FLOW RATE (GPM)
1	2246	2346	100	2:45	36.4
2	2405	2455	50	2:16	22.1
3	2677	2727	50	4:54	10.2
4	2780	2810	30	3:48	7.9
5	2850	2870	20	3:55	5.1
6	2910	2960	50	9:46	5.1

NOTES:

1. GAL – gallons
2. MIN:SEC – Minutes and Seconds recorded using stopwatch over total flow observed on the flow totalizer
3. GPM – gallons per minute

During the flow tests it was determined that bucket tests, as described in the AIS Construction and MIT Plan, were not feasible at the higher flow rates; and, was not required considering the accuracy of the totalizer at the prescribed flow rates. The totalizer being used, Neptune® T-10 Meter with 2-inch orifice, has an accuracy of between 100% and 101% at the flow range tested (5 to 40 GPM). The field team discussed that the operation of the bucket tests, which would involve temporarily shutting down the flow to move the discharge from the premix tank to the bucket, would be less accurate than the totalizer with uninterrupted flow.

The side-stream tests were used to simulate the KB-1 dispenser and chase-water injections into the main manifold during gravity drainage of the deoxygenation tank contents into the injection well.

The KB-1dispenser side-stream test consisted of injecting tap water dyed with food coloring (yellow Wilton® gel food coloring) into the 3/8-inch diameter KB-1 injection port on the main manifold during recirculation through the field-condition simulation test setup. The dyed tap-water side-stream injection was accomplished using a proportioning injector (Add-It® Proportioning Fertilizer Injector) filled with stock solution consisting of water and food coloring connected to 3/4-inch hose.

The discharge side of the proportioning injector used to simulate the KB-1 Dechlorinator was fitted with a totalizing flow meter (Assured Automation MW-PC-075 Series Water Meter) and 3/4-inch x 3/8-inch reducer and 3/8-inch tubing with male quick connect. The 3/8-inch male quick connect on the proportioning injector discharge was fastened to the female quick connect on the KB-1 side-stream on the main manifold, and flow from the tap was turned on slowly to inject the dyed tap water into the recirculation flow. The flow meter totalizer and stopwatch was used to increase the flow rate up to approximately 2 GPM. Thirty (30) gallons of dyed water was injected during this KB-1 side-stream test.

The chase-water side-stream test was run similarly to the KB-1 dispenser side-stream test. The 3/4-inch x 3/8-inch reducer and hose was removed from the discharge side of the proportioning injector and replaced with 3/4-inch hose. This hose was connected to the filling test adapter (see hydrostatic test description above). The filling test adapter was then connected to the chase-water injection port on the main manifold. The proportioning injector was filled with stock solution containing water and a blue dye. The flow meter totalizer and stopwatch was used to increase the flow rate up to approximately 5 GPM. Approximately 30 gallons of dyed water was injected during this chase-water side-stream test.

5.4 Results for Field Condition Simulation and Side-stream Tests

Both side-stream tests were successful. The yellow tracer dye used for the KB-1 dispenser side-stream test flowed into the main flow and the test water was dyed yellow. Similarly, the blue dye used in the chase water side-stream test mixed with the yellow dye resulting in green test water. Pictures of the side-stream test setup and results are provided below.

PHOTO	DESCRIPTION
	**Field Condition Setup** Premix tank with Sump Pump is shown in background. Main manifold is shown in foreground. Water is recirculated through the main manifold from and back to the premix tank.
	**Main Manifold with KB-1 Dispenser Simulation Setup** The KB-1 Dispenser Simulation Setup is shown connected to the KB-1 Sidesteam connection on the Main Manifold.

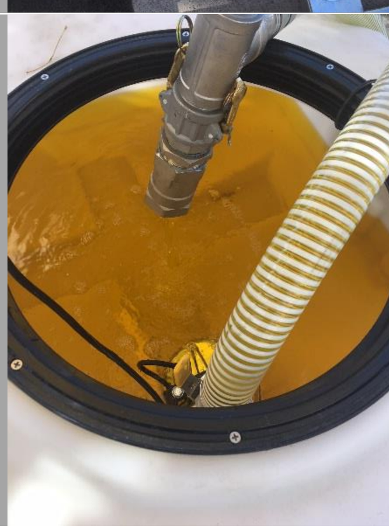
PHOTO	DESCRIPTION
	**KB-1 Dispenser Simulation Setup** The KB-1 Dispenser Simulation Setup including the proportioning injector, yellow dye, and flow totalizer are shown.
	**KB-1 Dispenser Simulation Sample** During the KB-1 Dispenser Simulation a sample was collected at the Main Manifold sample port SPT. The yellow color in the sample confirms that the KB-1 sidestream is functioning as designed.
	**KB-1 Dispenser Simulation Recirculation of Dye at Premix Tank** During the KB-1 Dispenser Simulation the test water was dyed yellow confirming that the KB-1 sidestream is functioning as designed.

PHOTO	DESCRIPTION
	**Chase Water Sidestream Simulation Setup** The Chase Water Simulation Setup including the proportioning injector and flow totalizer are shown. Blue dye was used during the chase water sidestream simulation.
	**Chase Water Sidestream Simulation Sample** During the Chase Water Sidestream Simulation a sample was collected at the Main Manifold sample port SPT. The green color (yellow and blue mixed) in the sample confirms that the sidestream was functioning as designed.
	**Chase Water Sidestream Recirculation of Dye at Premix Tank** During the Chase Water Sidestream Simulation the test water was dyed green (yellow mixed with blue) confirming that the sidestream is functioning as designed.

APPENDIX A
HYDROSTATIC PRESSURE TEST
FIELD FORMS

Record of Pressure Test

SANDIA NATIONAL LABORATORIES - TECHNICAL AREA V - IN-SITU BIOREMEDIATION TREATABILITY STUDY

Date: October 31, 2017
Location: Amec Foster Wheeler, 8519 Jefferson NE, Albuquerque, NM
Tested By: Kenneth Hale
Inspected By: Peter Guerra

Temperature: 62°
Weather: Partly Cloudy

Time	Description of Activity	Pressure (PSI)			Comments
		Gauge 1	Gauge 2	Gauge 3	
15:50	Test Setup	8.55	8.50	8.00	flush w/ H_2O remove air
15:55	Reading No. 1	8.57	8.50	8.00	
16:00	Reading No. 2	8.55	8.48	7.95	
16:05	Reading No. 3	8.55	8.46	7.92	
16:10	Reading No. 4	8.56	8.20	7.55	Cloudy/shaded
16:15	Reading No. 5	8.48	8.17	7.48	Cloudy/shaded

Conclusion: No change in pressure greater than 10%. Test is success with no observable leaks.

Record of Pressure Test

SANDIA NATIONAL LABORATORIES - TECHNICAL AREA V - IN-SITU BIOREMEDIATION TREATABILITY STUDY

Date: 11/01/2017
Temperature: 72°F
Location: Amec Foster Wheeler, 8519 Jefferson NE, Albuquerque, NM
Weather: SUNNY/CLEAR
Tested By: Kenneth Hale
Inspected By: Peter Guerra

Time	Description of Activity	Pressure (PSI)			Comments
		Gauge 1	Gauge 2	Gauge 3	
14:50	TEST SET-UP	10.2	10.4	9.0	Flush + Fill Remove air
14:55	Reading No. 1	10.2	10.5	9.0	
15:00	Reading No. 2	10.2	10.5	8.8	gauges in sun
15:05	Reading No. 3	10.2	10.5	8.6	" " "
15:10	Reading No. 4	10.2	10.5	8.2	" " "

Peter A Guerra

Conclusion:
- All pressures within 10% of start pressure
- No observable leaks
- TEST is successful