Exemption Request Documentation for Well Injection Depth Extraction (WIDE) for Deployment at the Battelle Columbus Laboratory Decommissioning Project West Jefferson, OH.

1.0 Introduction

The purpose of this document is to describe the field deployment of the Well Injection Depth Extraction (WIDE) soil flushing technology for remediation support at the Battelle Columbus Laboratories Decommissioning Project (BCDLP) West Jefferson North (WJN) facitlity (JN-1 Abandoned Filter Bed). The information provided herein is intended to support the proposed work plan submitted by BCLDP and the Informatics Corporation with funding provided by the U.S. Department of Energy through the Columbus Environmental Management Program, the Ohio Field Office, and the National Energy Technology Laboratory (NETL), Morgantown, WV. The WIDE technology was developed and field demonstrated through engineering and research funding from NETL. The Informatics Corporation is commercializing the technology.

This project is a single deployment for the *in situ* removal of radioactive Cesium-137 from the site soil. The project goal is to assist Battelle to radiologically release the site for unrestricted use. This document is intended to provide environmental permitting personnel with the following: hydrogeologic site description, description of the nature of the release, proposed remediation action, analysis of fluid to be injected, and ground water monitoring results.

2.0 Description of Site

Battelle's West Jefferson facility is located about 17 miles west of Columbus and 3 miles north-northeast of the town of West Jefferson in a rural agricultural area. It is at Madison County's eastern border along Big Darby Creek. The land surface is gently sloping except for the steep V-shaped valley of Silver Creek (now dammed and occupied by the lake) and the wide flat bottomed valley of Big Darby Creek.

[INSERT AERIAL MAP HERE]

2.1 Climate

The climate of the south-central Ohio region may be described as continental-temperate. Therefore, the region is subject to a wide seasonal range in temperature. Summers are warm with the mean temperature for the months of June, July, and August being 73.3 F. Temperatures of 90 F or above are expected for about 15 days during these months. For the months of December, January, and February, the mean temperature is 31.2 F, although the typical number of days per year which have temperatures below 32 F and below 0 F is 122 and 4, respectively. Precipitation is distributed fairly uniformly during the year, although 60 percent falls during the spring and summer seasons. The annual monthly average rainfall is about 3.2 inches with the greatest recorded rainfall for any 24-hour period being 3.87 inches, in July of 1947 (Beard and Gupta, 1990).

2.2 Geologic/Hydrogeologic Description

As part of the Battelle Columbus Laboratory Decommissioning Project, a site characterization was prepared. Characterization of the retired filter beds was initiated in 1988, prior to Stage 1 main site characterization. Thirty-four holes numbered 101-134 were drilled to a depth of 10 feet each. In July 1990, 10 additional boreholes were sampled as part of the Stage 2 site characterization. These boreholes were sampled to include all of the filter bed materials and permeable sand and gravel layers. The total depth of the boreholes ranged between 10 and 14.5 feet.

2.2.1 Geologic Characteristics

Geologically, this Area is made up of a variety of deposits including alluvial sands, sand and gravel artificial fills, and filter bed pebbles. In holes that penetrate the retired filter bed an unconsolidated layer of brown and black pebbles with white coatings can be seen. This varies in thickness from 0 to 2.5 feet and is most likely the old filter bed material. Coarse sand and gravel are widespread between 5 and 10 feet deep. These are underlain by brown and red colored till layers. The varied nature of sediments makes it difficult to correlate different layers, especially in the retired filter bed area.

2.2.2 Hydrogeologic Characteristics

The hydrogeologic units at the site correspond to the geologic units consisting of soil, alluvium, fill, till, and bedrock. The dominant flow of water is from NW to SE. The soil characteristics do not constitute a permeability interface that would affect the flow of groundwater. The alluvium is characterized as relatively impermeable by the Ohio Department of Natural Resources, mostly composed of fine to very fine- grained material derived from soil and glacial till. The hydrologic characteristics of fill are difficult to generalize; however, it is likely that the general fill is more conductive than native materials. This means it could provide the most reasonable path for water to travel. The till is densely compacted, unsorted glacial deposits consisting of silt, clay, sand, and gravel, with low to very low hydraulic conductivity.

In conclusion, a geologic and hydrogeologic characterization of the retired filter beds was performed. A review of the geologic information obtained through drilling indicates that the shallow geology at the site is the same as the general geology in central Ohio. The shallow geology is dominated by brown and gray colored till. Sand/gravel lenses of limited extent are present within the till. Hydrologically, the lake and the Big Darby Creek are the dominant surface features, and also serve as the discharge locations for shallow groundwater flow. Slug tests for permeability determination show that the till deposits have very low hydraulic conductivity, and the silty, sandy lenses within the till have moderate hydraulic conductivity.

3.0 Nature of the Cs 137 Contaminant Release

Approximately fifty years ago low levels of spent fuel were transferred into the filter beds of the West Jefferson site. When the filter beds were replaced in the early 1960s, the water tiles and much of the contaminated sand were removed, leaving only soluble isotopes. The major contaminant in question was Cesium. Site personnel essentially tried to blend the contaminant into a solution and flush it out. This did not completely remediate the beds, and the contaminant presently remains in low-level concentrations. The natural clay area was then graded and capped with a one-foot clay layer to prevent storm water from entering through the suspect area.

3.1 WIDE Description

The WIDE system is proposed for deployment at the BCDLP West Jefferson site. The WIDE system is a hybrid subsurface flushing/vapor-gas extraction system that uses Prefabricated Vertical Wells (PVWs) for the *in situ* remediation of contaminated groundwater and fine-grained soils with hydraulic conductivities ranging from 10^{-3} to 10^{-8} cm/s. The primary components of this system are a vacuum extraction system and a cyclone air/water separator. The vacuum extraction system simultaneously removes groundwater and soil gas, promoting volatilization of contaminants. The PVWs are the WIDE's subsurface elements that are going to be used as the avenue for the pressurized injection of potable water and a lixciviant into soil concurrent with the vacuum extraction for removal of the cesium. The PVWs are designed for depth-specific extraction of contaminated plumes with or without concurrent liquid injection. The WIDE technology has been designed to target the aerial and depth source points of a plume, thereby controlling and minimizing the volumes of liquids being extracted.

3.1.1 Liquids and Vapor Extraction using WIDE Technology

WIDE was developed for the *in situ* remediation of low-permeability soils and high clay-fraction subsurface soils. The WIDE system has been field demonstrated for removal of groundwater having soluble contaminant waste streams, dense non-aqueous phase liquids (DNAPLs), and light non-aqueous phase liquids (LNAPLs), and heavy metals. The liquid and vapor extraction process is based on a compressed air motive powering an eductor to develop the liquid suction lift. The air vacuum is transmitted to the PVWs through surface piping networks in which the extracted waste streams (groundwater, and liquid and air phase contaminants) are collected. The system will be configured using surface piping used for distributing the air vacuum, receiving the extracted groundwater, and introducing the injection liquids. The system will be set up to enable operation in modes of either: a) extraction only, b) injection only, or c) concurrent extraction/injection.

3.1.2 Site Preparation

The WIDE deployment will encompass a 60'x 120'area near the Big Darby Creek; however, the runout area will extend the site measurements to 70' x 130'. The site surface area will be covered with a composite geotextile system consisting of 3" of pea gravel, over a 6oz. non-woven geotextile, above a 20 mil. flexible membrane liner. This will limit contamination of the equipment. Other installation areas and the access road will be refurbished for stability. This process will consist of laying out the geotextile material, and bringing in truckloads of pea gravel. Battelle will stabilize the road and access areas, gravel the pads where equipment is being installed, and provide three inches of gravel surface over the textile on the remediation bed. Following installation, the Nilex penetrations will be sealed to minimize vacuum during liquid extraction.

4.0 WIDE Installation and Operational Information

Volume of Water to Saturate	9,629 gal. per 30'x 30' grid
Volume to Flush @ 100% Saturation	18,570 gal. per 30'x 30' grid
# PVWs per 30'x 30' grid	281
Total # PVWs	1861
PVW Installation	Depth Below Grade = 10'0" Length Above Grade = 1'0" Screened Interval = 0' to 3'0" (bgl)
PVW Spacing	2' on center, in off-set rows

5.0 WIDE Commissioning

Description of Equipment: The liquid and gas extraction process is based on a compressed air motive powering an eductor to develop the liquid suction lift. The air vacuum is transmitted to the PVWs through surface piping networks in which the extracted waste stream (groundwater, and liquid and air phase contaminants) is collected. The waste stream is routed in the piping to a blow-down and containment tank.

The WIDE system will be designed to function under the following operational sequences:

Sequence #1 Extraction Only: All of the PVWs operate under air vacuum specifically to lower the groundwater table and calibrate the extraction operation.

Sequence #2 Injection Only: This technique addresses aquifer recharge and saturation of the vadose zone promoting contaminant diffusion/desorption. Only potable water and a lixciviant will be injected into the subsurface. This established soil capillary injection pressures.

Sequence #3 Concurrent Injection/Extraction: This mode is for an aggressive soil-flushing scheme. Injection of liquids to the subsurface through the PVWs maintains saturated conditions and develops pressure gradients in the aquifer, promoting advective and diffusion transport of contaminants to the extraction PVWs. Only potable water and a lixciviant will be injected into the subsurface.

6.0 WIDE Operational Goals at Battelle

The operational goal will focus on flushing the cesium from the soil while maintaining the integrity of the subsurface environment. To accomplish this goal, the Operating staff will implement a multiphase strategy that include the following:

1. Operate the system within the confines of the site geological and hydrological conditions.
2. Design the system to function similarly to a closed-loop liquid/fluid circulation type process.
3. Operate the injection system to maintain pH and associated geochemical properties.
4. Utilize the system to function with a vacuum boundary at its perimeter to contain circulated liquids.
5. Concentrate on discrete grids (30'x30) for precise remediation control.

A Process Flow Diagram (PFD) is included, and a discussion of the operational strategy follows below.

1. Site Geological and Hydrological Conditions

The design of the WIDE system at Battelle will incorporate the PVWs as the mechanism for the pressurized injection of a flushing solution into the *in situ* soil concurrent with vacuum extraction of liquids from adjoining PVWs. The Cesium is largely immobile within the designated remediation area. This is due to the density of the natural clay soil present at the bottom and all four sides, creating a containment perimeter which functions as a natural, low permeability barrier. A clay cap was installed that further limits any pathways for water infiltration and seepage outside the filter bed boundary. Any groundwater within this area is thus confined and appears isolated from the regional groundwater system.

2. Closed-Loop Operation

The WIDE system at Battelle will deploy the following major elements in a manner similar to a closed loop system:

1) Prefabricated Vertical Wells (PVWs),
2) Groundwater and soil gas vacuum extraction system,
3) Liquid injection system, and
4) Aboveground treatment and liquid storage system.

The WIDE system will function under concurrent injection/extraction, extraction only, or injection only models. All extracted liquids will initially be pumped from the extraction header into holding tanks. The extractant will then flow through a pre-filter train (a 2-micron roughing filter in front of a 0.2 micron filter) to remove suspended solids before flowing through the filter treatment train (at a flow rate of less than 50 gallon per minute). The soluble Cesium will be sorbed to the filter media (provided by 3M Corporation) and the effluent will be pumped into effluent holding tanks. The effluent holding tank will be piped to the Lixciviant mixing tank for subsequent re-injection. The lixciviant mixed water will be held in a tank for re-injection as the flushing agent. Influent and effluent water will be monitored for cesium concentration and lixciviant pH throughout the project. Flow rates and volumes processed will be monitored. Both the system treatment train and the lixciviant mixing will operate in batch mode. Secondary containment for all tanks will conform to Battelle site requirements.

3. WIDE System Boundary Functions

The field installation will consist of a grid of PVWs in offset rows of injection/extraction lines at relatively close spacing, two foot on center. The PVWs will be connected to a surface network of piping that will be used for distributing the air vacuum and receiving the extracted fluids, and also introducing the injection liquids. A row of extraction PVWs will encompass the perimeter of the WIDE field. Thus, a vacuum boundary will be established that assures the further confinement of contaminants within the remediation area.

This closed-loop type system with boundary PVWs will assure the confinement of the work area. Groundwater monitoring wells will be installed internal to the grid as well as at the periphery to assist the Operations staff in their scrutiny of this containment. The wells will be monitored to identify groundwater elevation responses to mounding or depression.

4. Injection Phase

System operation will commence by flushing an individual grid (approximately 30'x30') with potable water. Depending upon the results of the potable water flush, the injection fluid may be charged with a co-solvent. The co-solvent (the lixciviant) is an acid based solution that will require system monitoring for pH, alkalinity, and hardness. The proposed lixciviant addition will be controlled in relation to the buffering capacity of the water. A laboratory study was performed by Battelle Northwest National Laboratory (BNNL) to optimize this lixciviant addition. The lixciviant strength has been optimized to utilize the lowest determined concentration to realize the required results.

Throughout the operation, the pH will be monitored to minimize impact on the soil. At project completion, any decrease in pH will be evaluated and addressed through the addition of Calcium Carbonate ($CaCO_3$).

5. Discrete Grid Operation

The field will be subdivided into grids encompassing approximately 30 square feet. Like the overall WIDE field, the individual grids will be operated with extraction PVWs at the grid perimeter to assure perimeter groundwater recovery. The WIDE field will be operated on an individual grid basis, not more than one to two grids at a time. This focused operation will contribute to the precise control of system parameters.

7.0 Field Sampling and Lab Analysis

8.1 The Battelle program manager shall provide oversight of sampling, review analytical data, and evaluate sample results. The site task leader will assure that all personnel assigned to participate have been trained, and that all appropriate procedures have been documented. A complete overview of Battelle's surface and subsurface sampling procedures is available on site.

8.2 Liquid grab samples of extracted groundwater from the WIDE system's extraction piping will be taken on at pre-determined intervals to monitor for contaminant concentration changes with system operation time.

8.3 In conjunction with the subsurface removal of Cs-137 accomplished by the WIDE technology, a surface separation technology for treatment of the contaminant will be accomplished using 3M filter disks. Battelle personnel will take groundwater that has been pumped into holding tanks and process it through a set of prefilters and cesium-removal cartridges before returning it to holding tanks for reinjection into the ground. 3M, with support from The United States Department of Energy National Energy Technology Laboratory (NETL), has developed this technology to remove dissolved contaminant materials from liquids using systems operating at flow rates up to 50 gallons per minute. This technology has previously demonstrated the capability to capture radionuclides, including cesium, at flow rates up to 20 GPM. Influent and effluent water will be monitored for cesium concentration throughout the site remediation process. [INSERT SAMPLING SCHEDULE] Sample analysis may be performed on site (Battelle), at 3M, or both. The system components and all filters and cartridges are the property of the United States government.

8.0 Waste Management

Battelle will be responsible for handling radioactively contaminated materials such as gloves, clothing 3M filter disks, soil cuttings, and sampling materials. Any other controlled waste will also be managed under Battelle's existing site procedures. Used supplies consisting of PVC piping, hoses, PVC cover sheeting, and water storage containers will be removed from the work site and either reused by the Federal Program manager or will be discarded. Informatics will incorporate Battelle's waste minimization procedures into its daily operations.

9.0 Description of Fluids to be Injected

1. Description of Injection Fluids
    a. Potable water: water will be obtained on-site at the BCLDP.
    b. A concentrated phosphate hydroxide lixciviant with a ph of 2.

10. Project Data Reduction and Review

All field and laboratory data collected during this project will be summarized, reduced, analyzed, reviewed, and reported in order to assess the success of the WIDE remediation strategy at the BCLDP West Jefferson site.

11. Project Report

This activity consists of a final technical and management report inclusive of all activities taking place, results of technical data interpretations, and recommendations for further advancement of WIDE at the site.

12. Ohio Environmental Protection Agency Oversight

OEPA oversight for related activities on this project at the Battelle Columbus Laboratories Decommissioning Project-West Jefferson site is the responsibility of:

[NEED TO FIND OUT WHO THE CONTACT PERSON FOR THIS SITE IS]

Work Cited

Beard, Thomas J., and Gupta, Neeraj, Draft Report on Geology and Hydrogeology of West Jefferson North Site. September 14, 1990.