APPROVAL PAGE

TREATMENT PLAN FOR TREATMENT OF 100-C-7 REMAINING PIPELINES AND SEWERS CHROMIUM-CONTAMINATED SOILS

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DFS-ERDF-029

Environmental Restoration Disposal Facility

Waste Disposal Operations

TREATMENT PLAN FOR TREATMENT OF 100-C-7 REMAINING PIPELINES AND SEWERS CHROMIUM-CONTAMINATED SOILS

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TERMS

ERDF	Environmental Restoration Disposal Facility
LDR	land disposal restriction
PFT	paint filter test
RPAS	Remaining Pipelines and Sewers
TCLP	toxicity characteristic leaching procedure
UTS	Universal Treatment Standards
WSCF	Waste Sampling and Characterization Facility

TABLE OF CONTENTS

1.0 Introduction

Bechtel Hanford, Inc., is the Environmental Restoration Contractor for the U.S. Department of Energy, Richland Operations at the Hanford Site. As the Environmental Restoration Contractor, Bechtel Hanford, Inc., is responsible for performing site investigations, characterization, remediation, and restoration of all locations identified as Remedial Action Sites at Hanford. As a result of remedial activities performed at various burial grounds, several small waste streams will require stabilization treatment of *Resource Conservation and Recovery Act of 1976* metals with concentrations above land disposal restriction (LDR) limits found in 40 *Code of Federal Regulations* (CFR) 268.48[1] Universal Treatment Standards (UTS).

One such waste stream is the 100-C-7 Remaining Pipelines and Sewers (RPAS) site. The waste stream requires stabilization treatment of chromium prior to disposal in the Environmental Restoration Disposal Facility (ERDF) at the Hanford Site. The contribution from chromium in the waste exceeds the LDR limit in 40 CFR 268.48.

2.0 Background

Stabilization treatment has been completed at the ERDF on the basis of treatability experiments that demonstrate reduction in leachability of the *Resource Conservation and Recovery Act of 1976* metals present in the waste to levels below the UTS. The treatability experiments have been documented in U.S. Environmental Protection Agency (EPA)-approved treatment plans that described the treatability experiments to be done and the full-scale treatment process. Comparison of the treatability experiment results to base-line analysis of the untreated waste via toxicity characteristic leaching procedure (TCLP) in Method 1311[2] yields a reduction ratio in leachability (expressed in mg/L) between the treated and untreated waste matrices. This comparison is an indication of successful treatment capacity inherent in the mixture of reagents and waste. The higher the reduction ratio, the more successful the mix will be in the full-scale treatment process for rendering the waste below UTS.

This stabilization treatment process has been completed at the ERDF on a case-by-case basis, one waste stream at a time. Each individual treatment plan, documenting treatability experiment mix ratio(s) and full-scale treatment processes, has been pre-approved by the EPA with careful consideration being given to the calculated reduction ratio.

3.0 Purpose

The purpose of this treatment plan is to obtain approval by EPA for stabilization of 100-C-7 RPAS waste. This treatment plan establishes a stabilization mixture for chromium and describes the actual process to stabilize the waste.

4.0 Scope

The scope of this treatment plan involves the treatment of chromium-contaminated waste from the 100-C-7 RPAS site. The plan covers analysis of the treatment method, the treatability experiments, and the full-scale treatment process.

5.0 Methodology

The treatability experiments analyzed determine a reduction ratio between the baseline (untreated sample) waste and a treatability experiment (waste + stabilization reagent). The reduction ratio yielded in the analysis of the mixture of 100-C-7 RPAS waste and the selected reagent will be applied in full-scale treatment. For purposes of this discussion, the reduction ratio is the ratio between the analyzed baseline sample (TCLP) described above and the results of the treatability experiment (TCLP). The reduction ratio demonstrates the ultimate treatment capability of a given mixture.

As a part of this process, a baseline sample (untreated waste) was analyzed along with a minimum of two treatability experiments (waste + weighted ratio of reagent). More than one mix can be selected for comparison purposes to determine the least amount of reagent that can be successfully used in treatment to reduce cost. Two experiments with different mixtures of reagents and waste were placed in the extraction vessel (see Table 2, SW-846, Method 1311) immediately after passing the paint filter test (PFT) (a complete mix) identified in Table 2 (SW-846, Method 9095) of this treatment plan. When treatment of any constituent (in this case chromium) achieves a 90% reduction in concentration as measured by TCLP, that treated waste may be land disposed. The basis of this decision is found in 40 CFR 268.49 (c) (1) (B), "Alternative LDR treatment standards for contaminated soil"[3] where metals in soil must be treated to 90% reduction of leachability. Any treatability experiment that does not achieve a 90% reduction in comparison to the baseline sample will not be considered for stabilization of the waste.

6.0 Treatment Plan for Chromium-Contaminated Waste

6.1 Waste Description

The wastes covered by this treatment plan are from the 100-C-7 waste stream. The waste is primarily made up of soil. The pile contains chromium in concentrations up to 137.0 mg/L (TCLP). No Underlying Hazardous Constituents are present above UTS.

6.2 Hazardous Characteristics

The 100-C-7 waste is designated as mixed waste. The waste is in a solid form, primarily soil and is considered inert material. With the exception of chromium, all other hazardous constituents are identified in quantities less than the maximum treatment standards for these contaminants in the UTS. Due to the concentrations of chromium in the soil, this waste must be treated to meet the standards in 40 CFR 268.48, or meet the conditions identified in 40 CFR 268.49 (c) (1) (B) prior to land disposal. The highest detected levels of hazardous constituents in the waste and treatment standards are shown in Table 1.

Table 1. Hazardous Constituents.

Constituent	Analysis	Heavy Metals (Highest value detected)	Treatment Standard (TCLP) (mg/L) 40CFR 268.48
Chromium	TCLP (mg/L)	137.0	0.6 mg/L TCLP

6.3 Treatment Standards

The treatment standard for this waste is a stabilization process for the heavy metals present utilizing a technology identified in 40 CFR 268.42[4]. Stabilization is a treatment technology that reduces the hazard potential of the waste by converting the contaminants into a less soluble mobile or toxic form.

6.4 Treatment Method

Ferrous sulfate heptahydrate was used as the primary reducing reagent. Portland cement was also used to produce a pH in the range of 9 to 11 in the TCLP leachate and to solidify the waste for disposal into the ERDF cell. The portland cement used conforms to ASTM C150. Type I or Type II cement as defined in ASTM C150.

Water is controlled to achieve the desired consistency. Water is added to the waste matrix using a fire hose. Testing and suitability of the treatment technology is discussed in Section 7.0 of this treatment plan.

Several mixtures of reagents and waste were tested. The mixtures in Table 2 of this treatment plan were successful in reducing the concentration of leachable chromium as prescribed in 40 CFR 268.49 (c) (1) (B). The lowest-cost mixture that passes the acceptance test process is typically used to treat that waste stream. Once a mixture is selected, the mixture ratios will be controlled in the field to ensure the characteristics of the production material matches the characteristics of the successful treatability experiment. Therefore, no subsequent testing of the production material is required. All sample mixtures produced during mixture development will be subjected to the acceptance tests shown in Table 2.

Table 2. Acceptance Test Program.

Test	Procedure	Reference	Acceptance Limit
Free Liquid	Method 9095[5]	SW-846[6]	No free liquids
TCLP	Method 1311	SW-846	Metal concentrations less than UTS limits in 40 CFR 268.48 or 40 CFR 268.49 (c) (1)(B)

7.0 Treatability Experiments

The purpose of the treatability experiment is to establish baseline treatment parameters for stabilizing the waste. The TCLP levels for chromium present in the untreated samples represent the baseline for determining if additional treatability experiments are needed, and to validate the mixture options prescribed in Table 3, Section 7.2 of this treatment plan.

7.1 Representative Samples

The full-scale treatment may consist of mixing one roll-off container of waste; one drum or box of waste; or several drums or boxes of waste in a single stabilization run. Samples (in containers approximately 5 gallons in size) were taken from the 100-C-7 RPAS site with the highest detected concentration of chromium present as indicated in Table 1. Portions of these samples were used as representative samples for baseline analysis and treatability experiments. Samples were retrieved using appropriate sampling equipment and transported to the Waste Sampling and Characterization Facility (WSCF). Samples were managed in accordance with approved Duratek Federal Services, Inc., procedures and WSCF procedures.

7.2 Treatability Experiment Test Plan

Weighted samples were taken from the generator-supplied container with the highest detected concentration of chromium present as indicated in Table 1. This operation was performed under a WSCF Test Plan.

Table 3 shows the successful ratios for each sample in weight percent. There are three constituents: waste, portland cement, and ferrous sulfate heptahydrate.

Table 3. 100-C-7 RPAS Treatability Experiments.

Mixture	Ferrous Sulfate Heptahydrate (Wt %)	Waste (Wt %)	Portland cement (Wt %)	Water (Wt %)
1	10	70	10	Note
2	10	60	20	Note

NOTE: Weigh out water (Wt%=10) by waste weight, but only add enough water to achieve a desired consistency in the mixture, and enough water for dissolving ferrous sulfate heptahydrate.

Stoichiometric calculations (Conner[7]) were initially performed to determine the ratios in Table 3. It was determined that the chromium level in the 100-C-7 RPAS TCLP leachate was fairly high, 137 mg/L, and was likely to be primarily in the Cr^{+6} valence state. Due to the 20:1 dilution in the test, the actual dissolved chromium would be approximately 2,740 mg/L, or 93% of the total chromium available. Nearly all of the chromium would be leachable. In this situation, stabilization of the chromium cannot be achieved without reduction of Cr^{+6} to Cr^{+3}, followed by addition of sufficient alkali in the form of cement to produce a pH in the preferred range of 9 to 11 in the TCLP leachate. The cement addition is determined experimentally, based on previous experience.

The preferred reducing agent was determined to be ferrous sulfate heptahydrate ($FeSO_4 \cdot 7H_2O$), because of its low cost, ease of use and safety in use. Thus, reduction of all of the Cr^{+6} to Cr^{+3} would require about 47 grams of ferrous sulfate heptahydrate per kilogram of soil or 4.7% by weight on a stoichiometric basis. Since the presence of other reducible species in the soil is unknown, an excess of reductant should be used; generally, a 10% excess is sufficient if no other reducible species is present. Since some of the chromium is likely in the Cr^{+6} valence state already, the addition of 5% reductant was assumed to be sufficient if all assumptions were correct.

After an unsuccessful attempt to achieve the proper reduction of leachable chromium in the first two treatability experiment mixtures, the laboratory test plan was modified to increase the reduction of Cr^{+6} to Cr^{+3}. Two changes were made in the test plan: 1) Increasing the set time after mixing the ferrous sulfate heptahydrate and waste and prior to adding portland cement from 10 minutes to one hour. 2) The weight percent of ferrous sulfate heptahydrate was increased from 5% to 10% and the waste weight was reduced in both mixtures by 5%. The changes in set time, increase in ferrous sulfate heptahydrate loading, and reduction in waste loading achieved a sufficient reductant capability in both Mix 1 and 2 to reduce TCLP levels sufficiently to meet the requirements of 40 CFR 268.49 (c) (1) (B).

Water was added as required to dissolve the ferrous sulfate heptahydrate, and for hydration of the portland cement. The amount added depended on the water content of the soil, the requirement for proper mixing, and the amount of portland cement used.

The WSCF laboratory test plan utilized to prepare and analyze the two successful mixtures is summarized as follows:

7.2.1 Weigh out the ratioed amounts for each sample in accordance with Table 3 to give a final weight of 120 grams.

7.2.2 Dissolve the ferrous sulfate heptahydrate in water (add water slowly) then add the solution to the soil and mix. Allow the mixture to set for one hour before adding the portland cement. Obtain a pH of the mixture after the ferrous sulfate heptahydrate is added, but before adding portland cement. This standing time is necessary to allow the reduction reaction to approach completion before adding cement, which raises the pH and slows or stops reduction.

7.2.4 After one hour, add the required amount of portland cement and mix the materials. Then remove five grams of the mixture and follow Method 1311 for determination of pH.

7.2.5 Perform a paint filter test on the mixture of waste, ferrous sulfate heptahydrate, and portland cement immediately after finishing the mixing process and every five minutes thereafter, if needed to determine when the mixture contains no free liquids.

7.2.6 As soon as the materials pass the PFT, place them in the TCLP extraction vessel, sizing as necessary to meet the requirements of Method 1311.

7.2.7 Add the proper extraction fluid (fluid 1 or 2) as determined from step 7.2.4, determination of pH.

7.2.8 Place the extraction vessels in the TCLP rotator for the time required by Method 1311, note the time, temperature and rotation speed and record in the TCLP logbook as required by Method 1311.

7.2.8 When the extraction period has finished, remove the vessels from the rotator, note the time and temperature and record in the TCLP logbook. Filter approximately 250 mL of the fluid into a properly labeled poly bottle; measure and record the pH, then acidify to <2 pH and store in the appropriate refrigerator.

7.2.9 Analyze the filtered TCLP extract.

NOTE: The material will be mixed by hand with a spoon. Any unused sample material will be bagged and placed back into an appropriate waste container. A PFT (Method 9095 of SW 846) will be conducted in five-minute intervals and will be performed on each mixture. The PFT will establish the time at which the mixture has no free liquids. This will establish the disposal time of the mixture in the full-scale process.

7.3 Evaluation of Test Results

The treatability experiment results were analyzed against the baseline untreated TCLP results from a large waste sample contained in the 5-gallon container from the 100-C-7 RPAS site. Any mixture that produced an analytical result below regulatory limits and that demonstrated that substantial treatment has been accomplished by comparing treatability experiment test results with regulatory limits is provided below for regulatory agencies concurrence that the mixture provides successful treatment. Any mixture that is determined to not be successful cannot be used for the treatment of the waste. Verification sampling will not be required for successful treatment mixes that regulatory agencies have concurred with.

The successful mixtures (from Table 3) are identified in Table 4 along with the baseline, untreated TCLP results from the soil sample, and the resulting reduction ratio.

Table 4. 100-C-7 RPAS Treatability Experiments (Including Results and Reduction Ratios).

Mixture	Ferrous Sulfate Heptahydrate (Wt %)	Waste (Wt %)	Portland cement (Wt %)	Water (Wt %)	Result (TCLP—mg/L)	Reduction Ratio
Baseline	-	-	-	-	94.8	-
1	10	70	10	10% or to desired consistency	5.51	17:1
2	10	60	20	10% or to desired consistency	2.82	34:1

The UTS for chromium is 0.6 mg/L TCLP. Based on the TCLP results identified in Table 4, treatment of chromium using either Mix 1 or Mix 2 would result in a concentration that achieves 90% reduction required by 40 CFR 268.49 (c) (1) (B) where metals in soil must be treated to 90% reduction of leachability. In addition, 90% reduction of leachable chromium is achieved in both Mix 1 and Mix 2 when their respective reduction ratios are applied to the highest detected concentration (Table 1).

8.0 Stabilization of 128B2 Chromium Waste

The stabilization of the 100-C-7 RPAS chromium-contaminated waste will be completed using a mixing box at the ERDF site (Section 8.4).

8.1 Determine Mixture Volumes and Weights

The bounding net waste weight of a container will be established for the 100-C-7 RPAS waste and will be used to establish the proper mix ratio. Water will be added to a desired consistency. Ferrous sulfate heptahydrate and portland cement will be added according to the successful treatability experiment test(s) (see Section 7.2 of this treatment plan).

8.2 Equipment and Supplies for Stabilization in the Mix Box

- Mix box
- Portland cement mix (1 or 2 ton Ag bags)
- Ferrous sulfate heptahydrate
- Water supply
- Track hoe
- Dozer
- Fork lift and drum attachments
- Hand tools, rope, and appropriate signage

8.3 Mobilization for Stabilization in the Mix Box

- Develop and maintain current procedures, including work plans, Radiation Work Permits, and job-specific Activity Hazards Analyses for mixing operations.
- Train personnel to procedures/equipment and to complete dry-run(s) with inert material as needed.

8.4 Stabilization Process using the Mix Box

- Prepare the mix box area with access and egress points for haul trucks transporting roll-off cans or fork lift with drum attachments.
- Ensure that personnel have inspected the area for soil fissures and run off.
- Inspect the mix box for cracks and other damage.

  NOTE: If damage is observed, do not start treatment operations.
- Dump waste into the mix box. Ensure that water is available as dust suppressant.
- Verify that the waste container is visibly clean.
- Mix waste mix according to Section 8.5 of this treatment plan.
- After mixing, clean the mix box using Daily Operations Cover.
- If waste is in the mix box and cannot be mixed until the next day, cover with fixative prior to stopping mix box operations.

8.5 Mixing the Waste

The calculated volume of water may be added to the waste using a totalizer to ensure the correct addition of water. The actual amount of water may vary depending on the moisture content of the waste. Water will be added at pressures that do not allow spread of material outside of the mix box. The calculated amount of ferrous sulfate heptahydrate will be dissolved in water and added to the soil as determined by the successful treatability experiment. After the one-hour wait time, portland cement will be added to the mix. The mixing process will be monitored by operations supervision to ensure proper mixing and to ensure that incomplete or improper mixing such as dry spots and/or excessive wet mixtures do not occur. Dry spots require further mixing and/or additional water. Excessively wet mixtures will be allowed additional time to cure inside the mix box prior to disposal, or may require additional portland cement.

8.6 Disposal of Stabilized Waste

After the waste can be handled without dripping from excessively wet mixtures, or particulate resulting from excessive dry mixtures, the mixture will be removed from the mix box and placed into the ERDF landfill. The minimum set-up time within the mix box is based on the time established in the treatability experiment when the mixture passed the PFT. The minimum set-up time is 10 minutes.

8.7 Sampling

The stabilization reagents, waste, and process used in the treatability experiments are meant to represent the process for full-scale treatment. The results of the successful treatability experiments will constitute the LDR compliance for disposal per 40 CFR 268.7 (c) (2)[8].

8.8 Spill Response

In the event of a spill outside the mix box, follow the ERDF Health and Safety Plan (DFS-ERDF-002.1, current revision[9]) to implement initial spill control. The cleanup will be accomplished by using available ERDF equipment (i.e., shovels, drums, etc.). Radiological controls will be used to protect personnel from any radiological hazards associated with the spill cleanup.

Loss of waste (a spill) within the ERDF cell is not considered a spill to the environment, but will be cleaned up in the same manner. In both cases, the waste will be placed into containers, the weight of the containers will be re-verified on the ERDF truck scale, and transported back to the Contamination Area set up for treatment operations to resume treatment operations for proper disposal.

9.0 References

The following references were used in the preparation of this treatment plan.

1. 40 CFR 268.48, "Universal Treatment Standards."
2. SW-846, 1998, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Rev. 5., U.S. Environmental Protection Agency, Method 1311.
3. 40 CFR 268.49 (c) (1) (B), "Alternative LDR treatment standards for contaminated soil."
4. 40 CFR 268.42, "Treatment Standards Expressed as Specified Technologies."
5. SW-846, 1998, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Rev. 5, U.S. Environmental Protection Agency, Method 9095.
6. SW-846, 1998, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Rev. 5, U.S. Environmental Protection Agency, Method 9095.
7. Jess R. Conner E-mail, 2005, *Stoichiometirc Calculation and Determination of Recipes to Immobilize Chromium in a Contaminated Soil*, February 26.
8. 40 CFR 268.7 (c) (2), "Testing, Tracking, and Recordkeeping Requirements for Generators, Treaters, and Disposal Facilities."
9. DFS-ERDF-002.1, *ERDF Health and Safety Plan*, Section 14.0, "Spill Response Plan."

Isom, Debra A (Debbi)

From: Smith, Douglas C (Chris)
Sent: Monday, September 26, 2005 8:49 AM
To: Isom, Debra A (Debbi)
Subject: FW: 100-B/C lead and chromium treatment plans

Debbi:

Please allow placement of the two items described below.

Thanks

Chris

From: Donnelly, Jack W
Sent: Monday, September 26, 2005 8:46 AM
To: Smith, Douglas C (Chris)
Subject: 100-B/C lead and chromium treatment plans

Good morning Chris:

I have the two treatment plans in our document control system for the lead and chromium contaminated soils. Now, I need to get copies to Dennis Faulk, John Price, and the adminstrative record; and will take the action to get them copies. However, I need your help in sending an email to Debbi Isom to grant permission to allow these two 100-B/C treatment plans be entered into the 100-BC-1 and 100-BC-2 adminstrative record. Can you send her an email please. Thanks.