TREATMENT GOALS
FOR SOIL INTERIM MEASURES
FORWARD RISK ASSESSMENT RESULTS

THE ENSIGN-BICKFORD COMPANY
Spanish Fork, Utah

Prepared For:

The Spanish Fork Technical Committee

and

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LIST OF ACRONYMS AND ABBREVIATIONS

Charter Oak	Charter Oak Environmental Services, Inc.
COPCs	Constituents of Potential Concern
DSHW	Utah Department of Environmental Quality, Division of Solid and Hazardous Waste
EBCo	The Ensign-Bickford Company
HHRA	Human Health Risk Assessment
IMWP	Interim Measures Work Plan
MTRA	Migration to Regional Aquifer
RFI	RCRA Facility Investigation
SWMU	Solid Waste Management Unit
the facility	The Ensign-Bickford Company, Spanish Fork, Utah Facility

1.0 PURPOSE AND SCOPE

This document presents forward human health risk assessment results for the interim measures soil treatment goals presented in Table 6-1 of the Interim Measures Work Plan (IMWP) (Charter Oak, 2005). The forward risk assessment results were calculated using the conservative exposure and health effect assumptions in the human health risk assessment. These results demonstrate that the treatment goals are protective of human health based on conservative assumptions regarding the placement of these treated soils as described in Section 2.0. These soil treatment goals will be applied during the implementation of soil remediation activities at The Ensign-Bickford Company (EBCo), Spanish Fork, Utah facility (the facility) to accept treated soils for consolidation and stockpiling on-site until such time that the final RFI risk assessment is completed. In the context of the RFI risk assessment, it will be determined where the treated soils will be placed on-site. These remediation activities are described in the IMWP.

The chemical fate/transport and human-health risk assessment methods and factors used to perform the forward risk assessment calculations on the treatment goals were largely described in the following documents:

- Proposed Human Health Risk Assessment Methods – RCRA Closure of Open Burning/Open Detonation Units, The Ensign-Bickford Company, Spanish Fork, Utah ("HHRA Methods") (Charter Oak, 2004) and subsequent modifications to the HHRA Methods based on further discussions with Division of Solid and Hazardous Waste (DSHW) staff and various comment letters and responses thereto.
- Migration to Regional Aquifer Assessment Work Plan, The Ensign-Bickford Company, Spanish Fork, Utah (MTRA Work Plan) (Charter Oak, 2004) and subsequent modifications to the MTRA methods and factors based on further discussions with DSHW staff and various comment letters and responses thereto.
- Treatment Goal Calculations – Supporting Information Binder (Revised July 2005), The Ensign-Bickford Company, Spanish Fork, Utah (Binder) (Charter Oak, 2005)

These documents and formal responses to DSHW comments provide detailed information supporting the methods applied herein and are available for review at DSHW.

2.0 KEY ASSUMPTIONS

The key assumptions that pertain to the treatment goal calculations include:

1. The thermal treatment process will greatly reduce the total mass of constituents and their concentrations in soil. As described in the IMWP, a removal efficiency of at least 99% will be demonstrated for RDX, HMX and TNT during the thermal treatment unit start-up period. However, it is possible that laboratory analytical results may indicate low-level, residual concentrations in treated soils. Hence, these potential low concentration residuals should be accounted for in the total risk represented by the soils remaining on site following Interim Measures.
2. The treatment goals will be applied to discrete volumes of soil (a "batch"). A batch will typically represent approximately 140 to 350 tons of treated soil, and possibly as much as one days worth of treated soils (approximately 720 tons). If concentrations in a given batch exceed the treatment goals, that batch will be re-treated or managed separately from soils that meet the treatment goals.
3. To ensure a conservative calculation it is assumed that the entire volume of treated soil contains constituents at the treatment goal concentrations, when in reality it is expected that the actual treated soil concentrations will be much lower than the treatment goals.
4. Following thermal treatment, treated soils will be replaced to the land surface in a single contiguous area (SWMU 27). The decision to evaluate a single area was made in order to simplify the treatment goal calculations and reduce the number of factors involved. This assumption may be revisited following the interim measure if the post-treatment soil concentration data indicate that it may be acceptable replace soils in other areas.
5. For purposes of calculating the forward risk assessment on the treatment goals, a total of 100,000 tons of soil will be treated and placed in SWMU 27. It is necessary to assume a specific amount of soil being treated in order to perform the calculations associated with the potential migration of constituents from the soil to the regional aquifer.
6. Within a reasonable timeframe following interim measures, the replaced soil will be re-vegetated to an extent that the wind-erosion and evapotranspiration properties of the upper soil horizon will be restored to ambient levels.
7. The target risk levels for the purpose of evaluating treatment goals for the applicable exposure scenarios (off-site resident, on-site industrial worker, on-site construction worker and visitor/trespasser) are $1x10^{-6}$ for carcinogens and a hazard index of ≤ 1 for noncarcinogens.

As discussed in the Interim Measures Work Plan, actual data for the treated soils and completed excavations will be used to assess risk as part of the final RFI human health risk assessment. Where appropriate, summary statistics may also be used. Therefore, additional flexibility in the placement of soils on the site may be supported. The permanent placement of soils in SWMU 27 or at other areas of the facility will be supported in the context of the RFI risk assessment.

3.0 RISK ASSESSMENT CALCULATIONS

The risk assessment calculations on the interim measures treatment goals were performed following the methodologies presented in the HHRA Methods (Charter Oak, 2004). Changes to some of the calculations, exposure variables, toxicity values and other factors have been made in response to comments from DSHW. These modifications are described fully in documents and electronic files submitted to DSHW and are not reproduced herein. The risk assessment results presented herein use the most updated assumptions, factors, values and calculations based on DSHW comments. The document entitled *Treatment Goal Calculations – Supporting Information Binder (Revised July 2005)* provides information supporting the calculation of a dilution attenuation factor (DAF) which is part of the calculation of hypothetical risk to off-site receptors via the soil leachate to ground water pathway. This document was originally submitted to DSHW in May 2005. A revised version, dated July 2005, replaces the original.

3.1 Forward Risk Assessment

The treatment goals (soil concentrations) presented in the IMWP serve as inputs to the risk assessment equations and the final output is a risk value. This is typically termed "forward" risk assessment. The forward risk assessment results for the applicable receptors are presented in Table 3-1. Cancer and noncancer risk estimates are presented for individual compounds. For potential carcinogenic compounds, treatment goals for individual constituents having a target cancer risk value of less than $1x10^{-6}$ are considered acceptable. For noncarcinogenic compounds, treatment goals having a target risk value (Hazard Quotient) of less than or equal to 1 are considered acceptable. As shown in Table 3-1, the treatment goals for the individual compounds are below the target cancer and noncancer risk values for each exposure scenario.

The potential cumulative effects of multiple constituents are also considered. Constituents of energetic materials (CEMs) are the primary constituents being addressed through the interim measure. Therefore, for the purposes of evaluating treatment goals, the cumulative risk for the CEM compounds are calculated for potential carcinogenic compounds (RDX, TNT, 2,4-DNT, 2,6-DNT and nitroglycerin) by summing the individual cancer risks. The summing of cancer risks for potential carcinogenic CEMs introduces an additional level of conservatism to the forward risk assessment results. As shown in Table 3-1, the cumulative cancer risk for the suspected carcinogenic CEMs is less than $1x10^{-6}$. The CEM compounds are also evaluated cumulatively for noncancer effects by summing the Hazard Quotients for each CEM compound. The resulting value is called a Hazard Index. As shown in Table 3-1, the Hazard Index for the CEMs is less than 1. This is a conservative method because it may not be toxicologically appropriate to sum the hazard quotients for each CEM.

Two of the CEM compounds (2,4-DNT and 2,6-DNT) are found in only a limited number of soil samples (approximately 5% of 1251 samples for 2,4-DNT and approximately 2% of 1251 samples for 2,6-DNT) and at concentrations much lower (maximum concentration of 11 mg/kg for 2,4-DNT and 1 mg/kg for 2,6-DNT) than other CEMs, such as PETN and RDX. The assumption that the DNT compounds will be present at the treatment goal concentrations in the full 100,000 tons of soil, greatly overestimates the mass of DNTs that will be present in the treated soils. This highly

conservative assumption was maintained to simplify the forward risk assessment calculations on the treatment goals.

While CEMs are present in nearly all the soils that will be subject to interim measures, other constituents (e.g. volatile organic compounds) are only present at concentrations exceeding risk-based concentrations in a small fraction of soils at the facility. Given the limited volume of soils containing these other constituents, cumulative risks associated with the treatment goals for these constituents are not evaluated. Demonstration that the treatment goals for these individual, non-CEM constituents meet target risk levels is sufficient for the interim measure. DSHW concurs with this approach for the evaluation of treatment goals for non-CEM constituents.

Table 3-1: Interim Measures Treatment Goals - Forward Risk Assessment Results

		Adult Off-Site Resident		Child Off-Site Resident	On-Site Construction Worker		On-Site Industrial Worker		Visitor-Trespasser	
COPCs (CEMs)	Treatment Goal (mg/kg)	Cancer	Non Cancer	Non Cancer	Cancer	Non Cancer	Cancer	Non Cancer	Cancer	Non Cancer
Cyclotrimethylenetrinitramine (RDX)	1	1.5E-07	8.0E-04	1.9E-03	2.7E-09	5.6E-04	3.8E-08	3.2E-04	9.8E-10	6.9E-06
Cyclotetramethylenetetranitramine (HMX)	429		5.3E-03	1.2E-02		1.6E-03		9.6E-03		1.9E-04
Pentaerythritol tetranitrate (PETN)	250		7.7E-03	1.6E-02		1.0E-02		7.3E-03		1.4E-04
2,4,6-Trinitrotoluene (TNT)	1	2.5E-08	3.1E-03	7.2E-03	7.6E-10	1.1E-03	1.1E-08	2.1E-03	2.8E-10	4.4E-05
Ethylene glycol dinitrate (EGDN)	10		1.5E-02	3.5E-02		4.2E-03		2.9E-03		5.5E-05
Diethylene glycol dinitrate (DEGDN)	10		8.1E-03	1.9E-02		4.2E-03		2.9E-03		5.5E-05
Triethylene glycol dinitrate (TEGDN)	10		1.5E-02	3.5E-02		4.2E-03		2.9E-03		5.5E-05
1,2,4-Butanetrioltrinitrate (BTTN)	10		1.1E-02	2.5E-02		4.2E-03		2.9E-03		5.5E-05
Metriol trinitrate (TMETN)	10		1.0E-02	2.4E-02		4.2E-03		2.9E-03		5.5E-05
Nitroglycerine (NG)	1	9.9E-09	2.6E-04	6.1E-04	4.2E-10	4.2E-04	7.3E-09	2.9E-04	1.6E-10	5.5E-06
2,4-Dinitrotoluene	0.08	8.3E-08	1.1E-04	2.6E-04	1.6E-09	8.4E-05	2.9E-08	5.9E-05	6.4E-10	1.1E-06
2,6-Dinitrotoluene	0.03	7.9E-08	2.1E-04	5.0E-04	6.1E-10	6.3E-06	1.1E-08	4.4E-05	2.4E-10	8.2E-07
	Sum:	3.4E-07	7.6E-02	1.8E-01	6.1E-09	3.5E-02	9.6E-08	3.4E-02	2.3E-09	6.6E-04

		Adult Off-Site Resident		Child Off-Site Resident	On-Site Construction Worker		On-Site Industrial Worker		Visitor-Trespasser	
COPCs (Non-CEMs)	Treatment Goal (mg/kg)	Cancer	Non Cancer	Non Cancer	Cancer	Non Cancer	Cancer	Non Cancer	Cancer	Non Cancer
1,2,4-Trimethylbenzene	19		1.6E-02	4.0E-02		9.9E-02		6.2E-02		4.2E-04
1,3,5-Trimethylbenzene	8		2.2E-02	6.0E-02		9.9E-02		6.2E-02		4.2E-04
Acetone	148		1.4E-03	3.2E-03		9.0E-05		1.5E-04		3.3E-06
Bromochloromethane	1.5		1.1E-03	2.5E-03		2.5E-04		1.4E-04		3.0E-06
Isopropylbenzene (Cumene)	24		6.4E-03	1.4E-02		3.9E-01		6.0E-03		4.4E-05
m,p-Xylene	3		9.9E-04	2.7E-03		9.3E-02		1.7E-03		1.2E-05
Methylene chloride	1.9	1.5E-07	3.4E-04	8.5E-04	1.7E-08	8.9E-04	3.0E-08	8.1E-05	3.3E-10	9.8E-07
Naphthalene	1		1.3E-02	3.8E-02		1.0E-01		6.4E-03		4.4E-05
n-Propylbenzene	459		1.2E-02	2.4E-02		2.0E-02		1.2E-02		2.5E-04
p-Cymene (P-Isopropyltoluene)	24		6.0E-04	1.3E-03		9.8E-02		1.7E-03		1.5E-05
sec-Butylbenzene	46		4.8E-03	7.5E-03		2.0E-03		1.2E-03		2.5E-05
Trichloroethene (TCE)	0.002	1.2E-08	6.1E-06	1.5E-05	5.2E-09	8.8E-06	8.7E-09	6.3E-06	7.7E-11	5.0E-08