

**ADDENDUM 01 TO THE
REVISED FORMER TANK FARM AREA IN SITU CHEMICAL OXIDATION WORK PLAN
OPERABLE UNIT 2
LOCKWOOD SOLVENT GROUNDWATER PLUME SITE
BILLINGS, MONTANA**

Prepared for:

**United States Environmental Protection Agency
Region 8 Montana Office
10 W. 15th Street, Suite 3200
Helena, Montana 59626**

Prepared by:

Tasman Geosciences, Inc.
917 1st Avenue N., Suite 3
Billings, Montana 59101
(406) 259-1033

March 20, 2017

Tasman Project No. Z05100003



TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
TABLE OF CONTENTS	i
ACRONYMS AND ABBREVIATIONS	iii
DISTRIBUTION LIST	iv
1.0 INTRODUCTION.....	1
2.0 BIOPOLYMER TRENCHING BACKGROUND	1
3.0 BIOPOLYMER TRENCH IMPLEMENTATION OVERVIEW.....	2
4.0 SITE-SPECIFIC BIOPOLYMER TRENCH IMPLEMENTATION	2
5.0 FURTHER DISCUSSION	3

FIGURES

- Figure 1 Proposed OS/VR Infrastructure Layout - BP Addendum
Figure 2 Previously Proposed OS/VR Infrastructure Layout

ACRONYMS AND ABBREVIATIONS

bgs	Below ground surface
BP	Biopolymer
Busan	Busan 1059 WS
HCL	Hydrochloric acid
ISCO	In situ chemical oxidation
LEB-H	Rantec LEB-H liquid enzyme breaker
LSGPS	Lockwood Solvent Groundwater Plume Site
OU2	Operable Unit 2
ppm	Parts per million
Soco	Soco West, Inc.
Tasman	Tasman Geosciences
VR	Vapor recovery
Work Plan	November 1, 2016 Revised Former Tank Farm Area In Situ Chemical Oxidation Work Plan

DISTRIBUTION LIST

The following individuals will receive a copy of this Biopolymer Slurry Vapor Recovery Trench Construction Addendum to the Revised Former Tank Farm Area In Situ Chemical Oxidation Work Plan upon approval, and will receive copies of any subsequent revisions:

Roger Hoogerheide
Remedial Project Manager
U.S. Environmental Protection Agency,
Region 8 Montana Office
10 W. 15th Street, Suite 3200
Helena, MT 59626
(406) 457-5031

Catherine LeCours
Project Manager
Pacific Western Technologies, Ltd.
54 North Last Chance Gulch, Suite 213
Helena, MT 59601
(406) 422-5495

Ian Bowen
US EPA Region 8
1595 Wynkoop Street
Mail Code: 8EPR-S
Denver, CO 80202-1129
(303) 312-7029

Richard Sloan
Remedial Project Officer
Remediation Division
Montana Department of Environmental
Quality
P.O. Box 200901
Helena, MT 59620
(406) 444-6454

Raj Mehta
President
Soco West, Inc.
100 First Stamford Place
Mail Box #14
Stamford, CT 06902
(203) 363-5218

Jim Sullivan
Project Manager
Tasman Geosciences, Inc.
917 First Avenue North, Suite 3
Billings, MT 59101
(406) 259-1033

1.0 INTRODUCTION

Tasman Geosciences (Tasman) has prepared this Addendum 01 to the approved Revised Former Tank Farm Area In Situ Chemical Oxidation (ISCO) Work Plan (Work Plan), dated November 1, 2016, on behalf of Soco West, Inc. (Soco) for Operable Unit 2 (OU2) of the Lockwood Solvent Groundwater Plume Site (LSGPS) located near Billings, Montana. This addendum addresses the proposed use of liquid-shored trenching with biopolymers (BP) during the excavation of vapor recovery (VR) trenches near the former tank farm area (Figure 1).

In December 2016 and January 2017 two separate attempts were made to excavate the previously proposed VR trenches (Figure 2). Excavations with a backhoe and later with an excavator were unsuccessful as trench wall failure occurred prior to reaching the fine-grained/sandy gravel interface. Based on the subsurface conditions encountered Tasman proposes the use of a BP slurry trenching technique to stabilize the trench during excavation and backfilling with gravel.

2.0 BIOPOLYMER TRENCHING BACKGROUND

Liquid-shored trenching using BPs has been utilized in the United States for almost two decades. The popularity of liquid shoring arises from its ability to stabilize trench sidewalls while excavating through the most challenging geologic conditions. The principal form of biopolymer used for trenching is based on a bio-gum produced from guar gum, an organic food-grade product used in many commercial food and candy manufacturing operations.

The ability to provide open trench stability is based on the ability of the BP slurry to form a film along the surface of the sidewalls in a trench that prevents penetration of the fluid and imparts a fluid pressure against the trench wall. This form of stabilization can be provided due to the structure of the guar molecule, its molecular weight, and bonding capabilities. During trenching guar molecules are attracted to the electrical charges within the soil matrix within the trench sidewalls. As the trench sidewalls are coated with guar, other molecules become enmeshed within the initial coating forming a filter cake. The filter cake acts as a barrier that greatly restricts the flow of fluid and simultaneously prevents outward migration of fluid from the trench into the surrounding formation.

BP shoring systems typically are made up using a fresh water solution of guar gum that is mixed within tanks immediately prior to placement in the trench. BP slurry is used in lieu of clay based fluids because it is bio-degradable and does not reduce permeability of the surrounding formations or transmissivity of gravel packs installed within the excavation. During construction of a trench system using liquid shoring, it is necessary to prevent the loss of viscosity and maintain other essential characteristics of the biopolymer solution. As guar gum is an organic product, it represents a food substrate for microbial populations that can negatively alter the properties of the slurry. Accordingly, the most appropriate means to counteract such effects is with the use of appropriate concentrations of additives for preservation of the solution against microbial degradation.

The additives typically used to preserve the slurry fluid properties include biocides in low concentrations to limit microbial growth. The fate of these biocides is confined to within the trench as the filter cake created mitigates the migration of fluid beyond the trench walls. Further, the concentration required for the proposed work will be quite low as the temperature likely encountered in the field will slow microbial growth, while the length of the trench excavation will enable completion within a time period capable of limiting microbial impacts.

Upon completion of backfilling within the trench, the BP slurry and the residual biocide within the trench can be efficiently broken down using a breaker solution. The breaker solution proposed for the project will be composed of an enzymatic breaker (LEB-H) and hydrochloric acid (HCL).

Various steps required for successful implementation of this construction approach are discussed in detail under Section 3.0 Biopolymer Trench Implementation.

3.0 BIOPOLYMER TRENCH IMPLEMENTATION OVERVIEW

Developing, preserving, and breaking the BP slurry has been carefully planned to ensure the longevity and usefulness of the slurry as a trench shoring liquid. The steps anticipated will thus include sterilization, preservation, and breakdown. The following items summarize the activities to be performed as part of each step, as they occur in the field.

Sterilization – On-site water and equipment each represent sources of microorganisms capable of breaking down the BP slurry without sterilization. To provide the required sterilization, on-site water, tanks, pumps, hoses, and piping will be pre-chlorinated to kill microorganisms using a sodium hypochlorite solution. A target chlorine concentration of 10 to 25 parts per million (ppm) is planned for such sterilization in conjunction with several hours of contact time.

Preservation - The standard approach to preserving the BP slurry is the addition of soda ash in combination with a biocide. Soda ash provides a mild alteration in the slurry pH to mitigate naturally occurring enzymes capable of breaking guar gum polymer chains. Naturally occurring enzymes are active in a neutral to acidic environment, thus adjusting the pH to approximately 9.5 prevents naturally occurring enzymes from attacking guar gum polymer chains.

The combination of pH level and a biocide prevents microorganisms from consuming the BP slurry for the duration of the construction period. The recommended chemical biocide is Busan 1059 WS (Busan). The filter cake formed by the BP slurry will restrict migration of the Busan beyond the limits of the excavation and Busan is among the first products to degrade in the subsurface.

Enzymatic Break - The approach to breaking the BP slurry is the combination of an enzymatic breaker along with a pH adjustment to between 5.5 and 7. The proposed breaker, LEB-H, is a non-hazardous liquid enzyme breaker that consists of a sodium chloride solution and enzyme proteins. The breaker returns the viscosity of the residual BP slurry to that of water. The pH adjustment from 9.5 to near or below neutral is accomplished through the gradual addition of HCL. The pH adjustment is required to optimize the performance of LEB-H and to create a prolific environment for the growth of microorganisms, which will consume the remaining BP biomass.

4.0 SITE-SPECIFIC BIOPOLYMER TRENCH IMPLEMENTATION

Trench construction will be carefully orchestrated to ensure that the BP slurry is adequately mixed and that the appropriate viscosity has been achieved prior to starting excavation. Following sterilization, initial mixing of the guar gum and soda ash with water will be done utilizing a portable high-speed colloidal mixer. The resulting BP slurry will be pumped into 500 BBL (21,000 gallon) frac tanks. Continuous agitation of the BP slurry will occur by pumping the mixture between three on site 500 BBL frac tanks. Excavation of the trench will begin at the north end of TF5 and proceed continuously to TF1 (Figure 1).

As the excavation progresses the BP slurry will be pumped from the frac tanks directly into the trench. The BP slurry level in the trench will be maintained at a minimum of 3 feet below ground

surface (bgs) to ensure trench stability. Trench depth will be monitored as needed using a weighted measuring tape or similar device. After a sufficient length of trench has been excavated, a vertical steel divider will be driven into the trench. The divider will allow for gravel to be dropped into the trench through the BP slurry by a backhoe or skid steer, while the excavator operates on the other side of the divider. Without the divider, gravel entrained in the slurry can be pulled towards the excavator bucket as excavation progresses. The divider will be removed and re-driven as needed.

After excavation and backfilling with gravel, any excess BP slurry will be pumped from the trench back into the frac tanks. The excess BP slurry will then be broken as described in the previous section and pumped from the frac tanks back to the trench. Finally, a breaker solution of approximately three trench pore volumes will be mixed and applied to the top of the trench, allowing for infiltration of the breaker solution into the gravel pore space. Tasman anticipates that after the enzymatic breaker solution has been applied any residual BP that remains will naturally attenuate and will not impact the efficiency of the VR trenches. At Tasman's earliest convenience the VR trenches and associated infrastructure will be completed as described in the ISCO Work Plan.

5.0 FURTHER DISCUSSION

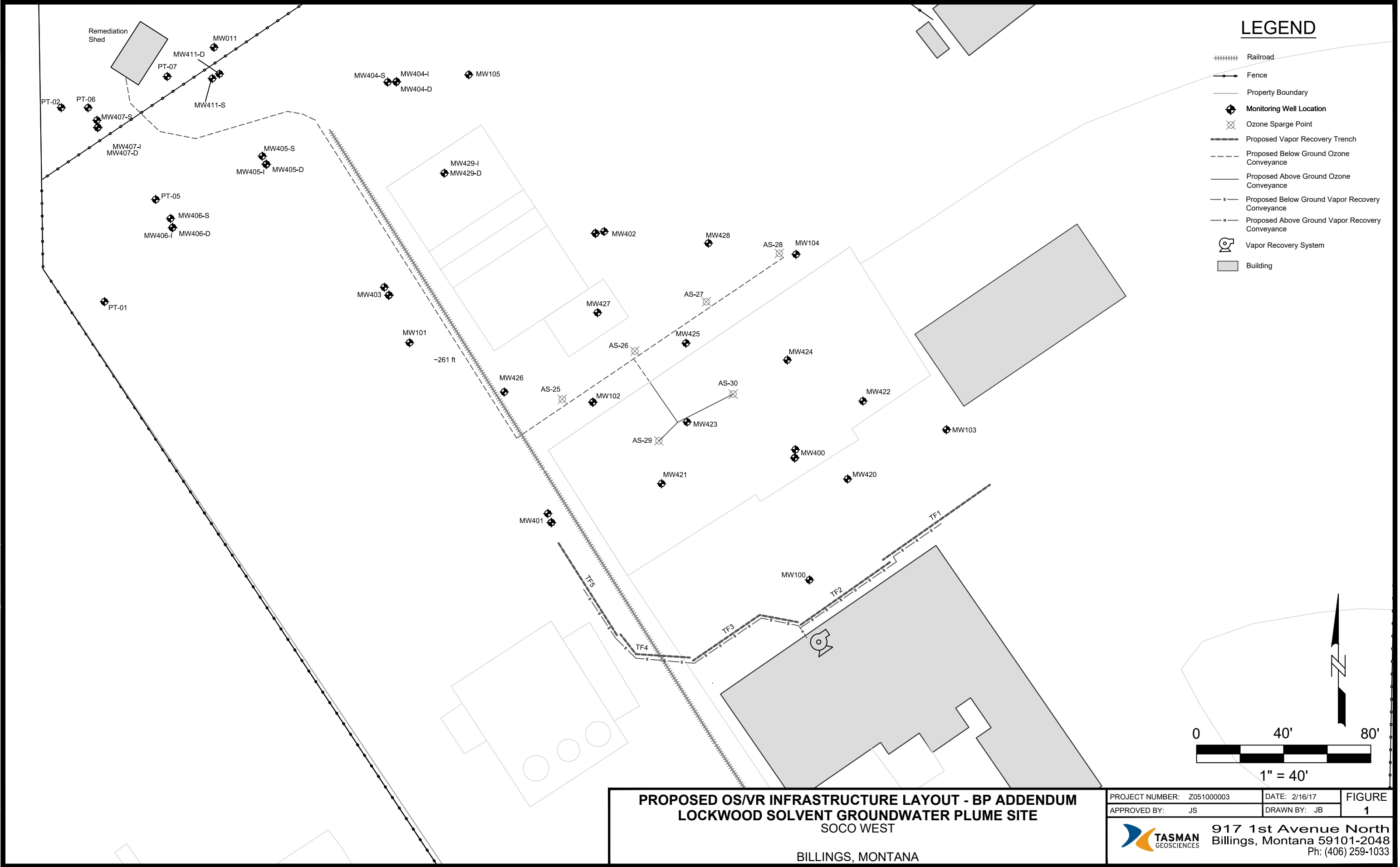
Based on Tasman's experiences with BP trenching, modifications to the previously proposed VR infrastructure layout (Figure 2) are required. The modifications proposed are for one continuous trench (Figure 1) to be excavated and backfilled as opposed to three separate excavations (Figure 2). In order for the continuous trench excavation to be implemented, approximately 300 feet of the existing rail spur will need to be dismantled and stored on site

The use of a continuous trench will increase efficiency during BP trenching and allow for a continuous connection between the VR system and the sandy gravel layer of the aquifer. Secondly, a continuous trench will allow for VR conveyance piping to remain underground until meeting at the vapor recovery system (Figure 1) and limit the opportunity for any vapor to freeze inside the piping during winter operation.

After installation and startup testing of the VR trenches and associated infrastructure, the former tank farm OS/VR systems will be activated and monitored per the ISCO Work Plan.

Figures

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