STATEMENT OF BASIS

Prepared by
California Department of Toxic Substances Control

PROPOSED RCRA CORRECTIVE ACTION SELECTION FOR

CHEMTRADE BAY POINT FACILITY
Chemtrade West US LLC
Pittsburg, California

February 10, 2020

Facility/Unit Type:	Contaminated soil, soil gas and groundwater at the Chemtrade Bay Point Facility
Contaminants:	Metals, acids, volatile organic compounds (VOCs)
Media:	Soil, Soil Gas and Groundwater
Remedy:	Groundwater hydraulic walls and permeable reactive barriers, soil cover, groundwater monitoring program, and Land Use Covenant.

List of Acronyms

AOC	Area of Concern
bgs	below ground surface
CACA	Corrective Action Consent Agreement
CEQA	California Environmental Quality Act
CMS	Corrective Measures Study
CMIP	Corrective Measures Implementation Plan
COC	Chemical of Concern
DTSC	Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ESL	Environmental Screening Level
ESQD	Explosive Safety Quantity Distance
GC-West	General Chemical West LLC
GCC	General Chemical Corporation
HHRA	Human Health Risk Assessment
kg	kilogram
L	liter
LUC	Land Use Covenant
mg	milligram
MOTCO	Marine Ocean Terminal Concord
NBA	Near-Bay Area
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RWQCB	Regional Water Quality Control Board
SWMU	solid waste management unit
TDS	total dissolved solids
VOC	volatile organic compound

Chemtrade Facility Boundary: – · – · –

Corrective Measures Implementation Areas – · – · –

Figure 1 - Aerial Photograph of the Chemtrade Facility, Chemtrade AOCs, Chemtrade Near-Bay Area and Adjacent Properties

1. INTRODUCTION

The Department of Toxic Substances Control (DTSC) has prepared this Statement of Basis to document the approval of a remedy proposed by Chemtrade West US LLC (Chemtrade) to address releases of hazardous waste or hazardous waste constituents at the Chemtrade Bay Point Facility (Facility). The Facility is located at the terminus of Nichols Road in Contra Costa County, adjacent to the southern shore of Suisun Bay and north of Port Chicago Highway. The Facility is bounded to the north by Honeywell International Inc. (Honeywell) property and Suisun Bay, and to the south by the Burlington Northern Santa Fe (BNSF) Railroad tracks and property. Honeywell property also bounds the Chemtrade Facility to the east and west (Figure 1).

Document Organization

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2. FACILITY DESCRIPTION

The authority to compel corrective action at the Facility is found in California Health and Safety Code, Chapter 6.5, Sections 25200.10 and 25187. Chemtrade is subject to the Corrective Action requirements of the Health and Safety Code because it is the successor-owner of a previous Facility owner, which was granted authority to operate a hazardous waste management facility pursuant to a Resource Conservation and Recovery Act (RCRA) Hazardous Waste Facility permit. The original RCRA permit was issued in 1983 to Allied-Chemical Corporation (Allied-Chemical). The Facility was sold to General Chemical Corporation (GCC) in 1986 at which time GCC submitted a notification of change in ownership. GCC renewed the permit, effective in 1994. GCC became a subsidiary of GenTek, Inc. (GenTek) in 1999 in a corporate reorganization. The permit was then renewed by General Chemical West, LLC (GC-West), a subsidiary of GCC, effective in 2006. GC-West was created in 2003 in connection with the bankruptcy reorganization of GenTek and its subsidiaries, including GCC. The Facility continued to operate as GC-West until 2014 when Chemtrade purchased GenTek and its subsidiaries, including GC-West. Chemtrade submitted a notification of change in ownership when they purchased GenTek and is the current Facility owner/operator. In connection with the Chemtrade acquisition of GenTek and its subsidiaries, the name of GC-West was changed to Chemtrade West US LLC. The permit was not

renewed in 2016 as Chemtrade implemented closure of the RCRA operations in 2016 (Jacobson James & Associates [JJ&A], 2017), and DTSC certified clean closure through correspondence to Chemtrade dated February 21, 2017 (DTSC, 2017). Chemtrade currently performs Corrective Action in accordance with the Corrective Action Consent Agreement executed between Chemtrade and DTSC in 2016 (Docket: HWCA-FY15/16-006).

2.1 OPERATIONS

The 26-acre Facility is part of the larger former (approximately 260-acre) Nichols Chemical Company property, which started in the early 1900s to manufacture primarily sulfuric acid from pyrite ore material brought in from the Sierra Nevada mountains. Portions of the original Nichols Chemical Company property were acquired by various entities over time. In 1920, the original 260-acre Nichols Chemical Company property was sold to Allied-Chemical which became the owner/operator. Operations during this time included production and/or repackaging of various high-grade acids (sulfuric, nitric and hydrofluoric acids), ammonium hydroxide, organochlorine pesticides, organic solvents, various polymers, lead arsenate, aluminum sulfate (alum) and molten sulfur transloading.

The United States Navy acquired 121 acres of the Allied-Chemical property to develop their "buffer zone". This property was part of the former Concord Naval Weapons Station (CNWS) and is now Marine Ocean Terminal Concord (MOTCO). The MOTCO operations have associated land use restrictions which are described in Section 5.1.

In 1986, GCC became the successor-owner of the 26-acre operating portion of the Allied-Chemical property operating as GCC and then as GC-West. The GC-West operations at the Facility included production of alum and chemically pure acids and etchants, blending/packaging of solvents, and molten sulfur transloading operations.

Allied-Chemical became Allied-Signal through a series of mergers. In 1999, following the Honeywell and Allied-Signal merger, Honeywell became the successor owner of the remaining 113 acres that surround the 26-acre Facility to the north, west and east.

In 2014, Chemtrade purchased GenTek and its subsidiaries, including GC-West. In 2015, Chemtrade stopped all operations at the Facility with the exception of alum production and molten sulfur transloading. In 2015, Facility decontamination and partial demolition was performed, with the exception of the alum plant and molten sulfur transloading areas. In 2016, Chemtrade completed decontamination and demolition of the RCRA hazardous waste management unit and DTSC permitting certified the clean closure in 2017 (DTSC, 2017).

2.2 HAZARDOUS MATERIAL AND HAZARDOUS WASTE MANAGEMENT

The Facility's and the other former Nichols Chemical Company properties' historical operations required management of what is known today as hazardous materials and hazardous waste. The historical operations at the Facility and adjacent properties pre-dated environmental regulations and included the use of fill containing pyrite cinder materials for Facility construction and on-site liquid and solid waste management.

The first RCRA hazardous waste facility permit was issued in 1983, with renewals effective in 1994 and 2006. The RCRA hazardous waste facility permit allowed for greater than 90-day on-site storage. Chemtrade closed the permitted system in accordance with RCRA requirements in 2016, and DTSC issued the closure certification through correspondence to Chemtrade dated February 21, 2017 (DTSC, 2017).

2.3 CORRECTIVE ACTION

In May 1992, DTSC completed a RCRA Facility Assessment (RFA) Report to evaluate areas in the Facility and the adjacent Allied-Chemical property where hazardous materials and hazardous wastes were managed, and assess their release potential (DTSC, 1992). The RFA recommended Corrective Action for thirteen (13) solid waste management units (SWMUs) and one hazardous waste management unit (HWMU) identified at the Facility. The first Corrective Action step was a RCRA Facility Investigation (RFI), initiated in 1995. The initial RFI findings, documented in a DTSC-approved December 1995 report, confirmed releases and impacts to Facility soil and groundwater (GTI, 1995). Based on the initial RFI findings and the operation's logistics, the Facility was organized into three Areas of Concern (AOCs) for additional RFI work. A fourth area identified as the Chemtrade Near-Bay Area (NBA) was added in 2014 when an area previously believed to be Honeywell property was determined to be part of the Facility. The three AOCs and Chemtrade-NBA locations are shown on Figure 1 and described below:

AOC-1: The main (operations) portion of the Facility (includes the one HWMU and 11 of the SWMUs).

AOC-2: The former National Pollutant Discharge Elimination System (NPDES) permitted wastewater treatment lagoon, which was identified in the RFA as a SWMU.

AOC-3: The former caustic storage area identified in the RFA as a SWMU.

Chemtrade-NBA: An undeveloped tidal wetland adjacent to Suisun Bay originally designated as part of the larger Honeywell West NBA that was not used for industrial operations.

In August 2007, DTSC approved the on-site Human Health Risk Assessment (HHRA), which evaluated human health risks for the three AOCs ((DTSC, 2007a; Montgomery Watson Harza (MWH, 2004). The HHRA did not include the Chemtrade-NBA because it was thought to be Honeywell's property at the time. Human health risk evaluation for the Chemtrade-NBA was initiated in 2011 by Honeywell (CH2M Hill, 2011 and 2012). Sampling conducted after the HHRA (2004), from the three AOCs and the Chemtrade-NBA, were evaluated in the Corrective Measures Study (CMS) (Terraphase Engineering Inc. [Terraphase], 2019). The 2007 and 2011 HHRAs are further discussed below in Section 5.

In December 2007, DTSC approved the On-Site RFI Summary Report (DTSC, 2007b; Jacobson Environmental (JE), 2007). In December 2008, DTSC approved the Revised CMS Work Plan Supplement (DTSC, 2008), which provided the framework for the CMS (LFR/JE, 2008).

On-site ecological risks evaluation was initiated in 2003 for AOC-2, in accordance with a DTSC-approved Ecological Risk Assessment Work Plan (MWH, 2003a, 2003b). AOC-1 and AOC-3 were not included as they were determined to not have suitable ecological habitat. Chemtrade initiated the Ecological Risk Assessment (ERA) in accordance with the ERA Work Plan, however, it was not completed and a screening-level ERA for AOC-2 was performed in the CMS (Terraphase, 2019). Ecological risk for the Chemtrade-NBA was initiated in 2011 by Honeywell because the Chemtrade-NBA was thought to be Honeywell property at the time (CH2M Hill, 2011 and 2012). Chemtrade completed the Chemtrade-NBA ERA in 2018 (Terraphase, 2018). The ERA is further discussed below in Section 5.

An offshore sediment investigation was conducted in September 2012 to evaluate potential offsite impacts (Terraphase, 2013). Sediment, pore water, and surface water samples were collected from the Suisun Bay offshore areas. The results indicated that metal concentrations in sediment were generally below reporting limits and within background ranges measured in San Francisco Bay and Suisun Bay. Additionally, metals concentrations in pore water were generally below California Toxics Rule levels (CTRs), with the exception of two minor exceedances of the saltwater CTR for nickel and one minor exceedance of the saltwater CTR for arsenic.

From 2007 to 2012, treatability studies were performed to evaluate potentially viable technologies for soil and groundwater cleanup for consideration in the CMS, including:

- Laboratory solidification/stabilization study for treatment of metals in soil and sediment (LFR, 2008).

- Laboratory groundwater neutralization and permeable reactive barrier study for treatment of metals in groundwater (LFR, 2009).

- Field pilot study to evaluate in-situ neutralization for treatment of metals in groundwater (JJ&A, 2012a).

Interim Measures have been performed at the Facility to address potential human and ecological pathways:

- AOC-1: In July 2004, the northern portion of AOC-1 was paved to cover exposed soil.

- AOC-2: From July 2013 to February 2014, a soil cover was installed over exposed soil in the southeast corner and bird netting was installed over the wastewater lagoon area to deter birds from direct exposure to soil and water, respectively. Approximately 482 tons of sediment and 5,532 tons of soil were removed to address the highest concentrations of chemicals of concern (COCs). The former wastewater treatment lagoon was then backfilled with approximately 60,000 tons of clean material to eliminate the potential for human and ecological receptors to come into contact with lagoon water and sediment (Terraphase, 2014). Consequently, lagoon water and sediment were eliminated as media of concern. Preventing ecological receptor exposure to un-capped surface soil, until a final remedy is implemented, is being achieved by mowing grasses to reduce its suitability as an ecological habitat and using coyote decoys to scare away animals (Terraphase, 2017).

- AOC-3: In January 2014, the caustic storage tank and equipment were removed and approximately 294 tons of soil were removed. The excavation was backfilled with clean soil (Terraphase, 2014b, 2016).

Soil-gas sampling be completed 2017 to assess the potential presence of a VOC source and evaluate the potential risk to current and future site workers due to vapor intrusion. A site-specific evaluation for vapor intrusion was performed using the Johnson and Ettinger subsurface vapor intrusion model. The modeling demonstrated that the VOC concentrations that concentrations did not exceed site-specific screening levels under a commercial/industrial use scenario and, therefore, there is no current or future vapor intrusion risk for site workers (Terraphase, 2018b). Risk was not evaluated under a residential use scenario and therefore, a deed restriction would be required to prohibit future residential site use.

The investigations performed to date have addressed soil, sediment, shallow and deep groundwater, surface water, and soil gas. COCs addressed by the Corrective Action work at the Facility are primarily metals and low pH, with localized presence of high pH and volatile organic compounds (VOCs).

2.4 ENVIRONMENTAL SETTING

The Facility is located adjacent to Suisun Bay, approximately 9 miles west of the confluence of the Sacramento River and the San Joaquin River, which forms the Sacramento-San Joaquin Delta region. The Facility is within the Suisun Bay flood plain, a relatively level plain that lies at an approximate elevation of sea level. North Contra Costa Wetlands are located to the west and east of the Facility.

Hills, with maximum elevations of approximately 600 feet above mean sea level, are located south of the Site. The Site's surface slopes gently northward, about 44 feet per mile. There is an approximate 5-foot elevation change across the Site. A 2- to 3-foot-tall scarp, reinforced with broken concrete, defines the northern boundary of the Site where it contacts Suisun Bay.

2.5 HYDROGEOLOGIC CONDITIONS

The Facility is located within the Pittsburg Plain Groundwater Basin. The Facility is underlain by fill material consisting of native soil mixed with pyrite ore materials. The depth of the fill material generally ranges up to approximately 5 feet below ground surface (bgs), with the exception of the area near the southwestern corner of AOC-2, where the thickness of the fill material is up to 15 feet. Beneath the fill is Bay Mud to depths of approximately 20 – 30 feet bgs, and unconsolidated Quaternary alluvial deposits in the southern half of AOC-1 to approximately 20 – 30 feet bgs. Under the alluvium and Bay Mud is a sand deposit up to a depth of 80 feet bgs. This sand layer is underlain by the bedrock that is found outcropping south of the Site.

Shallow and deep groundwater zones are present at depths ranging from approximately 1 to 10 feet bgs and 30 to 50 feet bgs, respectively. Groundwater flow at the Facility is generally north-northward towards Suisun Bay. A persistent mound is present in shallow groundwater in the central portion of AOC-1. This mound is approximately 1 to 2 feet higher than groundwater elevations in peripheral monitoring points. A technical memorandum was prepared in 2012 that concluded multiple factors could be contributing to the mound, including lower evapotranspiration occurring due to placement of fill/paving of the ground surface coupled with recharge from precipitation events and a potential historical or intermittent leak from an unknown utility line (JJ&A, 2012b).

Horizontal and vertical hydraulic conductivity in the shallow groundwater zone is estimated to be 1x10-4 and 1x10-6 centimeters per second (cm/s), respectively (IT, 1999; Mutch, 2017). The hydraulic conductivity of the deep groundwater zone is estimated to be between 10-3 to 10-4 cm/s (Mutch, 2017). The estimated travel time for shallow groundwater at the Facility to reach Suisun Bay is in the order of hundreds of years (Mutch, 2013, 2017). Vertical groundwater flow between the shallow and deep groundwater zones is typically downward, with occasional upward flow seasonally.

2.6 GROUNDWATER USES

The groundwater beneficial uses identified in the San Francisco Bay Regional Water Quality Control Plan (Basin Plan; RWQCB, 2017) include municipal or domestic water supply, agricultural supply, industrial service supply, and industrial process supply. However, shallow groundwater at the Site is not considered a viable source of drinking water due to high salinity, as measured by total dissolved solids (TDS) concentrations, per State Water Resources Control Board Resolution No. 88-63 (Revised by Resolution No. 2006-0008).

Deep groundwater beneath the Facility is not currently used for any purpose, and it is unlikely to support municipal or domestic uses because of elevated salinity. Deep groundwater in portions of the Facility, like shallow groundwater, is not considered a viable source of drinking water due to elevated levels of TDS, but it has been conservatively considered a potential municipal or domestic water supply for the remedy decision-making purpose.

The closest groundwater supply wells (two) are located approximately one-half mile south of the Facility. The next closest supply wells include one more than 0.5 miles to the east-southeast and another approximately 0.75 miles to the south. There is no risk of contamination to these supply wells from the Facility, because they are all located up-gradient or cross-gradient from the Facility.

2.7 SURFACE WATER USES

The Basin Plan identified beneficial uses of surface waters adjacent to the Facility (i.e., Suisun Bay) include ocean, commercial, and sport fishing; estuarine habitat; industrial service supply; fish migration; navigation; preservation of rare and endangered species; water contact recreation; noncontact water recreation; fish spawning; and wildlife habitat (RWQCB, 2017).

The Facility constructed a stormwater conveyance system in 2007 to route stormwater from AOC-1 directly to Suisun Bay via an aboveground conveyance pipe, in accordance with the General Storm Water Permit for Industrial Facilities (NPDES Permit No. CAS000001).

3. CONTAMINATED MEDIA

The following table summarizes the concentrations of COCs and/or contaminants of potential ecological concern (COPECs) detected in their respective media of concern:

MEDIA (units)	**COC and/ or COPEC**	**CONTAMINANT**	**MAXIMUM[1]**
Soil (mg/kg)	COPEC	Aluminum	36,000
	COPEC	Antimony	200
	COC and COPEC	Arsenic	52,174 and 5,300
	COPEC	Barium	400
	COPEC	Cadmium	15
	COPEC	Chromium (total)	210
	COPEC	Copper	750
	COC and COPEC	Lead	67,606 and 11,000
	COC and COPEC	Mercury	73,913 and 34,000
	COC and COPEC	Selenium	9,014 and 3,800
	COPEC	Silver	20
	COPEC	Thallium	6.1
	COPEC	Zinc	1,700

Shallow Groundwater (mg/L)	COPEC	Aluminum	842
	COPEC	Antimony	0.0814
	COC and COPEC	Arsenic	424
	COC and COPEC	Beryllium	0.0998
	COC and COPEC	Cadmium	14.5
	COC and COPEC	Cobalt	2.52
	COC and COPEC	Copper	912
	COPEC	Lead	0.0133
	COPEC	Mercury	0.00101
	COC	Molybdenum	0.103
	COC and COPEC	Nickel	5.17
	COPEC	Selenium	0.137
	COPEC	Silver	<0.01
	COPEC	Vanadium	0.336
	COC and COPEC	Zinc	2,870
	COPEC	1,2-Dichlorobenzene	0.021
	COC	1,4-Dichlorobenzene	0.0025
	COC	Benzene	0.0017
	COC	Chloroform	0.0025
	COC	Cis-1,2-Dichloroethene	0.130
	COC	Ethylbenzene	<0.002
	COC	Tetrachloroethene	0.0026
	COC	Trichloroethene	0.008
	COC	Vinyl Chloride	0.0011
Deep Groundwater (mg/L)	COC and COPEC	Arsenic	0.186
	COPEC	Cobalt	0.00324
	COPEC	Copper	0.00615
	COPEC	Nickel	0.0171
	COPEC	Selenium	0.0107
	COPEC	Silver	<0.001
	COC and COPEC	1,1-Dichloroethene	0.052
	COC and COPEC	Tetrachloroethene	0.68
	COC	Trichloroethene	0.014

Notes for above Concentrations of Selected COCs in Soil and Groundwater Table:

[1] Maximum concentrations are presented in the CMS Report. Soil maximums for COCs are based on all samples; Soil maximums for COPECs are based on samples taken from the top 6 feet bgs (ecological exposure depth); Groundwater maximums are based on the May 2017 sampling event.

< There was no detection of this chemical. The value is the analytical reporting limit (e.g., <0.002 means the chemical was not detected with the analytical reporting limit of 0.002).

4. CONTAMINANT FATE AND TRANSPORT

There is the potential for COCs in soil to migrate to groundwater, and for COCs in on-site groundwater to migrate off-site with groundwater flow. However, the shallow soils have low permeability and high organic content, which result in slow groundwater movement and the ability to retard chemical migration in groundwater. The estimated travel time for shallow groundwater at the Facility to reach Suisun Bay is in the order of hundreds of years (Mutch, 2013, 2017). Additionally, groundwater data do not show substantial change in chemical concentrations over time, which confirms COCs are not moving significantly from soil to groundwater or within the groundwater system.

5. EXPOSURE PATHWAYS

5.1 HUMAN HEALTH

Human health risk assessments (HHRAs) evaluated potential exposure pathways to the contaminants present in soil and groundwater at the Facility. The 2004 HHRA identified complete exposure pathways for the following receptors at AOCs 1-3: current/future industrial worker, current/future site visitor, current/future wastewater treatment unit maintenance worker and future construction worker (MWH, 2004). Elevated risks were identified for the industrial worker, wastewater treatment unit maintenance worker and future construction worker. Soil and groundwater samples collected after the 2004 HHRA were evaluated in the 2019 CMS (Terraphase, 2019). Groundwater samples were compared to site-specific background concentrations, 2004 HHRA maximum concentrations, and RWQCB environmental screening levels (ESLs).

Honeywell's 2011 HHRA identified the most plausible complete exposure pathways in the West-NBA, which included the Chemtrade-NBA because it was thought to be a part of Honeywell's West-NBA property at the time. One soil[1] sample was collected from the Chemtrade-NBA after the 2011 HHRA and is evaluated in the 2019 CMS (Terraphase, 2019). The 2011 HHRA identified the following complete pathways for the West-NBA: current/future intermittent maintenance workers, trench/ excavation workers and future trespassers (CH2M Hill, 2011). Future industrial workers and hypothetical future residential scenarios were also included for comparative purposes, but it is recognized that these are not reasonably anticipated scenarios.

The 2011 HHRA identified elevated risks in the West-NBA to intermittent maintenance workers from arsenic and lead, to trench/excavation workers from arsenic, and to trespassers from lead. However, these elevated risks are not present for the Chemtrade-NBA based on the following:

- Chemtrade-NBA Lead Exposure Point Concentration (EPC) is less than the DTSC Screening Level: the 2011 HHRA risk evaluation was based on sample data throughout the West-NBA, to define an exposure point concentration (EPC) based on a 95% Upper Confidence Limit (UCL) consistent with standard risk assessment practices. The lead EPC, based on the 95% UCL, for just the Chemtrade-NBA soil is 251.1 mg/kg (Attachment A), which is less than DTSC's commercial/industrial screening level of 320 mg/kg (DTSC, 2019). Therefore, lead is not a contaminant of concern in a commercial/industrial scenario for the Chemtrade-NBA and elevated risks are not present to intermittent maintenance workers or trespassers from lead. It is anticipated that a Land Use Covenant (LUC) will restrict the use of the site to commercial/industrial (described below). The LUC will also require a site-specific Health and Safety Plan (HASP) and a Soil and Groundwater Management Plan (SGMP).
- Incomplete Exposure Pathways at Chemtrade-NBA for Arsenic Exposure: "Intermittent maintenance workers" is defined in the 2011 HHRA as workers periodically monitoring and sampling groundwater, inspecting or repairing stormwater drains or berms or maintaining vegetation. Intermittent maintenance workers are not anticipated to be present at the Chemtrade-NBA. Currently, one piezometer (PZ-15) is located in the Chemtrade-NBA; however, PZ-15 is not anticipated to be a part of the post-construction groundwater monitoring program. There is a berm separating AOC-3 and the

[1] The Chemtrade-NBA is a tidal wetland and it is reasonable to define the surficial deposits as sediment. However, to maintain the naming convention from previous documents, "soil" is used.

Chemtrade-NBA; however, the berm will be inspected and/or repaired from the AOC-3 side of the berm. The Chemtrade-NBA is a naturally functioning tidal wetland and revegetation is not anticipated. Trenching and excavation within the Chemtrade-NBA wetland is also not a part of the proposed remedy and will be prohibited within the LUC. If ground disturbance activities or groundwater sampling is required in the Chemtrade-NBA in the future, work will be performed in accordance with the HASP and SGMP. Therefore, the intermittent maintenance worker and trench/excavation workers pathways are not complete.

	Chemtrade-NBA Samples							
	NS-50-01	NS-50-05	PZ-15-01	PZ-15-05	AOC-3-SS-105A-0.5	AOC-3-SS-105A-2	AOC-3-SS-105A-5	95%UCL*
Lead (mg/kg)	32	7.3	270	220	45	140	9.6	251.1

*95UCL is based on an intermittent maintenance worker exposure scenario and is calculated on samples collected in the top two feet below ground surface (underlined).

The potential for exposure of commercial/industrial workers to soil in unpaved areas at AOC-1 was addressed through the 2004 interim measure when GCC, Chemtrade's predecessor, paved the majority of unpaved areas in AOC-1. However, the exposure pathway exists for areas that remained unpaved. The potential for exposure of wastewater treatment unit maintenance workers was eliminated through the decommissioning of the unit and the implementation of the AOC-2 interim measure in 2013 – 2014 in which lagoon sediment was excavated and backfilled with clean soil.

The remaining exposure pathways to be addressed by the remedy are identified in the table below.

Contaminated Media	**Human Receptor Exposure Pathways**
Soil[1]	Ingestion (incidental consumption) Dermal Contact (skin)
Groundwater	Ingestion (incidental consumption) Dermal Contact (skin) Inhalation (breathing indoor air*)

* This pathway is based on one volatile organic compound (vinyl chloride) with concentrations that exceed the SFRWQCB vapor intrusion ESLs under a commercial/industrial land use.

The HHRA did not evaluate residential pathways because the Facility is an active industrial operation and located in an area zoned as heavy industrial. The Facility is expected to remain zoned as an industrial facility for the foreseeable future. Furthermore, future re-zoning to residential use is not anticipated due to the adjacent MOTCO facility located west and northwest of AOC-1. The MOTCO facility has an Explosive Safety Quantity Distance (ESQD) arc that prevents residential or sensitive land use within the arc boundary due to potential blast impacts associated with munitions management. The U.S. Army has confirmed that munitions

management will continue at the MOTCO facility for the foreseeable future, therefore requiring the ESQD arc to be maintained indefinitely. The arc boundary currently ends at the western edge of the Chemtrade Facility boundary. Based on May 2018 Chemtrade and MOTCO communications, residential or sensitive land uses (e.g., day care, hospital) on the Chemtrade Facility would still not be appropriate due to the proximity to the arc, as well as potential operational changes that could result in a temporary larger arc extending onto the Chemtrade Facility.

COCs have been detected in the AOCs and Chemtrade-NBA at concentrations that exceed residential levels. Chemtrade plans to establish activity and use limitations that will be recorded in a Land Use Covenant (listed in detail in the 2019 CMS), that will run with the land, prevent any future residential land use and address the restrictions associated with the adjacent MOTCO ESQD arc. Re-zoning of any portion of the Facility in the future that is not consistent with commercial/industrial land use would require an updated HHRA for future site users.

5.2 ECOLOGICAL

Ecological risk evaluations were performed for AOC-2 and the Chemtrade-NBA, as habitat was not identified at the other AOCs. AOC-1 is almost fully paved and the location of active operations. AOC-3 is the former caustic storage tank area that included a concrete pad and gravel surface; the area has been demolished and a soil cover is currently present. The potential types of ecological receptors evaluated included invertebrates, plants, birds and mammals representative of the Chemtrade-NBA wetland habitat and the AOC-2 upland terrestrial habitats. The most recent biological survey performed in 2013 did not identify any special-status wildlife or plant species (LSA, 2013).

The ecological evaluations included a screening-level ecological evaluation for AOC-2 (Terraphase, 2019). Maximum concentrations of COPECs in surficial soil (i.e., 0 to 6 feet bgs, based on the potential exposure pathways for vegetation and wildlife receptors) were screened against soil background levels and ecological site-specific screening levels developed for the West-NBA by Honeywell. The preliminary assessment identified COPECs in surficial soil exceeding risk based ecological remediation goals, and the presence of complete exposure pathways at AOC-2, which necessitates remedial action.

The evaluation of ecological risk for the Honeywell West NBA, which included the Chemtrade-NBA, was initiated in 2011 (CH2M Hill, 2011 and 2012). A follow-up evaluation for only the Chemtrade-NBA was completed in 2018 (Terraphase, 2018). The follow-up risk evaluations identified that the Chemtrade-NBA presents de minimis risks to ecological receptors (Terraphase, 2018).

A screening-level evaluation of potential risks to offsite ecological receptors in Suisun Bay was performed in the 2019 CMS. Samples were compared to CTRs, ESLs when CTRs were not available, and site-specific background concentrations. The groundwater evaluation identified the potential for groundwater to migrate off-site with concentrations of COCs exceeding screening-level water quality objectives.

The media and ecological receptor exposure pathways addressed by the remedy are summarized in the following table.

Contaminated Media	Ecological Receptor Exposure Pathways
AOC-2 Soil	Ingestion (incidental consumption) Dermal Contact (skin adsorption) Bioaccumulation and Food-chain Transfer (ingestion)
Groundwater (via migration off-site)	Direct contact (skin adsorption) Bioaccumulation and Food-chain Transfer (ingestion)

6. CLEANUP GOALS

Chemtrade developed cleanup goals for the Facility under the following assumptions:

- The Facility will be restricted to commercial/industrial use by current ownership and a Land Use Covenant to be recorded as part of the proposed remedy.
- Direct access to Facility groundwater and soil in AOCs 1 – 3 will be restricted by pavement, building pads, a clean soil/asphalt cover at AOC-2 and a portion of AOC-3, and private property access restrictions.
- The shallow aquifer at the site does not support a drinking water beneficial use based on low flow rates and salinity.

Chemtrade proposes cleanup goals to address exposure pathways as follows:

- Soil cleanup goals to protect visitors, commercial/industrial workers and construction workers from direct contact based on risk criteria and background levels for metals.
- Soil cleanup goals to protect ecological receptors from direct contact based on risk criteria and background levels for metals.
- Shallow groundwater cleanup goals to protect construction workers from direct contact based on background levels and RWQCB ESLs for direct exposure to metals in groundwater, and to protect commercial/industrial workers from VOCs by vapor intrusion.
- Deep groundwater cleanup goals to conservatively protect the Pittsburg Plain Groundwater Basin below the Site based on California's Drinking Water Maximum Contaminant Levels (MCLs), although it is unlikely to support municipal or domestic use based on elevated salinity.
- Shallow and deep groundwater cleanup goals to protect estuarine aquatic habitat from direct contact to COCs based on background levels for metals, CTRs and ESLs for COCs that do not have CTRs.

		PROPOSED CLEANUP GOALS[1]	
MEDIA (units)	**CONTAMINANT**	**Human Health** (AOCs 1 - 3)	**Ecological** (AOC 2)
Soil (mg/kg)	Aluminum	--	29,503
	Antimony	--	3.6
	Arsenic	29	29
	Barium	--	386

	Cadmium	--	1.0
	Chromium (total)	--	101
	Copper	--	67
	Lead	835	44
	Mercury	90	0.2
	Selenium	1,503	3.5
	Silver	--	4.2
	Thallium	--	2.5
	Zinc	--	176
Shallow Groundwater (mg/L)	**CONTAMINANT**	**Human Health** (AOCs 1 – 3)	**Ecological** (POC at Property Boundary)
	Metals		
	Aluminum	--	0.039
	Antimony	--	0.03
	Arsenic	1.2	0.036
	Beryllium	0.001	0.0027
	Cadmium	0.001	0.001
	Cobalt	0.006	0.004
	Copper	0.30	0.0108
	Lead	--	0.0045
	Mercury	--	0.0015
	Molybdenum	0.10	--
	Nickel	0.012	0.0082
	Selenium	--	0.005
	Silver	--	0.001
	Vanadium	--	0.0532
	Zinc	6.0	0.081
	Volatile Organic Compounds		
	1,2-Dichlorobenzene	--	0.014
	1,4-Dichlorobenzene	0.1	--
	Benzene	0.0097	--
	Chloroform	0.02	--
	Cis-1,2-Dichloroethene	0.95	--
	Ethylbenzene	0.11	--
	Tetrachloroethene	0.026	--
	Trichloroethene	0.049	--
	Vinyl Chloride	0.00053	--
Deep Groundwater (mg/L)	**CONTAMINANT**	**Human Health** (AOCs 1 - 3)	**Ecological** (POC at Property Boundary)
	Metals		
	Arsenic	0.01	0.036
	Cobalt	--	0.003
	Copper	--	0.0031
	Nickel	--	0.0082
	Selenium	--	0.005
	Silver	--	0.001
	Volatile Organic Compounds		
	1,1-Dichloroethene	0.006	0.025
	Tetrachloroethene	0.005	0.12
	Trichloroethene	0.005	--

Notes for Above Proposed Cleanup Goals Table:
[1] Where there is a human health and ecological cleanup goal, the lower of the human health cleanup goals and ecological cleanup goals shall be used.
-- Not Applicable
< The value is the analytical reporting limit (e.g., <0.002 means the chemical was not detected with the analytical reporting limit of 0.002).
POC – Point of Compliance

7. CORRECTIVE MEASURES STUDY

7.1 CORRECTIVE ACTION OPTIONS

Chemtrade completed the CMS to evaluate corrective action alternatives for the Facility's soil and groundwater (Terraphase, 2019). No Action is included as an alternative as required by the RCRA process. All alternatives, except No Action, will include a Land Use Covenant (LUC) over the Chemtrade-NBA. The LUC will restrict sensitive land uses, soil disturbances and groundwater use without a DTSC-approved HASP and SGMP. All alternatives, except No Action, will also include the following Groundwater Remedy for shallow and deep groundwater as a portion of the overall alternative.

Groundwater Remedy Elements for Shallow Groundwater (AOC-1, AOC-2 and AOC-3)

1. Land Use Covenant (LUC) limiting use of groundwater at the Facility, including prohibition on the installation of water wells and use of existing wells for any beneficial use,
2. Installation of hydraulic barrier walls at the eastern and western AOC boundaries,
3. Installation of hydraulic barrier walls with sections of permeable reactive barriers (PRBs) at the northern boundaries of AOC-1 adjacent to the Honeywell properties and several PRBs near the northern boundary of AOC-2/AOC-3 adjacent to the Chemtrade-NBA, and
4. Installation of monitoring and Point of Compliance (POC) wells and implementation of a DTSC-approved groundwater monitoring program.

Groundwater Remedy Elements for Deep Groundwater (AOC-1, AOC-2 and AOC-3)

The Groundwater Remedy elements to address deep groundwater for all corrective action alternatives, except the No Action option, include the following.

1. Land Use Covenant to restrict use of groundwater at the Facility without a DTSC-approved Groundwater Management Plan,
2. Implementation of a monitored natural attenuation program for metals and VOCs to confirm that cleanup goals are being achieved, and
3. Installation of monitoring and Point of Compliance (POC) wells and implementation of a DTSC-approved groundwater monitoring program.

The following table provides a summary of the corrective action alternatives evaluated for AOC-1, AOC-2, AOC-3 and Chemtrade-NBA.

AOC-1 and Chemtrade-NBA ALTERNATIVES [1]	DESCRIPTION
1. No Action	No controls, actions or treatment. (For comparison purposes only)

2. Chemtrade-NBA LUC, Groundwater Remedy and Soil Containment	This alternative includes the **Chemtrade-NBA LUC** and **Groundwater Remedy** described above this table for shallow and deep groundwater. **Soil Containment** components include: (1) an asphalt/concrete cap over AOC-1 soil, (2) operations and maintenance (O&M) of current concrete building pads, foundations, and asphalt/concrete cap, and (3) a Land Use Covenant prohibiting residential use, or any other type of sensitive land use, and soil disturbance without a DTSC-approved Soil Management Plan (SMP).
3. Chemtrade-NBA LUC, Groundwater Remedy, Soil Containment and Source Reduction	This alternative includes Alternative 2, with the addition of **Source Reduction**. The Source Reduction components include hot-spot excavation and offsite disposal of approximately 3,000 cubic yards (CY) of soil with COCs exceeding human health cleanup levels. Excavation will be backfilled with DTSC- approved clean, imported fill.
AOC-2 and AOC-3 ALTERNATIVES[1]	**DESCRIPTION**
1. No Action	No controls, actions or treatment. (For comparison purposes only)
2. Groundwater Remedy, Soil Containment and Shoreline Clean Zone	This alternative includes the **Groundwater Remedy** described above this table for shallow and deep groundwater. **Soil Containment** components include: (1) a low-permeability soil/asphalt cap over AOC-2 and a portion of AOC-3 soil, except for the Shoreline Clean Zone area, with a vegetative cover, (2) O&M of the cap, and (3) a Land Use Covenant prohibiting residential use, or any other type of sensitive land use, and soil disturbance without a DTSC-approved SMP. **Shoreline Clean Zone** component includes: (1) a pre-design investigation to determine if soil needs to be excavated within 100 feet of the Bay shoreline based on the proposed cleanup goals, and if necessary (2) excavation of soil and backfilling with DTSC-approved clean, imported fill to create a 100-foot shoreline clean zone between the AOC-2/ AOC-3 area and Suisun Bay.
3. Groundwater Remedy, Source Reduction, Soil Containment, and Shoreline Clean Zone	This alternative includes Alternative 2, with the addition of **Source Reduction**. The Source Reduction component includes excavation and offsite disposal of approximately 2,050 CY of soil from the top 3 feet of AOC-2 berms with COCs significantly exceeding cleanup levels prior to capping.
4. Groundwater Remedy, and Source Removal	This alternative includes the **Groundwater Remedy** and land use covenant elements of Alternative 2, with the addition of **Source Removal**. The Source Removal component includes: (1) excavation of approximately 36,300 CY of AOC-2 and

	AOC-3 soil, not to include areas backfilled from the AOC-2 IM, exceeding human health and ecological cleanup levels, (2) offsite disposal, and (3) backfill with DTSC-approved clean, imported soil and vegetated.

Notes for Above Alternatives Description Table:

[1] Before selecting the alternatives presented, Chemtrade evaluated various soil and groundwater treatment technologies:

Evaluated soil technologies included: in-situ stabilization/solidification, vitrification, and soil flushing; phytoremediation; excavation and on-site soil washing; excavation and on-site stabilization with on-site or off-site disposal; and excavation with off-site disposal (no treatment).

Evaluated groundwater technologies included: monitored natural attenuation, phytoremediation for groundwater capture; permeable reactive barrier; hydraulic barrier for containment; in-situ biological treatment; in-situ chemical treatment; and groundwater extraction and above-ground on-site treatment.

7.2 DECISION FACTORS AND CORRECTIVE ACTION STANDARDS

DTSC evaluated the corrective measure options presented in the CMS report against the following four corrective action standards:

- Protect human health and the environment
- Attain corrective action goals, including media cleanup standards
- Comply with any applicable standards for management of wastes
- Control the source of release to prevent further threat to human health or the environment.

DTSC also evaluated the options against the following decision factors:

- Short- and long-term effectiveness
- Reduction of toxicity, mobility, and/or volume
- Long term reliability
- Implementability
- Cost
- State and Community acceptance

7.3 SUMMARY OF CORRECTIVE MEASURES OPTIONS DISCUSSION*

AOC-1, Chemtrade-NBA, AOC 2&3 Alternative 1	**Groundwater and Soil: No Action**
This option would incur no capital investment and O&M costs, but it would also: – Allow contaminants remaining in surface soil to pose a threat to the health of visitors and industrial/commercial workers – Allow contaminants remaining in soil and groundwater to pose a threat to the health of construction workers engaged in subsurface work – Allow contaminants in AOC-2 soil to pose a threat to the health of ecological receptors – Allow contaminants in groundwater to potentially migrate off-site at concentrations exceeding regulatory water quality objectives protective of human health and ecological receptors	

AOC-1 & Chemtrade-NBA: Alternative 2	Groundwater and Soil: Chemtrade-NBA LUC, Groundwater Remedy and Soil Containment

This option would incur moderate capital investment and O&M costs, but it would also:

- Provide human health protection by eliminating exposure pathways for visitors, industrial/commercial workers to surface soil and mitigating construction worker exposure to deeper soils and groundwater through a DTSC-approved Soil and Groundwater Management Plan (SGMP)
- Provide human health protection by eliminating exposure pathways to groundwater through restrictions on groundwater use
- Reduce leaching and mobility of COCs in soil to groundwater by reducing infiltration via the asphalt/concrete cap
- Reduce concentrations of COCs in groundwater migrating off-site to meet water quality objectives for protection of potential off-site human and ecological receptors

AOC-1 & Chemtrade-NBA: Alternative 3	Groundwater and Soil: Chemtrade-NBA LUC, Groundwater Remedy, Soil Containment, and Source Reduction

This option would incur moderate capital investment and O&M costs greater than AOC-1 Alternative 2, but it would also:

- Provide human health protection by eliminating exposure pathways for visitors and industrial/commercial workers to surface soil and mitigating construction worker exposure to deeper soils and groundwater via a DTSC-approved SGMP
- Provide human health protection by eliminating exposure pathways to groundwater through restrictions on groundwater use
- Reduce leaching and mobility of COCs in soil to groundwater via excavation and disposal
- Reduce concentrations of COCs in groundwater migrating off-site to meet water quality objectives for protection of potential off-site human and ecological receptors
- Reduce the volume of COCs in soil by hot-spot soil removal of approximately 3,000 CY
- Require disposal of approximately 3,000 cubic yards of waste soil at off-site, permitted facilities
- Require transportation of waste and clean backfill materials over public roads

AOC-2&3: Alternative 2	Groundwater and Soil: Groundwater Remedy, Soil Containment and Shoreline Clean Zone

This option would incur moderate capital investment and O&M costs, but it would also:

- Provide human health protection by eliminating exposure pathways for visitors and industrial/commercial workers to surface soil and mitigating construction worker exposure to deeper soils and groundwater via a DTSC-approved SGMP

– Provide human health protection by eliminating exposure pathways to groundwater through restrictions on groundwater use – Provide ecological receptor protection by eliminating exposure pathways to soil via the cap – Reduce leaching and mobility of COCs in soil to groundwater via excavation and disposal – Reduce concentrations of COCs in groundwater migrating off-site to meet water quality objectives for protection of potential off-site human and ecological receptors – Reduce the volume of COCs in soil at the Shoreline Clean Zone, if they are found to be present above cleanup levels – Require transportation of clean fill material over public roads	
AOC-2&3: Alternative 3	**Groundwater and Soil: Groundwater Remedy, Source Reduction, Soil Containment, and Shoreline Clean Zone**
This option would incur the high end of moderate capital investment and O&M costs and it would also: – Provide human health protection by eliminating exposure pathways for visitors and industrial/commercial workers to surface soil and mitigating construction worker exposure to deeper soils and groundwater via a DTSC-approved SGMP – Provide human health protection by eliminating exposure pathways to groundwater through restrictions on groundwater use – Provide ecological receptor protection by eliminating exposure pathways to soil via excavation – Reduce leaching and mobility of COCs in soil to groundwater via excavation and disposal – Reduce concentrations of COCs in groundwater migrating off-site to meet water quality objectives for protection of potential off-site human and ecological receptors – Reduce the volume of COCs in soil at the Shoreline Clean Zone, if they are found to be present above cleanup levels – Reduce the volume of COCs in soil by hot-spot soil removal of approximately 2,050 cubic yards of waste soil from AOC-2 – Require disposal of approximately 2,050 cubic yards of waste soil at off-site, permitted facilities – Require transportation of waste and clean fill materials over public roads	
AOC-2&3: Alternative 4	**Groundwater and Soil: Groundwater Remedy, Soil Containment, and Source Removal**
This option would incur high capital investment and O&M costs and remove most contaminated soil within the AOC-2 and AOC-3 source area within a relatively short time, but it would also: – Incur high capital investment – Require engineering work to ensure stability of structures adjacent to the excavation – Require characterization and disposition of approximately 36,300 cubic yards of waste soil	

– Require waste disposal at off-site, permitted facilities – Require transportation of waste and clean fill materials over public roads – Have the potential to create significant environmental and community impacts – Not address soil and groundwater contamination beyond the excavated area

Notes on Corrective Measure Options Discussion Table
* For a more detailed evaluation of Corrective Action options, refer to the Draft Final Corrective Measures Study Report (Terraphase, 2019).

8. SELECTED REMEDY

The remedy DTSC approves for the Chemtrade Facility is described below:

PROPOSED REMEDY		DESCRIPTION
AOC-1, AOC-2 and AOC-3 *Shallow Groundwater*	Hydraulic Barrier Walls, Permeable Reactive Barriers, Land Use Restrictions	Includes: ✓ Construction of sheet pile or slurry hydraulic barrier walls for hydraulic containment along the western, eastern, and northern boundaries with permeable reactive barriers as "gates" along the northern boundaries to treat groundwater passively. ✓ Installing POC and performance monitoring wells ✓ Determining if additional soil removal is needed at the Shoreline Clean Zone area, and, if present, excavating the soil for on-site consolidation, and backfilling with DTSC-approved, clean material. ✓ Placing and maintaining the asphalt cap at AOC-1. ✓ Constructing an asphalt and vegetated soil cap over AOC-2 and a portion of the AOC-3 area, except for the Shoreline Clean Zone. ✓ Implementing a Facility-wide cap inspection and O&M program. ✓ Implementing a Facility-wide groundwater remedy performance monitoring program. ✓ Land Use Covenant regulating land use, soil disturbance and groundwater use.
AOC-1, AOC-2 and AOC-3 *Deep Groundwater*	Monitored Natural Attenuation, Land Use Restrictions	
AOC-1 *Soil Vapor*	Land Use Restrictions	
AOC-1 *Soil*	Soil Cap, Land Use Restrictions	
AOC-2/AOC-3 *Soil*	Soil Cap, 100 Foot Shoreline Clean Zone, Land Use Restrictions	
Chemtrade-NBA *Soil and groundwater*	Land Use Restrictions	

9. INNOVATIVE TECHNOLOGIES CONSIDERED

The remedy proposed includes the use of permeable reactive barriers to passively treat groundwater in-situ. This passive treatment technology is more labor and energy-efficient compared to groundwater extraction and above-ground treatment. In addition, this technology involves no moving parts, substantially reduces the amount of waste generated during remediation, and creates insignificant amounts of byproducts.

10. CALIFORNIA ENVIRONMENTAL QUALITY ACT

In compliance with the California Environmental Quality Act (CEQA), DTSC evaluated the potential impacts of the proposed remedy, examined how these impacts were addressed by the project plan, and prepared a draft CEQA Initial Study. DTSC concluded that an Environmental Impact Report would not be necessary to further identify significant impacts and that a Mitigated Negative Declaration would be sufficient to meet the requirements of CEQA. DTSC is conducting a 45-day public review period for comment regarding the proposed CEQA determination.

11. NEXT STEPS

Chemtrade will submit a various planning and design documents including: Corrective Measures Implementation Plan, Biological Monitoring Plan, Dust Control Plan, Storm Water Pollution Prevention Plan, Health & Safety Plan, and Transportation and Traffic Management Plan, to DTSC and implement it once approved. Activities associated with the project will include the following:

- ✓ Contracting, Planning and Permitting
- ✓ Publish and distribute a Work Notice announcing the date of commencement of the work and describing what should be expected in public spaces.
- ✓ Site Preparation and Setup
- ✓ Define and remove soil as necessary from the 100-foot Shoreline Clean Zone.
- ✓ Construct groundwater barrier walls and permeable reactive barrier gates.
- ✓ Place asphalt in AOC-1 and construct AOC-2/AOC-3 soil/asphalt cap.
- ✓ Install groundwater monitoring wells and begin performance monitoring.
- ✓ Submit Corrective Measures Completion Report to DTSC.
- ✓ Prepare, execute and record Facility Land Use Covenant.

12. CONTACT INFORMATION

Nancy Tu
Project Manager
Department of Toxic Substances Control
700 Heinz Avenue
Berkeley, California 94710

Phone: 510-540-3824
Facsimile: 510-540-3819
Email: Nancy.Tu@dtsc.ca.gov

Alejandro Vivas
Public Participation Specialist
Department of Toxic Substances Control
700 Heinz Avenue
Berkeley, California 94710

Phone: (510) 540-3911
Facsimile: (510) 540-3819
Email: Alejandro.Vivas@dtsc.ca.gov

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1	**UCL Statistics for Data Sets with Non-Detects**											
2												
3	User Selected Options											
4	Date/Time of Computation	ProUCL 5.18/8/2019 10:40:41 AM										
5	From File	Pb_set_a_4_samps.xls										
6	Full Precision	OFF										
7	Confidence Coefficient	95%										
8	Number of Bootstrap Operations	2000										
9												
10												
11	**Chemtrade-NBA Lead for Int. Maint. Worker**											
12												
13	**General Statistics**											
14	Total Number of Observations	4			Number of Distinct Observations	4						
15					Number of Missing Observations	0						
16	Minimum	32			Mean	121.8						
17	Maximum	270			Median	92.5						
18	SD	109.9			Std. Error of Mean	54.97						
19	Coefficient of Variation	0.903			Skewness	1.048						
20												
21	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use**											
22	**guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.**											
23	**For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**											
24	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1**											
25												
26	**Normal GOF Test**											
27	Shapiro Wilk Test Statistic	0.889			**Shapiro Wilk GOF Test**							
28	5% Shapiro Wilk Critical Value	0.748			Data appear Normal at 5% Significance Level							
29	Lilliefors Test Statistic	0.257			**Lilliefors GOF Test**							
30	5% Lilliefors Critical Value	0.375			Data appear Normal at 5% Significance Level							
31	**Data appear Normal at 5% Significance Level**											
32												
33	**Assuming Normal Distribution**											
34	**95% Normal UCL**				**95% UCLs (Adjusted for Skewness)**							
35	95% Student's-t UCL	251.1			95% Adjusted-CLT UCL (Chen-1995)	242.9						
36					95% Modified-t UCL (Johnson-1978)	255.9						
37												
38	**Gamma GOF Test**											
39	A-D Test Statistic	0.321			**Anderson-Darling Gamma GOF Test**							
40	5% A-D Critical Value	0.662			Detected data appear Gamma Distributed at 5% Significance Level							
41	K-S Test Statistic	0.285			**Kolmogorov-Smirnov Gamma GOF Test**							
42	5% K-S Critical Value	0.399			Detected data appear Gamma Distributed at 5% Significance Level							
43	**Detected data appear Gamma Distributed at 5% Significance Level**											
44												
45	**Gamma Statistics**											
46	k hat (MLE)	1.579			k star (bias corrected MLE)	0.561						
47	Theta hat (MLE)	77.09			Theta star (bias corrected MLE)	216.8						
48	nu hat (MLE)	12.63			nu star (bias corrected)	4.492						
49	MLE Mean (bias corrected)	121.8			MLE Sd (bias corrected)	162.5						
50					Approximate Chi Square Value (0.05)	0.925						

51	Adjusted Level of Significance					N/A	Adjusted Chi Square Value					N/A
52												
53	**Assuming Gamma Distribution**											
54	95% Approximate Gamma UCL (use when n>=50))					591.2	95% Adjusted Gamma UCL (use when n<50)					N/A
55												
56	**Lognormal GOF Test**											
57	Shapiro Wilk Test Statistic					0.932	**Shapiro Wilk Lognormal GOF Test**					
58	5% Shapiro Wilk Critical Value					0.748	Data appear Lognormal at 5% Significance Level					
59	Lilliefors Test Statistic					0.243	**Lilliefors Lognormal GOF Test**					
60	5% Lilliefors Critical Value					0.375	Data appear Lognormal at 5% Significance Level					
61	**Data appear Lognormal at 5% Significance Level**											
62												
63	**Lognormal Statistics**											
64	Minimum of Logged Data					3.466	Mean of logged Data					4.453
65	Maximum of Logged Data					5.598	SD of logged Data					0.99
66												
67	**Assuming Lognormal Distribution**											
68	95% H-UCL					6142	90% Chebyshev (MVUE) UCL					288.6
69	95% Chebyshev (MVUE) UCL					364.4	97.5% Chebyshev (MVUE) UCL					469.7
70	99% Chebyshev (MVUE) UCL					676.4						
71												
72	**Nonparametric Distribution Free UCL Statistics**											
73	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
74												
75	**Nonparametric Distribution Free UCLs**											
76	95% CLT UCL					212.2	95% Jackknife UCL					251.1
77	95% Standard Bootstrap UCL					N/A	95% Bootstrap-t UCL					N/A
78	95% Hall's Bootstrap UCL					N/A	95% Percentile Bootstrap UCL					N/A
79	95% BCA Bootstrap UCL					N/A						
80	90% Chebyshev(Mean, Sd) UCL					286.7	95% Chebyshev(Mean, Sd) UCL					361.3
81	97.5% Chebyshev(Mean, Sd) UCL					465	99% Chebyshev(Mean, Sd) UCL					668.7
82												
83	**Suggested UCL to Use**											
84	95% Student's-t UCL					251.1						
85												
86	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
87	Recommendations are based upon data size, data distribution, and skewness.											
88	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
89	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
90												