PALOS VERDES LANDFILL
REMEDIAL INVESTIGATION REPORT

APPENDIX D.10

TOXICITY PROFILES FOR THE KEY POTENTIAL CONTAMINANTS OF CONCERN

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Chemical	Acute Toxicity Summary	Chronic Toxicity Summary	Cancer Potential	Other
Benzene	Signs and symptoms from mild exposure include dizziness, weakness, euphoria, headache, ataxia and tightness in the chest. A burning sensation of the oral mucous membranes, esophagus, and stomach as well as nausea, vomiting, and abdominal pain may occur after ingestion. Inhalation results in bronchial irritation, cough, and hoarseness; pulmonary edema may be noted. Inhalation exposure to high levels of benzene may lead to depression of the central nervous system and induce blurred vision, tremors, shallow and rapid respiration, ventricular irregularities (including fatal cardiac arrhythmias), paralysis, unconsciousness, and death.	The major toxic effect is hematopoietic toxicity (affecting blood formation); chronic exposure of workers to low levels has been associated with blood disorders, such as leukemia and aplastic anemia (depression of all three types of blood cells in the absence of functioning marrow). Fatigue, headache, anorexia and dizziness may be noted following chronic exposure to benzene.	Benzene is listed as known human carcinogen. Benzene exposure has been associated with the development of leukemia in humans. Lifetime exposure to 100 ppm is associated with 140 excess deaths from leukemia/1,000 individuals; 10 ppm is associated with 14 excess deaths from leukemia/1,000 individuals. Benzene is weakly mutagenic in human lymphocytes. Both gavage and inhalation exposure to rodents have resulted in development of neoplasia.	Chromosomal aberrations in bone marrow and blood have been reported in experimental animals and some workers. 100 ml is the estimated lethal dose.
Bromodichlorometh ane (BDCM)	In animals, ingestion of large amounts of BDCM has led to liver and kidney injury, incoordination and sleepiness.	Limited evidence has shown BDCM to be toxic to developing fetuses.	Animal studies have shown that ingestion of BDCM in food or water can lead to liver, kidney, and intestinal cancer.	
Carbon Tetrachloride	Acute toxicity signs and symptoms include dyspnea, cyanosis, proteinuria, hematuria, jaundice, hepatomegaly, optic neuritis, ventricular fibrillation, eye-nose-throat irritation, headache, dizziness, nausea, vomiting, abdominal cramps, and diarrhea. CNS depression with deepening coma and death from respiratory arrest or circulatory collapse may result. In massive exposures, general kidney and liver damage may occur. In general, the main target organ is the liver.	Chronic exposure can produce hepatic cirrhosis and necrosis, renal damage, and serum changes. Developmental effects have been noted in animal studies.	Carbon tetrachloride is classified as a probable human carcinogen based on inadequate human data and sufficient evidence of hepatocellular carcinoma in rats, mice, and hamsters. All mutagenicity studies have been negative; this may be due to inadequate activation in the test systems.	Carbon tetrachloride is metabolized to a reactive radical intermediate, which is believed to induce lipid peroxidation and subsequent hepatotoxicity. There may be an age difference in susceptibility to carbon tetrachloride-induced hepatotoxicity. It is rapidly absorbed and distributed in the body, and is excreted primarily via the lung.

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Chloroform	Chloroform is a CNS and cardiac depressant; signs and symptoms include inebriation, dizziness, excitation, unconsciousness, nausea, and vomiting. Extreme exposure may cause cardiac irregularities, liver and kidney injury, death from cardiac arrest, and delayed liver and kidney damage. Delayed renal and hepatic toxicity as well as nausea, vomiting, and gastrointestinal irritation may also occur after ingestion. Respiratory depression, chemical pneumonitis, and pulmonary edema may occur following inhalation. Conjunctivitis and blepharospasm may occur from exposure to vapors of chloroform. Liquid chloroform in the eyes causes immediate burning pain, tearing, and reddening of conjunctiva. The corneal epithelium is usually injured and may temporarily be partially lost.	Repeated exposure results in liver injury and possible kidney injury. Chloroform is fetotoxic in rats and may be embryotoxic.	Listed as a probable human carcinogen, based on inadequate evidence in humans and sufficient evidence in animals. A statistically significant increased incidence of hepatocellular carcinoma was found in mice, due to oral ingestion of chloroform. Oral ingestion also induced kidney epithelial tumors in male rats. It is proven to be non-mutagenic in the Ames assay with and without metabolic activators.	Chloroform is rapidly and extensively absorbed through both respiratory and gastrointestinal tracts. Signs of chloroform poisoning in humans include a characteristic sweetish odor on the breath, dilated pupils, cold and clammy skin, initial excitation alternating with apathy, loss of sensation, abolition of motor functions, prostration, unconsciousness and eventual death. Toxic blood level: 70.0 to 250 mg/l; Lethal blood level: 390.0 mg/l. Fatal dose by ingestion or inhalation is reported to be 10 ml.

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1,4-Dichlorobenzene (*p*-Dichlorobenzene; PDB)	There is no evidence of severe toxicity in humans. Isolated cases of pulmonary granulomatosis, hemolytic anemia, and allergic purpura have been reported. Tingling of hands, vertigo, and weight loss occurred in a worker exposed to a mixture containing 1,4-dichlorobenzene.	Hepatic effects have been observed in rats and mice administered 1,4-dichlorobenzene by gavage; these effects included cloudiness, swelling, necrosis, porphyria, and increased liver weight. Renal lesions have also been reported in rats and mice receiving 1,4-dichlorobenzene by gavage; in some studies, multi-focal degeneration and necrosis occurred. Effects on bone marrow, nasal turbinates, small intestine, spleen, and thymus have also been described in rodents. Changes in weight of spleen, liver, heart, kidney, and lungs were noted in rats exposed by inhalation, as well as liver and kidney lesions, pulmonary edema and congestion, and reversible changes in the eye. Abnormal mitotic division has been induced in higher plants.	The carcinogenic classification of this compound has not been determined. In rats administered 1,4-dichlorobenzene by gavage renal and liver adenocarcinomas developed in males. Liver adenomas and carcinomas appeared in male and female mice. In one study, no fetotoxicity or teratogenicity occurred in rabbits.	

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1,1-Dichloroethene (Vinylidene chloride; 1,1-DCE)	Contact may irritate or burn the skin, is irritating to the eyes and may cause conjunctivitis and transient corneal injury. Inhalation of high concentrations produces CNS depression resulting in poor coordination, stupor, drunkenness, and unconsciousness. Narcosis has been noted at concentrations exceeding 4,000 ppm.	Inhalation may produce hepatic and renal dysfunction. Low-level oral or inhalation exposure produces symptoms similar to acute exposure. It was shown to be mutagenic in several bacterial test strains. It was also shown to be non-mutagenic in chinese hamster cells. Rats exposed by inhalation for six hours daily, five days per week, for 18 months at 25 or 75 ppm showed a target organ effect on the liver. The liver lesions, however, were reversible, as they disappeared during the last six months of the study after exposures had been discontinued.	1,1-DCE is classified as a possible human carcinogen, based on tumors observed in one mouse strain after inhalation exposure. It is mutagenic for Salmonella typhimurium in multiple assays. 1,1-DCE is structurally related to vinyl chloride, a known human carcinogen.	No toxic levels have been reported. A human study of 138 employees exposed to 5 to 20 ppm showed no changes in mortality or health parameters.
trans-1,2-Dichloroethene (*trans*-1,2-DCE)	Inhalation exposures have caused cardiovascular effects (heart enlargment at 3000 ppm) and hepatic degeneration (200 ppm), as well as respiratory toxicity. Inhalation causes nausea, vomiting, weakness, tremor, epigastric cramps, and CNS depression.	Inhalation exposure (200 ppm) in rats degeneration of the liver. Organ specific toxicity has not been observed in animals via the oral route of exposure.	Cancer effects have not been studied in humans or animals. The *trans*-isomer was not mutagenic to *Escherichia coli* strain k-12 in culture medium containing mouse liver microsomes. Additionally, it was not mutagenic in tests using *Salmonella typhimurium* strains in vitro without metabolic activation, nor in vivo with metabolic activation (host-mediated assay), nor in a cytogenetic analysis of bone marrow cells from female mice after single and repeated injections.	Human and animal studies are limited. Human studies have been limited to the neurological effects from inhalation exposure. Dichloroethene is largely excreted through the lungs.

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cis-1,2-Dichloroethene (*cis*-1,2-DCE)	This chemical is toxic via all exposure routes. It is an irritant of the skin and mucous membranes. Inhalation causes nausea, vomiting, weakness, tremor, epigastric cramps, and CNS depression. Ingestion also causes CNS depression. In general, the liver is the primary target organ.	Little toxicological information is available on cis-1,2-DCE. Inhalation exposure was shown to cause decreased drug metablolism in the liver.	This is not known to be carcinogenic in humans or laboratory animals. This isomer was not mutagenic in the Salmonella/microsome preincubation assay using five different strains, in both the presence and absence of rat and hamster liver. In a host-mediated assay using *Saccharomyces cerevisiae*, the *cis*-isomer showed evidence of mutagenic activity. The *cis*-isomer also induced unscheduled DNA synthesis in isolated hepatocytes.	
1,3-Dichloropropene	Nausea, vomitting, irritation of the skin and mucosa, breathing difficulties, headache, and fatigue were noted in humans who had inhaled 1,3-Dichloropropene.	Pregnant rats gave birth to fewer than expected rat pups when exposed to 1,3-DCP vapors.	Stomach cancer was noted in rats and mice that ingested 1,3-DCP in food.	
Ethylbenzene	Acute toxicity is low. Low-level ingestion or inhalation exposure causes irritation of the eyes, nose, throat, skin, and mucous membranes. At high levels of exposure the irritating effects are more pronounced and the exposed subject may feel week, dizzy, and drowsy.	Histopathologic changes in the liver and kidneys, and narcotic effects were noted in oral and inhalation animal studies. Inhalation exposure to concentrations of up to 1,000 ppm did not induce embryotoxicity, phytotoxicity, or teratogenicity in rats or rabbits. No adverse health effects were noted in human volunteers inhaling vapors at 100 ppm for eight hours.	Cancer potential is not indicated. Mutagenicity has not been demonstrated in this chemical.	Inhalation is the primary route of exposure.

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Methylene chloride	At high levels, it is a CNS depressant producing behavioral and performance deficits, depression, and coma, as well as toxicity to the liver, kidneys, and cardiovascular system. The CNS and liver are the primary target organs.	Oral exposure to drinking water resulted in changes in the blood and liver of rats. The potential for teratogenicity is low.	Methylene chloride is a probable human carcinogen based on evidence of carcinogenicity from inhalation bioassays using rats and mice, and lack of evidence in humans. Rats developed benign mammary gland neoplasms, and mice alveolar/bronchiolar and hepatocellular neoplasms. No conclusive association between exposure and incidence of liver or lung tumors found from human epidemiological studies. It is judged to be weakly mutagenic.	Methylene chloride is lethal to humans if swallowed or inhaled. It is absorbed through and is distributed rapidly from lung and gut, and is highly lipid-soluble.
N-Nitroso-di-N-propylamine	NA	NA	This chemical belongs to a class of chemicals (Nitrosoamines) that are known to cause cancer in humans and animals. In rats,liver tumors have developed from ingesting this chemical in water.	

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Tetrachloroethene (Perchloroethylene, PCE)	PCE is a central and peripheral nervous system depressant producing dizziness, confusion, headache, and nausea. It is also an irritant of eyes and mucous tissue. Overexposure can cause malaise, dizziness, fatigue, headache, lightheadedness, sweating, staggering, inebriation, and mental dullness which most often clear rapidly when the victim is moved to fresh air. Transient liver and kidney damage in humans has been associated with high dose exposures. Workers rendered unconscious for hours have survived without sequelae.	Dermal blistering and dermatitis may occur with repeated direct skin contact. Chronic inhalation exposure has been associated with the development of peripheral neuropathies. Occupational exposure has resulted in hepatitis, confusion, disorientation, muscle cramps, fatigue, and agitation. Chromosome abnormalities were seen in lymphocytes from exposed workers. In one study, no fetal toxicity or teratogenicity was detected from pregnant rats and mice exposed to 300 ppm PCE. However, fetotoxicity and developmental abnormalities have been described in other experimental animals. PCE is a proven hepatotoxin in mice.	PCE is carcinogenic in experimental animals, but epidemiologic evidence from studies of laundry and dry cleaning workers has been judged to be inadequate in the assessment of its potential for human carcinogenicity. It was not mutagenic in two strains of *Salmonella typhimurium*, but was mutagenic in a test using L5178Y mouse lymphoma cells, and is considered to be a weak mutagen.	PCE is readily absorbed and eliminated from the body via the lung. Metabolism of PCE is relatively slow, with only a few percent of the total dose being excreted as metabolites. An autopsy after a fatal PCE exposure revealed an eight-fold greater concentration in the brain than in the blood.
Tetrahydrofuran (THF)	The effects generally associated with exposure to THF is narcosis and hepatocellular dysfunction. However, THF is considered a relatively weak toxin with the potential for liver toxicity being evident only at high doses via ingestion and inhalation.	No evidence exists for THF having a genotoxic effect in bacteria or mammalian cells.	Ongoing bioassay test (by the NTP) have not been completed.	THF inhibits a number of enzyme reactions at concentrations ranging from 10 to 100 mM. It has also been noted to enhance the absorption of other compounds.

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Toluene	Toluene appears to produce reversible effects upon liver, renal, and nervous systems. Lower-level acute exposures in humans produce dizziness, exhilaration and confusion. High-level toluene exposure (or exposure in confined areas) has produced incoordination, ataxia, unconsciousness and eventually, death. Ingestion of toluene probably causes transient CNS depression. Ingestion may also result in a burning sensation of the oropharynx and stomach followed by nausea, vomiting (including hematemesis), and abdominal pain. Inhalation may result in bronchial and laryngeal irritation, upper bronchial lacrimation, and respiratory failure. However, concentrations in air of up to 800 ppm have caused only slight irritation to the human eye.	Profound muscle weakness secondary to hypokalemia may be noted following chronic inhalation. Hallucinations may be noted, especially following repeated inhalation. Rats exposed to 1,500 mg/cu m of air showed no signs of teratogenic effects.	No skin tumors developed in several strains of mice painted with toluene. A chronic bioassay of toluene in rats of both sexes reported no carcinogenic effects. Toluene did not change the number of sister-chromatid exchanges or chromosomal aberrations in human lymphocytes in vitro. It is non mutagenic in *Salmonella typhimurium* strains TA1535, TA1537, TA1538, TA98 and TA100 in the Ames assay, both with and without metabolic activation, and has been provisionally classified as non-mutagenic.	The nervous system appears to be the most sensitive to the effects of toluene. Lethal levels in human blood are reported to be 10.0 μg/ml. Human death has resulted from exposure to toluene at 10,000 ppm.

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1,1,1-Trichloroethane (1,1,1-TCA)	1,1,1-trichloroethane is a CNS and respiratory depressant, and a skin and mucous membrane irritant. Contact with eyes will result in chemosis and hyperemia. Following extreme acute exposure, hypotension and cardiac arrhythmia due to myocardial sensitization have occurred. Trichloroethane has a rapid anesthetic action. Acute overdoses may cause dizziness, unconsciousness and coma. Cerebral hypoxia has been reported. Human males exposed to 1,1,1-TCA at concentrations of up to 1,000 ppm experienced transient mild irritation and minimal impairment of coordination. However, at concentrations below 1,000 ppm, perceptual speed and manual dexterity were impaired. Nausea, vomiting, diarrhea, and burns of the esophagus have been noted after large ingestion exposures. May cause transient increases in liver enzyme levels and renal impairment. Extreme exposure may have adverse effects on the cardiac system.	Inhalation exposures in laboratory animals caused increased liver weights and fatty changes in the liver. Oral exposure of animals up to 5615 mg/kg-day (mice) and 1500 mg/kg-day (rats) did not result in organ specific toxicty; however, 2807 mg/kg-day decreased survival in mice exposed chronically. Prolonged dermal exposure has caused transient mild to severe dermatitis in humans. Chick embryo malformations were noted from air space injections of 1,1,1-TCA. It tested negative for teratogenicity and mutagenicity in a two-generation reproductive study performed on ICR Swiss mice and has proven to be non-fetotoxic in mice and rats.	Three out of 49 male rats ingesting high doses of 1,1,1-TCA developed liver-cell adenomas, and one rat developed hepatocellular carcinomas. It is not classifiable as to human carcinogenicity. 1,1,1-TCA showed mutagenic activity when tested by the *Salmonella*/microsome test, the basic test on *Drosophila*, and the micronucleus test on mouse bone marrow.	1,1,1-TCA levels in human blood above 1.0 to 1.5 mg/100 ml can result in death. From the available data, it can be estimated that a single exposure to concentrations of 1,1,1-TCA less than 5,000 ppm is probably not life-threatening to humans. Inhalation and lung absorption is the most important and rapid route of intake into the body. Unlike other chlorinated hydrocarbons, it has not been associated with evidence of liver or kidney damage.

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Trichloroethene (TCE)	TCE is toxic by ingestion, inhalation or dermal exposure. Optic neuritis and blindness have been reported following ingestion. Eye exposure to 160 ppm causes pain and irritation, but permanent injury is unlikely. Respiratory depression and cyanosis, and pulmonary hemorrhage and edema have been reported following ingestion and inhalation, respectively. TCE is a CNS depressant, producing headaches, dizziness, tremors, nausea and vomiting, fatigue and incoordination (full narcosis was noted at exposure concentrations of 2,500-6,000 ppm). Cases of severe liver necrosis have been reported as a result of anesthetic use of TCE. Renal failure may occur following oral or inhalation exposure to TCE. TCE is mildly irritating to the skin.	Prolonged exposures produce irritation of mucous membranes, and have been associated with impairment of peripheral nervous system function, persistent neuritis and temporary loss of tactile sense and paralysis of the fingers after direct contact with the solvent. Chronic exposure may produce varying degrees of dermatitis. Trigeminal nerve impairment has been noted in individuals chronically exposed to TCE. TCE was embryotoxic in rats at 131 ppb concentration in water.	TCE is a probable human carcinogen based on hepatocellular tumors observed in mice. Epidemiological studies in the late 1970s and early 1980s indicated that there were no increased cancer incidence associated with human occupational exposure to TCE. These studies were considered by EPA to be limited by the lack of exposure data, limited sample size and exposure to multiple substances. In the largest study to date, a retrospective cohort study of 6,929 workers exposed to TCE at an aircraft maintenance facility did not show any significant or persuasive association between TCE exposure and excess of cancer. Women employed in areas in which fabric cleaning and parachute repair were performed had more deaths than expected from multiple myeloma and non-Hodgkin's lymphoma. The investigators concluded that it was difficult to ascribe these excess cancers to any chemical, due to inconsistent mortality by sex, multiple and overlapping exposures and small numbers of exposed individuals. The result of this study was concluded to be consistent with the results of previous epidemiological studies of worker exposure to TCE. It has been shown to be mutagenic in vivo and in vitro.	The lowest concentration that produces unconsciousness in adult humans is 16 mg/l; the equivalent oral dose is 40-150 ml. Lethal blood levels range from 3 to 110 μg/ml in human blood, with an estimated fatal oral dose of 3 to 5 ml/kg.

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Vinyl chloride	This compound may cause CNS depression, fatigue, headache, vertigo, ataxia, euphoria, visual disturbances, numbness and tingling in the extremities, narcosis, loss of consciousness, and death from respiratory failure. Additionally, various pulmonary abnormalities have occurred including dyspnea, asthma, and pneumonoconiosis. Nausea, vomiting, diarrhea, and severe epigastric pain can result from ingestion of the liquid. Angiosarcoma, hepatomegaly, and splenomegaly have been reported as toxic effects of this agent.	Fetotoxicity and congenital malformations have been seen in animals.	Vinyl chloride is a human carcinogen. Vinyl chloride can induce angiosarcoma, a rare form of liver cancer. Cancers of the brain, lung, and blood and digestive systems, and melanoma have also been documented. Vinyl chloride has induced DNA damage, unscheduled DNA synthesis, DNA inhibition, mutations, chromosome aberrations, sister chromatid exchanges, micronuclei, and oncogenic transformation in a variety of in vivo or in vitro assays.	There may be a long latency period between initial exposure and the onset of symptoms.
Xylenes (o-Xylene, m-Xylene, and p-Xylene)	Industrial exposure to vapors in confined areas has resulted in collapse, coma, and death. Acute ingestion of xylene solvents probably causes transient CNS depression. Inhalation may result in bronchial and laryngeal irritation and lacrimation; respiratory failure and cardiac arrhythmia may also occur. Ingestion may result in a burning sensation of the oropharynx and stomach, nausea, vomiting (including hematemesis), and abdominal pain. Transient liver injury may be noted.	Animal studies have shown xylene to be both fetotoxic and teratogenic in several mice species at high doses. An increase in tumor incidence or response was not found in rats or mice ingesting technical grade xylene mixtures. Bioassays for mutagenicity have shown both positive and negative results. Myoglobinemia, proteinuria, oliguria, rhabdomyolysis, and acute renal failure may be noted especially following repeated inhalation or accidental ingestion.	Xylenes are not classifiable as to human carcinogenicity.	Blood concentrations of 3 to 40 μg/ml are likely to cause death in humans. Xylenes are absorbed readily through the skin, mucous membranes, and pulmonary system, where they are translocated through the vascular system, and have been reported to cross the human placenta.