Golder Associates Inc.

200 Century Parkway, Suite C
Mt. Laurel, NJ 08054
Tel: (856) 793-2005
Fax: (856) 793-2006
www.golder.com

FEASIBILITY STUDY FOR OPERABLE UNIT 3
NEASE CHEMICAL COMPANY
SALEM, OHIO

REVISION 1

Prepared for:

RÜTGERS Organics Corporation
201 Struble Road
State College, Pennsylvania

Prepared by:

Golder Associates Inc.
200 Century Parkway, Suite C
Mount Laurel, NJ 08054

DISTRIBUTION:

4 Copies	U.S. Environmental Protection Agency
2 Copies	Ohio Environmental Protection Agency
3 Copies	RÜTGERS Organics Corporation
2 Copies	Golder Associates Inc.

June 2008 Project No.: 933-6154

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF CONTENTS (continued)

LIST OF FIGURES

TABLE OF CONTENTS (continued)

LIST OF FIGURES (continued)

LIST OF APPENDICES

ACRONYMS

AOC	Administrative Order by Consent
ARAR	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
COC	Contaminant of Concern
COPCs	Chemicals of Potential Concern
CRZ	Contaminant Reduction Zone
CSM	Conceptual Site Model
CTE	Central Tendency Exposure
DMC	Excavated/Dredged Sediment
DSW	Division of Surface Water
EA	Endangerment Assessment
EPA	Environmental Protection Agency
FS	Feasibility Study
ft. MSL	Feet Above Mean Sea Level
GRA	General Response Actions
HHRA	Human Health Risk Assessment
IAR	Impact Assessment Report
IBI	Index of Biotic Integrity
IC	Institutional Control
ICI	Invertebrate Community Index
ISC	In-Situ Capping
I_{wb}	Index of Well-Being
LOAEL	Lowest Observed Adverse Effect Level
LTRA	Long-Term Removal Actions
MFLBC	Middle Fork Little Beaver Creek
mg/kg	Milligram per Kilogram
MNR	Monitored Natural Recovery
MPK	Mirex, Photomirex, and Kepone
msl	Mean Sea Level
NCP	National Contingency Plan
NOAEL	No Observed Adverse Effect Level
O&M	Operation and Maintenance
OAC	Ohio Administrative Code
ODOT	Ohio Department of Transportation
ORC	Ohio Revised Code
OU	Operable Unit
PCB	Polychlorinated Biphenyls
PDI	Pre-Design Investigation
PPM	Parts Per Million
PRG	Preliminary Remediation Goal
QA/QC	Quality Assurance/Quality Control
QHEI	Qualitative Habitat Evaluation Index
RAO	Remedial Action Objective
RI	Remedial Investigation
RM	River Mile

RME	Reasonable Maximum Exposure
ROC	RÜTGERS Organics Corporation
SSL	Soil Screening Level
STL	Severn Trent Laboratories, Inc.
SVOC	Semi-volatile Organic Compound
SWAC	Surface-Weighted Average Concentration
TBC	To Be Considered
TOC	Total Organic Carbon
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VAP	Voluntary Action Program
VOC	Volatile Organic Compound
WWH	Warmwater Habitat
WWTP	Waste Water Treatment Plant

Guide to Data Qualifiers:

Some analytical results are presented with a letter following the concentration value. These are data qualifiers assigned to the result by the analytical laboratory or by a data validator. The following are some common data qualifiers that may be used in this text - note that sometimes qualifiers are combined to create new meanings.

J	Quantitation is approximate due to limitations identified during data validation
U	indicates that a compound was not detected above its detection limit
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification
R	Unreliable result - analyte may not be present in this sample

1.0 INTRODUCTION

1.1 Overview

This Feasibility Study (FS) has been prepared by Golder Associates Inc. (Golder Associates), on behalf of RÜTGERS Organics Corporation (ROC) for Operable Unit 3 (OU-3) of the Nease Chemical Site, Salem, Ohio (Site). The location of the Site is shown on Figure 1. OU-3 consists of contaminated portions of Feeder Creek (located at the former Nease Chemical Facility) and Middle Fork Little Beaver Creek (MFLBC), including associated floodplain soils. The FS has been prepared in accordance with United States Environmental Protection Agency (USEPA) Guidance for Conducting Remedial Investigations and Feasibility Studies (RI/FS) under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; USEPA, October 1988) and the relevant agency guidance including Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites (USEPA, 2002) and USEPA's Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (USEPA, 2005a). Administratively, the FS is submitted in accordance with the requirements of the January 1988 Administrative Order by Consent (AOC).

The FS builds upon the results of the previous Remedial Investigation (RI) for the Site. The RI Report was approved by USEPA and the Ohio Environmental Protection Agency (Ohio EPA) on June 19, 1996. The final Endangerment Assessment (EA), which also forms part of the RI, and includes the Human Health Risk Assessment (HHRA) and the Ecological Risk Assessment, was approved by USEPA and Ohio EPA (collectively, the Agencies) on August 30, 2004.

The overall objective of this FS is to provide the technical basis for selection of a remedy for OU-3 that will be protective of human health and the environment and consistent with the National Contingency Plan (NCP). Operable Unit 1 (OU-1) of the site encompassed Long-Term Removal Actions (LTRA) that were the subject of a separate AOC that was entered in 1993. OU-1 actions included a shallow groundwater extraction and treatment system and sediment migration controls that have been operational since 1995. OU-2 is defined as the permanent remedy for potential source areas, including soils and groundwater, and a Record of Decision (ROD) was issued for OU-2 on September 29, 2005. The design of the OU-2 remedy is currently under development, concurrent with this FS and USEPA's remedy selection for OU-3.

Specific objectives of this FS are to:

- Develop and present a sound Conceptual Site Model (CSM), including the physical site setting, and the nature, extent, fate and transport of chemical impacts within that setting;
- Identify Remedial Action Objectives (RAOs) for media that have been identified as impacted with chemical constituents of potential concern (COPCs);
- Develop general response actions and identify, screen, and select remedial technologies and process options that address the RAOs;
- Assemble the retained technologies into a list of potential OU-3 remedial action alternatives; and
- Screen, and conduct a detailed analysis of the retained OU-3remedial action alternatives, and provide a comparative analysis of these alternatives.

An introduction to the CSM, RAOs, and the identification and screening of remedial technologies/process options was submitted by Golder Associates, on behalf of ROC, in an interim deliverable to the Agencies on November 29, 2007. The Agencies provided written comments on the interim deliverable on January 23, 2008 and this FS incorporates changes that address those comments.

2.0 CONCEPTUAL SITE MODEL

2.1 General Site Description

Figure 1 shows the location of the Site (including the former manufacturing facility and the MFLBC). The former Nease Chemical Site included a manufacturing area west of the Conrail Railroad tracks and wastewater ponds on both sides of the railroad tracks. Historically, Crane-Deming owned adjacent property between the railroad tracks and Allen Road. In 1998 ROC took ownership of this property, including the production building, with Crane-Deming continuing to lease and operate its pump manufacturing facility on the property. ROC subsequently sold a portion of the property north of the railroad tracks, including the former Crane Deming building, and MAC Trailer Company now manufactures trailers at this location.

Feeder Creek, which flows from the former manufacturing facility to the MFLBC, originates close to the railroad tracks and merges with several drainage ditches en route to its confluence with the MFLBC at Allen Road. Feeder Creek is the main route for surface water drainage from the former Nease facility to the MFLBC. As such, it likely represented the primary transport route for Site-related contaminants to enter the MFLBC system.

The MFLBC flows northeast from its source southwest of the former Nease facility, passing to the east of the Nease facility; the Nease facility (defined as where Feeder Creek meets the MFLBC) is at about River Mile 37.6. The facility is on a topographic high and ground generally slopes towards the creek. The MFLBC flows north out of the City of Salem through Mahoning County, turns to the east, and then flows south through Columbiana County until it joins West Fork Little Beaver Creek and North Fork Little Beaver Creek to form Little Beaver Creek. Little Beaver Creek flows south to the Ohio River at East Liverpool. The MFLBC extends approximately 40.6 river miles with an average gradient of 11.8 feet per mile (Ohio EPA, 2005), and drains a total area of approximately 496 square miles (RNC, 1996). The MFLBC is divided into two different use classifications according to the Ohio Revised Code (ORC) 3745-1-15. The MFLBC is classified as Warmwater Habitat from the headwater to the spillway at Lisbon (River Mile 12.5). From River Mile (RM) 12.5 to the mouth is classified as Exceptional Warmwater Habitat. All waters of the MFLBC are designated for agriculture, industry, and primary contact uses, but none are designated for “drink” use.

2.2 Previous Investigations and Actions

2.2.1 Previous Investigations Completed

The following sections describe investigation activities that have been conducted in OU-3. Results from these investigations, including physical, biological, and chemical conditions are discussed in Section 2.3. Table 1 summarizes the sources of chemistry data discussed in this FS.

Remedial Investigation – 1987-1996

The initial RI for the MFLBC was conducted in 1987-1995 (RNC, 1996). During the RI, a total of 61 sediment samples, 57 fish tissue samples, 118 floodplain soil samples, and 28 surface water samples were collected along the MFLBC and in other surface water bodies near the Nease facility including Slanker Pond and Feeder Creek. Samples were analyzed for a wide array of compounds, including volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, and pesticides (including mirex, photomirex, and kepone). Figures showing the locations of RI samples are included in Appendix A. As part of the MFLBC sampling program, a detailed mapping of sediment bodies was also conducted from river mile (RM) 38.5 to RM 21.5.

Beef and Milk Sampling – 1987-1998

During the RI period, chemical analyses of beef and milk fat from Grade A Dairy farms located along the MFLBC were performed by the Ohio Department of Agriculture to assess possible mirex uptake associated with exposure to floodplain soils and access to the creek. Mirex concentrations ranged from non-detect to 0.2 mg/kg in milk fat and up to 1.75 mg/kg in beef fat. Soil sampling conducted on the three dairy farms in 1989 showed mirex concentrations up to 6.3 mg/kg. Fences were installed along the MFLBC at two of the dairy farms (at RM 35 and 33.3) where some of the milk and beef fat samples had exceeded the then current FDA action level of 0.1 mg/kg[1]. At the third dairy farm, existing fencing previously installed by the farmer excluded cattle from the area of the floodplain with the highest mirex levels and from the creek itself and beef and milk samples collected from that farm had trace levels of mirex that did not exceed the action level. Subsequent beef and milk samples collected between 1990 and 1998 showed no evidence of mirex.

---

[1] The FDA action level of 0.1 mg/kg refers to an action level that was used in 1989-1990; however, the FDA does not currently list an action level for mirex in beef or milk fat.

Feeder Creek Sediment Investigation – 1996

Further investigation of sediment in Feeder Creek was conducted in October-November 1995 at various locations and depth intervals. These results are summarized in Figure 2.

MFLBC Assessment – 1999-2001

In 1999, Ohio EPA and Golder jointly conducted a field investigation of the MFLBC that included sampling and chemical analysis of sediment and fish tissue as well as a comprehensive biocriteria assessment of the MFLBC involving fish community, benthic macroinvertebrate community and habitat surveys conducted by Ohio EPA specialists. The results of this investigation were provided in the *Middle Fork Little Beaver Creek Impact Assessment Report*, prepared by Golder (2000). A figure showing sample locations from this investigation is included in Appendix A.

Additional fish tissue samples were collected separately by the Ohio EPA in 1999 and 2001. In a letter dated December 16, 2002, Dr. John Estenik of Ohio EPA provided a description of the 1999 Ohio EPA sampling and provided tables of data for the 1999 and 2001 sampling events. In 1999 40 fish tissue fillet samples were collected throughout the Little Beaver Basin and analyzed by Ohio EPA. Seventeen samples were collected from three locations in the Middle Fork Little Beaver Creek, 20 from three locations in Little Beaver Creek, two from one location in the North Fork Little Beaver Creek, and one from one location in the West Fork Little Beaver Creek.

Various Sediment and Floodplain Investigations 2003-2005

Between 2003 and 2005, ROC conducted several additional sediment and floodplain soil sampling events to address questions regarding various activities related to the MFLBC.

In December 2002, Columbiana County requested information about possible mirex contamination in a sand bar located downstream of the Franklin Square bridge at approximately River Mile 20.9 (see Figure 3). ROC responded by proposing to collect samples from the sand bar and have them analyzed for mirex, photomirex, and kepone (MPK). Samples were collected in July 2003 and analyzed for MPK, none of which were detected. The results of this investigation were submitted to the Agencies in a letter from Golder dated September 26, 2003.

In December 2004, ROC responded to a request from the Ohio Department of Transportation (ODOT), which planned to remove accumulated material from a drainage ditch that runs along

State Route (SR) 165 in the vicinity of the MFLBC. Previous mirex sampling data suggested that there was little risk from mirex contamination in this area, however, ROC proposed to collect six samples from the drainage ditch for MPK analysis (see Appendix A for sample locations). Mirex was detected in two out of the six samples, with a maximum concentration of 0.0382 mg/kg. The results of this sampling were reported to the Agencies in a memorandum dated June 2, 2005.

In March 2005, ROC responded to a request from the Boy Scouts of America regarding an area near the MFLBC at RM 13.3 known as Camp McKinley, that is used for scout outings. Four soil samples from the area were collected in May 2005 (see Appendix A for sample locations) and analyzed for mirex and photomirex; none was detected. The results of this work were reported to the Agencies in a memorandum from Golder dated July 8, 2005.

Sediment Body Mapping Investigation - 2005

An additional sediment body mapping investigation was conducted on the MFLBC in 2005 to update the results from the RI period, and to extend the sediment body mapping downstream to the Lisbon dam.

To verify that stream morphology and sediment depositional areas identified in the RI study had not changed materially since the RI mapping, several locations where high mirex concentrations and/or large fine-grain sediment bodies were previously identified during the RI were selected for evaluation. Field personnel re-mapped fine-grained sediment body dimensions and thicknesses in these areas and confirmed that the general stream morphology had changed very little and that fine-grained sediment bodies had not shifted significantly since the previous sediment mapping effort was conducted.

From RM 21.9 to RM 12.5, a detailed mapping of fine-grained sediment bodies was conducted by visual identification measuring length and width and probing thickness using a stainless steel rod. Additionally, the general shape of the body was recorded and the sediment material was described. Significant sediment deposition was identified at three locations along this stretch of the creek – at Lisbon Dam (RM 12.5) and farther upstream at RM 17.5 and RM 23.6. The results of this investigation were tabulated and added to the MFLBC database that was distributed to the Agencies.

Sediment, Fish Tissue, Floodplain Soil, and Surface Water Sampling – 2005-2006

Sediment, fish tissue, and surface water sampling were conducted in October of 2005. A total of 21 sediment, 22 fish tissue, and 8 surface water samples were taken from the MFLBC (see Figure 3 for sample locations). The sediment samples were analyzed for grain size distribution, mirex, photomirex, and kepone (MPK), and total organic carbon (TOC). The fish tissue samples were analyzed for percent lipids and MPK. Surface water samples were analyzed for MPK and total suspended solids (TSS). Ohio EPA cooperated with ROC on the field program and collected 5 split samples of sediment and a total of 22 samples of fish tissue. The majority (19 out of 21) of the sediment samples were collected from surficial sediments within the top 6 inches; however, deeper sediment samples were collected from two locations, RM 12.5 and RM 23.6, to determine whether mirex contamination was being buried in highly depositional areas by less contaminated sediment. Mirex was not detected in either of the deeper sediment samples collected, indicating that there has not been significant mirex burial in those areas. A data quality evaluation of the split samples collected during this investigation indicated that the analytical results from Ohio EPA's laboratory may be more reliable for fish and sediment, and so these data, together with the original RI data, are being used preferentially in the evaluation of remedial alternatives.

In the fall of 2006, surficial (0 to 6 inches below ground surface) soil samples were collected from the floodplain in 13 areas along the creek to establish current mirex levels in soils at selected locations within the floodplain of the MFLBC. Composite sampling techniques were used to obtain a representative measure of exposure associated with floodplain soil at each of the locations and to account for both compositional and distributional heterogeneity. The soil samples were analyzed for MPK and TOC.

Ohio Sport Fish Advisory Program

Ohio EPA maintains a Sport Fish Tissue Consumption Advisory Program throughout the State of Ohio (see Appendix D). Fish tissue and sediment samples are taken on a routine basis to assess potential human health risks associated with consuming fish tissue from surface water bodies. Based on analyses of fish tissue in the MFLBC, there are currently three fish species for which a fishing advisory is in place on the MFLBC from Allen Road in Salem (RM 37.6) to the mouth at Little Beaver Creek (RM 0). The current advisory recommends consuming no more than one meal per month of common carp and sauger based on polychlorinated biphenyl (PCB) contamination, and no more than one meal per month of freshwater drum due to mercury contamination. The one meal per month advisory on common carp is also based on mirex concentrations from Allen Road (RM 37.6) to State Route 14 in Millville (RM 25.6). In addition to these MFLBC-specific advisories, there is a state-wide advisory against consuming more than one-meal per week of any sport fish due to mercury contamination (Ohio EPA, 2008). PCB and mercury contamination are not related to the Nease Site and are therefore not the focus of this FS.

2.2.2 Previous Remedial Actions Completed

ROC has completed various interim remedial actions including Removal Actions in 1983, 1991, and on-going Operation and Maintenance (O&M) activities. These actions were primarily conducted for OU-2 purposes, including removal of drums and contaminated soils and sludges, and installation of a shallow groundwater treatment system. However, in addition to these actions, measures were taken to mitigate future releases of contamination into OU-3 (Feeder Creek and the MFLBC) as described below.

Interim Action, 1983

In response to concerns relating to the potential for sediments leaving the property and to prevent or minimize soil erosion, a number of steps were taken, which included: seeding of a former area to establish a grass ground cover; installation of hay-bale sediment barriers; and, installation of geotextile fabric barriers and rock dams across drainage swales and fresh water ditches.

Interim Action, 1991

In late 1991, ROC instituted further interim remedial actions at the property. These measures included the construction of berms and associated sediment control/outlet structures. The sediment control outlet structures have multiple features to trap and remove sediment (ROC, 1990). These features include silt fences, stone ballast berms, aggregate berms, filter fabrics, and perforated corrugated metal pipes. In addition, surface drainage channels were constructed to capture and divert unimpacted surface water runoff draining onto the property from the west away from the on-facility sources. In this way, sediment control measures handle a reduced quantity of run-off. All surface drainage channels were designed to accommodate any flows resulting from a 25-year, 24-hour storm event. Affected areas were seeded as part of the construction and since that time a vegetative cover has developed.

Periodic maintenance, including access controls, surface water drainage system, and general maintenance and inspection, is completed at the property.

2.3 Investigation Results

2.3.1 MFLBC Physical Conditions

A detailed description of the MFLBC habitats and physical conditions can be found in the RI report (RNC, 1996). Gradients of the MFLBC range from about one foot per mile to about 50 feet per mile and widths range from 10 feet to 120 feet. The average stream velocity measured during the RI was less than 0.5 meters per second, with a peak discharge of 40 cubic feet per second (cfs) above the Lisbon Dam and 300 cfs below. The MFLBC substrate includes bedrock outcrops, rubble-gravel-boulders, sand, silt, and clay at various locations, and Appendix B contains the results of sediment body mapping and classification.

From RM 38.3 to approximately RM 29, where the stream enters an area known as Egypt Swamp, sediment accretion rates are generally constant, with a steadily increasing cumulative sediment volume as shown on Figure 4. Total sediment volumes increase sharply within Egypt Swamp, likely due to decreased stream gradients (see Figure 5). The stream and its floodplain also widen in this area as shown on Figure 6, resulting in lower stream velocities and more sediment deposition. After exiting Egypt Swamp, sediment accretion rates are again reduced. When coarse grained (see Figure 7) and fine grained (see Figure 8) materials are considered separately, significantly different trends emerge throughout the study area. While fine-grained materials tended to follow a similar trend to the “total” sediment volume, the coarse grained sediments exhibit a much more consistent sediment accretion rate throughout the stream length. This indicates that fine-grained sediment deposition is influenced more strongly by stream morphology, and, as expected, fine-grained sediments accumulate more in low-energy areas of the creek, such as Egypt Swamp, than in more energetic reaches such as the area near the former Nease facility. Figure 9 shows the cumulative volume of mixed-grained or medium-grained sediments and Figure 10 shows the relative quantity and approximate distribution of sediment types for each 0.1 river mile segment between RM 31 and 37.6[2], along with the maximum detected mirex concentrations at each river mile station. Overall, fine-grained sediment bodies cover approximately 14% of the total creek bed surface area within this reach.

---

[2] As presented subsequently in the FS, this reach of MFLBC is of primary interest when evaluating remedial alternatives.

Stream gradients (defined as the change in surface water elevation over a unit distance along the centerline of the stream) were measured at 38 different RM locations along the MFLBC (see Figure 5[3]) from RM 38 to RM 1.5. Steeper gradients generally correspond to higher velocity stream flows. As shown on Figure 5, stream gradients are highest upstream of Egypt Swamp (RM 29) and downstream of the public park at Eagleton Road (RM 17.5).

Creek widths were also measured during the RI. As shown on Figure 6, the stream width is relatively constant at about 10 feet until approximately RM 33.2. After this point, the stream width fluctuates between approximately 20 feet and 60 feet for the next 13 miles. After approximately RM 20.2, the stream width increases steadily to Lisbon Dam (RM 12.5). The stream width decreases downstream of the dam and then increases sharply to a maximum value of about 120 feet within the last 8 miles before the mouth.

Annual peak discharge data from 1960 to 2006 for the closest stream gauge was downloaded from the United States Geological Survey (USGS) website to determine the timing of significant storm events on the creek. The most relevant stream gauge is located at East Liverpool on Little Beaver Creek at the confluence with the Ohio River. This stream gauge is located far downstream of the mouth of the MFLBC, so the discharge rates at this point are much higher than actual flows of the MFLBC, however, the data can still be used to identify significant storm events (such as hurricanes). As shown on Figure 11, three separate years, 1964, 1990, and 2004, had recorded peak discharges of about 20,000 cfs and greater, while data from all other years showed peak discharges of around 10,000 cfs and less. The timing of sediment and floodplain sampling events are also shown on Figure 11. Comparing stream data from before and after high energy storm events such as those shown in 1964, 1990, and 2004 provides information on whether sediment scouring causes significant downstream transport, or modified deposition of sediments that could result in redistribution of contaminants. As indicated, sediment and floodplain soil sampling activities occurred both before and after the two most recent high energy flood events. As noted in Section 2.2.1, no significant changes in stream morphology and distribution of fine grained sediment was observed as a result of these flood events.

---

[3] Points lying in between the measured values were estimated by interpolation.

2.3.2 MFLBC Biological and Habitat Conditions

A detailed description of habitat and wildlife along the MFLBC was provided in the RI report (RNC, 1996). In addition, the Ohio EPA Division of Surface Water (DSW) routinely performs studies to assess the quality of aquatic life and habitat in various waterbodies throughout the state. DSW uses three metrics, known as biocriteria, to assess the health of aquatic biological communities, and a separate numerical index, known as the Qualitative Habitat Evaluation Index (QHEI), to assess the quality of aquatic habitat. The three biocriteria are referred to as the Invertebrate Community Index (ICI), the Modified Index of Well-Being (Modified I_{wb}), and the Index of Biotic Integrity (IBI). Results from the various biocriteria studies that have been conducted on the MFLBC are shown on Figure 12 through Figure 14 along with the goals applied to each stream segment and ranges of insignificant departure from those goals. The results for the habitat index, QHEI, are shown on Figure 15.

Compared to biocriteria results from 1985/1987, the 1999 study results indicate that the health of ecological communities in the reach immediately downstream of the Salem Wastewater Treatment Plant (WWTP) and the former Nease facility showed significant improvement. Further downstream, it was determined that past channel modifications and influences other than the Nease Site may impact the ability to meet certain biocriteria goals. In the lower reaches, where mirex concentrations have always been very low, partial attainment of goals was also observed. Ohio EPA’s summary of designated use attainment based on biocriteria can be found in Appendix E.

As part of the Endangerment Assessment, an ecological risk assessment was conducted on Middle Fork Little Beaver Creek, including a description of the expected or known habitats and species in the area. An associated field survey, the *Ecological Habitat Inventory and Stream Survey*, provides records of major habitat types and vegetation, wetlands analysis, and observations of wildlife[4]. It has been estimated by the U.S. Forest Service that approximately 63,300 acres of Mahoning County and 147,000 acres of Columbiana County (24 and 43 percent of each county, respectively) are forested. Oak-hickory represents the dominant forest type in these two counties. A number of wetland and riparian habitat types have been found in association with the MFLBC: forested wetlands, scrub/ shrub wetlands, emergent wetlands, wetland forested overbank habitat, forested uplands (both successional and mature), upland mid-

---

[4] Results of this field study were included in Appendix N of the RI Report (Golder, 1996).

successional fields, upland early successional fields, upland forested overbank habitat, upland open grove habitat, agriculture/ pasture, and developed areas. Potential threats to the aquatic community of the MFLBC include the Salem WWTP and several small industries that discharge into the Buttermilk Creek, which is located upstream of the Nease Site. There are a variety of birds, mammals, reptiles and amphibians, and aquatic organisms, including species that are State threatened or endangered, or of special interest, that make their home in or around the MFLBC. A total of 40 species of birds were detected in the area. The American crow, belted kingfisher, black-capped chickadee, downy woodpecker, great blue heron, song sparrow, white-throated sparrow, and wood duck were all observed in more than half of the creek stretches surveyed. In order to characterize winter bird usage, data from Christmas Bird Counts conducted over a span of five years was used. Based on this information, the ten most common bird species observed during the winter included the European starling, Canada goose, mourning dove, American crow, house finch, house sparrow, rock dove, dark-eyed junco, northern cardinal, and mallard. A total of 15 species of mammals were detected in the area. The beaver, raccoon, river otter, striped skunk, Virginia opossum, white-tailed deer, and woodchuck were all observed in more than half of the creek stretches surveyed. A total of 12 species of reptiles and amphibians were detected in the area. The northern brown snake and ribbon snake were both observed in exactly half of the stretches surveyed. A total of 12 families, made up of over 50 species of fish, were qualitatively observed by fish tissue sampling conducted in 1990. Herbivores, omnivores, and carnivores were all represented among the fish sampled. In 1993, a specific survey was conducted in order to determine the presence of habitat in the MFLBC for the federally endangered Indiana bat. Studies concluded that while potentially suitable habitat was present, none of the areas of critical habitat correspond to the MFLBC.

2.3.3 Nature and Extent of Contamination

The nature and extent of contamination in the MFLBC related to the Nease Site have been extensively investigated as described in Section 2.2.1. The approved Endangerment Assessment (Environ, 2004) estimated potential risks from Site-related contamination. A total of 155 chemicals were detected in either on-facility or off-facility samples. This list was reduced to 49 chemicals for human health risk assessment based on such criteria as frequency of detection, facility-relation, availability of toxicity data, and a concentration-toxicity screen. For ecological risks, a total of 16 chemicals were assessed for potential toxicity to OU-3 receptors based on factors such as on-facility detections (or lack-thereof), background concentrations, screening benchmarks, site-relatedness, spatial distribution, frequency of occurrence in MFLBC media, and potential for bioaccumulation or biomagnification. The results of the Endangerment Assessment indicated that the only contaminant of potential concern (COPC) in the MFLBC that is related to the Nease site and which caused estimates of potential risk above USEPA's acceptable risk levels for human and ecological receptors was mirex[5] (Environ, 2004). The results of the EA are discussed in more detail in Section 3.1 as part of the development of RAOs and PRGs.

2.3.3.1 MFLBC Mirex Distribution

Sediment

The first significant sediment sampling effort on the MFLBC was conducted in 1990 as part of the RI work and included 42 sediment samples. Figure 16 shows the mirex and photomirex results from the 1990 sampling event, and indicates that the highest mirex concentrations were detected between river miles 31.4 and 35 with a maximum concentration of 1.68 mg/kg. Mirex was detected in sediments as far downstream as RM 1.9 but at much lower concentrations. Further sampling was conducted in 1993-1995 in conjunction with soil samples collected from adjacent floodplains and these results are shown on Figure 17. Mirex concentrations in 1993-1995 were consistent with those found in 1990 with the highest concentrations detected between RM 32 and RM 35.5 and a maximum detection of 1.19 mg/kg. Figure 18 shows the results of the 1999 sampling event. The results show a trend similar to the previous sampling, i.e. the highest concentrations were detected in the upstream portion of the stream near the former Nease facility and lower concentrations were measured downstream. In 2005 mirex was detected in 18 of 19 surface sediment samples collected, as shown in Figure 19. The highest detections were between RM 37 and RM 33.3 with a maximum concentration of 2.03 mg/kg at RM 35.4.

For comparison purposes, Figure 20 shows the results of all sediment mirex sampling events together. This clearly illustrates that the main area of contaminated sediment is the approximately 6.6-mile segment from RM 31 to RM 37.6. Normalizing the data according to the total organic carbon content (see Figure 21) confirms that the most significant impacts that are likely to be bioavailable[6] are from RM 31 to RM 37.6. These results suggest that there has not been a large-scale movement of mirex mass downstream, even during several high-energy storm events that have occurred since the original release.

---

[5] Photomirex is considered to have toxicological effects similar to mirex, so where applicable, photomirex concentrations and mirex concentrations have been summed for presentation on Figures.

[6] Mirex binds preferentially to organic carbon reducing its bioavailability.

Fish Tissue

Since 1987 several significant fish tissue sampling events have been conducted by both ROC and Ohio EPA[7]. The 1987 event included fillet and whole body data from both ROC and Ohio EPA and fillet data are illustrated in Figure 22. Fillet mirex concentrations ranged from non-detect to 0.37 mg/kg with no detections of mirex downstream of RM 17.5. In 1990, as part of the RI, 27 whole-body fish and 26 fish fillet tissue samples were collected from the MFLBC and other nearby surface water bodies[8]. As shown on Figure 23 mirex was detected in all MFLBC fillet samples with concentrations ranging from 0.0193 mg/kg to 1.82 mg/kg. In 1999 an additional 18 fish fillet samples were collected and analyzed by ROC and the results are summarized in Figure 24. Although reported concentrations were lower than in previous events, the distribution of mirex appears to be similar. In addition, fillet testing performed by Ohio EPA in 1997-2001 (see Figure 25) confirms that mirex concentrations have remained relatively low downstream of RM 25.5. ROC and Ohio EPA jointly collected additional fish tissue samples in 2005 in preparation for this FS. Ohio EPA's mirex results (see Table 2) show a range of concentrations from 0.0698 to 1.64 mg/kg[9] and the maximum detection was found within approximately 1 river mile of the maximum detection from the 1990 investigation (see Figure 26). This sample was the only one that exceeded 0.875 mg/kg, which is Ohio EPA's current threshold value for the 1 meal/month advisory (i.e. fish tissue concentrations below 0.875 mg/kg are safe to consume as frequently as 1 meal/week[10]).

It is important to note that the values shown on the various mirex graphs represent only the maximum detection at each location. In the case of fish tissue, multiple fish species were often collected at each sampling location. The mirex concentrations in the species not shown were often considerably lower than the maximum value shown.

---

[7] As shown in Table 1, USEPA also collected and analyzed fish tissue samples in 1987; however, USEPA raised concerns regarding the quality of these samples, and no information is available on whether fillet or whole body samples were analyzed. Given the uncertainty in these data, and with USEPA's concurrence, these data have not been used for FS purposes.

[8] Samples were collected from Slanker Pond on an adjacent property and from Stone Mill Run (a MFLBC tributaries), East Fork Little Beaver Creek, West Fork Little Beaver Creek, North Fork Little Beaver Creek, and Little Beaver Creek. None of the fillet tissue mirex concentrations in these water bodies exceeded the FDA action level of 0.1 mg/kg.

[9] As shown in Figure 24, differing results were reported by the ROC and Ohio EPA Laboratories; only Ohio EPA's data is relied upon in this FS.

[10] For other mirex advisory levels see Appendix D.

The complete fish fillet data set (i.e. all years combined) is shown on Figure 27. This graph shows that only one fish fillet sample location (from 1990) had a mirex concentration above 0.8 mg/kg downstream of approximately RM 31.5. These results confirm that the area of highest fish tissue mirex concentrations coincides with the highest mirex concentrations in sediment.

In addition to the fillet sample results described above, several investigations have included analyses of whole-body fish samples, which are relevant to ecological food chain exposure pathways. As shown on Figure 28, the most significant whole-body fish data set is from 1990, when the majority of samples showed mirex concentrations of 1.0 mg/kg and less. The only three samples that exceeded 1.0 mg/kg were of common carp, including the maximum detection of 6.2 mg/kg. Other investigations in 1985, 1987, and 2001 show similar concentrations to those measured in 1990. As shown in Figure 28, whole body samples collected in 2001 at and downstream of Lisbon Dam (RM 12.5) had concentrations of approximately 0.2 mg/kg and less.

Figure 29 through Figure 31 illustrate the relationship between fine-grained sediment bodies, mirex concentrations in sediment, and mirex concentrations in fish fillet samples. As shown, the highest concentrations of mirex in both sediment and fish are consistently detected in the upstream segment of the creek where fine grained sediment volumes are relatively low. Areas with high sediment volume, such as Egypt Swamp (see RM 29 through RM 24) generally have much lower mirex concentrations. One common carp fish tissue sample collected in 2005 from Egypt Swamp did have a mirex level of 790 ug/kg; based on the lengths of the three fish used for this sample, it is likely that these particular carp were relatively mature in age. The three fish had lengths of 506, 551, and 526 mm, which suggests they were more than 5 years old (see Appendix K). The mirex concentration in this particular common carp sample is therefore likely the result of long-term mirex accumulation in a relatively wide ranging species, and is not necessarily representative of typical mirex uptake into fish within this area of the creek.

Floodplain Soil

During the RI there were three primary phases of floodplain soil sampling. The first was in 1990 when transects across the stream were sampled. Each transect included, two samples from either bank (total of four samples per transect). This sampling approach was used to confirm that floodplain soils closer to the creek are more likely to have higher concentrations of mirex. Samples were collected as a vertical composite of the top 1 foot of soil. In August 1991 Ohio EPA collected samples from an area known as Colonial Villa (approximately RM 35.4) where there was a potential for exposure to nearby residents. Discrete samples were collected from 0-6 inch and 6-12 inch depths at each sample location. Analytical results for these samples showed mirex concentrations ranging from non-detect to 6.65 mg/kg with mirex concentrations consistently decreasing with depth. In 1993, Phase II of the RI was conducted, which included “grid” sampling in three areas along the stream (indicated on Figure 32). These areas were selected due to the expectation that there was significant deposition in these areas based on 1990 sampling results. Finally, in 1995, Phase III sampling was conducted to address areas where samples had not previously been collected. The results of floodplain soil sampling from the various investigations conducted between 1990 and 2005 are summarized on Figure 32. Each colored bar represents the maximum, average, and minimum detection at each river mile sampled.

The results from supplementary floodplain soil sampling conducted in September 2006 are shown in Figure 33. The Agencies and ROC selected several floodplain soil locations where RI results showed elevated mirex concentrations or where significant potential for human exposure exists (e.g. public parks, dairy farms, and residential areas). A total of 10 primary floodplain samples were collected as shown on Figure 33. This investigation included collecting composite samples from at least 5 discrete sample locations as shown on Figure 34 through Figure 40. Figure 41 shows TOC-normalized mirex concentrations in floodplain soil from the various investigations conducted between 1990 and 2005, and Figure 42 shows TOC-normalized mirex concentrations in floodplain soil from the 2006 investigation.

Surface Water

Seventeen samples of surface water were collected during the RI in the MFLBC. Mirex was not detected in any MFLBC surface water samples. In 2005 Ohio EPA requested that additional surface water samples be collected from the MFLBC for analysis with a detection limit not to exceed 0.001 ug/L. Ohio EPA personnel collected four surface water samples in October 2005 during a period of low flow in the stream. These samples were analyzed and were found to have no measurable mirex at the requested detection limit. In March 2006, four additional samples were collected at the same locations, but this sampling event targeted high stream flow to assess whether resuspended sediments might cause detectable mirex levels during high energy storm events. Mirex was not detected in any of these surface water samples, confirming that mirex is not a contaminant of concern (COC) in the surface water of the MFLBC. Surface water sample results are included here in Appendix F.

2.3.3.2 Feeder Creek Mirex & Photomirex Distribution

Feeder Creek is defined as the main stem shown on Figure 2 as well as the four “branches” labeled “Branch A” through “Branch D.” Surface water runoff from the former Nease facility, the former Ponds and groundwater seeps are being addressed under Operable Unit 2. It is anticipated that implementation of the remedies for OU-2 and OU-3 will be integrated so as to avoid re-contamination of Feeder Creek and the MFLBC during OU-2 actions.

Sediment

Feeder Creek sediment samples were collected during the RI and in a subsequent investigation in 1996. During the RI, sediment samples were collected from seven locations as shown on the Figure included in Appendix A. Mirex concentrations in these sediment samples ranged from 0.380 to 129 mg/kg (RNC, 1996). The maximum detection of 129 mg/kg was from a sample collected at location FC-3 (see Figure 2-17 of the RI, included in Appendix A of this report). The subsequent investigation in 1996 included depth-discrete samples from 0-3 inches, 3-6 inches, 6-10 inches, and 10-14 inches at six locations. Mirex was again detected in Feeder Creek sediment, with a maximum concentration of 0.845 mg/kg; photomirex was not detected. Depth-discrete sampling results showed that the highest mirex concentrations occurred in the top six inches of Feeder Creek sediment. Sample locations and results from the 1996 investigation are shown in Figure 2.

Surface Water

Four samples of surface water were collected during the RI in Feeder Creek. Mirex was detected in three samples at concentrations ranging from 0.0304 ug/L to 0.362 ug/L. Detections of mirex in Feeder Creek are likely due to the presence of suspended solids since mirex adheres strongly to fine-grained sediments and does not dissolve readily in water.

2.3.4 Surrounding Land Use

Residential properties are located adjacent to the former Nease facility along State Route 14. Other industrial/commercial facilities are located east and northeast of the former facility along Allen Road. The ROC property and areas to the east and northeast are zoned for industrial purposes. The properties bordering the MFLBC include residential, recreational, agricultural, and industrial/commercial uses. As shown in the aerial photograph on Figure 10, land use along the creek from RM 37.6 through RM 31 is primarily agricultural. There are two dairy farms located near RM 33 and RM 35. Colonial Villa, a residential area, is located between RM 35 and RM 36. There is also an industrial facility along SR 45 between RM 32 and RM 33.

2.3.5 Topography

The former Nease facility is located on the northeast flank of a topographic high that slopes gently to the northeast towards the MFLBC. The elevation at the former Nease facility ranges from approximately 1,160 to approximately 1,200 feet above mean sea level (ft. msl). Along the MFLBC, the topography of the banks varies extensively, from very flat areas with wide floodplains, to steep slopes with narrow floodplains. In several areas, one bank of the river has a wide floodplain while the other terminates abruptly in a steep slope (e.g. at RM 17.5). Within the reach of interest (RM 31 to RM 37.6), the floodplain width ranges from about 60 feet to about 1,000 feet (total width including stream channel) as shown on Figure 43 with an average width of about 375 feet and a total area of approximately 300 acres.

2.3.6 Site Hydrology

Surface water from the former Nease facility drains towards the MFLBC along three primary routes: the Feeder Creek system, an unnamed drainage system to the north, and the Route 14 drainage system. All of these drainage systems ultimately discharge into the MFLBC. Surface water from the large majority of the former facility, including several of the former ponds, drains to Feeder Creek (RNC, 1996).

The Middle, North, West, and East Forks of the Little Beaver Creek collectively drain the large majority of Columbiana County (approximately 96%). The drainage area of the MFLBC is approximately 496 square miles. (RNC, 1996)

During the RI, station-specific flow rates were measured as part of the MFLBC sampling program. Measured discharges ranged from 5.59 cubic feet per second (cfs) at RM 38.5 to 37.39 cfs at RM 21.7; 87.83 cfs at RM 17.5; and 822 cfs in Little Beaver Creek (RNC, 1996). These measurements occurred during a period of above average flow, the average flow recorded for the 63 years of prior record being 517 cfs at the Little Beaver Creek Station (compared to 822 cfs during the RI).

3.0 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

3.1 Endangerment Assessment Results

3.1.1 Potential Human Health Risks

The approved Endangerment Assessment for the Nease Chemical Site (Endangerment Assessment or EA; Environ, 2004) considered the potential risks associated with various current and future use scenarios for the former Nease facility and surrounding areas, including the MFLBC. The following discussion summarizes the potential exposures associated with media and areas that are part of OU-3[11]. OU-3 areas/media include Feeder Creek sediment and surface water, and MFLBC surface water, floodplain soil, sediment, fish, game, beef, milk, and vegetables. In the EA, the Site was divided into different areas for risk assessment purposes. The areas assessed in the EA include "on-facility" areas where former manufacturing operations took place, and "off-facility" areas adjacent to the former Nease facility. The on-facility portion is primarily located west of the railroad tracks but also includes former Ponds 3 and 4, which are located east of the tracks. The areas located east of the railroad tracks, including the MFLBC, were termed "off-facility," since manufacturing operations were not conducted in those areas. Feeder Creek traverses both the on- and off-facility areas. The MFLBC is located off-facility, and exposures along the MFLBC were considered separately for locations upstream and downstream of Lisbon dam.

Current Use Scenario - On-Facility Locations

- Current on-facility trespasser exposures to COPCs in Feeder Creek surface water and sediments were evaluated for several pathways. These included incidental ingestion of surface water, dermal contact with surface water, incidental ingestion of sediments, and dermal contact with sediments.

Current Use Scenario - Off-Facility Locations

- Current off-facility industrial worker exposures to COPCs in surface water and sediments were evaluated for several pathways. These included incidental ingestion of surface water, dermal contact with surface water, inhalation of air above surface water, incidental ingestion of sediments, and dermal contact with sediments.

- Current off-facility resident exposures to COPCs in game was evaluated for the ingestion pathway.

---

[11] Other areas and media were addressed as part of the OU-2 Feasibility Study (Golder, 2005) and the associated Record of Decision (USEPA, 2005b).

Current Use Scenario –MFLBC Locations

- Current MFLBC recreational visitor exposures to COPCs in floodplain soil, sediments, surface water, fish, and game were evaluated for several pathways upstream and downstream of Lisbon dam. These included incidental ingestion of soils, dermal contact with soil, inhalation of wind-blown soil dust, incidental ingestion of surface water, dermal contact with surface water, incidental ingestion of sediments, dermal contact with sediments, ingestion of fish, and ingestion of game.

- Current MFLBC residential exposures to COPCs in floodplain soil, sediments, surface water, fish, game, and vegetables were evaluated for several pathways upstream and downstream of Lisbon dam. These included incidental ingestion of soils, dermal contact with soil, inhalation of wind-blown soil dust, incidental ingestion of surface water, dermal contact with surface water, incidental ingestion of sediments, dermal contact with sediments, ingestion of fish, ingestion of game, and ingestion of home-grown vegetables.

Future Use Scenario – On-Facility Locations

- Future on-facility industrial worker exposures to COPCs in Feeder Creek surface water and sediments were evaluated for several pathways. These included incidental ingestion of surface water, dermal contact with surface water, inhalation of air above surface water, incidental ingestion of sediments, and dermal contact with sediments.

- Future on-facility resident exposures to COPCs in Feeder Creek surface water and sediments were evaluated for several pathways. These included incidental ingestion of surface water, dermal contact with surface water, incidental ingestion of sediments, and dermal contact with sediments.

Future Use Scenario – Off-Facility Locations

- Future off-facility industrial worker exposures to COPCs in Feeder Creek surface water and sediments were evaluated for several pathways. These included incidental ingestion of surface water, dermal contact with surface water, inhalation of air above surface water, incidental ingestion of sediments, and dermal contact with sediments.

- Future off-facility residential exposures to COPCs in game, beef, milk, and fish were evaluated for the ingestion pathway.

Future Use Scenario – MFLBC Locations

- Future MFLBC recreational visitor exposures to COPCs in soil, surface water, sediments, fish, game, beef, and milk were evaluated for several pathways upstream and downstream of Lisbon dam. These included incidental ingestion of soil, dermal contact with soil, inhalation of wind-blown soil dust, incidental ingestion of surface water, dermal contact with surface water, incidental ingestion of sediments, dermal contact with sediments, ingestion of fish, ingestion of game, ingestion of beef, and ingestion of milk.

- Future MFLBC residential exposures to COPCs in soil, surface water, sediments, fish, game, vegetables, beef, and milk were evaluated for several pathways upstream and downstream of Lisbon dam. These included incidental ingestion of soil, dermal contact with soil, incidental ingestion of surface water, dermal contact with surface water, incidental ingestion of sediments, dermal contact with sediments, ingestion of fish, ingestion of game, ingestion of home-grown vegetables, ingestion of beef, and ingestion of milk.

Summary of Health Risks

The EA presented two risk calculations for each exposure receptor and pathway combination, one based on Reasonable Maximum Exposures (RMEs) and the other on Central Tendency Exposures (CTEs). In all cases, the risk calculations assumed that no remediation was conducted either for OU-2 or OU-3 media/areas, and that existing measures (such as fencing at dairy farms) did not exist for hypothetical future exposures. As such, the results represent a conservative (health-protective) assessment of "baseline" risks to which post-remedy conditions may be compared. The RME represents the most conservative "high end" exposures as defined by USEPA, "exposure above about the 90th percentile of the populated distribution" (USEPA 1995b). The RME is further defined as the highest possible exposure that is reasonably expected to occur and, as such, incorporates several conservative default exposure assumptions. The CTE risk calculations generally reflect the central estimates of exposure or dose, and may be based on either the arithmetic mean exposure or the median exposure. USEPA's acceptable risk range[12] is 10^{-4} to 10^{-6} for potential excess cancer risks and a hazard index equal to or less than one for potential non-cancer risks to any target organ/system.

The following paragraphs and Table 3 provide a summary of the risk estimates for each of the receptors and exposure scenarios listed above associated with OU-3. As discussed above in Section 2.3.3, the EA determined that the only Nease-related chemical of potential concern that resulted in estimates of potentially unacceptable human health risks in OU-3 media/areas was mirex. While risk estimates from exposure to photomirex did not exceed acceptable risk levels, photomirex and mirex toxicity may be additive, and so the risk estimates presented herein are summations of risks due to both mirex and photomirex.

---

[12] In the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Part 300), USEPA states that "For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual between 10^{-4} and 10^{-6} using information on the relationship between dose and response."

Current Use Scenarios – On- and Off-Facility and MFLBC Locations

None of the current exposure scenarios resulted in risks that exceed USEPA's acceptable criteria for OU-3 media.

Future Use Scenarios – On- and Off-Facility Locations

Industrial Worker

None of the future exposure scenarios for industrial workers resulted in risks that exceed USEPA's acceptable criteria for OU-3 media.

Resident

Potential non-carcinogenic risks exceed USEPA's acceptable hazard index of 1.0 for future off-facility residents, as a result of RME to mirex in both beef and fish via ingestion. Central tendency estimates for this pathway did not exceed USEPA's criteria.

Future Use Scenarios – MFLBC Locations

Upstream

Recreational Visitor

Potential carcinogenic and non-carcinogenic risks exceed USEPA's acceptable range for future MFLBC recreational visitors upstream of Lisbon dam as a result of RME to mirex in fish via ingestion. CTE risk estimates for this pathway indicate a carcinogenic risk within USEPA's risk range and a hazard index of 1.74.

Resident

Potential carcinogenic and non-carcinogenic risks exceed USEPA's acceptable range for the future MFLBC residents upstream of Lisbon dam as a result of RME to mirex in fish via ingestion. CTE risk estimates for this pathway indicate a carcinogenic risk within USEPA's risk range and a hazard index of 1.74. The RME non-carcinogenic hazard index estimate for ingestion of beef also exceeds the acceptable level of 1.0; CTE estimates did not exceed USEPA's criterion.

Downstream

Recreational Visitor

None of the future exposure scenarios for MFLBC recreational visitors downstream of Lisbon dam resulted in risks that exceed USEPA's acceptable criteria for OU-3 media.

Resident

Potential non-carcinogenic risks exceed USEPA's acceptable hazard index of 1.0 for future MFLBC residents downstream of Lisbon dam as a result of RME to mirex in beef via ingestion. It is important to note that this exposure pathway assumed that mirex concentrations in beef were equivalent to the levels measured in dairy farms located upstream of Lisbon dam and prior to fencing of the MFLBC. Floodplain soil and sediment mirex concentrations downstream of Lisbon dam are significantly lower than in the areas where mirex was historically detected in beef and milk, so it is highly unlikely that residents downstream of the dam could be exposed to these levels of mirex. CTE risk estimates for this pathway did not exceed USEPA's criteria.

3.1.2 Ecological Risk Assessment

The following discussion summarizes potential ecological risks associated with OU-3 media (MFLBC and Feeder Creek) as identified in the approved EA. The MFLBC was split into three reaches for assessment of floodplain soil risks and 15 reaches for assessment of sediment risks. The reach designations can be found on Figures IX-1A and IX-6 of the EA (included in Appendix A of this report).

Feeder Creek

Potential risks to lower trophic level aquatic and semi-aquatic biota, were assessed on a sample location by sample location basis comparing the measured concentration of mirex to toxicological benchmark values. Mirex (including photomirex) concentrations exceeded benchmark levels for surface water and sediment in Feeder Creek, although surface water detections of mirex were considered likely due to the presence of suspended particulates, rather than dissolved mirex. These exceedances of benchmark values indicate that there is a potential for adverse ecological effects on lower trophic level biota. Since Feeder Creek does not provide suitable habitat for fish, it was not necessary to evaluate food-chain risks associated with exposure to Feeder Creek; however, since Feeder Creek feeds the MFLBC, which does provide habitat for fish, it needs to be addressed as part of the remedy as part of mitigating food-chain risks in the MFLBC.

MFLBC

Direct contact risks were assessed by comparing measured concentrations against media-specific benchmark values and the EA concluded that there were no significant risks for aquatic populations based on water quality benchmarks but that there was some level of potential risk associated with mirex exceedances of the sediment benchmark concentration. Aquatic community health, however, is more reliably evaluated using Ohio EPA's biocriteria metrics. As discussed previously, the area of the creek with the highest mirex concentrations is substantially attaining biocriteria goals, while many areas of the creek with lower mirex concentrations do not attain their designated use. This suggests that mirex may not be having a significant impact on fish and aquatic invertebrate communities. Even though it appears that mirex may have little impact on invertebrate communities based on the ICI, the IBI standards are not attained in several areas close to the Nease site, which could be attributable to a variety of stressors.

Risks to nine upper trophic wildlife receptors (five birds and four mammals) were evaluated based on an area-wide assessment of the MFLBC using food-chain modeling to estimate daily dietary intakes. This assessment conservatively assumed that each receptor acquires its entire diet from the contaminated areas of the MFLBC[13]. The following summarizes the potential risks associated with mirex estimated in the EA:

- There are no significant risks predicted in floodplain Reach 3 (downstream Lisbon Dam) for any receptors.

- There are no significant risks predicted for herbivorous, carnivorous or piscivorous birds, or for herbivorous mammals that would be exposed via food chain pathways.

- There are predicted exceedances of dietary no observed adverse effect levels (NOAELs) for the insectivorous short-tailed shrew for mirex + photomirex. The predicted exceedances are relatively low (HQ values of about 2.11 in Reach 1 and 3.46 for all MFLBC reaches combined) based on the 1990 survey data. These HQ values are less than 1 when based on dietary lowest observed adverse effect level (LOAELs).

- There are predicted exceedances of dietary NOAELs for the carnivorous red fox for mirex + photomirex in Reaches 1 and 2. HQ values of 5.85 and 2.5 were estimated for mirex + photomirex for Reaches 1 and 2, respectively, and 9.59 for all MFLBC reaches combined, based on the 1990 survey data. The HQ values for mirex + photomirex are about 1.8 and 0.78 in Reaches 1 and 2 based on dietary LOAELs.

- There are predicted exceedances of dietary NOAELs for the piscivorous mink for mirex + photomirex in 9 of the 15 sediment reaches. HQ values range from about 1.1 to 4.5 based on 1990 survey data. The HQ values are all less than 1 when based on dietary LOAELs.

---

[13] In the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Part 300), USEPA states that "For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual between 10^{-4} and 10^{-6} using information on the relationship between dose and response."

In addition to the mirex risks summarized above, some hazard quotients in excess of 1.0 were calculated based on reported detections of kepone. Kepone was never manufactured, stored, or used at the Nease facility and reported detections were infrequent (in 16 of 136 soil samples) and kepone is not a risk-driver for OU-3 remedy selection.

3.1.3 Summary of Potential Site Risks

The approved Endangerment Assessment considered current and future human use scenarios and ecological receptors. The following text and Table 3 presents a summary of the potential risks associated with these scenarios for OU-3 media/areas.

Human Health Risks

- None of the current use scenarios result in potential risks exceeding USEPA's acceptable criteria.

- None of the calculated potential risks for future trespassers and industrial workers exceed USEPA's acceptable criteria.

- Potential exposure to mirex in fish is responsible for the majority of the unacceptable potential risk calculated for hypothetical future resident exposures[14] and recreational visitor exposures to the MFLBC. Potentially unacceptable risk is also associated with hypothetical future exposure to mirex in beef fat for cows raised in contaminated areas of the MFLBC. Risk estimates for consumption of milk fall within USEPA's acceptable criteria for hypothetical future resident exposures.

- Risks from direct contact with sediment and surface water do not exceed USEPA's acceptable criteria. A direct contact advisory was placed on the MFLBC by the Ohio Department of Health (ODH) in 1988 as a precautionary measure when less data were available. Subsequent analyses, presented in Appendix G, indicate that the direct contact advisory is not necessary. In September 2205, based on the EA and the assessment in Appendix G, USEPA and Ohio EPA requested ODH to reassess the contact advisory.

Ecological Risks

- Hazard quotients exceeding 1.0 were calculated for several upper trophic wildlife receptors as a result of exposure to mirex in floodplain surface soil and sediment and associated uptake into fish tissue.

---

[14] Although there are currently residents living along MFLBC, this exposure scenario is "hypothetical" because it assumes that the existing fish consumption advisory is lifted while mirex concentrations in fish remain at current levels, and that mirex concentrations in beef and milk return to their pre-1990 levels.

3.2 ARARs and TBCs

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites comply with legally applicable or relevant and appropriate cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under Federal or State law, which are collectively referred to as “Applicable or Relevant and Appropriate Requirements” (ARARs), unless such ARARs are waived under CERCLA § 121(d)(4). “Applicable” requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. “Relevant and appropriate” requirements are those requirements that, while not legally “applicable”, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site. Only those State standards[15] that are promulgated, are identified by the State in a timely manner, and are more stringent than Federal requirements may be applicable or relevant and appropriate. ARARs may relate to the substances addressed by the remedial action (chemical-specific), to the location of the site (location-specific), or the manner in which the remedial action is implemented (action-specific).

In addition to ARARs, the lead agency may, as appropriate, identify other advisories, criteria, or guidance to be considered (TBC) for a particular situation. The "TBC" category consists of guidance, criteria, or advisories that have been developed by USEPA, other federal agencies or states/territories that may be useful in developing CERCLA remedies.

The following discussion focuses on potential chemical-specific ARARs and “TBC” information for the Site that are considered when establishing Preliminary Remediation Goals (PRGs). Location-specific and action-specific ARARs and TBCs are discussed in Section 6 in the detailed evaluation of each alternative.

Chemical-Specific ARARs and TBCs

Chemical-specific ARARs and TBCs represent health or risk-based concentration limits in various environmental media for relevant chemicals. State standards are considered ARARs only where they are promulgated and are more stringent than the Federal ARAR-equivalent. As such,

---

[15] The Ohio EPA provided a generic list of potential ARARs which is included in Appendix L of this FS.

where equivalent Federal and State ARARs exist, only the Federal ARARs are cited. The following potential chemical-specific ARARS and TBCs have been identified for OU-3 media:

Federal Chemical Specific ARARs or TBCs

- USEPA has not promulgated any sediment criteria for mirex.
- USEPA Soil Screening Levels (SSLs) (USEPA 1996a) are unpromulgated and as such are not ARAR but are classified as TBC. As stated in the USEPA Soil Screening Guidance: User's Guide (USEPA, July 1996) the "SSLs are not national cleanup standards. SSLs alone do not trigger the need for a response action or define 'unacceptable' levels of contaminants in soil." USEPA has not published a SSL for mirex.
- USEPA Recommended Water Quality Criteria are unpromulgated and as such are not ARAR but are classified as TBC. The purpose of the Recommended Water Quality Criteria are to give guidance to states for setting water quality criteria. For mirex, USEPA has recommended a chronic criterion continuous concentration (CCC) of 0.001 ug/L, based on protection of aquatic life.

State Chemical Specific ARARs

- Ohio has promulgated generic direct contact soil standards (Ohio Administrative Code (OAC) 3745-300-08) as part of their Voluntary Action Program (VAP). These generic standards are listed as either risk derived or are based on saturation. In addition, Ohio has other nonpromulgated soil cleanup guidance (Ohio EPA, 2002) for the VAP which are not ARAR. Ohio EPA has not published any standards or guidance for mirex in soil or sediment.
- Ohio EPA has promulgated water quality criteria for surface water in the State of Ohio within the Ohio River drainage basin (including the MFLBC) (OAC 3745-1-34). These criteria may be ARARs for Feeder Creek and the MFLBC, and include a value of 0.00011 ug/L for mirex in surface water in the Ohio River Basin based on human health considerations including drink and nondrink exposures.

3.3 Preliminary Remediation Goals

PRGs have been developed from the results of the risk assessment and consideration of the chemical specific ARARs discussed above. The PRGs consist of numerical target ranges in specific media and are intended to guide the development and evaluation of remedial alternatives. PRGs have been established for OU-3 sediment and floodplain surface soil based on the results of the EA as there are no chemical-specific ARARs for mirex in these media. A specific PRG is not required for surface water as measurements indicate that the USEPA recommended chronic criterion for protection of aquatic life is not exceeded in the MFLBC (see Section 2.3.3.1) and neither the MFLBC nor Feeder Creek is used as potable water sources.

3.3.1 PRGs for Sediment

There are two primary pathways/receptors of potential concern for sediment:

- Ecological risks to wildlife associated with consumption of contaminated fish tissue.
- Human health risks associated with consumption of contaminated fish tissue.

Based on the results of the EA the most sensitive ecological receptor that potentially consumes fish from the MFLBC is the mink. In the EA, potential risks for the mink were calculated directly using measured fish tissue concentrations and for all reaches of the MFLBC combined NOAEL and LOAEL based hazard quotients of 1.87 and 0.37 were calculated, respectively. Considering individual reaches, the maximum NOAEL based hazard quotient was 4.57 and the maximum LOAEL based hazard quotient was 0.91. These data indicate that only modest reductions in mirex levels in fish tissue are required to be protective of food chain receptors. USEPA has proposed a methodology for calculating a sediment-biota accumulation factor for mirex in the MFLBC based largely on correlations between measured sediment and fish tissue concentrations (see Appendix H). Noting the uncertainty in these calculations, a sediment mirex PRG range of 0.477 to 0.753 mg/kg for the LOAEL criterion was recommended to achieve sufficient risk reduction to protect ecological receptors. The PRG range is based on USEPA’s recommendation in Appendix H, which states that “the upper two-thirds of the 1990 PRG ranges are probably the best estimates that can be made with the presently available data.”

Based on the risk evaluation presented in the EA and summarized above, ROC believes that the upper end of this range would be protective. Sediment-to-fish bioaccumulation factors will be further evaluated based on additional data collection as part of a pre-design investigation (PDI).

The estimated carcinogenic and non-carcinogenic risks to residents and recreational visitors along the MFLBC exceeded USEPA’s acceptable criteria as shown on Table 3. The EA calculations conservatively assumed that all fish consumed from the MFLBC would contain mirex at a concentration of 1.27 mg/kg. However, as shown on Figure 26, the results of fish tissue sampling in 2005 indicate that only one sample at a single location (RM 33.3[16]) had fish with mirex concentrations above this value, so risks are likely overestimated by the EA. Based on the results of the human health risk assessment and USEPA's sediment-biota accumulation calculations, reducing sediment concentrations to below the ecological PRG is expected to bring the human health risks from fish consumption to within the USEPA's acceptable criteria. A long-term monitoring program will be implemented to assess fish tissue reductions. In addition, the associated mirex concentration reduction in fish tissue is expected to result in the current fishing advisory for the MFLBC based on mirex no longer being required[17].

3.3.2 PRGs for Floodplain Soil

PRG ranges for mirex in floodplain soil have been estimated based on two potential exposures/receptors:

- Ecological risks associated with direct and food-chain exposure to floodplain soils; and,
- Human health risks associated with consumption of beef and dairy products produced from cattle grazing within the contaminated floodplain.

Ecological Exposures

An ecological PRG for mirex in floodplain soil was determined following the same procedure as used in the FS for OU-2 (Golder, 2005) which relies on back calculating, through a food chain model, a soil concentration that would result in a hazard quotient of unity. Food chain modeling methods are described in detail in Chapter X of the EA. Consistent with the OU-2 assessment, the two most sensitive terrestrial ecological receptors are the short-tailed shrew and the red fox (Golder, 2005). For the red fox, the home range plays an important role in the calculation of PRGs that will be protective of populations. In the present case, a home range of approximately 504 ha (1,245 acres) was used for the red fox based on the Ohio EPA Ecological Risk Assessment Guidance Document dated February 2003 (Ohio EPA, 2003). The PRG calculations incorporate the home range of the fox by including the percentage of the range that is comprised of floodplain

---

[16] It is also important to note that although one sample of common carp at this location had a mirex concentration exceeding 1.27 mg/kg, there were two other species collected at this location that had mirex concentrations of less than 0.5 mg/kg.

[17] A current fishing advisory is in place throughout the entire MFLBC due to mercury and PCB contamination in fish tissue, and for mirex over a limited portion of the MFLBC. Reducing the mirex concentrations in the stream will not affect advisories that are based on contaminants not related to the Nease site (i.e. mercury and PCBs).

soil potentially containing mirex. No adjustments to the dietary composition for home range were made for the less wide-ranging short-tailed shrew.

To account for possible variations along the MFLBC, the floodplain area potentially within the home range of the red fox was determined in two separate areas of the creek, one where the floodplain is narrow and mirex concentrations are known to be elevated, and another where the floodplain is very wide (see Appendix I). The floodplain accounts for 5% to 24% of the home range of the red fox in these two areas. Using the exposure point concentration and estimated LOAEL- and NOAEL-based hazard quotients from the approved EA, a back calculation of the floodplain soil concentration that would result in a hazard quotient of one was performed as presented in Appendix I.

The table below shows the floodplain soil concentrations resulting in a hazard quotient of one based on the NOAEL and the LOAEL for each receptor including consideration of home range. Based upon this analysis, ROC believes a mirex PRG in the range of 0.862 to 4.14 mg/kg for floodplain soil is appropriate for all ecological receptors. The specific PRG for a given area may depend upon the width of the floodplain (i.e. wider floodplain areas will have a lower PRG than narrower floodplain areas due to higher potential for exposure). These levels will assure no material effect on all the identified receptor populations.

Receptor	NOAEL-Based PRG (mg/kg)	LOAEL-Based PRG (mg/kg)
Short-tailed Shrew	0.186	0.930
Red Fox	0.267 to 1.281	0.862 to 4.14

Human Exposures – Beef and Milk Ingestion

As described in the EA, milk and beef samples were collected from three farms along the MFLBC prior to the construction of fences to exclude cattle on those farms from the MFLBC and contaminated portions of the floodplain. Fencing was installed by the farm owner at the farm at RM 22.5 prior to beef and milk sampling, so these cattle were already excluded from the highest mirex levels in the floodplain and from the creek itself. Milk and beef sampled at that location never exceeded the FDA action level at that time, which was 0.1 mg/kg. In the years since the fences were installed, mirex has not been detected in milk or beef. The uptake of mirex into cattle is a complicated process where both uptake from soil into feed plants, as well as biotransfer from feeding (including incidental soil ingestion) into beef and milk fat need to be considered. Since it is not possible to determine exactly which floodplain soil concentrations produced corresponding levels of mirex in cattle, a number of assumptions need to be made about the uptake of mirex into cattle. USEPA prepared a memorandum dated May 1, 2008 that summarizes the existing literature related to uptake of mirex into beef and milk fat (see Appendix J). Based on these analyses, PRG ranges were calculated based on a range of potential plant uptake of mirex, a range of incidental soil ingestion rates, and a range of supplemental (uncontaminated) feed ingestion rates.

Soil Mirex Preliminary Remedial Goals for Cattle and Dairy Pasture

Cattle Food Source	**Product**	**Soil Mirex PRG Range mg/kg**
Graze in and/or provided forage from contaminated floodplains (100 % of total)	Beef	0.6 – 2.8
	Milk	0.3 – 1.4
Graze in or provided forage from contaminated floodplains (26 %) with supplementary clean feed (74 % of total)	Milk	0.5 – 1.6

The PRG ranges shown above have been calculated based on a 10^{-5} cancer risk level, which is the midpoint of USEPA's acceptable risk range and is considered the "point of departure" for Ohio EPA. Although USEPA's approach uses the best available published literature, there are several conservative assumptions that have been made. The most notable assumption is that when grazing, dairy and beef cows consume all their forage from the contaminated floodplain. This is highly unlikely since the floodplain is generally a narrow stretch along the stream and it is unlikely to produce enough forage to sustain a herd of cows. In addition, discussions with dairy farmers during the 2005-2006 investigations indicated that cows are generally kept indoors during the cold winter months, so during that time no exposure to floodplain contamination would take place. Furthermore, the pharmacokinetics of mirex distribution and elimination in cows are not fully understood, so assuming that cows are constantly exposed to mirex is a conservative way to estimate uptake. For example, it is possible that if cows are brought indoors for winter, or during particularly wet weather, some elimination of mirex through lactation will occur and so concentrations may decline, at least temporarily. Another significant uncertainty identified in USEPA's memo relates to soil ingestion rates. Only one appropriate soil ingestion rate was identified in the literature, so this value was used for all cattle, regardless of whether or not they also consumed feed from a clean, supplemental source. This likely represents an overestimate of the soil ingestion rate for those cattle that consume a large percentage of their diet from a supplemental source.

The use of these conservative assumptions suggests that the lower end of the PRG range represents an unrealistic overestimation of potential risks. In addition, the milk-based PRG range appears to be especially conservative given that potential risks estimated in the EA showed no unacceptable future risks from consumption of milk (see Table 3). The risks estimated for beef in the EA are higher than milk due to higher concentrations of mirex detected in beef samples. Some further insight on the PRG range is afforded by historic soil, beef and milk data collected from dairy farms in the floodplain. At the Dairy Farm near River Mile 33, concentrations in beef ranged from non-detect to 1.75 mg/kg with 8 out of 18 samples exceeding 0.1 mg/kg, while concentrations in milk at the same farm ranged from non-detect to 0.2 mg/kg with only 3 out of 18 samples exceeding 0.1 mg/kg. This comparison suggests that beef is a more significant pathway that milk for mirex uptake, even though the PRG calculations predict higher concentrations in milk. Furthermore, at the dairy farm at RM 22.5, where mirex was only detected at "trace" concentrations in milk, soil mirex concentrations were measured up to 0.79 mg/kg. This value is within the milk-based PRG range and suggests that the low-end of the PRG range is unrealistic.

Based on the PRG ranges calculated for ecological and human receptors as described above, and taking into account the conservative assumptions used to calculate the human health PRG ranges, ROC believes that a mirex concentration of 1.0 mg/kg (ppm) is an appropriate PRG for floodplain soil. This is the same PRG selected by USEPA for OU-2 soils at the former Nease facility portion of the Site.

3.4 Preliminary Remedial Action Objectives

Based on the CSM presented in Section 2.0, the results of the EA presented in Section 3.1, and the PRGs presented in Section 3.3, the following preliminary RAOs have been established for OU-3.

RAO 1 – Mitigate[18] Mirex Uptake in Fish from Exposure to MFLBC Sediment

Achievement of the sediment PRGs established in Section 3.3.1 on a surface-weighted average concentration (SWAC[19]) basis for relevant exposure units (anticipated to be approximately 1.0 river mile) is expected to result in this objective being satisfied.

RAO 2 – Mitigate Additional Mirex Contamination of Floodplain from MFLBC Sediment

Mirex levels in floodplain soil have arisen from previous flooding events that deposited mirex impacted sediment from the MFLBC onto the floodplain. Avoiding additional contamination of the floodplain is therefore important, although since the current concentrations are significantly higher in the floodplain than in sediment, this is not a likely scenario.

RAO 3 – Mitigate Ecological Exposures to Unacceptable Levels of Mirex in Floodplain Soil; and RAO 4 –Protect Cattle from Unacceptable Mirex Uptake from Floodplain Soil

Achievement of the floodplain soil PRGs established in Section 3.3.2 on a SWAC basis for relevant exposure units (anticipated to be approximately 1 acre) is expected to result in satisfaction of both RAO 3 and 4.

RAO 5 –Mitigate Additional Mirex Contamination of MFLBC from Feeder Creek.

Mirex contamination in MFLBC sediment arose from sediment transport via Feeder Creek and interim controls are currently in place to mitigate ongoing transport pursuant to an AOC with USEPA. Permanent measures are required to afford continued protection of the MFLBC.

---

[18] For the purposes of this section "Mitigate" and "Mitigation" refer to remediation to Site-specific standards to achieve acceptable risk goals. These standards and goals will be further defined in future Site-related documents.

[19] USEPA Region 5 often uses SWAC as the basis to establish PRGs because of the association between bioavailable contamination in surface sediments and uptake into biota. However, historical sampling within MFLBC may have been biased to target the soft sediments even where soft sediment bodies did not cover the entire creek bottom. Therefore, the SWAC approach may be modified based on the PDI to reflect soft, mirex-containing sediments.

4.0 DEVELOPMENT AND SCREENING OF TECHNOLOGIES

4.1 General Response Actions

General Response Actions (GRAs) were identified that address the RAOs presented in Section 3.0 by either reducing the concentration of chemical impacts or reducing the likelihood of exposures to impacted media. The following GRAs were identified for the Site:

- No action;
- Institutional controls;
- Containment;
- Removal;
- Backfilling;
- Disposal.

Remedial technologies and process options associated with each of the GRAs were subsequently identified and screened as discussed below.

4.2 Screening of Technologies and Process Options

This section presents the remedial technologies (and related process options) that would potentially achieve the RAOs. Screening of remedial technologies was based on the following criteria:

- Effectiveness: This criterion evaluates the ability of a technology to achieve the RAOs, and provide long-term protectiveness of human health and the environment. Potential short-term impacts to human health and the environment, and the reliability of the technology are also important components of this screening criterion;

- Implementability: This criterion addresses the technical and administrative feasibility of implementing the technology as well as the availability of required services and materials; and,

- Cost: This criterion utilizes engineering judgment to develop relative estimated costs of each technology for a given RAO. The cost estimates are qualitative (low, moderate, high) at this technology screening stage of the FS.

The following provides a description of the technologies and process options considered for each RAO and summarizes the results of the technology screening. It should be noted that containment and removal, rather than treatment, are the primary technology options discussed (with the exception of Monitored Natural Recovery, which may include a minimal amount of natural degradation). The reason that treatment has not been considered is that there are no feasible in-situ or ex-situ treatment technologies, for mirex, due to its resistance both chemical and biological breakdown. This FS focuses on other established remediation alternatives for mirex that are capable of reducing risk from mirex exposures to within acceptable levels.

4.2.1 Screening of Technologies / Process Options for RAO-1, RAO-2, and RAO-5 (Sediment)

4.2.1.1 Capping

Capping can be used in two distinct ways as part of sediment remediation: in-situ capping (ISC) of contaminated sediment; and capping of excavated/dredged sediment (DMC) that is placed in a designated disposal area (often referred to as Contained Aquatic Disposal). The primary functions of a cap in both cases include physical isolation of contaminated sediment from the aquatic environment, stabilization and erosion protection, and chemical isolation and reduction of movement of contaminants in the water body. Capping eliminates resuspension and transport of contaminants and reduces them to acceptable levels. Caps can be made of a variety of materials, such as sand, geotextiles and geomembranes, gravel, silts and clays, and can include treatment elements such as activated carbon, organoclays, phosphate additives for metals, zero valent iron, and biopolymers. Site conditions may impose limitations on capping effectiveness. For example, for capping to be a successful remedy, it is important that all sources of contamination are being controlled (i.e. no future releases of the contaminant into the system), and that potential human disruption of caps is controllable (e.g. recreational usage by motor boats). In addition there must be adequate water depth to allow for placement of a cap, which typically includes 2 feet of cap material, and sediments and slopes in the water body must be able to support the cap.

In-Situ Capping (ISC)

ISC involves placing a subaqueous cap of clean isolating material over an in-situ deposit of contaminated sediment. Naturally occurring sand, or other granular material, is usually used as the capping material. Other materials used for capping include permeable geotextiles, engineered clay and aggregate materials. Some caps may include materials that are used to reduce the flux or bioavailability of contaminants, such as activated carbon, coke, low permeability membranes, and reactive core mats. Typical cap designs include three main layers, isolation, armor, and habitat (USEPA, 2005a). The physical isolation layer is used as the primary method for reducing the potential for direct contact with the sediments. The required cap thickness depends on the presence of burrowing organisms that could potentially move the contaminants to the surface, a process referred to as bioturbation. The isolation layer typically consists of a granular material such as sand, and an adequate cap thickness must be placed to account for consolidation. The armor layer (also known as the stabilization component) is used to provide protection to the isolation layer and stabilization to both the contaminated sediment and the cap itself. In general, the erosion protection features of an in-situ cap are designed based on the 100-year storm. Finally, a habitat layer is placed atop the other capping layers to restore the habitat to its natural condition.

At some sites, advective and diffusive processes can result in movement of contaminants through the cap. While a correctly designed cap will control the movement of chemicals bound to the underlying sediments, there can be a potential for transport in the dissolved phase through pore water and/or groundwater, and diffusion across the concentration gradient is also possible. In the present case, where mirex is the primary COC, these mechanisms are not likely to be significant.

Advantages of ISC include rapid risk reduction, relatively easy implementation (under amenable conditions), cost-effectiveness (no sediment processing or disposal required), and habitat enhancement potential. Disadvantages include water depth reduction, the potential for sediment resuspension during cap placement, and the requirement for long-term monitoring and maintenance and institutional controls (ICs).

Dredged Material Capping (DMC)

DMC refers to the process of capping previously excavated/dredged sediments that have been placed in another area of the water body (also referred to as Contained Aquatic Disposal). While this approach is not very common in environmental remediation projects, there are specialized cases where it is not possible to either place an in-situ cap or to excavate and dispose of the materials on land (USEPA, 2005a). Once sediments are excavated and then re-placed in the water body, a cap similar to that described above for ISC is designed and placed over the sediment. This approach can be used to consolidate small pockets of sediment into one location so that a continuous cap can be placed over a smaller area.

Effectiveness: Moderate to High

Capping is expected to be highly effective for minimizing migration of contaminants. There have been many successful sediment capping projects that have shown that the danger of re-exposure from high energy flood events is low. Short-term impacts from capping tend to be less than those from dredging; however, the existing habitat is completely covered by the cap, so the aquatic ecosystem is still affected

Implementability: Low to Moderate

Conventional equipment is used and methods and materials are readily available for cap construction, however, the region of the MFLBC that is being targeted for remediation tends to have shallow water depths (less than 1 ft), so placement of a cap would significantly alter the natural morphology of the stream. In this case, a typical cap thickness will likely be greater than the existing water depth, which could have significant impacts on flooding potential. In order to maintain existing surface water flow and morphology, significant effort would be required to redirect and reconstruct the stream following capping. The MFLBC is also prone to transport of debris such as logs and branches from dead trees that are washed into the stream during high energy storm events or placed by beavers. These debris items could cause significant disruption to a placed cap. O&M of a cap would also be difficult to implement since the properties along the stream are privately owned.

Cost: High

Compared to other technologies, the cost for capping is expected to be high given the difficulties involved in placing a cap in shallow water while maintaining existing morphology and flood control. The cost is also increased due to the significant level of O&M likely to be required to maintain isolation in the future.

Status: Eliminated

Due to the difficulty in implementing and maintaining this remedy, capping has been eliminated from further consideration.

4.2.1.2 Dredging

There are two main types of environmental dredging that are potentially applicable to the MFLBC: mechanical and hydraulic. Other specialized dredging tools have been developed, but these are generally only used under unique circumstances where traditional mechanical or hydraulic dredging are not feasible. Environmental dredging equipment, both mechanical and hydraulic, has been adapted from standard navigational dredging tools to address issues specific to removal of contaminated sediments, including techniques to reduce and control resuspension and downstream transport of contaminated sediment, and reduce and control generation of residual sediment.

Resuspension refers to sediments that are disturbed during dredging and become resuspended in the water column. Resuspended sediment may travel downstream with the current, or may settle out in place, depending on site conditions. Resuspension of sediment can often be limited to less than 1% of the removed sediment mass but can range from 0.5% to 9% (USEPA, 2005a). Resuspension also occurs during natural events, such as during storms, which can produce higher levels of residuals than dredging.

Residual sediment refers to sediments that are targeted for removal but due to dredging limitations, are left behind. Residuals are generated when the dredging equipment cannot adequately remove all of the sediment, or when resuspended sediments re-settle out of suspension. Residuals can be controlled by experienced contractors and by starting at the upstream end of each dredging area. In this way, resuspended sediments are more likely to settle out of the water column in an area where dredging has not yet taken place. When the dredging operation moves downstream, it captures some of the mass that would otherwise have become residuals. At the farthest downstream end of the dredging operation, a small amount of resuspended particles may move downstream, but the relatively low mass is not likely to cause exceedances of the cleanup goal when the particles have settled out in a cleaner area. Risk from residual contamination can also be reduced by adding a thin layer (6-12 inches) of clean backfill after dredging has been completed, resulting in mixing of clean backfill with the residual sediments so as to achieve cleanup goals (USEPA, 2005a). Clean backfill is typically chosen to resemble the material removed, and in the case of sediment remediation, a fine-grained material would likely be used for backfilling. Given the strong sorptive properties of organic carbon with respect to mirex, addition of a clean backfill material with a higher level of organic carbon content than typical sand fill may help reduce the bioavailability of any residual mirex.

Site conditions conducive to dredging include nearby availability of disposal sites, low current velocity, and contaminants that are highly correlated with sediment grain size. Advantages of this sediment remediation option include ready availability of technologies, removal of contaminated materials, and maximization of flexibility in future use of the water body. Limitations include typically higher cost, complex implementation and uncertainty regarding residual contamination remaining after dredging.

Dredging operations often generate a high volume of water in addition to sediments, especially when there is a significant water depth above the sediments, or when hydraulic dredging is used. Before disposal, it is generally necessary to dewater the sediments so that there is at least 70% solids in the material. The dewatering process can involve a variety of technologies including belt presses, spreading on land and allowing sediment to dry by evaporation, or utilizing geotextile tubes. These tubes, which come in a variety of sizes, are constructed from high strength polypropylene and polyester fabric, and are designed to retain the sediment solids and allow water to be drained. Water generation can also be limited in small waterbodies by conducting excavation "in the dry" within sheet pile cofferdams from which the water is removed by pumping. In order to minimize disturbance of the floodplain areas adjacent to the MFLBC where dredging would occur, dewatering would likely be conducted at the former Nease facility using geotextile tubes (such as Geotubes® or similar). Since mirex is relatively insoluble in water, it is expected that mirex will remain sorbed to sediment particles, which are retained by the geotextile. Therefore, it is anticipated that the dewatering effluent can be released back to surface water with minimal treatment. If, however, during detailed design of this technology it is determined that treatment of the residual water is necessary, it will likely involve additional filtration and, possibly, adsorption using activated carbon. The existing on-Site treatment plant may be considered for this treatment process, or a separate facility may be constructed depending upon various factors such as cost and feasibility. The details of any required treatment would be developed as part of the remedial design.

Once removed, dredged materials must be disposed of either on- or off-site. Confined disposal facilities (CDFs), if located close to the dredging site, can be designed to handle a variety of materials. In the present case, consolidation of dredged material at the Nease site, where more highly impacted materials are being addressed under the OU-2 Record of Decision (USEPA, 2005b) represent a protective and pragmatic option. Commercial landfills, are offsite where materials can be transported by truck or rail, can accept material that complies with the conditions of their permits.

Mechanical Dredging

Mechanical dredging equipment includes conventional buckets or clamshells, enclosed buckets, and backhoes. Clamshells are supported by wires and utilize a circular shaped cutting action, which often leads to significant residual contamination. Enclosed buckets are also supported by wires but recent design improvements have yielded level cut capabilities, which greatly reduce the amount of residuals. These enclosed buckets are also nearly watertight, so generation of water with sediments is reduced. Clamshells and enclosed buckets can also be supported by an articulated mechanical fixed-arm for added support as an alternative to using wires. Advantages of this design option include rugged capability of removing hard packed materials, ability to remove debris and work in tight areas, and deep water operability. Mechanical dredging has many advantages, including a variety of available bucket sizes and types, and modifications can be made if site conditions require specialized tools to remove contaminated sediment. Disadvantages include difficulty in retaining fine-grained loose material in conventional buckets, and low production rates per hour. Transport of sediment from mechanical dredging generally occurs in batches via a variety of transportation methods such as barge, rail, or truck.

Hydraulic Dredging

Hydraulic dredging can involve the use of plain suction, hydraulic pipelines, horizontal augers, and/or pumps with cutters. Most hydraulic dredging consists of a dredgehead/cutter head to mechanically dislodge and loosen sediment, pump suction that results in hydraulic entrainment, discharge through a pipeline, with advancement of the dredge by spuds, winches, and cables. Horizontal augers, have limited operating depths, result in moderate production, and can achieve relatively level and accurate cuts. Advantages include capability of excavating most types of materials, ability to pump directly and continuously to disposal sites, and availability in small to large sizes with varying production capabilities. Disadvantages include the need for comparatively large adjacent land area for the associated dewatering and solids processing facility and the possibility of dredgehead clogging from cohesive material and debris. Hydraulic dredging can also increase the volume of removed sediments by 4 to 10 times by entraining the sediment in water.

Effectiveness: Moderate to High

Dredging can be a highly effective remedial option. Once contaminated sediments have been removed, there is no chance of future exposures, unlike capping where a compromised cap may allow sediments to again be exposed to the environment. Dredging effectiveness is impacted by site conditions and can be reduced by the generation of significant residuals and resuspended particles in some cases. Effectiveness will be greatest where water depths are shallow or if the stream flow can be easily diverted around the remediation area so that dredging "in the dry" can be used to reduce resuspension and residual generation. The use of clean backfill can also be used to mitigate the impacts of residuals and is a commonly accepted method by USEPA. Short-term impacts include total destruction of aquatic habitat and disturbance to nearby communities during the work including transportation of dredged materials.

Implementability: Moderate

The implementability of dredging is expected to be moderate. Due to a long history of dredging operations for both navigational and environmental purposes, it has become a highly flexible technology. Either mechanical or hydraulic, or a combination of both based on site-specific conditions, can be used to achieve a more implementable remedy. The main difficulties involved with implementing a dredging remedy are accessing the locations in the stream where sediments need to be removed and minimizing the volume of water generated, however, standard approaches are available for achieving water diversion around dredging locations in small streams such as the MFLBC.

Costs: Moderate to High

Compared to other alternatives, dredging costs are expected to be moderate to high. As described above, the flexibility available when selecting dredging equipment allows for selection of the most cost-effective approach. The cost of this technology will vary depending on how much water needs to be diverted, or, in the case that water cannot be diverted, costs will be affected by how much water needs to be removed from sediments before they can be disposed. The costs of this technology are also closely linked to costs associated with transport and disposal of the removed contaminated sediments.

Status: Retained

This technology is moderately to highly effective at mitigating risks from exposure to contaminated sediment. It is more easily implemented than a capping remedy in the MFLBC. This technology has been retained for further consideration.

4.2.1.3 Monitored Natural Recovery

Monitored Natural Recovery (MNR) includes leaving contaminated sediment in place and relying on naturally occurring processes to reduce the bioavailability or toxicity of the pollutants over time. Advantages of this design option include high implementability, cost-effectiveness, and ecosystem preservation. Disadvantages include potential longer-term exposure, negative public perception, and uncertainty about the time frame for achieving PRGs. Uncertainties exist in the ability to predict future sedimentation rates in dynamic environments and the ability to predict rates of contaminant flux through stable sediment (USEPA, 2005a). Site conditions that are especially conducive to MNR include a reasonably stable sediment bed, cohesive or well-armored sediment, and limited impacts on the existing biological community. MNR begins with a conceptual site model that is used to characterize the key overall dynamics of the site, such as sources, contaminant fate and transport, and exposure pathways and receptors. In order for MNR to be an effective remedy, all sources of contamination must be controlled including direct discharges, background, and non-point sources. Once MNR is selected, long-term monitoring of the system is conducted until remedial goals are attained.

A variety of natural recovery processes can occur that reduce the risk to receptors from sediment contamination. These natural processes can be categorized into three main types, physical, biological, and chemical (USEPA, 2005a). While physical processes do not directly change the chemical nature of contaminants, biological and chemical processes do. Instead, physical processes contain the pollutant in place and reduce the chance of migration. Examples of physical processes include erosion, dispersion, dilution, and volatilization. Biological processes involve the facilitation of chemical change by microorganisms that live in the sediment. This process is often referred to as biodegradation. Chemical processes involve a geochemical change that results from changes in redox potential that can reduce bioavailability of certain contaminants.

Effectiveness: Low to High

The effectiveness of MNR is highly dependent upon the physical and biological characteristics of the stream system, and on the chemical and physical properties of the contaminant. MNR can have high effectiveness if all sources are controlled and the sediment bed is stable. Over time, contaminated sediments are buried, dispersed, and diluted by clean sediment entering the system. In systems where sediments are buried but are not dispersed or diluted, there is a potential for future re-exposure from erosion/scouring of the sediments, thus potentially reducing the effectiveness of this remedy. In addition, if a contaminant is recalcitrant to biodegradation (such as mirex), biological degradation processed cannot be relied upon to reduce contaminant levels. Although there are a variety of reasons why effectiveness can be reduced, it is also important to consider that, unlike more active remedies, MNR does not involve any damage to the existing aquatic habitat and biological community. If existing contaminant levels are low enough that toxicity to aquatic organisms is low, there will typically be less damage done if sediments are left in place without being disturbed.

Implementability: High

MNR is considered to be easy to implement compared to other technologies since only monitoring is required.

Cost: Low to Moderate

The main costs involved with MNR are in the long-term monitoring. Although initial costs are low compared to other technologies, it can be expensive to conduct a long-term monitoring program that includes fish tissue and sediment sampling and analysis. As discussed in Section 6, estimated costs of both a MNR remedy and a sediment removal remedy have been developed for this FS. As shown in Tables 9 and 11, the total long-term monitoring costs of the MNR alternative may be 60 percent greater than the costs of monitoring for the removal alternative. In addition, a time frame of 30 years has been assumed for costing purposes, but a longer period of monitoring may be required for the MNR alternative, increasing its cost.

Status: Retained

There is existing evidence to suggest that MNR processes are already improving the health of the stream (e.g. biocriteria have shown significant improvements in fish and invertebrate metrics). Given the potentially high effectiveness and low cost, MNR has been retained for further evaluation in this FS.

4.2.2 Screening of Technologies / Process Options for RAO-3 and RAO-4 (Floodplain Soil)

4.2.2.1 Containment: Soil Barrier Cover

Similar to sediment capping, covers are used to prevent direct contact with the contaminated soils and to mitigate erosion from surface water runoff that could carry contaminated particles into the MFLBC. In most cases, the ground surface is first graded and cleared of all bulky debris and existing vegetation. A geosynthetic fabric is then generally placed on top of the ground surface area. This layer is used as an additional barrier from direct contact exposures and to define the original ground surface for future maintenance. A soil cover is then placed using erosion resistant soils, such as silty loam, that are also able to support vegetation.

Soil covers generally must be monitored and maintained to prevent future re-exposure of buried materials. Proper design of surface water management via grading is important to prevent erosion and may be difficult in riparian areas. Institutional controls, along with engineering design and analysis and routine inspections, can also contribute to maintaining long-term effectiveness. In order to avoid physical disturbances, deed restrictions can be used to limit future use of the area where soil cover is placed. As noted in the OU-2 FS (Golder, 2005), in order to protect ecological receptors, soil barrier covers must on the order of 2 feet thick. The erosion potential of a soil barrier cover is typically analyzed using conservative input variables and compared to the USEPA recommended maximum allowable soil loss of 2 tons/acre/year. Inspections, as well as maintenance and repairs, should be conducted on a regular basis, typically once per year and after large storm events. Maintenance usually involves vegetation care and repairs are done on an as-needed basis.

Effectiveness: Moderate to High

Soil barrier covers can effectively mitigate exposure to underlying contaminated materials and can be designed to withstand erosion; however, the contaminated materials remain in place so there is potential for future exposures if the cover is compromised. Short-term impacts include a loss of existing habitat and disturbance to nearby communities from transport and placement of cover materials.

Implementability: Low to Moderate

Conventional equipment is usually used and methods and materials are readily available for soil cover construction. However, construction, O&M of covers on private property may prove challenging and, without soil removal, may detrimentally change the flooding pattern of the creek. Also, proper surface water management in riparian areas may be difficult.

Cost: Moderate

Although soil cover costs can often be low compared to other alternatives, in this particular case, costs are expected to be higher than typical soil cover costs due to access and mobilization issues.

Status: Eliminated

Due to the expected challenges in implementing this technology and its moderate effectiveness, it has been eliminated from further consideration for floodplain soil.

4.2.2.2 Excavation and Backfilling

Excavation involves removing contaminated soil and transporting it to a suitable disposal location. Following excavation of the contaminated soil, the area is restored using clean fill that is able to support vegetation.

Excavated soils will need to be transported either for consolidation within the Nease Site, or to an off-Site disposal facility. Disposal at an off-Site location will have higher costs and will cause more disruption to surrounding communities through which the soils would be transported. Consolidation of MFLBC floodplain soils within the Nease Site, where more highly impacted soil is being addressed under the OU-2 Record of Decision (USEPA, 2005b) represents a protective and pragmatic option.

Effectiveness: High

This option provides for removal of contaminated soils from the floodplain, thus eliminating the potential for future exposures. Short-term impacts include a loss of existing habitat and disturbance to nearby communities from transport of excavated material and clean backfill.

Implementability: Moderate

Conventional equipment is usually used and methods and materials are readily available for excavation. However, it will be difficult to remove soil without disturbing the existing habitat. In these cases, targeted excavation could be performed to meet a surface weighted average concentration-based PRG while mitigating damage to the natural habitat.

Costs: Moderate to High

Compared to other options for floodplain soil, the costs are expected to be moderate to high. Higher costs will be incurred if materials are disposed of at an off-Site facility.

Status: Retained

4.2.2.3 Exclusion of Cows using Fencing

As described previously, the most significant human health pathway from floodplain soil contamination is potential future uptake of mirex into beef and milk fat. After installing fencing in areas where dairy cows previously had access to impacted soil, mirex was no longer detected in beef and milk fat samples. A combination of fences and bridges could continue to be used at dairy and beef farms along the creek.

Effectiveness: Low to High

This technique has proven to be highly effective at eliminating mirex uptake into beef and milk fat. This would eliminate the primary pathway of concern from floodplain soil to humans. However, this approach does nothing to mitigate exposure to floodplain soil by ecological receptors.

Implementability: High

Past experience has shown that it is easy to install durable fences and bridges[20] that exclude cows from MFLBC media. Conventional equipment is used and methods and materials are readily available. Maintenance is also straightforward, although access to private property would be required.

---

[20] The existing fences have been in place for approximately 18 years.

Costs: Low

Installation and maintenance of fences is inexpensive compared to other soil remediation alternatives.

Status: Eliminated

Although this technology has been effective at eliminating risks to human health from mirex contaminated floodplain soil, it does not provide protection of ecological receptors, so it has been eliminated as a technology for OU-3[21].

---

[21] Existing fencing is expected to remain in place for the foreseeable future, so although this technology has not been retained for screening of alternatives, it will likely still be a component of risk mitigation at the Site.

5.0 SCREENING OF REMEDIAL ALTERNATIVES FOR OU-3

5.1 Assembly of Alternatives

The retained technologies presented in Section 4.0 have been assembled into five remedial action alternatives for further evaluation. A No Action (or in this case No Further Action) alternative (Alternative No. 1) was identified consistent with the NCP. The remaining alternatives were assembled as described below. Each of these alternatives includes two options (designated as “a” and “b”). The only difference between these options is the method of disposal for removed soils and sediments. The “a” designation involves on-Site consolidation of the contaminated materials beneath a low-permeability cover as part of the OU-2 remedy, while the “b” designation involves off-Site transport and disposal of the materials at an approved disposal facility.

- Alternative 2 was assembled to provide minimal disruption to MFLBC habitat by allowing for MNR recovery of MFLBC sediments and targeted removal of floodplain soil to meet the PRG on a surface weighted average concentration (SWAC) basis. This alternative also includes removal/cover of Feeder Creek sediments as necessary to mitigate further releases of mirex into the MFLBC.

- Alternative 3 was assembled to provide targeted removal and backfilling (as necessary) of MFLBC sediments to meet the PRG on a surface weighted average concentration (SWAC) basis, targeted removal of floodplain soil to meet a SWAC PRG, and removal/cover of Feeder Creek sediments as necessary to mitigate further releases of mirex into the MFLBC.

- Alternative 4 was assembled to provide aggressive removal of mirex-contaminated media. This includes removing all sediments in Feeder Creek that have measured mirex concentrations, removing all sediments in the MFLBC from RM 31 to RM 37.6 that have measured mirex concentrations, and removing all floodplain soils along the MFLBC from RM 31 to RM 37.6 that have measured mirex levels.

A description and screening level evaluation of each alternative is presented below and a summary of the Alternatives is presented in Table 4. The screening level evaluation is based on the same three NCP criteria used for the screening of remedial technologies: effectiveness, implementability, and relative cost.

5.2 Alternative No. 1 – No Further Action

5.2.1 Description

Other than the continued maintenance of surface water runoff and sediment control structures on the former Nease Chemical Site, as required by an existing AOC (USEPA, 1995), no other remedial actions would be implemented that would address elements of OU-3. The following summarizes the major components of Alternative 1:

RAO	Action
RAO-1 MFLBC Sediment - to - Fish	No Action
RAO-2 MFLBC Sediment - to - Floodplain	No Action
RAO-3 MFLBC Floodplain Soil Ecological	No Action
RAO-4 MFLBC Floodplain Soil - to - Cattle	No Action
RAO-5 Feeder Creek	Maintain Surface Water and Sediment Controls

5.2.2 Effectiveness: Low

A summary of the effectiveness of this alternative is presented below:

- This alternative does not address the uptake of mirex from sediment into fish tissue (RAO-1). However, although no direct action would be taken, there is still the potential for a reduction in risk to receptors over time as natural recovery occurs due to the deposition of clean material on top of contaminated sediments. Sediment sampling conducted from 1987 to 2005 shows that mirex has not moved significantly downstream over this time period in spite of major storm events (see Figure 20). Under this alternative, there would be no monitoring to assess recovery.

- This alternative does not address mitigation of potential additional mirex contamination of the floodplain from MFLBC sediment (RAO-2).

- This alternative does not address mitigation of ecological exposures to unacceptable levels of mirex in floodplain soil (RAO-3).

- At the present time, there is no cattle exposure to unacceptable mirex levels in floodplain soil due to the presence of fences. As long as fences remain in place no action is necessary to protect cattle from unacceptable mirex uptake; however, this alternative does not provide for permanent protection of cattle from unacceptable mirex uptake from floodplain soil (RAO-4) since it does not require fences to be maintained.

- This alternative includes continued maintenance of the existing surface water runoff and sediment control structures at the Nease Site as required by USEPA’s existing order. Therefore, no future mirex contamination from Feeder Creek is expected (RAO-5).

In summary, although risk reduction may occur with this alternative, it does not fully control future exposures to impacted media. Therefore, the effectiveness of this alternative in providing overall protection of human health and the environment is low.

5.2.3 Implementability: High

This alternative is easily implemented.

5.2.4 Cost: Low

The cost of this alternative is low relative to the other alternatives, although the cost to continue to operate and maintain the sediment control structures is on the order of $360,000.

5.2.5 Status: Retained

This alternative has been retained as Alternative A[22] for detailed analysis in Section 6.0 consistent with the NCP and to serve as a baseline for comparing the effectiveness of other remedial alternatives.

5.3 Common Remedial Alternative Elements

Each of the following common remedial elements is included in the remaining alternatives assembled and screened in this section. These common remedial elements include remedial action components as well as PDI activities and are summarized below.

Common Remedial Action Components

No Further Action for MFLBC Sediment between the headwaters and RM 37.6 (former Nease facility) and downstream of RM 31

Based on the ecological and human-health based PRG range of 0.477 to 0.753 mg/kg in sediment, there are no locations downstream of RM 31 or upstream of RM 37.6[23] where unacceptable risks from sediment exist. Therefore, all remedial alternatives focus on remediation in the reach from RM 37.6 to RM 31. All alternatives include no further action for the rest of the sediment in the MFLBC. The area within this reach that will need to be addressed as part of the selected remedy will be further refined during a Pre-Design Investigation (PDI).

Sediment Control Structures on Feeder Creek

All of the assembled alternatives will include removal of the existing sediment control structures on Feeder Creek. These were constructed as an interim measure under an AOC by USEPA to mitigate the release of mirex-contaminated sediment into the MFLBC. With the exception of the no further action alternative (above), the other alternatives all address the Feeder Creek – to –

---

[22] A letter based identification system is used for the retained alternatives.

[23] Although mirex has not been detected above even the lower end of the sediment PRG range upstream of RM 37, Feeder Creek discharges to the MFLBC at RM 37.6, so this additional portion of the stream (RM 37 to RM 37.6) will be assessed as part of the PDI to determine whether remediation is necessary.

MFLBC pathway by removal and/or cover of Feeder Creek sediments. Therefore, the existing sediment control structures on Feeder Creek would no longer be necessary.

Former Nease Manufacturing Site Surface Water Management

All of the assembled alternatives (including no further action) include surface water management at the former Nease Manufacturing Site. It is important to ensure that erosion of site soils cannot re-contaminate Feeder Creek and the MFLBC. As part of the OU-2 remedy, soil covers will be placed on all areas that exceed the OU-2 ecological surface soil PRG of 1 mg/kg. These covers will mitigate the future release of unacceptable levels of mirex into the creek system. As part of the OU-2 remedial design, a property-wide surface water management system will be developed and constructed during remedial action to provide for the effective control of surface water runoff and to minimize future soil erosion from contaminated areas. The property-wide surface water management system will consist of the following components:

- A grading plan that integrates final surface topography in the remediated areas into the surrounding areas;
- The use of proper slopes, berms, channels, etc., and surface armoring using natural vegetation and/or synthetic materials to efficiently convey surface water runoff from the remediated areas and provide erosion protection; and,
- A program of regular inspection, maintenance and repair (as necessary) to assure continued effectiveness of the surface water management system.

The property-wide surface water management system will be developed during detailed design of the OU-2 remedy in accordance with state and local soil erosion and sedimentation control requirements.

Surface Water Sampling

Although no unacceptable risks from mirex in surface water have been estimated for OU-3, Ohio EPA has a surface water quality criterion for mirex and remediation activities could inadvertently cause a release of mirex. Therefore, mirex levels in surface water in Feeder Creek and MFLBC will be measured at least once after the post-construction recovery period.

Long-Term Fish Tissue and Sediment Monitoring Program

The Ohio EPA has developed a long-term sampling plan for the MFLBC that is included as Appendix K. This plan calls for sampling of fish tissue no sooner than 5 years following completion of the sediment remediation, so as to give the ecological system time to begin to adjust to reduced mirex concentrations in sediment. The results of fish tissue monitoring will be used to re-assess the need for a sport fishing advisory based on mirex. It is anticipated that fish tissue monitoring will be conducted as a collaborative effort with the Ohio EPA Division of Surface Water. The frequency of fish tissue sampling will be flexible and will be based on the results of the baseline monitoring and first post-remediation monitoring event. For cost purposes, it has been assumed that fish tissue monitoring will be required once every five years. Fish tissue samples will be collected for two or three representative species and for fillet and, in select cases, whole body analyses to assess human health and ecological risks, respectively. Fish tissue samples would be analyzed for mirex and percent lipids. If MNR is selected for MFLBC sediment then a long-term sediment monitoring program will also be undertaken, involving one sediment sample being collected from each of the same river mile locations as for fish tissue samples. Sediment monitoring at the rate of one sample per river mile is used for estimating purposes in this FS; however, a more focused sampling approach may be approved during detailed design of the remedy based on results of the PDI. Sediment samples would be analyzed for mirex, total organic carbon, and grain size distribution.

Transport and Disposal of Removed Sediment/Soil

All of the assembled alternatives (excluding no further action) include removal of floodplain soil and/or sediment, which will need to be transported for disposal. There are two basic options for disposal of contaminated soil/sediment. One option is to consolidate these materials within the Site (e.g. on the former Nease manufacturing property beneath the planned OU-2 low permeability cap). The other option is to dispose of the materials at an appropriate disposal facility off-Site.

Processing/Handling/Dewatering of Removed Sediment

Depending upon the sediment dredging/removal technique selected during the detailed design, various processing may be required prior to ultimate disposal. The most common processing necessary is dewatering. Unless all water can be diverted from the sediment in the stream for a long enough period to let the sediments dry out, some level of dewatering will be required. For example, the use of hydraulic dredges typically increases the removed volume by about 4 times (3 parts water to 1 part solids in the removed slurry) or more. Dewatering can be accomplished by a variety of techniques as described in Section 4.2.1.2.

Construction/Performance Monitoring

Construction and performance monitoring are required for demonstrating the compliance of any implemented remedy with the remedial goals. Construction monitoring is used to assess acute risks to the community, ecology, and workers that may occur as a result of implementing the remedy. Performance monitoring is used post-remediation to assess whether short- and long-term risk reduction goals will be met by the implemented remedy.

Dredging and excavation remedies require a combination of construction and performance monitoring. Construction monitoring for dredging includes measuring downgradient transport of resuspended particles (e.g. by using real-time turbidity meters). Construction monitoring for a soil excavation would likely include dust control and monitoring. Performance monitoring for dredging and excavation operations would include sampling and analyzing residual sediments/soil to verify that SWAC-based PRGs have been attained.

Common PDI Activities

The following summarizes the PDI activities that are included in all of the assembled alternatives (except for No Further Action). A PDI work plan that describes the activities in detail will be completed and submitted to the Agencies for approval. Notably, the details of all PDI activities would be developed in cooperation with the Agencies. Additional alternative-specific PDI activities are listed for each alternative retained for further consideration.

MFLBC Sediment

- Detailed mapping of fine-grained sediment bodies in the targeted remediation area. The sediment mapping will be used in the detailed design of sediment remediation, including the design of appropriate monitoring for the MNR alternative (Alternative 2).

- Sediment sampling for mirex and total organic carbon analysis. This assessment may include the collection of sediment pore water for analysis of mirex to determine whether biota accumulation factors can be better correlated with pore water concentrations. Sediment sampling for mirex analysis will provide a baseline for assessing whether remedial goals are met. Sediment sampling will target fine-grained sediments because mirex is more likely to adhere to these organic-rich sediments. Discrete sampling will likely be performed to determine whether there are “hot-spots” where targeted remediation can be conducted to efficiently achieve the surface-area weighted average concentration-based PRG. In addition to surface sampling, depth-discrete sampling (e.g. coring) will be conducted to determine the extent to which buried mirex contamination needs to be addressed as part of the remedy. Sample locations will include both the MFLBC and Feeder Creek.

- Fish tissue sampling for mirex and percent lipid analysis. Fish tissue analyses would include both whole body and fillet samples to provide a baseline sampling event consistent with Ohio EPA's proposed long-term program. The results of fish tissue sampling can be used to further refine the understanding of sediment-to-biota uptake.

MFLBC Floodplain Soil

- Physical characterization of areas targeted for removal/cover. Physical assessments may include assessing surface water drainage patterns to determine whether covering floodplain soils can be conducted without adversely affecting surface water drainage.

- Chemical characterization of areas targeted for removal/cover. This assessment will include mirex and total organic carbon analyses. Discrete sampling will likely be performed to determine whether there are "hot-spots" where targeted remediation can be conducted to efficiently achieve the surface weighted average concentration–based PRG. The PDI will also define the extent of the areas targeted for remediation discussed in Sections 6.3 and 0.

Flood Plain/Wetlands

An assessment of the 100-year flood plain and the presence/absence of wetlands in areas where remediation may be conducted will be included in the PDI to provide data for design.

5.4 Alternative No. 2a

5.4.1 Description

A summary of Alternative 2a is presented below:

RAO	Action
RAO-1 & RAO-2 MFLBC Sediment	Monitored Natural Recovery
RAO-3 & RAO-4 MFLBC Floodplain Soil	Targeted removal to meet SWAC PRG
RAO-5 Feeder Creek	Sediment removal/cover
Soil and Sediment Disposal	On-Site consolidation

The common remedial elements presented in Section 5.3 are also included in Alternative 2a.

Mirex Uptake in Fish from Exposure to MFLBC Sediment (RAO-1)

Alternative 2a provides MNR of sediment to meet RAO-1. As described in Section 0, natural recovery can occur through a variety of mechanisms including burying, reduction of bioavailability, degradation, and transport out of the system. The MNR alternative is different from the No Further Action alternative because a well designed long-term monitoring program is included as part of MNR, which allows for assessment of the recovery progress. Biocriteria studies performed by Ohio EPA have shown an increase in the overall health of the stream in the reach targeted for remediation. As shown in Appendix E, in 1985/1987 the only location within the targeted reach that had even partial attainment of the designated use was at River Mile 35.4. However, by the time of the 1999 study, partial to full attainment had also been achieved at all relevant stations, including river miles 36.7 (less than 1 mile downstream of Nease), 33.3, and 32.0. Although the reasons for non-attainment can be complex and involve physical as well as multiple chemical stressors unrelated to the Nease Site, it is clear that the overall aquatic health of the stream has naturally improved and the mirex contamination is not causing impairment of ecological populations. Nonetheless, mirex concentrations in sediment and fish (as shown on Figure 20, Figure 27 and Figure 28) have reportedly remained relatively constant throughout the monitoring period (1987 to 2005).

Mirex Contamination of Floodplain from MFLBC Sediment (RAO-2)

In this alternative, sediments currently in the MFLBC would remain in place and so there remains a possibility that future flooding could cause some portion of these sediments to be deposited in the floodplain. The floodplain portion of this alternative includes removal of soils to achieve the PRG, and it is expected that this removal will reduce the potential risks sufficiently that any additional deposition that occurs in the future will not raise floodplain soil risks above unacceptable levels. To verify this condition, this alternative would involve a floodplain sampling program in depositional areas following a large storm/flooding event.

Mitigate Exposures to Unacceptable Levels of Mirex in Floodplain Soil (RAO-3 and RAO-4)

Alternative 2a provides for targeted removal of floodplain soils where mirex concentrations exceed the PRG. Soil removal would use a targeted approach so that the surface weighted average concentration within a given exposure area meets the established PRG. The targeted approach will be designed so as to minimize unacceptable damage to valuable riparian habitat. The extent of areas to be removed will be determined as part of the PDI.

Mirex Contamination of MFLBC from Feeder Creek (RAO-5)

This alternative includes removal/cover of contaminated sediments in Feeder Creek to mitigate potential future releases of mirex into the MFLBC. It is anticipated that sediment will be removed to a specified depth along the entire creek (e.g. 2-feet unless coarse material or bedrock is encountered first). It is anticipated that the entire channel would be excavated, a geotextile would be placed and rip-rap substrate will be placed on top. However, in the event that removal of 2-feet eliminates all mirex contamination a cover may not be necessary. The detailed design will follow the PDI and determine the most cost-effective combination of removal and cover to mitigate future mirex releases and preserve the surface water management function of the Creek.

On-Site Consolidation of Soil/Sediment

Soil and sediment removed as part of this alternative will be consolidated on-Site at the former Nease facility within Operable Unit 2 (OU-2). USEPA's existing Record of Decision for OU-2 requires the construction of low permeability cover over soils with similar, or higher, mirex concentrations, and it is anticipated that sufficient space exists within the required area of the cover to accommodate OU-3 materials. Any materials that cannot be accommodated within the OU-2 design would be disposed at an appropriately permitted off-Site facility approved by the Agencies.

5.4.2 Effectiveness

Alternative 2a will effectively achieve remedial action objectives RAO-3, RAO-4, and RAO-5. Alternative 2a may also achieve RAO-1 and RAO-2, although there is not currently sufficient evidence to show natural recovery with respect to mirex concentrations in sediment and fish. Mirex is resistant to biodegradation in the environment and burying with clean sediment does not appear to be a significant recovery mechanism to date in the MFLBC. Therefore it is difficult to predict a recovery time, but it is anticipated that it will take at least 15 years and maybe 30 years or more.

In summary, while Alternative 2a would be rapidly effective for achieving RAO-3, RAO-4, and RAO-5, it may not fully address RAO-1 and RAO-2 in an acceptable timeframe.

5.4.3 Implementability

The elements of this alternative utilize technologies and skills that are readily available and so implementation will be straightforward.

5.4.4 Cost

The cost of Alternative 2a relative to the other alternatives is expected to be low to moderate.

5.4.5 Status: Retained

Alternative 2 has been retained, and designated as Alternative B, for detailed analysis.

5.5 Alternative No. 2b

5.5.1 Description

This alternative is identical to Alternative No. 2a except that removed sediments and soils would be transported to an off-Site disposal facility rather than being consolidated on-Site at the former Nease facility.

5.5.2 Effectiveness

Alternative 2b will be equally as effective in the long-term as Alternative 2a (see Section 5.4.2).

5.5.3 Implementability

The primary action components of Alternative 2b are identical to Alternative 2a, so those aspects are equally easy to implement. However, because materials will need to be transported off-Site for disposal, there will be additional disruption and short-term risk to neighboring communities due to increased vehicular traffic. In addition, it may be difficult to find a disposal facility within a reasonable distance that will be able and willing to accept the materials.

5.5.4 Cost

Alternative 2b has significant additional costs compared to Alternative 2a because it includes off-Site transport and disposal of all excavated soil and sediment. As stated above, a local facility may not be available that will be able to accept the volume of material removed under this alternative. This would lead to high transportation and disposal costs.

5.5.5 Status: Eliminated

Alternative 2b has been eliminated because while it provides the same level of long-term effectiveness as Alternative 2a, it is more difficult to implement and will be more costly.

5.6 Alternative No. 3a

5.6.1 Description

A summary of Alternative 3a is presented below:

RAO	Action
RAO-1 & RAO-2 MFLBC Sediment	Targeted removal/backfilling to meet SWAC PRG
RAO-3 & RAO-4 MFLBC Floodplain Soil	Targeted removal to meet SWAC PRG
RAO-5 Feeder Creek	Sediment removal/cover
Soil and Sediment Disposal	On-Site Consolidation

The common remedial elements presented in Section 5.3 are also included in Alternative 3a.

MFLBC Sediment (RAO-1 and RAO-2)

Alternative 3a provides for targeted removal with backfilling as needed to meet a surface weighted average concentration PRG. This approach would include a PDI to identify areas of elevated mirex concentrations and refine current estimates of sediment body areas and volumes. Based on the PDI results, areas will be targeted for removal that have elevated concentrations of mirex and will reduce the SWAC of the given exposure area to below the PRG. In this alternative, rather than remove sediments from an entire reach, a targeted approach is used that minimizes habitat damage while achieving the PRG. In addition to sediment removal, it is anticipated that clean backfill may be added in select areas to address residuals from dredging and enhance habitat restoration (see Section 4.2.1.2 for a description of backfilling in conjunction with sediment dredging). Given that the estimated sediment PRG for protection of human and ecological receptors through the fish consumption pathway was lower than the estimated floodplain soil PRG, addressing RAO-1 in this way will also achieve RAO-2.

Mitigate Exposures to Unacceptable Levels of Mirex in Floodplain Soil (RAO-3 and RAO-4)

Alternative 3a provides the same approach for RAO-3 and RAO-4 as Alternative 2a.

Mirex Contamination of MFLBC from Feeder Creek (RAO-5)

Alternative 3a provides the same approach for RAO-5 as Alternative 2a.

On-Site Consolidation of Soil/Sediment

Alternative 3a utilizes the same approach as Alternative 2a, although the volume of material will be greater due to the additional removal of sediment from the MFLBC.

5.6.2 Effectiveness

Alternative 3a will effectively achieve all RAOs and provide protection of human health and the environment. While habitat destruction is unavoidable with this alternative the disturbance will be limited by using a targeted approach to achieve the PRGs.

5.6.3 Implementability

In general, the technologies and skills utilized in Alternative 3a are readily available and so implementation will be straightforward.

5.6.4 Cost

The cost of Alternative 3a relative to the other alternatives is expected to be moderate.

5.6.5 Status: Retained

Alternative 3a has been retained and designated as Alternative C for detailed analysis.

5.7 Alternative No. 3b

5.7.1 Description

This alternative is identical to Alternative No. 3a except that removed sediments and soils would be transported to an off-Site disposal facility rather than being consolidated on-Site at the former Nease facility.

5.7.2 Effectiveness

Alternative 3b will be equally as effective in the long-term as Alternative 3a (see Section 5.6.2).

5.7.3 Implementability

The primary action components of Alternative 3b are identical to Alternative 3a, so those aspects are equally easy to implement. However, because materials will need to be transported off-Site for disposal, there will be additional disruption and short-term risk to neighboring communities due to increased vehicular traffic. As described in Section 5.5.3, it may be difficult to find a local facility that is able and willing to accept the materials removed under this Alternative.

5.7.4 Cost

Alternative 3b has additional costs compared to Alternative 3a because it includes off-Site transport and disposal of all excavated soil and sediments.

5.7.5 Status: Eliminated

Alternative 3b has been eliminated because while it offers the same level of long-term effectiveness as Alternative 3a it is more difficult to implement, and will be more costly.

5.8 Alternative No. 4a

5.8.1 Description

A summary of Alternative 4a is presented below:

RAO	Action
RAO-1 & RAO-2 MFLBC Sediment	Remove All Mirex-Contaminated Sediment from RM 37 to RM 31.5
RAO-3 & RAO-4 MFLBC Floodplain Soil	Remove all areas with Mirex-Contaminated Floodplain Soil above the PRG
RAO-5 Feeder Creek	Remove All Mirex-Contaminated Sediment
Soil and Sediment Disposal	On-Site Consolidation

The common remedial elements presented in Section 5.3 are also included in Alternative 4a.

MFLBC Sediment (RAO-1 and RAO-2)

The primary difference between Alternative 4a and 3a is that it requires much more extensive removal of contaminated sediment rather than a targeted approach, and potential backfilling is not included. In order to achieve RAO-1 and RAO-2, all sediment in the MFLBC from RM 31 to RM 37.6 that contains mirex would be removed.

MFLBC Floodplain Soil (RAO-3 and RAO-4)

Similar to MFLBC sediment, Alternative 4a achieves RAO-3 and RAO-4 by removing all floodplain soil areas where mirex is detected above the PRG, rather than using a targeted approach to minimize habitat destruction.

Mirex Contamination of MFLBC from Feeder Creek (RAO-5)

This alternative achieves RAO-5 by removing all sediment containing mirex in Feeder Creek.

5.8.2 Effectiveness

Alternative 4a may achieve all RAOs by meeting the PRGs in the short-term; however, it will be no more effective in attaining the PRGs than less invasive remedies and will be less effective overall due to extensive impacts to the habitat of the receptor species that the remedy is designed to protect. There will be much greater deleterious impacts on the environment since the entire stream bottom habitat from RM 31 to RM 37.6 will be destroyed by sediment removal, likely resulting in a longer recovery time. As noted by USEPA (2005), it is effectively impossible to remove all sediment without some residuals remaining and so the potential exists that this alternative would not achieve the sediment PRG. This alternative would also involve the destruction of large areas of wooded riparian zone habitat and agricultural land along the creek in order to remove all floodplain soil areas. In addition, the increased volume of materials and the need to manage them will have potentially greater short-term effects, such as local disturbance, from construction of temporary roads, increased truck traffic, etc. Construction time for this alternative is expected to be at least double the construction time for any other alternative and will require multiple construction seasons. Although attempts would be made to minimize adverse effects of remediation, with the longer construction times necessary to complete this alternative, the adverse impacts would be expected be more severe and to continue longer than they would for other, less invasive alternatives.

5.8.3 Implementability

The technologies and skills used in Alternative 4a are readily available; however, it will be difficult to implement this remedy. It may be difficult to obtain access to remediation areas from some property owners due to concerns over extensive disruption to their property. In addition, significant infrastructure, such as temporary access roads and staging areas along the creek will be required along a much larger portion of the MFLBC to implement this remedy. A higher volume of sediment would need to be handled and dewatered, which may require more area than is available at the former Nease facility.

5.8.4 Cost

The cost of Alternative 4a relative to the other alternatives is expected to be very high due to the much greater volume of sediment and soil that will need to be removed, transported, and disposed. There will also be significant cost involved in accessing remote areas and attempting to restore damaged habitats.

5.8.5 Status: Eliminated

Alternative 4a has been eliminated from further consideration as it is less effective, more difficult to implement, and more costly compared to other alternatives.

5.9 Alternative No. 4b

5.9.1 Description

This alternative is identical to Alternative No. 4a except that removed sediments and soils would be transported to an off-Site disposal facility rather than being consolidated on-Site at the former Nease facility.

5.9.2 Effectiveness

Alternative 4b will be equally as effective in the long-term as Alternative 4a (see Section 5.8.2).

5.9.3 Implementability

The primary action components of Alternative 4b are identical to Alternative 4a, so those aspects of implementability are the same. However, because materials will need to be transported off-Site for disposal, there will be additional disruption and short-term risk to neighboring communities due to increased vehicular traffic. In addition, as discussed in Section 5.5.3, it will likely be difficult to find a local facility that is able to accept the materials removed as part of this Alternative. Given that the volume of materials to be removed are much greater than Alternatives 2b and 3b, it will be even more unlikely that an appropriate facility will be available, thus making it difficult to implement this alternative.

5.9.4 Cost

Alternative 4b has much higher costs than Alternative 4a because it includes off-Site transport and disposal of all excavated soil and sediments, and, as discussed above, there is not likely to be a facility nearby that is able to accept the large volume of materials generated.

5.9.5 Status: Eliminated

Alternative 4b has been eliminated because it will be more difficult to implement and more costly than Alternative 4a, which has also been eliminated.

6.0 DETAILED ANALYSIS OF OU-3 ALTERNATIVES

6.1 NCP Evaluation Criteria

The selection of a remedial alternative is based on an evaluation of nine criteria established in the NCP. Two criteria (state acceptance and community acceptance) will not be evaluated in this report because they will be evaluated during the public comment period after USEPA proposes its Preferred Alternative. The remaining seven criteria are listed below.

Threshold criteria are those which must be met in order for an alternative to be eligible for selection. The two threshold criteria are described below.

- Overall Protection of Human Health and the Environment

  Under this criterion, an alternative should be assessed to determine whether it can adequately protect human health and the environment, in both the short-term and long-term, from unacceptable risks posed by hazardous substances, pollutants or contaminants present at the Site, by eliminating, reducing or controlling exposures to chemical impacts in Site media. This criterion is an overall assessment of protection based on a composite of factors assessed under other evaluation criteria, especially long-term effectiveness and permanence and short-term effectiveness.

- Compliance with ARARs

  This criterion evaluates whether the alternative will likely be able to attain ARARs under federal environmental laws and state environmental or facility siting laws, or provides grounds for invoking a legal waiver of such requirements.

ARARs may relate to the substances addressed by the remedial action (chemical-specific), to the location of the remedial action (location-specific), or the manner in which the remedial action is implemented (action-specific). The remedial actions associated with OU-3 alternatives need comply only with the substantive aspects of ARARs, not with the corresponding administrative requirements (e.g., consultation, issuance of permits, documentation, record keeping, and enforcement).

- *Chemical-Specific ARARs:* As discussed in Section 3.2 there are no chemical-specific ARARs for mirex in the primary media of concern in OU-3 (i.e., soil and sediment).

- *Action-Specific ARARs:* As shown on Table L-1 in Appendix L, the action-specific ARARs are separated into the following four categories for discussion purposes: air pollution control, hazardous waste management, drinking water, and surface water.

Federal action-specific ARARs are listed separately. Each alternative will be evaluated with respect to its ability to comply with these action-specific ARARs.

- *Location-Specific ARARs:* Location-specific ARARs set restrictions on the conduct of remedial activities in particular locations (e.g. floodplains). Table L-1 (Appendix L) presents the potential State and Federal location-specific ARARs. These include the Federal Clean Water Act Section 404, Fish and Wildlife Coordination Act (16 USC 661-666c), Executive Orders on Floodplain Management and Wetlands Protection (CERCLA Floodplain and Wetlands Assessments-EO 11988 and 11990), Erosion and Sediment Control (OAC 1501-15-1), and Water Use Designation for the Little Beaver Creek Drainage Basin (OAC 3745-1-15).

- *TBCs Information:* As shown on Table L-1 (Appendix L), a number of regulations/guidance were identified as TBC information potentially pertaining to the retained alternatives. This TBC information will be considered during the detailed design. As discussed in Section 3.2, in addition to ARARs, the lead agency may, as appropriate, identify other advisories, criteria, or guidance to be considered for a particular remedial component.

Balancing criteria are used to weigh the alternatives in order to help determine the best selection for the Site. The five balancing criteria are described below.

- Short-Term Effectiveness

  This criterion evaluates the impacts of the alternative during implementation with respect to human health and the environment. The short-term impacts of an alternative are assessed considering: short-term risks that might be posed to the community during implementation of an alternative; potential impacts on workers during remedial action and the effectiveness and reliability of protective measures; potential environmental impacts of the remedial action and the effectiveness and reliability of mitigation measures during implementation. In addition, relative remediation time frames are discussed for each alternative.

- Reduction of Toxicity, Mobility, and Volume Through Treatment

  Under this criterion, the degree to which an alternative employs recycling or treatment that reduces toxicity, mobility, or volume are assessed, including how treatment is used to address the principal threats posed at the site. Factors that are considered include: the treatment or recycling processes; the alternatives employed and the materials they will treat; the amount of hazardous substances, pollutants or contaminants that will be destroyed, treated, or recycled; the degree of expected reduction in toxicity, mobility or volume of the waste due to treatment or recycling and the specification of which reduction(s) are occurring; the degree to which the treatment is irreversible; the type and quantity of residuals that will remain following treatment considering the persistence, toxicity, and mobility of such hazardous substances and their constituents; and the degree to which treatment reduces the inherent hazards posed by principal threats at the site.

- Long-Term Effectiveness and Permanence

  Under this criterion, an alternative is assessed for the long-term effectiveness and permanence it affords, along with the degree of uncertainty that the alternative will prove successful. Factors that are considered, as appropriate, include: the magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities; and the adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste.

- Implementability

  This criterion addresses the technical and administrative feasibility of implementing the alternative as well as the availability of various services and materials required.

- Cost

  Cost items evaluated include capital and O&M expenditures to implement the alternative, presented as a present worth estimate.

Each of the retained alternatives described in Section 5.0, and summarized in Table 4, are evaluated in accordance with the above seven NCP criteria in the following sections.

6.2 Alternative A

6.2.1 Overall Protection of Human Health and the Environment

The No Further Action alternative would adequately protect human health under current conditions because there are no current risks posed by Nease-related contaminants in OU-3 media that are outside of USEPA’s acceptable criteria. However, the No Further Action alternative provides no reduction in risk to human health posed by future exposure scenarios discussed in Section 3.0. Complete protection of the environment is also not afforded by this alternative since potential ecological exposure pathways to mirex in surface soil in the floodplain and in sediment (through fish uptake) are not mitigated.

Although existing natural recovery processes would continue to occur in the MFLBC, recovery within the floodplain is less likely and recovery of the MFLBC sediments is uncertain given the lack of a clear decreasing trend in concentrations over the monitoring period to date. In addition, without continued monitoring of the MFLBC environment, it would not be possible to verify that natural recovery is occurring at a sufficient rate to be protective of ecological and human receptors. As a result, this alternative does not pass the threshold criteria of Overall Protection of

Human Health and the Environment. This alternative has nonetheless been retained for detailed analysis as required by the NCP.

6.2.2 Compliance with ARARs

This alternative would continue to comply with chemical and location specific ARARs. Action-specific ARARs do not apply.

6.2.3 Short-Term Effectiveness

No additional short-term risks to the community, workers, or the environment are posed by implementation of this alternative. Given that mirex is relatively resistant to degradation in the environment, this alternative will have the longest remediation time since no mirex-contaminated media will be removed or contained.

6.2.4 Long-Term Effectiveness and Permanence

This alternative does not provide long-term effectiveness as it does not address potential future exposure pathways. Natural recovery of sediment, fish, and floodplain soil chemical impacts along the MFLBC may be an effective long-term measure that utilizes naturally occurring processes, which are expected to continue to stabilize and restore the aquatic habitat quality. However, routine monitoring is not included to verify the continued effectiveness of natural recovery processes. As required by the AOC for OU-1, this alternative includes the continued O&M of fabric barriers in Feeder Creek and surface water and sediment controls at the former Nease facility. Therefore, this alternative will be effective at mitigating potential future releases of mirex into the MFLBC.

Because chemical impacts would be left in place, five-year reviews would be conducted to assess the continued protectiveness of this option.

6.2.5 Reduction of Toxicity, Mobility, and Volume

Natural recovery, under favorable conditions, acts without human intervention to reduce the toxicity, mobility, and volume of chemicals in soil or sediment. These processes include photolysis, biodegradation, dispersion, dilution, sorption, volatilization, chemical or biological stabilization, and transformation, among others (USEPA 1999). Mirex does not readily degrade in the environment, so ongoing natural recovery processes at the Site are not likely to reduce the volume (mass) of mirex in MFLBC media in a reasonable timeframe. Other natural recovery processes, such as aging (sorption to organic particles of soil/sediment) and burying by clean material are expected to reduce the toxicity and mobility of mirex. However, the progress of natural recovery would not be verified under this alternative given the absence of monitoring.

6.2.6 Implementability

The No Further Action alternative is straightforward and easy to implement.

6.2.7 Cost

A cost estimate for this remedial alternative is shown in Tables 5, 6, and 7. The costs associated with this remedy would be for the continued O&M of fabric barriers on Feeder Creek. The total present worth cost for this alternative is $360,000 based upon 30 years of O&M of the fabric barriers.

6.3 Alternative B

A conceptual layout of Alternative B is shown on Figure 44. This alternative provides for MNR of MFLBC sediments, excavation/backfilling of floodplain surface soil, and removal/cover of Feeder Creek sediments.

An important design consideration for the MNR portion of this alternative is to define appropriate exposure units for ecological and human receptors. This unit defines the area over which the SWAC PRG would need to be met to meet the RAOs. In the case of ecological receptors, the PRG is based on exposures to the mink. As described in USEPA's Wildlife Exposure Factors Handbook (USEPA, 1993), mink home ranges within river line habitats are generally linear. One key stream study showed home ranges for minks ranging from 0.62 to 3.1 miles. Human exposures to mirex in fish tissue will likely occur within the reaches of the creek where access is readily available. These locations are primarily at, or near, bridges for local roads that cross the creek. Between RM 31 and RM 37.6 there are seven locations where local roads or driveways cross the MFLBC: RM 37.6, RM 37.5, RM 36.7, RM 35.4, RM 35.1, RM 33.3, and RM 32. Based on the mink home range and a consideration of potential human uses, an exposure unit of one (1.0) river mile is considered appropriate for purposes of this FS. Sediment monitoring at the rate of one composite sample per river mile is used for estimating purposes in this FS; however, a more focused sediment sampling approach may be developed as part of the detailed design, based on results of the PDI. Similarly the appropriate exposure unit for attainment of the SWAC PRG for floodplain soil depends upon both potential ecological and human exposures. The critical ecological receptors range over about 1 to 1,245 acres and farm areas also exceed 1 acre. Accordingly, a floodplain soil exposure unit of at least 1 acre is considered appropriate for purposes of this FS.

Ohio EPA has proposed a long-term fish tissue monitoring program for the MFLBC (see Appendix K). In order to assess the effectiveness of MNR, fish tissue samples would be composited across each one-mile reach of the creek within the targeted area (RM 31 to RM 37.6) and analyzed for mirex and percent lipids. Consistent with Ohio EPA's proposal, 2 to 3 species would be collected at each river mile, and analyzed as fillets; approximately 50% of the samples would also be analyzed for whole body concentrations. In addition to fish tissue, one sediment sample would also be collected at each location, and analyzed for mirex, total organic carbon, and grain size distribution. In addition to the 6 river miles were sediment mirex concentrations exceed the PRG, natural recovery monitoring would also include additional upstream and downstream locations (total of 6 additional locations were assumed for cost estimating). For cost estimating purposes, an allowance equal to an additional 30% of samples has also been included for Quality Assurance/Quality Control (QA/QC) purposes (e.g. matrix spike/matrix spike duplicate (MS/MSD) and field duplicates). The detailed monitoring program would be developed following a PDI.

As shown on Figure 44, there are four areas that exceed the floodplain soil PRG of 1.0 mg/kg and will be targeted for removal under this alternative. The combined area is approximately 6.5 acres, or 31,460 square yards. For cost estimating purposes, it has been assumed that removal of the upper 6 inches of soil will be required in these areas, resulting in a total in-place volume of 5,300 cubic yards. Given that these floodplain areas include densely vegetated/wooded habitat, the goal of this alternative will be to minimize habitat destruction while achieving the SWAC PRG. A PDI will be conducted to define the extents of the targeted floodplain remediation areas shown on Figure 44. Backfill will be placed as necessary to maintain proper surface water management and avoid erosion.

This alternative also includes removal of mirex-contaminated sediment from Feeder Creek. The scope of this removal will include removing up to 2 feet of sediment[24] along the entire creek. Water flow from Feeder Creek will be redirected during remediation activities. This will most likely be achieved by temporarily pumping water around the removal area. Following removal of sediment, post-excavation sampling may be conducted to confirm that mirex contamination has been removed. Alternatively, a geotextile separator and rip-rap backfill will be placed to mitigate future releases of mirex from any remaining sediments. Institutional controls and O&M may be required depending on the levels of mirex remaining after construction and these issues be addressed in the design. Enhanced surface water management at the former Nease facility is being designed as part of the OU-2 remedy (including control of seeps) so as to eliminate unacceptable future releases to OU-3 media.

6.3.1 Overall Protection of Human Health and the Environment

This alternative will provide both short-term and long-term protection of human health and the environment as a result of the following:

- Exposures to mirex as a result of sediment contamination (ecological and human exposures through contaminated fish tissue) will be mitigated by MNR of sediment in the MFLBC. Estimated current risks to ecological receptors exceed acceptable levels and current risks to human receptors are low due to the existing Ohio EPA Sport Fish Advisories that limit consumption to no more than one meal per month based on non-Site related contaminants (mercury and PCB from Allen Road to the mouth) and mirex (from Allen Road to State Route 14). Compliance with fish advisories, however, is not enforceable and, therefore, overall protection is less certain for remedies that require long time frames, such as MNR. It is uncertain whether or not the mercury and PCB fishing advisory, which is unrelated to the Nease Site, will remain in place beyond the time necessary for mirex to attenuate.

- Exposures to mirex due to contamination of floodplain soils (ecological food chain exposures and potential human exposure through beef and milk) will be mitigated by removal of mirex-contaminated soils.

- Potential future releases of mirex contaminated sediment from Feeder Creek will be mitigated by removal of mirex-contaminated sediment in Feeder Creek.

---

[24] The sediment thickness removed may be more limited if bedrock is encountered shallower than 2 feet.

6.3.2 Compliance with ARARs

Alternative B involves disturbing surficial materials in floodplain areas of the MFLBC. These activities can be conducted in a manner that will comply with the substantive requirements of location and action-specific ARARs including local and State Erosion and Sediment Control ARARs, ambient air quality standards for particulates, and protection of wetlands and floodplains. Similarly removal of sediment from Feeder Creek might trigger Ohio Water Quality Criteria that are related to dredging, filling, obstructing or altering waters of the state.

An evaluation of the specific requirements needed to comply with the location and action-specific ARARs will be conducted during detailed design, including a wetlands assessment and floodplain evaluation. Engineering controls and monitoring will be used to assure that the final remedy complies with the substantive requirements of ARARs. While there are several location and action-specific ARARs and TBCs that will be addressed during remedial design, none are anticipated to be problematic and compliance with these requirements is expected.

6.3.3 Short-Term Effectiveness

The activities associated with this alternative may lead to some manageable short-term impacts to the community due to transportation of contaminated floodplain soil to the former Nease facility. In general, potential exposure during transport of soil is minimal and not likely to cause unacceptable risks; however, engineering controls will be used to further reduce the potential exposure (e.g. using covered trucks, misting soil so that airborne dust does not escape during transport, etc.).

Potential environmental impacts from this alternative may result from the excavation of floodplain soil. Existing vegetation will need to be cleared in order to remove the contaminated soil. In some locations, temporary roads may need to be constructed in order to access remote floodplain areas. These short-term impacts will be mitigated by using a targeted approach that reduces disruption to the existing habitat while achieving the RAOs. Affected areas will be revegated upon completion of the remedy.

The time frame for achieving floodplain soil-related remediation goals will be short given that contaminated soils will be removed. Ecological and potential future human health risks will be immediately reduced following remedy implementation. Similar to Alternative A, it is difficult to estimate the time frame for achieving MFLBC sediment-related remediation goals. However, this alternative provides for monitoring of MFLBC sediment and fish tissue to assess the progress of natural recovery. This alternative provides for removal of mirex contamination in Feeder Creek, and so will mitigate potential future releases of mirex into the MFLBC in a short time frame.

6.3.4 Long-Term Effectiveness and Permanence

Long-term permanent protection of human health and the environment is provided via the reduction of chemical concentrations in site media from the following actions provided by Alternative B:

- Excavation of MFLBC floodplain soils; and,
- Removal of mirex-contaminated sediment along the entire length of Feeder Creek.

These processes are irreversible and will result in the permanent removal of chemical impacts, and thus will add to the long-term protection of human health and the environment afforded by this alternative.

This alternative also provides for MNR of MFLBC sediment. Most processes involved in natural recovery are considered irreversible and will thus add to the long-term protection of human health and the environment. In addition, some natural recovery processes, such as burying of contaminated sediment with clean sediment, may be reversible (e.g. there is a potential for scouring that could lead to future exposures to unacceptable levels of mirex), although historical evidence from past storms does not suggest that this is a major concern. Based on monitoring results to date, it is difficult to predict a recovery time, although it is anticipated that it will take at least 15 years, and maybe more than 30 years.

Because certain residual chemical impacts would remain in place, five-year reviews would be required to re-assess the continued effectiveness of this alternative. There may be additional requirements (e.g. 5-year reviews, O&M, ICs, etc.) associated with management of materials consolidated at the former Nease facility; however, these requirements will be addressed as part of the OU-2 design, which will be integrated with the remedy selected for OU-3.

6.3.5 Reduction of Toxicity, Mobility and Volume

The same remedial components that will result in the irreversible removal actions discussed above will also result in the control of exposures to OU-3 media; however, this reduction in exposures will not occur through treatment of mirex. Removal of floodplain soil and contaminated sediments in Feeder Creek and placement within a confined disposal facility will reduce the toxicity, mobility, and volume of contaminants in these areas, although not through treatment, *per se*. As illustrated by the improvement in several biological health metrics, recovery of the aquatic system is already occurring in the MFLBC (see Section 0). MNR provides for reduced toxicity mobility through sequestration (treatment) processes (e.g. sorption to organic carbon) and burying with clean sediments. However, MNR is not likely to significantly reduce the volume of mirex in a reasonable timeframe, given its apparent resistance to biodegradation.

6.3.6 Implementability

All of the remedial components provided by this alternative are implementable as they utilize well established practices and the services and materials required are standard within the industry and readily available. The long-term monitoring requirements for the MFLBC sediment MNR component provided by this alternative can be readily performed and the personnel and equipment are easily available.

There are, however, some implementability concerns associated with accessing remote floodplain areas along the MFLBC for soil removal. Portions of the floodplain are at the base of steep slopes, so it may be difficult for excavation equipment to reach the floodplain in these areas.

6.3.7 Cost

A preliminary cost estimate for Alternative B is presented in Tables 5, 8, and 9. The total estimated present worth cost of this Alternative is $2,180,000. It was assumed for this alternative that fish tissue and sediment monitoring would be required over 30 years and that sampling would be conducted every 5 years. The cost estimates also assume that 30 years of annual site inspection and maintenance of Feeder Creek will be required.

6.4 Alternative C

A conceptual layout of Alternative C is included on Figure 45. This alternative includes targeted removal of sediment and floodplain soil to meet their respective surface weighted average concentration PRGs. Sediment remediation would be conducted in the river mile reach between approximately RM 31 and RM 37.6 as shown on Figure 45. Based on sediment sampling results discussed in Section 2.3.3.1, there are three primary sections where removal likely will be necessary: RM 31 to RM 32.3, RM 32.8 to RM 35.8, and RM 36.3 to RM 36.9. For purposes of this FS, remediation reaches were determined by assuming mirex contamination extends from a location with an exceedance of the PRG halfway to the nearest sample location where mirex levels were below the PRG[25]. Based on the sediment body volumes presented in Appendix B, the total fine-grained sediment body volume within these reaches is approximately 4,300 cubic yards. In the event that this alternative is selected, the associated PDI will include further delineation of sediment bodies for removal. This alternative also includes the option of using backfilling to achieve the sediment SWAC PRG in addition to removal (dredging). Cost estimates for removal of sediment assume that mechanical dredging will be the most practical approach (e.g. using a backhoe from the creek banks), although hydraulic removal via vac truck (or similar) may be more cost-effective in some areas. Mechanical dredging operations would likely include the installation of sheet pile coffer dams (or similar) to isolate and dewater sediment bodies as to reduce the amount of sediment dewatering subsequently required.

Sediment remediation would occur starting upstream and working downstream. This allows for re-capture of sediment particles that become resuspended as a result of disturbance and are carried short distances downstream. In order to access the sediment in the MLFBC, staging areas will likely be required along the MFLBC. Floodplain areas requiring remediation may be used for this purpose, where possible, to minimize the number of disturbed floodplain areas; however, it may also be necessary to perform clearing/grubbing of vegetation in the floodplain and construction of temporary access roads in other areas so that equipment can be placed along the stream for dredging.

It is anticipated that dredged sediment will be loaded into trucks/tankers and transported to the former Nease facility for dewatering, rather than setting up temporary dewatering facilities along the creek. This approach will lead to less disturbance of the floodplain since it will allow for

---

[25] Data from 1990-1995 (i.e. RI data) and Ohio EPA's 2005 data were relied upon for this assessment.

smaller staging areas along the MFLBC. Since mirex adheres strongly to particles and is virtually insoluble, the primary concern for the quality of dewatering effluent is the presence of particulates. It is anticipated that dewatering will be conducted using Geotubes® (or similar) which have been shown to produce water free of particulates, therefore, treatment of the water may not be necessary. If, however, during detailed design of this technology it is determined that treatment of the residual water is necessary, it will likely involve additional filtration and, possibly, adsorption using activated carbon. The existing on-Site treatment plant may be considered for this treatment process, or a separate facility may be constructed depending upon various factors such as cost and feasibility. The details of any required treatment would be developed as part of the remedial design.

The ideal time for conducting sediment removal is when surface water flow rates are low. Based on data collected by USGS on Little Beaver Creek at East Liverpool, discharge rates in this watershed are highest from January to May and are lowest from June to October. It is anticipated that, based on the anticipated sediment volume described above, construction of this alternative can be accomplished within one construction season between June and October. Assuming that mechanical removal is used for dredging, the volume of water removed with sediment will be minimized (compared to hydraulic methods). It is expected that about 20 truck trips per day may be required to transport sediment from MFLBC to the former Nease facility for dewatering throughout the construction period. Removed floodplain soil will also be transported to the former Nease facility in a similar manner. It is expected that floodplain soil and sediment removal will be conducted simultaneously and can both be completed within the same construction period.

As described previously in Section 6.3, the anticipated exposure unit for sediment-related ecological and human health risks is 1.0 river mile. During detailed design, each 1.0 river mile segment between RM 31 and 37.6 will be characterized and a targeted removal approach will be developed to achieve the SWAC PRG while minimizing short-term deleterious impacts to aquatic and riparian habitats. Post remediation sediment sampling would be conducted to confirm attainment of the PRG.

A long-term fish tissue monitoring program is also included in this alternative to assess the effectiveness of sediment dredging. Fish tissue samples would be composited across each one-mile reach of the creek between RM 31 and RM 37.6 and analyzed for mirex and percent lipids.

Consistent with Ohio EPA's proposed monitoring program (see Appendix K), two to three species would be collected at each river mile and analyzed as fillets; approximately 50% of the samples would be also analyzed for whole body concentrations. One upstream and one downstream location would also be selected for comparative fish tissue sampling. For cost estimating purposes, an allowance equal to an additional 30% of samples has also been included for QA/QC purposes. The fish monitoring described herein is an estimate for FS purposes; the detailed monitoring program would be developed in design.

MFLBC floodplain soil and Feeder Creek sediment are addressed in the same manner in this Alternative as in Alternative B (see Section 6.3).

6.4.1 Overall Protection of Human Health and the Environment

This alternative will provide both short-term and long-term protection of human health and the environment as a result of the following:

- Exposures to mirex due to contamination of MFLBC sediment (ecological and human exposures through contaminated fish tissue) will be mitigated by targeted sediment dredging.
- Exposures to mirex due to contamination of floodplain soils (ecological food chain exposures and potential human exposure through beef and milk) will be mitigated by removal of mirex-contaminated soils.
- Potential future releases of mirex contaminated sediment from Feeder Creek will be mitigated by removal of mirex-contaminated sediment in Feeder Creek.

6.4.2 Compliance with ARARs

Alternative B involves disturbing surficial materials in floodplain areas of the MFLBC. These activities can be conducted in a manner that will comply with the substantive requirements of location and action-specific ARARs including local and State Erosion and Sediment Control ARARs, ambient air quality standards for particulates, and protection of wetlands and floodplains. Similarly removal of sediment from the MFLBC and Feeder Creek might trigger Ohio Water Quality Criteria that are related to dredging, filling, obstructing or altering waters of the state.

An evaluation of the specific requirements needed to comply with the location and action-specific ARARs will be conducted during detailed design, including a wetlands assessment and floodplain evaluation. Engineering controls and monitoring will be used to assure that the final remedy complies with the substantive requirements of ARARs. While there are several location and action-specific ARARs and TBCs that will be addressed during remedial design, none are anticipated to be problematic and compliance with these requirements is expected.

6.4.3 Short-Term Effectiveness

The activities associated with this alternative may lead to some manageable short-term impacts to the community due to transportation of contaminated sediment and floodplain soil to the former Nease facility. In general, potential exposure during transport is minimal and not likely to cause unacceptable risks; however, engineering controls will be used to further reduce the potential exposure (e.g. using covered trucks, misting soil so that airborne dust does not escape during transport, etc.).

Environmental impacts from this alternative will result from the dredging of MFLBC sediment and excavation of MFLBC floodplain soil. Existing vegetation will need to be cleared in order to remove contaminated soil and dredging activities will disturb both aquatic and riparian habitats. In some locations, temporary roads may need to be constructed in order to access remote sediment and floodplain areas. These short-term impacts will be minimized by using a targeted approach that reduces disruption to the existing habitat while achieving the RAOs.

The time frame for achieving remediation goals will be relatively short given that contaminated sediment and soils will be removed. Ecological and potential future human health risks associated with floodplain soils will be immediately reduced following remedy implementation. The timeframe over which fish tissue levels will decline following sediment removal is uncertain as mirex will remain in tissue even after exposure has ceased. For this reason, long-term monitoring is required and will not be initiated until 5-years after the remedy has been implemented. This alternative provides for removal of mirex contamination in Feeder Creek, and so it will mitigate potential future releases of mirex into the MFLBC in a short time frame.

Construction of this remedy will involve appropriate work zone and traffic flow management to minimize short-term impacts to the local population during construction. Exclusion zones will be delineated where only those with appropriate training and protection will be allowed to enter and where the active remediation will be conducted. Outside each exclusion zone, a contaminant reduction zone (CRZ) will be set up that will only be accessible to those that are authorized to enter the exclusion zone or are helping to decontaminate personnel and equipment leaving the exclusion zone. In addition to the delineation and use of these remediation zones, it is anticipated that a traffic control plan would be developed to specify truck routes, waiting areas and related procedures to minimize waiting disturbances from the remediation activities.

There may be additional requirements (e.g. 5-year reviews, O&M, ICs, etc.) associated with management of materials consolidated at the former Nease facility; however, these requirements will be addressed as part of the OU-2 design, which will be developed to integrate with the remedy selected for OU-3.

6.4.4 Long-Term Effectiveness and Permanence

Long-term permanent protection of human health and the environment is provided via the reduction of chemical concentrations in site media from the following actions provided by Alternative C:

- Dredging of MFLBC sediments;
- Excavation of MFLBC floodplain soils; and,
- Removal of mirex-contaminated sediment along the entire length of Feeder Creek.

These processes are irreversible and will result in the permanent removal of chemical impacts, and thus will add to the long-term protection of human health and the environment afforded by this alternative. Requirements associated with management of materials consolidated at the former Nease facility are addressed under OU-2.

6.4.5 Reduction of Toxicity, Mobility, and Volume

The same remedial components that will result in the irreversible removal actions discussed above will also result in the control of exposures to OU-3 media; however, this reduction in exposure will not occur through treatment of mirex. Removal of floodplain soil and contaminated sediments in the MFLBC and Feeder Creek and placement within a confined disposal facility will reduce the toxicity, mobility and volume of contaminants in these areas, although not through treatment, *per se*.

6.4.6 Implementability

All of the remedial components provided by this alternative are implementable as they utilize well established practices and the services and materials required are standard within the industry and readily available. The long-term fish tissue monitoring requirements for the MFLBC provided by this alternative can be readily performed and the personnel and equipment are easily available.

There are, however, some implementability concerns associated with accessing remote areas along the MFLBC for both sediment dredging and soil removal. Portions of the floodplain are at the base of steep slopes, so it may be difficult for dredging/excavation equipment to reach the impacted areas.

6.4.7 Cost

A preliminary cost estimate for Alternative C is presented in Tables 5, 10, and 11. The total estimated present worth cost of Alternative C is $3,770,000. It was assumed for this alternative that fish tissue monitoring would be required over 30 years and that sampling would be conducted every 5 years. The cost estimates also assume that 30 years of annual site inspection and maintenance of Feeder Creek will be required.

7.0 COMPARATIVE EVALUATION OF ALTERNATIVES

7.1 Overall Protection of Human Health and the Environment

Under the current use scenario, all retained OU-3 alternatives, including the No Further Action alternative, provide protection of human health. However, the No Further Action alternative does not provide current protection of ecological receptors nor does it address potential future human and ecological exposures of concern.

Alternatives B and C will provide future protection of human health and the environment. However, the timeframe to achieve protection is expected to be longer for Alternative B than Alternative C. The greatest certainty of timely protection of human health and the environment is provided by Alternative C because the PRGs and RAOs for both sediment and floodplain soil will be met quickly, while using a targeted approach to minimize environmental disruption.

7.2 Compliance with ARARs

All three alternatives are expected to be able to comply with applicable action- and location-specific ARARs. There are no relevant chemical-specific ARARs for this Operable Unit.

7.3 Short-Term Effectiveness

Alternative A will result in the least short-term adverse impacts while Alternative C will result in the highest degree of short-term impacts, including significant disruption of aquatic and riparian habitats.

Due to the resistance of mirex to degradation, the time frame for remediation will be longest for Alternative A, and will be longer for Alternative B than for Alternative C. Because Alternative C includes the removal of mirex from all three impacted areas (MFLBC sediment and floodplain and Feeder Creek sediment), it will likely provide the shortest overall remediation time frame.

7.4 Long-Term Effectiveness and Permanence

Alternative C will have the highest long-term effectiveness and permanence because mirex contamination will have been removed from each component of the system. Alternative A may provide long-term effectiveness as natural recovery processes will eventually reduce mirex concentrations to acceptable levels, but the time frame for achieving remediation goals will be very long and the progress of recovery would not be monitored. Alternative B provides a greater long-term effectiveness for floodplain soil and Feeder Creek sediment than Alternative A because active remediation will be conducted. Alternative C contains the same features as Alternative B and also the added effectiveness and permanence of sediment removal from the MFLBC.

7.5 Reduction of Toxicity, Mobility, and Volume

The reduction of exposures to mirex-contaminated OU-3 media is highest for Alternative C since it provides for removal of the highest volume (mass) of mirex-contaminated media from the system. Alternative A provides the least reduction since no removal action will be taken. Exposure reductions are not associated with treatment *per se*, as feasible treatment methods are not available.

7.6 Implementability

In general, all three alternatives are implementable since the technologies and skills are readily available. Alternative A is the easiest to implement and Alternative C is the most difficult to implement due to potential difficulties accessing some portions of the floodplain and the MFLBC for soil/sediment removal.

7.7 Cost

The present worth costs for each of the alternatives is listed below in order of increasing costs:

- Alternative A – $360,000
- Alternative B – $2,180,000
- Alternative C – $3,770,000

7.8 Summary

The following table provides a summary of the relative rankings of the two[26] primary retained OU-3 remedial alternatives for each of the seven NCP criteria. The remedial alternatives assigned a rank of "First" is considered to be the most preferable in the associated category (i.e., most effective, most easily implemented, etc.).

---

[26] Alternative A was excluded because it does not pass the threshold criterion of Overall Protection of Human Health and the Environment..

Relative Ranking	*Protection of Human Health and Environment*	*Compliance With ARARs*	*Short-Term Effectiveness*		*Long-Term Effectiveness*	*Reduction of Toxicity, Mobility, Volume***	*Implementability*	*Cost*
			Potential Short-Term Impacts	*Remediation Time Frame*				
*First**	Alt. C	Alt. B, C	Alt. B	Alt. C	Alt. C	Alt. C	Alt. B	Alt. B
Second	Alt. B		Alt. C	Alt. B	Alt. B	Alt. B	Alt. C	Alt. C

* Indicates most preferable alternative(s) in given category.

** Neither of the alternatives will achieve substantial reductions of toxicity, mobility, and volume through treatment; however, each alternative will have varying levels of reduction of exposure.

8.0 REFERENCES

Environ, 2004. Endangerment Assessment for the Nease Chemical Company Salem, Ohio Site. April 2004.

Golder Associates Inc. (Golder) 1996. Remedial Investigation Report Volume 5. Appendix N: Middle Fork of Little Beaver Creek. Prepared for the Ruetgers-Nease Chemical Company, Inc., State College, Pennsylvania. May 1996.

Golder, 2000. Middle Fork of Little Beaver Creek, Mahoning and Columbiana Counties, Ohio, Impact Assessment Report. Dated March 2000.

Ohio Environmental Protection Agency (Ohio EPA), 2005. Total Maximum Daily Loads for the Little Beaver Creek Watershed. Division of Surface Water. Final Report. August 17, 2005.

Ohio EPA, 2008. 2008 Ohio Sport Fish Consumption Advisory. Division of Surface Water. February 2008.

RNC, 1996. Remedial Investigation Report, Nease Site, Salem, Ohio. Compiled by Golder Associates Inc., Mt. Laurel, NJ. May 1996.

State of Ohio, 2006. State of Ohio Cooperative Fish Tissue Monitoring Program Sport Fish Tissue Consumption Advisory Program. Revised November 2006.

USEPA, 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, EPA-600/R-93/187A and b.

United States Environmental Protection Agency (USEPA), 2002. Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC. OSWER Directive 9285.6-08. February.

USEPA, 2005a. Contaminated Sediment Remediation Guidance for Hazardous Waste Sites. Office of Solid Waste and Emergency Response, OSWER Directive 9355.0-85. December.

USEPA, 2005b. Nease Chemical Site Operable Unit Two Record of Decision. September 2005.