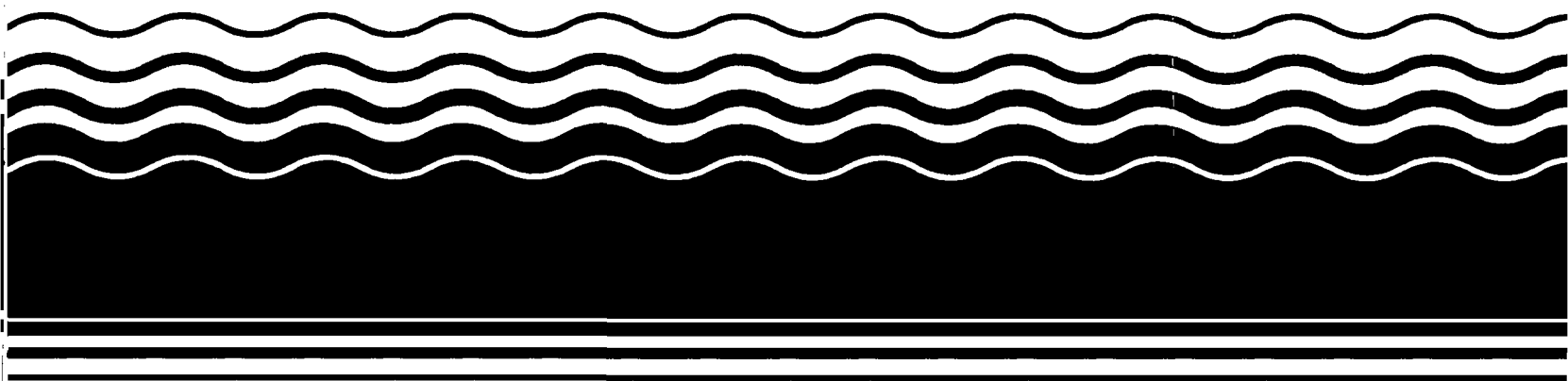


EPA/ROD/R04-95/226
June 1995

**EPA Superfund
Record of Decision:**

**Fort Hartford Coal Co. Stone Quarry
(OU 1), Olaton, KY
3/30/1995**



FORT HARTFORD STONE QUARRY NPL
SITE
OLATON, KENTUCKY



RECORD OF DECISION
REMEDIAL DESIGN/REMEDIAL ACTION

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I. DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Fort Hartford Stone Quarry Site
Olaton, Ohio County, Kentucky

STATEMENT OF BASIS AND PURPOSE

This decision document represents the selected remedial action for the Fort Hartford Stone Quarry Site developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This decision is based on the contents of the administrative record for the Fort Hartford Stone Quarry Site.

The State of Kentucky concurs on the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases from this Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent or substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

This final remedy addresses remediation of ground-water (and hence spring and surface water) as well as air contamination by eliminating or reducing the risks posed by the Site, through treatment, engineering and institutional controls.

The major components of the selected remedy include:

- Institutional controls (fencing, etc..) to prevent exposure to ground water and airborne ammonia;
- Continued diversion of intruding mine water/ground water away from salt cake fines (SCFs) via pumping with subsequent treatment for ammonia content and discharge to the Rough River;

- Deed restrictions;
- A ground-water, spring and surface water monitoring program to determine the effectiveness of plume containment and contaminant reduction;
- Containment of night air emissions via portal doors;
- An air monitoring program to determine effectiveness of night containment of ammonia emissions; and
- Forced ventilation of mine air to two dispersion stacks should monitoring reveal night containment of air emissions ineffective.

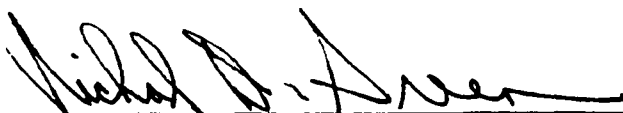
STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and State requirements that are applicable or relevant and appropriate to the remedial action and is cost-effective. This remedy also utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable, and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility and volume as a principal element. However, because treatment of the principle threats at the site was not found to be practicable, this remedy does not satisfy the statutory preference for treatment of all Site wastes as a principle element.

Because this remedy will result in hazardous substances remaining on-site above health-based levels, a review will be conducted at least every five years beginning no later than five years from the date of commencement of construction of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Reviews may be conducted on a more frequent bases as EPA deems necessary.

30 MAR 95

Date



Richard D. Green, Associate Director
Office of Superfund and Emergency Response

II. SITE DESCRIPTION, SITE HISTORY, AND SUMMARY OF ENFORCEMENT
AND COMMUNITY RELATIONS

A. SITE LOCATION AND DESCRIPTION

The Fort Hartford Stone Quarry site is located approximately 1.25 miles northwest of Olaton, Kentucky, in east-central Ohio County. It is bounded to the north by the Rough River and Davison Station Wildlife Management Area, to the south by Davison Station Road (now Underwood Road), to the east by one residence and Caney Creek, and to the west by agricultural land and Cane Run Creek. Figure 2.1 gives the general location of the Site.

The property encompasses approximately 850 acres with an underground mine portion consisting of approximately 120 acres. The mine consists of two lobes. The first lobe, the Rough River lobe has three primary entrances that were used during mining operations. The second lobe, the Caney Creek lobe, has five entrances.

From the late 1950s until about 1978, limestone was excavated from the mine. The lower three-fourth of the limestone was mined with the remaining upper one-fourth left intact to serve as the roof which is supported by unmined limestone pillars.

The Olaton/Ohio County area is situated in the east-central perimeter of the Western Kentucky Coal Fields as shown in Figure 2.2. This region is characterized by low, rolling hills of Pennsylvanian age shales, siltstones, and limestones which are exposed as a result of normal and high angle reverse faulting which has occurred within this zone. The alluviated valleys comprise a small portion of the area and have a general elevation of 380 to 420 feet; the hills surrounding the site rise to a maximum elevation of about 625 feet.

The major recognized geologic units at the Site, from youngest to oldest (going vertically downward) are:

- Tar Springs Sandstone
- Glen Dean Limestone
- Hardinsburg Sandstone
- Haney Limestone
- Big Clifty Sandstone
- Beech Creek Limestone
- Elwren Formation (sandstone)
- Reelsville Formation (transgressive limestone)

- Sample Sandstone

A total of 21,765 residents live in Ohio County based upon the 1980 census (Morris, 1980). The largest town in Ohio County is Beaver Dam with 3200 people. A total of 19 other incorporated communities are located in the county as well as a number of unincorporated settlements. The principal natural resources include oil and gas, coal, limestone, wood products, and fire clay.

There are 56 residences within a one-mile radius of the property boundary which includes the community of Olaton to the south/southeast and portions of Davison Station Wildlife Management Area to the north/northwest. Approximately half of these residences have private wells for potable water use with the remainder being on city water.

B. SITE HISTORY AND ENFORCEMENT ACTIVITIES

Beginning in 1981, by-products of secondary aluminum recovery, or salt cake fines (SCFs), were placed in the mine by Barmet Aluminum Corporation (Barmet). In 1988, EPA proposed that the site be added to the National Priorities List (NPL) after receiving a mean hazard ranking score of 43.84. The site was ranked because of concern that ammonia, chlorides, and possibly metals were posing a significant threat to human health and the environment through air and ground-water exposure pathways.

As a result, on September 20, 1989, an Administrative Order on Consent (AOC) was signed between EPA and Barmet. The AOC required Barmet to perform expedited response actions and an RI/FS study for the site. The expedited response actions, performed by Barmet and overseen by EPA were stated in the AOC as follows:

- To identify all areas where water was entering the mine storage areas;
- To identify all areas of SCF storage within the mine where there was either a potential for water to contact the salt cake fines or where the contact of water with salt cake fines was occurring;
- To isolate from water all SCFs in the mine by sealing off water intrusion areas, diverting water away from the SCFs and moving SCFs into dry parts of the mine; and

- To take actions in accordance with a written health and safety plan.

These actions commenced immediately after approval of an Expedited Response Action Plan (ERAP) in May 1990. Activities performed as part of accomplishing the above-mentioned objectives included grading the site for drainage away from SCF areas, repairing mine roof collapses which were allowing water intrusion into the mine, permanently closing 26 sinkholes which could allow water intrusion, and obtaining a discharge permit from the KNREPC for controlled discharge of site drainage into the Rough River.

After the expedited response actions were completed, the RI at the Fort Hartford Site was conducted to determine the nature and extent of any contamination. Field activities began in December 1991 and concluded in September 1993. In order to give an accurate depiction of site risks, samples were collected and evaluated from several media at Fort Hartford. The September 1994 Remedial Investigation (RI) report gives greater detail on sampling locations and methodology. Section IV of this document summarizes the sampling results.

Samples were taken to characterize the source material (SCFs) in the mine. Salt cake fines were sampled in the fresh (least reacted) state, the pre-rod-mill (larger grain size) state, the wet (partially or fully reacted) state, the crusted (reacted) state, and in a dry state beneath crusted material.

An Air Pathway Analysis was conducted to characterize the nature and extent of contaminant air emissions from the site. Meteorological data were collected on-site to determine length and height of contaminant dispersion. Ammonia emissions were measured from the mine portals as well as in areas at the site fenceline and off-site. This monitoring program was conducted over a 17-month period from August 1990 through December 1992.

Soils were sampled surficially and in the subsurface to determine if contamination was present. This sampling was performed in August and September of 1992.

The Rough River, Caney Creek and Cane Run Creek were sampled for surface water and sediment over a period of four quarters from August 1992 to May 1993. Samples of water exiting the mine (mine flumes) were also collected.

To determine the nature and extent of impacts to ground water from SCFs within the mine, 17 ground-water monitoring locations were selected throughout the site. An additional monitoring well drilled before the RI was begun (MW 1) was also sampled during the RI. Well locations were selected based on proximity to the mine and source material, faulting and impounded water within the mine. Wells were constructed to penetrate vertically through all water-bearing zones. A more thorough investigation of the geology beneath the mine was also performed to discern contaminant migration pathways as well as structural stability.

In addition to chemical samples, ecological sampling was conducted at the Fort Hartford Site. Sampling was in a tiered approach developed and approved by the U.S. Fish and Wildlife Service. Results from one tier determine whether the next tier of evaluation is necessary. Activities were conducted in two tiers: (1) contacts with natural resource trustees and a literature review, endangered species surveys, and terrestrial field assessments; and (2) acute toxicity tests. Toxicity testing was performed for aquatic and terrestrial organisms.

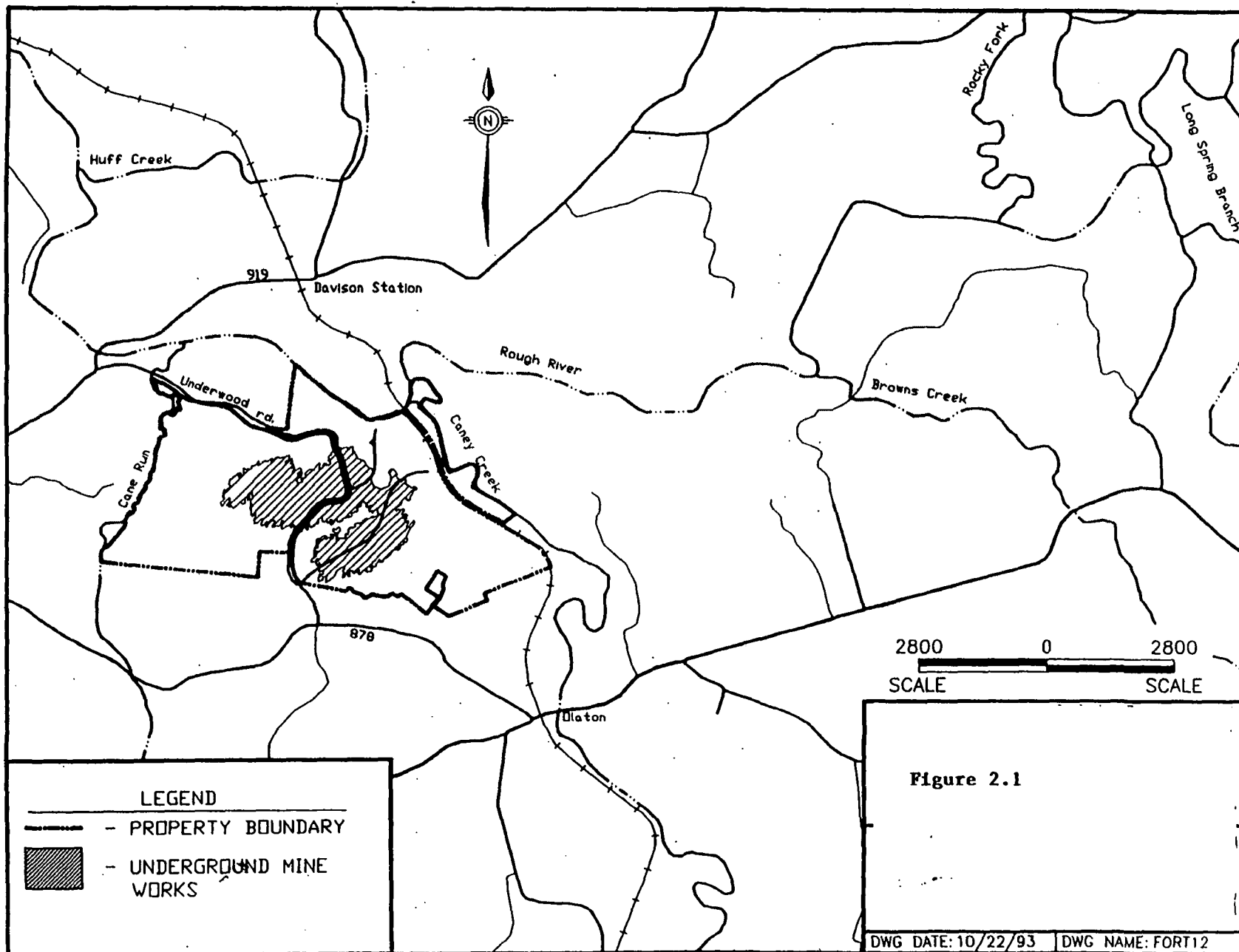
C. COMMUNITY RELATIONS ACTIVITIES

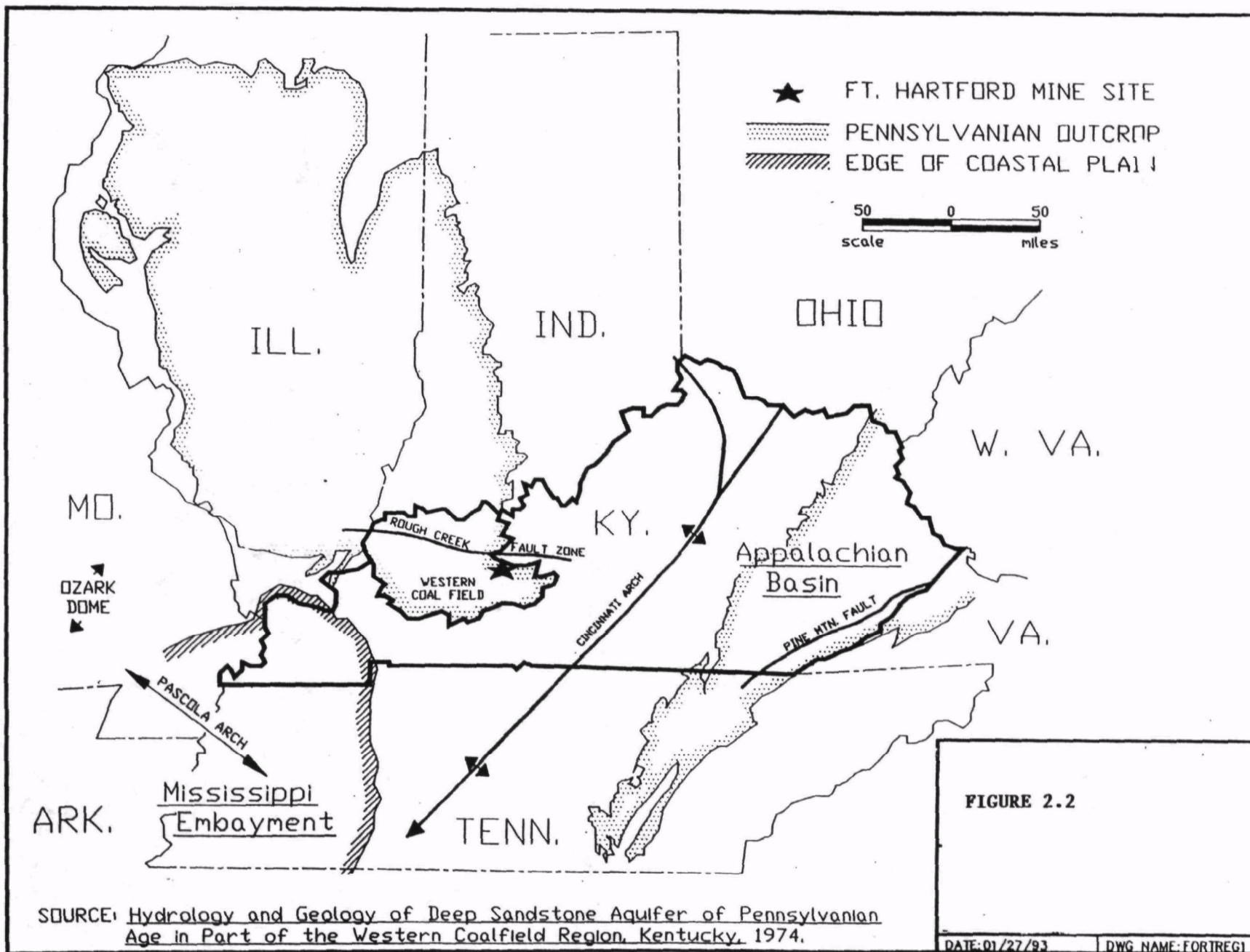
A Community Relations Plan (CRP) for the Fort Hartford Site was finalized in September 1990. This document lists contacts and interested parties throughout government and the local community. It also establishes communication pathways to assure timely dissemination of pertinent information. Prior to assembling the CRP, community interviews were conducted by EPA in June 1990 to gain insight on the community climate.

EPA held a RI/FS kickoff meeting in December 1991 to announce the beginning of the RI/FS to the public. The RI and FS reports were finalized in September 1994. These reports and all other documents concerning the Site have been made available to the public in the Fort Hartford Stone Quarry NPL Site Information Repository in the Ohio County Record Clerk's Office in the Ohio County Courthouse.

The Proposed Plan was sent out to the public on October 31, 1994, and a public meeting to discuss the Proposed Plan was held on November 17, 1994. This meeting was used to gain insight on public opinion concerning the remedial alternatives. Prior to this, community interviews were conducted in August 1994.

A public comment period was held on the Proposed Plan from November 3 to December 6, 1994. Comments received have been incorporated into the Responsiveness Summary (Appendix B) of this document.





III. SCOPE AND ROLE OF THE RESPONSE ACTION

The scope of this response action is to address remaining air and ground water/spring and surface water concerns at the Site. As discussed previously in Section II of this document, actions were implemented beginning in May 1990 to identify all areas of the mine where water was contacting SCFs and to divert this water away and treat it before discharging to the Rough River. SCFs were also relocated to drier areas of the mine.

During the development of the EPA RI, areas of concern were delineated for ammonia in the air and ammonia, chlorides and aluminum in ground water (and hence in some springs and surface water). These contaminants result from the reaction of SCFs with moisture.

The FS determined that the most effective method of addressing ground-water concerns at the Fort Hartford Site is by continuing to divert mine water away from SCFs and relocate them to drier areas of the mine. Air will be most effectively addressed in a contingency manner outlined in subsequent sections of this document. The first part of the selected remedy requires portal doors to seal off the mine during night hours. Doors would be opened during daylight hours when adequate turbulent mixing conditions exist to disperse ammonia away from the ground into the upper atmosphere. Should monitoring reveal that ammonia levels are not being reduced acceptably, portal doors will be permanently sealed off and emissions will be ducted to high stacks. These high stacks would inject air into the upper atmosphere, a proven way of adequate dispersion.

A ground-water monitoring program will be conducted both to determine the effectiveness of the ground-water plume containment as well as reduction in contaminant concentrations. Air monitoring will be conducted to determine if the portal doors being opened and closed are effective. Since wastes are remaining on-site as part of this remedy, ground-water and air data will be evaluated in the five-year review to determine if further action is required.

This selected alternative for the Fort Hartford Site will address all known concerns at the Site. It is intended to address the entire Site with regards to threats to human health and the environment posed by the Site, as indicated by the Risk Assessment included in the September 1994 RI report. Findings of the Risk Assessment are summarized in Section V of this document.

This is the only ROD contemplated for this Site.

IV. SUMMARY OF SITE CHARACTERISTICS

A. CONTAMINANT CHARACTERISTICS

The primary constituents of concern at the Site are ammonia, chlorides and aluminum. These are all by-products of the reaction of SCFs with water. Chlorides and aluminum are mobilized by water passing through the bulk material and carrying them downward into subsurface formations via percolation.

Ammonia is formed in the gaseous phase when SCFs contact water. More details of the ammonia concentrations predicted by the RI modelling are given below in this section.

If Site soils contained sufficient concentrations of these constituents, the potential would exist for cross-media transfer to underlying water bearing zones since these contaminants would not sorb well on soil. Since Site soils do not contain appreciable concentrations of these contaminants, this is not a concern.

Due to the above-mentioned affinity of these contaminants for the aqueous phase, no SCF-related exceedances were found in the sediment of the streams around the site while a small number of slight exceedances were found in surface water.

B. AFFECTED MEDIA CHARACTERISTICS

For site management purposes, the Fort Hartford site can be divided into specific affected media. The following discussion summarizes the characteristics of each media that are relevant to the identification, screening and selection of remedial technologies and strategies. For more detailed information on sampling and results, refer to the Remedial Investigation Report on file in the Administrative Record for the Fort Hartford Stone Quarry Superfund Site.

1. Soil

The EPA RI at the site took surficial and subsurface (vadose) soil samples to characterize the nature and extent of any soil contamination. Due to the size of the site (over 850 acres), sampling efforts focused on those areas most susceptible to site-related impacts. Surficial samples were collected from 0 to 12" and 12 to 24" and composited. Discrete vadose samples were

collected at 5 foot intervals until the water table or bedrock was intercepted.

During the weeks of August 24, 1992, to September 10, 1992, 20 surficial soil samples were collected. Of the 20 locations, three were selected as offsite background locations for comparison.

Vadose sampling was conducted from August 31 to September 11, 1992. In all, 33 samples were collected from 15 locations.

Low level exceedances were noted for various compounds and analytes in both surficial and vadose zone samples. Based on these exceedances, the following contaminants were retained for further analysis in the Risk Assessment. (See Section V of this document.)

Volatiles (VOAs) and Semivolatiles (PNAs)

| | | |
|------------------------|------------------------|----------------|
| Naphthalene | 2-methylnaphthalene | Phenanthrene |
| Fluoranthene | Benzo(a)anthracene | Chrysene |
| Carbazole | Pyrene | Benzo(a)pyrene |
| Benzo(g,h,i)perylene | Acenaphthene | Dibenzofuran |
| Benzo(k)fluoranthene | Acenaphthylene | Benzene |
| Anthracene | Benzo(b)fluoranthene | Fluorene |
| Indeno(1,2,3-cd)pyrene | Dibenzo(a,h)anthracene | |

(These volatiles may indicate that the area is impacted by fossil fuels.)

Inorganics/Wet Chemistry Parameters

| | | | |
|-----------|-----------|----------|-----------|
| Chlorides | Ammonia | Aluminum | Arsenic |
| Sodium | Potassium | Barium | Beryllium |
| Chromium | Copper | Cobalt | Iron |
| Vanadium | Zinc | | |

Pesticides/PCBs

| | | | |
|--------------|--------------------|-----------------|----------|
| alpha-BHC | 4,4'-DDT | 4,4'-DDE | Dieldrin |
| Methoxychlor | gamma-Chlordane | Endrin aldehyde | Endrin |
| Aroclor-1260 | Heptachlor epoxide | | |

(These chlorinated pesticides were also retained although the source of these compounds was suspected to be non site-related.)

Five surface soil samples collected on-site were found to contain chloride concentrations in excess of two times background. Each of these locations (i.e. mine entrances, mechanic shop) are associated with past Site operations where Salt cake fines may have been released

to the environment. One vadose sample was found to contain elevated concentrations of leachable chlorides.

Surface soil leachable ammonia concentrations were above the method detection limit at 10 locations. These elevated concentrations were at locations corresponding to elevated chloride levels. Three vadose zone sampling locations showed samples with elevated concentrations of ammonia.

Aluminum concentrations in all surficial soils were below background levels. Two vadose samples had elevated aluminum concentrations. These results did not suggest a significant departure from naturally-occurring levels and are not considered indicative of site impacts, however, due to the association between SCFs and aluminum, this parameter was retained for inclusion in the risk assessment.

A geotechnical investigation was also performed at the Site. This study was used to gain additional understanding of the subsurface environment and soil and ground-water migration pathways. This report can be found in the Information Repository for the Fort Hartford site.

2. Surface Water and Sediments

Surface water samples were collected on a quarterly basis from August 1992 to May 1993 (four quarters) in order to account for seasonal variation in flow conditions. Surface water samples included all aqueous samples from instream locations (Rough River, Caney Creek and Cane Run Creek), natural on-Site spring locations and the Rough River and Caney Creek mine flumes. Figure 4.1 shows the location of all surface water and sediment samples.

Mine flumes were evaluated based on the possibility that they may have served as historical sources of instream contamination. Evaluation of data in comparison to background concentrations in the streams into which the respective mine flumes flow resulted in the inclusion of potassium, sodium, ammonia, chlorides, sulfates, barium, cadmium, calcium, chromium, copper, magnesium, selenium and zinc on the list of possible source-related contaminants.

Instream surface water results show that aluminum,

potassium, ammonia, chlorides, barium, calcium, iron, lead, magnesium, nickel and zinc were each detected in at least one sample at a concentration greater than background, although these were quite infrequent and sporadic. This has led to the conclusion that the observed exceedances do not show a pattern indicative of continual influx of SCF constituents. In spite of this fact, all of the above-mentioned constituents were retained for inclusion in the risk assessment.

Spring data showed impacts for magnesium, potassium sodium, selenium, chlorides, sulfates, ammonia, cadmium, chromium, iron, manganese, vanadium and zinc. Each parameter was retained for the risk assessment.

Sediment samples were collected during August 1992 and February 1993, coinciding with the first and third surface water sample delivery groups. These samples were collected for contaminant analysis as well as acute toxicity testing.

Sediments at locations BQ27, CB36 and CQ37 showed signs of historical SCF impacts. These locations were predictably near mine entrances.

3. Groundwater

Figure 4.2 shows all ground-water monitoring locations for the Fort Hartford site. Sixteen ground-water monitoring locations were selected to determine the nature and extent of impacts to ground water at the site (one of the original 17 locations came up dry). Multiple samples were collected from discrete intervals using the Westbay (Trademark) multi-level monitoring system. The monitoring system and sample zones were all approved by EPA. A total of 32 ground-water samples were collected from July 27, 1993, to August 18, 1993. The slightly impacted and impacted zones were determined to be:

Haney/Upper Big Clifty Contact at MW4
Upper Big Clifty Sandstone at MWs 8, 9, and 10
Lower Big Clifty Sandstone at MW10
Beech Creek/Elwren Contact at MWs 9 and 18
Reelsville Limestone at MW7

Please refer to Section II of this document for a description of the vertical location of each stratum. Ground water at the following well locations shows

indications of possible site-related impacts: MW4, MW7, MW8, MW9, MW10, and MW18. Based on the results from the zones at each location, the parameters listed in Table 4.1 were retained for inclusion in the risk assessment. Inclusion of a parameter on the list does not indicate its linkage to SCFs.

Residential Ground-water Sampling

Ground water was also sampled at off-site residential locations in conjunction with the on-site sampling efforts. Residential wells within a 2-mile radius of the center of the Site were sampled. Figure 4.3 shows these locations. All results were below drinking water standards.

4. Air

An Air Pathway Analysis was conducted to characterize the nature and extent of contaminant emissions in air from the Site. It was revealed that the only contaminant in significant levels was ammonia. For more detail on the analysis, the *Fort Hartford Site Air Pathway Analysis* report, dated October 28, 1993, can be found in the Administrative Record for the site.

The emission and meteorological monitoring program was conducted during a 17-month period from August 1990 through December 1992. Air monitoring locations are shown in Figure 4.4 of this document. Modelling was performed with the data collected in this effort.

Based on the modelling, exceedances of the KNREPC 8-hour ammonia standard of 0.4 mg/m³ were predicted along the site perimeter with the greatest potential exceedances along the north and northwestern sides of the site.

SUMMARY OF GROUNDWATER BACKGROUND ACTION LEVEL EXCEEDANCES
FOR ALL MONITORING FORMATIONS
FORT HARTFORD STONE QUARRY NPL SITE
OLATON, KENTUCKY

| PARAMETER | FORMATION | | | | |
|---------------------|------------|-------|-------|-----------|------------|
| | HANEY/MgBC | UMgBC | LMgBC | BC/ELWREN | REELSVILLE |
| ORGANICS | | | | | |
| 2-Butanone | X | | | | |
| Benzene | X | | | | X |
| Styrene | X | | | | |
| Xylenes | X | | | | X |
| Toluene | | | | | X |
| Ethylbenzene | | | | | X |
| Phenol | X | | | X | |
| 2-Methylphenol | | | | | X |
| 4-Methylphenol | | | | | X |
| Naphthalene | | | | | X |
| 2-Methylnaphthalene | | | | | X |
| 4,4'-DDT | | X | | | |
| INORGANICS | | | | | |
| Arsenic | | | | X | |
| Barium | X | X | X | X | |
| Cadmium | | X | X | X | |
| Calcium | X | X | X | X | |
| Chromium | X | | X | X | X |
| Cobalt | | X | X | | |
| Copper | X | X | X | | |
| Iron | | X | X | X | X |
| Lead | X | X | X | X | |
| Magnesium | X | X | X | X | |
| Manganese | | X | X | X | |
| Nickel | X | X | X | | |
| Potassium | X | X | X | X | |
| Selenium | X | | | | |
| Sodium | X | X | X | X | X |
| Thallium | X | | | | |
| Zinc | | | | X | |
| Cyanide | X | | | | |
| Ammonia | X | X | X | X | |
| Chlorides | X | X | X | X | X |
| Sulfates | X | X | X | X | X |

NOTES:

All organic parameters detected in impacted wells are listed.

Inorganic and wet chemistry parameters are listed if they exceeded the BAL for the formation.

HANEY/MgBC = Haney Limestone/Big Clifty Sandstone Contact

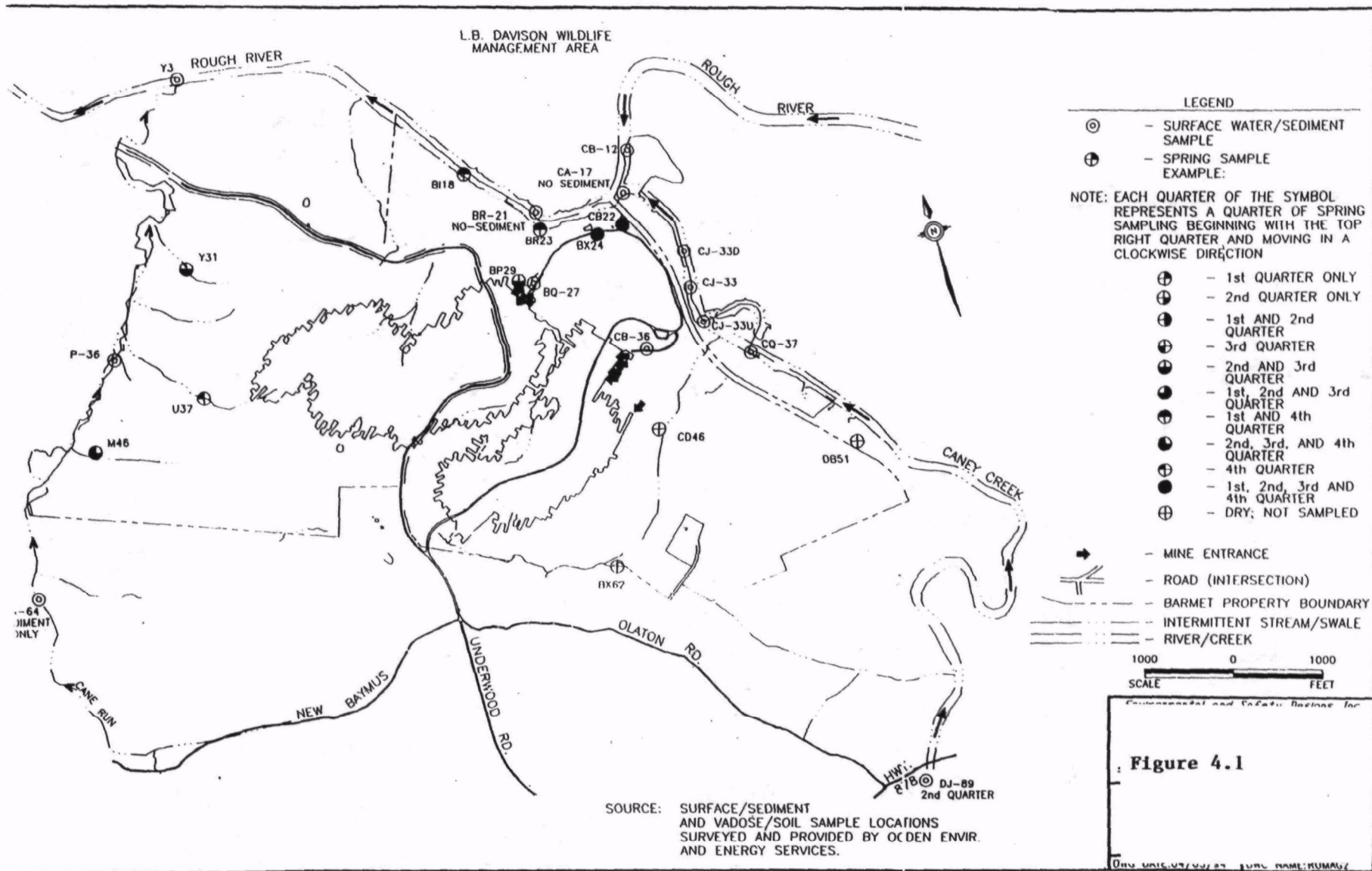
UMgBC = Upper Big Clifty Sandstone Formation

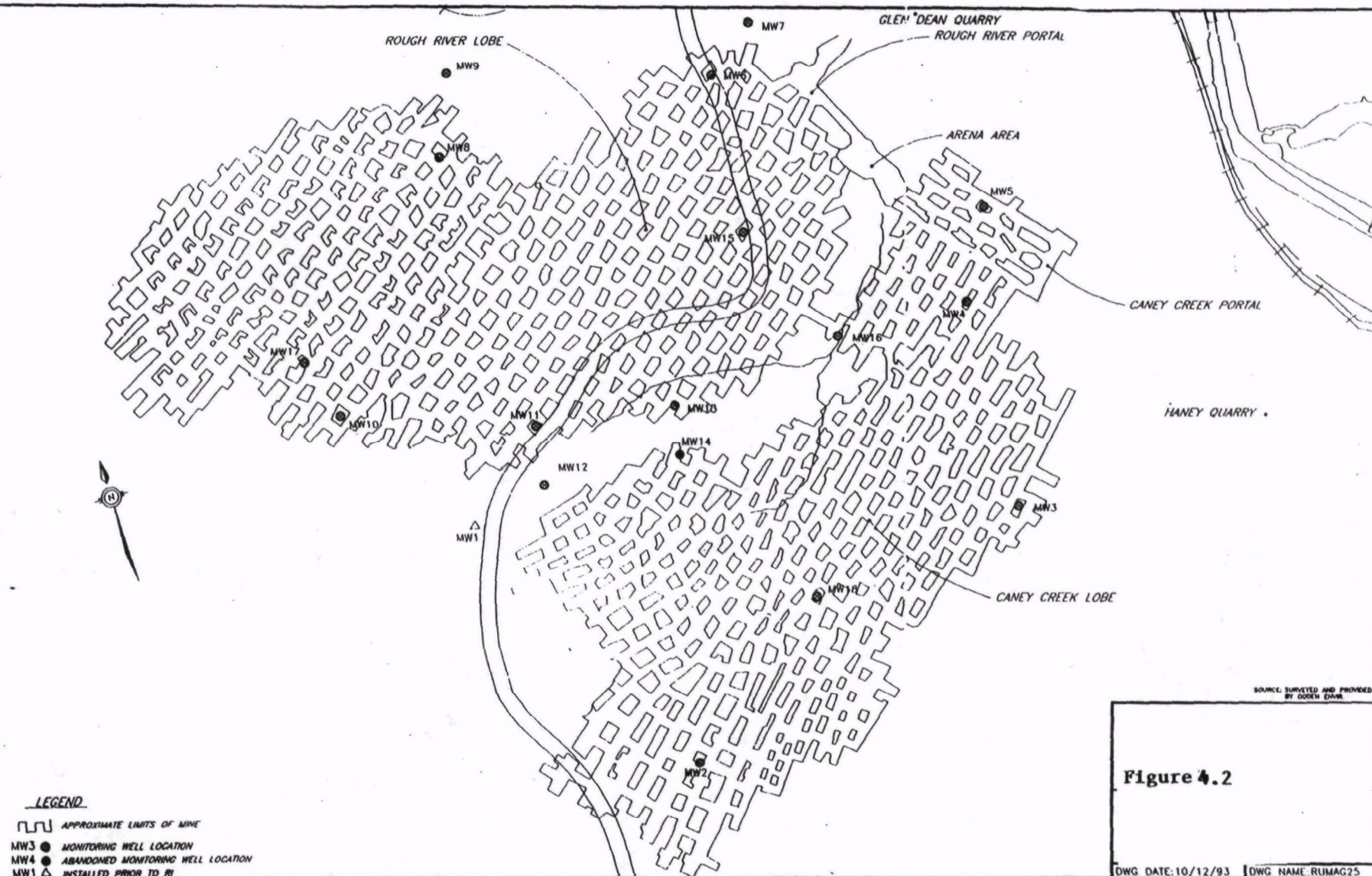
LMgBC = Lower Big Clifty Sandstone Formation

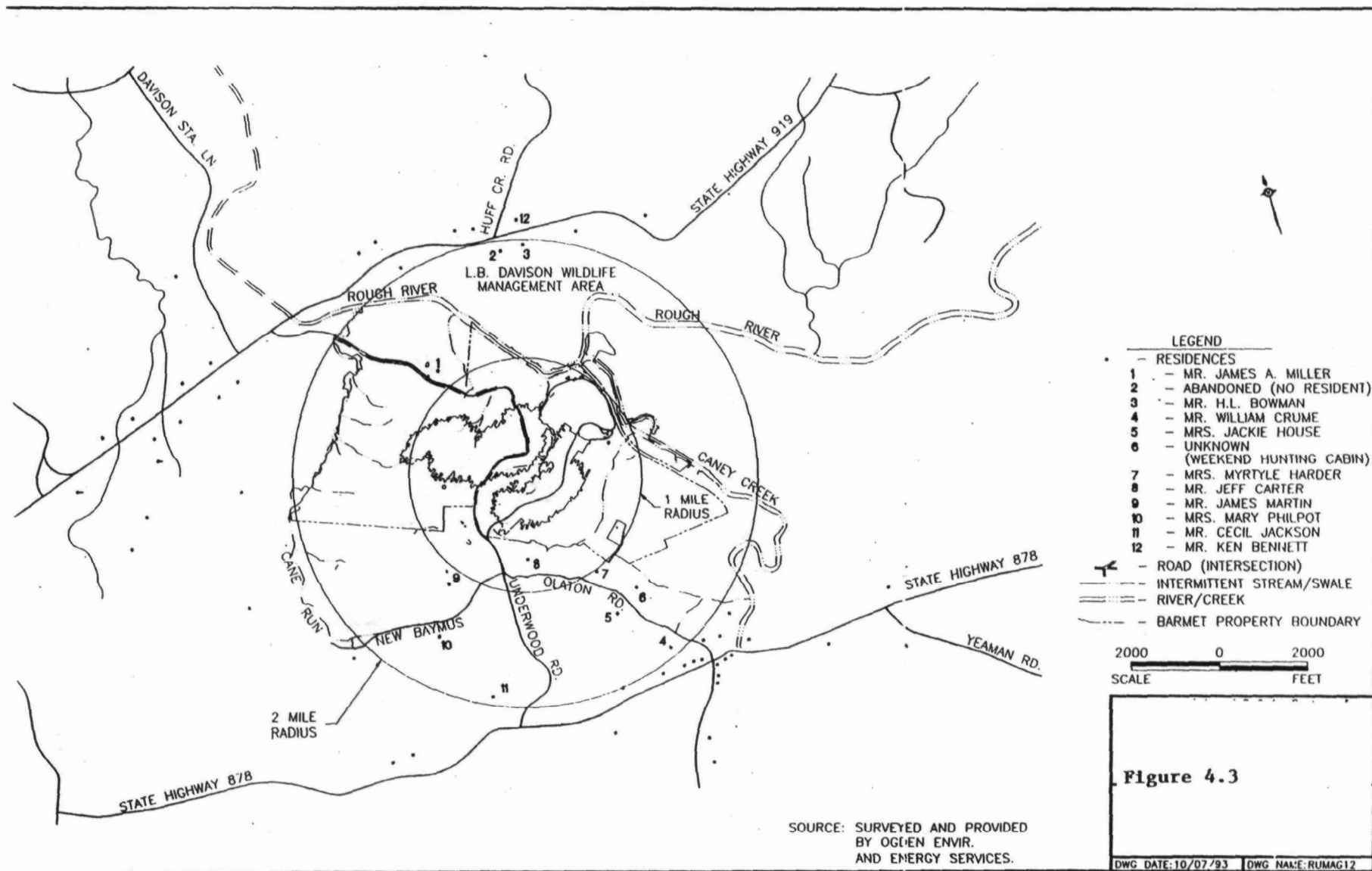
BC/ELWREN = Beech Creek/Elwren Contact

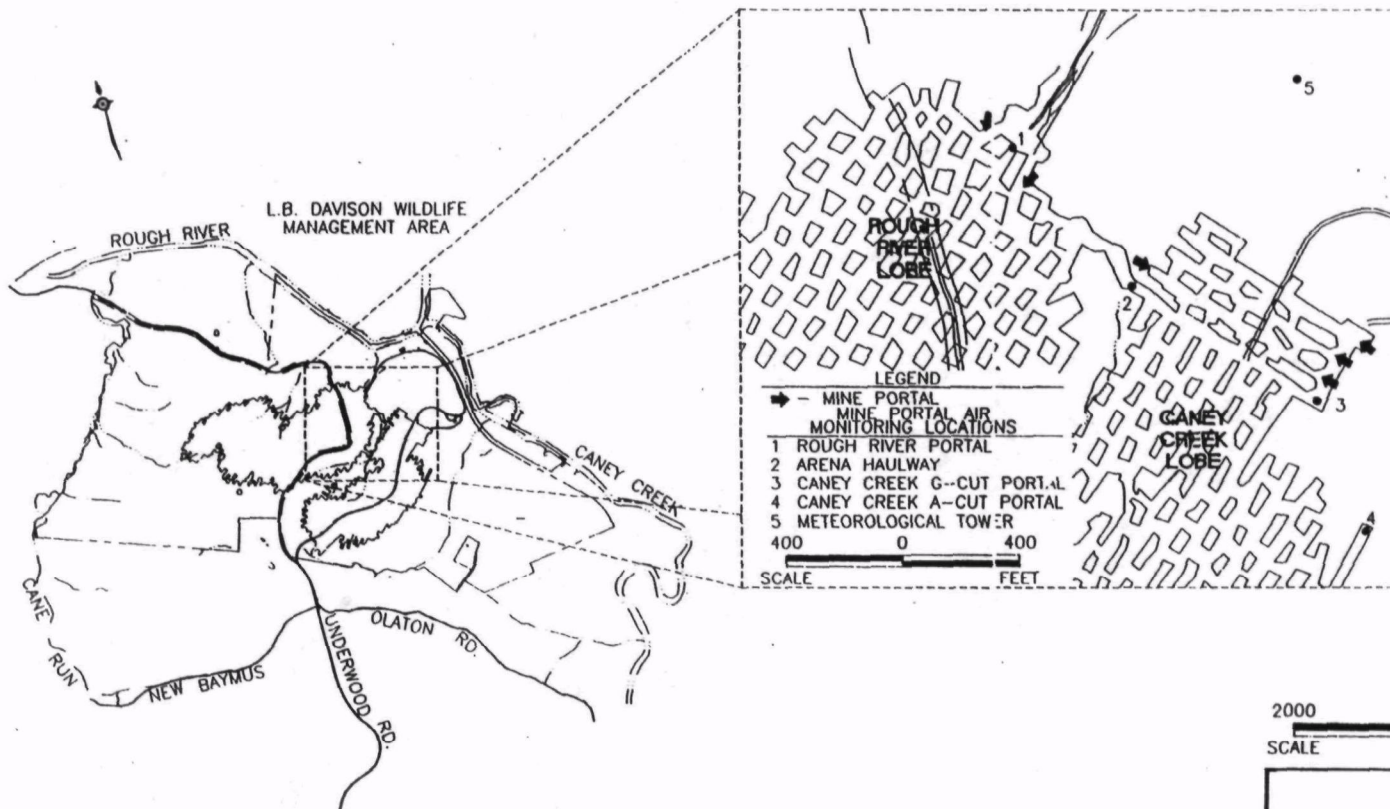
REELSVILLE = Reelsville Limestone Formation

Background (non-impacted) zone data is not presented.









LEGEND

- ROAD (INTERSECTION)
- - - INTERMITTENT STREAM/SWALE
- == RIVER/CREEK
- BARMET PROPERTY BOUNDARY

LEGEND

- ★ MINE PORTAL AIR MONITORING LOCATIONS
- 1 ROUGH RIVER PORTAL
- 2 ARENA HAULWAY
- 3 CANEY CREEK G-CUT PORTAL
- 4 CANEY CREEK A-CUT PORTAL
- 5 METEOROLOGICAL TOWER

400 0 400
SCALE FEET

2000 0 2000
SCALE FEET

Figure 4.4

SOURCE: SURVEYED AND PROVIDED BY OGDEN ENVIR. AND ENERGY SERVICES.

DWG DATE: 10/07/93 DWG NAME: RUMAC21

V. SUMMARY OF SITE RISKS

Air, ground water, surface water and sediments in streams around the site, source material (SCFs) and soils were all considered to have potentially complete current and future exposure pathways. The risk assessment was performed for the matrices listed above and can be found in the September 1994 RI report.

A. SELECTION OF CONTAMINANTS OF POTENTIAL CONCERN

The hazard identification involved the selection of contaminants of potential concern (COPCs), detected contaminants which have inherent toxic or carcinogenic effects that are likely to pose the greatest concern with respect to the protection of public health and the environment. Selected contaminants of concern which were found to drive the Risk Assessment (or account for approximately 90% of the risk) at the Fort Harford site include:

- * Aluminum
- * Ammonia
- * Chlorides

Delineation of all COCs for each media can be found in Tables 5.1 through 5.5 of this document. Monitoring data from the RI report were used to calculate exposure concentrations for the exposure scenarios described below.

B. EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the type and magnitude of exposures to the chemicals of potential concern that are present at or migrating from the site. The results of the exposure assessment are combined with chemical-specific toxicity and carcinogenicity information to characterize potential risks.

Populations at greatest risk are those who would potentially inhale gaseous contaminants emanating from mine portals and those who would potentially use contaminated ground water from bedrock aquifers. Inhalation is the primary route of exposure for the air pathway. Ingestion (potable use) would be the primary exposure route for ground water.

Exposure Point Concentrations

Exposure point concentrations were calculated for air, ground water, surface water and sediments, source material (SCFs) and soils. The reasonable maximum exposure (RME) point concentration was calculated after testing the data's distribution. The 95%

Upper Confidence Limit (UCL) on the arithmetic mean was calculated for each COPC in each area. The RME was the lower of the 95% UCL or the maximum detected concentration.

Because the exposure point concentrations (UCLs) tables are quite numerous, they will not be included in this document. They can, however, be found in Appendix I to the September 1994 RI report for the Fort Hartford Site, Tables 1 through 17. Air, ground water, surface water and sediment, source material and soil (surface and subsurface) data from the RI were used to derive exposure point concentrations. The RI report contains data for samples taken for the COPCs for the time frames and locations discussed in Section III of this document.

Some of the analytical results are reported as "non-detects", meaning the actual concentration of the contaminant analyzed for is between zero and the detection limit. The risk assessment calculations were based on assuming that all non-detect samples were contaminated at a concentration equal to one-half the detection limit. This makes the risk assessment more conservative.

Exposure Dose Calculations

Average daily exposure doses (ExDs) were calculated for each exposure pathway using standard assumptions in EPA Risk Assessment guidance. Exposure scenarios and calculations with assumptions will be summarized below. For cancer effects, doses were averaged over a lifetime (70 years); doses for non-cancer effects were averaged over the exposure period (U.S. EPA 1989a). It is important to note that each exposure scenario is both for present and future conditions. The scenarios have been evaluated under current conditions (since they are more conservative in these cases, ex. contaminant levels will dissipate with time), but are evaluated for future conditions as well.

The results of the risk calculations for each of the following scenarios are presented in the *Risk Characterization* portion of this section.

1. Soil Pathway (Direct Ingestion and Dermal Contact)

This pathway addresses the potential for intake of contaminants through direct ingestion of contaminated soil and dermal contact with said soil (and subsequent transdermal absorption). Figure 5.1 and Table 5.6, respectively, provide risk formulae and risk/hazard assumptions applied for calculating soil exposure point doses at the Fort Hartford site.

2. Surface Water Pathway (Direct Ingestion)

The human exposure pathway for surface water was evaluated on the basis of direct ingestion of surface water contaminants. Figure 5.2 presents the formulae with assumptions used to calculate chronic daily intake and risk/hazard via the surface water pathway. As stated previously, surface water includes all streams adjacent to the site as well as springs and mine flumes.

3. Sediment Pathway (Direct Ingestion and Dermal Contact)

The sediment pathway addresses the risk/hazard based on the potential for intake of contaminants through direct ingestion of contaminated sediments and dermal contact with these sediments (and subsequent transdermal absorption). Formulae and assumptions are similar to those in the soil and surface water scenarios and have been adapted from RAGS, Volume I, Parts A&B, to account for site-specific conditions. More details on calculations and assumptions for this pathway can be found in Figure 7.3 and Table 7.13 of the September 1994 RI report. These are identical to Figure 5.3 and Table 5.8, respectively, in this document.

4. Ground water

The human exposure pathway for ground water was based on direct ingestion of ground-water contaminants. Exposure point concentrations and subsequent risk calculations were performed on a zone-specific basis for each of the following formations beneath the Site: Haney Limestone/Big Clifty Sandstone Contact, Upper Big Clifty Sandstone, Lower Big Clifty Sandstone, Beech Creek/Elwren Contact and the Reelsville Limestone. No specific risk/hazard characterization was performed for the residential wells sampled near the Site since no parameter was detected in excess of any on-site background levels. Figure 7.5 and Table 7.21 in the September 1994 RI report give assumptions and calculations used for exposure doses and carcinogenic as well as non-carcinogenic risk. These have been adapted from RAGS, Volume I, Parts A&B, to account for site-specific conditions. Figure 5.4 and Table 5.9, respectively, in this document, correspond to these two cites from the RI.

5. Source Material (SCFs)

This pathway addresses the potential for intake of contaminants through direct ingestion of source material and dermal contact (and subsequent transdermal absorption) with the SCFs. Figure 7.5 and Table 7.21 in the RI report (Figure 5.4 and Table 5.9, respectively, herein) provide formulae and assumptions for

calculating exposure doses and subsequent carcinogenic and non-carcinogenic risks. Risk/hazard formulae are standard for calculating recreational use exposures (through chronic daily intake).

6. Air Pathway (Inhalation Pathway)

The air pathway encompasses both gaseous (i.e., ammonia) and particulate-related exposures. For ammonia, the results of one year of mine portal monitoring were compiled and reduced to produce the input database for refined dispersion modelling. Details on the steps taken in selecting the refined model and the actual dispersion modelling exercise can be found in the Air Pathway Analysis report on file in the Fort Hartford Information Repository. Modelled values were compared to exposure criteria and ARARs.

PM10 monitoring was conducted during August and September of 1993 to determine if visible fugitive particulate emissions at the site were presenting concerns to human health and the environment.

C. TOXICITY ASSESSMENT

Under current EPA guidelines, the likelihood of carcinogenic and non-carcinogenic systemic effects due to exposure to site chemicals are considered separately. Criteria for evaluating the potential of site chemicals to cause these two types of adverse effects are described below.

Criteria for Non-Carcinogenic Effects

The Reference Dose (RfD) is an estimate of the highest human intake of a chemical, expressed as mg/kg/day, that does not cause adverse effects when exposure is long-term (lifetime). RfD values are based on animal or human toxicity studies from which a no-observed-adverse-effect level (NOAEL) is experimentally determined. The NOAEL is the highest dose at which there was no statistically or biologically significant adverse effect observed. The RfD is derived by dividing the NOAEL from the selected study by an uncertainty factor. The uncertainty factor consists of multiples of 10 to account for specific areas of uncertainty in the available data.

The dose calculated from the exposure assessment is compared to the RfD to determine whether adverse effects might occur. If the predicted exposure dose is below the level of the RfD, no adverse health effects are expected according to current EPA guidelines.

Table 5.10 herein gives toxicological database information for all potential contaminants of concern at the Fort Hartford Site.

Criteria for Carcinogenic Effects

EPA uses a weight-of-evidence system to convey how likely a chemical is to be a human carcinogen, based on epidemiological studies, animal studies, and other supportive data. The classification system of EPA for characterization of the overall weight of evidence of carcinogenicity includes: Group A - Known Human Carcinogen; Group B - Probable Human Carcinogen; Group C - Possible Human Carcinogen; Group D - Not Classifiable as to Human Carcinogenicity; Group E - Evidence of non-Carcinogenicity for Humans. Group B is subdivided into two groups: Group B1 - limited human evidence for carcinogenicity; and Group B2 - sufficient data in animals, but inadequate or no evidence in humans.

For chemicals with carcinogenic effects, EPA calculates the cancer risk associated with a given dose by multiplying the dose from a given route of exposure by a cancer potency factor or potency slope. EPA derives potency factors from the upper 95% confidence limit of the slope of the extrapolated dose-response curve, which shows the relationship between a given dose and the associated tumor incidence. As a result, the predicted cancer risk is an upper-bound estimate of the potential risk associated with exposure. Table 5.10 of this document gives the cancer slope factors (CSFs) for all potential contaminants of concern at the Fort Hartford Site.

D. RISK CHARACTERIZATION

The risks for each of the scenarios presented in the *Exposure Assessment* portion of this section are quantified in this section and can be found summarized in Table 5.7. Table 5.7 is a synopsis of Tables 5.11 through 5.13. All of the added lifetime risks for each scenario, as well as the total carcinogenic and non-carcinogenic risks presented by the site are included.

For Table 5.7, more than one risk is presented under the surface water, sediments, ground water, and source material headings. When totalling site risk, the more conservative (higher) number is used to obtain the total at the bottom of the table. In this way, a worst-case scenario is presented for carcinogenic and non-carcinogenic effects. As can be seen, the total site presents unacceptable carcinogenic as well as non-carcinogenic risks.

An acceptable risk is one which is less than 1×10^{-4} for carcinogens and less than or equal to 1.0 for non-carcinogens. As shown in Table 5.7, soils alone present no unacceptable risks. Surface water in both springs and streams presents an unacceptable non-carcinogenic risk. Of the five ground water zones, all except one, the Beech Creek/Elwren are acceptable for carcinogens, while all zones except the Reelsville are unacceptable for non-carcinogenic risks. For the scenario evaluated, source material provides no unacceptable risks, however, water from reaction with source material poses unacceptable non-carcinogenic risks.

The "N.A's" in Table 5.7 under the air headings appear since air was not evaluated in the way of a conventional risk assessment. It was known that air would be the driving media for the Fort Hartford Risk Assessment and a decision was made between risk assessors and modellers to only compare modelled ammonia concentrations to the EPA annual standard of 0.1 mg/m^3 instead of performing a Hazard Index calculation (ammonia presents no carcinogenic risks). The decision was that if ammonia concentrations exceeded the EPA standard, that the Hazard Index would be considered greater than 1.0 (unacceptable). Figure 5.3 is an example of the isopleths (modelled lines of constant concentration) and how concentrations were determined at different points on-site.

E. ENVIRONMENTAL RISKS

An ecological evaluation was performed at the Site which was detailed in the *Ecological Assessment Summary Report* as well as Section 3.5 of the RI Report. A tiered approach was taken to first identify the potential ecological stressors and receptors, and secondly to evaluate the stresses (if any) on the ecosystem. Various endangered species surveys were performed and no endangered species were observed or identified as being a concern on-site. Both aquatic and terrestrial surveys were performed, as well as toxicity testing, to conclusively determine the effect of the site on the aquatic and terrestrial habitats in the area.

Endangered Species and Critical Habitats

1. Orange Pimpleback Mussel (*Plethobasus cooperianus*)

A report entitled *Aquatic Mollusca of the Rough River in the Vicinity of the Ft. Hartford Mine Site, Ohio County, Kentucky* was prepared by Dr. Mark E. Gordon of the Tennessee Cooperative Fishery Research Unit. This report was submitted to EPA in July 1991. This report stated that the endangered mussel *Plethobasus*

cooperianus (not found in the Rough River or Caney Creek) was typical of larger streams than those at the Fort Hartford Site. Dr. Gordon did note depauperate fauna in Rough River just downstream of the KPDES effluent discharge pipe location, but was unable to conclude whether this was caused by former mining activities in the area (i.e., limestone rock pushed into the stream) or if the condition was site-related. Dr. Gordon concluded that there was no evidence that the depauperate species in Rough River at this location were site-related, however, he could not rule out this possibility.

2. Indiana (*Myotis sodalis*) and Gray (*Myotis grisescens*) Bats

Dr. Michael J. Harvey of Tennessee Technological University conducted the survey and prepared the report, *Survey for Endangered Indiana and Gray Bats at the Ft. Hartford Mine Site, Olaton, Ohio County, Kentucky*. This report was also submitted to EPA in July 1991. During the three day study at the site, none of the endangered species bats were discovered. Dr. Harvey's report concluded that due to the continuing presence of human activity in and around the mine, that suitable habitat did not exist for these species. He went on to state that, "It is quite unlikely that operations/activities at the site would have any negative impacts on Indiana or gray bats, or on other bat species."

Aquatic Effects

The authors of the aquatic survey (Ecological Specialists, Inc.) concluded that statistical data indicated no significant difference in numbers between study sites (study sizes were small which resulted in wide confidence margins). Also, several non-point source discharges such as feed lot runoff (i.e., sewage and farm wastes) and historical strip mining activities were identified as potential significant ecological stressors to the Caney Creek and Rough River.

The biotic indices determined by Ecological Specialists, Inc., indicate slightly better water quality in the distal upstream Rough River sample. The biotic indices are equivalent for all other sample locations which indicates that Caney Creek may have an effect on the proximal upstream and downstream faunal species of the Rough River. It was also found through biotic indices that the upstream (background location C1) showed a source affecting Caney Creek other than the Ft. Hartford site.

In addition, Ecological Specialists, Inc. concluded that "the lack of habitat, water depth, and poor water quality all contribute to the low density and diversity of fauna throughout

Caney Creek." Due to the low dissolved oxygen, high turbidity, and resulting high biological/chemical oxygen demand, density and diversity appear to be lower than expected in the Rough River.

Toxicity observed in upstream Caney Creek samples and the lack of significant difference between sample locations in surface waters associated with the site indicate no adverse, site-related ecological effects.

Terrestrial Effects

The terrestrial survey identified stressed vegetation near historical gaseous emission sources (i.e., former breakthrough locations on the Rough River mine lobe perimeter) or a mine portal. The stressed vegetation near the breakthrough locations was found to be rejuvenating, and the remaining stressed vegetation was a result of timbering/logging that had been historically conducted on-site. The terrestrial report, as well as the aquatic report are included in Appendix F of the September 1994 Remedial Investigation report for the Fort Hartford site.

F. REMEDIAL GOALS

In order to facilitate the FS process, remedial goals for each impacted medium are necessary. Remedial Goals are those concentrations of the COCs carried through in calculations for each exposure scenario of the risk assessment. Remedial Goal Options (RGOs) are pathway and medium specific, risk-based remedial goals, calculated under the exposure scenarios used to estimate risk and/or hazard. RGOs were calculated for all exposure pathways which were found to exceed 1×10^{-4} cancer risk and/or a hazard index (HI) of 1.0. Pages 7-135 through 7-137 of the Risk Assessment for the Fort Hartford Site give all remedial goal options calculated. These RGOs can also be found in Tables 5.14 through 5.16 of this document.

The Remedial Goal for the air media at the Site is ammonia and it is being addressed via diurnal containment of emissions with venting in evening hours when favorable conditions exist for dispersion. The remedy contains contingency measures for ducting to a high stack for proven dispersion should nocturnal venting^s fail to meet EPA's expectations.

The remedial goal for air at the Site is as follows:

Ammonia: 0.4 mg/m³ (8-hour Kentucky ARAR)

The RGOs for contaminants in ground and surface water will be

monitoring parameters at the Site since these contaminants are being addressed at the Site via source control, continued ground-water monitoring, diversion, and natural attenuation.

G. UNCERTAINTIES

All estimates of risk are based upon numerous assumptions with uncertainties. In addition to limitations associated with site-specific chemical data, other assumptions and uncertainties that affect the accuracy of the site-specific risk characterizations result from the extrapolation of potential adverse human health effects from animal studies, the extrapolation of effects observed at high-dose to low-dose effects, the modelling of dose-response effects, and route-to-route extrapolation.

The use of acceptable levels (established standards, criteria and guidelines) and unit cancer risk values which are derived from animal studies introduces uncertainty into the risk estimates. In addition, the exposure assumptions used in estimating individual dose levels are often surrounded by uncertainties. As such, these estimates should not stand alone from the various assumptions and uncertainties upon which they are based. In developing numerical indices of risk, an attempt is made to evaluate the effect of the assumptions and limitations on the numerical estimates.

The uncertainty factors which are incorporated into these risk estimates are believed to be conservative. As such, when they are considered collectively, exposure and subsequently risk may be overestimated. On the other hand, these risk calculations were based on present conditions at the site, including present concentrations of contaminants in the various site media. Additional risk could occur should the concentrations increase in any of the site media.

Confidence in the computed risk and hazard values for source-related pathways is low. The exposure pathways developed to evaluate potential human health effects related to these media would not be completed under most reasonable future site use scenarios. Furthermore, the data used to compute risk/hazard are not equivalent in quality to that produced for other media. Due to the nature of the materials, the precision and accuracy of the analytical methods was reduced. Therefore, risk/hazard values computed for source related media should be used for screening purposes only.

H. CONCLUSIONS

Hazard Indices were unacceptable for surface water (springs and in-stream), ground water (all formations assessed), and source material (reaction water). The Beech Creek/Elwren aquifer had only a slightly unacceptable cancer risk, which may have been due to naturally-occurring petroleum chemicals.

An alternative approach was developed to address air risks since the site media did not fit the conventional risk assessment mold. Modelling produced isopleth diagrams depicting maximum 8-hour, maximum 24-hour and annual average ammonia concentrations resulting from mine portal emissions. Ammonia concentration patterns were predicted for years 1993, 1998, 2003, and 2013. An acute exposure standard of 0.4 mg/m^3 (KNREPC, 8-hour) was established for comparison with predicted 24-hour average concentrations. A chronic standard of 0.1 mg/m^3 (EPA) was established for comparison to maximum annual average concentrations. Any exceedance of these standards is considered to be equal for risk management purposes to a HI of greater than 1.0.

Between 1993 and 2013 the 0.1 mg/m^3 annual average ammonia concentration isopleth is predicted to retract significantly. The 8-hour KNREPC standard of 0.4 mg/m^3 is predicted to be continually exceeded between the years 1993 and 2013 (HI greater than 1.0) under baseline (no action) conditions.

Other than past stressed vegetation and currently stressed vegetation in the immediate vicinity of the mine portals, the studies find no evidence of site-related ecological stress.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response actions in this ROD, may present an imminent and substantial endangerment to public health, welfare and the environment.

Table 5.1
Surface Soil Contaminants of Concern

Benzo(a)anthracene
Benzo(b/k)fluoranthene
Benzo(a)pyrene
Indeno(1,2,3-cd)perylene
Dibenzo(a,h)anthracene
Beryllium

Notes:

Compounds/parameters listed are those detected at concentrations in excess of the BAL and which were projected to pose a significant potential individual risk/hazard (carcinogenic unit risk $> 1E-7$ or hazard quotient > 0.1).

Parameters which were not detected in any onsite soil sample at a concentration in excess of the corresponding BAL are not listed.

Table 5.2
Surface Water Contaminants of Concern

| Instream Surface Water | Impacted Springs |
|---|---|
| Aluminum (CC,CR) Iron (CC,CR) Lead (CC) | Aluminum (1) Cadmium (1) Iron Manganese (1) Sodium Vanadium (1) Chlorides Sulfates |

Notes:

Compounds/parameters listed are those detected at concentrations in excess of the BAL and which were projected to pose a significant potential individual risk/hazard (carcinogenic unit risk $> 1E-7$ or hazard quotient > 0.1) or had a maximum four quarter average in excess of the corresponding ARAR.

Parameters which were not detected in any instream surface water sample at a concentration in excess of the corresponding BAL are not listed.

(1) indicates parameters for which the exposure concentration used in the baseline risk assessment was less than two times the four quarter background average in the hypothetical receiving stream.

(RR) = Rough River; (CC) = Caney Creek; and (CR) = Cane Run -- these designation were used to show which stream produced samples with parameter concentrations in excess of corresponding background.

TABLE 5.3 - SUMMARY OF GROUNDWATER CONTAMINANTS OF CONCERN
ON A FORMATION SPECIFIC BASIS
FORT HARTFORD STONE QUARRY NPL SITE
OLATON, KENTUCKY

| PARAMETER | HANEY/MgBC | UMgBC | FORMATION | | |
|-------------------|------------|-------|-----------|-----------|------------|
| | | | LMgBC | BC/ELWREN | REELSVILLE |
| <u>ORGANICS</u> | | | | | |
| Benzene | X | | | X | |
| Styrene | X | | | | |
| 4,4' - DDT | | X | | | |
| <u>INORGANICS</u> | | | | | |
| Arsenic | | | | X | |
| Barium | X | X | X | X | |
| Cadmium | X | X | X | | |
| Chromium | X | | X | | X |
| Iron | | X | X | X | X |
| Lead | X | X | | | |
| Manganese | | X | X | | |
| Potassium | X | | | | |
| Selenium | X | | | | |
| Sodium | X | X | X | X | X |
| Thallium | X | | | | |
| Ammonia | X | X | X | | |
| Chlorides | X | X | X | X | X |
| Sulfates | X | X | | | |

NOTES:

Inorganic and wet chemistry parameters are listed if they exceeded the BAL for the formation.

HANEY/MgBC = Haney Limestone/Big Clifty Sandstone contact

UMgBC = Upper Big Clifty Sandstone formation

LMgBC = Lower Big Clifty Sandstone formation

BC/ELWREN = Beech

REELSVILLE = Reelsville

Background (non-impacted) zone data is not presented.

Only those parameters with individual unit risk $> 1E-7$, hazard quotients > 0.1 and/or that were found to exceed an ARAR at the maximum two quarter average were retained as COCs.

**TABLE 5.4 – SOURCE MATERIAL CONTAMINANTS OF CONCERN
ON A SUBSAMPLE SPECIFIC BASIS
FORT HARTFORD STONE QUARRY NPL SITE
OLATON, KENTUCKY**

| PARAMETER | AS RECEIVED MATERIAL | WATER FROM REACTION | BASIS |
|-----------|-------------------------|------------------------|----------|
| Aluminum | X | X | SMCL |
| Antimony | | X | HQ,MCL |
| Arsenic | X | X | RISK,HQ |
| Beryllium | X | X | RISK,MCL |
| Cadmium | | X | HQ,MCL |
| Chromium | | X | HQ,MCL |
| Iron | X | X | SMCL |
| Lead | X | X | MCL-TT |
| Manganese | | X | SMCL |
| Nickel | | X | MCL |
| Potassium | | X | HQ |
| Selenium | | X | HQ,MCL |
| Silver | | X | HQ,HA |
| Sodium | | X | HQ,HA |
| Thallium | | X | HQ,MCL |
| Vanadium | | X | HQ,RAL |
| Ammonia | | X | HQ,HA |
| Chlorides | | X | SMCL |
| Sulfates | | X | SMCL |

NOTES:

As received material COC were selected based on individual unit risk of $> 1E-7$
and/or hazard quotient in excess of 0.1.

Water from reaction COCs were selected based on individual unit risk $> 1E-7$
hazard quotient > 0.1 and/or exceedance of ARAR.

Basis indicates the reason the parameter was retained as a COC.

MCL = Maximum Contaminant Level; SMCL = Secondary MCL; HA = EPA Health Advisory;

MCL-TT = Treatment Technology Based MCL; RAL = Superfund Removal Action Level

HEAST-RfD = Specific Reference Dose Drinking Water Equivalent Concentration;

HQ = Hazard Quotient > 0.1 .

| Table 5.5 Sediment Contaminants of Concern | |
|---|----------------------|
| Instream Sediments | Mine Flume Sediments |
| Arsenic (CR) Beryllium (CR) Iron (CR) Benzo(a)pyrene (1)(CC) | None |

Notes:

Compounds/parameters listed are those detected at concentrations in excess of the BAL and which were projected to pose a significant potential individual risk/hazard (carcinogenic unit risk $> 1E-7$ or hazard quotient > 0.1).

Parameters which were not detected in any instream or mine flume sediment sample at a concentration in excess of the corresponding BAL are not listed.

(1) designates organic compounds which were detected at similar or higher concentrations in corresponding background samples.

(RR) = Rough River; (CC) = Caney Creek; and (CR) = Cane Run -- these designation were used to show which stream produced samples with parameter concentrations in excess of corresponding background.

For instream sediment risk screening, the exposure concentration for each inorganic parameter except chromium was below the BAL for at least one other stream.

| Table 5.6 Assumptions for Ingestion and Dermal Contact Exposure to Soil Contaminants of Concern at the Fort Hartford Stone Quarry Site in Olaton, Kentucky* | | | |
|---|---|-------------------------------------|---|
| Exposure | Future Child Resident | Future Adult Resident | Current Adult Workers |
| ORAL | | | |
| Daily soil ingestion level | 200 mg | 100 mg | 50 mg |
| Fraction of time onsite in contaminated areas | 100% ^b | 100% ^a | 100% ^a |
| Portion of ingested contaminant absorbed | 100% | 100% | 100% |
| Days per year onsite | 350 days | 350 days | 260 days |
| Years onsite | 6 years | 24 years | 25 years |
| Body weight | 16 kg | 70 kg | 70 kg |
| Lifetime | Averaging time based on 30 years for non-carcinogens, and 70 years for carcinogens (see Soil Exposure Formulae Key) | | Averaging time based on 25 years for non-carcinogens, and 70 years for carcinogens (see Soil Exposure Formulae Key) |
| DERMAL | | | |
| Skin area contaminated | 3730 cm ² | 3500 cm ² | 3500 cm ² |
| Soil adherence per cm ² of skin | 1 mg | 1 mg | 1 mg |
| Portion of contaminant absorbed | 0.01 (Organics) * 0.001 (Metals) | 0.01 (Organics) * 0.001 (Metals) | 0.01 (Organics) * 0.001 (Metals) |
| Days per year onsite | 350 days | 350 days | 260 days |
| Years onsite | 6 years | 24 years | 25 years |
| Body weight | 16 kg | 70 kg | 70 kg |
| Lifetime | Averaging time based on 30 years for non-carcinogens, and 70 years for carcinogens (see Soil Exposure Formulae Key) | | Averaging time based on 25 years for non-carcinogens, and 70 years for carcinogens (see Soil Exposure Formulae Key) |

- Notes:**
- * References values from USEPA, RAGS, 12/89, OSWER Directive #9285.6-03, and USEPA, Region IV New Interim Guidance (2/11/92).
 - ^b Uniform contaminant distribution over the entire site area is assumed. No fraction of time factor was utilized in these calculations, uniform exposure to the entire site at average contaminant concentrations (conservative); only analytical hits used to compute contaminant averages.
 - * 1.0% (Organics) or 0.1% (Metals) dermal transfer assumed; includes consideration of soil matrix effect.

Table 5.7
Total Site Risk

| | <u>Cancer Effects</u> <u>(Carcinogenic Risk)</u> | <u>Non-Cancer Effects</u> <u>(HI)</u> |
|--|---|--|
| Soils | 3×10^{-5} | 0.4 |
| <u>Surface Water</u> | | |
| Springs | ----- | 1.1 |
| In-stream | ----- | 1.9 |
| <u>Sediments</u> | | |
| Mine Flume | 6×10^{-6} | 0.0 |
| In-stream | 2×10^{-5} | 0.3 |
| <u>Ground Water</u> | | |
| Haney/ Big Clifty Contact | 6×10^{-7} | 51 |
| Upper Big Clifty | 3×10^{-7} | 14.0 |
| Lower Big Clifty | ----- | 10.0 |
| Beech Crk/ Elwren | 2.1×10^{-4} | 2.0 |
| Reelsville | ----- | 1.0 |
| Air | N.A. | N.A. |
| <u>SCFs</u> | | |
| Material | 1×10^{-5} | 0.6 |
| Reaction Water | 4×10^{-5} | 11 |
| Total | 3×10^{-4} | 64.6 |

| Table 5.8 Assumptions for Ingestion and Dermal Contact Exposure to Sediment Contaminants of Concern Fort Hartford Stone Quarry Site, Olaton, Kentucky* | | |
|--|---|-------------------------------------|
| Exposure | Child Recreational User | Adult Recreational/ Commercial User |
| ORAL | | |
| Daily soil ingestion level | 200 mg | 100 mg |
| Fraction of time onsite in contaminated areas | 100%* | 100%* |
| Portion of ingested contaminant absorbed | 100% | 100% |
| Days per year onsite* | 140 days | 104 days |
| Years onsite | 6 years | 24 years |
| Body weight | 16 kg | 70 kg |
| Lifetime | Averaging time based on 30 years for non-carcinogens, and 70 years for carcinogens (see Sediment Exposure Formulae Key) | |
| DERMAL | | |
| Skin area contaminated | 3730 cm ² | 3500 cm ² |
| Soil adherence per cm ² of skin | 1 mg | 1 mg |
| Portion of contaminant absorbed | 0.01 (Organics) * 0.001 (Metals) | 0.01 (Organics) * 0.001 (Metals) |
| Days per year onsite | 140 days | 104 days |
| Years onsite | 6 years | 24 years |
| Body weight | 16 kg | 70 kg |
| Lifetime | Averaging time based on 30 years for non-carcinogens, and 70 years for carcinogens (see Sediment Exposure Formulae Key) | |

Notes:

- * References values from USEPA, RAGS, 12/89, OSWER Directive #9285.6-03, and USEPA, Region IV New Interim Guidance (2/11/92).
- * Uniform contaminant distribution over the entire site area is assumed. No fraction of time factor was utilized in these calculations, uniform exposure to the entire site at maximum contaminant concentrations was assumed for conservatism.
- * 1.0% (Organics) or 0.1% (Metals) dermal transfer assumed; includes consideration of soil matrix effect.
- * The lifetime weighted average exposure frequency is 112 days/year; individual life stage exposure frequencies were applied per personal communication with Sally Wiley, KDEP, Risk Assessment Section, July 13, 1993.

| Table 5.9 Assumptions for Ingestion and Dermal Contact Exposure to As Received Source Material Contaminants of Concern at the Ft. Hartford Stone Quarry Site in Olaton, Kentucky* | | |
|--|---|--|
| Exposure | Future Child Resident | Future Adult Resident |
| ORAL | | |
| Daily source ingestion level | 200 mg | 100 mg |
| Fraction of time onsite in contaminated areas | 100% ^b | 100% ^b |
| Portion of ingested contaminant absorbed | 100% | 100% |
| Days per year onsite | 140 days | 104 days |
| Years onsite | 6 years | 24 years |
| Body weight | 16 kg | 70 kg |
| Lifetime | Averaging time based on 30 years for non-carcinogens, and 70 years for carcinogens (see Source Exposure Formulae Key) | |
| DERMAL | | |
| Skin area contaminated | 3730 cm ² | 3500 cm ² |
| Source adherence per cm ² of skin | 1 mg | 1 mg |
| Portion of contaminant absorbed | 0.01 (Organics) ^c 0.001 (Metals) | 0.01 (Organics) ^c 0.001 (Metals) |
| Days onsite | 140 days | 104 days |
| Years onsite | 6 years | 24 years |
| Body weight | 16 kg | 70 kg |
| Lifetime | Averaging time based on 30 years for non-carcinogens, and 70 years for carcinogens (see Source Exposure Formulae Key) | |

Notes:

- ^a References values from USEPA, RAGS, 12/89, OSWER Directive #9285.6-03, and USEPA, Region IV New Interim Guidance (2/11/92).
- ^b Uniform contaminant distribution over the entire site area is assumed. No fraction of time factor was utilized in these calculations, uniform exposure to the entire site at average contaminant concentrations (conservative); only analytical hits used to compute contaminant averages.
- ^c 1.0% (Organics) or 0.1% (Metals) dermal transfer assumed; includes consideration of soil matrix effect.

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| TABLE 5.10 - TOXICOLOGICAL DATABASE INFORMATION FOR POTENTIAL CONTAMINANTS OF CONCERN FORT HARTFORD STONE QUARRY NPL SITE OLATON, KENTUCKY | | | | | | | | | | | |
|---|--|--|--|----------|------|-----------------|----------------------------|---------------|--------------------------------|-----|---|
| PARAMETER | SLOPE FACTOR ORAL (MG/KG/DAY) ⁻¹ | TOXICITY EQUVALENCY FACTOR (UNITLESS) | REFERENCE DOSE ORAL (MG/KG/DAY) | UF | MF | CANCER CLASS | SUPERFUND HAL (UG/L) | MCL (MG/L) | OTHER (see notes) (mg/L) | Ref | |
| VOLATILES | | | | | | | | | | | |
| 2,2'-oxybis (1-chloropropane) | ND | NOT APPLICABLE | ND | ND | ND | ND | ND | ND | ND | ND | |
| Benzene | 2.0E-02 | 1 | NOT APPLICABLE | ND | ND | A | 100 | 0.005 | 0.2 | 6 | |
| Bromomethane | ND | NOT APPLICABLE | 0.0014 | 1 | 1000 | D | 50 | 0.1 | 0.7 | 7 | |
| 2-Butanone | ND | NOT APPLICABLE | 0.6 | 1 | 3000 | D | ND | ND | ND | ND | |
| Chloromethane | 1.3E-02 | 2 | NOT APPLICABLE | ND | ND | C | 100 | ND | ND | ND | |
| Dimethyl disulfide | ND | NOT APPLICABLE | ND | ND | ND | ND | ND | ND | ND | ND | |
| Ethylbenzene | ND | NOT APPLICABLE | 0.1 | 1 | 1000 | D | 1000 | 0.7 | 0.7 | 4 | |
| Methane | ND | NOT APPLICABLE | ND | ND | ND | ND | ND | ND | ND | ND | |
| Styrene | 3.0E-02 | 1 | NOT APPLICABLE | 0.2 | 1 | C | 1000 | 0.1 | 0.1 | 4 | |
| Toluene | ND | NOT APPLICABLE | 0.2 | 1 | 1000 | D | 3000 | 1 | 1 | 4 | |
| Trichloroethylene | 1.1E-02 | 11 | NOT APPLICABLE | 0.006 | 11 | ND | ND | 300 | 0.005 | 0.5 | 7 |
| Xylene | ND | NOT APPLICABLE | 2 | 1 | 100 | D | 40000 | 10 | 10 | 4 | |
| SEMI-VOLATILES | | | | | | | | | | | |
| 1,2,4-Trichlorobenzene | ND | ND | 0.01 | 1 | 1000 | D | 100 | 0.07* | 0.07 | 5 | |
| Acenaphthene | ND | ND | 0.06 | 1 | 3000 | D | 2100 | ND | ND | ND | |
| Acenaphthylene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | |
| Anthracene | ND | ND | 0.3 | 2 | 3000 | D | ND | ND | ND | ND | |
| Benzo(a)anthracene | 7.3E+00 | 3 | 1.0E-01 | ND | ND | B2 | 0.1 | ND | ND | ND | |
| Benzo(a)pyrene | 7.3E+00 | 1 | ND | ND | ND | B2 | 0.2 | 0.0002 | ND | ND | |
| Benzo(b)fluoranthene | 7.3E+00 | 3 | 1.0E-01 | ND | ND | B2 | 0.2 | ND | ND | ND | |
| Benzo(g,h,i)perylene | ND | ND | ND | ND | ND | D | ND | ND | ND | ND | |
| Benzo(k)fluoranthene | 7.3E+00 | 3 | 1.0E-01 | ND | ND | B2 | 0.2 | ND | ND | ND | |
| Benzoic acid | ND | ND | 4 | 1 | 1 | D | ND | ND | ND | ND | |
| Carbazole | 2.0E-02 | 2 | ND | ND | ND | B2 | ND | ND | ND | ND | |
| o-Cresol | ND | ND | 0.05 | 2 | 1000 | C | ND | ND | ND | ND | |
| p-Cresol | ND | ND | 0.05 | 17 | ND | C | ND | ND | ND | ND | |
| Chrysene | 7.3E+00 | 3 | 1.0E-02 | ND | ND | B2 | 0.2 | ND | ND | ND | |
| Dibenzo(a,h)anthracene | 7.3E+00 | 3 | 1.0E+00 | ND | ND | B2 | 0.3 | ND | ND | ND | |
| Dibenzofuran | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | |
| Fluoranthene | ND | ND | 0.04 | 1 | 3000 | D | ND | ND | ND | ND | |
| Fluorene | ND | ND | 0.04 | 1 | 3000 | D | 1400 | ND | ND | ND | |
| Indeno(1,2,3-cd)pyrene | 7.3E+00 | 3 | 1.0E-01 | ND | ND | B2 | 0.4 | ND | ND | ND | |
| 2-Methylnaphthalene | ND | ND | 0.04 | 16 | ND | ND | ND | ND | ND | ND | |
| Naphthalene | ND | ND | 0.04 | 2 | 1000 | D | 100 | ND | 0.02 | 5 | |
| Nitrosodiphenylamine | 4.0E-03 | 1 | ND | ND | ND | B2 | ND | ND | ND | ND | |
| Phenanthrene | ND | ND | 0.05 | 15 | ND | ND | ND | ND | ND | ND | |
| Phenol | ND | ND | 0.6 | 1 | 100 | D | 6000 | ND | 4 | 5 | |
| Pyrene | ND | ND | 0.03 | 1 | 3000 | D | 1100 | ND | ND | ND | |
| PESTICIDES | | | | | | | | | | | |
| alpha-BHC | 6.3E+00 | 1 | NOT APPLICABLE | 0.0003 | 19 | ND | ND | ND | ND | ND | |
| gamma-Chlordane | 1.3E+00 | 1 | NOT APPLICABLE | 0.00006 | 1 | B2 | 2 | 0.002 | 0.002 | 7 | |
| 4,4'-DDT | 3.4E-01 | 1 | NOT APPLICABLE | 0.0005 | 1 | B2 | ND | ND | ND | ND | |
| 4,4'-DDE | 3.4E-01 | 1 | NOT APPLICABLE | 0.0005 | 16 | ND | ND | ND | ND | ND | |
| Dieldrin | 1.6E+01 | 1 | NOT APPLICABLE | 0.00005 | 1 | B2 | 0.2 | ND | 0.0005 | 5 | |
| Endosulfan II | ND | NOT APPLICABLE | 0.00005 | 2 | 3000 | D | ND | ND | ND | ND | |
| Endrin | ND | NOT APPLICABLE | 0.0003 | 1 | 100 | D | 3 | 0.002 | 0.002 | 4 | |
| Endrin Alderhyde | ND | NOT APPLICABLE | 0.0003 | 15 | ND | ND | ND | ND | ND | ND | |
| Heptachlor | 4.5E+00 | 1 | NOT APPLICABLE | 0.00003 | 1 | B2 | 0.8 | 0.0004 | 0.003 | 5 | |
| Heptachlor epoxide | 9.1E+00 | 1 | NOT APPLICABLE | 0.000013 | 1 | B2 | 0.4 | 0.0002 | 0.0001 | 5 | |
| Methoxychlor | ND | NOT APPLICABLE | 0.005 | 1 | 1000 | D | 50 | 0.04 | 0.04 | 4 | |

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| TABLE 5.10 TOXICOLOGICAL DATABASE INFORMATION FOR POTENTIAL CONTAMINANTS OF CONCERN FORT HARTFORD STONE QUARRY NPL SITE OLATON, KENTUCKY | | | | | | | | | | |
|--|--|--|--|------|----|-----------------|----------------------------|---------------|----------------------|-----|
| PARAMETER | SLOPE FACTOR ORAL (MG/KG/DAY) - 1 | TOXICITY EQUVALENCY FACTOR (UNITLESS) | REFERENCE DOSE ORAL (MG/KG/DAY) | UF | MF | CANCER CLASS | SUPERFUND RAL (UG/L) | MCL (mg/L) | OTHER (see notes) | Ref |
| INORGANICS/WET CHEMISTRY | | | | | | | | | | |
| Aluminum | ND | NOT APPLICABLE | 2.9 12 | ND | ND | ND | ND | ND | 0.05 - 0.2 | 8 |
| Ammonia | ND | NOT APPLICABLE | 1 2 | ND | ND | D | 34000 | ND | 30 | 8 |
| Antimony | ND | NOT APPLICABLE | 0.0004 1 | 1000 | 1 | D | 15 | 0.006 | 0.006 | 4 |
| Arsenic | 1.75E+00 1 | NOT APPLICABLE | 0.0003 1 | 3 | 1 | A | 50 | 0.05 | ND | 4 |
| Barium | ND | NOT APPLICABLE | 0.07 1 | 3 | 1 | D | 5000 | 2 | 2 | 4 |
| Beryllium | 4.3E+00 1 | NOT APPLICABLE | 0.005 1 | 100 | 1 | B2 | 1 | 0.004 | 0.004 | 4 |
| Cadmium | ND | NOT APPLICABLE | 0.0005 1 | 10 | 1 | B1 | 5 | 0.005 | 0.005 | 4 |
| Calcium | ND | NOT APPLICABLE | ND | ND | ND | ND | ND | ND | ND | 4 |
| Chlorides | ND | NOT APPLICABLE | ND | ND | ND | ND | ND | ND | 250 | 6 |
| Chromium III | ND | NOT APPLICABLE | 1 1 | 100 | 10 | D | ND | ND | ND | 4 |
| Chromium VI | ND | NOT APPLICABLE | 0.005 1 | 100 | 10 | D | 200 | 0.1 | 0.1 4, 10 | 4 |
| Cobalt | ND | NOT APPLICABLE | 0.06 14 | ND | ND | ND | ND | ND | ND | 10 |
| Copper | ND | NOT APPLICABLE | ND | ND | ND | D | 1300 | TT - 1.3 | 1.3 | 4 |
| Cyanide | ND | NOT APPLICABLE | 0.02 1 | 100 | 5 | D | 200 | 0.2 | 0.2 | 5 |
| Iron | ND | NOT APPLICABLE | 0.3 14 | ND | ND | ND | ND | ND | 0.3 | 6 |
| Lead | ND | NOT APPLICABLE | ND | ND | ND | B2 | 30 | TT - 0.015 | ND | 4 |
| Magnesium | ND | NOT APPLICABLE | ND | ND | ND | ND | ND | ND | ND | 4 |
| Manganese (food) | ND | NOT APPLICABLE | 0.14 1 | 1 | 1 | ND | ND | ND | ND | 4 |
| Manganese (water) | ND | NOT APPLICABLE | 0.005 1 | 1 | 1 | ND | 200 | ND | 0.05 | 8 |
| Mercury | ND | NOT APPLICABLE | 0.0003 2 | 1000 | 1 | D | 10 | 0.002 | 0.002 | 4 |
| Nickel | ND | NOT APPLICABLE | 0.02 1 | 300 | 1 | D | 500 | 0.1 | 0.1 | 4 |
| Potassium | ND | NOT APPLICABLE | 50 14 | ND | ND | ND | ND | ND | ND | 4 |
| Selenium | ND | NOT APPLICABLE | 0.005 2 | 3 | 1 | ND | 200 | 0.05 | 0.05 | 4 |
| Silver | ND | NOT APPLICABLE | 0.005 1 | 3 | 1 | ND | 100 | ND | 0.1 | 8 |
| Sodium | ND | NOT APPLICABLE | 34 14 | ND | ND | ND | ND | ND | 17 | 8 |
| Sulfates | ND | NOT APPLICABLE | ND | ND | ND | ND | 500000 | ND | 250 | 8 |
| Sulfides | ND | NOT APPLICABLE | ND | ND | ND | ND | ND | ND | ND | 4 |
| Thallium (as sulfate/chloride salt) | ND | NOT APPLICABLE | 0.00006 1 | 3000 | 1 | D | 2 | 0.002 | 0.0005 | 4 |
| Vanadium | ND | NOT APPLICABLE | 0.007 2 | 100 | 1 | D | 30 | ND | ND | 4 |
| Zinc | ND | NOT APPLICABLE | 0.3 1 | 3 | 1 | D | 3000 | ND | 2 | 5 |
| pH | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | -- | -- | -- | -- | -- | 8.5 - 8.5 | 8 |

NOTES:

- 1 - IRIS (Integrated Risk Information System)
- 2 - HEAST (Health Effects Summary Tables)
- 3 - Toxicity Equivalency Factor (relative to Benzo(a)pyrene) established in Interim USEPA, Region IV guidance 2/11/92; exposure concentrations are multiplied by the TEF within risk/hazard formulas.
- 4 - Maximum Contaminant Level (MCL) (or Treatment Technology based MCL)
- 5 - Lifetime Health Advisory for 70 Kg adult
- 6 - 10 day Health Advisory for 10 KG child
- 7 - Drinking Water Equivalent Level (DWEL)
- 8 - Secondary MCL (SMCL - aesthetic based)
- 9 - Inhalation Unit Risk in micrograms/cubic meter
- 10 - MCL and RAL based on total Chromium.
- 11 - August 10, 1993 correspondence from EPA
- 12 - RfD provided in USEPA Region III Soil Screening Concentration Table, First Quarter, 1994; see # 14.
- 13 - RfD for pyrene used as surrogate, see # 14.
- 14 - Surrogate and/or provisional RfDs suggested by Kevin Koporec, USEPA Office of Health Assessment, phone conversation 2/2/94.
- 15 - RfD for Endrin used as surrogate, see # 14.
- 16 - RfD for DDT applied as surrogate RfD for DDE due to structural similarity.
- 17 - RfD for o-Cresol used as surrogate, see # 14.
- 18 - RfD for Naphthalene used as surrogate, see # 14.
- 20 - RfD for gamma-BHC used as surrogate; per 2/4/94 phone conversation with Jim Holdar, USEPA Point of Contact for BHC.
- * - proposed MCLs
- ND - No data available
- RAL - Removal Action Level
- UF - denotes Uncertainty Factor
- MF - denotes Modification Factor

| TABLE 5-11 SUMMARY OF CARCINOGENIC RISK ASSOCIATED WITH EXPOSURE TO CONTAMINATED MEDIA FORT HARTFORD STONE QUARRY NPL SITE OLATON, KENTUCKY | | | | |
|---|-----------------|----------------------|---------|---------|
| MEDIUM/PARAMETER | ASSOCIATED RISK | | | |
| SOIL | ONSITE | BACKGROUND LOCATIONS | | |
| Benzo(a)anthracene | 1.7E-07 | NA | | |
| Benzo(b/k)fluoranthene | 6.5E-07 | NA | | |
| Benzo(a)pyrene | 2.4E-06 | NA | | |
| Indeno(1,2,3-cd)pyrene | 1.2E-07 | NA | | |
| Dibenz(a,h)anthracene | 2.9E-07 | NA | | |
| Arsenic | 2.3E-05 | 1.9E-05 | | |
| Beryllium | 7.5E-06 | NA | | |
| Soil Pathway Total Risk | 3E-05 | 2E-05 | | |
| SURFACE WATER | | | | |
| Not Applicable | | | | |
| SEDIMENTS - INSTREAM | ONSITE | RR | CC | CR |
| Benzo(a)pyrene | 6.9E-07 | NA | 1.0E-06 | NA |
| Arsenic | 1.9E-05 | 1.4E-05 | 1.3E-05 | 4.0E-06 |
| Beryllium | 3.1E-06 | NA | 4.1E-06 | NA |
| Instream Sediment Pathway Total Risk | 2E-05 | 1E-05 | 2E-05 | 4E-06 |
| SEDIMENTS - MINE FLUMES | ONSITE | BACKGROUND LOCATIONS | | |
| Arsenic | 6.0E-06 | See Notes | | |
| Mine Flume Sediment Pathway Total Risk | 6E-06 | | | |
| GROUNDWATER | | | | |
| ZONE 1 | ONSITE | BACKGROUND LOCATIONS | | |
| Benzene | 4.4E-07 | NA | | |
| Styrene | 1.4E-07 | NA | | |
| Arsenic | NA | 2.0E-04 | | |
| Zone 1 GW Pathway Risk | 6E-07 | 2E-04 | | |
| ZONE 2 | ONSITE | BACKGROUND LOCATIONS | | |
| 4,4'-DDT | 3.0E-07 | NA | | |
| Arsenic | NA | 5.5E-05 | | |
| Zone 2 GW Pathway Risk | 3E-07 | 6E-05 | | |
| ZONE 3 | ONSITE | BACKGROUND LOCATIONS | | |
| Arsenic | NA | 1.2E-04 | | |
| Zone 3 GW Pathway Risk | NA | 1E-04 | | |
| ZONE 4 | ONSITE | BACKGROUND LOCATIONS | | |
| Benzene | 8.7E-07 | NA | | |
| Arsenic | 2.1E-04 | 6.3E-05 | | |
| Zone 4 GW Pathway Risk | 2E-04 | 6E-05 | | |
| ZONE 5 | ONSITE | BACKGROUND LOCATIONS | | |
| Arsenic | NA | 5.0E-05 | | |
| Zone 5 GW Pathway Risk | NA | 5E-05 | | |
| AS RECEIVED SALT CAKE FIN | ONSITE | BACKGROUND LOCATIONS | | |
| Arsenic | 9.9E-06 | See Notes | | |
| Beryllium | 1.7E-06 | | | |
| As Rec'd Total Pathway Risk | 1E-05 | | | |
| WATER FROM REACTION | ONSITE | BACKGROUND LOCATIONS | | |
| Arsenic | 7.1E-06 | See Notes | | |
| Beryllium | 3.5E-05 | | | |
| Water from Reaction Total Pathway Risk | 4E-05 | | | |

NOTES:

The designations RR, CC, and CR represent background location values in Rough River, Caney Creek and Cane Run, respectively.

Mine flume sediment risk may be compared to that in receiving streams to provide a frame of reference.

Neither as received salt cake fines or water from reaction results have corresponding background values. The computed risk may be compared to background soil and surface water or groundwater risk, respectively.

Groundwater ZONES are referenced as follows: ZONE1 - Haney Limestone/Big City Contact; ZONE2 - Upper Big City Sandstone; ZONE3 - Lower Big City Sandstone; ZONE4 - Beech Creek/Ehren Contact; ZONE5 - Reelsville Limestone.

| TABLE 5-12 SUMMARY OF NON-CARCINOGENIC HAZARD ASSOCIATED WITH EXPOSURE TO CONTAMINATED MEDIA FORT HARTFORD STONE QUARRY NPL SITE OLATON, KENTUCKY | | | | |
|---|-------------------|----------------------|------|------|
| MEDIUM/PARAMETER | ASSOCIATED HAZARD | | | |
| SOIL | ONSITE | BACKGROUND LOCATIONS | | |
| Arsenic | 0.1 | 0.1 | | |
| Iron | 0.3 | 0.2 | | |
| Soil Pathway Total Hazard | 0.5 | 0.4 | | |
| SURFACE WATER-INSTREAM | ONSITE | RR | CC | CR |
| Iron | 0.3 | 0.2 | 0.2 | |
| Manganese ** | 1.6 | 1.5 | 0.9 | 0.3 |
| Instream SW Pathway Total Hazard | 1.9 | 1.7 | 1.1 | 0.3 |
| SURFACE WATER-SPRINGS | ONSITE | BACKGROUND LOCATIONS | | |
| Cadmium | 0.4 | 0.4 | | |
| Iron | 0.2 | | | |
| Manganese | 0.2 | 0.4 | | |
| Sodium | 0.2 | | | |
| Vanadium | 0.1 | 0.1 | | |
| Spring Pathway Total Hazard | 1.1 | 0.9 | | |
| SEDIMENTS - INSTREAM | ONSITE | RR | CC | CR |
| Arsenic | 0.1 | 0.1 | <0.1 | <0.1 |
| Antimony | | | | 0.1 |
| Iron | 0.2 | | 0.2 | |
| Instream Sediment Pathway Total Hazard | 0.3 | 0.1 | 0.2 | 0.1 |
| SEDIMENTS - MINE FLUMES | ONSITE | BACKGROUND LOCATIONS | | |
| Not Applicable | <0.1 | See Notes | | |
| Mine Flume Sediment Pathway Total Hazard | 0.0 | | | |
| GROUNDWATER | | | | |
| ZONE 1 | ONSITE | BACKGROUND LOCATIONS | | |
| Arsenic | | 0.9 | | |
| Barium | 0.5 | | | |
| Cadmium | 0.7 | | | |
| Chromium | 0.1 | | | |
| Iron | 0 | 0.2 | | |
| Potassium | 1.1 | | | |
| Selenium | 0.2 | | | |
| Sodium | 24 | 0.2 | | |
| Ammonia | 23 | | | |
| Zone 1 GW Pathway Hazard | 51 | 1 | | |
| ZONE 2 | ONSITE | BACKGROUND LOCATIONS | | |
| Arsenic | | 0.2 | | |
| Barium | 2.1 | | | |
| Cadmium | 0.3 | | | |
| Iron | 0.6 | 0.1 | | |
| Manganese | 2.7 | | | |
| Sodium | 5.9 | 0.3 | | |
| Ammonia | 2.4 | | | |
| Zone 2 GW Pathway Hazard | 14 | 1 | | |

| TABLE 5.12 (continued) - SUMMARY OF NON-CARCINOGENIC HAZARD ASSOCIATED WITH EXPOSURE TO CONTAMINATED MEDIA FORT HARTFORD STONE QUARRY NPL SITE OLATON, KENTUCKY | | |
|---|-------------------|----------------------|
| MEDIUM/PARAMETER | ASSOCIATED HAZARD | |
| ZONE 3 | ONSITE | BACKGROUND LOCATIONS |
| Arsenic | | 0.5 |
| Barium | 0.7 | |
| Cadmium | 0.7 | |
| Chromium | 0.2 | |
| Iron | 0.3 | |
| Manganese | 2.9 | |
| Sodium | 4.5 | 0.3 |
| Ammonia | 0.4 | |
| Zone 3 GW Pathway Hazard | 10 | 1 |
| ZONE 4 | ONSITE | BACKGROUND LOCATIONS |
| Arsenic | 0.9 | 0.3 |
| Barium | 0.5 | |
| Sodium | 0.9 | 0.6 |
| Zone 4 GW Pathway Hazard | 2 | 1 |
| ZONE 5 | ONSITE | BACKGROUND LOCATIONS |
| Arsenic | | 0.2 |
| Chromium | 0.1 | |
| Iron | 0.1 | |
| Sodium | 0.1 | 0.6 |
| Zone 5 GW Pathway Hazard | 1 | 1 |
| AS RECEIVED SALT CAKE FINE | ONSITE | BACKGROUND LOCATIONS |
| Aluminum | 0.2 | See Notes |
| Arsenic | 0.1 | |
| Iron | 0.2 | |
| As Rec'd Total Pathway Hazard | 0.8 | |
| WATER FROM REACTION | ONSITE | BACKGROUND LOCATIONS |
| Antimony | 0.5 | See Notes |
| Arsenic | 0.1 | |
| Cadmium | 0.2 | |
| Chromium | 0.2 | |
| Potassium | 0.8 | |
| Selenium | 0.1 | |
| Silver | 0.1 | |
| Sodium | 5.7 | |
| Thallium | 0.1 | |
| Vanadium | 0.4 | |
| Ammonia | 3.1 | |
| Water from Reaction | | |
| Total Pathway Hazard | 11 | |

NOTES:

'X' indicates parameter contributed to computed hazard index.

'XX' indicates the primary contributors to the hazard index with hazard quotients greater than 1.

'**' indicates manganese was not detected in any instream sample above BALs.

Only parameters with hazard quotients in excess of 0.1 are listed.

The designations RR, CC, and CR represent background location values in Rough River, Caney Creek and Cane Run, respectively.

Mine sludge sediment hazard may be compared to that in receiving streams to provide a frame of reference.

Neither as received salt cake fines or water from reaction results have corresponding background values. The computed hazard may be compared to background soil and surface water or groundwater hazard, respectively.

Groundwater ZONES are referenced as follows: ZONE1 - Haney Limestone/Big Clifty Contact; ZONE2 - Upper Big Clifty Sandstone; ZONE3 - Lower Big Clifty

TABLE 5.1-3 SUMMARY OF GROUNDWATER, SURFACE, AND WATER FROM REACTION CONCENTRATIONS THAT EXCEED ARAR
FORT HARTFORD STONE QUARRY NPL SITE
OLATON, KENTUCKY

| MEDIUM/PARAMETER | ARAR Ref. (MG/L) | ONSITE (MG/L) | BACKGROUND LOCATIONS (MG/L) |
|----------------------------|---------------------|------------------|----------------------------------|
| GROUNDWATER | | | |
| ZONE 1 | | | |
| Cadmium | 0.005 MCL | 0.01 | BDL |
| Lead | 0.015 TT - MCL | 0.0205 | 0.0023 |
| Sodium | 17 HA | 23450 | 240 |
| Thallium | 0.002 MCL | 0.014 | BDL |
| Chlorides | 250 SMCL | 48250 | 15.3 |
| Sulfates | 250 SMCL | 558.5 | 51.1 |
| Ammonia | 30 HA | 665 | 0.7 |
| Aluminum | 0.05 - 0.2 SMCL | BDL | 3.44 |
| ZONE 2 | | | |
| Barium | 2 MCL | 4.15 | 0.154 |
| Iron | 0.3 SMCL | 4.85 | 1.27 |
| Lead | 0.015 TT - MCL | 0.0395 | 0.0021 |
| Manganese | 0.05 SMCL | 0.384 | 0.0093 |
| Sodium | 17 HA | 5710 | 292 |
| Chlorides | 250 SMCL | 16840 | 7.9 |
| Ammonia | 30 HA | 67.1 | 0.7 |
| Aluminum | 0.05 - 0.2 SMCL | BDL | 1.95 |
| ZONE 3 | | | |
| Cadmium | 0.005 MCL | 1.42 | BDL |
| Iron | 0.3 SMCL | 2.43 | 0.26 |
| Manganese | 0.05 SMCL | 0.411 | 0.0077 |
| Sodium | 17 HA | 4330 | 268.9 |
| Chlorides | 250 SMCL | 16680 | 12 |
| Aluminum | 0.05 - 0.2 SMCL | BDL | 0.249 |
| ZONE 4 | | | |
| Iron | 0.3 SMCL | 0.63 | 0.63 |
| Sodium | 17 HA | 912 | 572 |
| Chlorides | 250 SMCL | 1405 | 1405 |
| ZONE 5 | | | |
| Iron | 0.3 SMCL | 1.26 | 0.029 |
| Sodium | 17 HA | 1060 | 545 |
| Chlorides | 250 SMCL | 403 | 7.3 |
| SURFACE WATER | | | |
| | | ONSITE | BACKGROUND |
| | | | CANEY CREEK CANE RUN ROUGH RIVER |
| Aluminum | 0.05 - 0.2 SMCL | 1.84 | 1.18 0.308 1.31 |
| Iron | 0.3 SMCL | 2.77 | 1.63 0.388 1.61 |
| Lead | 0.015 TT - MCL | 0.021 | 0.006 BDL 0.004 |
| Manganese | 0.05 SMCL | 0.227 | 0.133 0.04 0.212 |
| | | ONSITE | BACKGROUND |
| Aluminum | 0.05 - 0.2 SMCL | 1.56 | 0.944 |
| Iron | 0.3 SMCL | 1.73 | 0.836 |
| Manganese | 0.05 SMCL | 0.031 | 0.049 |
| Cadmium | 0.005 MCL | 0.005 | 0.005 |
| Sodium | 17 HA | 175.75 | 4.89 |
| Vanadium | 30 HA | 0.023 | 0.023 |
| Chlorides | 250 SMCL | 260.8 | 5.8 |
| Sulfates | 250 SMCL | 408.5 | 20.6 |
| WATER FROM REACTION | | | |
| RESULTING CONCENTRATION | | | |
| Aluminum | 0.05 - 0.2 SMCL | 5.61 | |
| Antimony | 0.006 MCL | 0.06 | |
| Beryllium | 0.004 MCL | 0.02 | |
| Cadmium | 0.005 MCL | 0.03 | |
| Chromium | 0.1 MCL | 0.26 | |
| Iron | 0.3 SMCL | 0.76 | |
| Manganese | 0.05 SMCL | 0.15 | |
| Nickel | 0.1 MCL | 0.52 | |
| Selenium | 0.05 MCL | 0.18 | |
| Silver | 0.1 HA | 0.17 | |
| Sodium | 17 HA | 62631 | |
| Thallium | 0.005 MCL | 0.03 | |
| Vanadium | 0.03 RAL | 0.83 | |
| Ammonia | 30 HA | 995 | |
| Chlorides | 250 SMCL | 112281 | |
| Sulfates | 250 SMCL | 634 | |

NOTES:

- MCL refers to maximum contaminant level.
- SMCL is a secondary (usually aesthetic based) MCL.
- HA refers to Health Advisory.
- TT - MCL refers to a treatment technology-based MCL, such as lead.
- All units are in mg/L.
- All 'water from reaction' concentrations listed exceed the corresponding ARARs; no background data apply to this medium.

Boxed and shaded values designate concentrations that exceed corresponding ARARs.

TABLE 5.1.4 SURFACE WATER REMEDIAL GOAL OPTIONS
UNDER A RESIDENTIAL USER EXPOSURE SCENARIO
FORT HARTFORD MINE
CLATON, KENTUCKY

| HAZARD - BASED: | | REFERENCE | | MAXIMUM | OTHER DRINKING | | | REMEDIAL | REMEDIAL | REMEDIAL | APPLICABLE | EXPOSURE |
|---------------------|-----------------|----------------|-------------|-------------|----------------|-------------|---------------|-------------|-------------|----------|---------------|----------|
| | DOSE | HAZARD | CONTAMINANT | WATER REF. | | SUPERFUND | GOAL OPTION | GOAL OPTION | GOAL OPTION | SURFACE | POINT | |
| PARAMETER | ORAL | INDEX | LEVEL | STANDARDS | Reference | RAL | HQ = 0.1 | HQ = 1 | HQ = 10 | WATERS | CONCENTRATION | |
| | (MG/KG/DAY) | @ 4 QTR MAX | (MG/L) | (MG/L) | | (UG/L) | (MG/L) | (MG/L) | (MG/L) | | (MG/L) | |
| INORGANICS/WET CHEM | | | | | | | | | | | | |
| Aluminum* | 2.9 | 2.2E-02 | NA | 0.05 | 1 | NA | 8.25E+00 | 8.25E+01 | 8.25E+02 | 5,6 | 1.84E+00 | |
| Cadmium | 0.0005 | 3.8E-01 | 0.005 | 0.005 | 2 | 5 | 1.42E-03 | 1.42E-02 | 1.42E-01 | 6 | 5.40E-03 | |
| Iron* | 0.3 | 2.0E-01 | NA | 0.3 | 2 | NA | 8.53E-01 | 8.53E+00 | 8.53E+01 | 5,6 | 1.73E+00 | |
| Lead | NRV | NRV | NA | 0.015 | 4 | 30 | ARAR | ARAR | ARAR | 5 | 2.10E-02 | |
| Manganese | 0.005 | 2.1E-01 | NA | 0.05 | 2 | 200 | 1.42E-02 | 1.42E-01 | 1.42E+00 | 5,6 | 3.05E-02 | |
| Sodium* | 34 | 1.8E-01 | NA | 20 | 3 | NA | 9.67E+01 | 9.67E+02 | 9.67E+03 | 6 | 1.76E+02 | |
| Vanadium | 0.007 | 1.1E-01 | NA | NA | | 30 | 1.99E-02 | 1.99E-01 | 1.99E+00 | 6 | 2.26E-02 | |
| Chlorides | NRV | NRV | NA | 250 | 2 | | ARAR | ARAR | ARAR | 6 | 2.61E+02 | |
| Sulfates | NRV | NRV | NA | 250 | 2 | 30 | ARAR | ARAR | ARAR | 6 | 4.09E+02 | |
| CARCINOGEN - BASED: | | | | | | | | | | | | |
| | SLOPE | TOXICITY | | REMEDIAL | REMEDIAL | REMEDIAL | EXPOSURE | | | | | |
| | FACTOR | EQUIVALENCY | CANCER | GOAL OPTION | GOAL OPTION | GOAL OPTION | POINT | | | | | |
| | ORAL | FACTOR | RISK | RISK = 1E-4 | RISK = 1E-5 | RISK = 1E-6 | CONCENTRATION | | | | | |
| PARAMETER | (MG/KG/DAY) - 1 | (UNITLESS) | @ 4 QTR MAX | (MG/L) | (MG/L) | (MG/L) | (MG/L) | | | | | |
| INORGANICS/WET CHEM | | | | | | | | | | | | |
| Aluminum* | NRV | NOT APPLICABLE | NRV | NRV | NRV | NRV | 1.84E+00 | | | | | |
| Cadmium | NRV | NOT APPLICABLE | NRV | NRV | NRV | NRV | 5.40E-03 | | | | | |
| Iron* | NRV | NOT APPLICABLE | NRV | NRV | NRV | NRV | 1.73E+00 | | | | | |
| Lead | NRV | NOT APPLICABLE | NRV | NRV | NRV | NRV | 2.10E-02 | | | | | |
| Manganese | NRV | NOT APPLICABLE | NRV | NRV | NRV | NRV | 3.05E-02 | | | | | |
| Sodium* | NRV | NOT APPLICABLE | NRV | NRV | NRV | NRV | 1.76E+02 | | | | | |
| Vanadium | NRV | NOT APPLICABLE | NRV | NRV | NRV | NRV | 2.26E-02 | | | | | |
| Chlorides | NRV | NOT APPLICABLE | NRV | NRV | NRV | NRV | 2.61E+02 | | | | | |
| Sulfates | NRV | NOT APPLICABLE | NRV | NRV | NRV | NRV | 4.09E+02 | | | | | |

NOTES:

RfD and Slope Factor (a.k.a. Cancer Potency Factor) values obtained from IRIS (September 1993 and February 1994) and/or HEAST 1993.

None of the identified surface water contaminants of concern support a significant volatilization (and inhalation) exposure pathway.

The exposure point concentrations referenced are from all onsite instream surface water locations; which includes concentrations for

aluminum, iron, lead, and manganese; concentrations for all other parameters were obtained from spring surface water data.

Tables 3 through 6 in Appendix I contain additional exposure point concentrations for reference.

MCL = Maximum Contaminant Level; SMCL = Secondary MCL; HA = EPA Health Advisory; MCL-TT = Treatment Technology Based MCL;

HEAST-RfD = Specific Reference Dose Drinking Water Equivalent Concentration; RAL = Superfund Removal Action Level

NA indicates no value was available, NRV indicates no risk value (slope factor or reference dose) was available for the compound.

No hit greater than BAL was reported at any spring sampling location.

* - Indicates provisional RfDs were used to develop RGOs.

1 - Most conservative value of SMCL range, 0.5 - 0.2, SMCL

2 - SMCL

3 - HA

4 - Treatment Technology (TT) based MCL

5 - Applies to instream surface water.

6 - Applies to surface water in springs.

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TABLE 3.15 GROUNDWATER REMEDIAL GOAL OPTIONS
(UNDER RESIDENTIAL EXPOSURE SCENARIO)
FORT HARTFORD STONE QUARRY NPL SITE
OLATON, KENTUCKY

| HAZARD-BASED: | | REFERENCE | HAZARD | MCL OR | REMEDIAL | REMEDIAL | REMEDIAL | APPLIES | EXPOSURE |
|--------------------------|-----------------|-------------|-------------|-------------|-------------|-------------|---------------|-----------|---------------|
| | | DOSE | INDEX | OTHER ARAR | GOAL OPTION | GOAL OPTION | GOAL OPTION | TO WATER- | POINT |
| | | ORAL | | | HQ = 0.1 | HQ = 1 | HQ = 10 | BEARING | CONCENTRATION |
| PARAMETER | | (MG/KG/DAY) | @ 2 QTR MAX | (MG/L) | REF | (MG/L) | (MG/L) | ZONE #'S | (MG/L) |
| INORGANICS/WET CHEMISTRY | | | | | | | | | |
| Arsenic | 0.0003 | 9.14E-01 | 0.05 MCL | | 8.53E-04 | 8.53E-03 | 8.53E-02 | 4 | 7.80E-03 |
| Barium | 0.07 | 5.07E-01 | 2 MCL | | 1.99E-01 | 1.99E+00 | 1.99E+01 | 1,2,3,4 | 1.01E+00 |
| Cadmium | 0.0005 | 7.03E-01 | 0.005 MCL | | 1.42E-03 | 1.42E-02 | 1.42E-01 | 1,2,3 | 1.00E-02 |
| Chromium | 0.005 | 1.24E-01 | 0.1 MCL | | 1.42E-02 | 1.42E-01 | 1.42E+00 | 1,3,5 | 1.77E-02 |
| Iron* | 0.3 | 5.68E-01 | 0.3 SMCL | | 8.53E-01 | 8.53E+00 | 8.53E+01 | 2,3,4,5 | 4.85E+00 |
| Lead | NRV | NRV | 0.015 MCL-T | | ARAR | ARAR | ARAR | 1,2 | 2.05E-02 |
| Manganese | 0.005 | 2.70E+00 | 0.05 SMCL | | 1.42E-02 | 1.42E-01 | 1.42E+00 | 2,3 | 3.84E-01 |
| Potassium* | 50 | 1.15E+00 | NA | | 1.42E+02 | 1.42E+03 | 1.42E+04 | 1 | 1.64E+03 |
| Selenium | 0.005 | 2.37E-01 | 0.1 HA | | 1.42E-02 | 1.42E-01 | 1.42E+00 | 1 | 3.37E-02 |
| Sodium* | 34 | 2.42E+01 | 17 HA | | 9.67E+01 | 9.67E+02 | 9.67E+03 | 1,2,3,4,5 | 2.35E+04 |
| Thallium | 0.007 | 7.03E-02 | 0.002 MCL | | 1.99E-02 | 1.99E-01 | 1.99E+00 | 1 | 1.40E-02 |
| Chlorides | NRV | NRV | 250 SMCL | | ARAR | ARAR | ARAR | 1,2,3,4,5 | 4.83E+04 |
| Sulfates | NRV | NRV | 250 SMCL | | ARAR | ARAR | ARAR | 1 | 5.59E+02 |
| Ammonia* | 1 | 2.34E+01 | 30 HA | | 2.84E+00 | 2.84E+01 | 2.84E+02 | 1,2,3 | 6.65E+02 |
| CARCINOGEN-BASED: | | | | | | | | | |
| PARAMETER | SLOPE | CANCER | REMEDIAL | REMEDIAL | REMEDIAL | APPLIES | EXPOSURE | | |
| | FACTOR | RISK | GOAL OPTION | GOAL OPTION | GOAL OPTION | TO WATER- | POINT | | |
| | ORAL | @ 2 QTR MAX | RISK = 1E-4 | RISK = 1E-5 | RISK = 1E-6 | BEARING | CONCENTRATION | | |
| | (MG/KG/DAY) = 1 | | (MG/L) | (MG/L) | (MG/L) | ZONE #'S | (MG/L) | | |
| INORGANICS/WET CHEMISTRY | | | | | | | | | |
| Arsenic | 1.75 | 2.08E-04 | 3.79E-03 | 3.79E-04 | 3.79E-05 | 4 | 7.80E-03 | | |
| Barium | NRV | NRV | NRV | NRV | NRV | NRV | 1.01E+00 | | |
| Cadmium | NRV | NRV | NRV | NRV | NRV | NRV | 1.00E-02 | | |
| Chromium | NRV | NRV | NRV | NRV | NRV | NRV | 1.77E-02 | | |
| Iron* | NRV | NRV | NRV | NRV | NRV | NRV | 4.85E+00 | | |
| Lead | NRV | NRV | NRV | NRV | NRV | NRV | 2.05E-02 | | |
| Manganese | NRV | NRV | NRV | NRV | NRV | NRV | 3.84E-01 | | |
| Potassium* | NRV | NRV | NRV | NRV | NRV | NRV | 1.64E+03 | | |
| Selenium | NRV | NRV | NRV | NRV | NRV | NRV | 3.37E-02 | | |
| Sodium* | NRV | NRV | NRV | NRV | NRV | NRV | 2.35E+04 | | |
| Thallium | NRV | NRV | NRV | NRV | NRV | NRV | 1.40E-02 | | |
| Chlorides | NRV | NRV | NRV | NRV | NRV | NRV | 4.83E+04 | | |
| Sulfates | NRV | NRV | NRV | NRV | NRV | NRV | 5.59E+02 | | |
| Ammonia* | NRV | NRV | NRV | NRV | NRV | NRV | 6.65E+02 | | |

NOTES:

RD and Slope Factor (a.k.a. Cancer Potency Factor) values obtained from IRIS (September 1993 and February 1994) and/or HEAST 1993.

* denotes provisional RD; ammonia RD is based on an organoleptic concentration (taste threshold) and is extremely conservative.

The exposure point concentrations referenced are the maximum two quarter averages representative of zone 1; manganese and iron concentrations are from zone 2, and the concentration for arsenic is from zone 4.

Tables 10 through 15 in Appendix I include additional exposure point concentrations for reference.

MCL = Maximum Contaminant Level; SMCL = Secondary MCL; HA = EPA Health Advisory; MCL-TT = Treatment Technology Based MCL;

HEAST-RD = Specific Reference Dose Drinking Water Equivalent Concentration; RAL = Superfund Removal Action Level

NA indicates no ARAR is available; NRV indicates the no risk value (slope factor or reference dose) is available for the parameter

1 Haney Limestone/Upper Big Clifty Contact Zone

2 Upper Big Clifty Sandstone Formation Zone

3 Lower Big Clifty Sandstone Formation Zone

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**TABLE 5.16- WATER FROM REACTION SOURCE MATERIAL REMEDIAL GOAL OPTIONS
UNDER A RECREATIONAL USER EXPOSURE SCENARIO
FORT HARTFORD STONE QUARRY NPL SITE
OLATON, KENTUCKY**

| HAZARD - BASED: | REFERENCE | HAZARD | MCL OR OTHER | ARAR | REMEDIAL | REMEDIAL | REMEDIAL | 95% UCL OR MAX. |
|---------------------|-----------------|----------------|----------------|--------------|--------------|--------------|-----------------|-----------------|
| | DOSE | INDEX | | REFERENCE | GOAL OPTIONS | GOAL OPTIONS | GOAL OPTIONS | WATER FROM RXN |
| | ORAL | | ARAR | | HQ = 0.1 | HQ = 1.0 | HQ = 10.0 | CONCENTRATION |
| PARAMETER | (MG/KG/DAY) | @ 95% UCL | (MG/L) | | (MG/L) | (MG/L) | (MG/L) | (MG/L) |
| INORGANICS/WET CHEM | | | | | | | | |
| Aluminum | 2.9 | 6.0E-03 | 0.05-0.2 SMCL | | 9.35E+01 | 9.35E+02 | 9.35E+03 | 5.61E+00 |
| Antimony | 0.0004 | 4.7E-01 | 0.006 MCL | | 1.29E-02 | 1.29E-01 | 1.29E+00 | 0.06 |
| Arsenic | 0.0003 | 1.0E-01 | 0.05 MCL | | 9.68E-03 | 9.68E-02 | 9.68E-01 | 0.01 |
| Beryllium | 0.005 | 1.2E-02 | 0.004 MCL | | 1.61E-01 | 1.61E+00 | 1.61E+01 | 0.02 |
| Cadmium | 0.0005 | 1.9E-01 | 0.005 MCL | | 1.61E-02 | 1.61E-01 | 1.61E+00 | 0.03 |
| Chromium | 0.005 | 1.6E-01 | 0.1 MCL | | 1.61E-01 | 1.61E+00 | 1.61E+01 | 0.26 |
| Iron | 0.3 | 7.9E-03 | 0.3 SMCL | | 9.68E+00 | 9.68E+01 | 9.68E+02 | 0.76 |
| Lead | NRV | NRV | 0.015 MCL - TT | | NRV | NRV | NRV | 0.11 |
| Manganese | 0.005 | 9.3E-02 | 0.05 SMCL | | 1.61E-01 | 1.61E+00 | 1.61E+01 | 0.15 |
| Nickel | 0.02 | 8.1E-02 | 0.1 MCL | | 6.45E-01 | 6.45E+00 | 6.45E+01 | 0.52 |
| Potassium | 50 | 8.4E-01 | NA | | 1.61E+03 | 1.61E+04 | 1.61E+05 | 13600 |
| Selenium | 0.005 | 1.1E-01 | 0.05 MCL | | 1.61E-01 | 1.61E+00 | 1.61E+01 | 0.18 |
| Silver | 0.005 | 1.1E-01 | 0.1 HA | | 1.61E-01 | 1.61E+00 | 1.61E+01 | 0.17 |
| Sodium | 34 | 5.7E+00 | 17 HA | | 1.10E+03 | 1.10E+04 | 1.10E+05 | 62631 |
| Thallium | 0.0008 | 1.2E-01 | 0.0005 MCL | | 2.58E-02 | 2.58E-01 | 2.58E+00 | 0.03 |
| Vanadium | 0.007 | 3.7E-01 | 0.03 RAL | | 2.26E-01 | 2.26E+00 | 2.26E+01 | 0.83 |
| Ammonia | 1 | 3.1E+00 | 30 HA | | 3.23E+01 | 3.23E+02 | 3.23E+03 | 995 |
| Chlorides | NRV | NRV | 250 SMCL | | NRV | NRV | NRV | 112281 |
| Sulfates | NRV | NRV | 250 SMCL | | NRV | NRV | NRV | 634 |
| CARCINOGEN - BASED | | | | | | | | |
| | SLOPE | TOXICITY | | REMEDIAL | REMEDIAL | REMEDIAL | 95% UCL OR MAX. | |
| | FACTOR | EQUIVALENCY | CANCER | GOAL OPTIONS | GOAL OPTIONS | GOAL OPTIONS | WATER FROM RXN | |
| | ORAL | FACTOR | RISK | RISK = 1E-4 | RISK = 1E-5 | RISK = 1E-6 | CONCENTRATION | |
| PARAMETER | (MG/KG/DAY) - 1 | (UNITLESS) | @ 95% UCL | (MG/L) | (MG/L) | (MG/L) | (MG/L) | |
| INORGANICS/WET CHEM | | | | | | | | |
| Arsenic | 1.75 | NOT APPLICABLE | 7.1E-06 | | | | | 0.01 |
| Beryllium | 4.3 | NOT APPLICABLE | 3.5E-05 | | | | | 0.02 |

NOTES:

RfD and Slope Factor (a.k.a. Cancer Potency Factor) values obtained from IRIS (September 1993 and February 1994) and/or HEAST 1993.
The 95 % UCL means were used to compute risks and hazard quotients at maximum; the 95% UCL means and averages were computed using data presented in Section 4.1.
The maximum concentrations referenced are the maximum four quarter averages representative of all shallow monitoring wells.
No other carcinogens were reported for which there are slope factors; therefore, carcinogen-based RGOs can only be calculated for arsenic and beryllium.
NRV indicates no risk value (slope factor or reference dose) is available.
MCL = Maximum Contaminant Level; SMCL = Secondary MCL; HA = EPA Health Advisory; MCL-TT = Treatment Technology Based MCL;
HEAST-RfD = Specific Reference Dose Drinking Water Equivalent Concentration, RAL = Superfund Removal Action Level

Figure 3.1
Formulae for Calculating Carcinogenic and Non-carcinogenic Risk for Soil
Fort Hartford Stone Quarry NPL Site
Olaton, Kentucky

The following formulae for computing soil risk (carcinogenic and non-carcinogenic) were adapted from RAGS, Volume I, Parts A and B to reflect Site-specific considerations.

Residential Scenario

Soil Ingestion Pathway

Age-adjusted Ingestion Factor ($IF_{soil/adj}$)

$$IF_{soil/adj} \text{ (mg-yr/kg-day)} = \frac{IR_{soil/age 1-6} \times ED_{age 1-6}}{BW_{age 1-6}} + \frac{IR_{soil/age 7-31} \times ED_{age 7-31}}{BW_{age 7-31}}$$

where:

| | |
|----------------------|---|
| $IF_{soil/adj}$ | age-adjusted soil ingestion factor (mg-yr/kg-day) |
| $BW_{age 1-6}$ | average body weight from ages 1-6 (kg) |
| $BW_{age 7-31}$ | average body weight from ages 7-31 (kg) |
| $ED_{age 1-6}$ | exposure duration during ages 1-6 (yr) |
| $ED_{age 7-31}$ | exposure duration during ages 7-31 (yr) |
| $IR_{soil/age 1-6}$ | ingestion rate of soil age 1-6 (mg/day) |
| $IR_{soil/age 7-31}$ | ingestion rate of soil age 7-31 (mg/day) |

Default Value

| |
|------------------|
| 110 mg-yr/kg-day |
| 16 kg |
| 70 kg |
| 6 years |
| 24 years |
| 200 mg/day |
| 100 mg/day |

Dermal Contact Pathway

Age-adjusted Contact Factor ($CF_{soil/adj}$)

$$CF_{soil/adj} \text{ (mg-yr/kg-day)} = \frac{SA_{age 1-6} \times AF \times ED_{age 1-6}}{BW_{age 1-6}} + \frac{SA_{age 7-31} \times AF \times ED_{age 7-31}}{BW_{age 7-31}}$$

where:

| | |
|-----------------|--|
| $CF_{soil/adj}$ | age-adjusted contact factor (mg-yr-event/kg-day) |
| $SA_{age 1-6}$ | skin surface area available for contact (cm ² /event) |
| $SA_{age 7-31}$ | skin surface area available for contact (cm ² /event) |
| AF | soil to skin adherence factor (mg/cm ²) |
| $ED_{age 1-6}$ | exposure duration during age 1-6 (yr) |
| $ED_{age 7-31}$ | exposure duration during age 7-31 (yr) |

Default Values

| |
|-----------------------------|
| 2600 mg-yr-event/kg-day |
| 3730 cm ² /event |
| 3500 cm ² /event |
| 1 mg/cm ² |
| 6 yr |
| 24 yr |

Figure 5.1 (continued)
Formulae for Calculating Carcinogenic and Non-carcinogenic Risk for
Soil

**Risk (Hazard Index) Based on Combined Daily Absorbed Dose (Ingestion + Dermal Contact)
Non-Carcinogens**

$$\text{Hazard Index} = ((C_s \times ((IF_{\text{soil/adj}} \times 10^{-6} \text{ kg/mg} \times EF_R) / AT_{NC}) / (RfD_o))) + (C_s \times ((CF_{\text{soil/adj}} \times 10^{-6} \text{ kg/mg} \times EF_R \times ABS) / AT_{NC})) / (RfD_o \times ADJ))$$

Carcinogens

Risk =

$$(C_s \times ((IF_{\text{soil/adj}} \times 10^{-6} \text{ kg/mg} \times EF_R) / AT_C)) \times (SF_o) + (C_s \times ((CF_{\text{soil/adj}} \times 10^{-6} \text{ kg/mg} \times EF_R \times ABS) / AT_C)) \times (SF_o / ADJ))$$

where:

C_s Chemical concentration in soil
 EF_R Residential exposure frequency
 AT_{NC} Averaging time (non-carcinogen)
 AT_C Averaging time (carcinogen)
 ABS Absorption factor (unitless)

RfD Reference Dose (mg/kg/day)
 SF_o Slope Factor (mg/kg/day)⁻¹
 ADJ Administered to Absorbed Adjustment Factor

Default Values

Chemical-specific
350 days/year
10,950 days
25,550 days
0.01 (Organic Compounds)
0.001 (Metals)
Chemical-specific
Chemical-specific
0.8 Volatiles
0.5 Semivolatiles
0.2 Metals

Risk Formulae Notes

Figure 5.1

Notes:

- ^a Reference: *Risk Assessment Guidance for Superfund, Volume I-Human Health Evaluation Manual, Part A. USEPA/OERR, EPA/540/1-89/002, December 1989 (RAGS, Volume I, Part A), RAGS, Volume I, Part B - Development of Risk-based Preliminary Remediation Goals - Interim, USEPA/ORD, EPA/540/R-92/003, December 1991 (RAGS, Volume I, Part B), and Risk Assessment Guidance for Superfund, Volume I-Human Health Evaluation Manual, Supplemental Guidance-Standard Default Exposure Factors-Interim Final, USEPA/OERR, OSWER Directive: 9285.6-03, March 25, 1991.*
- ^b Absorbed doses for ingestion exposure are assumed to be the equivalent of administered doses (100% oral ingestion). Therefore, no conversion factor is incorporated into the associated formulae.
- ^c Dermal pathway adjustment factors provided by Mr. Glenn Adams, USEPA Region IV Risk Assessment Section, personal conversation, July 13, 1993. Skin surface area values were provided by Ms. Sally Wiley, KDEP, Risk Assessment Section, personal conversation, July 13, 1993.
- ^d Absorption factor assumes 1.0 percent of organics and 0.1 percent of inorganic contaminants present in adsorbed soils will be absorbed by the exposed individual via the dermal contact pathway.

Figure 5.2
Formulae for Calculating Carcinogenic Risk and Non-carcinogenic Hazard for
Surface Water at Fort Hartford Stone Quarry NPL Site, Olaton, Kentucky

The following formulae for computing surface water risk/hazard (carcinogenic and non-carcinogenic) were adapted from RAGS, Volume I, Parts A. and B to account for Site-specific considerations.

Residential Scenario**Chronic Daily Intake****Surface Water Ingestion Pathway****Age-adjusted Ingestion Factor (IF_{SW/adj})**

$$IF_{SW/adj} \text{ (mg-yr/kg-day)} = \frac{IR_{SW/age 1-6} \times ED_{age 1-6}}{BW_{age 1-6}} + \frac{IR_{SW/age 7-31} \times ED_{age 7-31}}{BW_{age 7-31}}$$

where:

| | |
|---------------------------|---|
| IF _{SW/adj} | age-adjusted surface water ingestion factor (liter-yr/kg-day) |
| BW _{age 1-6} | average body weight from ages 1-6 (kg) |
| BW _{age 7-31} | average body weight from ages 7-31 (kg) |
| ED _{age 1-6} | exposure duration during ages 1-6 (yr) |
| ED _{age 7-31} | exposure duration during ages 7-31 (yr) |
| IR _{SW/age 1-6} | ingestion rate of surface water age 1-6 (mg/day) |
| IR _{SW/age 7-31} | ingestion rate of surface water age 7-31 (mg/day) |

Default Values

| |
|-------------------|
| 1.1 l-year/kg-day |
| 16 kg |
| 70 kg |
| 6 years |
| 24 years |
| 1 liter/day |
| 2 liter/day |

Risk (Hazard Index)**Non-Carcinogens****Hazard Index =**

$$(C_{iw} \times (IF_{SW/adj} \times EF_R) / AT_{NC}) / RfD_o$$

Carcinogens**Risk =**

$$(C_{iw} \times (IF_{SW/adj} \times EF_R) / AT_C) \times SF_o$$

where:

| | |
|------------------|---|
| C _i | Chemical concentration in surface water |
| EF _R | Residential exposure frequency |
| AT _{NC} | Averaging time (non-carcinogen) |
| AT _C | Averaging time (carcinogen) |
| RfD _o | Reference Dose (mg/kg/day) |
| SF _o | Slope Factor (mg/kg/day) ⁻¹ |

Default Values

| |
|-------------------|
| Chemical-specific |
| 350 days/year |
| 10,950 days |
| 25,550 days |
| Chemical-specific |
| Chemical-specific |

Notes:

- * Reference: RAGS, Volume I, Parts A & B, and Risk Assessment Guidance for Superfund, Volume I-Human Health Evaluation Manual, Supplemental Guidance-Standard Default Exposure Factors-Interim Final, USEPA/OERR, OSWER Directive: 9285.6-03, March 25, 1991. Absorbed doses for ingestion exposure are assumed to be the equivalent of administered doses (100% oral ingestion). Therefore, no conversion factor is incorporated into the associated formulae.

Figure 5.3
Formulae for Calculating Carcinogenic and Non-carcinogenic Risk for Sediment
Fort Hartford Stone Quarry NPL Site
Olaton, Kentucky

The following formulae for computing sediment risk (carcinogenic and non-carcinogenic) were adapted from RAGS, Volume I, Parts A and B to account for Site-specific considerations.

Recreational/commercial Scenario
Sediment Ingestion Pathway

Age-adjusted Ingestion Factor ($IF_{sed/adj}$)

$$IF_{sed/adj} \text{ (mg-yr/kg-day)} = \frac{IR_{sed/age1-6} \times ED_{age1-6}}{BW_{age1-6}} + \frac{IR_{sed/age7-31} \times ED_{age7-31}}{BW_{age7-31}}$$

where:

| | |
|--------------------|---|
| $IF_{sed/adj}$ | age-adjusted sediment ingestion factor (mg-yr/kg-day) |
| BW_{age1-6} | average body weight from ages 1-6 (kg) |
| $BW_{age7-31}$ | average body weight from ages 7-31 (kg) |
| ED_{age1-6} | exposure duration during ages 1-6 (yr) |
| $ED_{age7-31}$ | exposure duration during ages 7-31 (yr) |
| $IR_{sed/age1-6}$ | ingestion rate of sediment age 1-6 (mg/day) |
| $IR_{sed/age7-31}$ | ingestion rate of sediment age 7-31 (mg/day) |

Default Values

| |
|------------------|
| 110 mg-yr/kg-day |
| 16 kg |
| 70 kg |
| 6 years |
| 24 years |
| 200 mg/day |
| 100 mg/day |

Dermal Contact Pathway

Age-adjusted Contact Factor ($CF_{sed/adj}$)

$$CF_{sed/adj} \text{ (mg-yr/kg-day)} = \frac{SA_{age1-6} \times AF \times ED_{age1-6}}{BW_{age1-6}} + \frac{SA_{age7-31} \times AF \times ED_{age7-31}}{BW_{age7-31}}$$

where:

| | |
|----------------|--|
| $CF_{sed/adj}$ | age-adjusted contact factor (mg-yr/kg-day) |
| SA_{age1-6} | skin surface area (cm ² /event) |
| $SA_{age7-31}$ | skin surface area (cm ² /event) |
| AF | sediment absorption factor (mg/cm ²) |
| ED_{age1-6} | exposure duration during age 1-6 (yr) |
| $ED_{age7-31}$ | exposure duration during age 7-31 (yr) |

Default Values

| |
|-----------------------------|
| 2600 mg-yr-event/kg-day |
| 3730 cm ² /event |
| 3500 cm ² /event |
| 1 mg/cm ² |
| 6 yr |
| 24 yr |

Figure 5.3 (continued)
Formulae for Calculating Carcinogenic and Non-carcinogenic Risk for Sediment
Fort Hartford Stone Quarry NPL Site
Olaton, Kentucky

Risk (Hazard Index) Based on Combined Daily Absorbed Dose (Ingestion + Dermal Contact)

Non-Carcinogens

Hazard Index =

$$((C_s \times ((IF_{sed/adj} \times 10^{-6} \text{ kg/mg} \times EF_R) / AT_{NC}) / (RfD_o))) + (((CF_{sed/adj} \times 10^{-6} \text{ kg/mg} \times EF_R \times ABS) / AT_{NC}) / (RfD_o \times ADJ))$$

Carcinogens

Risk =

$$(C_s \times ((IF_{sed/adj} \times 10^{-6} \text{ kg/mg} \times EF_R) / AT_C)) \times (SF_o) + (((CF_{sed/adj} \times 10^{-6} \text{ kg/mg} \times EF_R \times ABS) / AT_C)) \times (SF_o / ADJ)$$

where:

| | | Default Values |
|-----------|---|--|
| C_s | Chemical concentration in sediment | Chemical-specific |
| EF_R | Recreational exposure frequency (lifetime weighted average) | 112 days/year |
| AT_{NC} | Averaging time (non-carcinogen) | 10,950 days |
| AT_C | Averaging time (carcinogen) | 25,550 days |
| ABS | Absorption factor (unitless) | 0.01 (Organic Compounds) 0.001 (Metals) |
| RfD | Reference Dose (mg/kg/day) | Chemical-specific |
| SF_o | Slope Factor (mg/kg/day) ⁻¹ | Chemical-specific |
| ADJ | Administered to Absorbed Adjustment Factor | 0.8 Volatiles 0.5 Semivolatiles 0.2 Metals |

Notes:

- ^a Reference: RAGS, Volume I, Parts A & B, and Risk Assessment Guidance for Superfund, Volume I-Human Health Evaluation Manual, Supplemental Guidance-Standard Default Exposure Factors-Interim Final, USEPA/OERR, OSWER Directive: 9285.6-03, March 25, 1991.
- ^b Absorbed doses for ingestion exposure are assumed to be the equivalent of administered doses (100% oral ingestion). Therefore, no conversion factor is incorporated into the associated formulae.
- ^c Dermal pathway adjustment factors provided by Mr. Glenn Adams, USEPA Region IV Risk Assessment Section, personal conversation, July 13, 1993. Skin surface area values were provided by Ms. Sally Wiley, KDEP, Risk Assessment Section, personal conversation, July 13, 1993.
- ^d Absorption factor assumes 1.0 percent of organics and 0.1 percent of inorganic contaminants present in adsorbed soils will be absorbed by the exposed individual via the dermal contact pathway.

Figure 5.3 (continued)
Formulae for Calculating Carcinogenic and Non-carcinogenic Risk for
As Received Source Material

Risk (Hazard Index) Based on Combined Daily Absorbed Dose (Ingestion + Dermal Contact)

Non-Carcinogens

Hazard Index =

$$((C_s \times ((IF_{\text{source}/adj} \times 10^{-6} \text{ kg/mg} \times EF_R) / AT_{NC}) / (RfD_o))) + (C_s \times ((CF_{\text{source}/adj} \times 10^{-6} \text{ kg/mg} \times EF_R \times ABS) / AT_{NC}) / (RfD_o \times ADJ))$$

Carcinogens

Risk =

$$(C_s \times ((IF_{\text{source}/adj} \times 10^{-6} \text{ kg/mg} \times EF_R) / AT_C) \times (SF_o)) + (C_s \times (((CF_{\text{source}/adj} \times 10^{-6} \text{ kg/mg} \times EF_R \times ABS) / AT_C) \times (SF_o / ADJ)))$$

where:

| | | |
|-----------|---|--|
| C_s | Chemical concentration in source | <u>Default Values</u> |
| EF_R | Recreational exposure frequency (life stage weighted average) | Chemical-specific 112 days/year |
| AT_{NC} | Averaging time (non-carcinogen) | 3,360 days |
| AT_C | Averaging time (carcinogen) | 25,550 days |
| ABS | Absorption factor (unitless) | 0.01 (Organic Compounds) 0.001 (Metals) |
| RfD | Reference Dose (mg/kg/day) | Chemical-specific |
| SF_o | Slope Factor (mg/kg/day) ⁻¹ | Chemical-specific |
| ADJ | Administered to Absorbed Adjustment Factor | 0.8 Volatiles 0.5 Semivolatiles 0.2 Metals |

Risk Formulae Notes

Figure

Notes:

- ^a Reference: RAGS, Volume I, Parts A & B, and Risk Assessment Guidance for Superfund, Volume I-Human Health Evaluation Manual, Supplemental Guidance-Standard Default Exposure Factors-Interim Final, USEPA/OERR, OSWER Directive: 9285.6-03, March 25, 1991.
- ^b Absorbed doses for ingestion exposure are assumed to be the equivalent of administered doses (100% oral ingestion). Therefore, no conversion factor is incorporated into the associated formulae.
- ^c Dermal pathway adjustment factors provided by Mr. Glenn Adams, USEPA Region IV Risk Assessment Section, personal conversation, July 13, 1993. Skin surface area default values were provided by Ms. Sally Wiley, KDEP, Risk Assessment Section, personal conversation, July 13, 1993.
- ^d Absorption factor assumes 1.0 percent of organics and 0.1 percent of inorganic contaminants present in adsorbed soils will be absorbed by the exposed individual via the dermal contact pathway.

Figure 5.4

**Formulae for Calculating Carcinogenic and Non-carcinogenic Risk for As Received Salt Cake Fines
Fort Hartford Stone Quarry NPL Site
Olaton, Kentucky**

The following formulae for computing source material risk (carcinogenic and non-carcinogenic) were adapted from RAGS, Volume I, Parts A and B to account for Site-specific considerations.

Recreational User Scenario**Source Ingestion Pathway**Age-adjusted Ingestion Factor ($IF_{source/adj}$)

$$IF_{source/adj} \text{ (mg-yr/kg-day)} = \frac{IR_{source/age1-6} \times ED_{age1-6}}{BW_{age1-6}} + \frac{IR_{source/age7-31} \times ED_{age7-31}}{BW_{age7-31}}$$

where:

| | |
|-----------------------|---|
| $IF_{source/adj}$ | age-adjusted source ingestion factor (mg-yr/kg-day) |
| BW_{age1-6} | average body weight from ages 1-6 (kg) |
| $BW_{age7-31}$ | average body weight from ages 7-31 (kg) |
| ED_{age1-6} | exposure duration during ages 1-6 (yr) |
| $ED_{age7-31}$ | exposure duration during ages 7-31 (yr) |
| $IR_{source/age1-6}$ | ingestion rate of source age 1-6 (mg/day) |
| $IR_{source/age7-31}$ | ingestion rate of source age 7-31 (mg/day) |

Default Values

| |
|------------------|
| 110 mg-yr/kg-day |
| 16 kg |
| 70 kg |
| 6 years |
| 24 years |
| 200 mg/day |
| 100 mg/day |

Dermal Contact PathwayAge-adjusted Contact Factor ($CF_{source/adj}$)

$$CF_{source/adj} \text{ (mg-yr/kg-day)} = \frac{SA_{age1-6} \times AF \times ED_{age1-6}}{BW_{age1-6}} + \frac{SA_{age7-31} \times AF \times ED_{age7-31}}{BW_{age7-31}}$$

where:

| | |
|-------------------|--|
| $CF_{source/adj}$ | age-adjusted contact factor (mg-yr-event/kg-day) |
| SA_{age1-6} | skin surface area available for contact (cm ² /event) |
| $SA_{age7-31}$ | skin surface area available for contact (cm ² /event) |
| AF | source to skin adherence factor (mg/cm ²) |
| ED_{age1-6} | exposure duration during age 1-6 (yr) |
| $ED_{age7-31}$ | exposure duration during age 7-31 (yr) |

Default Values

| |
|-----------------------------|
| 2600 mg-yr-event/kg-day |
| 3730 cm ² /event |
| 3500 cm ² /event |
| 1 mg/cm ² |
| 6 yr |
| 24 yr |

VI. DESCRIPTION OF REMEDIAL ALTERNATIVES

In the previous section of this document, several risk scenarios were developed. Of these scenarios, contaminated ground water was unacceptable in every aquifer evaluated. The unacceptable scenario for surface water (springs and in-stream) is thought to be due to contamination exiting through seeps into the streams. Water of reaction with salt cake fines is also an unacceptable exposure route. Air was deemed to be an unacceptable exposure route by the method of modelling and comparison with standards.

A total of six alternatives were evaluated for remediating ground water (and consequently springs and surface water), as well as air. Some of these alternatives provided sufficient protection from water of reaction of salt cake fines. With the exception of Alternative 1 which involves no action, the alternatives are all varying combinations of air containment; ground water diversion from SCFs and discharge to Rough River; confirmatory monitoring of air, surface water and ground water; and institutional controls. Two of the alternatives involve excavation of the SCFs from the mine. Alternative 5 involves treating the SCFs via a proprietary process whereas Alternative 6 involves landfilling them. The alternatives are as follows:

Alternative 1: No Action

The National Contingency Plan (NCP) requires the development of a no-action alternative as a basis for comparison of alternatives. Therefore, remedial Alternative 1 consists of implementing no remedial action at the site, including no restriction of future access to the site and no site maintenance.

The Site would be left in its present condition and allowed to deteriorate. Because no action would be taken, there are no costs associated with this remedial alternative. There is also no implementation time.

Alternative 2: Institutional Controls & Deed Restrictions plus Continued Diversion, Treatment & Discharge of Intruding Mine Water

Alternative 2 consists of maintaining site security to prevent accidental exposure by trespassers, as well as deed restrictions to prevent future residential well installation. Diversion of water from SCFs in the mine would be continued with subsequent treatment and discharge to the Rough River. Treatment would continue to be sedimentation and reduction of ammonia content.

Discharge is under a Kentucky National Pollutant Discharge Elimination System (NPDES) permit.

Because this remedy would also result in contaminants remaining on-site, CERCLA requires a five-year review.

The present-worth cost of Alternative 2 ranges from 7.1 to 8.6 million dollars. Since Alternative 2 only involves continuing what has been going on at the site over the past several years, implementation time is considered zero.

Alternative 3: Alternative 2 plus Containment of Night Air Emissions via Portal Doors

Alternative 3 consists of all measures employed in Alternative 2 plus containment of night air emissions with doors on mine portals. Portals would only be open during daylight hours when atmospheric conditions would enhance the dispersion of fugitive ammonia emissions. Portal opening and closing would be on an automatic basis with manual override. Based on air quality data and emissions modelling, EPA feels that this measure should bring ammonia concentrations into compliance with KNREPC's 8-hour standard.

Continued diversion of ground water away from SCFs would ensure no additional ground water (and hence surface water) contamination or migration. This measure would also aid in controlling ammonia emissions.

The five-year review described in Alternative 2 would also be necessary for Alternative 3 since contamination would remain on-site for this remedial alternative as well.

The present-worth cost associated with this alternative ranges from 7.5 to 8.9 million dollars. Time to implementation is less than one year.

Alternative 4A: Alternative 2 plus Forced Ventilation of Mine Air to Two Dispersion Stacks

Alternative 4A consists of all measures employed in Alternative 2 plus permanently sealing off all portals to the mine and using fans to force mine air through two tall stacks. Emissions would be released at a height in the atmosphere where turbulent mixing would ensure adequate dispersion. Based on air modelling conducted during the FS, EPA feels confident that this alternative will meet KNREPC's 8-hour ammonia standard.

Continued diversion of ground water away from SCFs would ensure no additional ground water (and hence surface water) contamination or migration. This measure would also aid in controlling ammonia emissions.

The five-year review described in Alternative 2 would also be necessary for Alternative 4A since contamination would remain on-site for this remedial alternative as well.

This alternative involves extensive and possibly hazardous construction inside the mine. Workers would be at risk for injury or possibly death due to possible collapses and oxygen-deficient, high-ammonia content air.

The present-worth cost associated with Alternative 4A is between 8.9 and 10.3 million dollars. Time to implementation is four years.

Alternative 4B: Alternative 4A plus Acid Gas Scrubbers

Alternative 4B is identical to Alternative 4A with the addition of acid gas scrubbers to reduce ammonia emissions before discharge to the atmosphere. While EPA is certain that this alternative would comply with the KNREPC ammonia standard for air, as well as ground-water requirements, scrubbers would be unnecessary since amounts of ammonia projected to exit the stacks would be well within acceptable limits. This alternative involves the same hazard to workers as Alternative 4A.

Present-worth cost associated with Alternative 4B is between 13.7 and 15.2 million dollars. Time to implementation is four years.

Alternative 5: Alternative 2 plus Excavation of SCFs and Treatment with NARTEC

Alternative 5 employs all measures in Alternative 2 with the addition of excavation of SCFs and treatment with NARTEC, a proprietary chemical process for converting SCFs into stable, non-hazardous, and somewhat useful products. Ground-water and intruding mine water diversion via pumping and discharge would continue until all SCFs were removed from the mine. A dry system would also be employed to trap fugitive dust during excavation, since water sprays would react with the fines to form ammonia.

The by-products of the NARTEC process are several salts of which under 10% would be marketable. The remainder of the by-products would have to be landfilled.

The same risks and hazards of work in the mine discussed in Alternatives 4A and 4B would apply to this alternative.

This alternative would eventually meet all air and ground-water ARARs. Since no contaminants would remain on-Site for this alternative, no five-year review would be required under CERCLA.

The present-worth cost associated with Alternative 5 is 115 to 130 million dollars. Time to implementation is projected at 12 years.

Alternative 6: Alternative 2 plus Excavating and Landfilling the SCFs at an off-Site Location

Alternative 6 employs all measures taken in Alternative 2 with the addition of excavation and landfilling of SCFs. SCFs would be taken to an off-site landfill. Ground-water and intruding mine water diversion via pumping and discharge would continue until all SCFs were removed from the mine. In all probability, the large amount of waste at Fort Hartford would necessitate the creation of its own landfill. A dry collection system similar to the one in Alternative 5 would be employed for collecting fugitive dust emissions.

This alternative would involve the same extremely hazardous working conditions as those found in Alternatives 4A, 4B, and 5.

Since all of the SCFs would be removed from the site, all air and ground-water standards should eventually be met. Consequently, no five-year review would be required by CERCLA.

The present-worth cost associated with Alternative 6 is 75 million dollars. Time to implementation is 12 years.

VII. COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

A detailed comparative analysis was performed on the six remedial alternatives developed during the FS and the modifications submitted during the public comment period using the nine evaluation criteria set forth in the NCP. The advantages and disadvantages of each alternative were evaluated in order to identify the alternative with the best balance among the nine criteria. Figure 7.1 provides a summary of the comparison between these alternatives.

Threshold Criteria:

A. OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

This criterion addresses whether or not an alternative provides adequate protection and describes how risks are eliminated, reduced, or controlled through treatment and engineering or institutional controls.

Alternative 6 is estimated to be protective for air since all SCFs would be removed and hence, no more ammonia generated. Ground-water, surface water and springs are expected to be in compliance with health-based levels for the COPCs within the next year or two due to continued diversion, treatment and discharge of mine water. Alternative 5 should theoretically provide the same protection as Alternative 6 since SCFs will also be removed for this alternative. As with Alternative 6, ground-water, surface water and springs are expected to near health-based levels within the next year or two due to continued diversion, treatment and discharge of mine water.

Alternatives 4A and 4B will ensure that the applicable or relevant and appropriate requirements (ARARs) for air are met and consequently that human health and the environment is protected. This will be done by sealing off the mine and ducting ammonia-laden gas out high stacks where adequate turbulent mixing and dispersion can occur. Conservative modelling of ammonia concentrations estimates that even Alternative 4A (without the scrubber in 4B) will have no problems meeting these levels. It is for this reason that Alternative 4B was dropped out early in the FS. Ground-water, surface water and springs will near compliance with health-based levels within the next year or two due to continued diversion, treatment and discharge of mine water.

Alternative 3 should be protective for the air pathway. Based on air modelling conducted during the FS, EPA feels that the portal doors could be effective, however, the performance of this

alternative would only be known upon implementation since all estimates are based on models and the site conditions are quite unique. The continued ground-water diversion, treatment and discharge will work to make levels in ground water, surface water and seeps come into compliance with health-based standards within the next year or two.

Alternative 2 is not estimated to be protective for the air pathway, since no air control measures are employed. As stated previously, levels of ammonia and site contaminants in mine flumes have decreased dramatically to near-compliance levels. Ground water, surface water and seeps are nearly in compliance at the present and are expected to near compliance for health-based standards within the next year or two due to the continued water diversion and fines relocation measures.

Alternative 1 is not estimated to be protective of human health and the environment since it does not eliminate, reduce, or control risks by treating contamination in the environment.

B. COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

This criterion addresses whether or not an alternative will meet all ARARs or provide grounds for invoking a waiver. Each alternative was evaluated for compliance with ARARs, including chemical-specific, action-specific and location-specific ARARs. For a complete listing of all ARARs and "To be considered" (TBC) criteria, refer to Section IX of this document.

ARARs exist for the air medium. The ARAR which is currently and is projected to be continually exceeded if no action is taken is the KNREPC 8-hour standard of 0.4 mg/m³. The ground-water, surface water and seeps, the other unacceptable exposure routes in the Risk Assessment (Section V of this document), have no ARARs, only TBCs, or health advisory levels as follows:

| | |
|------------|---------------------------------|
| Ammonia: | 34 mg/l (health advisory level) |
| Chlorides: | 250 mg/l (secondary MCL) |
| Aluminum: | .05 - .2 mg/l (secondary MCL) |

The actions taken in each alternative will cause Alternatives 4A, 4B, 5 and 6 to meet the KNREPC 8-hour air ARAR. Alternatives 4A and 4B involve containment of ammonia emissions with release at adequate dispersion times. Since Alternatives 5 and 6 involve removal of the SCF (source) material, air standards would also be met.

Alternative 3's containment of emissions with night dispersion should meet the KNREPC air ARAR, but EPA can not be absolutely certain about the effectiveness of the portal system. For this reason, Alternative 4A has been combined with Alternative 3 as part of the selected remedy.

Alternative 2 will not meet air ARARs since no actions to address air are incorporated in this alternative. The same effectiveness for the ground-water and surface water TBCs applies for this remedy as does for Alternatives 3 through 6.

Alternative 1 will not meet air ARARs since no actions to address air are incorporated into this alternative either. Since mine flume diversion, treatment and discharge would be suspended for the site under this alternative, it is doubtful that TBCs for ground water and surface water would be met either.

Since Alternative 1 involves no action, it is conceivable that TBCs for ground water could be exceeded since the mine water diversion and SCF relocation actions which have been ongoing since the start of the RI would cease. However, as stated previously, the TBCs listed above for ground-water and surface water should be met within the next year or two by continuing the actions which have been ongoing at the Site. These actions would be continued for Alternatives 2, 3, 4A, 4B, 5 and 6.

Primary Balancing Criteria:

C. LONG-TERM EFFECTIVENESS AND PERMANENCE

This refers to the ability of an alternative to maintain reliable protection of human health and the environment over time, once cleanup objectives are met.

Alternatives 5 and 6 are certainly the most effective in the long-term since waste will be removed from the mine, thus eliminating the source of, and hence, air and ground-water concerns.

Alternatives 4A and 4B are highly effective in the long-term for air, even though source material will not be removed from the Site. Ducting ammonia-laden air to high stacks which will exit in the turbulent mixing layer of the atmosphere is a proven effective way of producing air which complies with ammonia ARARs.

Alternative 3 should be effective in the long term for air ARARs. Again, this method of air protection is not as proven as those in Alternatives 4A and 4B.

Alternatives 1 and 2 are not effective in the long term (or even the short term) for air concerns since neither includes measures for addressing this media.

Alternatives 2 through 6 are all effective in meeting and maintaining health-based TBCs for ground water and surface water, as explained previously in this section. Since Alternative 1 involves discontinuing current mine flume diversion from SCFs, treatment and discharge, it would not be effective for either obtaining or maintaining health-based TBCs.

D. REDUCTION OF TOXICITY, MOBILITY OR VOLUME THROUGH TREATMENT

This section discusses the anticipated performance of the treatment technologies an alternative may employ. The degree of reduction of toxicity, mobility or volume through treatment varies depending on the methods of contaminated air handling and water diversion from SCFs involved.

For the air media, Alternatives 5 and 6 will halt the entry of any ammonia gas in the air by removing the source, thus reducing mobility and volume of gaseous emissions from the Site. Alternatives 4A and 4B will and Alternative 3 should disperse the ammonia to a height where acceptable isopleths are created, thus reducing the mobility and volume of contaminated gas. Alternatives 1 and 2 do not reduce the toxicity, mobility or volume of ammonia in the air.

For ground water and hence springs and surface water, Alternatives 2 through 6 will halt the spread of any ground-water contamination and gradually bring levels to those acceptable under health advisories. Alternative 1 will not act to decrease the toxicity, mobility, or volume. In fact, by ceasing the mine flume diversion and treatment, ground-water, spring and surface water concentrations could again increase.

E. SHORT-TERM EFFECTIVENESS

This involves the period of time required to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup objectives are achieved. The following factors were used to evaluate the short-term effectiveness of each alternative: protection of the community during remedial actions, protection to workers during remedial actions, environmental impacts from implementation of alternatives, and the time until remedial action objectives are met.

With respect to the community, Alternatives 3, 4A and 4B do not pose additional risks or nuisances to the community. Alternatives 1 and 2 pose no risks over those that already exist. The excavation involved in Alternatives 5 and 6 would undoubtedly result in a large amount of fugitive dust generation which even if controlled could be a community concern. Alternatives 5 and 6, especially Alternative 6, would involve frequent truck traffic from the site through residential areas for an estimated 12 years each. This would be expected to create an extreme nuisance to the community.

Short-term protection for Alternatives 5 and 6 is not good since they take 12 years to implement. Potential for ammonia emissions will still exist during this time, along with fugitive dust. Alternatives 4A and 4B are better in that they only take four years to achieve protection and fugitive dust should not be a problem. If Alternative 3 performs adequately, which EPA feels it should, protection will be achieved in one year. Short-term protection is a good balance with time and effectiveness for Alternative 3. While protection is only partial and non-existent for Alternatives 2 and 1, respectively, their objectives could each be met with no implementation time.

Risks to workers for Alternative 1 are non-existent, minimal for Alternative 2, more so for Alternative 3 and appreciable for Alternatives 4A and 4B. Alternatives 4A and 4B would involve extensive and possibly hazardous construction inside the mine. Alternatives 5 and 6 are both extremely dangerous for workers. Injuries and even fatalities would not be uncommon due to conditions under which imminent collapse could occur and low oxygen, high ammonia air.

F. IMPLEMENTABILITY

This is the technical and administrative feasibility of an alternative, including the availability of goods and services needed to implement the solution.

Alternatives 1 and 2 are very feasible since they involve no action and continuing what is currently working at the Site. While Alternative 3 will involve fitting doors to irregular mine portals and installing an automated system for closing and opening them, it should not present any difficult implementation problems.

Alternatives 4A and 4B would present implementation problems. As a result of the hazardous mine working conditions, workers would be required to wear Level B protection. Work could be quite

difficult under these conditions. In addition to everything mentioned previously, the mine is dark and has many limestone blocks to trip a worker and make it inaccessible to vehicles and equipment. Workers would have to be tethered to the outside of the mine with air supply lines as potentially fatal levels of ammonia exist inside the mine.

Alternatives 5 and 6 are both equally dangerous and more so than 4A and 4B since SCFs would have to be excavated from every remote corner of the mine. More man-hours would be spent in the mine under conditions of even greater hazard.

G. COSTS

Cost include capital costs as well as operation and maintenance costs and is presented in present value. This evaluation examines the estimated costs for implementing the remedial alternatives. The estimated present-worth value of each alternative is as follows:

| | |
|-----------------|------------------------|
| Alternative 1: | \$0 |
| Alternative 2: | \$7.1 to 8.6 million |
| Alternative 3: | \$7.5 to 8.9 million |
| Alternative 4A: | \$8.9 to 10.3 million |
| Alternative 4B: | \$13.7 to 15.2 million |
| Alternative 5: | \$115 to 130 million |
| Alternative 6: | \$75 million |

Modifying Criteria:

H. STATE ACCEPTANCE

This indicates whether, based on review of the RI report, FS report, and Proposed Plan, U.S. EPA and KNREPC agree on the preferred alternative. EPA and KNREPC are in agreement on the selected alternative. Appendix A of this document contains a letter of concurrence from KNREPC.

I. COMMUNITY ACCEPTANCE

This indicates the public support of a given alternative. This criterion is addressed in the *Responsiveness Summary*, Appendix B to this document. The community accepts the selected remedy.

Figure 7.1
Comparative Analysis of Remedial Alternatives

| Criteria | Alternative 1 No Action | Alternative 2 Institutional Controls/ Pump, Treat Intruding Water | Alternative 3 Institutional Controls and Containment of Night Air Emissions/ Pump, Treat Intruding Water | Alternative 4a Forced Ventilation of Mine Air/ Pump, Treat Intruding Water | Alternative 5 Excavate, Treat SCFs with NARTEC Process/ Interim Engineering Controls on Air Emissions and Groundwater | Alternative 6 Excavate, Landfill SCFs at Offsite Location/ Interim Engineering Controls on Air Emissions and Groundwater |
|---|----------------------------|---|--|---|---|--|
| Overall Protection of Human Health and the Environment | | | | | | |
| — Direct Contact/SCFs Ingestion | Not protective. | Institutional controls effectively eliminate the risk of direct human contact with SCFs. | Same as Alternative 2. | Same as Alternative 2. | Risk of direct human contact with SCFs and ingestion of SCFs dust is increased during the 10 - 12 year period of excavation and removal of SCFs from the mine. After treatment, contact with oxides residuals is prevent through institutional controls. | Risk of direct human contact with SCFs and ingestion of SCFs dust is increased during the 10 - 12 year period of excavation and removal of SCFs from the mine. After the material is landfilled, the risk associated with direct contact with SCFs is eliminated as long as the landfill is maintained. |
| — Groundwater Ingestion by Future Onsite Residents | Not protective. | Protective. Exposure is prevented until restoration of groundwater can occur. | Same as Alternative 2. | Same as Alternative 2. | Same as Alternative 2. | Same as Alternative 2 onsite. The landfill will prevent the contamination of groundwater as long as it is maintained. |
| — Exposure to Airborne Ammonia Emissions | Not protective. | A small area offsite carries the potential for acute exposures to ammonia in air for 10 to 20 years. | Protective. | Same as Alternative 3. | Same as Alternative 3. | Risk of fugitive ammonia and dust emissions at the landfill. |

Notes:

SCFs = Salt Cake Fines
 RARE = Applicable or Relevant and Appropriate Requirements
 CL = chloride
 AlN = aluminum nitride
 NH₃ = ammonia
 O&M = Operation and maintenance

VIII. SELECTED REMEDY

Based upon consideration of the requirements of CERCLA, the NCP, the detailed analysis of alternatives and public and State comments, EPA selected a remedy involving source control, ground-water diversion, and air containment for the Site. At the completion of this remedy, the risk associated with this Site has been calculated at 10^{-6} which is determined to be protective of human health and the environment. The total present-worth cost of the selected remedy, a combination of Alternatives 3 and 4A, is estimated at 8.9 to 10.3 million dollars. Costs will be at the higher end of this range should measures for Alternative 4A (discussed below) be necessary.

A. SOURCE CONTROL

Source control will address the SCF material remaining in the mine. Since the source material at Fort Hartford only can migrate when reacted with water, the main objective for source control at Fort Hartford is keeping the SCFs as dry as possible.

The selected remedy includes continuing surveillance in the mine to determine new areas of moisture such as new breakthroughs, etc.. Any new breakthroughs or sinkholes would quickly be repaired. It also includes SCF relocation measures to dryer areas and water diversion within the mine away from the SCFs. These measures have been ongoing since 1990 and have been quite successful in containing the source material and the spread of any of its related constituents to the ground-water (and hence springs and surface water) or air pathways.

The plan for source control is to continue what has been done over the past four years with a few enhancements to make it even more effective. Although the majority of SCFs have been moved from high-moisture areas, SCFs will be moved on an as-needed basis to prevent contact with moisture, including high humidity. The water diversion pumping system used in the past will be upgraded to a more permanent, automated system which has the feature of being accessible from the outside of the mine. This is due to new sumps being installed from the ground surface to natural low points of the mine floor. It is anticipated that approximately six to eight sump pumps will be necessary to remove water from various areas of the mine. The exact locations of the sumps will be determined during in-mine surveys conducted during remedial design.

Treatment and discharge will be under a new KNREPC permit. Treatment will be for ammonia and sediment suspended in the mine

flumes. Discharge will be to the Rough River, as in the past.

B. GROUND-WATER REMEDIATION

Source control is expected to nearly eliminate reaction of SCFs with water, thereby allowing natural attenuation processes to act in reducing contaminant levels in the ground water (and hence springs and surface water) to health-based TBCs stated in Section IX of this document.

Treatment of diverted mine flumes will continue to be for ammonia via an air stripper or some other type of ammonia reduction system if a better one is developed prior to RD. This would be followed by sedimentation.

Monitoring will be performed semi-annually for ground-water, surface water and springs to gauge the progress of attenuation and restoration.

Performance Standards

1. Monitoring Locations and Parameters for Assessing Effectiveness of Reduction to Health-based Levels

Parameters:

Locations:

Full TCL/TAL list

- SCF-impacted ground-water monitoring wells used in the RI with supplementary sampling at other RI wells
- SCF-impacted seeps used in the RI plus supplementary sampling at other RI points
- SCF-impacted surface water points used in the RI plus supplementary sampling at other RI points
- selected residential wells monitored in the RI

2. Treatment Standards

Treatment standards for the mine flumes before discharge to the Rough River are specified in the KPDES permit.

3. Discharge Standards

Discharges from the ground-water and seep treatment system shall comply with all ARARs, including, but not limited to,

requirements of the National Pollutant Discharge Elimination System (NPDES) permitting program under the Clean Water Act, 33 U.S.C. {1251 et seq.} and all effluent limits established by EPA, as well as Kentucky Surface Water Quality Standards.

4. Design Standards

The design, construction and operation of the treatment system shall be conducted in accordance with all ARARs. Design will also be performed in an effort to minimize all environmental impacts to terrestrial and aquatic habitats in the area.

5. Other Standards

Section IX of this document lists all other Applicable or Relevant and Appropriate Requirements (ARARs) and "To Be Considered" (TBC) health-based guidelines pertaining to this remedial action at the Fort Hartford Site.

C. AIR REMEDIATION

As stated previously in this section, the selected remedy involves a combination of Alternatives 3 and 4A from the FS. Should the portal doors in Alternative 3 fail to meet EPA's expectations, the measures in Alternative 4A (i.e., sealing off the mine and ducting emissions to high stacks) will be employed. While EPA feels confident that the measures in Alternative 3 should work, it chose to combine Alternatives 3 and 4A so that if the five-year-review shows that the portal doors are not performing to EPA's expectations, the mine will be sealed off and emissions ducted via a forced air ventilation system to high stacks as stated in Alternative 4A. As stated in Section VII (Comparison of Alternatives) of this document, while the effectiveness of the high stacks can be guaranteed, the construction involved for Alternative 4A is extremely hazardous to workers. Hopefully, contingency measures will not be necessary, thus avoiding the unsafe worker conditions inherent in Alternative 4A.

Performance Standards

1. Ambient Air Standards

| | |
|--------------------------------|-----------------------|
| KNREPC 8-hour standard: | 0.4 mg/m ³ |
| EPA 24-hour standard: | 0.4 mg/m ³ |
| EPA annual (chronic) standard: | 0.1 mg/m ³ |

2. Design Standards

The design, construction and operation of the portal door system and the high stack and forced air system shall be constructed in accordance with all ARARs. Design will be performed in an effort to minimize impacts to terrestrial and aquatic habitats in the area.

3. Monitoring

Monitoring will be conducted semiannually and will consist of 24-hour ammonia monitoring for a 30-day period.

4. Other Standards

Section IX of this document lists all other ARARs and TBCs pertaining to this remedial action at the Fort Hartford Site.

D. COMPLIANCE TESTING AND MONITORING

No later than five years from the date of commencement of remedial construction, a five year review will be completed for the Fort Hartford Site since waste remains on-Site. Five year reviews regularly occur after the first five-year-review at intervals of no greater than five years.

Semi-annual ground-water, seep and surface water monitoring will be performed for the parameters listed above under *Monitoring Locations and Parameters for Assessing Effectiveness of Reduction to Health-based Levels* (page 2 of this Section) beginning with the date of construction completion. If EPA is satisfied that concentrations have come into compliance with health-based levels and have been maintained for an acceptable time, EPA may decide that it is permissible to conduct monitoring on a less frequent basis. Air monitoring will also be performed on a semi-annual basis to insure that levels of ammonia in the ambient air are compliant with those set forth under *Air Remediation, Performance Standards, Ambient Air* in this Section. When levels reach acceptable values, it will also be at EPA's discretion to decrease monitoring frequency.

At the time of the first or any five-year-review, EPA will evaluate semi-annual air and water monitoring, along with all ARARs and TBCs in part IX of this document. This review will be conducted to determine if the source control component and

natural attenuation are functioning effectively to reduce contaminants in ground water, seeps and surface water to acceptable health-based levels and also to insure that these contaminants are not migrating to nearby residences. The first five-year review will also determine if the portal doors for Alternative 3 are functioning effectively enough to reduce ammonia levels in ambient air to those ARARs discussed earlier and in Section IX.

EPA will evaluate five-year reviews for ground-water, spring and surface water concentrations to insure that they are not increasing or moving close to residences in the area. Should a five-year review reveal any other inadequacies for the *Source Control* component of this section, EPA will reevaluate the effectiveness of the source control component and may make recommendations to improve its capabilities.

IX. STATUTORY DETERMINATIONS

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that achieve adequate protection of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that when complete, the selected remedial action for this Site must comply with applicable or relevant and appropriate environmental standards established under federal and State environmental laws unless a statutory waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity or mobility of hazardous wastes as their principle element. The following sections discuss how the selected remedy meets these statutory requirements.

A. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy protects human health and the environment by preventing moisture from contacting SCFs inside the mine. This, together with natural attenuation, prevents migration of any contaminated ground water in the plume beneath the surface or in springs and surface water.

The selected remedy also contains two measures for containing ammonia-laden air coming from the mine. The first measure involves installing doors to seal off the portals during night hours and open them during day hours when adequate dispersion and mixing conditions exist to move emissions from ground level into the upper atmosphere. Should this first measure not produce compliant isopleths (lines of constant concentration) for ammonia about the site and surrounding areas, then a contingency measure in the remedy will be employed. The secondary or contingency measure in this ROD for air involves permanently sealing off the portal doors (keeping the doors continually closed) and using forced ventilation to duct mine air to two dispersion stacks which would inject emissions into upper mixing layers of the atmosphere where adequate dispersion would definitely produce ambient air compliant with State and federal regulations previously outlined in this document.

Institutional controls and monitoring into perpetuity will insure that the public is not affected by the Site at a future time.

Implementation of the selected remedy should not pose any

unacceptable short-term risks or cross-media impacts to the Site, the workers or the community. Should the high-stack measures in this remedy be required, extreme caution will be taken while workers are in the mine as provided for in an EPA-approved Health and Safety Plan. Risks to the environment will be minimal.

B. ATTAINMENT OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS OF ENVIRONMENTAL LAWS

The selected remedy of source control via water diversion and fines relocation with discharge to Rough River as well as containment (and possibly ducting to a high stack) of air will comply with all applicable or relevant and appropriate chemical, action and location-specific requirements (ARARs). ARARs are presented below.

Action-Specific ARARs:

- * Clean Water Act Discharge Limitations NPDES Permit 40 CFR 122, 125, 129, 136; Pretreatment Standards 40 CFR 403.5. Prohibits unpermitted discharge of any pollutant or combination of pollutants into waters of the U.S. from any point source, including storm water runoff from industrial areas. Applicable.
- * Clean Water Act Wetlands Regulations, Part 404, CFR 230. Controls the discharge of dredged or fill materials into waters of the U.S. Applicable.
- * Occupational Safety and Health Standards (OSHA) 29 CFR 1910.1200. Employee right to know; information to on-site workers regarding chemicals they must work with. Applicable.
- * Department of Labor, Mine Safety Regulations, 30 CFR 11.150. Mining safety requirements regarding safety and health of personnel performing activities within the mine. Applicable.
- * 803 KAR Chapter 2. Kentucky supplement to OSHA "right to know" regulations. Applicable.
- * 401 KAR Chapter 30. Solid waste general administrative procedures. Applicable.
- * 401 KAR Chapter 47. Solid waste facility performance standards for protection of human health and

environment. Applicable.

- * 401 KAR 51, New Source Requirements relating to emissions from the mine during remediation. Applicable.
- * 401 KAR Chapter 63:022. Regulates new (installed after 11/11/86) sources (other than NESHAPS) emitting toxic pollutants, including ammonia. Applicable.
- * 401 KAR Chapter 1. Regulates transportation of hazardous materials. Applicable.
- * 815 KAR, Chapters 7, 10, 15, 20 and 35. Kentucky building codes applying to construction of on-site structures. Applicable.
- * 401 KAR Chapter 4. Requirements for water withdrawal from and construction in streams. None anticipated, but applicable.
- * 401 KAR Chapter 5. KPDES requirements and water quality standards. Applicable to discharge of intruding mine water to the Rough River.

Location-Specific ARARs:

- * Fish and Wildlife Coordination Act, 16 U.S.C. 661, 742a, 2901. Requires action to protect fish and wildlife from actions modifying streams or areas affecting streams. No stream impacts expected, but applicable.
- * Clean Water Act, Section 404 Pertaining to Wetlands, 33 U.S.C. Section 1251 et seq. Prohibits discharge of dredged or fill material into navigable waters without a permit. Applicable.
- * KRS 149, various chapters, 402 KAR Chapter 3. Forestry statute and regulations pertaining to on-site silvacultural activities. Applicable.

Chemical-Specific:

- * Safe Drinking Water Act MCLs, 40 CFR Sections 141.11 - 141.16. MCLs have been set for toxic compounds as enforceable standards for public drinking systems.

Secondary MCLs (SMCLs) are unenforceable goals regulating the aesthetic quality of drinking water. Relevant and appropriate as standards of protection for ground water that is a source or potential source of drinking water.

- * Safe Drinking Water Act, MCLGs, 40 CFR Sections 141.50 - 141.51. MCLGs (Maximum Contaminant Level Goals) are non-enforceable concentrations that are protective of adverse human health effects and allow adequate margin of safety. Relevant and appropriate since this ground water is a potential source of drinking water.
- * Clean Water Act (CWA) Water Quality Criteria. Criteria used by the State, in conjunction with a designated use for a stream segment. These are non-enforceable criteria both for protection of aquatic life and human health, by direct ingestion, or ingestion of aquatic organisms. Applicable to the quality of site surface water, especially discharges of metals, ammonia, and chlorides to the Rough River.
- * Clean Air Act (CAA) National Ambient Air Quality Standards (NAAQS), 40 CFR, Part 50.6. Sets primary and secondary standards for protection of public health from exposure to the "criteria pollutants," among which is respirable particulate matter, PM10. Applicable to particulate matter emissions from the mine.
- * Method for Determination of Particulate Matter, 40 CFR 50, Appendix J. Determination for the presence of particulate matter. Applicable.
- * USEPA Regulations on Ambient Air Monitoring, 40 CFR 53.22, 40 CFR 53.34. Test procedures for ammonia and particulate matter in air. Applicable to discharge of air contaminants and gaseous and particulate emissions from the mine.
- * KRS 224.320 and 330. Maintain a reasonable degree of purity of the air resources; limits the contaminants that may be emitted into the air in contravention of the emission standards or ambient air standards. Applicable.
- * 401 KAR 63:021. Regulates existing (as of 11/11/86) sources emitting toxic (other than NESHAP) air pollutants including ammonia gas. Applicable.

- * 401 KAR Chapter 53. Regulates particulate emissions. Ambient air quality standards; particulate emissions from the mine.
- * Kentucky Water Quality Standards, 401 KAR 5:031. Water quality criteria for protection of aquatic life, including free ammonia, chlorides, arsenic, and other metals. Applicable to Rough River discharge.
- * KRS 224.01-400. Regulates releases of hazardous substances (including ammonia) into the environment. Applicable.
- * 401 KAR Chapter 8, 401 KAR 5:037. Concerns ground-water protection. Applicable.

Other Criteria To-Be-Considered:

- * Executive Order 11988, Floodplain Management Policy. Sets forth policy for the protection of floodplains.
- * Executive Order 11990, Wetlands Protection Policy. Sets forth policy for the protection of wetlands. Applicable although wetlands on and adjacent to the Site were not shown to be impacted by Site constituents.
- * USEPA Ground-water Protection Strategy. Sets forth policy for the protection and classification of ground water regarding potential use as a drinking water source.
- * USEPA Drinking Water Health Advisories. Advisories based upon current understanding of toxicology of contaminants.

C. COST-EFFECTIVENESS

The selected remedy is cost-effective because it has been determined to provide overall effectiveness proportional to its costs, the net present worth value being between 8.9 and 10.3 million dollars. Other alternatives such as #5 and #6, which were determined to meet ARARs, were much less cost-effective. In addition to not meeting ARARs for the Site, the other alternatives are only partially protective.

D. UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES (OR RESOURCE RECOVERY TECHNOLOGIES) TO THE MAXIMUM EXTENT PRACTICABLE

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for the Fort Hartford Stone Quarry Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence, reduction of toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, and cost, also considering the statutory preference for treatment as a principle element and community input.

The selected remedy should be fairly easy to implement with the lowest cost and least risk to workers of the scenarios which would be protective of human health and the environment.

E. PREFERENCE FOR TREATMENT AS A PRINCIPLE ELEMENT

The remedy provides for treating water diverted from the mine for ammonia and sediment before discharge to Rough River. Five-year-reviews are also included. These provisions insure that the remedy will be evaluated at intervals of no less than five years starting from the date of construction commencement and, if it is not meeting the standards set forth in this Record of Decision, the remedy will be upgraded to meet those standards.

Appendix A

Letters from Support Agencies

PHILLIP J. SHEPHERD
SECRETARY



BRERETON C. JONES
GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
FRANKFORT OFFICE PARK
14 REILLY ROAD
FRANKFORT, KENTUCKY 40601

March 20, 1995

Harold W. Taylor
U.S. Environmental Protection Agency
345 Courtland Street, N.E.
Atlanta GA 30365

RE: Revised Draft Record of Decision
Fort Hartford Stone Quarry NPL site
Ohio County, Kentucky

Dear Mr. Taylor:

The Kentucky Division of Waste Management (KDWM) has reviewed the above document. Substantial changes have been made, and KDWM appreciates USEPA's demonstrated willingness to explore these areas and achieve mutual agreement. In view of these changes, KDWM concurs with the remedy this ROD proposes with the following reservations:

1) Concerning ecological risk, KDWM's interpretation of the data presented for the Rough River is different than that of USEPA. While USEPA has concluded that no additional risks are present due to site contaminants, KDWM does not agree with this interpretation. In addition, KDWM remains concerned that ground-level releases of air with high ammonia concentrations could impact the Davidson Wildlife Management Area. While USEPA has stated that the selected remedy does not add any additional risk to this area, KDWM suggests that Barmet be required to perform limited air sampling and ecological study to insure that such damage does not occur.

2) While it is clear that USEPA does not feel that soil sample methodology has biased the results of the site's Risk Assessment, KDWM feels that this should be confirmed through further sampling. It is possible that the act of compositing soil samples from a greater depth has had a dilution effect on whatever contaminants are present, potentially masking the effect this pathway might have on human health. The potential effect on site workers and possible future residents is unknown. While Barmet has stated their intent to restrict future development of this site, it is not clear that such intent constitutes long-term assurance that no development

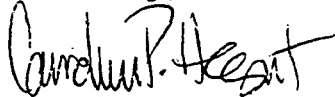
Mr. Taylor
Page two
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will take place. It is also unclear exactly what mechanism will be used to insure that the site remains undeveloped. If such assurances cannot be provided, it may be necessary for KDWM to obtain restrictions as may be applicable under KRS 224.01-400.

While KDWM does concur with USEPA regarding the necessity of the actions proposed in this ROD, we feel that the above reservations need to be addressed. To accomplish this, USEPA may wish to consider the creation of an additional Operable Unit for this site. KDWM feels that these issues could be addressed in a manner that is not time- or cost-intensive, one that could eliminate further environmental and human health concerns.

Thank you for your consideration of these comments. If you have any questions or concerns, please feel free to call Eric Liebenauer at (502) 564-6716.

Sincerely,



Caroline P. Haight P.E., Director
Division of Waste Management

c: Jeff Pratt
Rick Hogan
Randy McDowell

CPH/JP/RH/EL/el

Appendix B
Responsiveness Summary

APPENDIX B

FORT HARTFORD STONE QUARRY NPL SITE
RESPONSIVENESS SUMMARY

A. OVERVIEW

When the public comment period began, EPA had selected a preferred alternative for the Fort Hartford Stone Quarry Site in Olaton, Kentucky. EPA's preferred alternative addressed the air and ground-water/spring and surface water contamination problems at the Site. The preferred alternative involved continued diversion of intruding mine water away from SCFs, SCF relocation to dryer areas of the mine, and treatment of mine flumes with subsequent discharge to Rough River. Air was to be addressed in a two-phased approach. Containment of air from the mine would be achieved at night via portal doors which would open during the daytime hours when conditions for adequate dispersion exist. Should phase I not be effective, the remedy called for permanently sealing off the mine and ducting the air via forced ventilation to two high stacks.

Judging from the comments received during the public comment period, the residents and city officials of Olaton would support the continued mine water diversion and treatment measures with two phased air containment, as outlined above and in the body of this document. In a letter dated December 13, 1994, the PRPs for the Fort Hartford Site expressed concern that the type of treatment for the mine water before discharge to the Rough River not be specified since technologies for ammonia removal are currently being reevaluated to ascertain which would be best for the Site. EPA feels that this is a practical suggestion and has only specified in the ROD that treatment be for ammonia and sediments, as it has been in the past.

These sections follow:

- * Background on Community Involvement
- * Summary of Comments Received During the Public Comment

Period and Agency Responses

- Part I: Summary and Response to Local Community Concerns
- Part II: Comprehensive Response to Specified Legal and Technical Questions

* Remaining Concerns

* Attachment: Community Relations Activities at Fort Hartford Stone Quarry

B. BACKGROUND ON COMMUNITY INVOLVEMENT

Community concern about the Fort Hartford site has been minimal. Most concerns center around obtaining access to city water lines. In the past, some citizens were interested in the stressed levels of vegetation from ammonia gases coming from the Site as well ammonia odors. Expedited response actions beginning in 1990 included water diversion, repairing all breakthroughs which were allowing ammonia to escape and other actions. These actions coupled with community outreach have eliminated these concerns. The majority of citizens and local officials in the area are aware of the Site, but have not expressed undue concern.

During interviews, residents and local officials expressed concern for private wells in the area, since approximately half of the residents in the area do not have access to city water. The homeowners would all like city water if hookups were available. It should be noted that contamination has not impacted and is not projected to impact any residential wells.

Although everyone interviewed knew about the Site's existence, no one except a few close neighbors considered the Site to be a problem. One neighbor not in the immediate vicinity of the Site was concerned about his well water since his infant had experienced intestinal problems. The water was tested, showing all levels within the acceptable range. It was determined that the child's problems were not Site-related.

City and County officials wanted to be kept informed about Site findings, as did the Site's neighbors.

The major concerns expressed during the remedial planning activities at the Fort Hartford Stone Quarry Site focused on the possible health effects from contamination at the Site. These concerns and how EPA addressed them are described below:

1. Several citizens living nearest to the Site expressed concerns about using their well water. Citizens questioned Barmet's contractor performing tests on their wells.

EPA Response: EPA informed citizens of past sampling events overseen by EPA which had revealed no impacts to residential wells in the area. Citizens were reassured that EPA would be overseeing Barmet's contractor in the field as well as evaluating all sampling results.

2. Local citizens were concerned about the effect the Site was having on property values.

EPA Response: EPA sympathized and said that it hoped that remedial activities at the Site would help bring the property values up.

3. Citizens expressed concerns about odors and stressed vegetation caused by ammonia gases emanating from the Site.

EPA Response: These conditions were corrected during expedited response actions which took place before the Remedial Investigation ever began. All known sinkholes and breakthroughs connecting to the mine (32 total) were repaired, while some portals were permanently shut. Water was diverted away from SCFs inside the mine. SCFs were also relocated to dryer areas of the mine to prevent ammonia formation. These actions coupled with community interviews as well as the RI kickoff meeting and fact sheet served to eliminate these concerns.

C. SUMMARY OF COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD AND AGENCY RESPONSES

The public comment period on the proposed plan for the Fort Hartford Stone Quarry NPL Site was held from November 3, 1994, to December 6, 1994. EPA held a public meeting on November 17, 1994, to present the proposed plan to the public. Comments received during this time are summarized below. Part I of this section addresses those community concerns and comments that are non-technical in nature. Responses to specific legal and technical questions are provided in Part II.

Part I - Summary and Response to Local Community Concerns

Comments Made During the November 17, 1994, EPA Public Meeting

For the detailed transcript of the public meeting, please consult

the administrative record for the Fort Hartford NPL Site.

1. A citizen requested that EPA define deed restrictions. He also wanted to know how to get in touch with EPA in the future.

EPA Response: EPA stated that deed restrictions varied from site to site but that here they would include statements placed on deeds at the local Courthouse. These statements would inform any potential buyer of the Site and related waste. EPA also stated that legislation could also be passed by the County forbidding wells to be installed on certain properties. EPA gave the gentleman a toll free number to call to speak with EPA personnel.

2. Several citizens and one local official stood up and expressed concern that ground-water contamination from the Site could be impacting their potable domestic wells. Another local official questioned if EPA had the funding or the authority to require the PRPs to pay for a water line for the area.

EPA Response: EPA's hydrogeologist, Bill O'Steen answered this question and showed several visual aids on the overhead projector in doing so. He stated that contamination had not migrated vertically to the depth of the residential wells. More importantly, residential wells are located sufficiently away from the Site laterally. He explained how EPA knows the velocity of the ground water and by the knowing the distance to the nearest home, a conservative time to reach residences could be calculated. This amount of time would be several hundred years if nothing was done in the remedial action. Mr. O'Steen also explained that no ground water would migrate past the Rough River to the north since the Rough River is a low point for the area.

Because no ground-water threat exists, EPA stated that the Superfund laws could not pay for or obligate PRPs to pay for a water line for the residents around the Site. Glenn Adams of EPA did, however, give some information on other programs within the agency which could possibly help the residents attain a water line.

3. A citizen questioned how EPA would know whether or not the air and ground water plumes were being contained and reduced in concentration and what would be done if they were not.

EPA Response: EPA stated that the ROD included monitoring measures biannually for ground water and air. EPA also explained the five-year review process: that since wastes were remaining

on-Site, EPA would be required to conduct a review at least once every five years beginning with the date of construction commencement. EPA stated that if the five year review revealed the need, the forced air ventilation and stack system would be installed and other ground-water measures could be employed.

4. A citizen asked whether or not dye traces could be used to ascertain pathways of ground-water contamination.

EPA Response: Mr. O'Steen stated that while dye traces are helpful in karst terrains and where faults and fractures exist, the effectiveness at Fort Hartford would be minimal since the areas in question are too deep and the dye would move too slowly. He also stated that an inordinately large amount of dye would have to be used at Fort Hartford.

5. A local official inquired whether any metals had been found in the ground water.

EPA Response: EPA responded that the only heavy metal found in somewhat high concentrations was arsenic which is a human carcinogen. All levels, however, were within acceptable standards.

6. Citizens asked who owned the Site and who the PRPs were.

EPA Response: EPA explained that Barmet was the main PRP and that they had entered into an agreement with Alcoa and the Bank of Louisville for financing Remedial Design and Remedial Action (RD/RA) at the Site.

7. A citizen expressed concern that the plan to contain ammonia emissions from the mine was only a temporary solution or "band aid".

EPA Response: EPA stated that at the current time the known alternatives were based on current technologies and the risks at the Site. Keeping the water away from the material and containing emissions is the best alternative technically and based on risks to workers.

8. A citizen asked about the NARTEC process in remedial alternative #5.

EPA Response: EPA explained how NARTEC worked and that it had been used mainly in Europe. The two places in the states where it was being tried did not have any definitive results in yet. The places in Europe were successful for NARTEC, however, based

on their rates, cleanup of Fort Hartford would take 20 years and be very costly. EPA also explained that about 80% of NARTEC's by-products would still need to be landfilled.

Part II: Comprehensive Response to Specified Legal and Technical Questions

Comments Made By PRPs in the December 13, 1994, Letter to EPA

The only legal and technical question received was in the December 13, 1994, letter to EPA from Barmet Aluminum. This letter can be found in the administrative record for the Fort Hartford Stone Quarry Site.

The PRPs agreed with EPA's selected remedy for the Site but wished for EPA to not specify the method of treatment for ammonia for the intruding mine water before discharge to Rough River. The FS specified a particular treatment system, namely air stripping in a packed aeration tower. Treatment is to assure that Ambient Water Quality Criteria (AWQC) for ammonia will not be exceeded in the Rough River from the discharge of the intruding mine water.

Barmet hoped that EPA would not specify the type of technology, thus allowing extra time before Remedial Design (RD) for more treatability studies to determine the optimal ammonia removal technology.

EPA recognizes that ammonia's chemical and physical properties do not render it easily removed by air stripping. Different types of air stripping, chlorination, and ozonation, along with other treatment technologies are being examined to determine the best method of ammonia removal in the mine flumes before RD. Should a technology prove more effective than air stripping, EPA will utilize it.

D. REMAINING CONCERNS

EPA is unaware of any remaining concerns.

**ATTACHMENT A - COMMUNITY RELATIONS ACTIVITIES AT MURRAY OHIO DUMP
SUPERFUND SITE**

Community relations activities conducted for the Fort Hartford Stone Quarry Site have included:

- * Distribution of an RI/FS kickoff fact sheet (December 1991)
- * Community interviews (June 1990 and August 1994)
- * An RI/FS kickoff public meeting (December 1991)
- * Distribution of a proposed plan fact sheet (November 1994)
- * A proposed plan public meeting in Olaton to record comments by the public, including potentially responsible parties (November 1994)
- * Phone calls to various members of the community throughout the RI/FS to address their various concerns