Per the Federal Facility Agreement for Iowa Army Ammunition Plant, Article X.B.1, the attached document is the final version of the submitted document.

TECHNICAL MEMORANDUM NO. 5
BASELINE ECOLOGICAL RISK ASSESSMENT
IOWA ARMY AMMUNITION PLANT

Introduction

The Omaha District of the U. S. Army Corps of Engineers (USACE) has directed MWH Americas, Inc. (MWH) to revise the Draft Baseline Ecological Risk Assessment (BERA) for the Iowa Army Ammunition Plant (IAAAP), outside Middletown, Iowa. The Draft Final BERA will address issues raised by the Army, regulatory agencies, and natural resource trustees. MWH was tasked with preparing a series of Technical Memoranda (TM) that constitutes the planning documents for this BERA. Four TMs have already been developed around the following topics:

1. Development of Assessment and Measurement Endpoints
2. Water and Sediment Data Collection
3. Development of Hazard Models and Ecological PRGs
4. Contaminant Screening Process

The fifth TM addresses three separate topics recommended by the United States Fish and Wildlife Services (USFWS) for inclusion in the Draft Final BERA. The USFWS recommendations were as follows:

- The explosives toxicity reference values (TRVs) published by the U.S. Army Center for Health Promotion and Preventative Medicine (USACHPMM) be used for the risk calculations for Indiana bat.

- Critical aquatic sediment and surface water concentrations be derived for the mammalian and avian receptors in the aquatic conceptual model.

- The Indiana bat be considered as an ecological receptor in the terrestrial conceptual model.

In response to the USFWS recommendations, the Army prepared three e-mailed memoranda detailing how each of the recommendations will be implemented in preparing the Draft Final BERA. The Army received further comments from the USFWS regarding the procedures detailed in the memoranda. Two conference calls were held on April 26th and 27th, 2004 to discuss USFWS comments and reach consensus regarding the procedures. The attendees on the conference calls with their affiliations are listed below:

Rodger Allison	:	Iowa Army Ammunition Plant
Steve Bellrichard	:	Iowa Army Ammunition Plant
Kevin Howe	:	US Army Corps of Engineers
Randy Sellers	:	US Army Corps of Engineers
Terry Walker	:	US Army Corps of Engineers
Lia Gaizick	:	USACHPPM

Roger Walton	:	US Army Environmental Center
Pinaki Banerjee	:	MWH
Mike Kierski	:	MWH
Melenie Mutchler	:	MKM
Scott Marquess	:	US Environmental Protection Agency
Mike Coffey	:	USFWS
Ginger Molitor	:	USFWS
Dan Cook	:	Iowa Department of Natural Resources

The procedures agreed to by the attendees for addressing each of the three topics are presented below.

SELECTION OF TOXICITY REFERENCE VALUE FOR INDIANA BAT FOR EXPOSURE TO EXPLOSIVES

The TRVs used in the BERA are based on protection of receptors at the community level. The Lowest observed Adverse Effects Level (LOAEL) or the No observed Adverse Effects Level (NOAEL) based TRVs were selected from studies that used reproduction or growth as endpoints. However, for an Indiana bat, a threatened and endangered species, protection at the individual level may be desirable. Studies that generate TRVs based on protection of individuals are not readily available. USACHPPM. (2000) conducted studies with explosives, such as TNT and RDX, to determine ED10 (an effect or response in 10% of the population) and LED 10 (95% lower confidence limit for not exceeding a benchmark response) values. The study data used to calculate the values were based on changes in body weight, hemoglobin, and hematocrit in dogs. These were determined to be the most sensitive endpoints and may be ecologically significant to sensitive species. The USACHPPM derived ED 10 value of 0.2 mg/kg-d for TNT is proposed for use as the TRV in the hazard quotient (HQ) calculation for the endangered Indiana bat in the Draft Final BERA.

The ED10 value for RDX in the USACHPPM study was found to be 1.19 mg/kg-d. The NOAEL value used in the BERA for RDX was 1.38 mg/kg-d. Because the two values are comparable, the NOAEL and LOAEL based TRVs for RDX will be used in the Draft Final BERA.

PROCEDURE FOR CALCULATING SURFACE WATER AND SEDIMENT CRITICAL CONCENTRATIONS

The BERA will be revised to add critical concentrations (CC) of contaminants of potential ecological concern (COPEC) to Indiana bat and Belted kingfisher from exposure to constituents in surface water and sediment. The CCs are to be used as a management tool by the risk managers for making remedial decisions. The CCs are not meant to be used as clean-up goals, but are rather one line of evidence to be used to evaluate if a site poses a potential risk to ecological receptors.

Critical Concentrations are COPEC concentrations that may pose a risk to a specific receptor. The CCs are calculated analyte concentrations in surface water and sediment that equate to a LOAEL based HQ of one. The LOAEL based CCs will be back calculated based on the dose models presented as Equations 2 and 5 in Section 3.3 of the Draft BERA. For each analyte, exposure doses are set equal to the LOAEL based TRV and solved for Cw-j or Cse-j, which represents the COPEC concentrations in surface water and sediment, respectively. The resulting CC values are the COPEC concentrations that correspond to LOAEL based HQ of one for Indiana bat and Belted kingfisher.

Exposure to surface water or sediment, containing COPECs at or below the LOAEL based CCs, should not result in unacceptable levels of risk to ecological receptors. Further evaluation will be conducted for constituents with LOAEL based HQs exceeding one. No observed Adverse Effects Level (NOAEL) based CCs will be calculated for such constituents to provide risk managers with additional information regarding sensitivity of the HQ estimates. The ED 10 value of 0.2 mg/kg-d and LOAEL value of 8 mg/kg-d determined in the USACHPPM study for TNT will be used for calculating CCs for Indiana bat. Tables will be presented with range of risk estimates calculated based on LOAEL and NOAEL (ED10 for TNT for Indiana bat) based TRVs for some of the COPECs (when HQs exceed one based on LOAEL based TRVs).

Calculation of Surface Water CC

1) *The following equation will be used for Belted kingfisher:*

$$CC_{w\text{-}j} = \frac{TRV \times BW}{IR_w + IR_f \times P_f \times BAF_{fish}}$$

where,

$CC_{w\text{-}j}$	=	Critical concentration of COPEC (j) in water, mg/L
IR_w	=	Ingestion rate of water, L/d
IR_f	=	Ingestion rate of food, kg/d
P_f	=	Fraction of fish ingested as proportion of total food intake, unitless
BW	=	Body weight, kg
BAF_{fish}	=	Bioconcentration factor (water-to-fish)

The Kingfisher's food consumption consists of 2% sediment and 98% fish. Calculation of CCs in water will be based on the assumption that COPEC concentration in fish tissue is bioaccumulated from COPEC concentration in water and that contaminants in sediment do not contribute to the bioaccumulation in fish tissue. Also, COPEC concentrations in sediment will not be considered for calculating surface water CC. Values for all parameters in this and all other equations are as listed in the Draft BERA.

2) The following equation will be used for Indiana bat:

$$CC_{w\text{-}j} = \frac{TRV \times BW}{IR_w + IR_f \times P_{insect} \times BAF_{aq-inv}}$$

where,

P_{insect} = Fraction of insect ingested as a proportion of total diet, unitless

$BAF_{aq\text{-}inv}$ = Bioaccumulation factor (water-to-aquatic invertebrate)

For calculating water CC, it is assumed that food consumption for Indiana bats consists of 100% aquatic invertebrate. To calculate surface water CC, COPEC concentrations in sediment will not be considered. The selected surface water CC will be the lower of the CCs calculated for Belted kingfisher and Indiana bat.

<u>Calculation of Sediment CC</u>

For calculating sediment CCs, COPEC concentrations in water will not be considered. The selected sediment CC will be the lower of the CCs calculated for Belted kingfisher and Indiana bat.

1) The following equation will be used for Belted kingfisher:

$$CC_{se\text{-}j} = \frac{TRV \times BW}{IR_f \times P_{se} \times CF_{se}}$$

where,

$CC_{se\text{-}j}$ = Critical concentration of COPEC (j) in sediment, mg/kg

P_{se} = Fraction of sediment ingested as a proportion of total food intake, unitless (as proportion of food ingested)

CF_{se} = Conversion factor (sediment dry weight to wet weight), (mg/kg wet sediment)/(mg/kg dry sediment)

2) The following equation will be used for Indiana bat:

$$CC_{se\text{-}j} = \frac{TRV \times BW}{IR_f \times P_{insect} \times BSAF_{aq-inv}}$$

<u>DEVELOPMENT OF DOSE MODEL FOR INDIANA BAT EXPOSURE VIA TERRESTRIAL PATHWAY</u>

Remedial management decisions at IAAAP are expected to be made for individual areas of concern (AOCs). Risk estimates developed for each AOCs may be used as a management tool for making such decisions. The proposed dose model for the Indiana bat is focused towards developing risk estimates for exposure to COPECs in soil at each AOC. A revised Conceptual Site Model (CSM) and the ecorisk pathway for Indiana bat are presented in Figures 1 and 2.

Indiana bat's diet consists of 100% flying insects. USACE (2001) notes that Indiana bat eats both aquatic and terrestrial insects. The exposure dose model for the Indiana bat via the aquatic pathway was developed based on the assumption that it exclusively consumes aquatic insects. Similarly, for development of exposure dose model via the terrestrial pathway, it will be assumed that Indiana bat only consumes terrestrial insects. This approach allows evaluation of exposure to Indiana bat from COPECs in soil at particular AOCs.

The proposed exposure dose model for Indiana bat as a terrestrial insectivore may be expressed as:

$$E_j = (IR_w \times C_{w\text{-}j})/(BW) + [(IR_f \times P_{terr\text{-}insect} \times C_{terr\text{-}insect\text{-}j})/(BW)] \times AUF$$

Where,

E_j	=	Exposure dose from COPEC (j), mg/kg/d
IR_w	=	Ingestion rate of water, L/d
$C_{w\text{-}j}$	=	COPEC concentration (j) in water, mg/L
IR_f	=	Ingestion rate of food, kg/d
$P_{terr\text{-}insect}$	=	Fraction of insect ingested as a proportion of total diet, unitless
$C_{terr\text{-}insect\text{-}j}$	=	COPEC concentration (j) in aquatic insect, mg/kg
BW	=	Body weight, kg
AUF	=	Area use factor

The COPEC concentrations in terrestrial insects will be estimated using the following equation:

$$C_{terr\text{-}inv\text{-}j} = C_{s\text{-}j} \times BAF_{terr\text{-}inv}$$

Where,

$C_{terr\text{-}inv\text{-}j}$	=	COPEC concentration (j) in terrestrial invertebrate, mg/kg
$C_{s\text{-}j}$	=	COPEC concentration (j) in soil, mg/kg
$BAF_{terr\text{-}inv}$	=	Bioaccumulation factor (soil-to-terrestrial invertebrate), (mg/kg dry tissue)/(mg/kg dry soil)

Soil-to-terrestrial invertebrate bioaccumulation factor (BAF) values account for uptake of COPECs from soil by terrestrial invertebrates. Significant uncertainties are associated with empirical models that could describe the soil to plant to insect uptake of food that is partly obtained from soil and partly obtained from plants. Literature that specifically provides values (or approach for estimation) for uptake of chemicals from soil by flying terrestrial insects is not available. As a conservative approach, the soil-to-terrestrial invertebrate BAF values will be used. $BAF_{terr\text{-}inv}$ values are primarily developed based on uptake by worms, which is expected to overestimate uptake compared to those by flying insects because worms are in contact with the soil during 100 % of their life cycle. The procedure to estimate $BAF_{terr\text{-}inv}$ values was provided in Section 3.5 of the Draft BERA.

Uncertainties related to using the soil-to-worm based BAF values will be discussed in the Draft Final BERA as a sensitivity analysis. The sensitivity analysis will evaluate exposure parameters such as TRV and BAF. Range of HQ estimates will be presented for COPECs for which the HQs exceed one when literature based BAFs are used. The HQ values estimated based on the literature-based BAF values represent the upper end of the risk estimates. Concentrations of selected constituents in soil and flying insects were monitored at the Savanna Army Depot in Illinois and Badger Army Ammunition Plant in Wisconsin. Available data from these sites will be reviewed to determine BAF values for the insects. Risk estimates will be developed based on these measured values, when available, to represent HQ estimates that are less conservative than those based on BAF values developed using soil to worm model. Tables will be presented with range of risk estimates calculated for some of the COPECs with two BAF values, one based on the soil to worm model and the other BAF value based on measured insect concentrations.

The Indiana bat is expected to drink water at the rate of 0.0012 L/day (as listed on Table 3-2 in the Draft BERA). Receptors at specific AOCs may also receive intake of COPECs through ingestion of water. The exposure point concentrations of each COPECs in the watershed in which the specific AOC is located will be used to estimate exposure dose.

IAAAP (2003) discusses foraging and roosting behavior of Indiana Bat at the IAAAP. The Indiana bats were found primarily foraging along edges of agricultural fields, along and in the floodplain of the water bodies, and in forested areas around headwaters of the surface water bodies. The bats were found to spend some time around a stone quarry, although it is not clear if they are foraging or roosting in that area. Some of the bats were found to fly across an open field, but not forage there. The bats were not specifically found to forage near the production lines. The nature and extent of contamination around the production lines are limited to areas close to the lines that are not forested. Based on the foraging and roosting characteristics described in IAAAP (2003), the bats are not expected to forage around the AOCs. However, as a conservative approach, it is assumed that the bats are foraging in the AOCs.

The IAAAP is a 19,000-acre facility. The AOCs, and therefore, soil contamination by COPECs, cover only a small portion of the site. An Indiana bat, whose average foraging territory range from 70 acres for juveniles to 526 acres for females (USACE 2001), primarily is expected to catch insects from areas outside the AOCs, with only a fraction from near the AOCs. Area of most AOCs is lower than the average home range of a juvenile Indiana bat. Therefore, an AUF will be used for the bat, which is equivalent to the ratio of the area of an AOC to the average foraging area of a juvenile bat. The areal extent of sampling constitutes the exposure area for each AOC.

The USFWS believed that the nightly foraging ranges within a habitat unit, that may contain an AOC patch, could be much smaller compared to the species territory range of 70 to 526 acres. IAAAP (2003) noted that the core foraging area of an individual Indiana bat (Sodalis 824) was found to be in a field south of K-road. This is the only terrestrial area identified in the report, which could be significant part of a bat's diet. It was postulated that this area could be used to represent an alternate estimate of AUF and characterize the sensitivity associated with AUF estimates, if found to be smaller than the average foraging area of 70 acres for juvenile bat. However, the area of this field was found to be more than 200 acres. Therefore, it was determined that AUFs will only be calculated based on an average foraging area of 70 acres.

REFERENCES:

Iowa Army Ammunition Plant (IAAAP) 2003 Indian Bat Investigations. Bat Conservation and Management, Inc. Prepared for IAAAP. 2003.

USACHPPM, 2000. Wildlife Toxicity Assessment for 2,4,6-Trinitrotoluene. Project Number 39-EJ-1138-00. Aberdeen Proving Ground, Maryland. October.

US Army Corps of Engineers (Baltimore District). 2001. Indiana Bat Prey Tissue Sampling Work Plan Picatinny Arsenal New Jersey Task Order 5. Prepared by IT Corporation. Total Environmental Restoration Contract Number DACA31-95-D-0083. April.

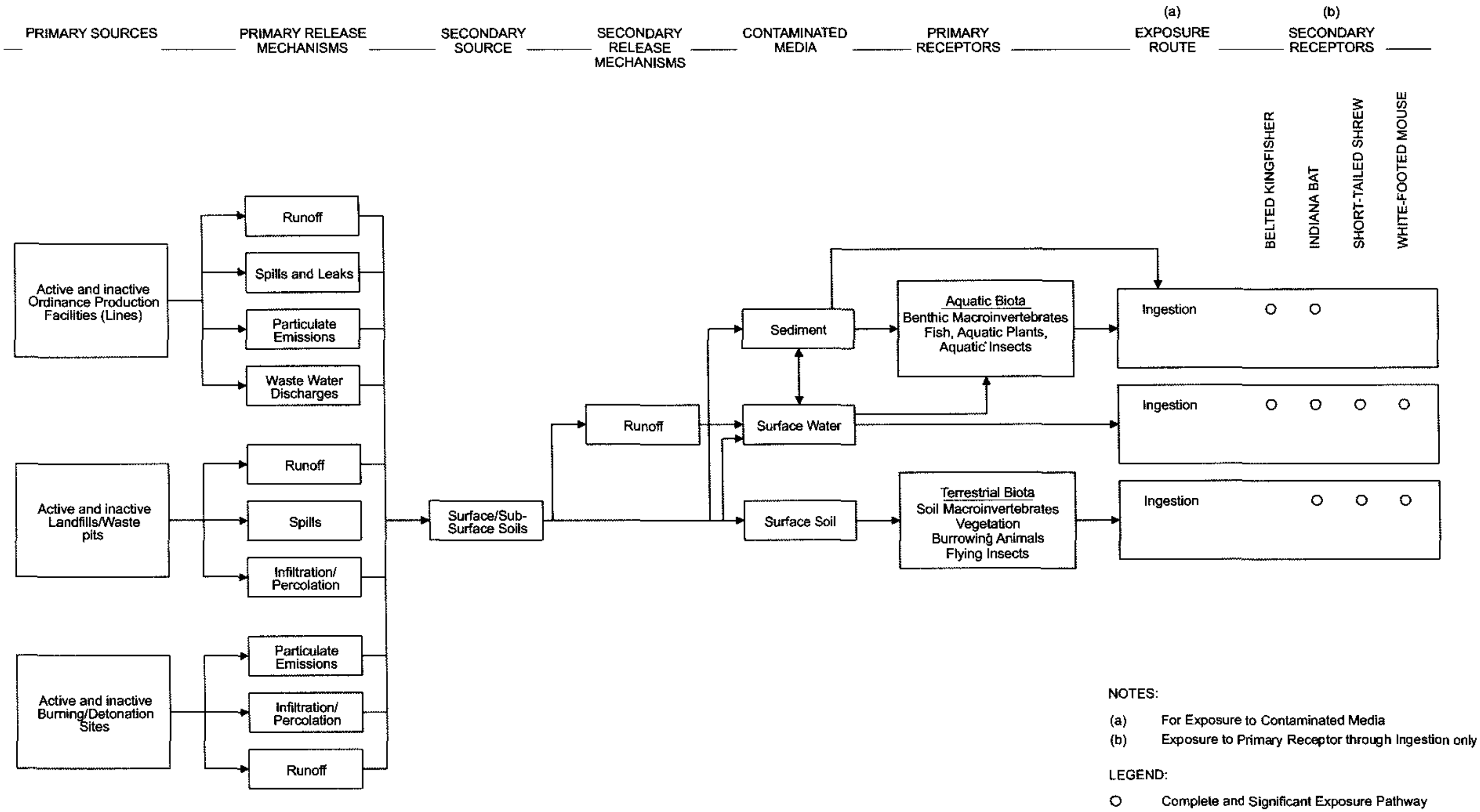

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Figure 1
CONCEPTUAL SITE MODEL
BASELINE ECOLOGICAL RISK ASSESSMENT
IOWA ARMY AMMUNITION PLANT
Middletown, Iowa

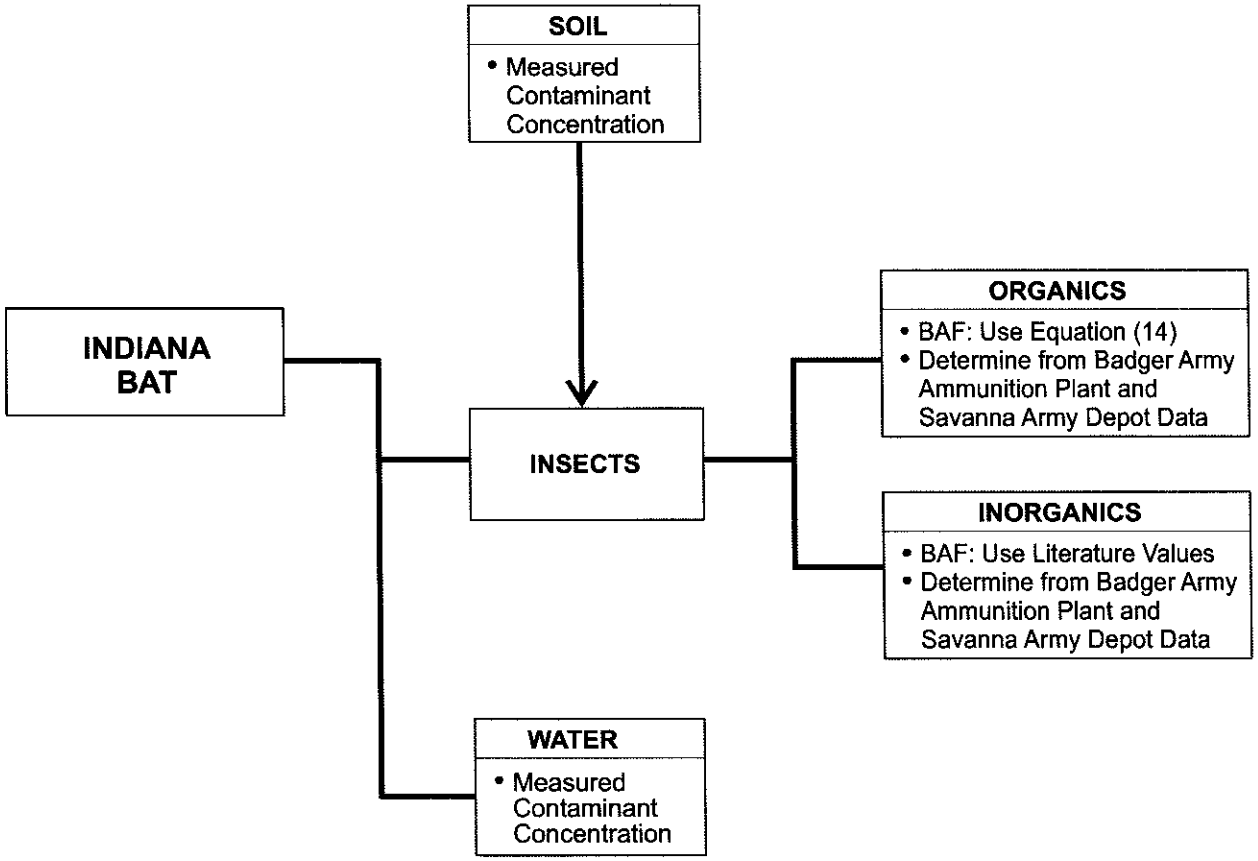

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Figure 2

ECORISK PATHWAY FOR INDIANA BAT VIA THE TERRESTRIAL PATHWAY

ECOLOGICAL RISK ASSESSMENT
IOWA ARMY AMMUNITION PLANT
Iowa