SDMS US EPA REGION V

COLOR - RESOLUTION - 3

IMAGERY INSERT FORM

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SITE NAME	**SAUGET AREA 2**
DOC ID #	**157300**
DOCUMENT VARIATION	**X COLOR OR __ RESOLUTION**
PRP	
PHASE	**SAR**
OPERABLE UNITS	
PHASE (AR DOCUMENTS ONLY)	___ Remedial ___ Removal ___ Deletion Docket ___ ___ Original ___ Update #___ Volume __of __

COMMENT(S)

COLOR SITE MAPS (ALSO 2 OVERSIZED MAPS, UNABLE TO BE SCANNED)

Exhibit 16

INTRODUCTION

In the response to the dramatic loss of wetlands, the U.S. Fish and Wildlife Service (FWS) initiated the National Wetlands Inventory (NWI) Program in 1975 to provide detailed information on the remaining wetlands in the United States. Coastal wetlands and wetlands along major river systems were the first areas scheduled for inventory due to their biological and omic significance. To date, approximately one-half of the United States has been inventoried.

The NWI is mapping all wetlands and deepwater habitats throughout the United States. Therefore, this inventory includes lakes, rivers, and streams as well as marshes, bogs, swamps, etc. Because of the magnitude of the inventory, a classification system was needed that would meet four long-range objectives set forth by the FWS: (1) to describe ecological units that have certain homogenous natural attributes; (2) to arrange these units in a system that will aid decisions about resource management; (3) to furnish units for inventory and mapping; and (4) to provide uniformity in concepts and terminology throughout the United States. The classification system chosen was developed by Lewis M. Cowardin et al., and described in the publication, Classification of Wetlands and Deepwater Habitats in the United States, 1979, U.S. Fish and Wildlife Service.

In the classification system, wetlands are defined as "lands transitional between aquatic and terrestrial systems where the water table is usually at or near the surface, or the land is covered by shallow water." In addition, the definition requires that one or more of the following three attributes be present: (1) at least periodically the land supports predominantly hydrophytes (wetland plants), (2) the substrate is predominantly undrained hydric soil (wetland soils), or (3) the substrate is nonsoil and is saturated with or covered by shallow water at some time during the growing season of each year." All wetlands mapped through the inventory are consistent with this definition, and with the mapping conventions set forth by the FWS.

The structure of the classification system is hierarchical, progressing from systems and subsystems at the most general levels to classes, subclasses, and modifying terms. The map codes read from left to right (general to specific) as follows:

System-Subsystem-Class-Subclass-Modifier

A system is a complex of wetlands and deepwater habitats that share the influence of similar hydrologic, geomorphologic, chemical. or biological factors. Each system may be subdivided into a subsystem which further defines the characteristics.

Classes describe the general appearance of the habitat in terms of either the dominant life form of the vegetation or physiography and composition of the substrate. Subclasses are finer distinctions under each class.

Modifiers are used to further define wetlands based upon general hydrologic conditions, soil conditions, and man-made or beaver-made modifications to wetlands.

For example, the code PEM1Fh describes a marshy area that has been artificially created through the use of a dike, or impoundment.

P = Palustrine - See definition under Ponds and Marshes.

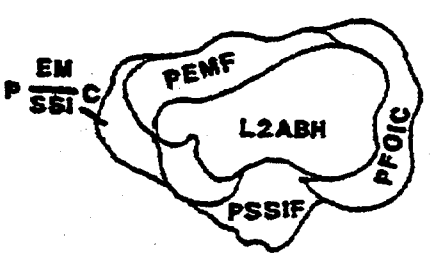
EM = Erect rooted, herbaceous, wetland plants, excluding mosses and lichens.

1 = Persistent - The emergent vegetation is visible throughout the year (cattails, sedges, etc.)

F= Semipermanently flooded - Water stands throughout the growing season in lost years. When surface water is absent, the water table is usually at or very near the surface of the land.

h = Diked/Impounded - Created or modified by a man-made barrier that purposely or unintentionally obstructs the flow of water.

To provide detail, each wetland habitat type is mapped separately and is given a separate classification code. For example the complex picture below has 5 separate wetland communities even though the types are often difficult to distinguish when observed in the field.



Where overlap of two vegetation types occur, such as Emergent Wetland grading into the Scrub-Shrub Wetland, both community descriptions are used when interpreting community types. An area such as this will be classified on the NWI maps as $P^{EM}C$, with the upper class representing slightly more than half the vegetation present, and the lower class representing slightly less than half.

The three wetland systems found in Illinois are described below along with the most common codes found in each system. For a more detailed description, please refer to Cowardin et al.

Ponds and Marshes

System P = Palustrine: Area dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. Areas lacking such vegetation are also included if they have all of the following acteristics :

1. Area less than 20 acres (8 hectares).

2. No active wave formed or bedrock shoreline.

3. Water depth in deepest part of basin less than 6.6 feet (2 meters) at low water. May be situated at the edge of a lake or river or in river floodplain.

There are no subsystems under this system, but several classes are recognized. A few examples follow:

Class SS = Scrub-shrub - Woody Vegetation less than 20 feet (6.0 meters) tall.

Subclass 1-5 = Broad leaved deciduous, needle leaved deciduous, etc.

Evergreen versus deciduous, and needle-leaved versus broad-leaved are determined on the basis of which subclass represents more than 75% areal canopy coverage during the broad leaf bearing seasons.

Class UB = Unconsolidated Bottom - Vegetation is absent over the majority (70%) of the area. Bottom consists of mud, sand, cobble, gravel, or organic matter.

Class EM = Emergent - Vegetation includes erect, rooted herbaceous hydrophytes representing more than 30 % of the areal cover.

Subclass 1 = Persistent - Vegetation remains upright and visible throughout the year.

Subclass 2 = Nonpersistent - Vegetation dies back and is not visible during the non-growing season.

Examples of the common codes found in Illinois:

(1) PEMA - describes an area with water present for only brief periods during the growing season.

P - palustrine EM - emergent vegetation A - temporarily wet.

(2) PEMAf - same as PEMA, but showing evidence of farming -f.

(3) PEMAd - same as PEMA, but partly drained -d.

(4) PEM1C - an area with surface water present for extended periods during the growing season.

P - palustrine EM - emergent vegetation 1 - persistent C - seasonally flooded.

(5) PFO1A - forested area with brief periods of flooding during the growing season.

P - palustrine FO - forested 1 - broad-leaved deciduous A - temporarily flooded.

(6) PUBG - describes a pond, borrow pit, or other small open water area.

P - palustrine UB - unconsolidated bottom G- intermittently exposed.

Lakes and Reservoirs

System L = Lacustrine: Deepwater habitats with all the following characteristics:

1. Situated in a topographic depression or damned river channel.

2. Lacking trees, shrubs, persistent emergents, emergent mosses, or lichens with greater than 30% areal coverage.

3. Total area exceeds 20 acres. Areas less than 20 acres may be included in the lacustrine System if an active wave formed or bedrock shoreline makes up all or part of the boundary, or if water is greater than 6.6 feet in the deepest part of the basin at low water. Lakes can be divided into two subsystems:

Subsystem1 = Limnetic; deep water (greater than 6.6 feet).

Subsystem 2 = Littoral; from shore to a depth of 6.6 feet.

Several classes are associated with the lacustrine system. The class describes the substrate or vegetation type. An example follows:

Class AB = Aquatic Bed - area dominated by plants that grow principally on or below the surface for most of the growing season in most years (algae, duckweed, etc).

Examples of the most common codes found in Illinois.

(1) L1UBH or L1OWH - describes a large deep lake or reservoir. L - lacustrine 1- limnetic OW - open water (or UB - unconsolidated bottom) H - permanently flooded.

(2) L2ABG - describes a shallow, vegetated area of a lake. L- lacustrine 2 - littoral AB - aquatic bed G - intermittently exposed.

Rivers and Streams

System R = Riverine: Wetland and deepwater habitats contained within a channel with periodically or continuously moving water. Divided into 4 subsystems:

Subsystem 2 = Lower Perennial - Water velocity slow, but some water flows throughout the year. Gradient is low. The substrate consists of sand and mud. Oxygen deficits may occur.

Subsystem 3 = Upper Perennial - Gradient high, water velocity fast. Water flows throughout the year. Substrate consists of rock, cobble, gravel, and sand. Dissolved oxygen content high.

Subsystem 4 = Intermittent - Flowing water present only part of the year. When water is not flowing, it may remain in isolated pools or surface water may be present.

Subsystem 5 = Unknown Perennial - Water velocity and substrate type unknown. Flowing water present all year.

This system includes many of the same classes as the palustrine and lacustrine systems. A few common examples follow:

(1) R2UBH - slow moving perennial river or stream.

R - Riverine 2 - lower perennial UB - unconsolidated bottom H- permanent.

(2) R2UBHX - perennial river or stream that has been modified by man.

R- riverine 2 - lower perennial UB - unconsolidated bottom H- permanent X - excavated

(3) R4SBF - intermittent stream.

R - riverine 4 - intermittent SB - stream bed F - semipermanently flooded.

Cowardin Classification System **Locate Wetlands Near You Onlilne** **Purchase a CD of NWI Data For Your County** **Download Free NWI Data For Your County** **Order 7.**

Return to Wetlands Homepage

PEM/FO1A

Enter NWI attribute (RETURN to exit): PEM/FO1A
PEM/FO1A P_EM_/FO1A_____
[P] Palustrine, [EM] Emergent / , [FO] Forested, [1] Broad-Leaved Deciduous, [A] Temporarily Flooded

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

1. are less than 8 hectares (20 acres);
2. do not have an active wave-formed or bedrock shoreline feature;
3. have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin;
4. have a salinity due to ocean-derived salts of less than 0.5 ppt.

All water bodies visible on the aerial photography that are less than 8 hectares (20 acres) in size are considered to be in the Palustrine System unless depth information is available, or unless an active wave-formed or bedrock shoreline feature is visible.

Limits: The Palustrine System is bounded by upland or by any of the other four systems.

Description. The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers.

Class

Class describes the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate. Life forms (e.g. trees, shrubs, emergents) are used to define classes because they are easily recognizable, do not change distribution rapidly, and have traditionally been used to classify wetlands. Other forms of vegetation such as submerged or floating-leaved vascular plants are more difficult to detect. Substrates reflect regional and local variations in geology and the influence of wind, waves, and currents on erosion and deposition of substrate materials.

[EM] Emergent - Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. All water regimes are included except subtidal and irregularly exposed.

[FO] Forested - Characterized by woody vegetation that is 6 m tall or taller. All water regimes are included except subtidal.

(1) Broad-leaved Deciduous - No definition given.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

[A] Temporarily Flooded - Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

PEM/SS1A

Enter NWI attribute (RETURN to exit): PEM/SS1A
PEM/SS1A P_EM_/SS1A_____
[P] Palustrine, [EM] Emergent / , [SS] Scrub-Shrub, [1] Broad-Leaved Deciduous, [A] Temporarily Flooded

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

1. are less than 8 hectares (20 acres);
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Limits: The Palustrine System is bounded by upland or by any of the other four systems.

Description. The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers.

Class

Class describes the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate. Life forms (e.g. trees, shrubs, emergents) are used to define classes because they are easily recognizable, do not change distribution rapidly, and have traditionally been used to classify wetlands. Other forms of vegetation such as submerged or floating-leaved vascular plants are more difficult to detect. Substrates reflect regional and local variations in geology and the influence of wind, waves, and currents on erosion and deposition of substrate materials.

[EM] Emergent - Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. All water regimes are included except subtidal and irregularly exposed.

[SS] Scrub-Shrub - Includes areas dominated by woody vegetation less than 6 m (20 feet) tall. The species include true shrubs, young trees (saplings), and trees or shrubs that are small or stunted because of environmental conditions. All water regimes except subtidal are included.

(1) Broad-leaved Deciduous - No definition given.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

[A] Temporarily Flooded - Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

PEM/SS1C

Enter NWI attribute (RETURN to exit): PEM/SS1C
PEM/SS1C P_EM_/SS1C_____
[P] Palustrine, [EM] Emergent / , [SS] Scrub-Shrub, [1] Broad-Leaved Deciduous, [C] Seasonally Flooded

Description type, Short, Long, None? (s/l/n): l

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Substrates reflect regional and local variations in geology and the influence of wind, waves, and currents on erosion and deposition of substrate materials.

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(1) Broad-leaved Deciduous - No definition given.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

[C] Seasonally Flooded - Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface.

PEMA

Enter NWI attribute (RETURN to exit): PEMA
PEMA P_EM_____A_____
[P] Palustrine, [EM] Emergent, [A] Temporarily Flooded

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

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[A] Temporarily Flooded - Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

PEMAf

Enter NWI attribute (RETURN to exit): PEMAf
PEMAf P_EM_____A____f_____
[P] Palustrine, [EM] Emergent, [A] Temporarily Flooded, [f] Farmed

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

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[A] Temporarily Flooded - Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

Special Modifiers

Special modifiers are used to indicate wetlands and deepwater habitats modified or created by man or beaver. When used in combination, the letters should be listed in alphabetical order (e.g. PUBHhs).

[f] Farmed - The soil surface has been mechanically or physically altered for production of crops, but hydrophytes will become reestablished if farming is discontinued. The National Wetlands Inventory has operational instructions in place regarding the mapping of farmed wetlands. Farmed wetlands are limited to the following:

- farmed prairie potholes and pothole type depressions
- farmed intermittent lake bottoms (playa lakes)
- cranberry bogs
- diked former tidelands in California

PEMAh

Enter NWI attribute (RETURN to exit): PEMAh
PEMAh P_EM_____A____h_____
[P] Palustrine, [EM] Emergent, [A] Temporarily Flooded, [h] Diked/Impounded

Description type, Short, Long, None? (s/l/n): l

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1. are less than 8 hectares (20 acres);
2. do not have an active wave-formed or bedrock shoreline feature;
3. have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin;
4. have a salinity due to ocean-derived salts of less than 0.5 ppt.

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[EM] Emergent - Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. All water regimes are included except subtidal and irregularly exposed.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

[A] Temporarily Flooded - Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

Special Modifiers

Special modifiers are used to indicate wetlands and deepwater habitats modified or created by man or beaver. When used in combination, the letters should be listed in alphabetical order (e.g. PUBHhs).

[h] Diked / Impounded - Created or modified by a man-made barrier or dam which obstructs the inflow or outflow of water. Originally, Diked and Impounded are described as separate modifiers (Cowardin et al. 1979). They have been combined here due to photointerpretation limitations.For clarification of the extent of impoundment see discussion of Lacustrine System limits.

PEMC

Enter NWI attribute (RETURN to exit): PEMC
PEMC P_EM_____C_____
[P] Palustrine, [EM] Emergent, [C] Seasonally Flooded

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

1. are less than 8 hectares (20 acres);
2. do not have an active wave-formed or bedrock shoreline feature;
3. have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin;
4. have a salinity due to ocean-derived salts of less than 0.5 ppt.

All water bodies visible on the aerial photography that are less than 8 hectares (20 acres) in size are considered to be in the Palustrine System unless depth information is available, or unless an active wave-formed or bedrock shoreline feature is visible.

Limits: The Palustrine System is bounded by upland or by any of the other four systems.

Description. The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers.

Class

Class describes the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate. Life forms (e.g. trees, shrubs, emergents) are used to define classes because they are easily recognizable, do not change distribution rapidly, and have traditionally been used to classify wetlands. Other forms of vegetation such as submerged or floating-leaved vascular plants are more difficult to detect. Substrates reflect regional and local variations in geology and the influence of wind, waves, and currents on erosion and deposition of substrate materials.

[EM] Emergent - Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. All water regimes are included except subtidal and irregularly exposed.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

[C] Seasonally Flooded - Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface.

PEMCh

Enter NWI attribute (RETURN to exit): PEMCh
PEMCh P_EM_____C____h_____
[P] Palustrine, [EM] Emergent, [C] Seasonally Flooded, [h] Diked/Impounded

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

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Special Modifiers

Special modifiers are used to indicate wetlands and deepwater habitats modified or created by man or beaver. When used in combination, the letters should be listed in alphabetical order (e.g. PUBHhs).

[h] Diked / Impounded - Created or modified by a man-made barrier or dam which obstructs the inflow or outflow of water. Originally, Diked and Impounded are described as separate modifiers (Cowardin et al. 1979). They have been combined here due to photointerpretation limitations.For clarification of the extent of impoundment see discussion of Lacustrine System limits.

PEMCx

Enter NWI attribute (RETURN to exit): PEMCx
PEMCx P_EM_____C____x_____
[P] Palustrine, [EM] Emergent, [C] Seasonally Flooded, [x] Excavated

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

5. are less than 8 hectares (20 acres);
6. do not have an active wave-formed or bedrock shoreline feature;
7. have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin;
8. have a salinity due to ocean-derived salts of less than 0.5 ppt.

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Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

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[C] Seasonally Flooded - Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface.

Special Modifiers

Special modifiers are used to indicate wetlands and deepwater habitats modified or created by man or beaver. When used in combination, the letters should be listed in alphabetical order (e.g. PUBHhs).

[x] Excavated - Lies within a basin or channel excavated by man

PEMFx

Enter NWI attribute (RETURN to exit): PEMFx
PEMFx P_EM_____F____x_____
[P] Palustrine, [EM] Emergent, [F] Semipermanently Flooded, [x] Excavated

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

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[F] Semipermanently Flooded - Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

Special Modifiers

Special modifiers are used to indicate wetlands and deepwater habitats modified or created by man or beaver. When used in combination, the letters should be listed in alphabetical order (e.g. PUBHhs).

[x] Excavated - Lies within a basin or channel excavated by man

PFO1A

Enter NWI attribute (RETURN to exit): PFO1A
PFO1A P_FO1____A_____
[P] Palustrine, [FO] Forested, [1] Broad-Leaved Deciduous, [A] Temporarily Flooded

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

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[FO] Forested - Characterized by woody vegetation that is 6 m tall or taller. All water regimes are included except subtidal.

(1) Broad-leaved Deciduous - No definition given.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

[A] Temporarily Flooded - Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

PFO1C

Enter NWI attribute (RETURN to exit): PFO1C
PFO1C P_FO1____C_____
[P] Palustrine, [FO] Forested, [1] Broad-Leaved Deciduous, [C] Seasonally Flooded

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

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Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

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[C] Seasonally Flooded - Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface.

PSS1/EMA

Enter NWI attribute (RETURN to exit): PSS1/EMA
PSS1/EMA P_SS1/EM_A_____
[P] Palustrine, [SS] Scrub-Shrub, [1] Broad-Leaved Deciduous / , [EM] Emergent, [A] Temporarily Flooded

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

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[SS] Scrub-Shrub - Includes areas dominated by woody vegetation less than 6 m (20 feet) tall. The species include true shrubs, young trees (saplings), and trees or shrubs that are small or stunted because of environmental conditions. All water regimes except subtidal are included.

(1) Broad-leaved Deciduous - No definition given.

[EM] Emergent - Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. All water regimes are included except subtidal and irregularly exposed.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

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[A] Temporarily Flooded - Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

PSS1A

Enter NWI attribute (RETURN to exit): PSS1A
PSS1A P_SS1____A_____
[P] Palustrine, [SS] Scrub-Shrub, [1] Broad-Leaved Deciduous, [A] Temporarily Flooded

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

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(1) Broad-leaved Deciduous - No definition given.

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PSS1C

Enter NWI attribute (RETURN to exit): PSS1C
PSS1C P_SS1____C_____
[P] Palustrine, [SS] Scrub-Shrub, [1] Broad-Leaved Deciduous, [C] Seasonally Flooded

Description type, Short, Long, None? (s/l/n): l

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PUBF

Enter NWI attribute (RETURN to exit): PUBF
PUBF P_UB_____F_____
[P] Palustrine, [UB] Unconsolidated Bottom, [F] Semipermanently Flooded

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

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[UB] Unconsolidated Bottom - Includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%. Water regimes are restricted to the following: subtidal, permanent-tidal, semipermanent-tidal, permanently flooded, intermittently flooded, and semipermanently flooded.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

[F] Semipermanently Flooded - Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

PUBFh

Enter NWI attribute (RETURN to exit): PUBFh
PUBFh P_UB_____F____h_____
[P] Palustrine, [UB] Unconsolidated Bottom, [F] Semipermanently Flooded, [h] Diked/Impounded

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

1. are less than 8 hectares (20 acres);
2. do not have an active wave-formed or bedrock shoreline feature;
3. have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin;
4. have a salinity due to ocean-derived salts of less than 0.5 ppt.

All water bodies visible on the aerial photography that are less than 8 hectares (20 acres) in size are considered to be in the Palustrine System unless depth information is available, or unless an active wave-formed or bedrock shoreline feature is visible.

Limits: The Palustrine System is bounded by upland or by any of the other four systems.

Description. The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers.

Class

Class describes the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate. Life forms (e.g. trees, shrubs, emergents) are used to define classes because they are easily recognizable, do not change distribution rapidly, and have traditionally been used to classify wetlands. Other forms of vegetation such as submerged or floating-leaved vascular plants are more difficult to detect. Substrates reflect regional and local variations in geology and the influence of wind, waves, and currents on erosion and deposition of substrate materials.

[UB] Unconsolidated Bottom - Includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%. Water regimes are restricted to the following: subtidal, permanent-tidal, semipermanent-tidal, permanently flooded, intermittently flooded, and semipermanently flooded.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

[F] Semipermanently Flooded - Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

Special Modifiers

Special modifiers are used to indicate wetlands and deepwater habitats modified or created by man or beaver. When used in combination, the letters should be listed in alphabetical order (e.g. PUBHhs).

[h] Diked / Impounded - Created or modified by a man-made barrier or dam which obstructs the inflow or outflow of water. Originally, Diked and Impounded are described as separate modifiers (Cowardin et al. 1979). They have been combined here due to photointerpretation limitations. For clarification of the extent of impoundment see discussion of Lacustrine System limits.

PUBFx

Enter NWI attribute (RETURN to exit): PUBFx
PUBFx P_UB_____F____x_____
[P] Palustrine, [UB] Unconsolidated Bottom, [F] Semipermanently Flooded, [x] Excavated

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

1. are less than 8 hectares (20 acres);
2. do not have an active wave-formed or bedrock shoreline feature;
3. have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin;
4. have a salinity due to ocean-derived salts of less than 0.5 ppt.

All water bodies visible on the aerial photography that are less than 8 hectares (20 acres) in size are considered to be in the Palustrine System unless depth information is available, or unless an active wave-formed or bedrock shoreline feature is visible.

Limits: The Palustrine System is bounded by upland or by any of the other four systems.

Description. The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers.

Class

Class describes the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate. Life forms (e.g. trees, shrubs, emergents) are used to define classes because they are easily recognizable, do not change distribution rapidly, and have traditionally been used to classify wetlands. Other forms of vegetation such as submerged or floating-leaved vascular plants are more difficult to detect. Substrates reflect regional and local variations in geology and the influence of wind, waves, and currents on erosion and deposition of substrate materials.

[UB] Unconsolidated Bottom - Includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%. Water regimes are restricted to the following: subtidal, permanent-tidal, semipermanent-tidal, permanently flooded, intermittently flooded, and semipermanently flooded.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

[F] Semipermanently Flooded - Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

Special Modifiers

Special modifiers are used to indicate wetlands and deepwater habitats modified or created by man or beaver. When used in combination, the letters should be listed in alphabetical order (e.g. PUBHhs).

[x] Excavated - Lies within a basin or channel excavated by man

PUBG

Enter NWI attribute (RETURN to exit): PUBG
PUBG P_UB_____G_____
[P] Palustrine, [UB] Unconsolidated Bottom, [G] Intermittently Exposed

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

1. are less than 8 hectares (20 acres);
2. do not have an active wave-formed or bedrock shoreline feature;
3. have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin;
4. have a salinity due to ocean-derived salts of less than 0.5 ppt.

All water bodies visible on the aerial photography that are less than 8 hectares (20 acres) in size are considered to be in the Palustrine System unless depth information is available, or unless an active wave-formed or bedrock shoreline feature is visible.

Limits: The Palustrine System is bounded by upland or by any of the other four systems.

Description. The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water

bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers.

Class

Class describes the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate. Life forms (e.g. trees, shrubs, emergents) are used to define classes because they are easily recognizable, do not change distribution rapidly, and have traditionally been used to classify wetlands. Other forms of vegetation such as submerged or floating-leaved vascular plants are more difficult to detect. Substrates reflect regional and local variations in geology and the influence of wind, waves, and currents on erosion and deposition of substrate materials.

[UB] Unconsolidated Bottom - Includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%. Water regimes are restricted to the following: subtidal, permanent-tidal, semipermanent-tidal, permanently flooded, intermittently flooded, and semipermanently flooded.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

[G] Intermittently Exposed - Surface water is present throughout the year except in years of extreme drought.

PUBGx

Enter NWI attribute (RETURN to exit): PUBGx
PUBGx P_UB_____G____x_____
[P] Palustrine, [UB] Unconsolidated Bottom, [G] Intermittently Exposed, [x] Excavated

Description type, Short, Long, None? (s/l/n): l

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:

1. are less than 8 hectares (20 acres);
2. do not have an active wave-formed or bedrock shoreline feature;
3. have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin;

4. have a salinity due to ocean-derived salts of less than 0.5 ppt.

All water bodies visible on the aerial photography that are less than 8 hectares (20 acres) in size are considered to be in the Palustrine System unless depth information is available, or unless an active wave-formed or bedrock shoreline feature is visible.

Limits: The Palustrine System is bounded by upland or by any of the other four systems.

Description. The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers.

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[UB] Unconsolidated Bottom - Includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%. Water regimes are restricted to the following: subtidal, permanent-tidal, semipermanent-tidal, permanently flooded, intermittently flooded, and semipermanently flooded.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

[G] Intermittently Exposed - Surface water is present throughout the year except in years of extreme drought.

Special Modifiers

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[x] Excavated - Lies within a basin or channel excavated by man

R2UBH

Enter NWI attribute (RETURN to exit): R2UBH
R2UBH R2UB_____H_____
[R] Riverine, [2] Lower Perennial, [UB] Unconsolidated Bottom, [H] Permanently flooded

Description type, Short, Long, None? (s/l/n): l

[R] Riverine - The Riverine System includes all wetlands and deepwater habitats contained in natural or artificial channels periodically or continuously containing flowing water or which forms a connecting link between the two bodies of standing water. Upland islands or Palustrine wetlands may occur in the channel, but they are not part of the Riverine System.

Limits: The Riverine System is bounded on the landward side by upland, by the channel bank (including natural and man-made levees), or by wetlands dominated by trees, shrubs, persistent emergents, mosses, or lichens. In braided streams, the system is bounded by the banks forming the outer limits of the depression within which the braiding occurs.

The Riverine System terminates at the downstream end where the concentration of ocean-derived salts in the water exceeds 0.5 ppt during the period of annual average low flow, or where the channel enters a lake. It terminates at the upstream end where tributary streams originate, or where the channel leaves a lake. Springs discharging into a channel are considered part of the Riverine System.

Where a river enters a lake, the extension of the Lacustrine shoreline across the mouth of the river forms the Riverine / Lacustrine break. Oxbow lakes are placed in the Palustrine or Lacustrine Systems unless they are connected to a Riverine System by an open channel at both ends either permanently or intermittently. Run-of-the-river dams should be handled in the same manner as described above, with the Lacustrine System extending upstream to the contour approximating the normal spillway or pool elevation.

The USGS maps or USGS Water Resources Data (stream gauge data) are used as the primary data source in determining if the riverine channel is a perennial or intermittent stream.

(2) Lower Perennial - This Subsystem is characterized by a low gradient and slow water velocity. There is no tidal influence, and some water flows throughout the year. The substrate consists mainly of sand and mud. The floodplain is well developed. Oxygen deficits may sometimes occur.

Class

Class describes the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate. Life forms (e.g. trees,

shrubs, emergents) are used to define classes because they are easily recognizable, do not change distribution rapidly, and have traditionally been used to classify wetlands. Other forms of vegetation such as submerged or floating-leaved vascular plants are more difficult to detect. Substrates reflect regional and local variations in geology and the influence of wind, waves, and currents on erosion and deposition of substrate materials.

[UB] Unconsolidated Bottom - Includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%. Water regimes are restricted to the following: subtidal, permanent-tidal, semipermanent-tidal, permanently flooded, intermittently flooded, and semipermanently flooded.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

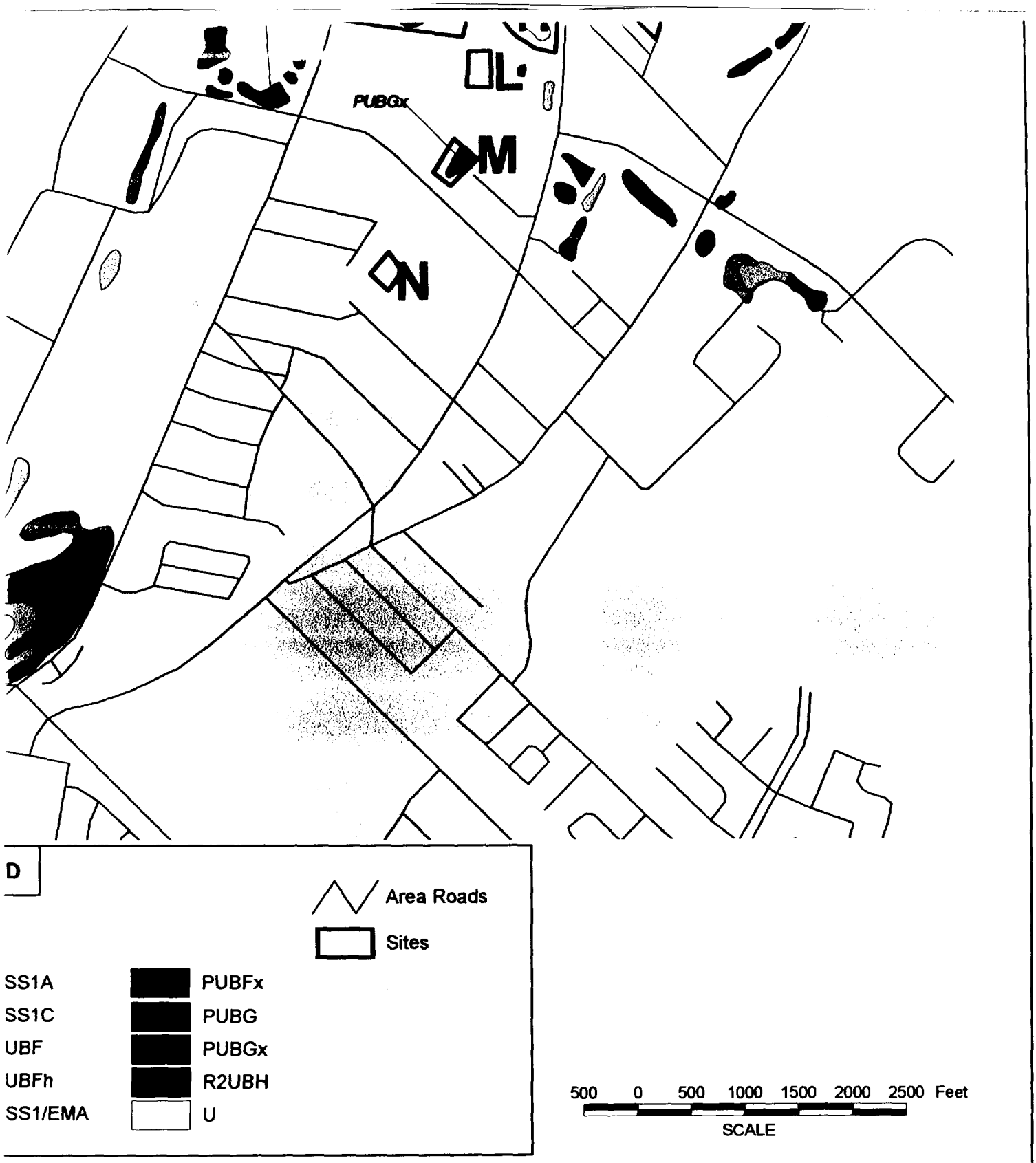
[H] Permanently Flooded - Water covers the land surface throughout the year in all years.

U

Enter NWI attribute (RETURN to exit): U
U U_____
[U] Upland

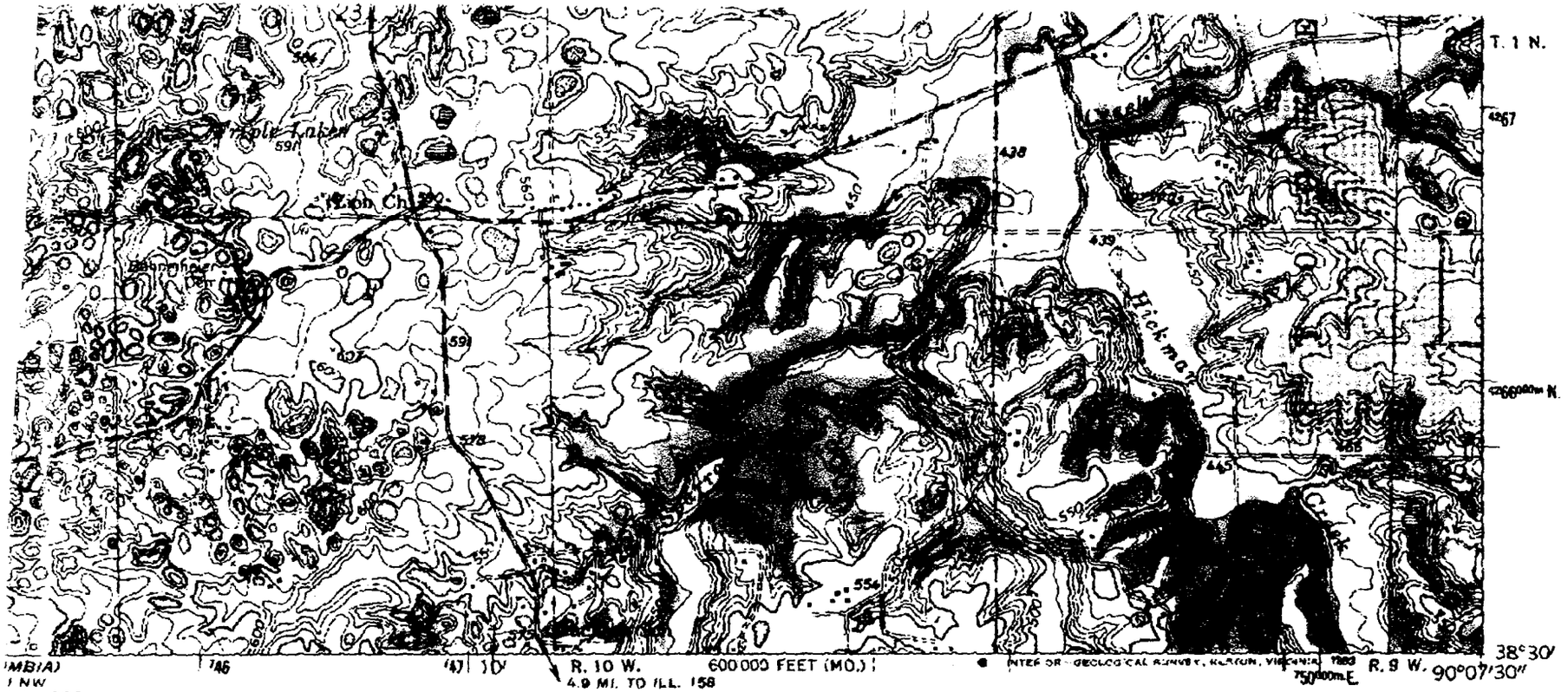
Description type, Short, Long, None? (s/l/n): l

[U] Upland - All areas not defined as wetland or deepwater habitats.



National Wetlands Inventory Classification
Sauget Area Delineation

Exhibit 17



1:24 000

1 MILE

4000 5000 6000 7000 FEET

1 KILOMETER

ERVAL 10 FEET
ENT 5-FOOT CONTOURS
RTICAL DATUM OF 1929

STANDARDS FOR SPATIAL ACCURACY–CLASS 2
R, COLORADO 80225, OR RESTON, VIRGINIA 22092
Y, CHAMPAIGN, ILLINOIS 61820
OGY AND LAND SURVEY
RESOURCES, ROLLA, MISSOURI 65401
S AND SYMBOLS IS AVAILABLE ON REQUEST

ROAD CLASSIFICATION

Primary highway, hard surface

Light-duty road, hard or improved surface

Secondary highway, hard surface

Unimproved road

Interstate Route

U. S. Route

State Route

QUADRANGLE LOCATION

Revisions shown in purple compiled from aerial photographs taken 1988 and other sources. This information not field checked. Map edited 1993

Information shown in purple may not meet USGS content standards and may conflict with previously mapped contours

Purple tint indicates extension of urban areas

CAHOKIA, ILL.–MO.

38090-E2-TF-024

1954

REVISED 1993

DMA 2961 II SW–SERIES V863

1993 Hourly Precipitation Data

from:
NOAA National Data Centers
http://www/ncdc.noaa.gov/pub/orders/07305650011290101112 6.html

Exhibit 18

1993 Rainfall Data

STATION NAME COOPID 110510	YEAR	MONTH	DAY	HOUR01	RAINFALL	HOUR02	RAINFALL	HOUR03	RAINFALL	HOUR04	RAINFALL	HOUR05	RAINFALL	HOUR06	RAINFALL	HOUR07	RAINFALL	HOUR08	RAINFALL	HOUR09	RAINFALL	HOUR10	RAINFALL	HOUR11	RAINFALL
BELLEVILLE SIU RSRCH	1993	1	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	1	2	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	1	3	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	10
BELLEVILLE SIU RSRCH	1993	1	4	100	0	200	0	300	0	400	10	500	30	600	20	700	10	800	20	900	10	1000	10	1100	10
BELLEVILLE SIU RSRCH	1993	1	9	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	1	12	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	10	1100	0
BELLEVILLE SIU RSRCH	1993	1	20	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	20	1000	20	1100	20
BELLEVILLE SIU RSRCH	1993	1	21	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	10	1100	0
BELLEVILLE SIU RSRCH	1993	1	23	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	1	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	10
BELLEVILLE SIU RSRCH	1993	2	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	2	11	100	0	200	0	300	0	400	0	500	10	600	0	700	10	800	0	900	10	1000	0	1100	10
BELLEVILLE SIU RSRCH	1993	2	15	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	2	20	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	2	21	100	10	200	0	300	10	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	2	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	2	25	100	0	200	10	300	0	400	0	500	10	600	0	700	10	800	0	900	10	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	2	100	0	200	0	300	0	400	10	500	10	600	10	700	0	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	3	100	0	200	0	300	0	400	0	500	10	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	4	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	16	100	10	200	10	300	0	400	10	500	0	600	10	700	0	800	0	900	0	1000	0	1100	0
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BELLEVILLE SIU RSRCH	1993	3	31	100	0	200	10	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	3	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	5	100	0	200	0	300	0	400	0	500	0	600	10	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	7	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	8	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	12	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
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BELLEVILLE SIU RSRCH	1993	4	14	100	0	200	10	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	15	100	0	200	0	300	0	400	0	500	10	600	10	700	10	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	16	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	19	100	0	200	0	300	0	400	0	500	0	600	20	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	23	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	10	1100	0
BELLEVILLE SIU RSRCH	1993	4	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	25	100	20	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	26	100	0	200	0	300	0	400	0	500	0	600	0	700	10	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	29	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	2	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	3	100	0	200	0	300	0	400	0	500	10	600	10	700	10	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	4	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	5	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	30	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	2	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	10	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	6	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	9	100	20	200	20	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	11	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	12	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	18	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	30	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	19	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	20	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	10	1000	0	1100	40
BELLEVILLE SIU RSRCH	1993	6	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	25	100	10	200	0	300	0	400	10	500	20	600	30	700	20	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	28	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	30	100	0	200	0	300	0	400	0	500	10	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	7	1	100	0	200	0	300	0	400	0	500	0	600	0	700	60	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	7	6	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	7	7	100	20	200	10	300	0	400	10	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0

1993 Rainfall Data

STATION NAME COOPID 110510	YEAR	MONTH	DAY	HOUR01	RAINFALL	HOUR02	RAINFALL	HOUR03	RAINFALL	HOUR04	RAINFALL	HOUR05	RAINFALL	HOUR06	RAINFALL	HOUR07	RAINFALL	HOUR08	RAINFALL	HOUR09	RAINFALL	HOUR10	RAINFALL	HOUR11	RAINFALL
BELLEVILLE SIU RSRCH	1993	1	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	1	2	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	1	3	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	10
BELLEVILLE SIU RSRCH	1993	1	4	100	0	200	0	300	0	400	10	500	30	600	20	700	10	800	20	900	10	1000	10	1100	10
BELLEVILLE SIU RSRCH	1993	1	9	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	1	12	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	10	1100	0
BELLEVILLE SIU RSRCH	1993	1	20	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	20	1000	20	1100	20
BELLEVILLE SIU RSRCH	1993	1	21	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	10	1100	0
BELLEVILLE SIU RSRCH	1993	1	23	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	1	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	10
BELLEVILLE SIU RSRCH	1993	2	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	2	11	100	0	200	0	300	0	400	0	500	10	600	0	700	10	800	0	900	10	1000	0	1100	10
BELLEVILLE SIU RSRCH	1993	2	15	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	2	20	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	2	21	100	10	200	0	300	10	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	2	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	2	25	100	0	200	10	300	0	400	0	500	10	600	0	700	10	800	0	900	10	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	2	100	0	200	0	300	0	400	10	500	10	600	10	700	0	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	3	100	0	200	0	300	0	400	0	500	10	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	4	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	16	100	10	200	10	300	0	400	10	500	0	600	10	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	19	100	0	200	0	300	0	400	0	500	10	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	20	100	0	200	0	300	10	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	22	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	10	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	3	31	100	0	200	10	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	3	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	5	100	0	200	0	300	0	400	0	500	0	600	10	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	7	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	8	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	12	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	13	100	0	200	10	300	0	400	0	500	0	600	20	700	20	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	14	100	0	200	10	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	15	100	0	200	0	300	0	400	0	500	10	600	10	700	10	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	16	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	19	100	0	200	0	300	0	400	0	500	0	600	20	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	23	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	10	1100	0
BELLEVILLE SIU RSRCH	1993	4	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	25	100	20	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	26	100	0	200	0	300	0	400	0	500	0	600	0	700	10	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	4	29	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	2	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	3	100	0	200	0	300	0	400	0	500	10	600	10	700	10	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	4	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	5	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	5	30	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	2	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	10	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	6	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	9	100	20	200	20	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	11	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	12	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	18	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	30	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	19	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	20	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	10	1000	0	1100	40
BELLEVILLE SIU RSRCH	1993	6	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	25	100	10	200	0	300	0	400	10	500	20	600	30	700	20	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	28	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	6	30	100	0	200	0	300	0	400	0	500	10	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	7	1	100	0	200	0	300	0	400	0	500	0	600	0	700	60	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	7	6	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	7	7	100	20	200	10	300	0	400	10	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0

1993 Rainfall Data

STATION NAME COOPID 110510	YEAR	MONTH	DAY	HOUR01	RAINFALL	HOUR02	RAINFALL	HOUR03	RAINFALL	HOUR04	RAINFALL	HOUR05	RAINFALL	HOUR06	RAINFALL	HOUR07	RAINFALL	HOUR08	RAINFALL	HOUR09	RAINFALL	HOUR10	RAINFALL	HOUR11	RAINFALL
BELLEVILLE SIU RSRCH	1993	7	13	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	7	14	100	0	200	20	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	7	15	100	0	200	0	300	0	400	0	500	0	600	30	700	10	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	7	16	100	10	200	40	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	7	18	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	7	20	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	7	31	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	8	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	8	4	100	0	200	10	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	8	5	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	8	10	100	0	200	0	300	0	400	0	500	0	600	0	700	40	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	8	11	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	8	12	100	10	200	0	300	10	400	30	500	50	600	10	700	20	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	8	18	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	8	23	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	8	31	100	0	200	10	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	9	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	9	2	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	9	3	100	10	200	10	300	20	400	10	500	0	600	0	700	10	800	0	900	10	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	9	8	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	10	1100	0
BELLEVILLE SIU RSRCH	1993	9	14	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	20	1100	10
BELLEVILLE SIU RSRCH	1993	9	19	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	9	22	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	10	900	0	1000	0	1100	20
BELLEVILLE SIU RSRCH	1993	9	23	100	10	200	0	300	0	400	0	500	0	600	10	700	0	800	100	900	80	1000	10	1100	0
BELLEVILLE SIU RSRCH	1993	9	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	10
BELLEVILLE SIU RSRCH	1993	9	25	100	0	200	0	300	0	400	0	500	0	600	0	700	20	800	20	900	30	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	9	26	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	10	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	10	11	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	10	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	10	16	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	10	18	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	10	19	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	10	20	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	10	900	10	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	11	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	11	2	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	11	12	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	10
BELLEVILLE SIU RSRCH	1993	11	13	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	11	14	100	60	200	20	300	70	400	10	500	10	600	20	700	30	800	30	900	20	1000	20	1100	10
BELLEVILLE SIU RSRCH	1993	11	16	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	11	17	100	10	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	11	24	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	10	1100	0
BELLEVILLE SIU RSRCH	1993	11	25	100	0	200	0	300	0	400	0	500	10	600	10	700	0	800	10	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	11	26	100	0	200	10	300	20	400	10	500	0	600	10	700	10	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	11	27	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	12	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	12	2	100	0	200	0	300	0	400	20	500	10	600	10	700	0	800	0	900	0	1000	10	1100	0
BELLEVILLE SIU RSRCH	1993	12	3	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	12	4	100	0	200	10	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	12	14	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1993	12	25	100	0	200	0	300	0	400	10	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0
BELLEVILLE SIU RSRCH	1994	1	1	100	0	200	0	300	0	400	0	500	0	600	0	700	0	800	0	900	0	1000	0	1100	0

1993 Rainfall Data

STATION NAME COOPID 110510	YEAR	MONTH	DAY	HOUR12	RAINFALL	HOUR13	RAINFALL	HOUR14	RAINFALL	HOUR15	RAINFALL	HOUR16	RAINFALL	HOUR17	RAINFALL	HOUR18	RAINFALL	HOUR19	RAINFALL	HOUR20	RAINFALL	HOUR21	RAINFALL	HOUR22	RAINFALL
BELLEVILLE SIU RSRCH	1993	1	1	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	1	2	1200	0	1300	0	1400	0	1500	10	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	1	3	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	10
BELLEVILLE SIU RSRCH	1993	1	4	1200	30	1300	0	1400	10	1500	0	1600	0	1700	10	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	1	9	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	10	1900	0	2000	0	2100	10	2200	0
BELLEVILLE SIU RSRCH	1993	1	12	1200	0	1300	10	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	1	20	1200	30	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	10	2000	10	2100	0	2200	10
BELLEVILLE SIU RSRCH	1993	1	21	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	1	23	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	10
BELLEVILLE SIU RSRCH	1993	1	24	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	2	1	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	2	11	1200	0	1300	0	1400	0	1500	10	1600	0	1700	10	1800	0	1900	0	2000	10	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	2	15	1200	0	1300	0	1400	0	1500	10	1600	0	1700	10	1800	10	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	2	20	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	10	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	2	21	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	2	24	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	2	25	1200	10	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	3	1	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	3	2	1200	0	1300	0	1400	10	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	3	3	1200	0	1300	10	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	3	4	1200	0	1300	0	1400	10	1500	0	1600	0	1700	0	1800	0	1900	0	2000	10	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	3	16	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	3	19	1200	0	1300	0	1400	0	1500	10	1600	0	1700	10	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	3	20	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	3	22	1200	0	1300	0	1400	0	1500	0	1600	0	1700	10	1800	10	1900	0	2000	10	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	3	24	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	3	31	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	1	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	3	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	10	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	5	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	7	1200	0	1300	0	1400	0	1500	0	1600	0	1700	10	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	8	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	10	2200	10
BELLEVILLE SIU RSRCH	1993	4	12	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	10	2100	10	2200	10
BELLEVILLE SIU RSRCH	1993	4	13	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	14	1200	0	1300	10	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	10	2100	10	2200	0
BELLEVILLE SIU RSRCH	1993	4	15	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	16	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	19	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	20	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	23	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	24	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	25	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	26	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	4	29	1200	0	1300	0	1400	0	1500	0	1600	10	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	5	1	1200	0	1300	0	1400	10	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	5	2	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	10	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	5	3	1200	10	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	5	4	1200	10	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	5	5	1200	99999	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	5	24	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	99999	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	5	30	1200	0	1300	10	1400	0	1500	0	1600	0	1700	10	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	6	1	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	6	2	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	6	6	1200	0	1300	0	1400	10	1500	100	1600	10	1700	10	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	6	9	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	6	11	1200	0	1300	0	1400	50	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	6	12	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	6	18	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	6	19	1200	0	1300	0	1400	0	1500	0	1600	110	1700	0	1800	0	1900	0	2000	10	2100	0	2200	10
BELLEVILLE SIU RSRCH	1993	6	20	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	6	24	1200	10	1300	40	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	6	25	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	6	28	1200	0	1300	0	1400	0	1500	0	1600	0	1700	10	1800	0	1900	0	2000	30	2100	10	2200	0
BELLEVILLE SIU RSRCH	1993	6	30	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	7	1	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	7	6	1200	0	1300	0	1400	0	1500	0	1600	0	1700	10	1800	10	1900	0	2000	20	2100	10	2200	0
BELLEVILLE SIU RSRCH	1993	7	7	1200	0	1300	0	1400	0	1500	30	1600	10	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0

1993 Rainfall Data

STATION NAME COOPID 110510	YEAR	MONTH	DAY	HOUR12	RAINFALL	HOUR13	RAINFALL	HOUR14	RAINFALL	HOUR15	RAINFALL	HOUR16	RAINFALL	HOUR17	RAINFALL	HOUR18	RAINFALL	HOUR19	RAINFALL	HOUR20	RAINFALL	HOUR21	RAINFALL	HOUR22	RAINFALL
BELLEVILLE SIU RSRCH	1993	7	13	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	10	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	7	14	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	7	15	1200	0	1300	0	1400	0	1500	0	1600	40	1700	20	1800	0	1900	0	2000	0	2100	0	2200	20
BELLEVILLE SIU RSRCH	1993	7	16	1200	10	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	7	18	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	20	2000	70	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	7	20	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	80	1900	10	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	7	31	1200	0	1300	0	1400	0	1500	0	1600	0	1700	70	1800	30	1900	10	2000	10	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	8	1	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	8	4	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	8	5	1200	0	1300	0	1400	0	1500	0	1600	10	1700	10	1800	10	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	8	10	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	8	11	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	8	12	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	8	18	1200	0	1300	0	1400	10	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	8	23	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	100	2000	10	2100	10	2200	0
BELLEVILLE SIU RSRCH	1993	8	31	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	9	1	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	9	2	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	50
BELLEVILLE SIU RSRCH	1993	9	3	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	9	8	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	9	14	1200	10	1300	20	1400	10	1500	40	1600	10	1700	0	1800	10	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	9	19	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	10	2000	0	2100	20	2200	10
BELLEVILLE SIU RSRCH	1993	9	22	1200	90	1300	0	1400	10	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	40	2200	10
BELLEVILLE SIU RSRCH	1993	9	23	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	9	24	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	9	25	1200	0	1300	0	1400	0	1500	0	1600	10	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	9	26	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	10
BELLEVILLE SIU RSRCH	1993	10	1	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	10	11	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	10	16	1200	0	1300	20	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	30	2100	40	2200	20
BELLEVILLE SIU RSRCH	1993	10	18	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	10	19	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	10	20	1200	0	1300	10	1400	0	1500	0	1600	20	1700	0	1800	10	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	11	1	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	11	2	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	10
BELLEVILLE SIU RSRCH	1993	11	12	1200	0	1300	10	1400	10	1500	0	1600	0	1700	0	1800	0	1900	10	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	11	13	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	11	14	1200	10	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	11	16	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	10	1900	20	2000	20	2100	10	2200	30
BELLEVILLE SIU RSRCH	1993	11	17	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	11	24	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	11	25	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	11	26	1200	0	1300	10	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	11	27	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	10
BELLEVILLE SIU RSRCH	1993	12	1	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	12	2	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	12	3	1200	0	1300	10	1400	10	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	12	4	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	12	14	1200	10	1300	0	1400	0	1500	0	1600	0	1700	0	1800	10	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1993	12	25	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0
BELLEVILLE SIU RSRCH	1994	1	1	1200	0	1300	0	1400	0	1500	0	1600	0	1700	0	1800	0	1900	0	2000	0	2100	0	2200	0

1993 Rainfall Data

STATION NAME COOPID 110510	YEAR	MONTH	DAY	HOUR23	RAINFALL	HOUR24	RAINFALL	TOTAL		Monthly Total Reported in Hundreths of an inch	Monthly Total Inches
										Jan	Jan
BELLEVILLE SIU RSRCH	1993	1	1	2300	0	2400	0	0		420	4.2
BELLEVILLE SIU RSRCH	1993	1	2	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	1	3	2300	10	2400	0	30			
BELLEVILLE SIU RSRCH	1993	1	4	2300	0	2400	0	170			
BELLEVILLE SIU RSRCH	1993	1	9	2300	0	2400	10	30			
BELLEVILLE SIU RSRCH	1993	1	12	2300	0	2400	0	20			
BELLEVILLE SIU RSRCH	1993	1	20	2300	10	2400	0	130			
BELLEVILLE SIU RSRCH	1993	1	21	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	1	23	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	1	24	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	2	1	2300	0	2400	0	0			
BELLEVILLE SIU RSRCH	1993	2	11	2300	0	2400	0	70		Feb	Feb
BELLEVILLE SIU RSRCH	1993	2	15	2300	0	2400	0	30		190	1.9
BELLEVILLE SIU RSRCH	1993	2	20	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	2	21	2300	0	2400	0	20			
BELLEVILLE SIU RSRCH	1993	2	24	2300	0	2400	10	10			
BELLEVILLE SIU RSRCH	1993	2	25	2300	0	2400	0	50			
BELLEVILLE SIU RSRCH	1993	3	1	2300	0	2400	0	0			
BELLEVILLE SIU RSRCH	1993	3	2	2300	0	2400	0	50		Mar	Mar
BELLEVILLE SIU RSRCH	1993	3	3	2300	0	2400	0	20		230	2.3
BELLEVILLE SIU RSRCH	1993	3	4	2300	0	2400	0	20			
BELLEVILLE SIU RSRCH	1993	3	16	2300	0	2400	0	40			
BELLEVILLE SIU RSRCH	1993	3	19	2300	0	2400	0	30			
BELLEVILLE SIU RSRCH	1993	3	20	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	3	22	2300	0	2400	0	40			
BELLEVILLE SIU RSRCH	1993	3	24	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	3	31	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	4	1	2300	0	2400	0	0			
BELLEVILLE SIU RSRCH	1993	4	3	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	4	5	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	4	7	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	4	8	2300	0	2400	0	20		APRIL	APRIL
BELLEVILLE SIU RSRCH	1993	4	12	2300	0	2400	10	40		350	3.5
BELLEVILLE SIU RSRCH	1993	4	13	2300	0	2400	0	50			
BELLEVILLE SIU RSRCH	1993	4	14	2300	10	2400	10	60			
BELLEVILLE SIU RSRCH	1993	4	15	2300	0	2400	0	40			
BELLEVILLE SIU RSRCH	1993	4	16	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	4	19	2300	0	2400	0	40			
BELLEVILLE SIU RSRCH	1993	4	23	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	4	24	2300	0	2400	10	10			
BELLEVILLE SIU RSRCH	1993	4	25	2300	0	2400	0	20			
BELLEVILLE SIU RSRCH	1993	4	26	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	4	29	2300	0	2400	0	10		MAY	MAY
BELLEVILLE SIU RSRCH	1993	5	1	2300	0	2400	0	10		110	1.1
BELLEVILLE SIU RSRCH	1993	5	2	2300	0	2400	0	60			
BELLEVILLE SIU RSRCH	1993	5	3	2300	10	2400	0	10			
BELLEVILLE SIU RSRCH	1993	5	4	2300	0	2400	0	0	P		
BELLEVILLE SIU RSRCH	1993	5	5	2300	0	2400	0	0	P		
BELLEVILLE SIU RSRCH	1993	5	24	2300	0	2400	0	20			
BELLEVILLE SIU RSRCH	1993	5	30	2300	0	2400	0	0			
BELLEVILLE SIU RSRCH	1993	6	1	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	6	2	2300	0	2400	0	130		JUNE	JUNE
BELLEVILLE SIU RSRCH	1993	6	6	2300	0	2400	0	40		660	6.6
BELLEVILLE SIU RSRCH	1993	6	9	2300	0	2400	0	50			
BELLEVILLE SIU RSRCH	1993	6	11	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	6	12	2300	0	2400	0	30			
BELLEVILLE SIU RSRCH	1993	6	18	2300	0	2400	0	130			
BELLEVILLE SIU RSRCH	1993	6	19	2300	0	2400	0	50			
BELLEVILLE SIU RSRCH	1993	6	20	2300	0	2400	0	50			
BELLEVILLE SIU RSRCH	1993	6	24	2300	0	2400	0	100			
BELLEVILLE SIU RSRCH	1993	6	25	2300	0	2400	0	50			
BELLEVILLE SIU RSRCH	1993	6	28	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	6	30	2300	0	2400	0	60			
BELLEVILLE SIU RSRCH	1993	7	1	2300	0	2400	20	70			
BELLEVILLE SIU RSRCH	1993	7	6	2300	0	2400	0	80			
BELLEVILLE SIU RSRCH	1993	7	7	2300	0	2400					

1993 Rainfall Data

STATION NAME											
COOPID 110510	YEAR	MONTH	DAY	HOUR23	RAINFALL	HOUR24	RAINFALL	TOTAL		Monthly Total	Monthly Total
										Reported in Hundreths of an inch	Inches
BELLEVILLE SIU RSRCH	1993	7	13	2300	0	2400	10	20		JULY	JULY
BELLEVILLE SIU RSRCH	1993	7	14	2300	0	2400	0	20		740	7.4
BELLEVILLE SIU RSRCH	1993	7	15	2300	10	2400	0	130			
BELLEVILLE SIU RSRCH	1993	7	16	2300	0	2400	0	60			
BELLEVILLE SIU RSRCH	1993	7	18	2300	0	2400	0	90			
BELLEVILLE SIU RSRCH	1993	7	20	2300	0	2400	0	90			
BELLEVILLE SIU RSRCH	1993	7	31	2300	0	2400	0	120			
BELLEVILLE SIU RSRCH	1993	8	1	2300	0	2400	0	0			
BELLEVILLE SIU RSRCH	1993	8	4	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	8	5	2300	0	2400	0	30			
BELLEVILLE SIU RSRCH	1993	8	10	2300	0	2400	0	50			
BELLEVILLE SIU RSRCH	1993	8	11	2300	0	2400	10	10		AUG	AUG
BELLEVILLE SIU RSRCH	1993	8	12	2300	0	2400	0	130		370	3.7
BELLEVILLE SIU RSRCH	1993	8	18	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	8	23	2300	0	2400	0	120			
BELLEVILLE SIU RSRCH	1993	8	31	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	9	1	2300	0	2400	0	0			
BELLEVILLE SIU RSRCH	1993	9	2	2300	50	2400	20	120			
BELLEVILLE SIU RSRCH	1993	9	3	2300	0	2400	0	70			
BELLEVILLE SIU RSRCH	1993	9	8	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	9	14	2300	0	2400	0	130		SEPT	SEPT
BELLEVILLE SIU RSRCH	1993	9	19	2300	10	2400	0	50		880	8.8
BELLEVILLE SIU RSRCH	1993	9	22	2300	10	2400	0	190			
BELLEVILLE SIU RSRCH	1993	9	23	2300	0	2400	0	210			
BELLEVILLE SIU RSRCH	1993	9	24	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	9	25	2300	0	2400	0	80			
BELLEVILLE SIU RSRCH	1993	9	26	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	10	1	2300	0	2400	0	0			
BELLEVILLE SIU RSRCH	1993	10	11	2300	0	2400	0	10		OCT	OCT
BELLEVILLE SIU RSRCH	1993	10	16	2300	10	2400	0	120		210	2.1
BELLEVILLE SIU RSRCH	1993	10	18	2300	0	2400	10	10			
BELLEVILLE SIU RSRCH	1993	10	19	2300	10	2400	0	10			
BELLEVILLE SIU RSRCH	1993	10	20	2300	0	2400	0	60			
BELLEVILLE SIU RSRCH	1993	11	1	2300	0	2400	0	0			
BELLEVILLE SIU RSRCH	1993	11	2	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	11	12	2300	0	2400	0	40			
BELLEVILLE SIU RSRCH	1993	11	13	2300	10	2400	20	30			
BELLEVILLE SIU RSRCH	1993	11	14	2300	0	2400	0	310		NOV	NOV
BELLEVILLE SIU RSRCH	1993	11	16	2300	20	2400	0	110		650	6.5
BELLEVILLE SIU RSRCH	1993	11	17	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	11	24	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	11	25	2300	10	2400	10	50			
BELLEVILLE SIU RSRCH	1993	11	26	2300	0	2400	0	70			
BELLEVILLE SIU RSRCH	1993	11	27	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	12	1	2300	0	2400	0	0			
BELLEVILLE SIU RSRCH	1993	12	2	2300	0	2400	0	50		DEC	DEC
BELLEVILLE SIU RSRCH	1993	12	3	2300	0	2400	0	20		110	1.1
BELLEVILLE SIU RSRCH	1993	12	4	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1993	12	14	2300	0	2400	0	20			
BELLEVILLE SIU RSRCH	1993	12	25	2300	0	2400	0	10			
BELLEVILLE SIU RSRCH	1994	1	1	2300	0	2400	0	0			

Exhibit 19

SAUGET AREA 2
ILD000605790

Reference No. 10

150758

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
1222 SPRUCE STREET
ST. LOUIS, MISSOURI 63103-2833

28 February 2000

REPLY TO
ATTENTION OF
Planning, Programs, and Project Management Division
Project Management Branch for Flood Control and Support for Others

Mr. Ted Prescott
Project Manager
Site Assessment Unit
Federal Site Remediation Section
Bureau of Land Pollution Control
1021 North Grand Avenue East,
Springfield, Illinois 62794-9276

Dear Mr. Prescott:

Reference your request of 17 February 2000 regarding information the St. Louis District, U.S. Army Corps of Engineers, has concerning the Sauget and Cahokia, Illinois area. Enclosed are documents we have identified that we believe meet the intent of your request. Obviously, the District has done work in these areas for decades and a one week search would not produce all of the possible documents which may be in our possession. However, based on the scope of the request and the restricted time period these documents were readily identifiable as having potential information of benefit to your investigation.

In addition you were given a number of Illinois State Water Survey Reports which we felt were germane to your information requirements. These are not included in this package as we are not the source for this information.

If you have any questions or need clarification regarding this information, please feel free to call me at 314-331-8033. You can also reach me by email at Deborah.L.Roush@mvs02.usace.army.mil.

Sincerely,

Deborah L. Roush

Deborah L. Roush
Project Manager

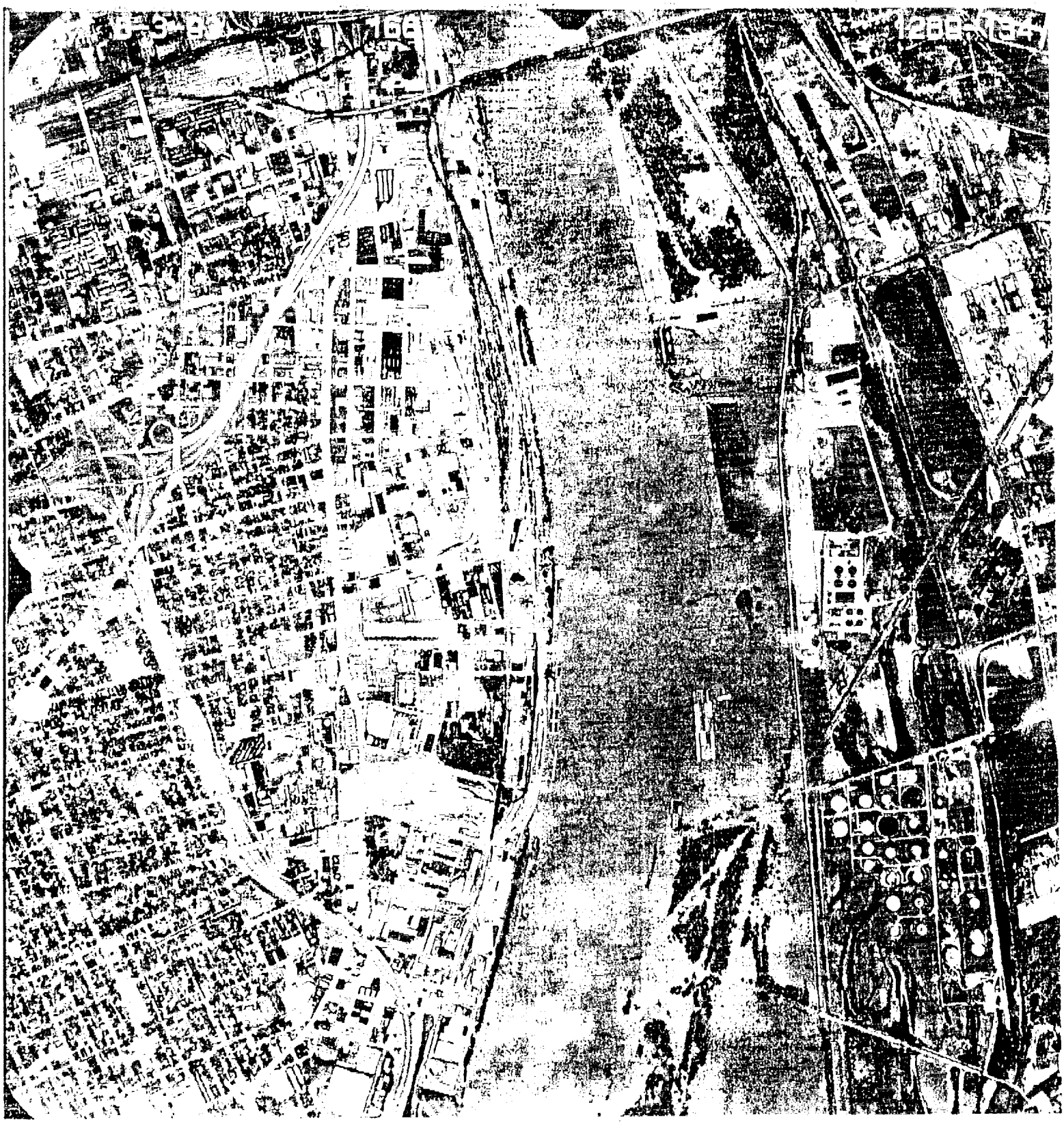

Exhibit 20

SAUGET AREA 2
ILD000605790

Reference No. 18

CORPS OF ENGINEERS, U. S. ARMY

150785

INVESTIGATION OF UNDERSEEPAGE MISSISSIPPI RIVER LEVEES, ALTON TO GALE, ILL.

TECHNICAL MEMORANDUM NO. 3-430

PREPARED FOR

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

BY

WATERWAYS EXPERIMENT STATION

VICKSBURG, MISSISSIPPI

ARMY-MRC VICKSBURG, MISS.

IN TWO VOLUMES VOL. 1

APRIL 1956

Exhibit 21

CERCLA Regulations and Keyword Index

1993 EDITION

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Exhibit 22

CERCLA Regulations and Keyword Index

1993 EDITION

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2.2.3 *Identify hazardous substances available to a pathway.* In evaluating each migration pathway, consider the following hazardous substances available to migrate from the sources at the site to the pathway:

- Ground water migration.
  - — Hazardous substances that meet the criteria for an observed release (see section 2.3) to ground water.
  - — All hazardous substances associated with a source with a ground water containment factor value greater than 0 (see section 3.1.2.1).
- Surface water migration—overland/flood component.
  - — Hazardous substances that meet the criteria for an observed release to surface water in the watershed being evaluated.
  - — All hazardous substances associated with a source with a surface water containment factor value greater than 0 for the watershed (see sections 4.1.2.1.2.1.1 and 4.1.2.1.2.2.1).
- Surface water migration—ground water to surface water component.
  - — Hazardous substances that meet the criteria for an observed release to ground water.
  - — All hazardous substances associated with a source with a ground water containment factor value greater than 0 (see sections 4.2.2.1.2 and 3.1.2.1).
- Air migration.
  - — Hazardous substances that meet the criteria for an observed release to the atmosphere.
  - — All gaseous hazardous substances associated with a source with a gascontainment factor value greater than 0 (see section 6.1.2.1.1).
  - — All particulate hazardous substances associated with a source with a particulate containment factor value greater than 0 (see section 6.1.2.2.1).
- For each migration pathway, in those instances when the specific source(s) containing the hazardous substance cannot be documented, consider that hazardous substance to be available to migrate to the pathway when it can be associated (see section 2.2.2) with at least one source having a containment factor value greater than 0 for that pathway.

In evaluating the soil exposure pathway, consider the following hazardous substances available to the pathway:

- Soil exposure—resident population threat.
  - — All hazardous substances that meet the criteria for observed contamination at the site (see section 5.0.1).
- Soil exposure—nearby population threat.
  - — All hazardous substances that meet the criteria for observed contamination at areas with an attractiveness/accessibility factor value greater than 0 (see section 5.2.1.1).

2.3 *Likelihood of release.* Likelihood of release is a measure of the likelihood that a waste has been or will be released to the environment. The likelihood of release factor category is assigned the maximum value of 550 for a migration pathway whenever the criteria for an observed release are met for that pathway. If the criteria for an observed release are met, do not evaluate potential to release for that pathway. When the criteria for an observed release are not met, evaluate potential to release for that pathway, with a maximum value of 500. The evaluation of potential to release varies by migration pathway (see sections 3, 4 and 6).

Establish an observed release either by direct observation of the release of a hazardous substance into the media being evaluated (for example, surface water) or by chemical analysis of samples appropriate to the pathway being evaluated (see sections 3, 4, and 6). The minimum standard to establish an observed release by chemical analysis is analytical evidence of a hazardous substance in the media significantly above the background level. Further, some portion of the release must be attributable to the site. Use the criteria in Table 2-3 as the standard for determining analytical significance. (The criteria in Table 2-3 are also used in establishing observed contamination for the soil exposure pathway, see section 5.0.1.) Separate criteria apply to radionuclides (see section 7.1.1).

2.4 *Waste characteristics.* The waste characteristics factor cate-

TABLE 2-3.—OBSERVED RELEASE CRITERIA FOR CHEMICAL ANALYSIS

Sample Measurement < Sample Quantitation Limit[a]

No observed release is established.

Sample Measurement ≥ Sample Quantitation Limit[a]

An observed release is established as follows:

- If the background concentration is not detected (or is less than the detection limit), an observed release is established when the sample measurement equals or exceeds the sample quantitation limit.[a]
- If the background concentration equals or exceeds the detection limit, an observed release is established when the sample measurement is 3 times or more above the background concentration.

[a] If the sample quantitation limit (SQL) cannot be established, determine if there is an observed release as follows:

— If the sample analysis was performed under the EPA Contract Laboratory Program, use the EPA contract-required quantitation limit (CRQL) in place of the SQL.

— If the sample analysis is not performed under the EPA Contract Laboratory Program, use the detection limit (DL) in place of the SQL.

Exhibit 23

CERCLA Regulations and Keyword Index

1993 EDITION

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gory includes the following factors: hazardous waste quantity, toxicity, and as appropriate to the pathway or threat being evaluated, mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential.

2.4.1 *Selection of substance potentially posing greatest hazard.* For all pathways (and threats), select the hazardous substance potentially posing the greatest hazard for the pathway (or threat) and use that substance in evaluating the waste characteristics category of the pathway (or threat). For the three migration pathways (and threats), base the selection of this hazardous substance on the toxicity factor value for the substance, combined with its mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential factor values, as applicable to the migration pathway (or threat). For the soil exposure pathway, base the selection on the toxicity factor alone.

Evaluation of the toxicity factor is specified in section 2.4.1.1. Use and evaluation of the mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential factors vary by pathway (or threat) and are specified under the appropriate pathway (or threat) section. Section 2.4.1.2 identifies the specific factors that are combined with toxicity in evaluating each pathway (or threat).

2.4.1.1 *Toxicity factor.* Evaluate toxicity for those hazardous substances at the site that are available to the pathway being scored. For all pathways and threats, except the surface water environmental threat, evaluate human toxicity as specified below. For the surface water environmental threat, evaluate ecosystem toxicity as specified in section 4.1.4.2.1.1.

Establish human toxicity factor values based on quantitative dose-response parameters for the following three types of toxicity:

- Cancer—Use slope factors (also referred to as cancer potency factors) combined with weight-of-evidence ratings for carcinogenicity. If a slope factor is not available for a substance, use its ED_{10} value to estimate a slope factor as follows:

$$\text{Slope factor} = \frac{1}{6\,(ED_{10})}$$

- Noncancer toxicological responses of chronic exposure—use reference dose (RfD) values.
- Noncancer toxicological responses of acute exposure—use acute toxicity parameters, such as the LD_{50}.

Assign human toxicity factor values to a hazardous substance using Table 2-4, as follows:

- If RfD and slope factor values are both available for the hazardous substance, assign the substance a value from Table 2-4 for each. Select the higher of the two values assigned and use it as the overall toxicity factor value for the hazardous substance.
- If either an RfD or slope factor value is available, but not both, assign the hazardous substance an overall toxicity factor value from Table 2-4 based solely on the available value (RfD or slope factor).
- If neither an RfD nor slope factor value is available, assign the hazardous substance an overall toxicity factor value from Table 2-4 based solely on acute toxicity. That is, consider acute toxicity in Table 2-4 only when both RfD and slope factor values are not available.
- If neither an RfD, nor slope factor, nor acute toxicity value is available, assign the hazardous substance an overall toxicity factor value of 0 and use other hazardous substances for which information is available in evaluating the pathway.

TABLE 2-4.—TOXICITY FACTOR EVALUATION

Chronic Toxicity (Human)

Reference dose (RfD) (mg/kg-day)	Assigned value
RfD < 0.0005	10,000
0.0005 ≤ RfD < 0.005	1,000
0.005 ≤ RfD < 0.05	100
0.05 ≤ RfD < 0.5	10
0.5 ≤ RfD	1
RfD not available	0

Carcinogenicity (Human)

Weight-of-evidence[a]/slope factor $(mg/kg\text{-}day)^{-1}$			Assigned value
A	B	C	
0.5 ≤ SF[b]	5 ≤ SF	50 ≤ SF	10,000
0.05 ≤ SF < 0.5	0.5 ≤ SF < 5	5 ≤ SF < 50	1,000
SF < 0.05	0.05 ≤ SF < 0.5	0.5 ≤ SF < 5	100
—	SF < 0.05	SF < 0.5	10
Slope factor not available	Slope factor not available	Slope factor not available	0

[a] A, B, and C refer to weight-of-evidence categories. Assign substances with a weight-of-evidence category of D (inadequate evidence of carcinogenicity) or E (evidence of lack of carcinogenicity) a value of 0 for carcinogenicity.

[b] SF = Slope factor.

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TABLE 2-4.—TOXICITY FACTOR EVALUATION—Continued

Acute Toxicity (Human)

Oral LD_{50} (mg/kg)	Dermal LD_{50} (mg/kg)	Dust or mist LC_{50} (mg/l)	Gas or vapor LC_{50} (ppm)	Assigned value
---	---	---	---	---
$LD_{50} < 5$	$LD_{50} < 2$	$LC_{50} < 0.2$	$LC_{50} < 20$	1,000
$5 \leq LD_{50} < 50$	$2 \leq LD_{50} < 20$	$0.2 \leq LC_{50} < 2$	$20 \leq LC_{50} < 200$	100
$50 \leq LD_{50} < 500$	$20 \leq LD_{50} < 200$	$2 \leq LC_{50} < 20$	$200 \leq LC_{50} < 2{,}000$	10
$500 \leq LD_{50}$	$200 \leq LD_{50}$	$20 \leq LC_{50}$	$2{,}000 \leq LC_{50}$	1
LD_{50} not available	LD_{50} not available	LC_{50} not available	LC_{50} not available	0

If a toxicity factor value of 0 is assigned to all hazardous substances available to a particular pathway (that is, insufficient toxicity data are available for evaluating all the substances), use a default value of 100 as the overall human toxicity factor value for all hazardous substances available to the pathway. For hazardous substances having usable toxicity data for multiple exposure routes (for example, inhalation and ingestion), consider all exposure routes and use the highest assigned value, regardless of exposure route, as the toxicity factor value.

For HRS purposes, assign both asbestos and lead (and its compounds) a human toxicity factor value of 10,000.

Separate criteria apply for assigning factor values for human toxicity and ecosystem toxicity for radionuclides (see sections 7.2.1 and 7.2.2).

2.4.1.2 *Hazardous substance selection.* For each hazardous substance evaluated for a migration pathway (or threat), combine the human toxicity factor value (or ecosystem toxicity factor value) for the hazardous substance with a mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential factor value as follows:

- Ground water migration.
  - — Determine a combined human toxicity/mobility factor value for the hazardous substance (see section 3.2.1).
- Surface water migration-overland/flood migration component.
  - — Determine a combined human toxicity/persistence factor value for the hazardous substance for the drinking water threat (see section 4.1.2.2.1).
  - — Determine a combined human toxicity/persistence/bioaccumulation factor value for the hazardous substance for the human food chain threat (see section 4.1.3.2.1).
  - — Determine a combined ecosystem toxicity/persistence/bioaccumulation factor value for the hazardous substance for the environmental threat (see section 4.1.4.2.1).
- Surface water migration-ground water to surface water migration component.
  - — Determine a combined human toxicity/mobility/persistence factor value for the hazardous substance for the drinking water threat (see section 4.2.2.2.1).
  - — Determine a combined human toxicity/mobility/persistence/bioaccumulation factor value for the hazardous substance for the human food chain threat (see section 4.2.3.2.1).
  - — Determine a combined ecosystem toxicity/mobility/persistence/bioaccumulation factor value for the hazardous substance for the environmental threat (see section 4.2.4.2.1).
- Air migration.
  - — Determine a combined human toxicity/mobility factor value for the hazardous substance (see section 6.2.1).

Determine each combined factor value for a hazardous substance by multiplying the individual factor values appropriate to the pathway (or threat). For each migration pathway (or threat) being evaluated, select the hazardous substance with the highest combined factor value and use that substance in evaluating the waste characteristics factor category of the pathway (or threat).

For the soil exposure pathway, select the hazardous substance with the highest human toxicity factor value from among the substances that meet the criteria for observed contamination for the threat evaluated and use that substance in evaluating the waste characteristics factor category.

2.4.2 *Hazardous waste quantity.* Evaluate the hazardous waste quantity factor by first assigning each source (or area of observed contamination) a source hazardous waste quantity value as specified below. Sum these values to obtain the hazardous waste quantity factor value for the pathway being evaluated.

In evaluating the hazardous waste quantity factor for the three migration pathways, allocate hazardous substances and hazardous wastestreams to specific sources in the manner specified in section 2.2.2, except: consider hazardous substances and hazardous wastestreams that cannot be allocated to any specific source to constitute a separate "unallocated source" for purposes of evaluating only this factor for the three migration pathways. Do not, however, include a hazardous substance or hazardous wastestream in the unallocated source for a migration pathway if there

assign a dilution weight of 0.5 for a "3-mile mixing zone in quiet flowing river"; instead assign a dilution weight based on the average annual flow.

If PF is less than 1, do not round it to the nearest integer; if PF is 1 or more, round to the nearest integer. Enter the value assigned in Table 4-1.

4.1.3.3.2.4 *Calculation of population factor value.* Sum the values for the Level I concentrations, Level II concentrations, and potential human food chain contamination factors for the watershed. Do not round this sum to the nearest integer. Assign it as the population factor value for the watershed. Enter this value in Table 4-1.

4.1.3.3.3 *Calculation of human food chain threat-targets factor category value.* Sum the food chain individual and population factor values for the watershed. Do not round this sum to the nearest integer. Assign it as the human food chain threat-targets factor category value for the watershed. Enter this value in Table 4-1.

4.1.3.4 *Calculation of human food chain threat score for a watershed.* Multiply the human food chain threat factor category values for likelihood of release, waste characteristics, and targets for the watershed, and round the product to the nearest integer. Then divide by 82,500. Assign the resulting value, subject to a maximum of 100, as the human food chain threat score for the watershed. Enter this score in Table 4-1.

4.1.4 *Environmental threat.* Evaluate the environmental threat for the watershed based on three factor categories: likelihood of release, waste characteristics, and targets.

4.1.4.1 *Environmental threat-likelihood of release.* Assign the same likelihood of release factor category value for the environmental threat for the watershed as would be assigned in section 4.1.2.1.3 for the drinking water threat. Enter this value in Table 4-1.

4.1.4.2 *Environmental threat-waste characteristics.* Evaluate the waste characteristics factor category for each watershed based on two factors: ecosystem toxicity/persistence/bioaccumulation and hazardous waste quantity.

TABLE 4-19.—ECOSYSTEM TOXICITY FACTOR VALUES

If an EPA chronic AWQC[a] or AALAC[b] is available, assign a value as follows:[c]

EPA chronic AWQC or AALAC	Assigned value
Less than 1 µg/l	10,000
1 to 10 µg/l	1,000
Greater than 10 to 100 µg/l	100
Greater than 100 to 1,000 µg/l	10
Greater than 1,000 µg/l	1

If neither an EPA chronic AWQC nor EPA chronic AALAC is available, assign a value based on the EPA acute AWQC or AALAC as follows:[c]

EPA acute AWQC or AALAC	Assigned value
Less than 100 µg/l	10,000
100 to 1,000 µg/l	1,000
Greater than 1,000 to 10,000 µg/l	100
Greater than 10,000 to 100,000 µg/l	10
Greater than 100,000 µg/l	1

If neither an EPA chronic or acute AWQC nor EPA chronic or acute AALAC is available, assign a value from the LC_{50} as follows:

LC_{50}	Assigned value
Less than 100 µg/l	10,000
100 to 1,000 µg/l	1,000
Greater than 1,000 to 10,000 µg/l	100
Greater than 10,000 to 100,000 µg/l	10
Greater than 100,000 µg/l	1

If none of the AWQCs and AALACs nor the LC_{50} is available, assign a value of 0.

[a]AWQC—Ambient Water Quality Criteria.

[b]AALAC—Ambient Aquatic Life Advisory Concentrations.

[c]Use the AWQC value in preference to the AALAC when both are available. See text for use of fresh water and marine values.

4.1.4.2.1 *Ecosystem toxicity/persistence/bioaccumulation.* Evaluate all those hazardous substances eligible to be evaluated for toxicity/persistence in the drinking water threat for the watershed (see section 4.1.2.2).

4.1.4.2.1.1 *Ecosystem toxicity.* Assign an ecosystem toxicity factor value from Table 4-19 to each hazardous substance on the basis of the following data hierarchy:

- EPA chronic Ambient Water Quality Criterion (AWQC) for the substance.
- EPA chronic Ambient Aquatic Life Advisory Concentrations (AALAC) for the substance.
- EPA acute AWQC for the substance.
- EPA acute AALAC for the substance.
- Lowest LC_{50} value for the substance.

In assigning the ecosystem toxicity factor value to the hazardous substance:

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- If either an EPA chronic AWQC or AALAC is available for the hazardous substance, use it to assign the ecosystem toxicity factor value. Use the chronic AWQC in preference to the chronic AALAC when both are available.
- If neither is available, use the EPA acute AWQC or AALAC to assign the ecosystem toxicity factor value. Use the acute AWQC in preference to the acute AALAC.
- If none of the chronic and acute AWQCs and AALACs is available, use the lowest LC_{50} value to assign the ecosystem toxicity factor value.
- If an LC_{50} value is also not available, assign an ecosystem toxicity factor value of 0 to the hazardous substance and use other hazardous substances for which data are available in evaluating the pathway.

If an ecosystem toxicity factor value of 0 is assigned to all hazardous substances eligible to be evaluated for the watershed (that is, insufficient data are available for evaluating all the substances), use a default value of 100 as the ecosystem toxicity factor value for all these hazardous substances.

With regard to the AWQC, AALAC, or LC_{50} selected for assigning the ecosystem toxicity factor value to the hazardous substance:

- If values for the selected AWQC, AALAC, or LC_{50} are available for both fresh water and marine water for the hazardous substance, use the value that corresponds to the type of water body (that is, fresh water or salt water) in which the sensitive environments are located to assign the ecosystem toxicity factor value to the hazardous substance.
- If, however, some of the sensitive environments being evaluated are in fresh water and some are in salt water, or if any are in brackish water, use the value (fresh water or marine) that yields the higher factor value to assign the ecosystem toxicity factor value to the hazardous substance.
- If a value for the selected AWQC, AALAC, or LC_{50} is available for either fresh water or marine water, but not for both, use the available one to assign an ecosystem toxicity factor value to the hazardous substance.

4.1.4.2.1.2 *Persistence.* Assign a persistence factor value to each hazardous substance as specified in section 4.1.2.2.1.2, except: use the predominant water category (that is lakes; or rivers, oceans, coastal tidal waters, or Great Lakes) between the probable point of entry and the nearest sensitive environment (not the nearest drinking water or resources intake) along the hazardous substance migration path for the watershed to determine which portion of Table 4-10 to use. Determine the predominant water category based on distance as specified in section 4.1.2.2.1.2. For contaminated sediments with no identified source, use the point where measurement begins rather than the probable point of entry.

4.1.4.2.1.3 *Ecosystem bioaccumulation potential.* Assign an ecosystem bioaccumulation potential factor value to each hazardous substance in the same manner specified for the bioaccumulation potential factor in section 4.1.3.2.1.3, except:

- Use BCF data for all aquatic organisms, not just for aquatic human food chain organisms.
- Use the BCF data that corresponds to the type of water body (that is, fresh water or salt water) in which the sensitive environments (not fisheries) are located.

4.1.4.2.1.4 *Calculation of ecosystem toxicity/persistence/bioaccumulation factor value.* Assign each hazardous substance an ecosystem toxicity/ persistence factor value from Table 4-20, based on the values assigned to the hazardous substance for the ecosystem toxicity and persistence factors. Then assign each hazardous substance an ecosystem toxicity/persistence/ bioaccumulation factor value from Table 4-21, based on the values assigned for the ecosystem toxicity/persistence and ecosystem bioaccumulation potential factors. Select the hazardous substance with the highest ecosystem toxicity/persistence/bioaccumulation factor value for the watershed and use it to assign the value to this factor. Enter this value in Table 4-1.

TABLE 4-20.—ECOSYSTEM TOXICITY/PERSISTENCE FACTOR VALUES[a]

Persistence factor value	Ecosystem toxicity factor value					
	10,000	1,000	100	10	1	0
1.0	10,000	1,000	100	10	1	0
0.4	4,000	400	40	4	0.4	0
0.07	700	70	7	0.7	0.07	0
0.0007	7	0.7	0.07	0.007	0.0007	0

[a]Do not round to nearest integer.

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to each floodplain category in which the source does not lie.

4.1.2.1.2.2.2 *Flood frequency.* For each source within the watershed, separately evaluate the flood frequency factor for each category of floodplain in which the source is partially or wholly located. Assign a flood frequency factor value from Table 4-9 to each floodplain category in which the source is located.

4.1.2.1.2.2.3 *Calculation of factor value for potential to release by flood.* For each source within the watershed and for each category of floodplain in which the source is partially or wholly located, calculate a separate potential to release by flood factor value. Calculate this value as the product of the containment (flood) value and the flood frequency value applicable to the source for the floodplain category. Select the highest value calculated for those sources that meet the minimum size requirement specified in section 4.1.2.1.2.1.1 and assign it as the value for the potential to release by flood factor for the watershed. However, if, for this watershed, no source at the site meets the minimum size requirement, select the highest value calculated for the sources at the site eligible to be evaluated for this watershed and assign it as the value for this factor.

TABLE 4-8.—CONTAINMENT (FLOOD) FACTOR VALUES

Containment criteria	Assigned value
Documentation that containment at the source is designed, constructed, operated, and maintained to prevent a washout of hazardous substances by the flood being evaluated.	0
Other	10

TABLE 4-9.—FLOOD FREQUENCY FACTOR VALUES

Floodplain category	Assigned value
Source floods annually	50
Source in 10-year floodplain	50
Source in 100-year floodplain	25
Source in 500-year floodplain	7
None of above	0

Enter this highest potential to release by flood factor value for the watershed in Table 4-1, as well as the values for containment (flood) and flood frequency that yield this highest value.

4.1.2.1.2.3 *Calculation of potential to release factor value.* Sum the factor values assigned to the watershed for potential to release by overland flow and potential to release by flood. Assign this sum as the potential to release factor value for the watershed, subject to a maximum value of 500. Enter this value in Table 4-1.

4.1.2.1.3 *Calculation of drinking water threat-likelihood of release factor category value.* If an observed release is established for the watershed, assign the observed release factor value of 550 as the likelihood of release factor category value for that watershed. Otherwise, assign the potential to release factor value for that watershed as the likelihood of release factor category value for that watershed. Enter the value assigned in Table 4-1.

4.1.2.2 *Drinking water threat-waste characteristics.* Evaluate the waste characteristics factor category for each watershed based on two factors: toxicity/persistence and hazardous waste quantity. Evaluate only those hazardous substances that are available to migrate from the sources at the site to surface water in the watershed via the overland/flood hazardous substance migration path for the watershed (see section 4.1.1.1). Such hazardous substances include:

- Hazardous substances that meet the criteria for an observed release to surface water in the watershed.
- All hazardous substances associated with a source that has a surface water containment factor value greater than 0 for the watershed (see sections 2.2.2, 2.2.3, 4.1.2.1.2.1.1, and 4.1.2.1.2.2.1).

4.1.2.2.1 *Toxicity/persistence.* For each hazardous substance, assign a toxicity factor value, a persistence factor value, and a combined toxicity/persistence factor value as specified in sections 4.1.2.2.1.1 through 4.1.2.2.1.3. Select the toxicity/persistence factor value for the watershed as specified in section 4.1.2.2.1.3.

4.1.2.2.1.1 *Toxicity.* Assign a toxicity factor value to each hazardous substance as specified in section 2.4.1.1.

4.1.2.2.1.2 *Persistence.* Assign a persistence factor value to each hazardous substance. In assigning this value, evaluate persistence based primarily on the half-life of the hazardous substance in surface water and secondarily on the sorption of the hazardous substance to sediments. The half-life in surface water is defined for HRS purposes as the time required to reduce the initial concentration in surface water by one-half as a result of the combined decay processes of biodegradation, hydrolysis, photolysis,

and volatilization. Sorption to sediments is evaluated for the HRS based on the logarithm of the n-octanol-water partition coefficient (log K_{ow}) of the hazardous substance.

Estimate the half-life ($t_{1/2}$) of a hazardous substance as follows:

$$t_{1/2} = \frac{1}{\frac{1}{h} + \frac{1}{b} + \frac{1}{p} + \frac{1}{v}}$$

where:

h = Hydrolysis half-life.

b = Biodegradation half-life.

p = Photolysis half-life.

v = Volatilization half-life.

If one or more of these four component half-lives cannot be estimated for the hazardous substance from available data, delete that component half-life from the above equation. If none of these four component half-lives can be estimated for the hazardous substance from available data, use the default procedure indicated below. Estimate a half-life for the hazardous substance for lakes or for rivers, oceans, coastal tidal waters, and Great Lakes, as appropriate.

If a half-life can be estimated for a hazardous substance:

- Assign that hazardous substance a persistence factor value from the appropriate portion of Table 4-10 (that is lakes; or rivers, oceans, coastal tidal waters, and Great Lakes).
- Select the appropriate portion of Table 4-10 as follows:
  - — If there is one or more drinking water intakes along the hazardous substance migration path for the watershed, select the nearest drinking water intake as measured from the probable point of entry. If the in- water segment between the probable point of entry and this selected intake includes both lakes and other water bodies, use the lakes portion of Table 4-10 only if more than half the distance to this selected intake lies in lake(s). Otherwise, use the rivers, oceans, coastal tidal waters, and Great Lakes portion of Table 4-10. For contaminated sediments with no identified source, use the point where measurement begins (see section 4.1.1.2) rather than the probable point of entry.
  - — If there are no drinking water intakes but there are intakes or points of use for any of the resource types listed in section 4.1.2.3.3, select the nearest such intake or point of use. Select the portion of Table 4-10 based on this intake or point of use in the manner specified for drinking water intakes.
  - — If there are no drinking water intakes and no specified resource intakes and points of use, but there is another type of resource listed in section 4.1.2.3.3 (for example, the water is usable for drinking water purposes even though not used), select the portion of Table 4-10 based on the nearest point of this resource in the manner specified for drinking water intakes.

If a half-life cannot be estimated for a hazardous substance from available data, use the following default procedure to assign a persistence factor value to that hazardous substance:

TABLE 4-10.—PERSISTENCE FACTOR VALUES—HALF-LIFE

Surface water category	Substance half-life (days)	Assigned value[a]
Rivers, oceans, coastal tidal waters, and Great Lakes	Less than or equal to 0.2	0.0007
	Greater than 0.2 to 0.5	0.07
	Greater than 0.5 to 1.5	0.4
	Greater than 1.5	1
Lakes	Less than or equal to 0.02	0.0007
	Greater than 0.02 to 2	0.07
	Greater than 2 to 20	0.4
	Greater than 20	1

[a]Do not round to nearest integer.

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- For those hazardous substances that are metals (or metalloids), assign a persistence factor value of 1 as a default for all surface water bodies.
- For other hazardous substances (both organic and inorganic), assign a persistence factor value of 0.4 as a default for rivers, oceans, coastal tidal waters, and Great Lakes, and a persistence factor value of 0.07 as a default for lakes. Select the appropriate value in the same manner specified for using Table 4-10.

Use the persistence factor value assigned based on half-life or the default procedure unless the hazardous substance can be assigned a higher factor value from Table 4-11, based on its Log K_{ow}. If a higher value can be assigned from Table 4-11, assign this higher value as the persistence factor value for the hazardous substance.

4.1.2.2.1.3 *Calculation of toxicity/persistence factor value.* Assign each hazardous substance a toxicity/persistence factor value from Table 4-12, based on the values assigned to the hazardous substance for the toxicity and persistence factors. Use the hazardous substance with the highest toxicity/persistence factor value for the watershed to assign the toxicity/persistence factor value for the drinking water threat for the watershed. Enter this value in Table 4-1.

TABLE 4-11.—PERSISTENCE FACTOR VALUES—LOG K_{ow}

Log K_{ow}	Assigned value[a]
Less than 3.5	0.0007
3.5 to less than 4.0	0.07
4.0 to 4.5	0.4
Greater than 4.5	1

[a]Use for lakes, rivers, oceans, coastal tidal waters, and Great Lakes. Do not round to nearest integer.

TABLE 4-12.—TOXICITY/PERSISTENCE FACTOR VALUES[a]

Persistence factor value	Toxicity factor value					
	10,000	1,000	100	10	1	0
1.0	10,000	1,000	100	10	1	0
0.4	4,000	400	40	4	0.4	0
0.07	700	70	7	0.7	0.07	0
0.0007	7	0.7	0.07	0.007	0.0007	0

[a]Do not round to nearest integer.

4.1.2.2.2 *Hazardous waste quantity.* Assign a hazardous waste quantity factor value for the watershed as specified in section 2.4.2. Enter this value in Table 4-1.

4.1.2.2.3 *Calculation of drinking water threat-waste characteristics factor category value.* Multiply the toxicity/persistence and hazardous waste quantity factor values for the watershed, subject to a maximum product of 1×10^8. Based on this product, assign a value from Table 2-7 (section 2.4.3.1) to the drinking water threat-waste characteristics factor category for the watershed. Enter this value in Table 4-1.

4.1.2.3 *Drinking water threat-targets.* Evaluate the targets factor category for each watershed based on three factors: nearest intake, population, and resources.

To evaluate the nearest intake and population factors, determine whether the target surface water intakes are subject to actual or potential contamination as specified in section 4.1.1.2. Use either an observed release based on direct observation at the intake or the exposure concentrations from samples (or comparable samples) taken at or beyond the intake to make this determination (see section 4.1.2.1.1). The exposure concentrations for a sample (that is, surface water, benthic, or sediment sample) consist of the concentrations of those hazardous substances present that are significantly above background levels and attributable at least in part to the site (that is, those hazardous substance concentrations that meet the criteria for an observed release).

When an intake is subject to actual contamination, evaluate it using Level I concentrations or Level II concentrations. If the actual contamination is based on an observed release by direct observation, use Level II concentrations for that intake. However, if the actual contamination is based on an observed release from samples, determine which level applies for the intake by comparing the exposure concentrations from samples (or comparable samples) to health-based benchmarks as specified in sections 2.5.1 and 2.5.2. Use the health-based benchmarks from Table 3-10 (section 3.3.1) in determining the level of contamination from samples. For contaminated sediments with no identified source, evaluate the actual contamination using Level II concentrations (see section 4.1.1.2).

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(see section 4.1.2.2.1.2), except: use the predominant water category (that is, lakes; or rivers, oceans, coastal tidal waters, or Great Lakes) between the probable point of entry and the nearest fishery (not the nearest drinking water or resources intake) along the hazardous substance migration path for the watershed to determine which portion of Table 4-10 to use. Determine the predominant water category based on distance as specified in section 4.1.2.2.1.2. For contaminated sediments with no identified source, use the point where measurement begins rather than the probable point of entry.

4.1.3.2.1.3 *Bioaccumulation potential.* Use the following data hierarchy to assign a bioaccumulation potential factor value to each hazardous substance:

- Bioconcentration factor (BCF) data.
- Logarithm of the n-octanol-water partition coefficient (log K_{ow}) data.
- Water solubility data.

Assign a bioaccumulation potential factor value to each hazardous substance from Table 4-15.

If BCF data are available for any aquatic human food chain organism for the substance being evaluated, assign the bioaccumulation potential factor value to the hazardous substance as follows:

- If BCF data are available for both fresh water and salt water for the hazardous substance, use the BCF data that correspond to the type of water body (that is, fresh water or salt water) in which the fisheries are located to assign the bioaccumulation potential factor value to the hazardous substance.
- If, however, some of the fisheries being evaluated are in fresh water and some are in salt water, or if any are in brackish water, use the BCF data that yield the higher factor value to assign the bioaccumulation potential factor value to the hazardous substance.
- If BCF data are available for either fresh water or salt water, but not for both, use the available BCF data to assign the bioaccumulation potential factor value to the hazardous substance.

TABLE 4-15.—BIOACCUMULATION POTENTIAL FACTOR VALUES[a]

If bioconcentration factor (BCF) data are available for any aquatic human food chain organism, assign a value as follows:[b]

BCF	Assigned value
Greater than or equal to 10,000	50,000
1,000 to less than 10,000	5,000
100 to less than 1,000	500
10 to less than 100	50
1 to less than 10	5
Less than 1	0.5

If BCF data are not available, and log K_{ow} data are available and do not exceed 6.0, assign a value to an organic hazardous substance as follows (for inorganic hazardous substances, skip this step and proceed to the next):

Log K_{ow}	Assigned value
5.5 to 6.0	50,000
4.5 to less than 5.5	5,000
3.2 to less than 4.5	500
2.0 to less than 3.2	50
0.8 to less than 2.0	5
Less than 0.8	0.5

If BCF data are not available, and if either Log K_{ow} data are not available, a log K_{ow} is available but exceeds 6.0, or the substance is an inorganic substance, assign a value as follows:

Water solubility (mg/l)	Assigned value
Less than 25	50,000
25 to 500	5,000
Greater than 500 to 1,500	500
Greater than 1,500	0.5

If none of these data are available, assign a value of 0.5.

[a]Do not round to nearest integer.

[b]See text for use of freshwater and saltwater BCF data.

If BCF data are not available for the hazardous substance, use log K_{ow} data to assign a bioaccumulation potential factor value to organic substances, but not to inorganic substances. If BCF data are not available, and if either log K_{ow} data are not available, the log K_{ow} is available but exceeds 6.0, or the substance is an inorganic substance, use water solubility data to assign a bioaccumulation potential factor value.

Do not distinguish between fresh water and salt water in assigning the bioaccumulation potential factor value based on log K_{ow} or water solubility data.

If none of these data are available, assign the hazardous substance a bioaccumulation potential factor value of 0.5.

4.1.3.2.1.4 *Calculation of toxicity/persistence/bioaccumulation factor value.* Assign each hazardous substance a toxicity/persistence factor value from Table 4-12, based on the values assigned to the hazardous substance for the toxicity and persistence factors. Then assign each hazardous substance a toxicity/persistence/bioaccumulation factor value from Table 4-16, based on

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the values assigned for the toxicity/persistence and bioaccumulation potential factors. Use the hazardous substance with the highest toxicity/ persistence/bioaccumulation factor value for the watershed to assign the value to this factor. Enter this value in Table 4-1.

TABLE 4-16.—TOXICITY/PERSISTENCE/BIOACCUMULATION FACTOR VALUES[a]

Toxicity/ Persistence Factor Value	Bioaccumulation Potential Factor Value					
	50,000	5,000	500	50	5	0.5
10,000	5×10^8	5×10^7	5×10^6	5×10^5	5×10^4	5,000
4,000	2×10^8	2×10^7	2×10^6	2×10^5	2×10^4	2,000
1,000	5×10^7	5×10^6	5×10^5	5×10^4	5,000	500
700	3.5×10^7	3.5×10^6	3.5×10^5	3.5×10^4	3,500	350
400	2×10^7	2×10^6	2×10^5	2×10^4	2,000	200
100	5×10^6	5×10^5	5×10^4	5,000	500	50
70	3.5×10^6	3.5×10^5	3.5×10^4	3,500	350	35
40	2×10^6	2×10^5	2×10^4	2,000	200	20
10	5×10^5	5×10^4	5,000	500	50	5
7	3.5×10^5	3.5×10^4	3,500	350	35	3.5
4	2×10^5	2×10^4	2,000	200	20	2
1	5×10^4	5,000	500	50	5	0.5
0.7	3.5×10^4	3,500	350	35	3.5	0.35
0.4	2×10^4	2,000	200	20	2	0.2
0.07	3,500	350	35	3.5	0.35	0.035
0.007	350	35	3.5	0.35	0.035	0.0035
0.0007	35	3.5	0.35	0.035	0.0035	0.00035
0	0	0	0	0	0	0

[a]Do not round to nearest integer.

4.1.3.2.2 *Hazardous waste quantity.* Assign the same factor value for hazardous waste quantity for the watershed as would be assigned in section 4.1.2.2.2 for the drinking water threat. Enter this value in Table 4-1.

4.1.3.2.3 *Calculation of human food chain threat-waste characteristics factor category value.* For the hazardous substance selected for the watershed in section 4.1.3.2.1.4, use its toxicity/persistence factor value and bioaccumulation potential factor value as follows to assign a value to the waste characteristics factor category. First, multiply the toxicity/persistence factor value and the hazardous waste quantity factor value for the watershed, subject to a maximum product of 1×10^8. Then multiply this product by the bioaccumulation potential factor value for this hazardous substance, subject to a maximum product of 1×10^{12}. Based on this second product, assign a value from Table 2-7 (section 2.4.3.1) to the human food chain threat-waste characteristics factor category for the watershed. Enter this value in Table 4-1.

4.1.3.3 *Human food chain threat-targets.* Evaluate two target factors for each watershed: food chain individual and population. For both factors, determine whether the target fisheries are subject to actual or potential human food chain contamination.

Consider a fishery (or portion of a fishery) within the target distance limit of the watershed to be subject to actual human food chain contamination if any of the following apply:

- A hazardous substance having a bioaccumulation potential factor value of 500 or greater is present either in an observed release by direct observation to the watershed or in a surface water or sediment sample from the watershed at a level that meets the criteria for an observed release to the watershed from the site, and at least a portion of the fishery is within the boundaries of the observed release (that is, it is located either at the point of direct observation or at or between the probable point of entry and the most distant sampling point establishing the observed release).
- The fishery is closed, and a hazardous substance for which the fishery has been closed has been documented in an observed release to the watershed from the site, and at least a portion of the fishery is within the boundaries of the observed release.
- A hazardous substance is present in a tissue sample from an essentially sessile, benthic, human food chain organism from the watershed at a level that meets the criteria for an observed release to the watershed from the site, and at least a portion of the fishery is within the boundaries of the observed release.

For a fishery that meets any of these three criteria, but that is not wholly within the boundaries of the observed release, consider only the portion of the fishery that is within the boundaries of the observed release to be subject to actual human food chain contamination. Consider the remainder of the fishery within the target distance limit to be subject to potential food chain contamination.

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- For those hazardous substances that are metals (or metalloids), assign a persistence factor value of 1 as a default for all surface water bodies.
- For other hazardous substances (both organic and inorganic), assign a persistence factor value of 0.4 as a default for rivers, oceans, coastal tidal waters, and Great Lakes, and a persistence factor value of 0.07 as a default for lakes. Select the appropriate value in the same manner specified for using Table 4-10.

Use the persistence factor value assigned based on half-life or the default procedure unless the hazardous substance can be assigned a higher factor value from Table 4-11, based on its Log K_{ow}. If a higher value can be assigned from Table 4-11, assign this higher value as the persistence factor value for the hazardous substance.

4.1.2.2.1.3 *Calculation of toxicity/persistence factor value.* Assign each hazardous substance a toxicity/persistence factor value from Table 4-12, based on the values assigned to the hazardous substance for the toxicity and persistence factors. Use the hazardous substance with the highest toxicity/persistence factor value for the watershed to assign the toxicity/persistence factor value for the drinking water threat for the watershed. Enter this value in Table 4-1.

TABLE 4-11.—PERSISTENCE FACTOR VALUES—LOG K_{ow}

Log K_{ow}	Assigned value[a]
Less than 3.5	0.0007
3.5 to less than 4.0	0.07
4.0 to 4.5	0.4
Greater than 4.5	1

[a]Use for lakes, rivers, oceans, coastal tidal waters, and Great Lakes. Do not round to nearest integer.

TABLE 4-12.—TOXICITY/PERSISTENCE FACTOR VALUES[a]

Persistence factor value	Toxicity factor value					
	10,000	1,000	100	10	1	0
1.0	10,000	1,000	100	10	1	0
0.4	4,000	400	40	4	0.4	0
0.07	700	70	7	0.7	0.07	0
0.0007	7	0.7	0.07	0.007	0.0007	0

[a]Do not round to nearest integer.

4.1.2.2.2 *Hazardous waste quantity.* Assign a hazardous waste quantity factor value for the watershed as specified in section 2.4.2. Enter this value in Table 4-1.

4.1.2.2.3 *Calculation of drinking water threat-waste characteristics factor category value.* Multiply the toxicity/persistence and hazardous waste quantity factor values for the watershed, subject to a maximum product of 1×10^8. Based on this product, assign a value from Table 2-7 (section 2.4.3.1) to the drinking water threat-waste characteristics factor category for the watershed. Enter this value in Table 4-1.

4.1.2.3 *Drinking water threat-targets.* Evaluate the targets factor category for each watershed based on three factors: nearest intake, population, and resources.

To evaluate the nearest intake and population factors, determine whether the target surface water intakes are subject to actual or potential contamination as specified in section 4.1.1.2. Use either an observed release based on direct observation at the intake or the exposure concentrations from samples (or comparable samples) taken at or beyond the intake to make this determination (see section 4.1.2.1.1). The exposure concentrations for a sample (that is, surface water, benthic, or sediment sample) consist of the concentrations of those hazardous substances present that are significantly above background levels and attributable at least in part to the site (that is, those hazardous substance concentrations that meet the criteria for an observed release).

When an intake is subject to actual contamination, evaluate it using Level I concentrations or Level II concentrations. If the actual contamination is based on an observed release by direct observation, use Level II concentrations for that intake. However, if the actual contamination is based on an observed release from samples, determine which level applies for the intake by comparing the exposure concentrations from samples (or comparable samples) to health-based benchmarks as specified in sections 2.5.1 and 2.5.2. Use the health-based benchmarks from Table 3-10 (section 3.3.1) in determining the level of contamination from samples. For contaminated sediments with no identified source, evaluate the actual contamination using Level II concentrations (see section 4.1.1.2).

(see section 4.1.2.2.1.2), except: use the predominant water category (that is, lakes; or rivers, oceans, coastal tidal waters, or Great Lakes) between the probable point of entry and the nearest fishery (not the nearest drinking water or resources intake) along the hazardous substance migration path for the watershed to determine which portion of Table 4-10 to use. Determine the predominant water category based on distance as specified in section 4.1.2.2.1.2. For contaminated sediments with no identified source, use the point where measurement begins rather than the probable point of entry.

4.1.3.2.1.3 *Bioaccumulation potential.* Use the following data hierarchy to assign a bioaccumulation potential factor value to each hazardous substance:

- Bioconcentration factor (BCF) data.
- Logarithm of the n-octanol-water partition coefficient (log K_{ow}) data.
- Water solubility data.

Assign a bioaccumulation potential factor value to each hazardous substance from Table 4-15.

If BCF data are available for any aquatic human food chain organism for the substance being evaluated, assign the bioaccumulation potential factor value to the hazardous substance as follows:

- If BCF data are available for both fresh water and salt water for the hazardous substance, use the BCF data that correspond to the type of water body (that is, fresh water or salt water) in which the fisheries are located to assign the bioaccumulation potential factor value to the hazardous substance.
- If, however, some of the fisheries being evaluated are in fresh water and some are in salt water, or if any are in brackish water, use the BCF data that yield the higher factor value to assign the bioaccumulation potential factor value to the hazardous substance.
- If BCF data are available for either fresh water or salt water, but not for both, use the available BCF data to assign the bioaccumulation potential factor value to the hazardous substance.

TABLE 4-15.—BIOACCUMULATION POTENTIAL FACTOR VALUES[a]

If bioconcentration factor (BCF) data are available for any aquatic human food chain organism, assign a value as follows:[b]

BCF	Assigned value
Greater than or equal to 10,000	50,000
1,000 to less than 10,000	5,000
100 to less than 1,000	500
10 to less than 100	50
1 to less than 10	5
Less than 1	0.5

If BCF data are not available, and log K_{ow} data are available and do not exceed 6.0, assign a value to an organic hazardous substance as follows (for inorganic hazardous substances, skip this step and proceed to the next):

Log K_{ow}	Assigned value
5.5 to 6.0	50,000
4.5 to less than 5.5	5,000
3.2 to less than 4.5	500
2.0 to less than 3.2	50
0.8 to less than 2.0	5
Less than 0.8	0.5

If BCF data are not available, and if either Log K_{ow} data are not available, a log K_{ow} is available but exceeds 6.0, or the substance is an inorganic substance, assign a value as follows:

Water solubility (mg/l)	Assigned value
Less than 25	50,000
25 to 500	5,000
Greater than 500 to 1,500	500
Greater than 1,500	0.5

If none of these data are available, assign a value of 0.5.

[a]Do not round to nearest integer.

[b]See text for use of freshwater and saltwater BCF data.

If BCF data are not available for the hazardous substance, use log K_{ow} data to assign a bioaccumulation potential factor value to organic substances, but not to inorganic substances. If BCF data are not available, and if either log K_{ow} data are not available, the log K_{ow} is available but exceeds 6.0, or the substance is an inorganic substance, use water solubility data to assign a bioaccumulation potential factor value.

Do not distinguish between fresh water and salt water in assigning the bioaccumulation potential factor value based on log K_{ow} or water solubility data.

If none of these data are available, assign the hazardous substance a bioaccumulation potential factor value of 0.5.

4.1.3.2.1.4 *Calculation of toxicity/persistence/bioaccumulation factor value.* Assign each hazardous substance a toxicity/persistence factor value from Table 4-12, based on the values assigned to the hazardous substance for the toxicity and persistence factors. Then assign each hazardous substance a toxicity/persistence/bioaccumulation factor value from Table 4-16, based on

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the values assigned for the toxicity/persistence and bioaccumulation potential factors. Use the hazardous substance with the highest toxicity/ persistence/bioaccumulation factor value for the watershed to assign the value to this factor. Enter this value in Table 4-1.

TABLE 4-16.—TOXICITY/PERSISTENCE/BIOACCUMULATION FACTOR VALUES[a]

Toxicity/ Persistence Factor Value	Bioaccumulation Potential Factor Value					
	50,000	5,000	500	50	5	0.5
10,000	5×10^8	5×10^7	5×10^6	5×10^5	5×10^4	5,000
4,000	2×10^8	2×10^7	2×10^6	2×10^5	2×10^4	2,000
1,000	5×10^7	5×10^6	5×10^5	5×10^4	5,000	500
700	3.5×10^7	3.5×10^6	3.5×10^5	3.5×10^4	3,500	350
400	2×10^7	2×10^6	2×10^5	2×10^4	2,000	200
100	5×10^6	5×10^5	5×10^4	5,000	500	50
70	3.5×10^6	3.5×10^5	3.5×10^4	3,500	350	35
40	2×10^6	2×10^5	2×10^4	2,000	200	20
10	5×10^5	5×10^4	5,000	500	50	5
7	3.5×10^5	3.5×10^4	3,500	350	35	3.5
4	2×10^5	2×10^4	2,000	200	20	2
1	5×10^4	5,000	500	50	5	0.5
0.7	3.5×10^4	3,500	350	35	3.5	0.35
0.4	2×10^4	2,000	200	20	2	0.2
0.07	3,500	350	35	3.5	0.35	0.035
0.007	350	35	3.5	0.35	0.035	0.0035
0.0007	35	3.5	0.35	0.035	0.0035	0.00035
0	0	0	0	0	0	0

[a]Do not round to nearest integer.

4.1.3.2.2 *Hazardous waste quantity.* Assign the same factor value for hazardous waste quantity for the watershed as would be assigned in section 4.1.2.2.2 for the drinking water threat. Enter this value in Table 4-1.

4.1.3.2.3 *Calculation of human food chain threat-waste characteristics factor category value.* For the hazardous substance selected for the watershed in section 4.1.3.2.1.4, use its toxicity/persistence factor value and bioaccumulation potential factor value as follows to assign a value to the waste characteristics factor category. First, multiply the toxicity/persistence factor value and the hazardous waste quantity factor value for the watershed, subject to a maximum product of 1×10^8. Then multiply this product by the bioaccumulation potential factor value for this hazardous substance, subject to a maximum product of 1×10^{12}. Based on this second product, assign a value from Table 2-7 (section 2.4.3.1) to the human food chain threat-waste characteristics factor category for the watershed. Enter this value in Table 4-1.

4.1.3.3 *Human food chain threat-targets.* Evaluate two target factors for each watershed: food chain individual and population. For both factors, determine whether the target fisheries are subject to actual or potential human food chain contamination.

Consider a fishery (or portion of a fishery) within the target distance limit of the watershed to be subject to actual human food chain contamination if any of the following apply:

- A hazardous substance having a bioaccumulation potential factor value of 500 or greater is present either in an observed release by direct observation to the watershed or in a surface water or sediment sample from the watershed at a level that meets the criteria for an observed release to the watershed from the site, and at least a portion of the fishery is within the boundaries of the observed release (that is, it is located either at the point of direct observation or at or between the probable point of entry and the most distant sampling point establishing the observed release).
- The fishery is closed, and a hazardous substance for which the fishery has been closed has been documented in an observed release to the watershed from the site, and at least a portion of the fishery is within the boundaries of the observed release.
- A hazardous substance is present in a tissue sample from an essentially sessile, benthic, human food chain organism from the watershed at a level that meets the criteria for an observed release to the watershed from the site, and at least a portion of the fishery is within the boundaries of the observed release.

For a fishery that meets any of these three criteria, but that is not wholly within the boundaries of the observed release, consider only the portion of the fishery that is within the boundaries of the observed release to be subject to actual human food chain contamination. Consider the remainder of the fishery within the target distance limit to be subject to potential food chain contamination.

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4.1.2.3.1 *Nearest intake.* Evaluate the nearest intake factor based on the drinking water intakes along the overland/flood hazardous substance migration path for the watershed. Include standby intakes in evaluating this factor only if they are used for supply at least once a year.

Assign the nearest intake factor a value as follows and enter the value in Table 4-1:

- If one or more of these drinking water intakes is subject to Level I concentrations as specified in section 4.1.2.3, assign a factor value of 50.
- If not, but if one or more of these drinking water intakes is subject to Level II concentrations, assign a factor value of 45.
- If none of these drinking water intakes is subject to Level I or Level II concentrations, determine the nearest of these drinking water intakes, as measured from the probable point of entry (or from the point where measurement begins for contaminated sediments with no identified source). Assign a dilution weight from Table 4-13 to this intake, based on the type of surface water body in which it is located. Multiply this dilution weight by 20, round the product to the nearest integer, and assign it as the factor value.

TABLE 4-13.—SURFACE WATER DILUTION WEIGHTS

Type of surface water body[a]		Assigned dilution weight[b]
Descriptor	Flow characteristics	
Minimal stream	Less than 10 cfs[c]	1
Small to moderate stream	10 to 100 cfs	0.1
Moderate to large stream	Greater than 100 to 1,000 cfs	0.01
Large stream to river	Greater than 1,000 to 10,000 cfs	0.001
Large river	Greater than 10,000 to 100,000 cfs	0.0001
Very large river	Greater than 100,000 cfs	0.00001
Coastal tidal waters[d]	Flow not applicable, depth not applicable	0.0001
Shallow ocean zone[e] or Great Lake	Flow not applicable, depth less than 20 feet	0.0001
Moderate depth ocean zone[e] or Great Lake	Flow not applicable, depth 20 to 200 feet	0.00001
Deep ocean zone[e] or Great Lake	Flow not applicable, depth greater than 200 feet	0.000005
3-mile mixing zone in quiet flowing river	10 cfs or greater	0.5

[a]*Treat each lake as a separate type of water body and assign a dilution weight as specified in text.*

[b]Do not round to nearest integer.

[c]cfs = cubic feet per second.

[d]Embayments, harbors, sounds, estuaries, back bays, lagoons, wetlands, etc., seaward from mouths of rivers and landward from baseline of Territorial Sea.

[e]Seaward from baseline of Territorial Sea. This baseline represents the generalized U.S. coastline. It is parallel to the seaward limit of the Territorial Sea and other maritime limits such as the inner boundary of the Federal fisheries jurisdiction and the limit of States jurisdiction under the Submerged Lands Act, as amended.

Assign the dilution weight from Table 4-13 as follows:

- For a river (that is, surface water body types specified in Table 4-13 as minimal stream through very large river), assign a dilution weight based on the average annual flow in the river at the intake. If available, use the average annual discharge as defined in the U.S. Geological Survey Water Resources Data Annual Report. Otherwise, estimate the average annual flow.
- For a lake, assign a dilution weight as follows:
  - — For a lake that has surface water flow entering the lake, assign a dilution weight based on the sum of the average annual flows for the surface water bodies entering the lake up to the point of the intake.
  - — For a lake that has no surface water flow entering, but that does have surface water flow leaving, assign a dilution weight based on the sum of the average annual flows for the surface water bodies leaving the lake.
  - — For a closed lake (that is, a lake without surface water flow entering or leaving), assign a dilution weight based on the average annual ground water flow into the lake, if available, using the dilution weight for the corresponding river flow range in Table 4-13. If not available, assign a default dilution weight of 1.
- For the ocean and the Great Lakes, assign a dilution weight based on depth.
- For coastal tidal waters, assign a dilution weight of 0.0001; do not consider depth or flow.

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4.1.2.3.1 *Nearest intake.* Evaluate the nearest intake factor based on the drinking water intakes along the overland/flood hazardous substance migration path for the watershed. Include standby intakes in evaluating this factor only if they are used for supply at least once a year.

Assign the nearest intake factor a value as follows and enter the value in Table 4-1:

- If one or more of these drinking water intakes is subject to Level I concentrations as specified in section 4.1.2.3, assign a factor value of 50.
- If not, but if one or more of these drinking water intakes is subject to Level II concentrations, assign a factor value of 45.
- If none of these drinking water intakes is subject to Level I or Level II concentrations, determine the nearest of these drinking water intakes, as measured from the probable point of entry (or from the point where measurement begins for contaminated sediments with no identified source). Assign a dilution weight from Table 4-13 to this intake, based on the type of surface water body in which it is located. Multiply this dilution weight by 20, round the product to the nearest integer, and assign it as the factor value.

TABLE 4-13.—SURFACE WATER DILUTION WEIGHTS

Type of surface water body[a]		Assigned dilution weight [b]
Descriptor	Flow characteristics	
Minimal stream	Less than 10 cfs[c]	1
Small to moderate stream	10 to 100 cfs	0.1
Moderate to large stream	Greater than 100 to 1,000 cfs	0.01
Large stream to river	Greater than 1,000 to 10,000 cfs	0.001
Large river	Greater than 10,000 to 100,000 cfs	0.0001
Very large river	Greater than 100,000 cfs	0.00001
Coastal tidal waters[d]	Flow not applicable, depth not applicable	0.0001
Shallow ocean zone[e] or Great Lake	Flow not applicable, depth less than 20 feet	0.0001
Moderate depth ocean zone[e] or Great Lake	Flow not applicable, depth 20 to 200 feet	0.00001
Deep ocean zone[e] or Great Lake	Flow not applicable, depth greater than 200 feet	0.000005
3-mile mixing zone in quiet flowing river	10 cfs or greater	0.5

[a]Treat each lake as a separate type of water body and assign a dilution weight as specified in text.

[b]Do not round to nearest integer.

[c]cfs = cubic feet per second.

[d]Embayments, harbors, sounds, estuaries, back bays, lagoons, wetlands, etc., seaward from mouths of rivers and landward from baseline of Territorial Sea.

[e]Seaward from baseline of Territorial Sea. This baseline represents the generalized U.S. coastline. It is parallel to the seaward limit of the Territorial Sea and other maritime limits such as the inner boundary of the Federal fisheries jurisdiction and the limit of States jurisdiction under the Submerged Lands Act, as amended.

Assign the dilution weight from Table 4-13 as follows:

- For a river (that is, surface water body types specified in Table 4-13 as minimal stream through very large river), assign a dilution weight based on the average annual flow in the river at the intake. If available, use the average annual discharge as defined in the U.S. Geological Survey Water Resources Data Annual Report. Otherwise, estimate the average annual flow.
- For a lake, assign a dilution weight as follows:
  - — For a lake that has surface water flow entering the lake, assign a dilution weight based on the sum of the average annual flows for the surface water bodies entering the lake up to the point of the intake.
  - — For a lake that has no surface water flow entering, but that does have surface water flow leaving, assign a dilution weight based on the sum of the average annual flows for the surface water bodies leaving the lake.
  - — For a closed lake (that is, a lake without surface water flow entering or leaving), assign a dilution weight based on the average annual ground water flow into the lake, if available, using the dilution weight for the corresponding river flow rate in Table 4-13. If not available, assign a default dilution weight of 1.
- For the ocean and the Great Lakes, assign a dilution weight based on depth.
- For coastal tidal waters, assign a dilution weight of 0.0001; do not consider depth or flow.

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- For a quiet-flowing river that has average annual flow of 10 cubic feet per second (cfs) or greater and that contains the probable point of entry to surface water, apply a zone of mixing in assigning the dilution weight:
  - — Start the zone of mixing at the probable point of entry and extend it for 3 miles from the probable point of entry, except: if the surface water characteristics change to turbulent within this 3-mile distance,extend the zone of mixing only to the point at which the change occurs.
  - — Assign a dilution weight of 0.5 to any intake that lies within this zone of mixing.
  - — Beyond this zone of mixing, assign a dilution weight the same as for any other river (that is, assign the dilution weight based on average annual flow).
  - — Treat a quiet-flowing river with an average annual flow of less than 10 cfs the same as any other river (that is, assign it a dilution weight of 1).

In those cases where water flows from a surface water body with a lower assigned dilution weight (from Table 4-13) to a surface water body with a higher assigned dilution weight (that is, water flows from a surface water body with more dilution to one with less dilution), use the lower assigned dilution weight as the dilution weight for the latter surface water body.

4.1.2.3.2 *Population.* In evaluating the population factor, include only persons served by drinking water drawn from intakes that are along the overland/flood hazardous substance migration path for the watershed and that are within the target distance limit specified in section 4.1.1.2. Include residents, students, and workers who regularly use the water. Exclude transient populations such as customers and travelers passing through the area. When a standby intake is maintained on a regular basis so that water can be withdrawn, include it in evaluating the population factor.

In estimating residential population, when the estimate is based on the number of residences, multiply each residence by the average number of persons per residence for the county in which the residence is located.

In estimating the population served by an intake, if the water from the intake is blended with other water (for example, water from other surface water intakes or ground water wells), apportion the total population regularly served by the blended system to the intake based on the intake's relative contribution to the total blended system. In estimating the intake's relative contribution, assume each well or intake contributes equally and apportion the population accordingly, except: if the relative contribution of any one intake or well exceeds 40 percent based on average annual pumpage or capacity, estimate the relative contribution of the wells and intakes considering the following data, if available:

- Average annual pumpage from the ground water wells and surface water intakes in the blended system.
- Capacities of the wells and intakes in the blended system.

For systems with standby surface water intakes or standby ground water wells, apportion the total population regularly served by the blended system as described above, except:

- Exclude standby ground water wells in apportioning the population.
- When using pumpage data for a standby surface water intake, use average pumpage for the period during which the standby intake is used rather than average annual pumpage.
- For that portion of the total population that could be apportioned to a standby surface water intake, assign that portion of the population either to that standby intake or to the other surface water intake(s) and ground water well(s) that serve that population; do not assign that portion of the population both to the standby intake and to the other intake(s) and well(s) in the blended system. Use the apportioning that results in the highest population factor value. (Either include all standby intake(s) or exclude some or all of the standby intake(s) as appropriate to obtain this highest value.) Note that the specific standby intake(s) included or excluded and, thus, the specific apportioning may vary in evaluating different watersheds and in evaluating the ground water pathway.

  4.1.2.3.2.1 *Level of contamination.* Evaluate the population factor based on three factors: Level I concentrations, Level II concentrations, and potential contamination. Determine which factor applies for an intake as specified in section 4.1.2.3. Evaluate intakes subject to Level I concentration as specified in section 4.1.2.3.2.2, intakes subject to Level II concentration as specified in section 4.1.2.3.2.3, and intakes subject to potential contamination as specified in section 4.1.2.3.2.4.

  For the potential contamination factor, use population ranges in evaluating the factor as specified in section 4.1.2.3.2.4. For the Level I and Level II concentrations factors, use the population estimate, not population ranges, in evaluating both factors.

  4.1.2.3.2.2 *Level I concentrations.* Sum the number of people served by drinking water from intakes subject to Level I concentrations. Multiply this sum by 10. Assign this product as the value for this factor. Enter this value in Table 4-1.

  4.1.2.3.2.3 *Level II concentrations.* Sum the number of people served by drinking water from intakes subject to Level II concentrations. Do not include people already counted under the Level I concentrations factor. Assign this sum as the value for this factor. Enter this value in Table 4-1.

  4.1.2.3.2.4 *Potential contamination.* For each applicable type of surface water body in Table 4-14, first determine the number

In addition, consider all other fisheries that are partially or wholly within the target distance limit for the watershed, including fisheries partially or wholly within the boundaries of an observed release for the watershed that do not meet any of the three criteria listed above, to be subject to potential human food chain contamination. If only a portion of the fishery is within the target distance limit for the watershed, include only that portion in evaluating the targets factor category.

TABLE 4-17.—HEALTH-BASED BENCHMARKS FOR HAZARDOUS SUBSTANCES IN HUMAN FOOD CHAIN

- Concentration corresponding to Food and Drug Administration Action Level (FDAAL) for fish or shellfish.
- Screening concentration for cancer corresponding to that concentration that corresponds to the 10^{-6} individual cancer risk for oral exposures.
- Screening concentration for noncancer toxicological responses corresponding to the Reference Dose (RfD) for oral exposures.

When a fishery (or portion of a fishery) is subject to actual food chain contamination, determine the part of the fishery subject to Level I concentrations and the part subject to Level II concentrations. If the actual food chain contamination is based on direct observation, evaluate it using Level II concentrations. However, if the actual food chain contamination is based on samples from the watershed, use these samples and, if available, additional tissue samples from aquatic human food chain organisms as specified below, to determine the part subject to Level I concentrations and the part subject to Level II concentrations:

- Determine the level of actual contamination from samples (including tissue samples from essentially sessile, benthic organisms) that meet the criteria for actual food chain contamination by comparing the exposure concentrations (see section 4.1.2.3) from these samples (or comparable samples) to the health-based benchmarks from Table 4-17, as described in section 2.5.1 and 2.5.2. Use only the exposure concentrations for those hazardous substances in the sample (or comparable samples) that meet the criteria for actual contamination of the fishery.
- In addition, determine the level of actual contamination from other tissue samples by comparing the concentrations of hazardous substances in the tissue samples (or comparable tissue samples) to the health-based benchmarks from Table 4-17, as described in sections 2.5.1 and 2.5.2. Use only those additional tissue samples and only those hazardous substances in the tissue samples that meet all the following criteria:
  - — The tissue sample is from a location that is within the boundaries of the actual food chain contamination for the site (that is, either at the point of direct observation or at or between the probable point of entry and the most distant sample point meeting the criteria for actual food chain contamination).
  - — The tissue sample is from a species of aquatic human food chain organism that spends extended periods of time within the boundaries of the actual food chain contamination for the site and that is not an essentially sessile, benthic organism.
  - — The hazardous substance is a substance that is also present in a surface water, benthic, or sediment sample from within the target distance limit for the watershed and, for such a sample, meets the criteria for actual food chain contamination.

4.1.3.3.1 *Food chain individual.* Evaluate the food chain individual factor based on the fisheries (or portions of fisheries) within the target distance limit for the watershed. Assign this factor a value as follows:

- If any fishery (or portion of a fishery) is subject to Level I concentrations, assign a value of 50.
- If not, but if any fishery (or portion of a fishery) is subject to Level II concentrations, assign a value of 45.
- If not, but if there is an observed release of a hazardous substance having a bioaccumulation potential factor value of 500 or greater to surface water in the watershed and there is a fishery (or portion of a fishery) present anywhere within the target distance limit, assign a value of 20.
- If there is no observed release to surface water in the watershed or there is no observed release of a hazardous substance having a bioaccumulation potential factor value of 500 or greater, but there is a fishery (or portion of a fishery) present anywhere within the target distance limit, assign a value as follows:
  - — Using Table 4-13, determine the highest dilution weight (that is, lowest amount of dilution) applicable to the fisheries (or portions of fisheries) within the target distance limit. Multiply this dilution weight by 20 and round to the nearest integer.
  - — Assign this calculated value as the factor value.
- If there are no fisheries (or portions of fisheries) within the target distance limit of the watershed, assign a value of 0.

Enter the value assigned in Table 4-1.

4.1.3.3.2 *Population.* Evaluate the population factor for the watershed based on three factors: Level I concentrations, Level II concentrations, and potential human food chain contamination. Determine which factor applies for a fishery (or portion of a fishery) as specified in section 4.1.3.3.

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Exhibit 29

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NewFields
Two Midtown Plaza
1349 West Peachtree Street
Suite 2000
Atlanta, Georgia 30309

Attention: Ms. Kathryn A. Wurzel, M.P.H., D.A.B.T.
Partner

Re: Literature Review for Threatened & Endangered Species for Areas Q and P
Sauget, Illinois
Acer Project No.:

Dear Ms. Wurzel:

Acer Environmental, Inc. appreciates the opportunity to provide NewFields a literature review for the likelihood of threatened and endangered species to utilize Areas Q and P at Sauget, Illinois (study site).

The literature review included a review of national and local databases on threatened and endangered (T&E) animal species. Because of the past disturbance in the study area plants were not considered a concern. A contact was also made with the Illinois Natural History Survey (INHS) to request information from their database on known occurrences of T&E species in the vicinity of the project. Numerous phone conversations with local natural resource professionals were conducted to discuss the likelihood that a T&E species would utilize the site in some form. Finally, a review of existing site information was conducted for baseline data on the site and information previously gathered.

Information gathered from the INHS for a ten-mile radius around the study site listed 14 different species and 19 known occurrences. Upon review of the list, four species and occurrences were omitted because the habitat was unsuitable for the species to occur. The ten-mile radius was utilized because of the possibility of T&E bird species to migrate to and from nesting and feeding sites. The listed species are the pied-billed grebe, least bittern, snowy egret, little blue heron, black-crowned night heron, yellow-crowned night heron, bald eagle, peregrine falcon, common moorhen, and yellow-headed blackbird.

The habitat requirements for the aforementioned list of T&E bird species is varied but all require wetlands and/or large water bodies for their survival. For the purposes of discussion the herons and egrets will be discussed as one group because they have similar habitat requirements. Also, the least bittern, yellow-headed blackbird and common moorhen

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will be discussed in similar terms because of habitat requirements. The following discussion will briefly address a species habitat requirement and likelihood of occurrence at the study site.

- **Bald Eagle** – requires large trees for nesting and large water bodies for feeding. In an original report by PRC Environmental Management, Inc. it was noted that a bald eagle was sighted flying over site at one time. This sighting is not a substantial observation because these birds migrate the river corridor on a seasonal basis. Also, these birds are becoming very common along the Mississippi River. According to the State's natural resource professionals the likelihood that the bald eagle would nest or roost in this area is very low because of the absence of very large trees. Furthermore, the likelihood that they would occasionally feed would be very low because of the industrial development activities along the river.
- **Peregrine Falcon** – requires large bluffs and large trees for nesting and open expanses for hunting. The reported nest located on an old bridge north of the study site was a brief happen stance. The nest is no longer located at the bridge. The probability of the occurrence is very unlikely because of the habitat type is not found in this area and the industrial activities in the local area.
- **Herons and Egrets** – require shallow water at the edge of vegetation for feeding and large trees for nesting. This is the most likely group to utilize the study site. However, the lack of open water and prey will keep these species from utilizing the local area. (According to NewFields staff Area Q dries during parts of the year and fisheries in these areas are minimal.) There is a direct relationship to bird occurrence and amount of prey. The most likely location in the vicinity of the study site for the birds to utilize is the river. However, these birds are known to forage creeks, drainage ditches and ponds, provided there is water depths from 1 to 50 cm, and sufficient food available. The opportunities for nesting are marginal because of the lack of large trees.
- **Least Bittern, Common Moorhen and Yellow-headed Blackbird** - requires large expanses of cattail and bulrush in order to nest. The majority of the emergent marsh on site is dominated by invasive species, which are generally not conducive for nesting. The only area that has potential T&E habitat is an emergent marsh in Area P. This area is small in size and adjacent to industrial and commercial activities. Also, these birds do not travel long distances to forage.
- **Pied-Billed Grebe** – requires dense vegetation adjacent to open water for nesting and foraging. The dense vegetation is abundant in the study site but the small open water areas and abundant food for foraging are not readily available.

From a review of the site photography provided by Newfields, aerial photographs and site maps, it would appear that the vegetation types in Area Q are not diverse enough to maintain any T&E population. This area was originally used for disposal of fly ash and

portions are being used for coal storage. In the areas that vegetation has established the areas are dominated by monocultures of invasive species. These species form dense clumps of vegetation prohibiting use of these areas by wildlife species. In Area P, the emergent marsh that does exist there has been reduced in size because of a commercial development. The vegetation in this location appears to be fairly diverse but the small size of the system may minimize the extent of use by a T&E species.

In reviewing the documentation by PRC Environmental Management, Inc. there appears to be a bias towards linking the study site to active use by a T&E species. From our review of the data there is a possibility that a T&E species could utilize the area. However, the large trees or plant diversity needed for a species to nest is not available and the lack of available feeding habitat and food is another factor limiting use. Finally, the river is the most likely area to be used by a T&E species for foraging but the industrial activities that occur along the river will minimize any activity.

In summary, there is potential for ten T&E species to utilize the site in some form. The likelihood for these species to actually use the site is minimal because of the lack of breeding and feeding habitat.

Attached are an e-mail with the list of T&E species and locations, contact forms from the two most informative contacts, and the Illinois Breeding Bird Atlas data for each listed bird species.

If you need any additional information or have any questions, please do not hesitate to contact me at the letterhead address.

Sincerely,

J. Patrick Barber
President

attachments

Illinois Endangered and Threatened Animals
within a 10 mi radius of Sauget

Scientific Name	Common Name	Locations
Podilymbus podiceps	Pied-billed Grebe	5 mi N & 8 mi NE
Ixobrychus exilis	Least Bittern	9 mi NE
Egretta thula	Snowy Egret	2.5 mi E
Egretta caerulea	Little Blue Heron	2.5 mi E & 4 mi NE
Nycticorax nycticorax	Black-crowned Night Heron	2.5 mi E & 4 mi NE
Nyctanassa violacea	Yellow-crowned Night Heron	2.5 mi E & 8.5 mi NE
Haliaeetus leucocephalus	Bald Eagle	5.5 mi E
Falco peregrinus	Peregrine Falcon	4.5 mi N
Gallinula chloropus	Common Moorhen	5 mi N, 9 mi NE, & 2.5 mi E
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	5 mi N
Ammocrypta clarum	Western Sand Darter	5.5 mi N
Caecidotea spatulata	Isopod	6 mi S
Gammarus acherondytes	Illinois Cave Amphipod	9 mi S
Rookery	Rookery	2.5 mi E & 4 mi NE

JP Barber

From: BOB GOTTFRIED [BGOTTFRIED@dnrmail.state.il.us]
nt: Friday, December 07, 2001 5:20 PM
o: jpbarber@acerenvironmental.org
Subject: Sauget

Saugetarea_T&E.wpd (12 KB)

Mr. Barber,

Attached you will find a Word Perfect file that contains a table of all of the Illinois Threatened and Endangered animals within a 10 mile radius of Sauget, that are known and in our database. Using a topographic map as a backdrop I picked a central location as a starting point. Depending on where a project is on the ground, the 10 mile radius may differ and other species may be found within that circle. Also, our database is dynamic, so this list should not be considered as a final list or complete. Absence of information should not be construed as a definitive statement to the presence or absence of a species in a specific location. This list should not be used as a substitute for an on the ground survey. Lastly, if the project that you are investigating moves forward, I highly recommend contacting the division of Resource Review and Coordination within the Illinois DNR before any final plans are made. This division will be able to address any Department concerns regarding this specific project. The person that you should contact is Keith Shank at 217-785-5500.

If there is anything else that I can do for you, or if there is any other information that I can provide, please feel free to contact me.

Robert Gottfried
Illinois Natural History Survey
Data Manager/DNR Liaison

Acer Environmental, Inc.

Record of Phone Conversation

Contact Information **Project Name:** Sauget, IL

Contact: Ms. Debbie Newman

Firm/Agency: Illinois Nature Preserve

Phone No.: 618 684-3840

Date: 7 Dec. 2001

Ms. Newman is the district biologist for the area that includes Sauget. The Audubon Society referred her as a local individual with knowledge of T&E Species locations and habits.

When asked about the bird rookery for the protected herons and egrets on Alerton Island, she confirmed that it was still active. Then I described the clients study area and she agreed that the birds would most likely use the river than the wetlands in area Q.

She also said that she did not know of any eagles nest in this local area. In fact, most of the eagle nests are located north of this area along mostly undisturbed forest locations. The lack of large mature trees and the area being industrialized would keep the eagles from nesting. Also, this situation would limit the eagles from hunting in this general location. This is not to say that they have not or would in the future. The probability of eagles roosting in non-breeding period would also be limited by the absences of large mature trees for roosting.

She informed me that the Peregrine Falcon nesting upstream of the site is a very old record. Since she had been working in this district she has not heard of the falcon. Also, Missouri Heritage Inventory was monitoring this area for falcons. She also stated that this area was not good habitat for the falcon.

When asked about other T&E species that she knew about in this local area she referenced the Pied Billed Grebe. However, she stated that this bird was known from one location and the local habitat would not be conducive for this species.

She referred me to Bob Gottfried at the Illinois Natural History Survey.

Acer Environmental, Inc.

Record of Phone Conversation

Contact Information **Project Name:** Sauget, IL

Contact: Ms. Bob Gottfried

Firm/Agency: Illinois Nature History Survey

Title: Data Manager/DNR Liaison

Phone No.: 217 785-8774

Date: 7 Dec. 2001

Mr. Gottfried is the Data Manager of the GIS database for T&E species.

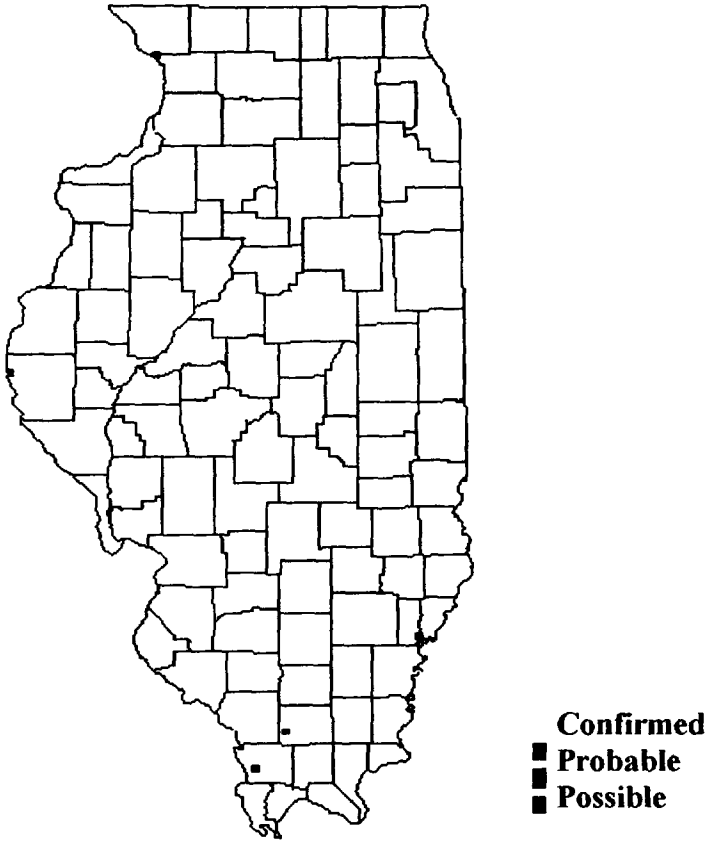
When asked about the the bird rookery for the protected herons and egrets on Alerton Island, he confirmed that it was still active.

She also said that she did not know of any eagles nest in this local area. In fact, most of the eagle nests are located north of this area along mostly undisturbed forest locations. The lack of large mature trees and the area being industrialized would keep the eagles from nesting. Also, this situation would limit the eagles from hunting in this general location. This is not to say that they have not or would in the future. The probability of eagles roosting in non-breeding period would also be limited by the absences of large mature trees for roosting.

He informed me that the Peregrine Falcon nesting upstream of the site was a very old record. This nest was located on a very old bridge upstream from the site. The falcon nest is not there anymore. This area is not good habitat for the falcon.

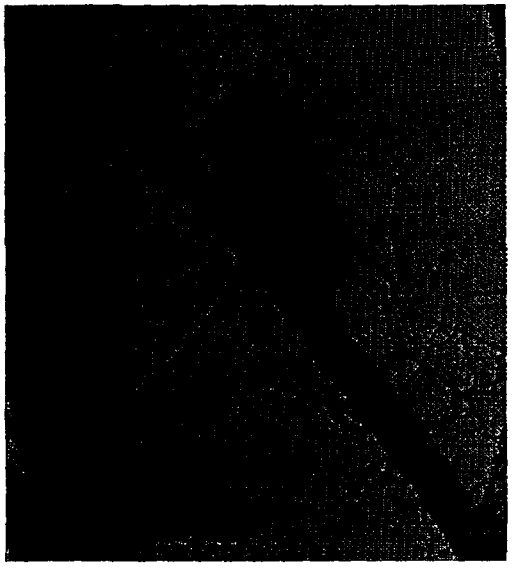
When asked about other T&E species that he knew about in this local area he told me that he would run a data base search for a radius of 10 miles around the local area. That is the average distance that most of these protected species would fly to feed. He could not give us the exact location of the species but he could give us general direction and distance. I told him that would suffice. He said he would send the information as soon as he could put it together.

Illinois Breeding Bird Atlas
Bald Eagle
Breeding Status



Illinois Department of Natural Resources, Division of Natural Heritage
Illinois Natural History Survey, Center for Wildlife Ecology

Bald Eagle
Haliaeetus leucocephalus



Taxonomy
Occurence in Illinois
Status
Habitat associations
Guilds
Food-habits
Environmental associations
Life history
Management practices
References

TAXONOMY

- Phylum: Chordata
- Class: Aves
- Order: Falconiformes
- Family: Acciptiridae
- Genus: *Haliaeetus*
- Species: *Haliaeetus leucocephalus*
- Authority: Linnaeus

Comments on taxonomy:
Often recognized as 2 subspecies *H. l. leucocephalus* (L.) (Southern bald eagle) and *H. l. alascanus* Townsend (Northern bald eagle) *15,16, 21,23*. N. bald eagle sometimes called *H. l. washingtoniensis* *16,32*. Northern race tends to be slightly bigger in size than southern race. Controversy over where to divide races by size and geography *15,16*. Previous scientific names - *Falco leucocephalus L., F. ossifragus, F. washingtonii, F. washingtonianus, H. washingtoni*

01,14,22,24. Other common names - American, white headed, or sea eagle*01,15*.

OCCURENCE IN ILLINOIS

Winter along Mississippi, Rock, and Illinois Rivers, nest in southern Illinois.

STATUS

Items in **bold** indicate applicable categories
Forest Service Categories: S = recommended for regional sensitive status, F = forest listed species, M = management indicator species

Federal Status:

Endangered	Threatened	Proposed for listing
Candidate for proposal	**Recovery plan approved**	Recovery plan received (USFWS)
Recovery plan in preparation	Under notice of review	Delisted
Migratory	EPA indicator	Forest Serv.- Shawnee species

State Status:

Endangered	Threatened	Proposed

Other:

Game	Furbearer	Nongame protected	
Sportfish	Commercial	Pest	None of the above

Comments on status:
See appendix 2. Recovery plan is currently in agency review stage.

HABITAT ASSOCIATIONS

Items in **bold** indicate applicable categories

General habitat:

Unknown	Terrestrial	Aquatic	**Riparian**

USFS timber inventory forest size class:

Unknown	Unstocked	Seedling	Sapling
Seedling/sapling	Pole	**Mature**	**Over mature**

Land use and land cover:

Unknown		Urban	Residential Commercial Industrial Transportation, communication Complex industrial/commercial Mixed Other
Agricultural	Crop, pasture Orchards, groves, nurseries Feedlot Other	Rangeland	Herbaceous Shrub and brush Mixed
Forestland	**Deciduous** **Evergreen** **Mixed**	**Water**	**Stream** **Lake** **Reservoir** Bay
Wetland	Forest Non-forest	Barren	Salt flat Beach Sand Rock Mine Transit Mix

Forest cover types:

Cover type	Structural stage	Canopy closure	Season
Red pine	Mature (9" dia. & 100 yrs. old)	41-70%	Fall/winter
Easter white pine	Mature (9" dia. & 100 yrs. old)	41-70%	Fall/winter
River birch-sycamore	Mature (9" dia. & 100 yrs. old)	41-70%	Fall/winter
Silver maple-American elm	Mature (9" dia. & 100 yrs. old)	41-70%	Fall/winter
Cottonwood	Mature (9" dia. & 100 yrs. old)	41-70%	Fall/winter
Elm-ash-cottonwood	Mature (9" dia. & 100 yrs. old)	41-70%	Fall/winter

Associated tree species:

- Cottonwood

National wetland inventory classifications:

System	Subsystem	Class	Subclass	Water regime modifiers	Water chemistry
Lacustrine	Littoral	Forest	Deciduous	Permanent nontidal	Freshwater
Riverine	Lower perennial	Forest	Deciduous	Permanent nontidal	Freshwater

Comments on species-habitat associations:

Bald eagles prefer large, tall trees (avg. 42-66 cm dbh) near rivers or reservoirs (0-1 km) *04,19,25,28,29,31,65*. Prefer trees which have 1 or 2 open edges; ex. riverbank, rangeland, cropland in which they roost or nest in the upper open branches, allowing for easy surveillance for food and accessibility *25,26,29,31*. Large dead or dying trees are also used *26,28,31*. During poor weather and winter nights eagles move to more protected trees making the edge affect less important *25,29,31*. SAF and NWI codes show the importance of mature floodplain trees. The land use classif. describes very basic habitat.

Important plant and animal association: Preys on fish, particularly gizzard shad (*Dorosoma cepedianum*) *04, 06,19*. Often roosts and nests in cottonwood *25,28,29,30,32*. Preys on fish year round* 04,06,19,34*. Also preys on wounded waterfowl during the hunting season *33,35,57*. Roosts and nests in tall trees along rivers and reservoirs *25,28,29,30,32*.

High value habitats

Habitat	Structural stage	Season
Cottonwood	Mature (9" dia. & 100 yrs. old)	All
Wet-mesic floodplain forest	Mature (9" dia. & 100 yrs. old)	All

Species-habitat interrelations: SAF forest cover type (cottonwood) forest class size (mature) season (summer/winter) function (nesting/feeding) value (high) Prefer large, tall, open trees for nesting and roosting because of easy food surveillance and accessibility *25,26,65*.

GUILDS

Feed-guilding:

Habitat	Structural stage	Season	Feed-guilds
Cottonwood	Mature (9" dia. & 100 yrs. old)	All	Water surface- fish Terrestrial surface- small mammals (< 1 kg) Terrestrial surface- large mammals (> 1 kg) Terrestrial surface- carrion Air- birds
Wet-mesic floodplain forest	Mature (9" dia. & 100 yrs. old)	All	Water surface- fish Terrestrial surface- small mammals (< 1 kg) Terrestrial surface- large mammals (> 1 kg) Terrestrial surface- carrion Air- birds

Comments on feed-guilding:
Prefer fish *06,19,26* but also prey on small mammals, wounded water- fowl, and carrion *37,57,62*.

Breed-guilding:

Habitat	Structural stage	Season	Breed-Guilds
Cottonwood	Mature (9" dia. & 100 yrs. old)	All	Tree canopy, large branches of live broad-leaved deciduous trees Tree canopy, large branches of live needle-leaved evergreen trees Tree canopy, large branches of dead broad-leaved deciduous trees Tree canopy, large branches of dead needle-leaved evergreen trees
Wet-mesic floodplain forest	Mature (9" dia. & 100 yrs. old)	All	Tree canopy, large branches of live broad-leaved deciduous trees Tree canopy, large branches of live needle-leaved evergreen trees Tree canopy, large branches of dead broad-leaved deciduous trees Tree canopy, large branches of dead needle-leaved evergreen trees

Comments on breed-guilding:
Choose mature tall trees for nests, often the largest tree in the stand. Nest most often in upper branches of deciduous trees with leaves camouflaging nest. However, also frequently use dead trees. Usually nest near water for food access *16,26,38,65*. Mate for as long as both in pair are alive. Mating takes place before or during nest construction *15,26,37,39*.

FOOD-HABITS

Trophic level is CARNIVORE

Food item	Life stage/plant part
Amiiformes (bowfin)	Unknown
Anguilliformes (American eel)	Unknown
Clupeiformes (herrings)	Juvenile
Clupeiformes (herrings)	Adult
Salmoniformes (trouts, salmons, smelts, pikes)	Unknown
Cypriniformes (carps, minnows, loaches)	Juvenile
Cypriniformes (carps, minnows, loaches)	Unknown
Siluriformes (catfishes)	Adult
Perciformes (basses, sunfishes, perches, sculpins)	Unknown
Testudines (turtles)	Unknown
Leporidae (rabbits, hares)	Unknown
Sciuridae (squirrels, chipmunks, marmots, prairie dogs)	Adult
Cricetidae (woodrats, mice, voles, lemmings, muskrats)	Unknown

Cervidae (elk, deer, moose)	See comments
Anatidae (swans, geese, ducks)	See comments
Galliformes	Unknown
Laridae (gulls, terns)	Adult
Corvidae (jays, magpies, crows)	Adult
Carrion	Not applicable
Important:	
Clupeiformes (herrings)	Juvenile
Clupeiformes (herrings)	Adult
Cypriniformes (carps, minnows, loaches)	Unknown
Juvenile:	
Amiiformes (bowfin)	Unknown
Amiiformes (bowfin)	Unknown
Anguilliformes (American eel)	Unknown
Clupeiformes (herrings)	Juvenile
Clupeiformes (herrings)	Adult
Salmoniformes (trouts, salmons, smelts, pikes)	Unknown
Cypriniformes (carps, minnows, loaches)	Juvenile
Cypriniformes (carps, minnows, loaches)	Unknown
Siluriformes (catfishes)	Adult
Perciformes (basses, sunfishes, perches, sculpins)	Unknown
Leporidae (rabbits, hares)	Unknown
Sciuridae (squirrels, chipmunks, marmots, prairie dogs)	Adult
Cricetidae (woodrats, mice, voles, lemmings, muskrats)	Unknown
Anatidae (swans, geese, ducks)	See comments
Galliformes	Unknown
Laridae (gulls, terns)	Adult
Corvidae (jays, magpies, crows)	Adult
Carrion	Not applicable
Adult:	
Amiiformes (bowfin)	Unknown
Anguilliformes (American eel)	Unknown
Clupeiformes (herrings)	Juvenile
Clupeiformes (herrings)	Adult
Salmoniformes (trouts, salmons, smelts, pikes)	Unknown
Cypriniformes (carps, minnows, loaches)	Juvenile
Cypriniformes (carps, minnows, loaches)	Unknown
Siluriformes (catfishes)	Adult

Perciformes (basses, sunfishes, perches, sculpins)	Unknown
Testudines (turtles)	Unknown
Leporidae (rabbits, hares)	Unknown
Sciuridae (squirrels, chipmunks, marmots, prairie dogs)	Adult
Cricetidae (woodrats, mice, voles, lemmings, muskrats)	Unknown
Cervidae (elk, deer, moose)	See comments
Anatidae (swans, geese, ducks)	See comments
Galliformes	Unknown
Laridae (gulls, terns)	Adult
Corvidae (jays, magpies, crows)	Adult
Carrion	Not applicable

Comments on food habits:
General: Fish is the staple food item and preferred when available. Generally prey on small fish which they can swallow whole. Otherwise prey on small mammals, waterfowl (particularly wounded), small birds, and carrion (ex.deer). Young eat the same food as adults *06,19,26,28,57,62*.
Juvenile: Young eat basically the same food as adults which is primarily fish. Adults bring food to young at eeyrie *16,26,34,35,37,38*.
Adult: Fish is the staple food item and preferred when available. Generally prey on small fish which they can swallow whole. Otherwise prey on small mammals, waterfowl (particularily wounded), small birds, chickens, and carrion (ex. deer) *06,19,26,28,62*.

ENVIRONMENTAL ASSOCIATIONS

General:

- Air temperature:see comments
- Water temperature: see comments
- Flow: see comments
- Flood plain: see comments
- Leaf litter/ground debris/humus: see comments
- Vegetation mosaics/edges: see comments
- Ecotones: woodland/water
- Coniferous forest: see comments
- Hardwood forest: see comments
- Canopy closure (%) of trees: see comments
- Overstem trees- ave. ht: see comments
- Overstem trees- ave. dbh: see comments
- Large lone trees: see comments
- Snags: see comments
- Vegetation successional stage: subclimax forest
- Human associations: wildlife refuges/sanctuaries

Limiting:

- Water temperature: see comments

- Flood plain: see comments
- Ecotones: woodland/water
- Canopy closure (%) of trees: see comments
- Overstem trees- ave. ht: see comments

Egg

- Air temperature:see comments
- Leaf litter/ground debris/humus: see comments
- Coniferous forest: see comments
- Hardwood forest: see comments
- Large lone trees: see comments

Feeding juvenile:

- Leaf litter/ground debris/humus: see comments
- Ecotones: woodland/water
- Hardwood forest: see comments
- Overstem trees- ave. ht: see comments
- Large lone trees: see comments

Resting juvenile:

- Air temperature:see comments
- Leaf litter/ground debris/humus: see comments
- Ecotones: woodland/water
- Hardwood forest: see comments
- Overstem trees- ave. ht: see comments
- Large lone trees: see comments

Feeding adult:

- Water temperature: see comments
- Flood plain: see comments
- Vegetation mosaics/edges: see comments
- Ecotones: woodland/water
- Hardwood forest: see comments
- Canopy closure (%) of trees: see comments
- Overstem trees- ave. ht: see comments
- Overstem trees- ave. dbh: see comments
- Large lone trees: see comments
- Snags: see comments
- Vegetation successional stage: subclimax forest
- Human associations: wildlife refuges/sanctuaries

Resting adult:

- Flow: see comments
- Flood plain: see comments

- Coniferous forest: see comments
- Hardwood forest: see comments
- Overstem trees- ave. ht: see comments
- Overstem trees- ave. dbh: see comments
- Large lone trees: see comments

Breeding adult:

- Leaf litter/ground debris/humus: see comments
- Ecotones: woodland/water
- Canopy closure (%) of trees: see comments
- Overstem trees- ave. ht: see comments
- Large lone trees: see comments

Comments on environmental associations:
General: Bald eagles' preferred food is fish so need open water during the winter to feed *25,27*. Cottonwoods are frequently used as roost and nest trees. The height of the tree, however, is the most important factor and the tallest trees in an area are used *19,25,26,28,29,31*. The average heighth is approximately 22 m and average dbh is 42-66 cm *25,28*. Edges and openings in forests are important for visibility and access *25,31*. Deciduous trees in the winter and dead trees year- round are frequently used for perches for similar reasons *29,31*. During the winter under conditions of severe wind or at night may seek conifers or floodplains surrounded by river bluffs for warmth *19,25,29*.
Egg: Nest in tall trees ex. cottonwood, sycamore, red pine, white pine, dead trees *26,32,37,39*. Eggs are laid in early March to the end of April and incubation is approximately 35 days. Eagles generally use the same nest from year to year and build a new nest on top of the old *15,32,39*. Nest consists of sticks lined with dried grasses, leaves, pine needles, herbs *15,26,32,39*
Feeding juvenile: Young remain in nest for approximately 10-13 weeks *15,35,38*. Although young learn to fly at about 10 weeks, they remain at eyrie for several more weeks and are continued to be fed by adults *32,38*. Nest is in tall trees ex. cottonwood, sycamore, red pine, white pine, dead trees; usually near water for their primary source of food - fish *26,32,37,39,42*. Nest consists of sticks lined with dead grasses, leaves, pine needles, and herbs *15,26,37,39*.
Resting juvenile: Young remain in nest for approximately 10-13 weeks *15,35,38*. Nest is in tall trees ex. cottonwood, sycamore, red pine, white pine, and dead trees *26,32,37,39,42*. Nest consists of sticks lined with dried grasses, leaves, pine needles, and herbs *15,26,32,39*. Night brooding is shared by both sexes and lasts from the natal down stage up to the 2nd plumage, approximately 3-4 weeks. Young are also shielded during conditions of severe weather *32,38*.
Feeding adult: Bald eagles' preferred food is fish so need open water during the winter to feed *25,27*. Cottonwoods are frequently used as roost and nest trees. The height of the tree, however, is the most important factor and the tallest trees in an area are chosen *19,25,26,28,29,31* the average heighth is approximately 22 m and average dbh is 42-66 cm *25,28*. Edges and openings in forests are also important for visibility *25,31*. Deciduous trees during the winter and dead trees year-round are frequently used for similar reasons *29,31*.
Resting adult: Cottonwoods are frequently used as roost trees. The height of the tree, however, is the most important factor and the tallest trees in an area are chosen for perches *19,25,26,28,29,31,34*. The average heighth is approximately 22 m and the average dbh is 42-66 cm *25,28*. Deciduous trees during the winter and dead trees year-round are frequently used for winter perches *29,31*. During the winter may seek confiers or floodplains surrounded by river bluffs for warmth under severe wind or at night *19,25,29,66,67*.

Breeding adult: During the breeding season the bald eagle pair begin building a new nest or adding to their old. Use sticks which they line with materials such as leaves, pine needles, and grass. Build nest in tall tree near water *15,26,32,39*.

LIFE HISTORY

Origin: Native *01,05*.

Physical description: Head, neck, and tail, white; general plumage, dark brown; primaries, black; bill, feet, and iris, yellow; female a little larger than male; female wing approximately 25 in., male wing approximately 23 in.; immature-whole plumage, very dark brown; legs yellow; attains adult plumage gradually, 3-4 years *01,05,15,33*.

Reproduction: Breeding season, february-march *26,38,39*; incubation approximately 35 days *15,21,32,35,39*; sexual maturity 5-6 years of age *21*; lay 2-3 eggs, 2 young/year but often only 1 chick is fledged, 1 clutch/year *15,21,26,32,35*; engage in courtship flights which sometimes consist of the pair locking talons in midair and descending several hundred feet in a series of somersaults *15*.

Behavior: Eagles exhibit territoriality over the immediate vicinity of their nest and perches during nest building, incubation of eggs, and raising of eaglets, tend to use the same nesting site every year *26,34,39*; Northern bald eagles migrate south to open water along rivers and reservoirs, there is some northern movement of southern bald eagles during the summer after the breeding season is over *15,16,26,68*; foraging strategy includes striking at live, dying, or dead fish in water, occasionally pursuing waterfowl in the air (particularly injured birds), and utilizing carrion *21,26*; nest in tall trees, ex. cottonwood, sycamore, dead trees *26,32,37,39*; young spend approximately 10-13 weeks in nest, during this time learn how to fly but continue to stay in or near nest *15,32,42*; generally are eaglets but the stronger one may out compete the other for food *15,16,26*; parental care of young consists of sheltering eaglets from severe weather and cold, guarding from predators, feeding for 10-13 weeks *26,32,34,37,38,39,42*; winter perch site preferences (used for loafing) include dead trees, deciduous trees (ex. cottonwood, sycamore, maple, & bald cypress); and tall trees in particular *19,29,68*; use similar trees during summer during "breaks" from brooding *34*.

Limiting factors: The concentration of organochlorine pesticides, polychlorinated biphenyls, and mercury have been monitored in bald eagle carcasses and eggshells since 1966, nearly all carcasses contained residues of DDE and PCBs but most, although not all, died from other causes, eggshells also exhibited thinning but it is not certain to what extent this is limiting reproductive success, most common cause of death is illegal shooting although this has decreased *21,43,44,45,46,47,48*; spermatogenesis was not found to be affected in males fed a sublethal dose diet of DDT *49*. Trichomoniasis has been recently reported in bald eagles that apparently fed on the parasite's host, rock and mourning doves, treatment with emetryl tablets produced complete recovery *50* habitat loss to agricultural and industrial uses, logging, and recreational utilization of lakes and lakeshores coupled with human disturbance has resulted in a long term decline *21,26,51,69*; loss of nesting sites is particularly critical *26*; Sprunt found low productivity to be due principally to fewer pairs of eagles producing young at a lower rate *26,52*.

Population parameters: The population trend for wintering bald eagles in Illinois fluctuates but is probably fairly stable *58,59,60,61*; there is now limited nesting in southern Illinois *40,41,54*; little is known about longevity or length of sexual activity, a dead bald eagle in the wild was 27 years old and captive bald eagles have lived to be 50 *26*; sex ratio is 1:1 *37*; little is known about mortality

and survival rates but Sherrod estimated adult mortality at 5.4% and a collective mortality of subadult birds before breeding age to be 90% *57*. The bald eagle recovery plan summarizes mortality factors *69*.

MANAGEMENT PRACTICES

Beneficial:

- Maintaining undisturbed/undeveloped areas
- Developing/maintaining edge (ecotones)
- Maintaining unique or special habitat features (wetlands, snags, caves, cliffs, talises, etc.
- Preserving endangered species habitat
- Establishing buffer zones
- Improving habitat on adjacent areas to increase carrying capacity
- Performing special survey prior to prescription
- Controlling land use and human activities
- Seasonal restriction of human use of habitats
- Controlling water levels
- Navigational improvements such as channelization and locks and dams
- Drawdown of ponds/lakes
- Developing/maintaining riparian habitat
- Developing/maintaining streamside vegetation to prevent erosion and provide riparian habitat
- Contouring to create windbreaks in mine areas
- Site preparation for revegetation of mined land- establishing noncommercial forest
- Site preparation for revegetation of mined land- establishing woody wildlife area
- Shelterwood method of silviculture- seed cut
- Seed tree method of silviculture- seed cut
- Selection method of silviculture- group
- Thinning operations in forest areas
- Thinning improvement cuts in forest areas
- Reforestation
- Developing/maintaining forest openings
- Burning forest openings
- Deferring for old growth in forest areas
- Deferring for special management (e.g. for cavities and snags) in forest areas
- Modifying forests for age diversity
- Developing/maintaining woodlots
- Developing/maintaining forest edge
- Developing/maintaining mature hardwood forest
- Prohibiting hunting
- Providing seasonal supplemental feeding
- Developing/maintaining water holes, ponds, potholes, etc.
- Restricting human disturbance during migration, breeding, and nesting
- Maintaining large trees for denning, nesting, or roosting
- Providing artificial nesting and roosting sites (platforms, nest boxes, cones, baskets, burro
- Creating wind and snowbreaks for winter wildlife protection
- Drawdown of ponds/lakes

Adverse:

- Locating, designing, developing, and constructing roads
- Locating, designing, and constructing powerlines
- Providing public access (develop roads, trails, parking areas or provide legal access)
- Draining ponds/lakes
- Strip mining
- Conducting exploratory drillings in mine areas
- Advance stripping to remove the vegetation and the topsoil in mine areas
- Constructing surface facilities in mine areas (preparation plant, soil stockpiles, refuse dis
- Clearcutting forests
- Shelterwood method of silviculture- removal cut
- Salvage thinning- mortality cuts in forest areas
- Salvage thinning- sanitation cuts in forest areas
- Forest protection- insect pest control
- Forest protection- disease pest control
- Removal of old trees
- Application of insecticides
- Using noise makers, flashing lights, or other repellants to drive individuals into other area

Existing:

- Developing/maintaining edge (ecotones)
- Maintaining unique or special habitat features (wetlands, snags, caves, cliffs, talises, etc.
- Preserving endangered species habitat
- Establishing buffer zones
- Performing special survey prior to prescription
- Controlling land use and human activities
- Developing/maintaining riparian habitat
- Thinning operations in forest areas
- Reforestation
- Deferring for special management (e.g. for cavities and snags) in forest areas
- Prohibiting hunting
- Restricting human disturbance during migration, breeding, and nesting
- Maintaining large trees for denning, nesting, or roosting
- Providing artificial nesting and roosting sites (platforms, nest boxes, cones, baskets, burro

Comments on management practices:
During the winter, bald eagles in Illinois are found primarily along major rivers. Therefore, beneficial management practices should protect riparian areas known to be frequented by the eagles. Do not remove known roosting trees, snags, or potential roosting trees with diameters exceeding 30 cm within 3 m of riverbank *31*. Buffer zones around roosting and nesting areas are also important with very restricted human activity (150-250 m from eagle area) *31,63*, understory vegetation can help minimize visual disturbances (within 30-50 m along shoreline and other boundary areas) *29,31*. Develop roosting sites for future years either through new plantings or thinning of trees *31*. Timber cutting and other similar activities should not be allowed during the nesting season *26*. Need buffer zone around nesting area (Feb.-June) similar to winter roosting areas *26*. Some of these practices are being used in Illinois. For wintering bald eagles: in Pike Co. land is being acquired. At Keokuk a plan of mitigation is being developed which includes artificial roosts and land acquisition. Trees have been planted to provide a visual barrier and the construction of a bridge was modified so less trees

were cut down. In Rock Island certain areas are restricted and trees have been planted to provide perch sites for the future. Every winter there is an extensive ground and air survey conducted for bald eagles. A management plan for wintering bald eagles in Illinois is being prepared. For breeding birds: the nest areas at the Crab Orchard National Wildlife Refuge and Savannah are restricted from human access*41*. At the 1984 midwest workshop on bald eagle research & management, the importance of minimizing human disturbance and protecting bald eagle wintering areas (and efforts of land aquisition) were paricularly emphasized *65,66*. The northern states bald eagle recovery plan was approved in 1983 by the U.S. Fish & Wildlife Service. The primary objective that they established is: to re-establish self-sustaining populations of bald eagles in suitable habitat throughout the northern states region. To achieve this, a goal was set at having 1,200 occupied breeding areas distributed over at least 16 states within the region by the year 2000 with an average annual productivity of at least 1.0 young/occupied nest. The 4 components of the recovery plan designed to achieve this are: 1) determine current population and habi- tat status 2) determine population and habitat levels needed to ac achieve recovery 3) protect, enhance, and increase bald eagle populations and 4) coordinate and conduct recovery efforts *69*.

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Illinois Breeding Bird Atlas
Peregrine Falcon
Breeding Status

Confirmed
Probable
Possible

Illinois Department of Natural Resources, Division of Natural Heritage
Illinois Natural History Survey, Center for Wildlife Ecology

Peregrine falcon
Falco peregrinus

Taxonomy
Occurence in Illinois
Status
Habitat associations
Guilds
Food-habits
Environmental associations
Life history
Management practices
References

TAXONOMY

- Phylum: Chordata
- Class: Aves
- Order: Falconiformes
- Family: Falconidae
- Genus: *Falco*
- Species: *Falco peregrinus*
- Authority: Tunstall

Comments on taxonomy:
Other common names are duck hawk and great-footed hawk *05,25,34*; only subspecies in eastern U.S. is *F. peregrinus anatum* Bonaparte *01, 15,26,29*.

OCCURENCE IN ILLINOIS

Last known breeding pair in Jackson Co.(1951) *06,31*; Extinct as breeding species in eastern U.S.

since 1964*16*; often sighted in fall migration near Mississippi R. And Lk. Michigan*22,23,24*. Two potential unassassed eyries in Jackson and Wabash Counties *34*. Known to stop over and perhaps winter in Shawnee National Forest *34*.

STATUS

Items in **bold** indicate applicable categories
Forest Service Categories: S = recommended for regional sensitive status, F = forest listed species, M = management indicator species

Federal Status:

Endangered	Threatened	Proposed for listing
Candidate for proposal	**Recovery plan approved**	Recovery plan received (USFWS)
Recovery plan in preparation	Under notice of review	Delisted
Migratory	EPA indicator	Forest Serv.- Shawnee species

State Status:

Endangered	Threatened	Proposed

Other:

Game	Furbearer	**Nongame protected**	
Sportfish	Commercial	Pest	None of the above

Comments on status:
Early April- mid May: early Sept.- Nov. Occasional migrant along Lake Michigan and rare migrant in remainder of state *06*. Original eastern breeding population now extinct *34*. No evidence of breeding pairs in the eastern U.S. after 1975 *16*. Recovery plan published in 1979. The peregrine falcon is protected under Illinois Endangered Species Act, 1972 *35*, Federal Endangered Species Act, 1977*34*, Illinois Wildlife Code 1971 *37*, and Migratory Bird Treaty Act, 1918 *36*, for other legal protection see *34*.

HABITAT ASSOCIATIONS

Items in **bold** indicate applicable categories

General habitat:

Unknown	**Terrestrial**	Aquatic	**Riparian**

USFS timber inventory forest size class:

Unknown	**Unstocked**	Seedling	Sapling
Seedling/sapling	Pole	**Mature**	**Over mature**

Land use and land cover:

Unknown		**Urban**	Residential **Commercial** Industrial Transportation, communication Complex industrial/commercial Mixed Other
Agricultural	**Crop, pasture** Orchards, groves, nurseries Feedlot Other	Rangeland	Herbaceous Shrub and brush Mixed
Forestland	Deciduous Evergreen Mixed	**Water**	**Stream** **Lake** **Reservoir** Bay
Wetland	**Forest** **Non-forest**	Barren	Salt flat Beach Sand **Rock** Mine Transit Mix

Forest cover types:

Cover type	Structural stage	Canopy closure	Season
Elm-ash-cottonwood	Mature (9" dia. & 100 yrs. old)	Unknown	Spring
Elm-ash-cottonwood	Mature (9" dia. & 100 yrs. old)	Unknown	Fall
Elm-ash-cottonwood	Old growth (trees over 100 yrs. old)	Unknown	Spring
Elm-ash-cottonwood	Old growth (trees over 100 yrs. old)	Unknown	Fall

Associated tree species: No records.

National wetland inventory classifications:

System	Subsystem	Class	Subclass	Water regime modifiers	Water chemistry
Lacustrine	Littoral	Forest	Broad-leaved deciduous	Permanent nontidal	Freshwater
Palustrine		Emergent vegetation	Persistent	Permanent nontidal	Freshwater

Palustrine		Forest	Broad-leaved deciduous	Permanent nontidal	Freshwater
Riverine	Unknown perennial	Forest	Broad-leaved deciduous	Permanent nontidal	Freshwater

Comments on species-habitat associations:
Historical nesting sites were in the bluffs of the Mississippi R. *6,16*; migrants most commonly seen along the Mississippi R. and Lk. Michigan *06*. The peregrine nests mostly on rock cliffs, bluffs and vertical escarpments. Also river gorges and watergaps with precipitous cliffs are preferred. Tree sites and city buildings may also be used *34*. The peregrine hunts over waterways, wetland areas such as swamps or marshes and open fields *34*.

Important plant and animal association: No comments.

High value habitats

Habitat	Structural stage	Season
Floodplain forest	Mature (9" dia. & 100 yrs. old)	Spring
Floodplain forest	Mature (9" dia. & 100 yrs. old)	Fall
Wetland	Special habitat	Spring
Wetland	Special habitat	Fall
Lake Michigan	Not applicable (HVAL-HAB cover)	Spring
Lake Michigan	Not applicable (HVAL-HAB cover)	Fall
Large river	Not applicable (HVAL-HAB cover)	Spring
Large river	Not applicable (HVAL-HAB cover)	Fall
Cliff	Not applicable (HVAL-HAB cover)	Spring
Cliff	Not applicable (HVAL-HAB cover)	Fall
Marsh restoration	Special habitat	Spring
Marsh restoration	Special habitat	Fall

Species-habitat interrelations: Peregrines may be found near rocky crags, ledges, bluffs, forested regions, open country, grasslands or scrub land *09,34*. Gigantic trees were used as nesting sites in 1800's, no such trees exist today *29*; recently, cliffs were most important nesting sites *02,03,19*; essential is a commanding view of surrounding area, migratory peregrines are most abundant along Lk. Michigan shores *06*. Habitat types used by migrating peregrines are essentially waterways, wetland areas such as swamps and marshes, open fields and woodland types found along edges of these areas. The best areas have combinations of these habitat types *34*. Peregrines require large

expanses of land over which they can capture bird prey in flight *34*.

GUILDS

Feed-guilding:
Air- birds
Terrestrial surface- birds
Water surface- birds

Habitat	Structural stage	Season	Feed-guilds
Agricultural field	Not applicable (HVAL-HAB cover)	All	Air- birds Terrestrial surface- birds Water surface- birds
Successional field	Special habitat	All	
Lakes and ponds	Not applicable (HVAL-HAB cover)	All	Air- birds Terrestrial surface- birds Water surface- birds
Wetland	Special habitat	All	Air- birds Terrestrial surface- birds Water surface- birds
Large river	Not applicable (HVAL-HAB cover)	All	Air- birds Terrestrial surface- birds Water surface- birds

Comments on feed-guilding:
Peregrines feed almost exclusively on birds, taken on the wing *05,21*. Open space above hunting area important to allow aerial capture. Hunting takes place over waterways, wetlands and open fields *34*.
Breed-guilding:

Habitat	Structural stage	Season	Breed-Guilds
Cliff	Not applicable	Spring	Terrestrial surface, cliff on ledge near top

Comments on breed-guilding:
Cliff ledges are the foci of many courtship and breeding behaviors, and preferred nesting sites *10*. Also may nest in trees and large buildings in metropolitan areas *34*.

FOOD-HABITS

Trophic level is CARNIVORE

Food item	Life stage/plant part
Birds	Adult
Ardeidae (herons, bitterns)	All
Anatidae (swans, geese, ducks)	All
Accipitridae (kites, hawks, eagles)	Unknown

Falconidae (kestrels, falcons)	Unknown
Charadriidae (plovers)	Unknown
Scolopacidae (curlews, sandpipers, snipes)	All
Laridae (gulls, terns)	All
Columbidae (pigeons, doves)	All
Columbidae (pigeons, doves)	Adult
Passeriformes	All
Hirundinidae (martins, swallows)	All
Corvidae (jays, magpies, crows)	All
Mimidae (mockingbirds, thrashers)	All
Muscicapidae (old world warblers & flycatchers, gnatcatchers)	All
Sturnidae (starlings)	All
Emberizinae (sparrows, longspurs)	All
Cardinalinae (cardinals, buntings)	All
Icterinae (blackbirds, orioles, meadowlarks)	All
Important:	
Birds	Adult
Anatidae (swans, geese, ducks)	All
Charadriidae (plovers)	Unknown
Scolopacidae (curlews, sandpipers, snipes)	All
Columbidae (pigeons, doves)	All
Columbidae (pigeons, doves)	Adult
Juvenile:	
Birds	Adult
Anatidae (swans, geese, ducks)	All
Charadriidae (plovers)	Unknown
Scolopacidae (curlews, sandpipers, snipes)	All
Columbidae (pigeons, doves)	All
Adult:	
Birds	Adult
Ardeidae (herons, bitterns)	All
Anatidae (swans, geese, ducks)	All
Accipitridae (kites, hawks, eagles)	Unknown
Falconidae (kestrels, falcons)	Unknown
Charadriidae (plovers)	Unknown
Scolopacidae (curlews, sandpipers, snipes)	All
Laridae (gulls, terns)	All
Columbidae (pigeons, doves)	All

Columbidae (pigeons, doves)	Adult
Passeriformes	All
Hirundinidae (martins, swallows)	All
Corvidae (jays, magpies, crows)	All
Mimidae (mockingbirds, thrashers)	All
Muscicapidae (old world warblers & flycatchers, gnatcatchers)	All
Sturnidae (starlings)	All
Emberizinae (sparrows, longspurs)	All
Cardinalinae (cardinals, buntings)	All
Icterinae (blackbirds, orioles, meadowlarks)	All

Comments on food habits:
General: Birds constitute nearly all of the peregrines diet; where avail- able, pigeons are preferred prey*21,25,28* waterfowl and shorebirds are especially important on wintering grounds *34*. Near metropolitan areas starlings and rock doves are important prey *34*.
Juvenile: Parents tear prey birds into pieces for hatchlings*28*. Food items are those eaten by adults.
Adult: See general food habits.

ENVIRONMENTAL ASSOCIATIONS

General:

- Flood plain: see comments
- Cliffs/ledges: see comments
- Aquatic habitats: freshwater marsh
- Aquatic habitats: swamp, general
- Aquatic habitats: mud flats
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Ecotones: woodland/water
- Pastures: see comments
- Grassland: see comments
- Meadows: see comments
- Old fields: see comments
- Hardwood forest: see comments
- Human associations: see comments
- Unknown

Limiting:

- Flood plain: see comments
- Cliffs/ledges: see comments
- Aquatic habitats: freshwater marsh
- Aquatic habitats: swamp, general
- Aquatic habitats: marsh
- Human associations: see comments

Egg

- Unknown

Feeding juvenile:

- Aquatic habitats: freshwater marsh
- Aquatic habitats: swamp, general
- Aquatic habitats: mud flats
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Pastures: see comments
- Grassland: see comments
- Meadows: see comments
- Old fields: see comments

Resting juvenile:

- Flood plain: see comments
- Cliffs/ledges: see comments
- Ecotones: woodland/water

Feeding adult:

- Aquatic habitats: freshwater marsh
- Aquatic habitats: swamp, general
- Aquatic habitats: mud flats
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Pastures: see comments
- Grassland: see comments
- Meadows: see comments
- Old fields: see comments

Resting adult:

- Flood plain: see comments
- Ecotones: woodland/water

Breeding adult:

- Flood plain: see comments
- Cliffs/ledges: see comments
- Ecotones: woodland/water

Comments on environmental associations:

General: Historically, peregrines bred along large (Mississippi R.) rivers and lakes (Lk. Michigan) *02,03,06*; peregrines most often nest in cliffs*19,21*; human encroachment is generally deleterious, however, peregrines have nested on occuppied buildings*15,18*.
Feeding juvenile: Nestlings are fed in nest. Accompany parents on hunting trip or to plucking post when fledged *09*.
Resting juvenile: Juveniles remain on nest ledge for 5-6 weeks *14*. Assume to adopt adult resting habits.
Feeding adult: Hunting occurs over waterways, wetlands, and open fields *34*. Pere- grines require large expanses of open space in which to capture prey in flight. Often soar after feeding *34*.
Resting adult: Adults roost on rocks or trees with a preference for rocks or even small trees growing out of rocks especially if there are dead branches to use as perches *34*.
Breeding adult: Breeding behavior is centered around nesting ledges *05,10,14,28*. Are also known to breed in trees or buildings in metropolitan areas *09,34*.

LIFE HISTORY

Origin: Native *34,35*.

Physical description: 5 inches in length, 40 inches wingspan *09,27*; 639 gm male, 1007 gm female/average weight *09*; blue-gray or slate back, light breast *09,27*.

Reproduction: The male arrives first at breeding site (February) and goes through a series of acrobatic displays to attract a mate *34*. Courtship in peregrines includes these displays and nest site selection *05,14*. In the eastern U.S., pairs were on their breeding grounds and had re-established territories by march *34*. Peregrines will return to the same area year after year *09,34*. Peregrines also mate for life but a mate will be replaced if dies *09*. Courtship feeding occurs in peregrines and the male presents food to the female with a bowing ceremony *09*. It is unclear which sex chooses nest site. Nest usually located on rock ledge, bluffs of vertical escarp- ment. No nest is construced *09*. Peregrines may appropriate old nests of buzzards, ravens or eagles *09*. Mating takes place on ledges or cliff tops, sometimes on tree branches *09*. 3-4 Eggs (2-5) are laid in late March or April *05,14,19,21*. A second clutch will often be laid if first is destroyed. *05,14,19,28*. Eggs are cream or buff with many red and red-brown markings *09*. Eggs are laid at 2-3 day inter- vals *09*. Incubation begins with second or third egg as a rule; done mostly by female though male if known to assist. Male brings food to female while incubating *09*. Incubation lasts approx. 28-29 days for each egg (approx. 33 days) *09,34*. Hatchlings are altricial. Male supplies food and female feeds young, though male will feed if female absent *09*. Young fly at 35-42 days after hatching. After fledging juveniles remain in vicinity and dependent on parents for approx. 2 months *09*. Hatching success in wild is approx. at 75 % with an average of 1 young fledging per laying pair *34*. Brown and Amadon (19662) report 2 or less young per year per breeding pair *09*. All pairs may not breed in particular years *09*. Sexual maturity is attained at 3 years of age *14,28,34*.

Behavior: Peregrines are territorial species that return to the same vicinity in successive years. Exact estimates of territory size is known to vary depending on availability of suitable nesting sites and prey availability *34*. Total ranges may vary from 1/4 - 240 mi.; ave. in Britain is 20.1 square miles *34*. The territory immediately surrounding a nest site is constantly and vigorously defended. The female is more aggressive than male *09*. Peregrines are excellent flyers and have been recorded at speeds of approx. 275 mph. (Stoop). Peregrines hunt food in the air and rarely on the ground. This species does not necessarily depend on speed to catch prey but manueverability and surprise also aid these falcons in hunting *34*. Open space above and around hunting areas is important for the peregrines hunting style *34*. The original eastern population of peregrines were either weakly migratory or non-

migratory *34*. The stock from which the introduced peregrines were derived is migratory. It is not yet known whether introduced birds will migrate. See *34*.

Limiting factors: Chemical pesticides, chlorinated hydrocarbons and specifically DDT and DDE are responsible for eggshell thinning and resulted in the demise of the eastern peregrine population beginning in 1946 *34*. The pesticide problem is not local but perhaps global. Even though DDT has been banned in the U.S., its use in Mexico, Central and South American countries presents a serious hazard to peregrines throughout the western hemisphere *34*. Indiscriminate shooting was reported to be the greatest factor contributing to adult mortality *34*. Egg collecting, natural predators, desease, falconers, and human disturbance at the nest site and during the nesting period are also contributing factors to annual loss of eggs and young *34*. There is no evidence that natural predation is a limiting factor. Enemies include the great horned owl (most adverse), racoon, gray fox, bobcat, striped skunk, oppossum, and black snake *34*.

Population parameters: The original eastern breeding population is now extinct. As of 1975 no breeding pairs occurred in the eastern U.S.*16* The recovery plan for peregrine falcons approved in 1979 assumes a first year mortality rate of 66.7% and 20% mortality thereafter. Also that 50% of breeding age birds nest successfully and 2.0 young per successful pair are produced with a sex ratio of 1:1 *34*. Because of dealing with an extirpated population and lack captive stock, the pro- posed introductions will be derived from parental stock described in *34*. p.30. The recovery plan estimates that over a 15 yr. period from 1980-1995, 2550 young captive-produced peregrines might have to be re- leased in order to establish 92 successful breeding pairs in the wild. Peregrines may live 12 yrs. in the wild, perhaps more in captivity. Average lifespan is approx. 2-3 yrs. *09*.

MANAGEMENT PRACTICES

Beneficial:

- Maintaining undisturbed/undeveloped areas
- Maintaining natural areas and nature preserves
- Maintaining unique or special habitat features (wetlands, snags, caves, cliffs, talises, etc.
- Preserving endangered species habitat
- Preserving sensitive species habitat
- Performing special survey prior to prescription
- Performing field survey prior to prescription
- Controlling land use and human activities
- Seasonal restriction of human use of habitats
- Controlling pollution
- Developing/maintaining snags
- Developing/maintaining wetlands
- Creating/maintaining wetlands from non-wetlands
- Developing/maintaining mudflats
- Protecting existing wetlands
- Restoration of wetlands (return flooded or drained areas to previous wetland conditions)
- Developing/maintaining riparian habitat
- Forest protection
- Deferring for old growth in forest areas
- Maintaining forests
- Providing protection from predators

- Providing food and cover for associated species
- Restricting human disturbance during migration, breeding, and nesting
- Estimating/maintaining nesting and escape cover
- Maintaining large trees for denning, nesting, or roosting
- Providing artificial nesting and roosting sites (platforms, nest boxes, cones, baskets, burro
- Maintaining undisturbed resting areas for migrating birds
- Providing ledges on highwalls of surface mines
- Stocking captive-reared wild strain animals

Adverse:

- Providing wildlife user trails
- Locating, designing, developing, and constructing roads
- Locating, designing, and constructing powerlines
- Recreational development
- Draining wetlands
- Applying pesticide on agricultural land
- Strip mining
- Applying pesticides
- Cutting and deforestation
- Removal of old trees
- Application of pesticides
- Application of insecticides

Comments on management practices:
Extirpation in Illinois was primarily due to pesticide (especially DDT) accumulations, causing catastrophic decline in hatching success *11,12*; the principal goals of the peregrine falcon recovery plan are; 1) preservation and management of essential nesting, wintering, and migration habitat, 2) captive propagation of peregrine and release of these birds into the wild, 3) protection of peregrines through law enforcement, elimination of environmental pollutants that adversely affect peregrines and 4) promotion of public support and understanding through a good education-information program *34*. Recovery can only proceed if there are adequate laws and strict enforcement protecting the birds from being killed or disturbed throughout their life cycle. The following are suggested: provide for additional habitat for prey base and open space to hunt prey, provide protection from predators, limit human disturbance, provide perch pole at or in vicinity of nest site, provide adequate feeding ledges and control access to site. The global pesticide problem must also be addressed. For more details on the recovery plan and management see *34*. The priority area for the recovery plan is the N.E. U.S.. No release sites have been proposed for Illinois, but are proposed for Wisconsin and Minnesota *34*. The U.S. Forest service, however, hopes to establish 2 breeding pairs in the Shawnee National Forest by the year 2020. (Proposed land and resource management plan, USFS, Shawnee National Forest, 1985).

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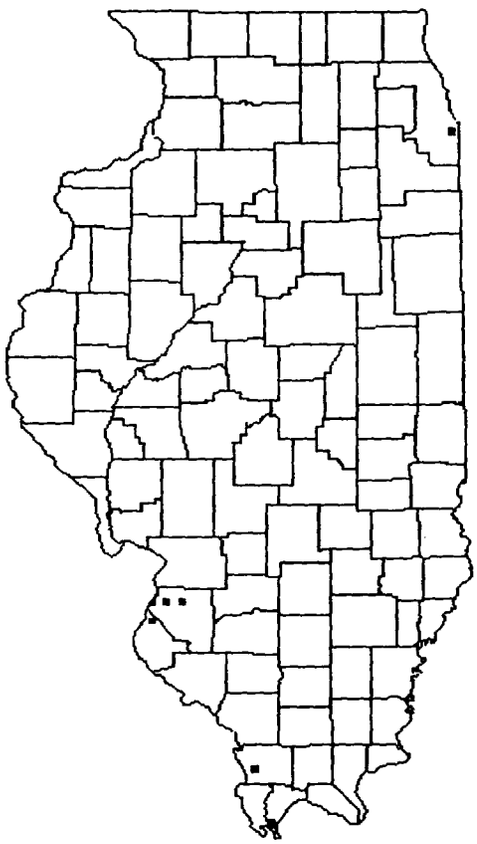
Illinois Breeding Bird Atlas
Little Blue Heron
Breeding Status

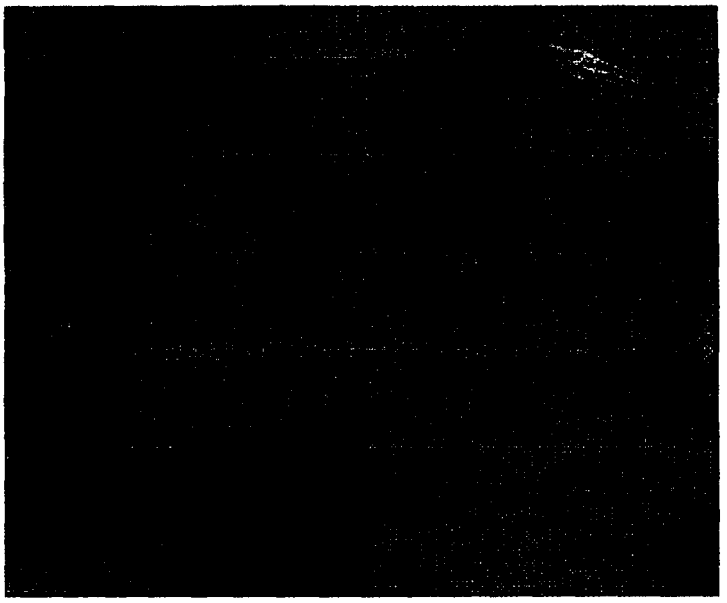


Confirmed
Probable
Possible

Illinois Department of Natural Resources, Division of Natural Heritage
Illinois Natural History Survey, Center for Wildlife Ecology

Little blue heron

Egretta caerulea



Taxonomy
Occurence in Illinois
Status
Habitat associations
Guilds
Food-habits
Environmental associations
Life history
Management practices
References

TAXONOMY

- Phylum: Chordata
- Class: Aves
- Order: Ciconiiformes
- Family: Ardeidae
- Genus: *Egretta*
- Species: *Egretta caerulea*
- Authority: Linnaeus

Comments on taxonomy:
Tribe: Ardeini. Other names:blue crane, little blue crane, little white crane (immature), levee walker (in Louisiana) *04*.

OCCURENCE IN ILLINOIS

The little blue heron is commonly seen periodically in Illinois but does not maintain a large breeding population *01,02,03*. Most recent breeding records:1980, 100 pairs at Pontoon Beach Colony, Madison Co.; 1981, 200-250 nests at Pontoon Beach Colony, Madison Co.; 1982, 250 nests at Pontoon Beach Colony, Madison Co. *23*.

STATUS

Items in **bold** indicate applicable categories
Forest Service Categories: S = recommended for regional sensitive status, F = forest listed species, M = management indicator species

Federal Status:

Endangered	Threatened	Proposed for listing
Candidate for proposal	Recovery plan approved	Recovery plan received (USFWS)
Recovery plan in preparation	Under notice of review	Delisted
Migratory	EPA indicator	**Forest Serv.- Shawnee species (F)**

State Status:

Endangered	Threatened	Proposed

Other:

Game	Furbearer	**Nongame protected**	
Sportfish	Commercial	Pest	None of the above

Comments on status:
Appeared on state endangered list 1977 and still satisfies requirements of list placement. As wetlands were drained the little blue heron suffered a precipitous decline in population size, has low population numbers, and their habitat is threatened *01*.

HABITAT ASSOCIATIONS

Items in **bold** indicate applicable categories

General habitat:

Unknown	Terrestrial	**Aquatic**	**Riparian**

USFS timber inventory forest size class:

Unknown	**Unstocked**	**Seedling**	**Sapling**
Seedling/sapling	**Pole**	**Mature**	**Over mature**

Land use and land cover:

Unknown		Urban	Residential Commercial Industrial Transportation, communication Complex industrial/commercial Mixed Other
Agricultural	**Crop, pasture** Orchards, groves, nurseries Feedlot Other	Rangeland	Herbaceous Shrub and brush Mixed
Forestland	Deciduous Evergreen Mixed	**Water**	**Stream** **Lake** **Reservoir** Bay
Wetland	**Forest** **Non-forest**	Barren	Salt flat Beach Sand Rock Mine Transit Mix

Forest cover types:

Cover type	Structural stage	Canopy closure	Season
Oak-gum-cypress	Young tree (1-9" dia.)	Unknown	Spring/summer
Oak-gum-cypress	Mature (9" dia. & 100 yrs. old)	Unknown	Spring/summer
Elm-ash-cottonwood	Young tree (1-9" dia.)	Unknown	Spring/summer
Elm-ash-cottonwood	Mature (9" dia. & 100 yrs. old)	Unknown	Spring/summer

Associated tree species:

- Cottonwood
- Black willow
- Sand-bar willow

National wetland inventory classifications:

System	Subsystem	Class	Subclass	Water regime modifiers	Water chemistry
Lacustrine	Littoral	Emergent vegetation	Persistent	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Emergent vegetation	Nonpersistent	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Flat	Mud	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Scrub/shrub	Deciduous	Intermittently exposed/permanent nontidal	Freshwater
Palustrine	Emergent vegetation	Persistent		Intermittently exposed/permanent nontidal	Freshwater
Palustrine	Emergent vegetation	Nonpersistent		Intermittently exposed/permanent nontidal	Freshwater
Palustrine	Flat	Mud		Intermittently exposed/permanent nontidal	Freshwater
Palustrine	Forest	Deciduous		Intermittently exposed/permanent nontidal	Freshwater
Palustrine	Scrub/shrub	Deciduous		Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Emergent vegetation	Persistent	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Emergent vegetation	Nonpersistent	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Flat	Mud	Intermittently exposed/permanent nontidal	Freshwater

Comments on species-habitat associations:
Little blue herons seem to prefer freshwater and are found in lakes ponds, marshes, sloughs, marshy shores of streams & coastal estuaries *01,02,04,05*. Also known to frequent rice fields. Little blue herons nest in a variety of trees, most often hardwoods. Throughout the literature these plant species

are common: buttonbush, willow sp., phragmites, and cottonwoods. Small fishes are a principal food item.

Important plant and animal association: Little blue herons are most often associated with other heron species such as snowy egret and tricolored heron *01*.

High value habitats

Habitat	Structural stage	Season
Water	Special habitat	Spring
Water	Special habitat	Summer
Wetland	Special habitat	Spring
Wetland	Special habitat	Summer
Marsh	Special habitat	Spring
Marsh	Special habitat	Summer
Swamp	Special habitat	Spring
Swamp	Special habitat	Summer
Shrub swamp	Special habitat	Spring
Shrub swamp	Special habitat	Summer
Lakes and ponds	Special habitat	Summer/fall
Reservoir	Special habitat	Summer/fall
Streams	Special habitat	Summer/fall
Marsh restoration	Special habitat	Summer/fall

Species-habitat interrelations: The little blue heron is found primarily in freshwater marshes, also lakes, ponds, sloughs and marshy stream borders. Shallow waters, sometimes mudflats are principle foraging grounds, though in their absence dry fields may be used. Nesting occurs in dense thickety growth forms that border wetlands, usually hardwoods. Foraging grounds appear to be most essential and optimal nesting habitat may be sacrificed.

GUILDS

Feed-guilding:

Habitat	Structural stage	Season	Feed-guilds
			Water bottom-unconsolidated bottom, invertebrates other than zooplankton or arthropods Water bottom-unconsolidated bottom, fish Water bottom-unconsolidated bottom, amphibians Water bottom-unconsolidated bottom, reptiles Water bottom-aquatic bed, invertebrates other than zooplankton or arthropods Water bottom-aquatic bed, fish Water bottom-aquatic bed, amphibians

Wetland	All	Spring	Water bottom-aquatic bed, reptiles Water column- invertebrates other than zooplankton or arthropods Water column- fish Water column- amphibians Water column- reptiles Water column- birds Water surface- invertebrates other than zooplankton or arthropods Water surface- fish Water surface- amphibians Water surface- reptiles Water surface- birds
Wetland	All	Spring	Terrestrial surface- arthropods Terrestrial surface- invertebrates other than arthropods Terrestrial surface- amphibians Terrestrial surface- reptiles Terrestrial surface- birds
Wetland	All	Summer	Water bottom-unconsolidated bottom, invertebrates other than zooplankton or arthropods Water bottom-unconsolidated bottom, fish Water bottom-unconsolidated bottom, amphibians Water bottom-unconsolidated bottom, reptiles Water bottom-aquatic bed, invertebrates other than zooplankton or arthropods Water bottom-aquatic bed, fish Water bottom-aquatic bed, amphibians Water bottom-aquatic bed, reptiles Water column- invertebrates other than zooplankton or arthropods Water column- fish Water column- amphibians Water column- reptiles Water column- birds Water surface- invertebrates other than zooplankton or arthropods Water surface- fish Water surface- amphibians Water surface- reptiles Water surface- birds
Wetland	All	Summer	Terrestrial surface- arthropods Terrestrial surface- invertebrates other than arthropods Terrestrial surface- amphibians Terrestrial surface- reptiles Terrestrial surface- birds

Comments on feed-guilding:
The little blue heron feeds primarily in shallow waters of lagoons, swamps, marshes, & also rice fields

& mudflats. Most important food items are small fishes and crayfishes *01,03*. If marshes or swamps dry up, the little blue heron has been known to survive solely on insects of grasslands, e.g. grasshoppers, crickets, and beetles *04*.

Breed-guilding:

Habitat	Structural stage	Season	Breed-Guilds
Wetland	Special habitat	Spring	Shrub strata, canopy of broad-leaved deciduous shrubs Shrub strata, canopy of needle-leaved deciduous shrubs Shrub strata, canopy of broad-leaved evergreen shrubs Shrub strata, canopy of needle-leaved evergreen shrubs Shrub strata, grass and grasslike vegetation extending into shrub strata Shrub strata, forb vegetation extending into shrub strata
Wetland	Special habitat	Summer	Shrub strata, canopy of broad-leaved deciduous shrubs Shrub strata, canopy of needle-leaved deciduous shrubs Shrub strata, canopy of broad-leaved evergreen shrubs Shrub strata, canopy of needle-leaved evergreen shrubs Shrub strata, grass and grasslike vegetation extending into shrub strata Shrub strata, forb vegetation extending into shrub strata

Comments on breed-guilding:
Little blue herons usually copulate in the nest or close to it *06, 07*. Nests are usually located in low dense thickety growth forms *03*. Little blue herons nest colonially in homogeneous groups often near other heron species *26*.

FOOD-HABITS

Trophic level is CARNIVORE

Food item	Life stage/plant part
Invertebrates	Unknown
Arthropoda	Unknown
Arachnida (spiders, ticks, scorpions, daddy longlegs)	See comments
Crustaceans	See comments
Malacostraca (isopods, amphipods, crayfishes)	See comments
Insecta	Unknown
Odonata (dragonflies, damselflies)	Unknown
Orthoptera (grasshoppers, crickets, cockroaches)	Unknown
Coleoptera (beetles)	Unknown
Osteichtyes (bony fishes)	See comments
Amphibians	Adult
Amphibians	Unknown

Salientia (frogs, toads)	See comments
Salientia (frogs, toads)	Juvenile
Salientia (frogs, toads)	Adult
Reptiles	See comments
Testudines (turtles)	See comments
Sauria (lizards, skinks, iguana)	See comments
Serpentes (snakes)	See comments
Important:	
Malacostraca (isopods, amphipods, crayfishes)	See comments
Osteichtyes (bony fishes)	See comments
Salientia (frogs, toads)	See comments
Juvenile:	
Invertebrates	Unknown
Arthropoda	Unknown
Arachnida (spiders, ticks, scorpions, daddy longlegs)	See comments
Crustaceans	See comments
Malacostraca (isopods, amphipods, crayfishes)	See comments
Insecta	Unknown
Odonata (dragonflies, damselflies)	Unknown
Orthoptera (grasshoppers, crickets, cockroaches)	Unknown
Coleoptera (beetles)	Unknown
Osteichtyes (bony fishes)	See comments
Amphibians	Adult
Amphibians	Unknown
Salientia (frogs, toads)	Juvenile
Reptiles	See comments
Testudines (turtles)	See comments
Sauria (lizards, skinks, iguana)	See comments
Serpentes (snakes)	See comments
Adult:	
Invertebrates	Unknown
Arthropoda	Unknown
Arachnida (spiders, ticks, scorpions, daddy longlegs)	See comments
Crustaceans	See comments
Malacostraca (isopods, amphipods, crayfishes)	See comments
Insecta	Unknown
Odonata (dragonflies, damselflies)	Unknown
Orthoptera (grasshoppers, crickets, cockroaches)	Unknown

Coleoptera (beetles)	Unknown
Osteichtyes (bony fishes)	See comments
Amphibians	Adult
Amphibians	Unknown
Salientia (frogs, toads)	Juvenile
Reptiles	See comments
Testudines (turtles)	See comments
Sauria (lizards, skinks, iguana)	See comments
Serpentes (snakes)	See comments

Comments on food habits:
General: Little blue herons prey chiefly (and always in Illinois) on freshwater animals. Most important are small fishes, crayfishes, frogs, and aquatic insects, also eaten are turtles, snakes, lizards, other insects, spiders *01,03,04,05,06,07,08,13*.
Juvenile: Juvenile food habits apparently do not differ from adult food habits *20*.
Adult: See general food habits.

ENVIRONMENTAL ASSOCIATIONS

General:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: vegetated streambank
- Aquatic habitats: island inhabitant
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: see comments
- Aquatic habitats: marsh
- Aquatic habitats: unknown
- Vegetation mosaics/edges: see comments
- Ecotones: see comments
- Shrubs: see comments
- Coniferous forest: see comments
- Hardwood forest: see comments
- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments
- Human associations: wildlife refuges/sanctuaries
- Human associations: see comments

Limiting:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: see comments
- Aquatic habitats: marsh

- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments
- Human associations: see comments

Feeding juvenile:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: see comments
- Aquatic habitats: marsh

Resting juvenile:

- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments

Feeding adult:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: see comments
- Aquatic habitats: marsh

Resting adult:

- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments

Breeding adult:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: see comments
- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments
- Human associations: see comments

Comments on environmental associations:
General: Marshes and swampy areas are essential to the little blue herons occurrence and survival *03*. Though primarily used as foraging sites, border vegetation occurring as dense thickety growth form are preferred and necessary for nesting *03*. Preferred nest sites may suffer for a prime foraging habitat *03*.
Feeding juvenile: Little blue herons must have unpolluted wetlands, as they forage primarily in shallow waters of sloughs, marshes, and swampy areas.
Resting juvenile: Roosts in dense thickets and trees in or near foraging and nesting habitats *05,07*.

Feeding adult: See comments on feeding juvenile.
Resting adult: See comments on resting juvenile.
Breeding adult: Little blue herons breed in wetland situations that provide a good foraging habitat and nesting structure. Preferred areas are undisturbed by human activity *01,03,10,17*.

LIFE HISTORY

Origin: Native *02*.

Physical description: Slender medium sized heron. 25"-29" length; 41" wingspread wt. to 14 oz. Adult:slatey blue-grey, with a deep maroon- brown neck; legs dark. Immature:all white; tips of primaries bluish black. Legs, deep olive. Bill:pale bluish tipped in black. Also seen in transitional "pied" or "calico" stage *03,04,07,22*. No subspecies *07,08*.

Reproduction: No information available on breeding in Illinois *00,03*. Little blue herons arrive on breeding grounds in Arkansas in mid- March *06*. This species breeds farther inland by preference. Males select territories upon arrival and subsequently start to display *07*. Little blue herons nest collonially and are usually associated with other species of herons *03*. Courtship displays occur on nesting territory and usually near eventual nest site *03, 06,07*. The ritualized courtship continues from sunrise to sunset. Males may build nest foundation before acquiring a mate. Copulation commences during initial stages of nest building and continues throughout laying period *07*. A good nest site requires a suitable supply of sticks and support for the nest *07*. The nest may range from a flimsy platform to a sometimes substantially bulky nest and takes approximately 5-6 (3-7) days to build *04,05,6,07*. The male gathers most sticks and gives them to female who does the actual construction *06,07*. Twig transfer is accompanied by an elaborate ceremony *07*. The nest is usually placed low, 5-10 ft, in dense vegetation, to occasionally 40 ft. in a swamp tree *03,04,07*. In Florida and Arkansas nest construction occurs the last week in March or 1st week in April *07*. Eggs are layed:Fla., Dec. 27-June 3, usually April 1-25; La., Apr. 7-May 16; Ark.,late Apr. *03,04,07*. Average clutch size is 4-5 (3-6) pale bluegreen eggs (44.0 X 33.5 Mm) and take approximately 5-8 days to lay with 1 egg layed every other day *06,07*. Little blue herons will replace a clutch that has been destroyed *07*. Both parents incubate for approximately 22-24 days *04,06,07*. Incubation begins with laying of the first egg *03* or the 2nd egg with partial incubation of the first *07*. Relieving ceremonies are similar to that of other heron spp. *05*. At hatching the young are covered with dark brownish grey down with buffy tips on crest *07*. It takes approximately 3-5 days for entire clutch to hatch and in Fla. peak hatching occurs the 2nd week in may *07*. There is apparently 1 brood/yr. *04,08*. Initially, young are fed by regurgitation of food in the nest. At the end of the first week young then grab the bill of their parents to stimulate regurgitation in the usual heron manner *05,06,07*. In Arkansas the total time to rear 4 young from the point of nest construction to their independence is approximately 80 days *06*. Palmer (1962) reports the time span from hatching to fledging is 35-40 days *07*. Wershkul (1979) reports for Miss. and Ala. parental care consists of:brooding (1-10 days); guardian (11-18 days); post-guardian (19-56 days) *12*. Yearling birds will nest but the proportion is not known *03,06*. Little blue herons are reported to breed at 1 year *08,15*. Even though subadult or "white" birds try to mate they constitute <2% of nestings at bird & sunken islands in Fla. *15*. The oldest bird recorded was found dead in Miss., 7 years 4 mos. *04*.

Behavior: Upon arrival (S. Illinois, late March; C. Illinois, early Apr.) Territories are selected and defended by males for hostile and sexual displays, copulation and nest site *07*. The size of the initial territory selected by the male is always greater than the size defended by the pair *07,13*. No quantitative figures are available. Pair formation occurs on the males territory after which a smaller "nesting territory" is defended by both against conspecifics and other nesting herons *07*. The little

blue heron exhibits a much less complex courtship ritual than other ardeids. "The stretch" is their principal display (see Rodgers 1978, Palmer 1962) *07,15*. The little blue heron breeds from S. Illinois and New England southward throughout the south Atlantic states and Mississippi River Valley to southern South America *01,05*. Its stay in Illinois is from mid-Apr. to early Sept. which includes few nesting birds and many post-breeding migrants *01,02*. The only current breeding site in Illinois is near St. Clair and Madison Co.'s *02,23* but more may exist *02*. Although a single brood pair-bond is the rule, much promiscuity exists *06,07*. In Arkansas, Meanley (1955) reported that many females were serviced more by foreign males than their own males *06*. Post-breeding dispersal (July-Oct) is very evident in the little blue heron with greatest movement in white immature birds *03,05*. Sightings have occurred in Nova Scotia, Quebec, Ontario, Wisc., Neb., etc. *05*. These erratic journeys may be caused in part by over-crowding on breeding grounds *05*. In the fall large numbers of white birds are seen in north and central Illinois and even in southern Ill. The ratio of one adult to five immatures is greater than would be accounted for by breeding productivity, which probably indicates an influx of young birds from colonies outside of Illinois *03*. There appears to be a periodicity in numbers of little blue herons seen in late summer in Illinois with peaks occurring every 20 years *03*.

Limiting factors: Although not as widely distributed and not as numerous, the little blue heron is still common in the southern states *05*. It has been reported to be expanding its range northward *07*. In Illinois breeding accounts for 1982 listed approximately 250 nests at the Pontoon Beach Colony, Madison Co. (Kleen 1983) and possibly more throughout the Mississippi Valley *23*. In recent years colonies have been lost by flooding (Clarksville) and cutting of trees (Gale & Grand Marais) *03*. Habitat destruction, draining of swamps, marshes and lagoons is a primary limiting factor in all wading bird populations *01,17*. Little blue herons forage mainly in shallow waters therefore the draining of wetlands limits foraging habitat that is probably more essential than optimal nesting habitat *03*. Little blue herons are also susceptible to eggshell thinning by the constant use of some pesticides (DDE, Dieldrin) *18*. Natural enemies of the little blue heron include racoons, crows, and in Fla. the fish crow is a principal cause of mortality *05*. Little blue herons, like most other herons, are disrupted by human activity and disturbance during the nesting season is a critical factor *17*. It has been assumed in heronries of nearly 100% nesting success, a key factor was rookery isolation *06*.

Population parameters: No information for Illinois exists. Since the 1940's for waders in general, populations in coastal zones are stable or increasing but are experiencing a decline in numbers in inland colonies of Fla., S.C., N.C., Va., and Tx. *19*. This implies freshwater inland wetland habitats in much of the southeastern U.S., Which once supported these populations, have been more greatly stressed or reduced in area than coastal wetlands *19*. The little blue heron is no longer the most common heron in these southeastern colonies. It has also been agreed in the northeast that post-breeding invasions of immatures has been greatly reduced since 1950's *19*. In the southeast U.S. The little blue heron shows a considerable flux in numbers of nests from year to year with a slightly downward trend overall. It has been placed (unofficially) as a species of "special concern" in Fla. and Alab. *25*. Hatching success was reported by Rodgers (92.1%), Maxwell & Kale (87%) and Werschkul (82%) *13,10,12*. Clutches were larger among little blue herons nesting in freshwater swamps and smaller in more southerly colonies and may be related to food supply *13*. The greatest cause of egg loss in Fla. was nest collapse (76%) and fish crow predation (10%) *13*. It appears mortality rates are greatest at the nestling stage. Nestling mortality rates increased with each later position in the hatching sequence *12*. The primary reason for this increase was the later chick's inability to compete with nest mates and ultimate starvation *12,13*. Overall nesting success reported; 93% Ark., 100% Fla., 14.5% Ala. *06*. High success may be due to isolation and food abundance *06,10*. Information on survival rates, rate of increase, or sex ratios unavailable.

MANAGEMENT PRACTICES

Beneficial:

- Maintaining natural areas and nature preserves
- Maintaining unique or special habitat features (wetlands, snags, caves, cliffs, talises, etc.
- Preserving endangered species habitat
- Performing field survey prior to prescription
- Controlling land use and human activities
- Seasonal restriction of human use of habitats
- Controlling pollution in aquatic habitats
- Developing/maintaining lakes and ponds
- Developing/maintaining wetlands
- Creating/maintaining wetlands from non-wetlands
- Developing/maintaining mudflats
- Protecting existing wetlands
- Protecting existing wetlands
- Restoration of wetlands (return flooded or drained areas to previous wetland conditions)
- Developing/maintaining riparian habitat
- Developing/maintaining riparian habitat
- Restricting human disturbance during migration, breeding, and nesting

Adverse:

- Channelization
- Dredging
- Draining ponds/lakes
- Draining wetlands
- Strip mining
- Applying pesticides
- Clearcutting forests

Comments on management practices:
Habitat preservation is the key factor in the protection of wading birds *17*. The draining of wetlands and constant use of pesticides is a serious threat. Sanctuaries are probably the best means of preserving habitat. Also survey and classify all areas to aid in quick solutions *17*. The little blue heron is protected by the Illinois Endangered Species Act as of 1977 *01*. It is also protected by the Migratory Bird Treaty Act of 1918 *24* & the Ill. Wildlife Code 1971 *27*.

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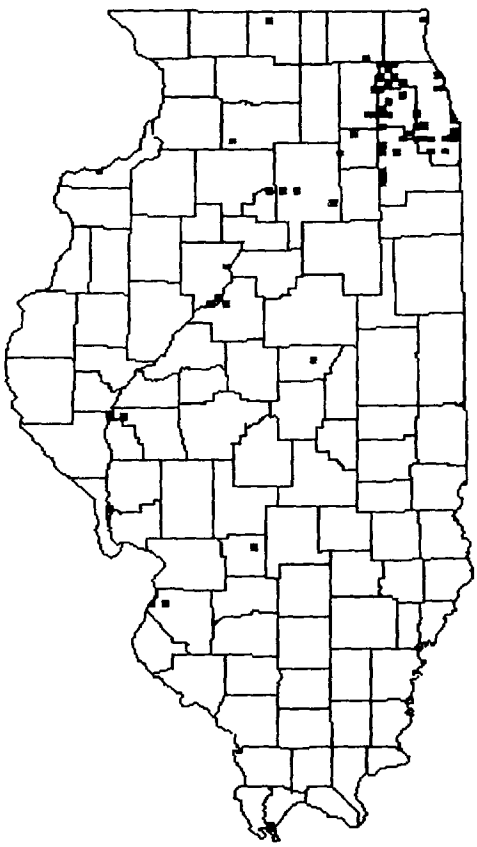
Illinois Breeding Bird Atlas
Black-crowned Night-Heron
Breeding Status



Confirmed
Probable
Possible

Illinois Department of Natural Resources, Division of Natural Heritage
Illinois Natural History Survey, Center for Wildlife Ecology

Black-crowned night-heron

Nycticorax nycticorax

Taxonomy
Occurence in Illinois
Status
Habitat associations
Guilds
Food-habits
Environmental associations
Life history
Management practices
References

TAXONOMY

- Phylum: Chordata
- Class: Aves
- Order: Ciconiiformes
- Family: Ardeidae
- Genus: *Nycticorax*
- Species: *Nycticorax nycticorax*
- Authority: Linnaeus

Comments on taxonomy:
Tribe: Nycticoracini *16*. Subspecies: *N.n. hoactli* (Gmelin); 4 subspecies, only *N.n. hoactli* present in North America *04*. Other names: American night heron; night heron; quawk; quok; squawk; qua-bird; mid-west, night raven, lake owl; Ga., red eye; Fla., night scrooglin, gobly-gossit, indian hen *05,07,13*.

OCCURENCE IN ILLINOIS

The black-crowned night-heron occurs in Illinois from early April- late October. It is a fairly common migrant and uncommon summer resident. Also a rare winter resident. Recent breeding accounts: 1982/83; over 500 nests at Pontoon Beach County; 177 nests at Barrington; 148 nests at Clear Lake; Lake Calumet, 55 nests *17*.

STATUS

Items in **bold** indicate applicable categories
Forest Service Categories: S = recommended for regional sensitive status, F = forest listed species, M = management indicator species

Federal Status:

Endangered	Threatened	Proposed for listing
Candidate for proposal	Recovery plan approved	Recovery plan received (USFWS)
Recovery plan in preparation	Under notice of review	Delisted
Migratory	EPA indicator	**Forest Serv.- Shawnee species (F)**

State Status:

Endangered	Threatened	Proposed

Other:

Game	Furbearer	**Nongame protected**	
Sportfish	Commercial	Pest	None of the above

Comments on status:
The black-crowned night-heron has shown a dramatic history of decline with only 4 sizeable colonies remaining in Illinois *01*. This species was placed on the Illinois endangered species list in 1977 and remains qualified for inclusion because of a) past history of decline b) small population numbers, and c) essential habitats are being threatened *01*. This species is also protected under the Migratory Bird Treaty Act of 1918 and the Illinois Wildlife Code of 1971 *19,22*.

HABITAT ASSOCIATIONS

Items in **bold** indicate applicable categories

General habitat:

Unknown	Terrestrial	Aquatic	**Riparian**

USFS timber inventory forest size class:

Unknown	**Unstocked**	**Seedling**	**Sapling**
Seedling/sapling	**Pole**	**Mature**	**Over mature**

Land use and land cover:

Unknown		Urban	Residential Commercial Industrial Transportation, communication Complex industrial/commercial Mixed Other
Agricultural	Crop, pasture Orchards, groves, nurseries Feedlot Other	Rangeland	Herbaceous Shrub and brush Mixed

Forestland	Deciduous Evergreen Mixed	**Water**	**Stream** **Lake** **Reservoir** **Bay**
Wetland	**Forest** **Non-forest**	Barren	Salt flat Beach Sand Rock Mine Transit Mix

Forest cover types:

Cover type	Structural stage	Canopy closure	Season
All	All	Unknown	Unknown

Associated tree species:

- Willow

National wetland inventory classifications:

System	Subsystem	Class	Subclass	Water regime modifiers	Water chemistry
Lacustrine	Littoral	Emergent vegetation	Persistent	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Emergent vegetation	Nonpersistent	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Flat	Mud	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Forest	Deciduous	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Forest	Evergreen	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Scrub/shrub	Deciduous	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Scrub/shrub	Evergreen	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Emergent vegetation	Persistent	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Emergent vegetation	Nonpersistent	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Flat	Mud	Intermittently exposed/permanent nontidal	Freshwater

Palustrine		Forest	Dead trees	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Forest	Deciduous	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Forest	Evergreen	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Scrub/shrub	Deciduous	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Scrub/shrub	Evergreen	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Emergent vegetation	Persistent	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Emergent vegetation	Nonpersistent	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Flat	Mud	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Forest	Deciduous	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Forest	Evergreen	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Scrub/shrub	Deciduous	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Scrub/shrub	Evergreen	Intermittently exposed/permanent nontidal	Freshwater

Comments on species-habitat associations:
The black-crowned night-heron seems adapted to nearly every conceivable habitat in which a wading bird may exist *04*. This species depends on wetlands for food and is found near freshwater ponds, lakes, sluggish streams, swamps, marshes, backwaters and shallow lagoons *12,14*. The proximity of foraging areas might be the most important factor in nest site selection, therefore, black- crowned night-herons utilize a wide variety of upland and lowland tree species and where suitable tree species cannot be found they will often nest in marsh vegetation where their nests are concealed *03,05, 14*.

Important plant and animal association: Gizzard shad.
Gizzard shad seem to be the principal food item of this species (and other herons) in Illinois *03,04,14*.

High value habitats

Habitat	Structural stage	Season
Forested wetland	Special habitat	Fall
Forested wetland	Special habitat	Spring/summer
Nonforested wetland	Special habitat	Fall
Nonforested wetland	Special habitat	Spring/summer
Wet-mesic upland forest	All	Fall

Wet-mesic upland forest	All	Spring/summer
Floodplain forest	All	Fall
Floodplain forest	All	Spring/summer
Wetland	Special habitat	Fall
Wetland	Special habitat	Spring/summer
Marsh	Special habitat	Fall
Marsh	Special habitat	Spring/summer
Swamp	Special habitat	Fall
Swamp	Special habitat	Spring/summer
Shrub swamp	Special habitat	Fall
Shrub swamp	Special habitat	Spring/summer
Lakes and ponds	Not applicable (HVAL-HAB cover)	Fall
Lakes and ponds	Not applicable (HVAL-HAB cover)	Spring/summer
Streams	Special habitat	Fall
Streams	Special habitat	Spring/summer
Marsh restoration	Special habitat	Fall
Marsh restoration	Special habitat	Spring/summer

Species-habitat interrelations: 1) Wetlands, foraging sites, high, spring/summer/fall *01,12,14*.
2) Bottomland forest, forested wetlands, nesting sites, high, spring/summer *01,04*.
The black-crowned night-heron's nesting sites are so varied, as to suggest the quality and proximity of foraging areas might be the most important factor in nest site selection *01,03,14*. Thus, this species frequents areas such as lagoons, backwaters, marshes, swamps, ponds, lakes, sluggish streams and rivers to secure a foraging site, consequently nesting in best available situation *01,03,05,07,13,14*.

GUILDS

Feed-guilding:

Habitat	Structural stage	Season	Feed-guilds
			Water bottom-unconsolidated bottom, arthropods Water bottom-aquatic bed, arthropods Water column- arthropods Water surface- arthropods Water bottom-unconsolidated bottom, invertebrates other than zooplankton or arthropods Water bottom-aquatic bed, invertebrates other than zooplankton or arthropods Water column- invertebrates other than zooplankton or arthropods Water surface- invertebrates other than zooplankton or arthropods

Wetland	Special habitat	All	Water bottom-unconsolidated bottom, fish Water bottom-aquatic bed, fish Water column- fish Water surface- fish Water bottom-unconsolidated bottom, amphibians Water bottom-aquatic bed, amphibians Water column- amphibians Water surface- amphibians Water bottom-unconsolidated bottom, reptiles Water bottom-aquatic bed, reptiles Water column- reptiles Water surface- reptiles
Wetland	Special habitat	All	Terrestrial surface- arthropods Terrestrial surface- invertebrates other than arthropods Terrestrial surface- amphibians Terrestrial surface- reptiles Terrestrial surface- birds Terrestrial surface- small mammals (< 1 kg)

Comments on feed-guilding:
The black-crowned night-heron is a wading bird that eats primarily fish and other aquatic life. This species is extremely adaptable and eats whatever is most plentiful at the time and place. It is also known to take young birds and small mammals (mice) *03,05,07*.

Breed-guilding:

Habitat	Structural stage	Season	Breed-Guilds
Wetland	Special habitat	Spring/summer	Terrestrial surface Shrub strata, canopy of broad-leaved deciduous shrubs Shrub strata, canopy of needle-leaved deciduous shrubs Shrub strata, canopy of broad-leaved evergreen shrubs Shrub strata, canopy of needle-leaved evergreen shrubs Shrub strata, grass and grasslike vegetation extending into shrub strata Tree canopy, large branches of live broad-leaved deciduous trees Tree canopy, large branches of live needle-leaved deciduous trees Tree canopy, large branches of live broad-leaved evergreen trees Tree canopy, large branches of live needle-leaved evergreen trees Tree canopy, large branches of dead broad-leaved deciduous trees Tree canopy, large branches of dead needle-leaved deciduous trees Tree canopy, large branches of dead broad-leaved evergreen trees

			Tree canopy, large branches of dead needle-leaved evergreen trees

Comments on breed-guilding:
The black-crowned night-heron usually copulates at or near its nest site *04*. Usually places nest in trees, shrubs, or marsh vegetation near accessable foraging areas *00,01,03,04*.

FOOD-HABITS

Trophic level is CARNIVORE

Food item	Life stage/plant part
Mollusca	Unknown
Mollusca: Gastropoda (snails)	Unkown
Arthropoda	Unknown
Crustaceans	Unknown
Malacostraca (isopods, amphipods, crayfishes)	Unknown
Insecta	Unknown
Odonata (dragonflies, damselflies)	Adult
Odonata (dragonflies, damselflies)	Nymph
Orthoptera (grasshoppers, crickets, cockroaches)	Unknown
Osteichthyes (bony fishes)	See comments
Semionotiformes (gars)	See comments
Anguilliformes (American eel)	See comments
Clupeiformes (herrings)	See comments
Salmoniformes (trouts, salmons, smelts, pikes)	See comments
Cypriniformes (carps, minnows, loaches)	See comments
Perciformes (basses, sunfishes, perches, sculpins)	See comments
Caudata (salamanders,newts,sirens,mudpuppies,hellbenders)	Unknown
Salientia (frogs, toads)	Juvenile
Salientia (frogs, toads)	Adult
Testudines (turtles)	Unknown
Sauria (lizards, skinks, iguana)	Unknown
Serpentes (snakes)	See comments
Mammals	See comments
Cricetidae (woodrats, mice, voles, lemmings, muskrat)	See comments
Ciconiiformes	See comments
Passeriformes	See comments
Important:	

Osteichthyes (bony fishes)	See comments
Clupeiformes (herrings)	See comments
Cypriniformes (carps, minnows, loaches)	See comments
Perciformes (basses, sunfishes, perches, sculpins)	See comments
Caudata (salamanders,newts,sirens,mudpuppies,hellbenders)	Unknown
Salientia (frogs, toads)	Juvenile
Salientia (frogs, toads)	Adult
Juvenile:	
Osteichthyes (bony fishes)	See comments
Clupeiformes (herrings)	See comments
Cypriniformes (carps, minnows, loaches)	See comments
Perciformes (basses, sunfishes, perches, sculpins)	See comments
Caudata (salamanders,newts,sirens,mudpuppies,hellbenders)	Unknown
Salientia (frogs, toads)	Juvenile
Salientia (frogs, toads)	Adult
Adult:	
Mollusca	Unknown
Mollusca: Gastropoda (snails)	Unkown
Arthropoda	Unknown
Crustaceans	Unknown
Malacostraca (isopods, amphipods, crayfishes)	Unknown
Insecta	Unknown
Odonata (dragonflies, damselflies)	Adult
Odonata (dragonflies, damselflies)	Nymph
Orthoptera (grasshoppers, crickets, cockroaches)	Unknown
Osteichthyes (bony fishes)	See comments
Semionotiformes (gars)	See comments
Anguilliformes (American eel)	See comments
Clupeiformes (herrings)	See comments
Salmoniformes (trouts, salmons, smelts, pikes)	See comments
Cypriniformes (carps, minnows, loaches)	See comments
Perciformes (basses, sunfishes, perches, sculpins)	See comments
Caudata (salamanders,newts,sirens,mudpuppies,hellbenders)	Unknown
Salientia (frogs, toads)	Juvenile
Salientia (frogs, toads)	Adult
Testudines (turtles)	Unknown
Sauria (lizards, skinks, iguana)	Unknown
Serpentes (snakes)	See comments

Mammals	See comments
Cricetidae (woodrats, mice, voles, lemmings, muskrat)	See comments
Ciconiiformes	See comments
Passeriformes	See comments

Comments on food habits:
General: The most important food item for the black-crowned night-heron in Illinois seems to be small fishes primarily gizzard shad *03,14*. This species has been reported to take some algae and other succulent plants, but it is classified as pre-eminently carnivorous *05,12*. The black-crowned night-heron is extremely adaptable and eats whatever is most plentiful at the time and place *07*.
Juvenile: Juvenile food items seem identical to adult food items but are presented in different forms depending on age of young. At hatching, young are fed predigested juices and size of food increases with age of young *04,12*. See general or important food items.
Adult: See general or important food items.

ENVIRONMENTAL ASSOCIATIONS

General:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Flood plain: see comments
- Aquatic habitats: typha-scirpus marsh
- Aquatic habitats: freshwater marsh
- Aquatic habitats: mud flats
- Aquatic habitats: vegetated streambank
- Aquatic habitats: island inhabitant
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: oxbow
- Aquatic habitats: backwaters
- Ecotones: woodland/water
- Orchards: see comments
- Pastures: see comments
- Shrubs: see comments
- Vines: see comments
- Coniferous forest: see comments
- Hardwood forest: see comments
- Human associations: public city parks
- Human associations: wildlife refuges/sanctuaries
- Unknown

Limiting:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Flood plain: see comments
- Aquatic habitats: typha-scirpus marsh

- Aquatic habitats: freshwater marsh
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh

Egg

- Unknown

Feeding juvenile:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: typha-scirpus marsh
- Aquatic habitats: freshwater marsh
- Aquatic habitats: mud flats
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: oxbow
- Aquatic habitats: backwaters

Resting juvenile:

- Flood plain: see comments
- Aquatic habitats: typha-scirpus marsh
- Aquatic habitats: freshwater marsh
- Shrubs: see comments
- Vines: see comments
- Coniferous forest: see comments
- Hardwood forest: see comments

Feeding adult:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: typha-scirpus marsh
- Aquatic habitats: freshwater marsh
- Aquatic habitats: mud flats
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: oxbow
- Aquatic habitats: backwaters

Resting adult:

- Flood plain: see comments
- Aquatic habitats: typha-scirpus marsh

- Aquatic habitats: freshwater marsh
- Shrubs: see comments
- Vines: see comments
- Coniferous forest: see comments
- Hardwood forest: see comments

Breeding adult:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Flood plain: see comments
- Aquatic habitats: typha-scirpus marsh
- Aquatic habitats: freshwater marsh
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: oxbow
- Aquatic habitats: backwaters

Comments on environmental associations:
General: Foraging areas appear more critical to the black-crowned night-heron than nest sites *01*. Unpolluted and undisturbed wetlands are essential as foraging areas and considering the adaptability of this species it can nest in a variety of situations *01,03,04,14*.
Feeding juvenile: Nestlings are fed in the nest and assumed to adopt adult feeding habits when fledged. See environmental assoc. for feeding adult *00*.
Resting juvenile: Juveniles initially rest in nest and near nest site after fledging. They then move to roost trees with adults. Since this species is highly variable in the placement of its nest, resting areas may be located from near ground, in shrubs, vines, to a variety of tree species *03,04,05,13*.
Feeding adult: Unpolluted, undisturbed wetlands are essential as foraging areas *01,03*.
Resting adult: Adults may rest near nest site and in roost trees *07*. Due to highly variable nest placement this species may rest in a variety of shrubs, vines and trees, etc. *04*.
Breeding adult: See species environmental associations and limiting factors. Also stability was seemingly critical to the selection of nest sites in North Carolina, Massachusetts and Virginia *08*. Birds will nest in any available vegetation that will support a nest *08*.

LIFE HISTORY

Origin: Native *02*.

Physical description: 23-28 ins. in length; 45 in. wingspread. Sexes are outwardly similar but males average larger. Body is heavy, chunky; short thick neck, short legs and heavy bill. Adults: head with black cap, short crest. 2-3 Narrow white plumes at back of head. Eyes scarlet, back black, underparts white, wings and tail gray. Immature: brown streaked or spotted with white *04,07,21*.

Reproduction: The black-crowned night-heron is seasonally monogamous *04*. It is a colonial nester often nesting with other heron species, but also nests singly *03*. It is reported that Illinois birds go directly to their nesting colonies as they return from wintering *03*, but palmer (1962) states there is a definite delay before the occupying of nesting territory *04*. Courtship and mating are not described for Illinois *03*. Palmer (1962) reports both sexes arrive at approx. the same time. After a delay the male selects a territory and begins to display. As with the snowy egret the displaying male

attracts a crowd, eventually letting 1 female in to nest *04,07*. Courtship is simple and once pair bond is formed it is maintained through the greeting display, billing and feather nibbling *04*. If the male chooses a territory containing an old nest the pair may rework this by adding new material. Typically the male brings the female sticks/twigs and she does the actual construction *04*. Unlike other heron species the male black-crowned night-heron rarely finishes the foundation (of a new nest) prior to pair formation *04*. The nest site of the black-crowned night-heron is highly variable ranging from ground level to over 160 ft. in a wide variety of upland and lowland trees, shrubs or aquatic vegetation *03,04,05*. This species will nest in any available vegetation that will support a nest *08*. The quality and proximity of foraging areas might be the most important factor in nest site selection *14*. Building material varies with habitat but generally consists of sticks/twigs or stems *04,07*. In New England it usually takes 2-5 days sometimes 7 days to complete nest construction *04, 05*. Copulation takes place in or near nest site and is typically preceeded by a greeting ceremony. Copulation usually occurs on 1st or 2nd day after pair formation. Duration averages 12 (8-17) seconds *04*. The first egg is layed on ave. 3.3 days after first copulation and 4-5 days after pair formation *04*. Nesting begins: Florida (Dec.); Georgia (mid Apr.); South Carolina (mid-late Apr.); New Jersey (early Apr.); New York (mid Apr.); Michigan (late Apr.-early May); Minnesota (late Apr.) *04*. Egg dates; north and central Illinois (24 Apr.-18 June); New England (May 13-20); California (May 3-23); New Jersey and Pennsylvania (Apr. 10-June 12); Florida (March 1-Apr. 17) *03,05*. Clutch size averages 3-5 (1-6) and rarely 7 or 8 eggs. The larger sets may be the product of 2 birds *04*. Mean clutch size apparently increases as move northward within the species range *08*. Mean clutch size also decreases as the season progresses. Apparently late nesters are usually young birds nesting for the first time and older individuals lay larger clutches *08*. Eggs are pale green-blue, 53 x 37 mm., and are apparently layed at 2 day intervals *03,04,05*. Incubation begins with the first egg and continues for 24-26 days. Both sexes incubate *04,05,07*. Upon hatching, young are partially covered with gray down with long whitish filaments on the crown *05*. The first day after hatching the young are fed pre-digested juices which are delivered into their open mouths *04,05*. After 3 days feeding consists of dropping larger pieces onto the floor or the rim of the nest and when older the young grab the parents bill in typical heron fashion *04,05*. Weights are approximately: 24.2 gm (1 day); 93.5 gm (5 days); 249.5 (10 Days); 598 gm (28 days) and 935 gm (44 days) *04,13*. First flight occurs at approximately 6 weeks usually to pursue adults to feeding areas to beg for food *04*. Young birds assume full adult plumage at approx. 2 1/2 years *05*. First year individuals were observed breeding in Rhode Island and New England but most usually not until 2-3 years *04,08,13*.

Behavior: The black-crowned night-heron is migratory spending from early Apr.-late Oct. in Illinois. This species breeds from Washington, Saskatchewan, Minnesota and New Brunswick south to South America and winters in the warmer parts of its range *01*. It is territorial on both nesting and feeding grounds *04*. On breeding grounds the male selects a territory that is used for hostile and sexual displays, copulation and nesting *04*. As with other heron species, initial territory of the male is larger than subsequent territory held by mated pair, which is little more than a few feet around nest *04*. The black-crowned night-heron engages in ritualized displays for threat, defense, and courtship *04*. The black-crowned night-heron is highly social and usually nests with other heron species, especially the great blue heron and great egret *04*. This species seems adapted to every conceivable habitat in which a wader may exist and it appears nest site selection revolves around the quality and proximity of foraging areas *14*. The black-crowned night-heron is an expert still-fisherman but also stalks its prey. Its periods of greatest activity are from dawn to sunrise and dusk until dark *05*. It is largely but not strictly nocturnal and sometimes feeds during daytime *07*. Most daylight hours are spent roosting in trees *07*. As in other herons, the black-crowned night-heron experiences a post-breeding dispersal, usually being the young birds that indulge in these erratic movements *03,04,05*. Northward flights begin in august soon after nesting is completed *03*. How soon southward flights

begin is not known but suspect migration back through Illinois takes place Sept.- Oct. *03*. Though most of the population is south of Illinois by October there are enough Nov., Dec., and Jan. records to suggest that a few individuals linger, perhaps regularly *03*. The lack of Feb. records may mean poor winter survival or just a paucity of observers *03*.

Limiting factors: Population size for Illinois is not known but only 4 sizeable breeding colonies remain *03,17*. Numbers have been reduced in many localities by land clearing, drainage, lumbering, and development *01,04*. Black-crowned night-herons are susceptible to pollution. The presence of organochlorines and heavy metals are present in eggs taken from Mass., N.J., M.Y., Md., R.I., Conn., Va., N.C., S.C., Fla., Ga., Ohio, Mich., Wisc., and Minn. *18*. This study could not positively relate residues to declines of night-heron populations but circumstantial evidence suggests that environmental pollutants may contribute to impaired reproductive success in the more contaminated areas *18*. Enemies include raccoons, crows, hawks, vultures, skunks, weasels and foxes *05, 10,13*. Black-crowned night-herons are particularly sensitive to disturbance just before and during laying *06*. In Quebec, disturbance reduced nesting success by inhibiting laying, increasing either nest abandonment or egg predation and increased nestling mortality *06*. The filling and draining of wetlands and continued use of persistent pesticides reduce viable foraging areas that are essential to this species *19*. Preservation and proper care of both nesting and foraging areas are critical and human encroachment during breeding season should be eliminated in order to prevent decreased nesting success *01*.

Population parameters: The relative trend for the black-crowned night- heron in Illinois is not known. Only 4 sizeable extant colonies: Pontoon Beach, Barrington, Clear Lake and Lake Calumet remain in 1983 and all are associated with areas that still have marshes near by *03,17*. Mortality rates have been reported as 61% for 1st year birds and 31% in older birds (after 2nd August of life) *12*. In Georgia nesting success was reported to be 87%, percent eggs that were successful was 71% *22*. Nesting success for Long Island was 100% with 94% eggs hatching. In Maryland, Virginia and North Carolina hatching success was 77.2% with 91.4% of hatchlings living through their 15th day *08*. 1 Estimate for productivity was made for Illinois. Neal (1976) found 3.3 young per nest in Waukegan *03*. Henney (1972) estimated 2.0-2.1 night-heron young had to fledge per nesting female to maintain a stable population *08*. No recent data is available. Black-crowned night-herons are reported to be stable or increasing their numbers in Massachusetts, Rhode Island, and Long Island *08*. No sex ratios are reported for Illinois. Average age of black-crowned night-herons is approx. 2 years 11 months and the oldest bird was found in Ohio at 21 years 1 month, for Illinois the oldest bird is just over 14 yrs. *12*. Life expectancy is 1.8 years and after the first year of life it increases to 2.7 years *12*.

MANAGEMENT PRACTICES

Beneficial:

- Maintaining undisturbed/undeveloped areas
- Maintaining natural areas and nature preserves
- Maintaining unique or special habitat features (wetlands, snags, caves, cliffs, talises, etc.
- Preserving endangered species habitat
- Preserving sensitive species habitat
- Performing special survey prior to prescription
- Performing field survey prior to prescription
- Controlling land use and human activities

- Seasonal restriction of human use of habitats
- Controlling pollution
- Controlling pollution in aquatic habitats
- Maintaining streams
- Developing/maintaining lakes and ponds
- Developing/maintaining wetlands
- Creating/maintaining wetlands from non-wetlands
- Developing/maintaining mudflats
- Protecting existing wetlands
- Restoration of wetlands (return flooded or drained areas to previous wetland conditions)
- Developing/maintaining riparian habitat
- Restricting human disturbance during migration, breeding, and nesting

Adverse:

- Channelization
- Dredging
- Draining ponds/lakes
- Draining wetlands
- Applying pesticide on agricultural land
- Strip mining
- Applying pesticides
- Cutting and deforestation

Existing:

- Performing special survey prior to prescription

Comments on management practices:
The filling and draining of wetlands and continued use of persistent pesticides constitute a serious threat to all wading birds *19*. The preservation and proper care of both nesting and foraging sites is critical to the black-crowned night-heron's continuation as a breeding bird in Illinois *01*. Sanctuaries are the best means of preserving habitat *19*. It is also important to locate extant colonies and protect them *03*. Human encroachment during the breeding season should be eliminated to prevent nest abandonment *01*. The black- crowned night-heron is protected as an endangered species in Illinois, by the Migratory Bird Treaty Act of 1918 and the Illinois Wildlife Code 1897 *01,19,22*.

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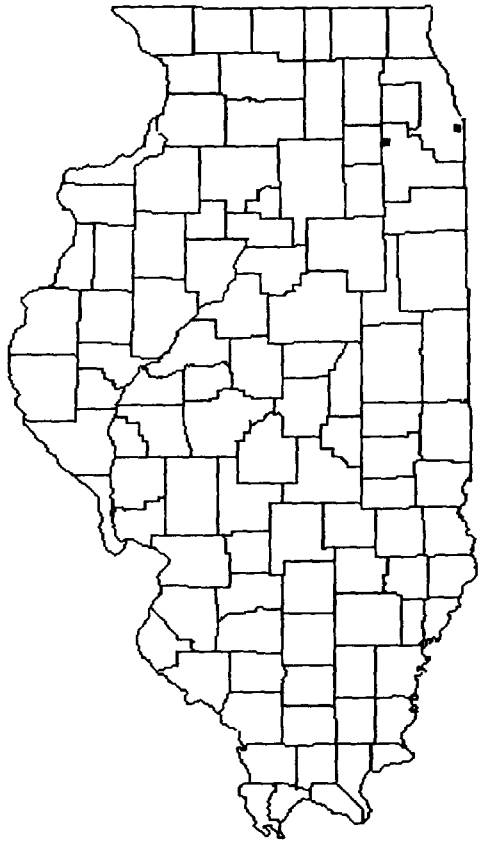
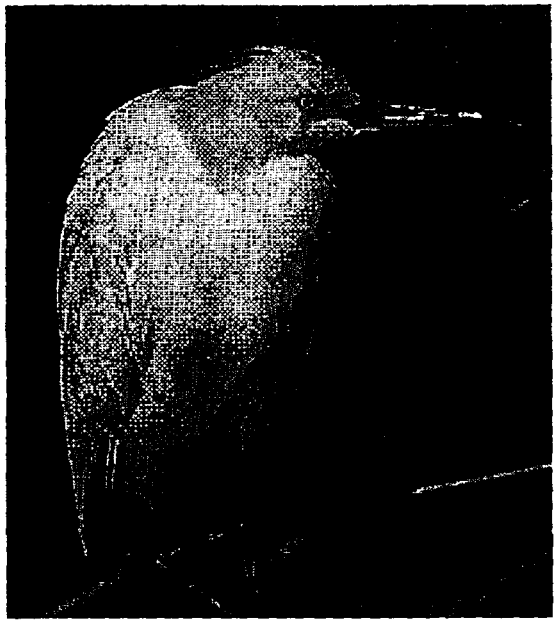
Illinois Breeding Bird Atlas
Snowy Egret
Breeding Status



Confirmed
Probable
Possible

Illinois Department of Natural Resources, Division of Natural Heritage
Illinois Natural History Survey, Center for Wildlife Ecology

Snowy egret
Egretta thula



Taxonomy
Occurence in Illinois
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Habitat associations
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References

TAXONOMY

- Phylum: Chordata
- Class: Aves
- Order: Ciconiiformes
- Family: Ardeidae
- Genus: *Egretta*
- Species: *Egretta thula*
- Authority: Molina

Comments on taxonomy:
Tribe:Ardeini. 2 subspecies:*Egretta thula thula* (Molina), found in Illinois, *E.t. brewsteri* (Thayer & Bangs), ave. larger, bill male 93.7 mm. wing 79.6, bill female 87.5 mm wing 264.9, found western regions of U.S. range.

OCCURENCE IN ILLINOIS

Lt. April-lt. August. Rare migrant and post-breeding wanderer. Rare local summer resident *18*. Recent breeding records: 1980: 2 nesting pairs, Pontoon Beach Colony, Madison Co.; 1981: 5 nests, Pontoon Beach Colony, Madison Co.; 1982: 3 Nests, Pontoon Beach Colony, Madison Co. *20*. Non-breeding snowy egrets appear widely over state esp. in lt. summer and fall with concentration in southern area of state *07*.

STATUS

Items in **bold** indicate applicable categories
Forest Service Categories: S = recommended for regional sensitive status, F = forest listed species, M = management indicator species

Federal Status:

Endangered	Threatened	Proposed for listing
Candidate for proposal	Recovery plan approved	Recovery plan received (USFWS)
Recovery plan in preparation	Under notice of review	Delisted
Migratory	EPA indicator	**Forest Serv.- Shawnee species (F)**

State Status:

Endangered	Threatened	Proposed

Other:

Game	Furbearer	**Nongame protected**	
Sportfish	Commercial	Pest	None of the above

Comments on status:
The snowy egret was hunted for its nuptial plumes and disappeared from Illinois in the late 19th century. Plume hunting was outlawed in the early 20th century which allowed populations to recover *04*. Reason for status: at present fewer than 50 pairs nest sporadically in or near the american bottoms region of Illinois, which is the first requirement for placement on the endangered species list: 1) low population numbers, 2) history of decline, 3) threatened habitat *01*.

HABITAT ASSOCIATIONS

Items in **bold** indicate applicable categories

General habitat:

Unknown	Terrestrial	**Aquatic**	**Riparian**

USFS timber inventory forest size class:

Unknown	**Unstocked**	**Seedling**	**Sapling**
Seedling/sapling	**Pole**	**Mature**	**Over mature**

Land use and land cover:

Unknown		Urban	Residential Commercial Industrial Transportation, communication Complex industrial/commercial Mixed Other
Agricultural	**Crop, pasture** Orchards, groves, nurseries Feedlot Other	Rangeland	Herbaceous Shrub and brush Mixed
Forestland	Deciduous Evergreen Mixed	**Water**	**Stream** **Lake** **Reservoir** Bay
Wetland	**Forest** **Non-forest**	Barren	Salt flat Beach Sand Rock Mine Transit Mix

Forest cover types:

Cover type	Structural stage	Canopy closure	Season
Oak-gum-cypress	Young tree (1-9" dia.)	Unknown	Spring/summer
Oak-gum-cypress	Mature (9" dia. & 100 yrs. old)	Unknown	Spring/summer
Elm-ash-cottonwood	Young tree (1-9" dia.)	Unknown	Spring/summer
Elm-ash-cottonwood	Mature (9" dia. & 100 yrs. old)	Unknown	Spring/summer

Associated tree species:

- Black willow
- Sand-bar willow

National wetland inventory classifications:

System	Subsystem	Class	Subclass	Water regime modifiers	Water chemistry
Lacustrine	Littoral	Emergent vegetation	Persistent	Unknown/unspecified	Unknown/unspecified
Lacustrine	Littoral	Emergent vegetation	Nonpersistent	Unknown/unspecified	Unknown/unspecified
Lacustrine	Littoral	Flat	Mud	Unknown/unspecified	Unknown/unspecified
Lacustrine	Littoral	Scrub/shrub	Deciduous	Unknown/unspecified	Unknown/unspecified
Palustrine		Emergent vegetation	Persistent	Unknown/unspecified	Unknown/unspecified
Palustrine		Emergent vegetation	Nonpersistent	Unknown/unspecified	Unknown/unspecified
Palustrine		Flat	Mud	Unknown/unspecified	Unknown/unspecified
Palustrine		Forest	Deciduous	Unknown/unspecified	Unknown/unspecified
Palustrine		Scrub/shrub	Deciduous	Unknown/unspecified	Unknown/unspecified
Riverine	Lower perennial	Emergent vegetation	Persistent	Unknown/unspecified	Unknown/unspecified
Riverine	Lower perennial	Emergent vegetation	Nonpersistent	Unknown/unspecified	Unknown/unspecified

Comments on species-habitat associations:
Due to the lack of information on snowy egrets in Illinois and their reported close association with little blue herons, habitat descriptions are generalized between the two species *00*.

Important plant and animal association: Snowy egrets and Louisiana herons *01*. Snowy egrets are highly social, frequently associating with little blue and louisiana herons in their nesting and foraging habitats*01*, willow sp. and buttonbush stands are common nesting places *01,06*.

High value habitats

Habitat	Structural stage	Season
Wetland	Special habitat	Spring
Wetland	Special habitat	Summer
Marsh	Special habitat	Spring
Marsh	Special habitat	Summer
Swamp	Special habitat	Spring
Swamp	Special habitat	Summer
Shrub swamp	Special habitat	Spring
Shrub swamp	Special habitat	Summer
Lake Michigan	Special habitat	Summer/fall
Reservoir	Special habitat	Summer/fall

River	Special habitat	Summer/fall
Marsh restoration	Special habitat	Summer/fall

Species-habitat interrelations: Due to the lack of habitat information of the snowy egret in Illinois, general and appropriate information has been reported from various southern studies. Also reported are its many similarities to the little blue heron *00*. Snowy egrets seem to prefer wetlands that afford a dense thicket of small trees or shrubs near water's edge for nesting *01,04,11,16*. Most foraging occurs in shallow waters *01,11*.

GUILDS

Feed-guilding:

Habitat	Structural stage	Season	Feed-guilds
Unknown high value habitat	Unknown	Unknown	Air- arthropods
Wetlands	Special habitat	All	Water bottom-unconsolidated bottom, arthropods Water bottom-unconsolidated bottom, invertebrates other than zooplankton or arthropods Water bottom-unconsolidated bottom, fish Water bottom-unconsolidated bottom, amphibians Water bottom-unconsolidated bottom, reptiles Water bottom-aquatic bed, arthropods Water bottom-aquatic bed, invertebrates other than zooplankton or arthropods Water bottom-aquatic bed, fish Water bottom-aquatic bed, amphibians Water bottom-aquatic bed, reptiles Water column- arthropods Water column- invertebrates other than zooplankton or arthropods Water column- fish Water column- amphibians Water column- reptiles Water surface- arthropods Water surface- invertebrates other than zooplankton or arthropods Water surface- fish Water surface- amphibians Water surface- reptiles

Comments on feed-guilding:
Snowy egrets forage primarily in wetland areas on small fishes, crustaceans, amphibians, reptiles and insects *04,05,06,07*. Have been reported to capture insects on wing *11*; take small mammals (especially microtus) *06*; accompany livestock (cattle, hogs) preying upon disturbed insects in dry fields *12*.

Breed-guilding:

Habitat	Structural stage	Season	Breed-Guilds
Wetland	Special habitat	Spring/summer	Shrub strata, canopy of broad-leaved deciduous shrubs Shrub strata, canopy of needle-leaved deciduous shrubs Shrub strata, canopy of broad-leaved evergreen shrubs Shrub strata, canopy of needle-leaved evergreen shrubs Shrub strata, grass and grasslike vegetation extending into shrub strata Tree canopy, branches of broad-leaved deciduous trees Tree canopy, branches of needle-leaved deciduous trees Tree canopy, branches of broad-leaved evergreen trees Tree canopy, branches of needle-leaved evergreen trees

Comments on breed-guilding:
It is reported copulation takes place in the nest or on a limb near it *08*. Snowy egrets may nest from ground -30 ft., ave. 5-10 ft. in dense thicket of vegetation usually bordering wetlands *01,04,06*.

FOOD-HABITS

Trophic level is CARNIVORE

Food item	Life stage/plant part
Invertebrates	Unknown
Mollusca	Unknown
Mollusca: Gastropoda (snails)	Unknown
Arthropoda	Unknown
Malacostraca (isopds, amphipods, crayfishes)	See comments
Insecta	Unknown
Orthoptera (grasshoppers, crickets, cockroaches)	Adult
Hymenoptera (ants, wasps, bees)	Adult
Osteichthyes (bony fishes)	See comments
Amphibians	See comments
Salientia (frogs, toads)	Juvenile
Salientia (frogs, toads)	Adult
Sauria (lizards, skinks, iguana)	Unknown
Serpentes (snakes)	See comments
Cricetidae (woodrats, mice, voles, lemmings, muskrats)(	Unknown
Important:	
Malacostraca (isopds, amphipods, crayfishes)	See comments
Osteichthyes (bony fishes)	See comments

Juvenile:	
Osteichthyes (bony fishes)	See comments
Salientia (frogs, toads)	Juvenile
Adult:	
Invertebrates	Unknown
Mollusca	Unknown
Mollusca: Gastropoda (snails)	Unknown
Arthropoda	Unknown
Malacostraca (isopds, amphipods, crayfishes)	See comments
Insecta	Unknown
Orthoptera (grasshoppers, crickets, cockroaches)	Adult
Hymenoptera (ants, wasps, bees)	Adult
Osteichthyes (bony fishes)	See comments
Amphibians	See comments
Salientia (frogs, toads)	Juvenile
Salientia (frogs, toads)	Adult
Sauria (lizards, skinks, iguana)	Unknown
Serpentes (snakes)	See comments
Cricetidae (woodrats, mice, voles, lemmings, muskrats)(	Unknown

Comments on food habits:
General: Snowy egrets feed primarily on small fishes, crayfishes, shrimps, frogs, lizards, snakes and insects. Feeds opportunistically according to prey abundance *08*, i.e. primarily shrimps where abundant, called "crayfish" bird in Louisiana. See feeding info. for building species.
Juvenile: Young fed by regurgitation mainly small fishes *16*. Tadpoles mentioned because very soft *11* when leave nest adopt adult food habits. See general food habits.
Adult: See general food habits.

ENVIRONMENTAL ASSOCIATIONS

General:

- Air temperature:see comments
- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: see comments
- Ecotones: see comments
- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments
- Human associations: wildlife refuges/sanctuaries
- Human associations: see comments

Limiting:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: see comments
- Human associations: see comments

Egg

- Air temperature:see comments

Feeding juvenile:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: see comments

Resting juvenile:

- Aquatic habitats: see comments
- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments

Feeding adult:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: see comments

Resting adult:

- Aquatic habitats: see comments
- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments

Breeding adult:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: see comments
- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments

Comments on environmental associations:
General: A primary factor in the decline of snowy egrets today is the draining, developing or polluting of their essential wetlands *01*. The availability of foraging and nesting areas are essential to the continuence of the snowy egret as a breeding bird in Illinois.
Egg: Eggs left uncovered for long periods of time may be "cooked" by hot sun *11,16*.
Feeding juvenile: The availability of undisturbed and pollution free wetlands for foraging *01*.
Resting juvenile: Assume upon fledging that juveniles adopt roosting habits of adults.

Feeding adult: See feeding juvenile.
Resting adult: In association with other social herons in lowland thickets and forest *01,07*.
Breeding adult: Herons exhibit a direct intolerance of man. Nesting sites must be undisturbed *01*. Prefer thickets and dense stands of young trees near water but seem not to prefer any particular species to place its nest *01,16*.

LIFE HISTORY

Origin: Native *02,07,18*.

Physical description: Outwardly similar though male slightly larger *05,06*. Weight:12-13 oz.; length:22-26"; wingspread:38-45" *05,06, 19*. Plumage:spotless white; black bill; black legs, birght yellow feet *05,06,08,09,19*. Feet turn coral-orange color early in breed- ing season *11*. Nuptial plumes acquired jan. Molted in june. Only heron with "recurved" scapular plumes *05*. Little information is available on life history in Illinois. Generalities are gleaned from the literature and geographical locations are stated *00*.

Reproduction: In Florida both sexes arrive in early to mid April *05, 06* and are not usually seen in Illinois until mid to late April *07*. First signs of breeding appear 10 days-2 weeks after arrival *08,10*. Nesting usually begins in early May but may vary *08*, snowy egrets are highly social throughout the year and nest colonially, usually with other species of herons *01,05,06,07*. Males alone select a territory *06*. Advertising is conspicuous and extremely vocal *05,06*. In Florida, a male may spend 5 days in courting *10*. Pair formation takes place on the breeding territory after a series of individual and mutual displays (meyerriecks 1959). Snowy egrets exhibit seasonal monogamy but several observations of promiscuity were reported *14*. The pair-bond is maintained by a series of mutual displays and joint nest building *06*. Location of nest may be from ground level - 30 ft. In trees (mean=5-10 ft.) *05,06,12*. It is usually placed in trees or thickets near water, but no particular plant species preferred *16*. Snowy egrets are highly social nesters and are usually (always in Illinois *07*) associated with little blue herons *01,05,06,07*. In mixed colonies the snowy egret may share the same tree with other spp.; Or scatter their nests, interspersing them, but usually placing them lower on limbs or branches *06*. Building materials vary with habitat *08*. Probably little use of old nests exists, but nest site and materials from old nest may be used *06*. The nest is usually a loose affair of sticks and twigs built by both sexes *08*. The male brings sticks to female who does the actual construction *06*. At Lake Alice, Florida, nest completion took from 4-7 days *06,10*. Little or no preliminary ritual exists prior to copulation, which takes place in the nest or very near *06*. Average duration is approximately 10 sec. Eggs are layed: Fla. Jan.-July, usually Apr.-May; Texas Apr.-June; Utah Apr.-May. average clutch size 3-4 (1-6) *05,06,08*. Eggs are pale bluish-green and may be layed on alternate days or as in Florida slightly more than 2 days apart (2.1 +Or- 0.04) *06,13*. Incubation may begin with either the first or second egg (fla. 54% With 1st, 44% with 2nd) *06,16*. Both sexes incubate *04,05,06*. A relieving ritual is performed and may vary in intensity between pairs *06,14*. In early studies incubation was reported to last approximately 18 days but more recent work observed 20-24 days *05,06,08,13*. At hatching young are covered with hair like down and weigh approximately 16.7 gm. *06*. Replacement clutch will be layed if original destroyed *13*. Both sexes feed young *04,06*. Initially food is placed on edge of nest allowing young to grab and possibly develop accuracy with its bill *06,10*. Later young grab parents' bill to stimulate feeding, in typical heron fashion *06*. Young herons leave the nest at 20-26 days spending approximately 3 days learning to fly and procure food *04,05,10*. Breeding may begin at 1 yr. (more information is needed) *06*. Snowy egrets usually rear 1 brood per year *08*.

Behavior: Territories are selected by males alone and are used for hostile and sexual displays,

copulation, and nesting *06*. No information exists on territory size, however, the initial size of the males territory is always larger than the subsequent area defended by the pair *06*. Palmer (1962) states a separate feeding territory may be defended *06*. Both sexes defend small area around nest from conspecifics and other species, especially other herons nesting in same colony *06*. Snowy egrets perform many ritualized behaviors as described in Meyerreicks 1960 *11*. Fighting is observed more frequently in snowy egrets than any other North American heron, though physical damage is rare *11*. Snowy egrets are migratory and limited to the western hemisphere *06*. It breeds and winters from central Chile and central Argentina north through South and Central America, the West Indies, and coastal areas of Mexico, and the Gulf and Atlantic coasts of the United States north to New Jersey *04,05,06*. Many individuals return to the same breeding grounds year after year *10,16*. Post-breeding dispersal is common and snowies have been sighted as far north as southern Canada *05,08*. In Illinois, fall populations are much greater than in spring, probably due to an influx from more southern breeding grounds *07*. This influx (post-breeding dispersal) probably begins in July and the number of birds remains relatively high most of August, depending on the availability of foraging sites *07*. Snowy egrets leave Illinois from late August - early September and are usually not seen after 12 September *07*. Foot-stirring, a foraging method, is particularly well developed in snowy egrets *05, 11,14*. The foot is used in a raking or stirring motion to poke and probe in shallow waters. The prey that are disturbed or "lured" to the yellow toes are quickly snapped up *14*.

Limiting factors: Data for limiting factors of snowy egrets is unavailable. In recent years, snowy egret populations have been estimated as approaching or even larger than their numbers prior to persecution *07*. Illinois probably never had a large breeding population of snowy egrets and current estimates suggest the total breeding population is probably less than 50 birds in a high year *07*. The availability of undisturbed nest sites and pollution free wetlands to forage in seem to be the greatest limiting factor to the snowy egret as a breeding bird in Illinois *01*. Predators in illinois seem few: racoons, mustelids, raptors, crows; where as in south, reptiles are a principal predator *03*. In georgia losses to the snowy egret were greatest during nesting stage and only 37% of all nests were successful in fledging at least one young *16*. In georgia, snowy egrets may suffer an annual mortality rate of approximately 52.4% (71.6% in their first year; 31.4% thereafter) *16*. No information on sex ratios is available but since snowy egrets exhibit seasonal monogamy one could assume approximatley 1:1. Much informaiton is needed for the snowy egret in Illinois.

MANAGEMENT PRACTICES

Beneficial:

- Maintaining natural areas and nature preserves
- Maintaining unique or special habitat features (wetlands, snags, caves, cliffs, talises, etc.
- Preserving endangered species habitat
- Preserving sensitive species habitat
- Performing field survey prior to prescription
- Controlling land use and human activities
- Seasonal restriction of human use of habitats
- Controlling pollution in aquatic habitats
- Developing/maintaining lakes and ponds
- Developing/maintaining wetlands
- Developing/maintaining wetlands
- Creating/maintaining wetlands from non-wetlands
- Developing/maintaining mudflats

- Protecting existing wetlands
- Protecting existing wetlands
- Restoration of wetlands (return flooded or drained areas to previous wetland conditions)
- Developing/maintaining riparian habitat
- Restricting human disturbance during migration, breeding, and nesting

Adverse:

- Channelization
- Dredging
- Draining ponds/lakes
- Draining wetlands
- Strip mining
- Applying pesticides
- Clearcutting forests

Existing:

- Performing field survey prior to prescription
- Animal management practices other than those included in ifwis list (see comments)

Comments on management practices:
The protection of forage and nest sites from disturbance and human encroachment is critical to the survival of the snowy egret as a breeding bird in Illinois *01*. The snowy egret is protected by the state endangered species act upon its addition to the list in 1977. The snowy egret is also protected by the Migratory Bird Treaty Act of 1918 *21* and the Illinois Wildlife Code *22*.

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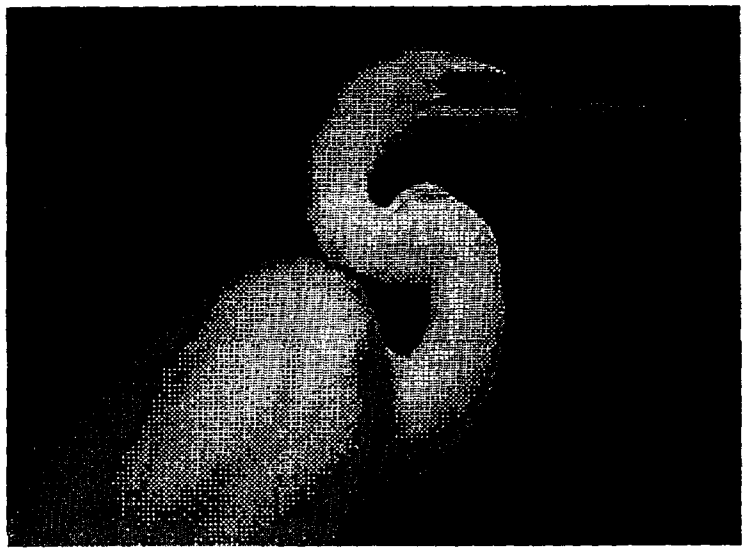
Great egret
Casmerodius albus



Taxonomy
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TAXONOMY

- Phylum: Chordata
- Class: Aves
- Order: Ciconiiformes
- Family: Ardeidae
- Genus: *Casmerodius*
- Species: *Casmerodius albus*
- Authority: Linnaeus

Comments on taxonomy:
Tribe:Ardeini. There are 6 subspecies of great egrets with only *C.a. egretta* occurring in North America *04*. Other names:common egret, American egret, angel bird, long white, great white egret, white crane, plumebirds, greater egret, white egret *04,08*.

OCCURENCE IN ILLINOIS

(Early Apr. - late Oct.) The great egret is a common migrant and summer resident along the Illinois & Mississippi rivers and a few other areas where nesting colonies are present; an uncommon migrant & post-breeding wanderer in remainder of state *02*. Recent breeding accounts: 1982; 31 nests at Clear Lake colony; 8 nests at Lake Depue (Bureau Co.); 8 Nests at Pontoon Beach colony; 5 nests at Lake Renwick; 1 nest at New Boston (Mercer Co.); 1983; 2 nests Pontoon Beach colony; Clear Lake, 61 nests; New Boston, 3 nests, Barrington 2 nests; Lake Renwick ? *17*.

STATUS

Items in **bold** indicate applicable categories
Forest Service Categories: S = recommended for regional sensitive status, F = forest listed species, M = management indicator species

Federal Status:

Endangered	Threatened	Proposed for listing
Candidate for proposal	Recovery plan approved	Recovery plan received (USFWS)
Recovery plan in preparation	Under notice of review	Delisted
Migratory	EPA indicator	**Forest Serv.- Shawnee species (F)**

State Status:

Endangered	Threatened	Proposed

Other:

Game	Furbearer	**Nongame protected**	
Sportfish	Commercial	Pest	None of the above

Comments on status:
The great egret was included on the Illinois Endangered Species List in 1977 *01*. Historically it experienced a major decline because of plume hunting which was followed by recovery and major expansion beginning in 1937 and then a steady decline resulting in an 80% decrease in population between 1973 & 1976 *01*. This species qualifies for inclusion as an endangered species due to: 1) its recent decline 2)small population numbers 3)habitat destruction *01*.

HABITAT ASSOCIATIONS

Items in **bold** indicate applicable categories

General habitat:

Unknown	Terrestrial	**Aquatic**	**Riparian**

USFS timber inventory forest size class:

Unknown	**Unstocked**	**Seedling**	**Sapling**
Seedling/sapling	**Pole**	**Mature**	**Over mature**

Land use and land cover:

Unknown		Urban	Residential Commercial Industrial Transportation, communication Complex industrial/commercial Mixed Other
Agricultural	**Crop, pasture** Orchards, groves, nurseries Feedlot Other	Rangeland	Herbaceous Shrub and brush Mixed
Forestland	Deciduous Evergreen Mixed	**Water**	**Stream** **Lake** **Reservoir** Bay
Wetland	**Forest** **Non-forest**	Barren	Salt flat Beach Sand Rock Mine Transit Mix

Forest cover types:

Cover type	Structural stage	Canopy closure	Season
Oak-gum-cypress	Young tree (1-9" dia.)	Unknown	Spring/summer
Oak-gum-cypress	Mature (9" dia. & 100 yrs. old)	Unknown	Spring/summer
Oak-gum-cypress	Old growth (trees 100 yrs. old)	Unknown	Spring/summer
Elm-ash-cottonwood	Young tree (1-9" dia.)	Unknown	Spring/summer
Elm-ash-cottonwood	Mature (9" dia. & 100 yrs. old)	Unknown	Spring/summer
Elm-ash-cottonwood	Old growth (trees 100 yrs. old)	Unknown	Spring/summer

Associated tree species:

- Green ash
- Cottonwood
- Slippery elm

- Silver maple
- Black willow

National wetland inventory classifications:

System	Subsystem	Class	Subclass	Water regime modifiers	Water chemistry
Lacustrine	Littoral	Emergent vegetation	Persitent	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Emergent vegetation	Nonpersistent	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Flat	Mud	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Forest	Dead trees	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Forest	Deciduous	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Scrub/shrub	Deciduous	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Emergent vegetation	Persistent	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Emergent vegetation	Nonpersistent	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Forest	Dead trees	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Forest	Deciduous	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Scrub/shrub	Deciduous	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Emergent vegetation	Persistent	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Emergent vegetation	Nonpersistent	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Flat	Mud	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Forest	Dead trees	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Forest	Deciduous	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Scrub/shrub	Deciduous	Intermittently exposed/permanent nontidal	Freshwater

Comments on species-habitat associations:
The great egret requires 2 distinct habitat types for survival: 1) foraging habitat in unpolluted wetland situations; 2) nesting habitat, usually near foraging habitat, containing either trees or shrubs that

provide enough support and building materials (twigs) for the nest *01,04,07*. Large herons seem to choose the largest trees for nesting but a wide variety of species and sizes are utilized *01*. In Illinois several particular species occur in favorable sites and are utilized by herons *06,07,11*. See comments on important plant/animal assoc.

Important plant and animal association: In Illinois, the great egret is associated with silver maple, cottonwood, black willow, slippery elm and green ashe as characteristic species present in its breeding habitat *06,07,11*. Gizzard shad seem to be the principal fish species consumed in Illinois *01,03,13*.

High value habitats

Habitat	Structural stage	Season
Cropland and pasture	Special habitat	Fall
Water	Special habitat	Spring
Water	Special habitat	Summer
Water	Special habitat	Fall
Wetland	Special habitat	Spring
Wetland	Special habitat	Summer
Wetland	Special habitat	Fall
Wet floodplain forest	Special habitat	Spring
Wet floodplain forest	Special habitat	Summer
Wet floodplain forest	Special habitat	Fall
Marsh	Special habitat	Spring
Marsh	Special habitat	Summer
Marsh	Special habitat	Fall
Swamp	Special habitat	Spring
Swamp	Special habitat	Summer
Swamp	Special habitat	Fall
Shrub swamp	Special habitat	Spring
Shrub swamp	Special habitat	Summer
Shrub swamp	Special habitat	Fall
Lakes and ponds	Special habitat	Spring
Lakes and ponds	Special habitat	Summer
Lakes and ponds	Special habitat	Fall
Streams	Special habitat	Spring
Streams	Special habitat	Summer
Streams	Special habitat	Fall
Marsh restoration	Special habitat	Spring
Marsh restoration	Special habitat	Summer
Marsh restoration	Special habitat	Fall

Species-habitat interrelations: Lowland forest & wetland situations are essential for the great egret. Two habitat types must be present for the breeding success of this species: 1) shallow, clear lagoons, backwaters, marshes, ponds etc. Provide foraging sites; 2) lowland forest, thickety growth forms that provide support and sticks/twigs for building material are essential for nesting habitat *01,02,04,07*.

GUILDS

Feed-guilding:

Habitat	Structural stage	Season	Feed-guilds
Wetland	Special habitat	Summer/fall	Water bottom-unconsolidated bottom, arthropods Water bottom-aquatic bed, arthropods Water column- arthropods Water surface- arthropods Water bottom-unconsolidated bottom, invertebrates other than zooplankton or arthropods Water bottom-aquatic bed, invertebrates other than zooplankton or arthropods Water column- invertebrates other than zooplankton or arthropods Water surface- invertebrates other than zooplankton or arthropods Water bottom-unconsolidated bottom, fish Water bottom-aquatic bed, fish Water column- fish Water surface- fish Water bottom-unconsolidated bottom, amphibians Water bottom-aquatic bed, amphibians Water column- amphibians Water surface- amphibians Water bottom-unconsolidated bottom, reptiles Water bottom-aquatic bed, reptiles Water column- reptiles Water surface- reptiles
Wetland	Special habitat	Fall/winter	Terrestrial surface- small mammals (< 1 kg) Terrestrial surface- arthropods Terrestrial surface- invertebrates other than arthropods Terrestrial surface- amphibians Terrestrial surface- reptiles Terrestrial surface- small mammals (< 1 kg)

Comments on feed-guilding:
The great egret is a wading bird that utilizes wetlands as its primary source of food; fish, crustaceans, frogs, snakes, and insects. Mudflats are also utilized *01,03,04,05,08,11,12,13*. The great egret is a carnivore but some vegetable matter may be taken as extraneous matter with animal food *05*. Although the foraging of the great egret has not been defined precisely it is considered to be similar to that of the great blue heron *03*.

Breed-guilding:

Habitat	Structural stage	Season	Breed-Guilds
Floodplain forest	Special habitat	Spring/summer	Shrub strata, canopy of broad-leaved deciduous shrubs Shrub strata, canopy of needle-leaved deciduous shrubs Shrub strata, canopy of broad-leaved evergreen shrubs Shrub strata, canopy of needle-leaved evergreen shrubs Shrub strata, forb vegetation extending into shrub strata Tree canopy, large branches of live broad-leaved deciduous trees Tree canopy, large branches of live needle-leaved deciduous trees Tree canopy, large branches of live broad-leaved evergreen trees Tree canopy, large branches of live needle-leaved evergreen trees Tree canopy, large branches of dead broad-leaved deciduous trees Tree canopy, large branches of dead needle-leaved deciduous trees
Wetland	Special habitat	Spring/summer	Shrub strata, canopy of broad-leaved deciduous shrubs Shrub strata, canopy of needle-leaved deciduous shrubs Shrub strata, canopy of broad-leaved evergreen shrubs Shrub strata, canopy of needle-leaved evergreen shrubs Shrub strata, forb vegetation extending into shrub strata Tree canopy, large branches of live broad-leaved deciduous trees Tree canopy, large branches of live needle-leaved deciduous trees Tree canopy, large branches of live broad-leaved evergreen trees Tree canopy, large branches of live needle-leaved evergreen trees Tree canopy, large branches of dead broad-leaved deciduous trees Tree canopy, large branches of dead needle-leaved deciduous trees

Comments on breed-guilding:
The great egret is a very social species and invariably nests colonially with other herons *03,04,05,08*. The larger herons prefer to nest in largest trees available and when the great blue heron is not present the great egret usually occupies the highest nest sites *07,11,15*. Heights may vary depending on plant species present *13*. The nest site requires adequate support and suitable supply of twigs/ sticks for building materials *04,05*. Nest sites are almost always found near water or foraging site *04,08*.

FOOD-HABITS

Trophic level is CARNIVORE

Food item	Life stage/plant part
Invertebrates	See comments
Mollusca: Gastropoda (snails)	See comments
Arthropoda	See comments
Malacostraca (isopods, amphipods, crayfishes)	See comments
Insecta	See comments
Orthoptera (grasshoppers, crickets, cockroaches)	See comments
Osteichthyes (bony fishes)	See comments
Clupeiformes (herrings)	See comments
Cypriniformes (carps, minnows, loaches)	See comments
Perciformes (basses, sunfishes, perches, sculpins)	See comments
Amphibians	See comments
Salientia (frogs, toads)	See comments
Reptiles	See comments
Serpentes (snakes)	See comments
Mammals	See comments
Cricetidae (woodrats, mice, voles, lemmings, muskrats)	See comments
Important:	
Malacostraca (isopods, amphipods, crayfishes)	See comments
Osteichthyes (bony fishes)	See comments
Clupeiformes (herrings)	See comments
Cypriniformes (carps, minnows, loaches)	See comments
Perciformes (basses, sunfishes, perches, sculpins)	See comments
Salientia (frogs, toads)	See comments
Juvenile:	
Malacostraca (isopods, amphipods, crayfishes)	See comments
Osteichthyes (bony fishes)	See comments
Clupeiformes (herrings)	See comments

Cypriniformes (carps, minnows, loaches)	See comments
Perciformes (basses, sunfishes, perches, sculpins)	See comments
Salientia (frogs, toads)	See comments
Adult:	
Invertebrates	See comments
Mollusca: Gastropoda (snails)	See comments
Arthropoda	See comments
Malacostraca (isopods, amphipods, crayfishes)	See comments
Insecta	See comments
Orthoptera (grasshoppers, crickets, cockroaches)	See comments
Osteichthyes (bony fishes)	See comments
Clupeiformes (herrings)	See comments
Cypriniformes (carps, minnows, loaches)	See comments
Perciformes (basses, sunfishes, perches, sculpins)	See comments
Amphibians	See comments
Salientia (frogs, toads)	See comments
Reptiles	See comments
Serpentes (snakes)	See comments
Mammals	See comments
Cricetidae (woodrats, mice, voles, lemmings, muskrats)	See comments

Comments on food habits:
General: In Illinois the great egrets principal food item seems to be gizzard shad *01,03,11*. Other food items include fish, frogs, crayfish, snakes, insects and some small mammals *04,05,08,11,12,13*. Some vegetable matter may be taken extraneously with animal food *05*.
Juvenile: Food of juveniles seems identical to adults with the exception of size. Food size increases as heron grows *03*.
Adult: See comments on general food habits.

ENVIRONMENTAL ASSOCIATIONS

General:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Flood plain: see comments
- Aquatic habitats: mud flats
- Aquatic habitats: island inhabitant
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: oxbow
- Aquatic habitats: backwaters
- Ecotones: woodland/water

- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments
- Agricultural crops: see comments
- Human associations: wildlife refuges/sanctuaries
- Unknown

Limiting:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Flood plain: see comments
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: backwaters
- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments

Egg

- Unknown

Feeding juvenile:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: mud flats
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: backwaters

Resting juvenile:

- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments

Feeding adult:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: mud flats
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: backwaters

Resting adult:

- Canopy closure (%) of trees: see comments

- Ground cover- shrub (%): see comments

Breeding adult:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: mud flats
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: backwaters
- Canopy closure (%) of trees: see comments
- Ground cover- shrub (%): see comments

Comments on environmental associations:
General: Unpolluted and undisturbed foraging sites are critical to all wading birds. The great egret must have foraging sites and nest site habitat *see card 5920* for one without the other is insufficient for heron survival *01,06,07*. Because of drainage & development, wetlands are considered a limitng factor as are the decreasing floodplain forests in Illinois *01*.
Feeding juvenile: Foraging areas that are free from pollution, and disturbance are critical for the great egret *01*. These include shallow clear lagoons, backwaters, marshes, along streams and rivers, mudflats.
Resting juvenile: Juveniles use the nest site for a while and then move to communal roost trees *03,04,05*. Trees are usually located in woods of swamps, floodplain forests and may be a considerable distance from foraging areas *03,04,05*.
Feeding adult: See comments on feeding juvenile.
Resting adult: The great egret is highly gregarious and utilizes communal roost trees at night *03,04,05*. Favored roosting places are where large numbers of birds congregate, may be near to or far from foraging sites *05*.
Breeding adult: As a breeding bird the great egret requires unpolluted and undisturbed wetland situations as foraging sites and floodplain forest or a thickety growth from that provides adequate support and suitable supply of sticks/twigs for a nesting site *01,04,07*.

LIFE HISTORY

Origin: Native *02*.

Physical description: Large 'all white' heron. Length 32-41 in., wingspread 55 in., weight 32-40 oz. (male averages larger than female) bill:yellow, 3.15-5.00 in. Legs & feet black. Nuptial plumage:acquired Jan.-Feb. No occipital crest or plumes. Scapular aigrettes extend far beyond tail and may number up to 54. Shed July- Aug. *04,05,08,11,18*.

Reproduction: Seasonal monogamy is probably the rule *04*. Little is known about the great egrets nesting activities for Illinois. Great egrets are migratory and are usually seen along larger river systems in Illinois by late March-early April *03*. It has been reported that near East St. Louis nests were occupied by 7 April and in northern Illinois nests were occupied by 5 April *03*. The start of breeding activities is accompanied by a change in color of the soft parts of great egrets *04*, but no time table is available for Illinois. Great egrets often nest with other herons, particularly great blue and black-crowned night-herons. In Fla., males only select territories several weeks after arrival and display. Females are attracted to the vicinity by the displaying males but are not immediately receptive *04*.

Information about pair-formation is unavailable. It is assumed ritualized as in other heron species *00*. Time required for nest construction unknown. Dates of nest construction include 13 March, Fla. and 17 Apr., Mich. *04*. Copula- tion takes place on males territory and if similar to other heron species, in or near nest site *04*. The nest is made of sticks/twigs or stems constructed into a flimsy platform *04,05,08,13*. It varies in location from 1 ft.-50 ft. (extreme 80 ft.) Depending on habitat available *01*. The great egret usually tries to nest as high as possible in the largest available plant species and only nests below the great blue heron *01,03,11,15*. In Illinois, great egrets frequent bottomland forest and cottonwoods, silver maple and green ash are the principal tree species utilized *06,07,11*. Most colonies are over water during part or all of nesting season. Laying frequency and clutch size are unavailable for Illinois *03*. Egg laying period has been estimated from 20 April- 14 June in southern Illinois *03*. Egg laying occurs in Feb. in Louisiana, April in Michigan, early April-early June in Maryland, 1st wk of may in South Carolina and begins in January in Florida and may continue through May *04,08*. Eggs are pale greenish blue, 56.5 x 40.5 mm *05,13*. The best estimate for Illinois is 2.2-2.5 eggs/ nest *03*. Great egrets usually lay 3-4 (1-6) eggs *04,05,08,09,12*. Other averages include; Fla. (2.8); Ga. (3.0), A (3.2), La. (2.9), Tx. (2.7). Ave. clutch size apparently increases from approx. 3 to 3- 4 moving northward from gulf states *04*. Kahl (1963) estimated 2.9 eggs/nest needed per pair to maintain a population *09*. In Fla. the interval between eggs is slightly less than 2 days (1.9 + Or - 0.37) *14*. Great egrets will lay a replacement clutch if the original is destroyed *14*. Maxwell & Kale (1977) report incubation begins with the first egg 55% and the 2nd egg 45% *14*. Both male and female incubate. Great egrets perform an elaborate relief ceremony according to Bent (1926) *05*. The incubation period for Illinois is 25 days *01*, Palmer (1962) & Bent (1926) both state 23-24 days and Sprunt & Chamberlain (1970) & Forbush (1929) both report 28 days *01,04,05,12,13*. In Fla. hatching occurred over 5.2 (1-7) days for 2.6 eggs with a 2 day interval between eggs *14*. Upon hatching nestlings are partially covered with long white down *04,05,10*. Teal (1964) reports young leave nest 2-3 weeks after hatching in Ga. *10*. In Illinois, nestling life lasts 42 days and also Palmer (1962) & Terres (1980) state first flight occurs 42 days after hatching *04,08*. Great egrets probably raise 1 brood/year *04,12,13*. Young are fed by regurgitation at first into the nest, followed by bill-grabbing similar to other heron species *05*. Kahl (1963) states that most great egrets are capable of breeding at 2 years old (or 3rd summer) *09*.

Behavior: The great egret is not usually sighted in Illinois until approx. 20 March *03*. In Fla., male alone selects territory which is used for hostile and sexual displays, copulation and nesting *04*. Adjacent feeding areas are also vigorously defended against all other smaller species of herons (not great blue heron) *04*. Both sexes defend this territory. Size is not known. No information is available on home range but Graber's (1978) report great egrets feeding usually within 9.6 km of their nesting colonies *01,03*. Great egrets are diurnal feeders, gathering at dusk in communal roost trees where they spend the night. Specific roosting trees are usually favored and may be near or a considerable distance from foraging areas *03*. The great egret exhibits extensive post-breeding dispersal and usually the young birds indulge in the erratic journeys *05*. There appear to be 2 summer populations in Illinois: 1) the Illinois breeding population that arrives in spring; 2) a population that arrives in summer from the south where nesting starts and finishes much earlier *03*. Coffey (1943) banded juvenile great egrets in Miss. and recovered 5 birds in Illinois in July & Aug. This may illustrate a northern movement *03*. Whether birds breeding in Illinois move northward has not been established but is suggested in the banding records of Bjorklund & Canterberry (1971) *03*. Transient great egrets seem to prefer the Illinois River over the Mississippi River and western to eastern Illinois *03*. Most great egrets have migrated south of Illinois by the end of October, though individuals have been reported as late as December *03*.

Limiting factors:: There are no documented figures on population size in Illinois. In 1976, 8 major colonies with approx. 100 nests remained in western and southern parts of Illinois including Bureau, Calhoun, Mason, Mercer, Monroe, Tazewell, Union & Will Counties. Recent breeding accounts for 1983 include approx. 4 colonies, 68 nests including Lake, Madison, Mercer, Mason with the largest colony of 61 nests at Clear Lake *17*. One of the largest heronries (820 occupied nests in 1962) in Tazewell Co. collapsed in 1974. It had existed since at least 1935 and great egrets arrived early April 13th (a 10 yr. Ave.) *06*. It is suggested that clear- cutting of trees, partial draining of a floodplain lake and pollution from various sources reduced the number of feeding habitats available to herons *01*. The great egret population has declined 80% between 1973-1976 *03*. Probably the most significnt cause of decline is habitat encroachment by man *01*. Predators include racoons, crows, vultures, with racoons being the most formidable *05,19*. Great egrets are also susceptible to eggshell thinning caused by hydrocarbons and the continuing use of persistent pesticides *01,19*.

Population parameters: An estimated trend from the literature leaves great egret populations down in Illinois though no recent figures are available *00*. The 80% decline experienced by great egrets between 1973-1976 probably involved movement to other areas but Bjorklund (1975) had observed what seemed to be increased egg and nestling mortality in locations altered (after logging) in Tazewell Co. *06*. The best estimate of eggs layed/nest for Illinois is 2.5- 2.2 *06*. Kahl (1963) states 2.9 eggs/nest are needed per pair to at least maintain a population *09*. Mortality rates for the great egret are approx. 76% the first year and 26% for subsequent years *09*. Life expectancy is approx. 1.4 yrs. and at the start of an individual's 2nd yr. life expectancy increases to 3.3 yrs. *09*. The oldest bird recovered was in Ohio at the age of 22 yrs. 7 mos. *08*. Age ratios for southern Illinois are 1.0 adults to 1.25 young at fledging and the ratio of spring to fall numbers are 1.0 (Mar.-May) to 12.9 (July-Oct.), a suggestion of post-breeding dispersal *03*.

MANAGEMENT PRACTICES

Beneficial:

- Maintaining natural areas and nature preserves
- Maintaining unique or special habitat features (wetlands, snags, caves, cliffs, talises, etc.
- Preserving endangered species habitat
- Preserving sensitive species habitat
- Performing special survey prior to prescription
- Performing field survey prior to prescription
- Controlling land use and human activities
- Seasonal restriction of human use of habitats
- Controlling pollution
- Controlling pollution in aquatic habitats
- Maintaining streams
- Developing/maintaining lakes and ponds
- Creating/maintaining islands within permanent impoundments
- Developing/maintaining wetlands
- Creating/maintaining wetlands from non-wetlands
- Developing/maintaining mudflats
- Maintaining bogs
- Protecting existing wetlands
- Restoration of wetlands (return flooded or drained areas to previous wetland conditions)

- Developing/maintaining riparian habitat
- Strip mining
- Restricting human disturbance during migration, breeding, and nesting

Adverse:

- Recreational development
- Channelization
- Navigational improvements such as channelization and locks and dams
- Dredging
- Providing public access (develop roads, trails, parking areas or provide legal access)
- Draining ponds/lakes
- Draining wetlands
- Applying herbicides
- Cutting and deforestation
- Clearcutting forests

Comments on management practices:
It is essential to protect both the foraging areas and nesting habitat of the great egret from pollution, disturbance, and human presence. One without the other is insufficient for heron survival and the continuation of the great heron as a breeding bird in Illinois *01,06, 07*. Sanctuaries are the best means of preserving habitat *19*. The great egret is protected by the Endangered Species Act of 1977 *01*. Also the Migratory Bird Treaty Act of 1918 *20* and the Illinois Wildlife Code 1971 *21*.

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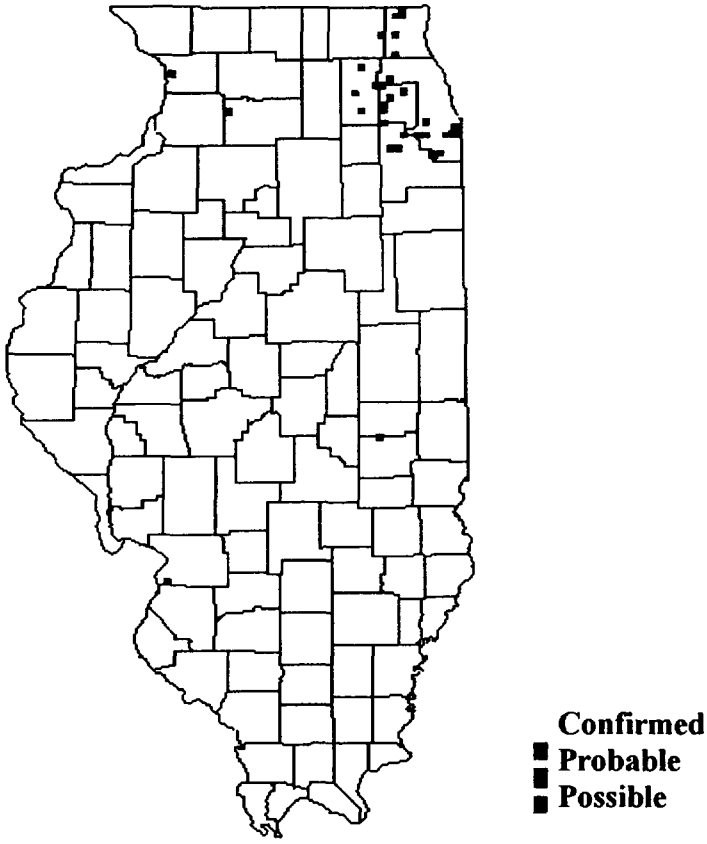
Illinois Breeding Bird Atlas
Common Moorhen
Breeding Status



Illinois Department of Natural Resources, Division of Natural Heritage
Illinois Natural History Survey, Center for Wildlife Ecology

Common Moorhen
Gallinula chloropus

Taxonomy
Occurence in Illinois
Status
Habitat associations
Guilds
Food-habits
Environmental associations
Life history
Management practices
References

TAXONOMY

- Phylum: Chordata
- Class: Aves
- Order: Gruiformes
- Family: Rallidae
- Genus: *Gallinula*
- Species: *Gallinula chloropus*
- Authority: Linnaeus

Comments on taxonomy:
Subspecies occurring in Illinois *G. c. cachinnaus* *09,13*. Common name changed from common gallinule to common moorhen in 1982 revision of A.O.U. Checklist *19* other vernacular: Florida gallinule, blue peter, red-bellied mud hen, water chicken, etc. See *03,13*.

OCCURENCE IN ILLINOIS

Resident in north. Occassional migrant and summer resident in central and southern Illinois *01*. 1982 breeding season: 15 nest lake calumet, broods sighted at L. Calumet (5); Riverdale (1), Redwing Slough (1), Ela Road Marsh (1). Probable nesting Cuba Marsh and McDonald's Wood (Lake Co.). For others sighted see *18*.

STATUS

Items in **bold** indicate applicable categories
Forest Service Categories: S = recommended for regional sensitive status, F = forest listed species, M = management indicator species

Federal Status:

Endangered	Threatened	Proposed for listing
Candidate for proposal	Recovery plan approved	Recovery plan received (USFWS)
Recovery plan in preparation	Under notice of review	Delisted
Migratory	EPA indicator	Forest Serv.- Shawnee species

State Status:

Endangered	**Threatened**	Proposed

Other:

Game	Furbearer	**Nongame protected**	
Sportfish	Commercial	Pest	None of the above

Comments on status:
Common moorhen was included on the threatened list for Illinois in 1977 *02*. This species population numbers are small and critical habitat is threatened *02,05*.

HABITAT ASSOCIATIONS

Items in **bold** indicate applicable categories

General habitat:

Unknown	**Terrestrial**	**Aquatic**	**Riparian**

USFS timber inventory forest size class:

Unknown	Unstocked	Seedling	Sapling
Seedling/sapling	Pole	Mature	Over mature

Land use and land cover:

Unknown		Urban	Residential Commercial Industrial Transportation, communication Complex industrial/commercial Mixed Other
Agricultural	**Crop, pasture** Orchards, groves, nurseries Feedlot Other	Rangeland	Herbaceous Shrub and brush Mixed
Forestland	Deciduous Evergreen Mixed	**Water**	**Stream** **Lake** **Reservoir** Bay

Wetland	Forest **Non-forest**	Barren	Salt flat Beach Sand Rock Mine Transit Mix

Forest cover types: No records.

Associated tree species: No records.

National wetland inventory classifications:

System	Subsystem	Class	Subclass	Water regime modifiers	Water chemistry
Lacustrine	Littoral	Emergent vegetation	Persistent	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Emergent vegetation	Nonpersistent	Intermittently exposed/permanent nontidal	Freshwater
Lacustrine	Littoral	Emergent vegetation	Narrowleaved persistent	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Emergent vegetation	Persistent	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Emergent vegetation	Nonpersistent	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Emergent vegetation	Narrowleaved persistent	Intermittently exposed/permanent nontidal	Freshwater
Palustrine		Scrub/shrub		Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Emergent vegetation	Persistent	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Emergent vegetation	Nonpersistent	Intermittently exposed/permanent nontidal	Freshwater
Riverine	Lower perennial	Emergent vegetation	Narrowleaved persistent	Intermittently exposed/permanent nontidal	Freshwater

Comments on species-habitat associations:
The common moorhen frequents freshwater marshes and ponds with emergent aquatic vegetation, primarily cattails and bulrushes *02*. Not necessarily large marshes, may be found in small patches of cattails at the edge of a lake or river *04*. During migration may occur in dusty fields, city boulevards, dry valleys *13*.

Important plant and animal association: Yellow-headed blackbird. Commonly associated in Illinois with the yellow-headed blackbird because of habitat similarities *02*.

High value habitats

Habitat	Structural stage	Season
Nonforested wetland	Special habitat	Spring
Nonforested wetland	Special habitat	Fall
Wetland	Special habitat	Spring
Wetland	Special habitat	Fall
Marsh	Special habitat	Spring
Lakes and ponds	Special habitat	Spring
Lakes and ponds	Special habitat	Fall

Species-habitat interrelations: Deeper open marshes are apparently a habitat requirement, although artificial or abnadoned flooded depressions with cattail growth serve as occassional nest sites in northeastern Illinois *02*. A general consensus of literature concludes preferred habitat is typha-scirpus marshes, but other plant species are often also present, i.E. Phragmites, carex, sparganium, and rice were all mentioned *05*. Water depth usually deeper pools present accompanying marsh shallows *04, 05*.

GUILDS

Feed-guilding:

Habitat	Structural stage	Season	Feed-guilds
Wetland	Special habitat	Fall	Terrestrial subsurface-roots, tubers, rhizomes of herbaceous plants Terrestrial surface-flowers and fruits of grass/grasslike vegetation Terrestrial surface- arthropods Terrestrial surface- invertebrates other than arthropods Water surface-floating vascular plants Water bottom-aquatic bed, arthropods Water surface- arthropods Water bottom-aquatic bed, invertebrates other than zooplankton or arthropods Water surface- invertebrates other than zooplankton or arthropods Water surface-rooted herbaceous plants at surface

Wetland	Special habitat	Spring/summer	errestrial subsurface-roots, tubers, rhizomes of herbaceous plants Terrestrial surface-flowers and fruits of grass/grasslike vegetation Terrestrial surface- arthropods Terrestrial surface- invertebrates other than arthropods Water surface-floating vascular plants Water bottom-aquatic bed, arthropods Water surface- arthropods Water bottom-aquatic bed, invertebrates other than zooplankton or arthropods Water surface- invertebrates other than zooplankton or arthropods Water surface-rooted herbaceous plants at surface

Comments on feed-guilding:
Walks on floating vegetation picking food items off plant and water surface. Also on land, feeding on insects and plants, also dives for food. Food items include seeds, grass, rootlets, soft parts of water plants, snails, grasshoppers, various other insects and worms *04*.

Breed-guilding:

Habitat	Structural stage	Season	Breed-Guilds
Wetland/td>	Special habitat	Fall	Terrestrial surface, grass and grasslike vegetation River/lake/marsh, vascular plants- floating, nonwoody, rooted River/lake/marsh, vascular plants- emergent, nonwoody River/lake/marsh, vascular plants- emergent, woody

Comments on breed-guilding:
Nest usually elevated slightly above water among robust emergents *02* usually around borders where water is not >2 ft. away *04*. Apparently copulation takes place in open water of marsh *04*.

FOOD-HABITS

Trophic level is OMNIVORE

Unknown
Unknown

Food item	Life stage/plant part
Plants	Unknown
Monocotyledoneae (monocots)	Roots
Monocotyledoneae (monocots)	Flowers
Monocotyledoneae (monocots)	Fruit/seeds
Monocotyledoneae (monocots)	Unknown
Annelida (segmented worms)	Unknown

Mollusca	Unknown
Mollusca: Gastropoda (snails)	Unknown
Insecta	Unknown
Ephemeroptera (mayflies)	Nymph
Odonata (dragonflies, damselflies)	Nymph
Orthoptera (grasshoppers, crickets, cockroaches)	Unknown
Homoptera (cicadas, aphids)	Unknown
Tricoptera (caddisflies)	Larva
Important:	
Monocotyledoneae (monocots)	Roots
Monocotyledoneae (monocots)	Fruit/seeds
Monocotyledoneae (monocots)	Unknown
Insecta	Unknown
Ephemeroptera (mayflies)	Nymph
Odonata (dragonflies, damselflies)	Nymph
Juvenile:	
Insecta	Unknown
Ephemeroptera (mayflies)	Nymph
Odonata (dragonflies, damselflies)	Nymph
Adult:	
Plants	Unknown
Monocotyledoneae (monocots)	Roots
Monocotyledoneae (monocots)	Flowers
Monocotyledoneae (monocots)	Fruit/seeds
Monocotyledoneae (monocots)	Unknown
Annelida (segmented worms)	Unknown
Mollusca	Unknown
Mollusca: Gastropoda (snails)	Unknown
Insecta	Unknown
Ephemeroptera (mayflies)	Nymph
Odonata (dragonflies, damselflies)	Nymph
Orthoptera (grasshoppers, crickets, cockroaches)	Unknown
Homoptera (cicadas, aphids)	Unknown
Tricoptera (caddisflies)	Larva

Comments on food habits:
General: Seeds, roots, soft parts of succulent water plants, snails, other small mollusks, grasshoppers, various other insects and worms *04*. Wetmore (1916) reports 96.75% of diet was vegetative 90.75 grass and rootlets, seeds and various weeds 6%. 3.25% was insect and small mollusks *04*.

Juvenile: No vegetable food presented to young *11*. Adopt adult habits when independent *00*.
Adult: See comments on general food habits

ENVIRONMENTAL ASSOCIATIONS

General:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Water depth preference: see comments
- Aquatic habitats: typha-scirpus marsh
- Aquatic habitats: freshwater marsh
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: ditches
- Aquatic habitats: seasonal wet depressions
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: oxbow
- Aquatic habitats: backwaters
- Vegetation mosaics/edges: see comments
- Ground cover- herbaceous (%): see comments
- Vegetation successional stage: vegetation-choked pond
- Unknown

Limiting:

- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: typha-scirpus marsh
- Aquatic habitats: freshwater marsh
- Ground cover- herbaceous (%): see comments
- Vegetation successional stage: vegetation-choked pond

Egg

- Unknown

Feeding juvenile:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: typha-scirpus marsh
- Aquatic habitats: freshwater marsh
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: seasonal wet depressions
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: oxbow
- Aquatic habitats: backwaters

Resting juvenile:

- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: typha-scirpus marsh
- Aquatic habitats: freshwater marsh
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: oxbow
- Aquatic habitats: backwaters

Feeding adult:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: typha-scirpus marsh
- Aquatic habitats: freshwater marsh
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: seasonal wet depressions
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: oxbow
- Aquatic habitats: backwaters

Resting adult:

- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: typha-scirpus marsh
- Aquatic habitats: freshwater marsh
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: oxbow
- Aquatic habitats: backwaters

Breeding adult:

- Biodegradable organics: clean waters that have not been polluted
- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: typha-scirpus marsh
- Aquatic habitats: freshwater marsh
- Aquatic habitats: sloughs, bayous
- Aquatic habitats: ditches
- Aquatic habitats: swamp
- Aquatic habitats: marsh
- Aquatic habitats: oxbow
- Aquatic habitats: backwaters
- Vegetation mosaics/edges: see comments
- Ground cover- herbaceous (%): see comments
- Vegetation successional stage: vegetation-choked pond

Comments on environmental associations:
General: See comments on high value habitat
Feeding juvenile: Assume seek food among aquatic vegetation where they live *00*.
Resting juvenile: Assume rest in nest, on brooding platforms and marsh vegetation *00*.
Feeding adult: Common moorhens seek food among aquatic vegetation of the wetlands where they live *04*. Food also obtained on dry land.
Resting adult: Rest on rafts of vegetation *14* and probably in dense marsh vegetation *00*.
Breeding adult: See comments on high-value habitat

LIFE HISTORY

Origin: Native *01*.

Physical description: Slate grey chicken-like bird; length 12-15 inches, wingspread 20-23 inches, wt. 14 oz. Sexes alike, female smaller. Chicken-like red bill with yellow tip and red frontal shield. Legs and feet yellow green, white lines along flanks and white undertail coverts. Immatures similar to adults but lighter in color and more brownish bill without red *03,13,16*.

Reproduction: Little information available for Illinois. Arrives on breeding grounds late April in Iowa and Wisc. With nesting beginning in early May *05*. Courtship likely begins during migration, continuing on breeding habitat *05*. Males establish territories and perform a ritualized display in the open water of the marsh *04*. Courtship behavior described in *04*. Female watches performance from seclusion of reeds. Male attracts female and pair bond is formed. Assume copulation takes place in water *00*. Who chooses nest site is unknown. Both sexes construct nest of primarily emergent vegetation (last years cattail growth, etc.) *05,09*. The nest is usually a shallow platform elevated slightly above water among robust emergents *02*. Krauth (1972) found nests in all types of emergent vegetation, concluding that cover was used in proportion to occurrence *05*. Nests usually placed in shallower parts or around borders where water not over 2 ft. All nests constructed with a sloping runway of rushes leading to the water. Some also have canopies of standing rushes *04,07*. Male often build other nest-like platforms on which to brood young *03,14*. May also use old muskrat or coot platforms *09*. The hen lays daily *05*. Eggs are cinnamon to olive buff, spotted or dotted with browns *03*. Clutch size from 4-17, usually 7-12, 44 x 31 mm (105) *04,09,13*. For summary of clutch sizes in N. America see *09*. Both sexes incubate. Bent (1926) reports incubation begins with 1st egg *04*, Krauth (1972) beginning with 5th egg *05* Terres (1980) reports 18-21 days, Bent (1926) reports approx. 21 days and Krauth (1972) suggests incubation poorly reported because period varies with each egg in clutch *05*. Krauth (1972) reports a 7 egg clutch requires 4 days to hatch *05*. Hatchlings are covered with black down, head and wings nearly naked, white beard *08*. Both sexes brood and feed young *05*. When dry, young leave nest *04*. Both sexes bring food to nest for 2-4 days, leading older chicks away from nest *11*. Young 1st feed themselves at 1 wk. and are capable of independent feeding at 3 wks., though parents feed for 6 wks., when young are able to fly. Young birds usually remain in parents territory for further 6 wks. *12*. Full growth is attained in approx. 10 wks. *05*. Sprunt & Chamberlain (1960) & Bent (1926) report 2 broods may be layed *04,13*. Seigfried & Frost (1975) report continuous breeding as a consequence of a continuously available favorable food supply *12*. Age at sexual maturity, min. and max. breeding ages unavailable. At two sites in La. 84.2% & 86.5% of eggs hatched *10* and at a 3rd site only 4 out of 143 eggs did not hatch *11*. Will lay replacement clutch *06*.

Behavior: Common moorhens are territorial but no estimates of size or home range size are available. Courtship is ritualized and described in *04*. May nest in small colonies *03*. Young are precocial

and leave nest soon after hatching *04*. A sharp spur at bend of wing assists in climbing *04*. Feet are large with long toes allowing this species to walk on floating vegetation. Young birds may gather in groups to 'play' in the water. When feeding broods cluster behind providing parent who feeds in linear routes in deep water over a large area *11*. Red and yellow bill may serve as a releaser for chicks feeding behavior *11*. No plant material fed to young *11*.

Limiting factors: Loss of habitat most critical *02*. Prefers open water marshes which may be important in courtship. Enemies include largemouth bass, bowfin, gar, snapping turtles, snakes, crows, etc. *04,11*. Moorhens can dive to escape enemies, often hiding underwater with head or bill concealed among water plants *04*. Pollution appears to have no effect on clutch size or hatchability of eggs, though significance of certain insecticide residues upon reproduction in birds seems more closely related to chick survival, which is unavailable *10*. More information is needed.

Population parameters: The common moorhen is certainly less abundant than before but may still occupy suitable habitat throughout Illinois. Relative population trend is probably down as drainage, alteration and destruction of marshes continues *02,05*. In La. brood sizes decreased as chicks become older, more active and independent. Weather and predators may be causes of high chick mortality in their 1st few days *11*. In La. Bell & Cordes (1975) report percent decrease in brood size, egg - 10 days 40%, 10-25 days 30%, 25-40 days 20%. Broods decreased from 4.7 yng. To 2.6 yng. as of 40 days *11*. No information available on survival rates, sex ratio, or average lifespan. A bird of 6 yrs. 3 mos. was trapped and released (place unspecified) *21*.

MANAGEMENT PRACTICES

Beneficial:

- Maintaining undisturbed/undeveloped areas
- Maintaining early stage of ecological succession
- Maintaining natural areas and nature preserves
- Developing/maintaining edge (ecotones)
- Maintaining unique or special habitat features (wetlands, snags, caves, cliffs, talises, etc.
- Preserving sensitive species habitat
- Performing special survey prior to prescription
- Performing field survey prior to prescription
- Controlling land use and human activities
- Controlling refuse disposal (landfills)
- Controlling pollution
- Controlling pollution in aquatic habitats
- Controlling water levels
- Maintaining streams
- Developing/maintaining lakes and ponds
- Creating/maintaining islands within permanent impoundments
- Developing/maintaining wetlands
- Creating/maintaining wetlands from non-wetlands
- Protecting existing wetlands
- Burning of wetlands to maintain successional stages
- Restoration of wetlands (return flooded or drained areas to previous wetland conditions)
- Developing/maintaining riparian habitat
- Developing/maintaining ditchbank vegetation to prevent erosion and provide riparian habitat

- No-till farming
- Developing/maintaining native vegetation

Adverse:

- Channelization
- Dredging
- Controlling aquatic plants
- Draining ponds/lakes
- Draining wetlands
- Removing bank vegetation
- Clean farming
- Uncontrolled grazing by domestic livestock
- Strip mining

Comments on management practices:
Because information is lacking on the common gallinule in Illinois only generalized management practices may be suggested. Maintenance of open marsh is critical. Water level manipulation & prescribed burning suggested control measures for keeping open areas in marshes *02*. Artificial wetland sites in some regions of the state may supplement the natural breeding habitat of this species *02*. Immediate management needs are for census of population numbers at key times of year and preservation of deep water marshes *05*. See *05* for areas of needed study and investigation goals. The common moorhen is protected by the Illinois Endangered Species Act 1972 & the Migratory Bird Treaty Act of 1918 *02,17* & the Illinois Wildlife Code 1971 *22*.

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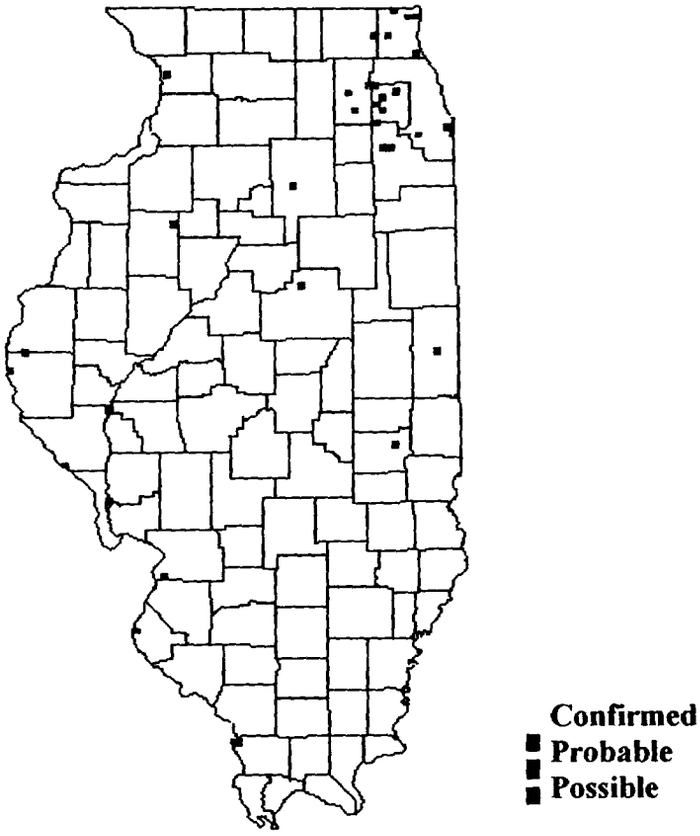
Illinois Breeding Bird Atlas
Least Bittern
Breeding Status



Illinois Department of Natural Resources, Division of Natural Heritage
Illinois Natural History Survey, Center for Wildlife Ecology

Least bittern
Ixobrychus exilis

Taxonomy
Occurence in Illinois
Status
Habitat associations
Guilds
Food-habits
Environmental associations
Life history
Management practices
References

TAXONOMY

- Phylum: Chordata
- Class: Aves
- Order: Ciconiiformes
- Family: Ardeidae
- Genus: *Ixobrychus*
- Species: *Ixobrychus exilis*
- Authority: Gmelin

Comments on taxonomy:
Other names: dwarf bittern; least heron; little bittern *03*.

OCCURENCE IN ILLINOIS

Uncommon migrant and summer resident *02*.

STATUS

Items in **bold** indicate applicable categories
Forest Service Categories: S = recommended for regional sensitive status, F = forest listed species, M = management indicator species

Federal Status:

Endangered	Threatened	Proposed for listing
Candidate for proposal	Recovery plan approved	Recovery plan received (USFWS)
Recovery plan in preparation	Under notice of review	Delisted
Migratory	EPA indicator	Forest Serv.- Shawnee species

State Status:

Endangered	Threatened	Proposed

Other:

Game	Furbearer	**Nongame protected**	
Sportfish	Commercial	Pest	None of the above

Comments on status:
The least bittern is protected by the Illinois Wildlife Code of 1971 *05*, and the Migratory Bird Treaty Act of 1918 *06*.

HABITAT ASSOCIATIONS

Items in **bold** indicate applicable categories

General habitat:

Unknown	**Terrestrial**	**Aquatic**	**Riparian**

USFS timber inventory forest size class:

Unknown	Unstocked	Seedling	Sapling
Seedling/sapling	Pole	Mature	Over mature

Land use and land cover:

Unknown		Urban	Residential Commercial Industrial Transportation, communication Complex industrial/commercial Mixed Other
Agricultural	Crop, pasture Orchards, groves, nurseries Feedlot Other	Rangeland	Herbaceous Shrub and brush Mixed
Forestland	Deciduous Evergreen Mixed	**Water**	**Stream** **Lake** **Reservoir** **Bay**

Wetland	**Forest** **Non-forest**	Barren	Salt flat Beach Sand Rock Mine Transit Mix

Forest cover types:

Cover type	Structural stage	Canopy closure	Season
Sweetgum-yellow poplar	Young tree (1-9" dia.)	Unknown	Unknown
Sweetgum-yellow poplar	Mature (9" dia. & 100 yrs. old)	Unknown	Unknown
Swamp chestnut oak-cherrybark oak	Young tree (1-9" dia.)	Unknown	Unknown
Swamp chestnut oak-cherrybark oak	Mature (9" dia. & 100 yrs. old)	Unknown	Unknown
Sweetgum-willow oak	Young tree (1-9" dia.)	Unknown	Unknown
Sweetgum-willow oak	Mature (9" dia. & 100 yrs. old)	Unknown	Unknown
Overcup oak-water hickory	Young tree (1-9" dia.)	Unknown	Unknown
Overcup oak-water hickory	Mature (9" dia. & 100 yrs. old)	Unknown	Unknown
Bald cypress	Young tree (1-9" dia.)	Unknown	Unknown
Bald cypress	Mature (9" dia. & 100 yrs. old)	Unknown	Unknown
Bald cypress-tupelo	Young tree (1-9" dia.)	Unknown	Unknown
Bald cypress-tupelo	Mature (9" dia. & 100 yrs. old)	Unknown	Unknown
Water tupelo-swamp tupelo	Young tree (1-9" dia.)	Unknown	Unknown
Water tupelo-swamp tupelo	Mature (9" dia. & 100 yrs. old)	Unknown	Unknown

Associated tree species: No records.

National wetland inventory classifications:

System	Subsystem	Class	Subclass	Water regime modifiers	Water chemistry
Palustrine		Emergent vegetation	Persistent	Unknown/unspecified	Unknown/unspecified
Palustrine		Scrub/shrub	Broad-leaved deciduous	Unknown/unspecified	Unknown/unspecified

Comments on species-habitat associations:
Found primarily in cattail marshes *02*.

Important plant and animal association: No comments.

High value habitats

Habitat	Structural stage	Season
Wetland	Not applicable (HVAL-HAB cover)	Spring
Wetland	Not applicable (HVAL-HAB cover)	Summer
Wetland	Not applicable (HVAL-HAB cover)	Fall
Marsh	Not applicable (HVAL-HAB cover)	Spring
Marsh	Not applicable (HVAL-HAB cover)	Summer
Marsh	Not applicable (HVAL-HAB cover)	Fall

Species-habitat interrelations: Found primarily in cattail marshes *02*; shy, secretive bird, hides in tall cattails and sedges *03*; feeds at edge of water, retreats into vegetation after capturing prey *03,12*. Nests in dense growth of marsh emergents, above shallow water but near to open water *03,09*

GUILDS

Feed-guilding:

Habitat	Structural stage	Season	Feed-guilds
Wetland	Not applicable (HVAL-HAB cover)	All	Water column- arthropods Water column- invertebrates other than zooplankton or arthropods Water column- fish Water column- amphibians Water column- mammals Water surface- arthropods Water surface- invertebrates other than zooplankton or

			arthropods Water surface- fish Water surface- amphibians Water surface- mammals
Marsh	Not applicable (HVAL-HAB cover)	All	Water column- arthropods Water column- invertebrates other than zooplankton or arthropods Water column- fish Water column- amphibians Water column- mammals Water surface- arthropods Water surface- invertebrates other than zooplankton or arthropods Water surface- fish Water surface- amphibians Water surface- mammals

Comments on feed-guilding:
Feed at edge of water in marshes; darts head toward water; captured fish is swallowed head first; besides small fishes, eats amphibians, aquatic insects and other invertebrates. Retreats into vegetation after capture *03,12*.

Breed-guilding:

Habitat	Structural stage	Season	Breed-Guilds
Wetland	Not applicable (HVAL-HAB cover)	Spring/summer	Surface of water column-river/lake/marsh, unconsolidated rooted herbaceous plants River/lake/marsh, vascular plants- emergent, nonwoody Terrestrial surface, marshy areas with hydrophytes but not hydric soils
Marsh	Not applicable (HVAL-HAB cover)	Spring/summer	Surface of water column-river/lake/marsh, unconsolidated rooted herbaceous plants River/lake/marsh, vascular plants- emergent, nonwoody Terrestrial surface, marshy areas with hydrophytes but not hydric soils

Comments on breed-guilding:
Nest in marshes; in cattails, bulrushes *03*; occasionally nest on ground; nest may be built on top of old nests of other birds *09,18*; natural clump of dead vegetation usually forms base of nest *18*; reports of nest heights vary- 6-24 in. *18*; <1 ft. *20*; 30-91 cm *17*; 8-14 in. *09*; nest made of dead vegetation around nest site *17,09,18*; nest throughout marsh, not just on edge *17*.

FOOD-HABITS

Trophic level is CARNIVORE

Food item	Life stage/plant part
Annelida (segmented worms)	Unknown
Annelida: hirudinea (leeches)	Unknown
Mollusca: Gastropoda (snails)	Unknown
Crustaceans	Unknown
Malacostraca (isopods, amphipods, crayfishes)	Unknown
Insecta	Unknown
Odonata (dragonflies, damselflies)	Unknown
Orthoptera (grasshoppers, crickets, cockroaches)	Unknown
Hemiptera	Unknown
Lepidoptera (butterflies, moths)	Unknown
Diptera (flies, midges, mosquitoes)	Unknown
Osteichthyes (bony fishes)	Unknown
Cypriniformes (carps, minnows, loaches)	Unknown
Perciformes (basses, sunfishes, perches, sculpins)	Unknown
Amphibians	Juvenile
Amphibians	Adult
Caudata (salamanders,newts,mudpuppies,sirens,hellbenders)	Unknown
Salientia (frogs, toads)	Juvenile
Salientia (frogs, toads)	Adult
Mammals	Unknown
Important:	
Crustaceans	Unknown
Insecta	Unknown
Osteichthyes (bony fishes)	
Juvenile:	
Malacostraca (isopods, amphipods, crayfishes)	Unknown
Osteichthyes (bony fishes)	Unknown
Salientia (frogs, toads)	Adult
Adult:	
Annelida (segmented worms)	Unknown
Annelida: hirudinea (leeches)	Unknown
Mollusca: Gastropoda (snails)	Unknown
Crustaceans	Unknown
Malacostraca (isopods, amphipods, crayfishes)	Unknown
Insecta	Unknown
Odonata (dragonflies, damselflies)	Unknown

Orthoptera (grasshoppers, crickets, cockroaches)	Unknown
Hemiptera	Unknown
Lepidoptera (butterflies, moths)	Unknown
Diptera (flies, midges, mosquitoes)	Unknown
Osteichthyes (bony fishes)	Unknown
Cypriniformes (carps, minnows, loaches)	Unknown
Perciformes (basses, sunfishes, perches, sculpins)	Unknown
Amphibians	Juvenile
Amphibians	Adult
Caudata (salamanders,newts,mudpuppies,sirens,hellbenders)	Unknown
Salientia (frogs, toads)	Juvenile
Salientia (frogs, toads)	Adult
Mammals	Unknown

Comments on food habits:
General: USBS survey of stomach contents = 40% fish, 10% crustaceans, 21% insects, 12% aquatic bugs *09*; also eat amphibians, leeches, slugs; occassionally shrews and mice *03,09*.
Juvenile: Young are fed regurgitated food by parent *09*. See [FH]
Adult: See [FH]

ENVIRONMENTAL ASSOCIATIONS

General:

- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitat zone: see comments
- Water depth preference: see comments
- Aquatic habitats: freshwater marsh
- Aquatic habitats: marsh
- Herbs-leguminous forbs: see comments
- Human associations: see comments
- Unknown

Limiting:

- Human associations: see comments

Egg

- Unknown

Feeding juvenile:

- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitat zone: see comments
- Aquatic habitats: freshwater marsh

- Aquatic habitats: marsh

Resting juvenile:

- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitat zone: see comments
- Aquatic habitats: freshwater marsh
- Aquatic habitats: marsh

Feeding adult:

- Aquatic habitat zone: see comments
- Aquatic habitats: freshwater marsh
- Aquatic habitats: marsh
- Herbs-leguminous forbs: see comments

Resting adult:

- Herbs-leguminous forbs: see comments

Breeding adult:

- Water depth preference: see comments
- Aquatic habitats: freshwater marsh
- Aquatic habitats: marsh
- Herbs-leguminous forbs: see comments

Comments on environmental associations:
General: All activities occur in herbaceous ground cover *14*; found in marshes *02,17,18,19*; limiting factor is habitat *17*; least bittern habitat is adversely affected by marsh drainage, pollution, insecticides, and development activities *09*.
Feeding juvenile: Feed in cattails, buttonbush, sawgrass, smartweed, and sedges *09,17, 19*
Resting juvenile: Rest in cattails, buttonbush, sawgrass, smartweed, and sedges *09,17, 18,19,20*
Feeding adult: Cattails, buttonbush, sawgrass, smartweed, sedges *09,17,18,19,20*
Resting adult: Cattails, buttonbush, sawgrass, smartweed, sedges *09,17,18,19,20*
Breeding adult: Use cattails *09,17,19*; buttonbush, sawgrass, smartweed *09* and sedges *17*; usually nest over water 3-28 in. deep *18*; in an Iowa study most nests over water 16-20 in. deep *20*; most nests 6 in. - 20 ft. from open water *18*.

LIFE HISTORY

Origin: Native *02*.

Physical description: Smallest heron; buffy wing patches, dark crown and back; length = 11-14 in. (male larger within span); wingspread = 16-18 in.; bill = 41-47.3 mm; tarsus = 37-42.7 mm; weight = 1.5 - 4 ounces *09*

Reproduction: Breeding season, in Virginia, eggs laid mid-May to mid- July, young in nest mid-June to mid-August *11*; copulation occurs on nest, prior to and during laying, continues into early incubation; eggs = 4-5, 31.3 x 23.93 mm; shell = smooth, not glossy; color = pale, bluish green,

usually laid one egg/day *08*; incubation period = 16- 18 days *10*; average number offspring = 3-4; may be single or double brooded; breeding behavior = seasonal monogamy; male chooses nesting site *09*

Behavior: Home range = one study found 2.5 acres/nest *09*; foraging = wader, freshwater marshes, does not remain at pool after capture, quickly retreats into vegetation *12*; nesting = on dense vegetation, 8-14 in. above shallow water; close to open water; usually singly but in suitable habitat high density may result in colonial appearance material = dried and living plants; round to oval (6-8 in.); Male 2/3 - 3/4 of nest; building continues after young have hatched; development of young = 2nd day - young grasp twigs; 5th day - able to leave nest, returning quickly; 6th day - leave nest readily; 8th day - leave and hide in vegetation; 10-14 days - nestling period, parents feed young away from nest *09*

Limiting factors: Habitats adversely affected by marsh drainage, pollution, insecticides and development activities of man *09* population parameters: hatching success = 84% *09* aquatic/terrestrial associations: long-billed marsh wren known to puncture eggs *09*

Diseases and Parasites: Helminths - nematodes *15*; ectoparasites *16* general disease and parasite reference *13*

Other: Little nest sanitation; shy, solitary bird; runs rapidly along ground *09*.

MANAGEMENT PRACTICES

Beneficial:

- Maintaining undisturbed/undeveloped areas
- Maintaining early stage of ecological succession
- Maintaining natural ecological succession
- Controlling land use and human activities
- Controlling pollution
- Controlling sedimentation
- Developing/maintaining wetlands
- Developing/maintaining mudflats
- Maintaining bogs
- Restricting human disturbance during migration, breeding, and nesting

Adverse:

- Channelization
- Navigational improvements such as channelization and locks and dams
- Dredging
- Controlling aquatic plants
- Draining ponds/lakes
- Draining wetlands
- Burning of wetlands to maintain successional stages
- Application of insecticides

Comments on management practices:

Have been adversely affected by marsh drainage, pollution, and insecticides *09*.

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17. 13M

18. 15M

19. 16M

20. 20M

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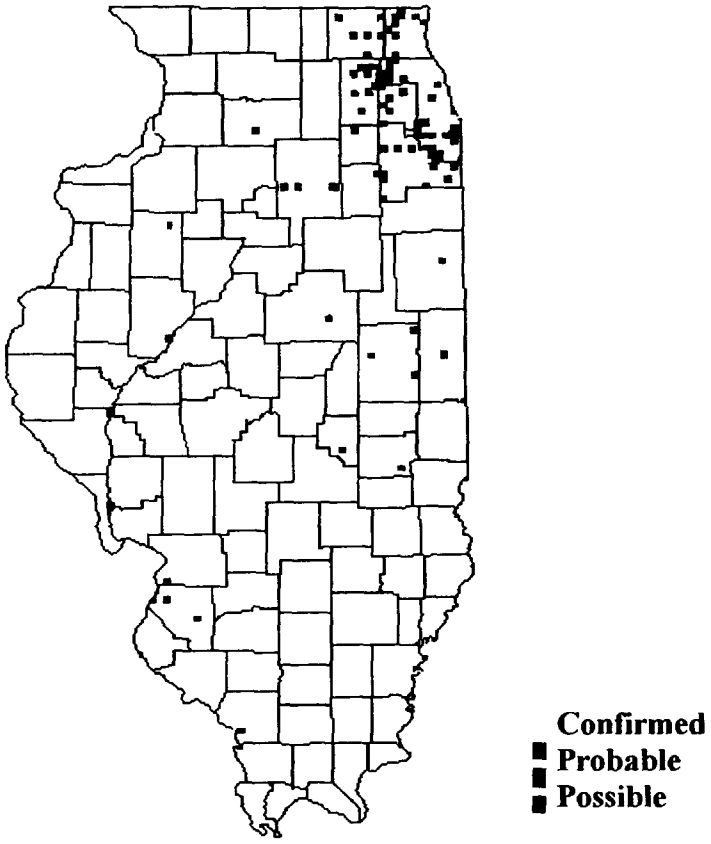
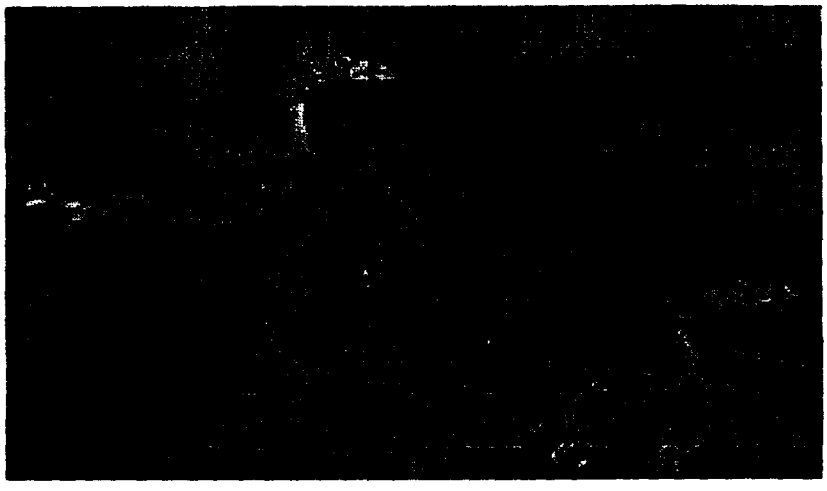
Illinois Breeding Bird Atlas
Pied-billed Grebe
Breeding Status



Illinois Department of Natural Resources, Division of Natural Heritage
Illinois Natural History Survey, Center for Wildlife Ecology

Pied-billed grebe
Podilymbus podiceps



Taxonomy
Occurence in Illinois
Status
Habitat associations
Guilds
Food-habits
Environmental associations
Life history
Management practices
References

TAXONOMY

- Phylum: Chordata
- Class: Aves
- Order: Podicipediformes
- Family: Podicipedidae
- Genus: *Podilymbus*
- Species: *Podilymbus podiceps*
- Authority: Linnaeus

Comments on taxonomy:
Other names: american dabchick; carolina grebe; dabchick; devil diver; dive-dapper; dipper; hell-diver; pied-billed dabchick; thick- billed grebe; water witch *05*.

OCCURENCE IN ILLINOIS

Common migrant. Fairly common summer resident in north. Uncommon summer resident in central. Rare summer resident in south. Uncommon winter resident in central and south. Occasional winter

resident in north *02*.

STATUS

Items in **bold** indicate applicable categories
Forest Service Categories: S = recommended for regional sensitive status, F = forest listed species, M = management indicator species

Federal Status:

Endangered	Threatened	Proposed for listing
Candidate for proposal	Recovery plan approved	Recovery plan received (USFWS)
Recovery plan in preparation	Under notice of review	Delisted
Migratory	EPA indicator	Forest Serv.- Shawnee species

State Status:

Endangered	Threatened	Proposed

Other:

Game	Furbearer	**Nongame protected**	
Sportfish	Commercial	Pest	None of the above

Comments on status:
P. podiceps is protected by the Illinois Wildlife Code of 1971 *03* and the Migratory Bird Treaty Act of 1918 *04*.

HABITAT ASSOCIATIONS

Items in **bold** indicate applicable categories

General habitat:

Unknown	Terrestrial	**Aquatic**	Riparian

USFS timber inventory forest size class:

Unknown	**Unstocked**	Seedling	Sapling
Seedling/sapling	Pole	Mature	Over mature

Land use and land cover:

Unknown	Urban	Residential Commercial Industrial Transportation, communication Complex industrial/commercial Mixed Other

Agricultural	Crop, pasture Orchards, groves, nurseries Feedlot Other	Rangeland	Herbaceous Shrub and brush Mixed
Forestland	Deciduous Evergreen Mixed	**Water**	**Stream** **Lake** **Reservoir** **Bay**
Wetland	Forest **Non-forest**	Barren	Salt flat Beach Sand Rock Mine Transit Mix

Forest cover types: No records.

Associated tree species: No records.

National wetland inventory classifications:

System	Subsystem	Class	Subclass	Water regime modifiers	Water chemistry
Lacustrine	Limnetic	Emergent vegetation		Unknown/unspecified	Unknown/unspecified
Lacustrine	Limnetic	Open water of unknown bottom type		Unknown/unspecified	Unknown/unspecified
Lacustrine	Littoral	Emergent vegetation	Nonpersistent	Unknown/unspecified	Unknown/unspecified
Lacustrine	Littoral	Unconsolidated bottom		Unknown/unspecified	Unknown/unspecified
Palustrine		Emergent vegetation	Persistent	Unknown/unspecified	Unknown/unspecified
Palustrine		Forest	Needle-leaved deciduous	Unknown/unspecified	Unknown/unspecified
Palustrine		Forest	Dead trees	Unknown/unspecified	Unknown/unspecified
Palustrine		Scrub/shrub	Broad-leaved deciduous	Unknown/unspecified	Unknown/unspecified
Riverine	Lower perennial	Aquatic bed	Floating	Unknown/unspecified	Unknown/unspecified
Riverine	Lower perennial	Emergent vegetation		Unknown/unspecified	Unknown/unspecified

Riverine	Lower perennial	Open water of unknown bottom type		Unknown/unspecified	Unknown/unspecified
Riverine	Unknown perennial	Emergent vegetation	Nonpersistent	Unknown/unspecified	Unknown/unspecified
Riverine	Unknown perennial	Unconsolidated bottom		Unknown/unspecified	Unknown/unspecified

Comments on species-habitat associations:
Found on saltwater bays and estuaries, but more common on freshwater ponds, streams, and marshes with emergent water plants; also found along open waters in marshes, and shores of inlets and bays *05*.

Important plant and animal association: No comments.

High value habitats

Habitat	Structural stage	Season
Bays and estuaries	Not applicable (HVAL-HAB cover)	All
Wetland	Not applicable (HVAL-HAB cover)	All
Marsh	Not applicable (HVAL-HAB cover)	All
Lakes and ponds	Not applicable (HVAL-HAB cover)	All
Streams	Not applicable (HVAL-HAB cover)	All

Species-habitat interrelations: Found on saltwater bays and estuaries, but more common on freshwater ponds, streams, rivers, lakes and marshes with emergent water plants; also found along open waters in marshes, and shores of inlets and bays *05,07,08*. Prefer ponds less than 7 ha. *21* especially with dense stands of emergent vegetation *11,18,19,20,21*. Nest in fairly shallow water; usually near to open water *11,19,22*.

GUILDS

Comments on feed-guilding:
Feeds mainly in freshwater ponds and marshes; dives for food *05*. Food is mostly insects, fish and crayfish *05*.

Breed-guilding:

Habitat	Structural stage	Season	Breed-Guilds
Lakes and ponds	Not applicable (HVAL-HAB cover)	Spring/summer	River/lake/marsh, vascular plants- floating, nonwoody, nonrooted River/lake/marsh, vascular plants- floating, nonwoody, rooted
Marsh	Not applicable (HVAL-HAB cover)	Spring/summer	River/lake/marsh, vascular plants- floating, nonwoody, nonrooted River/lake/marsh, vascular plants- floating, nonwoody, rooted

Comments on breed-guilding:
Nest is platform of floating aquatic vegetation, usually anchored to bottom of pond *18,20,22*. Often bouyed up by bulrush stems *18*. Made of flags, rushes, sedges, algae, and mud, often attached to grasses, reeds, or bushes in the water *05*.

FOOD-HABITS

Trophic level is CARNIVORE

Food item	Life stage/plant part
Plants	Fruit/seeds
Plants	See comments
Tracheophyta (vascular plants)	Fruit/seeds
Tracheophyta (vascular plants)	See comments
Monocotyledonae (monocots)	Fruit/seeds
Monocotyledonae (monocots)	See comments
Mollusca	Adult
Mollusca: Gastropoda (snails)	Adult
Arachnida (spiders, ticks, scorpions, daddy longlegs)	Adult
Crustaceans	Adult
Malacostraca (isopods, amphipods, crayfishes)	Adult
Insecta	Juvenile
Ephemeroptera (mayflies)	Juvenile
Odonata (dragonflies, damselfiles)	Juvenile
Hemiptera	Adult
Coleoptera (beetles)	Adult
Hymenoptera (ants, wasps, bees)	Adult
Osteichthyes (bony fishes)	Unknown
Anguilliformes (American eel)	Adult
Cypriniformes (carps, minnows, loaches)	Adult

Siluriformes (catfishes)	Adult
Gasterosteiformes (sticklebacks, pipefishes, seahorses)	Adult
Amphibians	Adult
Salientia (frogs, toads)	Juvenile
Salientia (frogs, toads)	Adult
Important:	
Juvenile:	
Insecta	Juvenile
Odonata (dragonflies, damselfiles)	Juvenile
Adult:	
Plants	Fruit/seeds
Plants	See comments
Tracheophyta (vascular plants)	Fruit/seeds
Tracheophyta (vascular plants)	See comments
Monocotyledonae (monocots)	Fruit/seeds
Monocotyledonae (monocots)	See comments
Mollusca	Adult
Mollusca: Gastropoda (snails)	Adult
Arachnida (spiders, ticks, scorpions, daddy longlegs)	Adult
Crustaceans	Adult
Malacostraca (isopods, amphipods, crayfishes)	Adult
Insecta	Juvenile
Ephemeroptera (mayflies)	Juvenile
Odonata (dragonflies, damselfiles)	Juvenile
Hemiptera	Adult
Coleoptera (beetles)	Adult
Hymenoptera (ants, wasps, bees)	Adult
Osteichthyes (bony fishes)	Unknown
Anguilliformes (American eel)	Adult
Cypriniformes (carps, minnows, loaches)	Adult
Siluriformes (catfishes)	Adult
Gasterosteiformes (sticklebacks, pipefishes, seahorses)	Adult
Amphibians	Adult
Salientia (frogs, toads)	Juvenile
Salientia (frogs, toads)	Adult

Comments on food habits:
General: Will also eat soft parts of aquatic plants *05*; main food is fish (24%), crayfish (27%),

insects (43%); some fish are carp, catfish, eels, roach, sticklebacks, sculpins, silversides, top minnows; insects include nymphs of dragonflies and damselflies, diving beetles, wasps, bees, ants; also eats snails, spiders, frogs and tadpoles, and some seeds and soft parts of aquatic plants *05*.
Juvenile: No comments.
Adult: See [FH], general & important food habits.

ENVIRONMENTAL ASSOCIATIONS

General:

- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Water level: permanent
- Water level: see comments
- Water depth preference: < 1 ft.
- Water depth preference: 1-5 ft.
- Water depth preference: see comments
- Aquatic habitats: freshwater marsh
- Aquatic habitats: freshwater marsh
- Aquatic habitats: see comments
- Aquatic habitats: see comments
- Herbs-leguminous forbs: see comments
- Unknown

Egg

- Unknown

Feeding juvenile:

- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: see comments
- Aquatic habitats: see comments

Resting juvenile:

- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: see comments
- Aquatic habitats: see comments

Feeding adult:

- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: see comments
- Aquatic habitats: see comments

Resting adult:

- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Aquatic habitats: see comments
- Aquatic habitats: see comments

Breeding adult:

- Aquatic habitat: shallows with emergent vegetation (littoral zone)
- Water level: see comments
- Water depth preference: < 1 ft.
- Water depth preference: 1-5 ft.
- Water depth preference: see comments
- Aquatic habitats: see comments
- Aquatic habitats: see comments

Comments on environmental associations:
General: Standing water, fresh *08*; associated with both seasonally and flooded wetlands; is found on ponds, rivers, lakes, fresh, coastal and brackish marshes having emergent vegetation; also found along open water of marshes and shores of inlets and bays *05,07*; herbaceous ground cover, nesting *08*.
Feeding juvenile: Young feed while on parents back when in ponds or marshes having emergent vegetation; or open water *07*; use cattail, bulrush *18,19*; burreed *18* spike rush *11*, arrowhead *27* sedge *11,18*. Prefer ponds <7 ha *21* with dense stands of emergent vegetation *03,11,18,19,21*.
Resting juvenile: Young rest in marshes or ponds having open water or emergent vegetation, and on nest of reeds or grasses *07*; use cattail, bulrush *18,19*; burreed *18*, spike rush *11*, arrowhead *22*, sedge *11,18*. Prefer ponds < 7 ha *21* with dense stands of emergent veg. *11,18,19,20,21*. In LA, broods usu. found in areas of open water at least 2 ha in size *20*.
Feeding adult: Feeds on ponds and marshes having emergent vegetation, also on lakes, rivers and in coastal and brackish marshes *07*. Use cattail, bulrush *18,19*; burreed *18*, spike rush *11*, arrowhead *22*, sedge *11,18*. Prefer ponds < 7 ha *21* with dense stands of emergent vegetation *11,18,19,20,21*.
Resting adult: Rest on open water or in emergent vegetation *07*. Use cattail, bulrush *18,19*; burreed *18*, spike rush *11*, arrowhead *22*, sedge *11,18*. Prefer ponds < 7 ha *21* with dense stands of emergent veg. *11,18,19,20,21*.
Breeding adult: Breeds on ponds with shore and emergent vegetation; marshes having areas of open water; marshy inlets and bays *07*; need fairly stable water levels so nests don't become stranded *11*. Use cattail, bulrush *18,19*; burreed *18*, spike rush *11*, arrowhead *22*, sedge *11,18*. Nest in fairly shallow water; in IA, nest over water 15-25 in. Deep *11* in WI, nests over water avg. 2 ft. deep *22*; in Manitoba, don't nest in water < 12.7 cm deep *19*. In LA, nest in water 8-12 in. deep *20*. Prefer ponds < 7 ha *21* with dense emergent veg. *11,18,19,20,21*. In IA, nests avg. 25.8 ft. from patch of open water *11*. In Manitoba, nests avg. 1.3 m from open water *19*. Polygonum used for nesting cover *27*. Additional ref. for br. adult niche: *11,27*.

LIFE HISTORY

Origin: Native *02*.

Physical description: 12-15 in. long with a 23 in. wingspread; small, stocky bird distinguished by its short, blunt bill encircled by a broad black band with the upper portion of the bill curved downward; brownest of the grebes and is the only one that doesn't have white wing patch; has white undertail coverts; in winter, no black on throat, chin and bill *05*.

Reproduction: The nest is built by both members of the pair and is made up of flags, rushes, sedge,

algae and mud and is attached to grasses, reeds or bushes in the water, usually takes 3-7 days to build and is well-concealed; eggs are laid from march-sept. And are blue-white initially and then turn brown; 4-7 eggs/clutch laid at a rate of 1/day; 2 broods/year *05*; incubation takes about 23 days and begins with the first egg laid *09*.

Behavior: Incubation is carried out mostly by the female; streaked or spotted chicks can swim almost immediately after hatching; the young will usually travel on parents back or will cling to their tail; the parents may feed the chicks while on their back and may even dive; the parents will return to the nest frequently with the young and during incubation the parents will cover the nest with water soaked material when they are absent *05,10*; species exhibits territoriality about the nest site; defended area is usually included within an arc of about 150 feet around the nest; home range is usually about twice the size of the nesting territory *11*; rarely flies and escapes by diving with a short leap or slowly by submerging; it is the most solitary of the grebes; the first grebe to arrive north in the spring and the last to leave in the fall; migrates in closely-massed flocks; swims much more than it flies *05,10*.

Limiting factors: Greatest losses of nests and eggs resulted from wind, rain, and storm tides; predators of eggs and young include raccoons (*Procyon lotor*), laughing gulls (*Larus atricilla*), and water snakes (*Natrix* sp.) *09*; Parasites: *Schistotaenia tenuicirrus* *12*; diseases and parasites general reference *13,14*; bacterial: cholera *15*; helminths: nematodes *16*, trematodes *17*.

Population parameters: In one study 89.6% of nests were successfully in producing some young; 10.3% were either abandoned or destroyed by adverse weather or predators *09*.

MANAGEMENT PRACTICES

Beneficial:

- Controlling sedimentation
- Controlling pollution in aquatic habitats
- Controlling water levels
- Controlling water levels
- Developing/maintaining lakes and ponds
- Developing/maintaining wetlands
- Maintaining bogs
- Limiting access of livestock to banks and water
- Controlling undesirable vertebrate species (feral dogs, etc.)
- Developing/maintaining water holes, ponds, potholes, etc.
- Restricting human disturbance during migration, breeding, and nesting
- Animal management practices other than those included in ifwis list (see comments)

Adverse:

- Channelization
- Navigational improvements such as channelization and locks and dams
- Dredging
- Draining wetlands
- Aquatic habitat management practices other than those included in ifwis lists (see comments)
- Applying herbicides
- Application of pesticides

- Application of insecticides

Comments on management practices:
Control water level fluctuations to obtain optimum vegetational development and to reduce nest loss, and increase trapping of fur- bearers, particularly raccoons (*Procyon lotor*) *11*; beneficial to maintain water levels and emergent vegetation for nesting, April through July *27*.

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18. 25M

19. 26M

20. 27M

21. 28M

22. 29M

23. 36M

24. 38M

25. 34M

26. 30M

27. 03M

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Exhibit 30

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TABLE 4-21.—ECOSYSTEM TOXICITY/PERSISTENCE/BIOACCUMULATION FACTOR VALUES[a]

Ecosystem Toxicity/ Persistence Factor Value	Ecosystem Bioaccumulation Potential Factor Value					
	50,000	5,000	500	50	5	0.5
10,000	5×10^8	5×10^7	5×10^6	5×10^5	5×10^4	5,000
4,000	2×10^8	2×10^7	2×10^6	2×10^5	2×10^4	2,000
1,000	5×10^7	5×10^6	5×10^5	5×10^4	5,000	500
700	3.5×10^7	3.5×10^6	3.5×10^5	3.5×10^4	3,500	350
400	2×10^7	2×10^6	2×10^5	2×10^4	2,000	200
100	5×10^6	5×10^5	5×10^4	5,000	500	50
70	3.5×10^6	3.5×10^5	3.5×10^4	3,500	350	35
40	2×10^6	2×10^5	2×10^4	2,000	200	20
10	5×10^5	5×10^4	5,000	500	50	5
7	3.5×10^5	3.5×10^4	3,500	350	35	3.5
4	2×10^5	2×10^4	2,000	200	20	2
1	5×10^4	5,000	500	50	5	0.5
0.7	3.5×10^4	3,500	350	35	3.5	0.35
0.4	2×10^4	2,000	200	20	2	0.2
0.07	3,500	350	35	3.5	0.35	0.035
0.007	350	35	3.5	0.35	0.035	0.0035
0.0007	35	3.5	0.35	0.035	0.0035	0.00035
0	0	0	0	0	0	0

[a]Do not round to nearest integer.

4.1.4.2.2 *Hazardous waste quantity.* Assign the same factor value for hazardous waste quantity for the watershed as would be assigned in section 4.1.2.2.2 for the drinking water threat. Enter this value in Table 4-1.

4.1.4.2.3 *Calculation of environmental threat-waste characteristics factor category value.* For the hazardous substance selected for the watershed in section 4.1.4.2.1.4, use its ecosystem toxicity/persistence factor value and ecosystem bioaccumulation potential factor value as follows to assign a value to the waste characteristics factor category. First, multiply the ecosystem toxicity/persistence factor value and the hazardous waste quantity factor value for the watershed, subject to a maximum product of 1×10^8. Then multiply this product by the ecosystem bioaccumulation potential factor value for this hazardous substance, subject to a maximum product of 1×10^{12}. Based on this second product, assign a value from Table 2-7 (section 2.4.3.1) to the environmental threat-waste characteristics factor category for the watershed. Enter this value in Table 4-1.

4.1.4.3 *Environmental threat-targets.* Evaluate the environmental threat-targets factor category for a watershed using one factor: sensitive environments.

4.1.4.3.1 *Sensitive environments.* Evaluate sensitive environments along the hazardous substance migration path for the watershed based on three factors: Level I concentrations, Level II concentrations, and potential contamination.

Determine which factor applies to each sensitive environment as specified in section 4.1.2.3, except: use ecological-based benchmarks (Table 4-22) rather than health-based benchmarks (Table 3-10) in determining the level of contamination from samples. In determining the level of actual contamination, use a point of direct observation anywhere within the sensitive environment or samples (that is, surface water, benthic, or sediment samples) taken anywhere within or beyond the sensitive environment (or anywhere adjacent to or beyond the sensitive environment if it is contiguous to the migration path).

4.1.4.3.1.1 *Level I concentrations.* Assign value(s) from Table 4-23 to each sensitive environment subject to Level I concentrations.

TABLE 4-22.—ECOLOGICAL-BASED BENCHMARKS FOR HAZARDOUS SUBSTANCES IN SURFACE WATER

- Concentration corresponding to EPA Ambient Water Quality Criteria (AWQC) for protection of aquatic life (fresh water or marine).
- Concentration corresponding to EPA Ambient Aquatic Life Advisory Concentrations (AALAC).
- Select the appropriate AWQC and AALAC as follows:
  - — Use chronic value, if available; otherwise use acute value.
  - — If the sensitive environment being evaluated is in fresh water, use fresh water value, except: if no fresh water value is available, use marine value if available.
  - — If the sensitive environment being evaluated is in salt water, use marine value, except: if no marine value is available, use fresh water value if available.
  - — If the sensitive environment being evaluated is in both fresh water and salt water, or is in brackish water, use lower of fresh water or marine values.

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TABLE 4-23.—SENSITIVE ENVIRONMENTS RATING VALUES

Sensitive environment	Assigned value
Critical habitat[a] for Federal designated endangered or threatened species Marine Sanctuary National Park Designated Federal Wilderness Area Areas identified under Coastal Zone Management Act[b] Sensitive areas identified under National Estuary Program[c] or Near Coastal Waters Program[d] Critical areas identified under the Clean Lakes Program[e] National Monument[f] National Seashore Recreational Area National Lakeshore Recreational Area	100
Habitat known to be used by Federal designated or proposed endangered or threatened species National Preserve National or State Wildlife Refuge Unit of Coastal Barrier Resources System Coastal Barrier (undeveloped) Federal land designated for protection of natural ecosystems Administratively Proposed Federal Wilderness Area Spawning areas critical[g] for the maintenance of fish/shellfish species within river, lake, or coastal tidal waters Migratory pathways and feeding areas critical for maintenance of anadromous fish species within river reaches or areas in lakes or coastal tidal waters in which the fish spend extended periods of time Terrestrial areas utilized for breeding by large or dense aggregations of animals[h] National river reach designated as Recreational	75
Habitat known to be used by State designated endangered or threatened species Habitat known to be used by species under review as to its Federal endangered or threatened status Coastal Barrier (partially developed) Federal designated Scenic or Wild River	50
State land designated for wildlife or game management State designated Scenic or Wild River State designated Natural Areas Particular areas, relatively small in size, important to maintenance of unique biotic communities	25
State designated areas for protection or maintenance of aquatic life[i]	5

[a]Critical habitat as defined in 50 CFR 424.02.

[b]Areas identified in State Coastal Zone Management plans as requiring protection because of ecological value.

[c]National Estuary Program study areas (subareas within estuaries) identified in Comprehensive Conservation and Management Plans as requiring protection because they support critical life stages of key estuarine species (Section 320 of Clean Water Act, as amended).

[d]Near Coastal Waters as defined in Sections 104(b)(3), 304(1), 319, and 320 of Clean Water Act, as amended.

[e]Clean Lakes Program critical areas (subareas within lakes, or in some cases entire small lakes) identified by State Clean Lake Plans as critical habitat (Section 314 of Clean Water Act, as amended).

[f]Use only for air migration pathway.

[g]Limit to areas described as being used for intense or concentrated spawning by a given species.

[h]For the air migration pathway, limit to terrestrial vertebrate species. For the surface water migration pathway, limit to terrestrial vertebrate species with aquatic or semiaquatic foraging habits.

[i]Areas designated under Section 305(a) of Clean Water Act, as amended.

For those sensitive environments that are wetlands, assign an additional value from Table 4-24. In assigning a value from Table 4-24, include only those portions of wetlands located along the hazardous substance migration path in the area of Level I concentrations. If a wetland is located partially along the area of Level I concentrations and partially along the area of Level II concentrations and/or potential contamination, then solely for purposes of Table 4-24, count the portion(s) along the areas of Level II concentrations or potential contamination under the Level II concentrations factor (section 4.1.4.3.1.2) or potential contamination factor (section 4.1.4.3.1.3), as appropriate.

Estimate the total length of wetlands along the hazardous substance migration path (that is, wetland frontage) in the area of Level I concentrations and assign a value from Table 4-24 based on this total length. Estimate this length as follows:

- For an isolated wetland or for a wetland where the probable point of entry to surface water is in the wetland, use the perimeter of that portion of the wetland subject to Level I concentrations as the length.
- For rivers, use the length of the wetlands contiguous to the in-water segment of the hazardous substance migration path (that is, wetland frontage).
- For lakes, oceans, coastal tidal waters, and Great Lakes, use the length of the wetlands along the shoreline within the target distance limit (that is, wetland frontage along the shoreline).

Calculate the Level I concentrations factor value (SH) for the watershed as follows:

TABLE 4-24.—WETLANDS RATING VALUES FOR SURFACE WATER MIGRATION PATHWAY

Total length of wetlands[a] (miles)	Assigned value
Less than 0.1	0
0.1 to 1	25
Greater than 1 to 2	50
Greater than 2 to 3	75
Greater than 3 to 4	100
Greater than 4 to 8	150
Greater than 8 to 12	250
Greater than 12 to 16	350
Greater than 16 to 20	450
Greater than 20	500

[a] Wetlands as defined in 40 CFR Section 230.3.

$$SH = 10(WH + \sum_{i=1}^{n} S_i)$$

where:

WH = Value assigned from Table 4-24 to wetlands along the area of Level I concentrations.

S_i = Value(s) assigned from Table 4-23 to sensitive environment i.

n = Number of sensitive environments from Table 4-23 subject to Level I concentrations.

Enter the value assigned in Table 4-1.

4.1.4.3.1.2 *Level II concentrations.* Assign value(s) from Table 4-23 to each sensitive environment subject to Level II concentrations. Do not include sensitive environments already counted for Table 4-23 under the Level I concentrations factor for this watershed.

For those sensitive environments that are wetlands, assign an additional value from Table 4-24. In assigning a value from Table 4-24, include only those portions of wetlands located along the hazardous substance migration path in the area of Level II concentrations, as specified in section 4.1.4.3.1.1.

Estimate the total length of wetlands along the hazardous substance migration path (that is, wetland frontage) in the area of Level II concentrations and assign a value from Table 4-24 based on this total length. Estimate this length as specified in section 4.1.4.3.1.1, except: for an isolated wetland or for a wetland where the probable point of entry to surface water is in the wetland, use the perimeter of that portion of the wetland subject to Level II (not Level I) concentrations as the length.

Calculate the Level II concentrations value (SL) for the watershed as follows:

$$SL = WL + \sum_{i=1}^{n} S_i$$

where:

WL = Value assigned from Table 4-24 to wetlands along the area of Level II concentrations.

S_i = Value(s) assigned from Table 4-23 to sensitive environment i.

n = Number of sensitive environments from Table 4-23 subject to Level II concentrations.

Enter the value assigned in Table 4-1.

4.1.4.3.1.3 *Potential contamination.* Assign value(s) from Table 4-23 to each sensitive environment subject to potential contamination. Do not include sensitive environments already counted for Table 4-23 under the Level I or Level II concentrations factors.

For each type of surface water body in Table 4-13 (section 4.1.2.3.1), sum the value(s) assigned from Table 4-23 to the sensitive environments along that type of surface water body, except: do not use the surface water body type "3-mile mixing zone in quiet

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flowing river." If a sensitive environment is along two or more types of surface water bodies (for example, Wildlife Refuge contiguous to both a moderate stream and a large river), assign the sensitive environment only to that surface water body type having the highest dilution weight value from Table 4-13.

For those sensitive environments that are wetlands, assign an additional value from Table 4-24. In assigning a value from Table 4-24, include only those portions of wetlands located along the hazardous substance migration path in the area of potential contamination, as specified in section 4.1.4.3.1.1. Aggregate these wetlands by type of surface water body, except: do not use the surface water body type "3-mile mixing zone in quiet flowing river." Treat the wetlands aggregated within each type of surface water body as separate sensitive environments solely for purposes of applying Table 4-24. Estimate the total length of the wetlands within each surface water body type as specified in section 4.1.4.3.1.1, except: for an isolated wetland or for a wetland where the probable point of entry to surface water is in the wetland, use the perimeter of that portion of the wetland subject to potential contamination (or the portion of that perimeter that is within the target distance limit) as the length. Assign a separate value from Table 4-24 for each type of surface water body in the watershed.

Calculate the potential contamination factor value (SP) for the watershed as follows:

$$SP = \frac{1}{10} \sum_{j=1}^{m} ([W_j + S_j]D_j)$$

where:

$$S_j = \sum_{i=1}^{n} S_{ij}$$

S_{ij} = Value(s) assigned from Table 4-23 to sensitive environment i in surface water body type j.

n = Number of sensitive environments from Table 4-23 subject to potential contamination.

W_j = alue assigned from Table 4-24 for wetlands along the area of potential contamination in surface water body type j.

D_j = Dilution weight from Table 4-13 for surface water body type j.

m = Number of different surface water body types from Table 4-13 in the watershed.

If SP is less than 1, do not round it to the nearest integer; if SP is 1 or more, round to the nearest integer. Enter this value for the potential contamination factor in Table 4-1.

4.1.4.3.1.4 *Calculation of environmental threat-targets factor category value.* Sum the values for the Level I concentrations, Level II concentrations, and potential contamination factors for the watershed. Do not round this sum to the nearest integer. Assign this sum as the environmental threat-targets factor category value for the watershed. Enter this value in Table 4-1.

4.1.4.4 *Calculation of environmental threat score for a watershed.* Multiply the environmental threat factor category values for likelihood of release, waste characteristics, and targets for the watershed, and round the product to the nearest integer. Then divide by 82,500. Assign the resulting value, subject to a maximum of 60, as the environmental threat score for the watershed. Enter this score in Table 4-1.

4.1.5 *Calculation of overland/flood migration component score for a watershed.* Sum the scores for the three threats for the watershed (that is, drinking water, human food chain, and environmental threats). Assign the resulting score, subject to a maximum value of 100, as the surface water overland/flood migration component score for the watershed. Enter this score in Table 4-1.

4.1.6 *Calculation of overland/flood migration component score.* Select the highest surface water overland/flood migration component score from the watersheds evaluated. Assign this score as the surface water overland/flood migration component score for the site, subject to a maximum score of 100. Enter this score in Table 4-1.

4.2 *Ground water to surface water migration component.* Use the ground water to surface water migration component to evaluate surface water threats that result from migration of hazardous substances from a source at the site to surface water via ground water. Evaluate three types of threats for this component: drinking water threat, human food chain threat, and environmental threat.

4.2.1 *General considerations.*

4.2.1.1 *Eligible surface waters.* Calculate ground water to surface water migration component scores only for surface waters (see section 4.0.2) for which all the following conditions are met:

- A portion of the surface water is within 1 mile of one or more sources at the site having a containment factor value greater than 0 (see section 4.2.2.1.2).
- No aquifer discontinuity is established between the source and the portion of the surface water within 1 mile of the source (see section 3.0.1.2.2). However, if hazardous substances have migrated across an apparent discontinuity within this 1 mile distance, do not consider a discontinuity present in scoring the site.

Exhibit 31

PB92963377

United States
Environmental Protection
Agency

Office of Solid Waste
and Emergency
Response

EPA 540-R-92-026
November 1992

Superfund

EPA

Hazard Ranking System Guidance Manual

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
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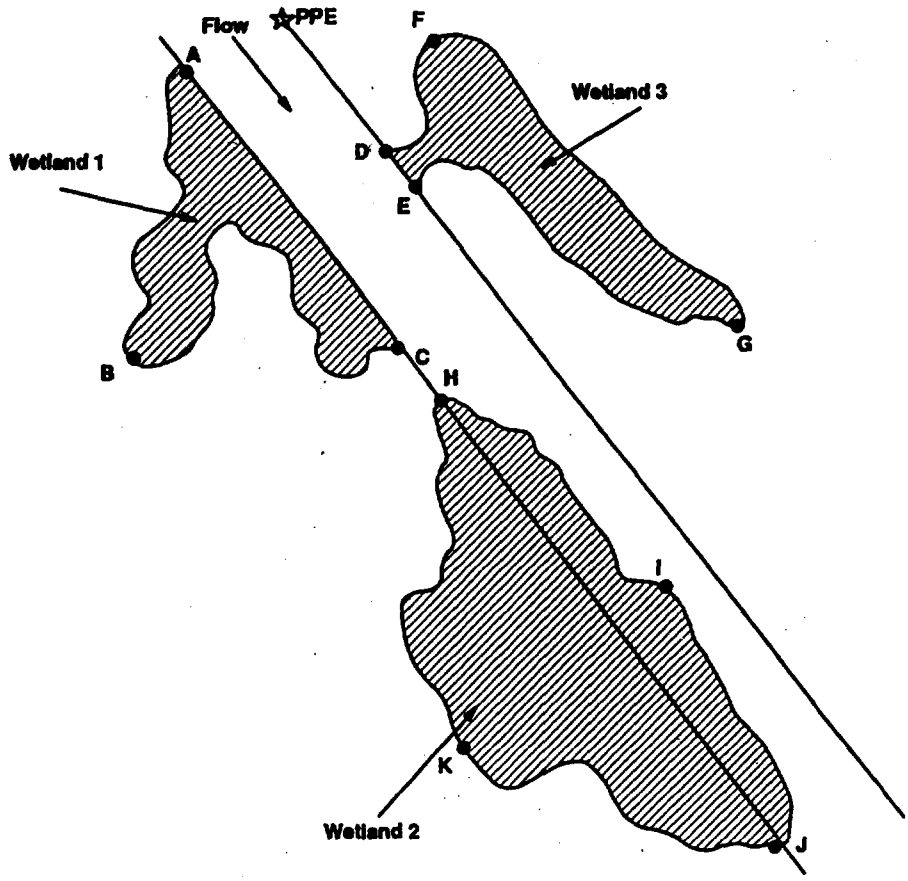
Exhibit 32

HIGHLIGHT 8-61
DETERMINING LENGTH FOR WETLANDS ALONG A RIVER



- The length of wetlands along a river or stream is determined by the frontage of wetlands contiguous to the waterway. The distance should be measured as the actual shoreline (frontage) distance and not the straight-line distance between the upstream and downstream points where the wetland meets the surface water body. In this example:

  - Frontage for Wetland 1 is the distance A to C, not the distance A to B to C.
  - Frontage for Wetland 2 is the distance H to I to J, not the distance H to J.
  - Length for Wetland 3 is the distance D to E.

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Calculate a separate ground water migration pathway score for each aquifer, using the factor category values for that aquifer for likelihood of release, waste characteristics, and targets. In doing so, include both the targets using water from that aquifer and the targets using water from all overlying aquifers through which the hazardous substances would migrate to reach the aquifer being evaluated. Assign the highest ground water migration pathway score that results for any aquifer as the ground water migration pathway score for the site.

3.0.1 *General considerations*

3.0.1.1 *Ground water target distance limit.* The target distance limit defines the maximum distance from the sources at the site over which targets are evaluated. Use a target distance limit of 4 miles for the ground water migration pathway, except when aquifer discontinuities apply (see section 3.0.1.2.2). Furthermore, consider any well with an observed release from a source at the site (see section 3.1.1) to lie within the target distance limit of the site, regardless of the well's distance from the sources at the site.

For sites that consist solely of a contaminated ground water plume with no identified source, begin measuring the 4-mile target distance limit at the center of the area of observed ground water contamination. Determine the area of observed ground water contamination based on available samples that meet the criteria for an observed release.

3.0.1.2 *Aquifer boundaries.* Combine multiple aquifers into a single hydrologic unit for scoring purposes if aquifer interconnections can be established for these aquifers. In contrast, restrict aquifer boundaries if aquifer discontinuities can be established.

3.0.1.2.1 *Aquifer interconnections.* Evaluate whether aquifer interconnections occur within 2 miles of the sources at the site. If they occur within this 2-mile distance, combine the aquifers having interconnections in scoring the site. In addition, if observed ground water contamination attributable to the sources at the site extends beyond 2 miles from the sources, use any locations within the limits of this observed ground water contamination in evaluating aquifer interconnections. If data are not adequate to establish aquifer interconnections, evaluate the aquifers as separate aquifers.

3.0.1.2.2 *Aquifer discontinuities.* Evaluate whether aquifer discontinuities occur within the 4-mile target distance limit. An aquifer discontinuity occurs for scoring purposes only when a geologic, topographic, or other structure or feature entirely transects an aquifer within the 4-mile target distance limit, thereby creating a continuous boundary to ground water flow within this limit. If two or more aquifers can be combined into a single hydrologic unit for scoring purposes, an aquifer discontinuity occurs only when the structure or feature entirely transects the boundaries of this single hydrologic unit.

When an aquifer discontinuity is established within the 4-mile target distance limit, exclude that portion of the aquifer beyond the discontinuity in evaluating the ground water migration pathway. However, if hazardous substances have migrated across an apparent discontinuity within the 4-mile target distance limit, do not consider this to be a discontinuity in scoring the site.

3.0.1.3 *Karst aquifer.* Give a karst aquifer that underlies any portion of the sources at the site special consideration in the evaluation of two potential to release factors (depth to aquifer in section 3.1.2.3 and travel time in section 3.1.2.4), one waste characteristics factor (mobility in section 3.2.1.2), and two targets factors (nearest well in section 3.3.1 and potential contamination in section 3.3.2.4).

3.1 *Likelihood of release.* For an aquifer, evaluate the likelihood of release factor category in terms of an observed release factor or a potential to release factor.

3.1.1 *Observed release.* Establish an observed release to an aquifer by demonstrating that the site has released a hazardous substance to the aquifer. Base this demonstration on either:

- Direct observation—a material that contains one or more hazardous substances has been deposited into or has been observed entering the aquifer.
- Chemical analysis—an analysis of ground water samples from the aquifer indicates that the concentration of hazardous substance(s) has increased significantly above the background concentration for the site (see section 2.3). Some portion of the significant increase must be attributable to the site to establish the observed release, except: when the source itself consists of a ground water plume with no identified source, no separate attribution is required.

If an observed release can be established for the aquifer, assign the aquifer an observed release factor value of 550, enter this value in Table 3-1, and proceed to section 3.1.3. If an observed release cannot be established for the aquifer, assign an observed release factor value of 0, enter this value in Table 3-1, and proceed to section 3.1.2.

3.1.2 *Potential to release.* Evaluate potential to release only if an observed release cannot be established for the aquifer. Evaluate potential to release based on four factors: containment, net precipitation, depth to aquifer, and travel time. For sources overlying karst terrain, give any karst aquifer that underlies any portion of the sources at the site special consideration in evaluating depth to aquifer and travel time, as specified in sections 3.1.2.3 and 3.1.2.4.

3.1.2.1 *Containment.* Assign a containment factor value from Table 3-2 to each source at the site. Select the highest containment factor value assigned to those sources with a source hazardous waste quantity value of 0.5 or more (see section 2.4.2.1.5). (Do not include this minimum size requirement in evaluating any other factor of this pathway.) Assign this highest value as the containment factor value for the aquifer being evaluated. Enter this value in Table 3-1.

If no source at the site meets the minimum size requirement, then select the highest value assigned to the sources at the site and assign it as the containment factor value for the aquifer being evaluated. Enter this value in Table 3-1.

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Calculate a separate ground water migration pathway score for each aquifer, using the factor category values for that aquifer for likelihood of release, waste characteristics, and targets. In doing so, include both the targets using water from that aquifer and the targets using water from all overlying aquifers through which the hazardous substances would migrate to reach the aquifer being evaluated. Assign the highest ground water migration pathway score that results for any aquifer as the ground water migration pathway score for the site.

3.0.1 *General considerations*

3.0.1.1 *Ground water target distance limit.* The target distance limit defines the maximum distance from the sources at the site over which targets are evaluated. Use a target distance limit of 4 miles for the ground water migration pathway, except when aquifer discontinuities apply (see section 3.0.1.2.2). Furthermore, consider any well with an observed release from a source at the site (see section 3.1.1) to lie within the target distance limit of the site, regardless of the well's distance from the sources at the site.

For sites that consist solely of a contaminated ground water plume with no identified source, begin measuring the 4-mile target distance limit at the center of the area of observed ground water contamination. Determine the area of observed ground water contamination based on available samples that meet the criteria for an observed release.

3.0.1.2 *Aquifer boundaries.* Combine multiple aquifers into a single hydrologic unit for scoring purposes if aquifer interconnections can be established for these aquifers. In contrast, restrict aquifer boundaries if aquifer discontinuities can be established.

3.0.1.2.1 *Aquifer interconnections.* Evaluate whether aquifer interconnections occur within 2 miles of the sources at the site. If they occur within this 2-mile distance, combine the aquifers having interconnections in scoring the site. In addition, if observed ground water contamination attributable to the sources at the site extends beyond 2 miles from the sources, use any locations within the limits of this observed ground water contamination in evaluating aquifer interconnections. If data are not adequate to establish aquifer interconnections, evaluate the aquifers as separate aquifers.

3.0.1.2.2 *Aquifer discontinuities.* Evaluate whether aquifer discontinuities occur within the 4-mile target distance limit. An aquifer discontinuity occurs for scoring purposes only when a geologic, topographic, or other structure or feature entirely transects an aquifer within the 4-mile target distance limit, thereby creating a continuous boundary to ground water flow within this limit. If two or more aquifers can be combined into a single hydrologic unit for scoring purposes, an aquifer discontinuity occurs only when the structure or feature entirely transects the boundaries of this single hydrologic unit.

When an aquifer discontinuity is established within the 4-mile target distance limit, exclude that portion of the aquifer beyond the discontinuity in evaluating the ground water migration pathway. However, if hazardous substances have migrated across an apparent discontinuity within the 4-mile target distance limit, do not consider this to be a discontinuity in scoring the site.

3.0.1.3 *Karst aquifer.* Give a karst aquifer that underlies any portion of the sources at the site special consideration in the evaluation of two potential to release factors (depth to aquifer in section 3.1.2.3 and travel time in section 3.1.2.4), one waste characteristics factor (mobility in section 3.2.1.2), and two targets factors (nearest well in section 3.3.1 and potential contamination in section 3.3.2.4).

3.1 *Likelihood of release.* For an aquifer, evaluate the likelihood of release factor category in terms of an observed release factor or a potential to release factor.

3.1.1 *Observed release.* Establish an observed release to an aquifer by demonstrating that the site has released a hazardous substance to the aquifer. Base this demonstration on either:

- Direct observation—a material that contains one or more hazardous substances has been deposited into or has been observed entering the aquifer.
- Chemical analysis—an analysis of ground water samples from the aquifer indicates that the concentration of hazardous substance(s) has increased significantly above the background concentration for the site (see section 2.3). Some portion of the significant increase must be attributable to the site to establish the observed release, except: when the source itself consists of a ground water plume with no identified source, no separate attribution is required.

If an observed release can be established for the aquifer, assign the aquifer an observed release factor value of 550, enter this value in Table 3-1, and proceed to section 3.1.3. If an observed release cannot be established for the aquifer, assign an observed release factor value of 0, enter this value in Table 3-1, and proceed to section 3.1.2.

3.1.2 *Potential to release.* Evaluate potential to release only if an observed release cannot be established for the aquifer. Evaluate potential to release based on four factors: containment, net precipitation, depth to aquifer, and travel time. For sources overlying karst terrain, give any karst aquifer that underlies any portion of the sources at the site special consideration in evaluating depth to aquifer and travel time, as specified in sections 3.1.2.3 and 3.1.2.4.

3.1.2.1 *Containment.* Assign a containment factor value from Table 3-2 to each source at the site. Select the highest containment factor value assigned to those sources with a source hazardous waste quantity value of 0.5 or more (see section 2.4.2.1.5). (Do not include this minimum size requirement in evaluating any other factor of this pathway.) Assign this highest value as the containment factor value for the aquifer being evaluated. Enter this value in Table 3-1.

If no source at the site meets the minimum size requirement, then select the highest value assigned to the sources at the site and assign it as the containment factor value for the aquifer being evaluated. Enter this value in Table 3-1.

TABLE 3-2.—CONTAINMENT FACTOR VALUES FOR GROUND WATER MIGRATION PATHWAY

Source	Assigned value
All Sources (Except Surface Impoundments, Land Treatment, Containers, and Tanks)	
Evidence of hazardous substance migration from source area (i.e., source area includes source and any associated containment structures).	10
No liner	10
No evidence of hazardous substance migration from source area, a liner, *and*:	
(a) None of the following present: (1) maintained engineered cover, or (2) functioning and maintained run-on control system and runoff management system, or (3) functioning leachate collection and removal system immediately above liner.	10
(b) Any one of the three items in (a) present	9
(c) Any two of the items in (a) present	7
(d) All three items in (a) present plus a functioning ground water monitoring system	5
(e) All items in (d) present, plus no bulk or non-containerized liquids nor materials containing free liquids deposited in source area.	3
No evidence of hazardous substance migration from source area, double liner with functioning leachate collection and removal system above and between liners, functioning ground water monitoring system, *and*:	
(f) Only one of the following deficiencies present in containment: (1) bulk or noncontainerized liquids or materials containing free liquids deposited in source area, or (2) no or nonfunctioning or nonmaintained run-on control system and runoff management system, or (3) no or nonmaintained engineered cover.	3
(g) None of the deficiencies in (f) present	0
Source area inside or under maintained intact structure that provides protection from precipitation so that neither runoff nor leachate is generated, liquids or materials containing free liquids not deposited in source area, and functioning and maintained run-on control present.	0
Surface Impoundment	
Evidence of hazardous substance migration from surface impoundment	10
No liner	10
Free liquids present with either no diking, unsound diking, or diking that is not regularly inspected and maintained	10
No evidence of hazardous substance migration from surface impoundment, free liquids present, sound diking that is regularly inspected and maintained, adequate freeboard, *and*:	
(a) Liner	9
(b) Liner with functioning leachate collection and removal system below liner, and functioning ground water monitoring system	5
(c) Double liner with functioning leachate collection and removal system between liners, and functioning ground water monitoring system.	3
No evidence of hazardous substance migration from surface impoundment and all free liquids eliminated at closure (either by removal of liquids or solidification of remaining wastes and waste residues).	Evaluate using **All sources** criteria (with no bulk or free liquid deposited).
Land Treatment	
Evidence of hazardous substance migration from land treatment zone	10
No functioning, maintained, run-on control and runoff management system	10
No evidence of hazardous substance migration from land treatment zone *and*:	
(a) Functioning and maintained run-on control and runoff management system	7
(b) Functioning and maintained run-on control and runoff management system, and vegetative cover established over entire land treatment area	5
(c) Land treatment area maintained in compliance with 40 CFR 264.280.	0
Containers	
All containers buried	Evaluate using **All sources** criteria.
Evidence of hazardous substance migration from container area (i.e., container area includes containers and any associated containment structures).	10
No liner (or no essentially impervious base) under container area	10
No diking (or no similar structure) surrounding container area	10
Diking surrounding container area unsound or not regularly inspected and maintained	10
No evidence of hazardous substance migration from container area, container area surrounded by sound diking that is regularly inspected and maintained, *and*:	
(a) Liner (or essentially impervious base) under container area	9
(b) Essentially impervious base under container area with liquids collection and removal system	7

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TABLE 3-2.—CONTAINMENT FACTOR VALUES FOR GROUND WATER MIGRATION PATHWAY—Continued

Source	Assigned value
(c) Containment system includes essentially impervious base, liquids collection system, sufficient capacity to contain 10 percent of volume of all containers, and functioning and maintained run-on control; plus functioning ground water monitoring system, and spilled or leaked hazardous substances and accumulated precipitation removed in timely manner to prevent overflow of collection system, at least weekly inspection of containers, hazardous substances in leaking or deteriorating containers transferred to containers in good condition, and containers sealed except when waste is added or removed.	5
(d) Free liquids present, containment system has sufficient capacity to hold total volume of all containers and to provide adequate freeboard, single liner under container area with functioning leachate collection and removal system below liner, and functioning ground water monitoring system	5
(e) Same as (d) except: double liner under container area with functioning leachate collection and removal system between liners.	3
Containers inside or under maintained intact structure that provides protection from precipitation so that neither runoff nor leachate would be generated from any unsealed or ruptured containers, liquids or materials containing free liquids not deposited in any container, and functioning and maintained run-off control present.	0
No evidence of hazardous substance migration from container area, containers leaking, and all free liquids eliminated at closure (either by removal of liquid or solidification of remaining wastes and waste residues).	Evaluate using **All sources** criteria (with no bulk or free liquid deposited).
Tank	
Below-ground tank	Evaluate using **All sources** criteria.
Evidence of hazardous substance migration from tank area (i.e., tank area includes tank, ancillary equipment such as piping, and any associated containment structures).	10
Tank and ancillary equipment not provided with secondary containment (e.g., liner under tank area, vault system, double wall).	10
No diking (or no similar structure) surrounding tank and ancillary equipment	10
Diking surrounding tank and ancillary equipment unsound or not regularly inspected and maintained	10
No evidence of hazardous substance migration from tank area, tank and ancillary equipment surrounded by sound diking that is regularly inspected and maintained, *and*:	
(a) Tank and ancillary equipment provided with secondary containment	9
(b) Tank and ancillary equipment provided with secondary containment with leak detection and collection system.	7
(c) Tank and ancillary equipment provided with secondary containment system that detects and collects spilled or leaked hazardous substances and accumulated precipitation and has sufficient capacity to contain 110 percent of volume of largest tank within containment area, spilled or leaked hazardous substances and accumulated precipitation removed in timely manner, at least weekly inspection of tank and secondary containment system, all leaking or unfit-for-use tank systems promptly responded to, and functioning ground water monitoring system.	5
(d) Containment system has sufficient capacity to hold volume of all tanks within tank containment area and to provide adequate freeboard, single liner under that containment area with functioning leachate collection and removal system below liner, and functioning ground water monitoring system	5
(e) Same as (d) except: double liner under tank containment area with functioning leachate collection and removal system between liners.	3
Tank is above ground, and inside or under maintained intact structure that provides protection from precipitation so that neither runoff nor leachate would be generated from any material released from tank, liquids or materials containing free liquids not deposited in any tank, and functioning and maintained run-on control present.	0

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3.1.2.2 *Net precipitation.* Assign a net precipitation factor value to the site. Figure 3-2 provides computed net precipitation factor values, based on site location. Where necessary, determine the net precipitation factor value as follows:

- Determine monthly precipitation and monthly evapotranspiration:
  - — Use local measured monthly averages.
  - — When local data are not available, use monthly averages from the nearest National Oceanographic and Atmospheric Administration weather station that is in a similar geographic setting.
  - — When measured monthly evapotranspiration is not available, calculate monthly potential evapotranspiration (E_i) as follows:

$$E_i = 0.6\ F_i\ (10\ T_i/I)^a$$

where:

E_i = Monthly potential evapotranspiration (inches) for month i.

F_i = Monthly latitude adjusting value for month i.

T_i = Mean monthly temperature (°C) for month i.

$$I = \sum_{i=1}^{12} (T_i/5)^{1.514}$$

$$a = 6.75 \times 10^{-7}\ I^3 - 7.71 \times 10^{-5}\ I^2 + 1.79 \times 10^{-2}\ I + 0.49239$$

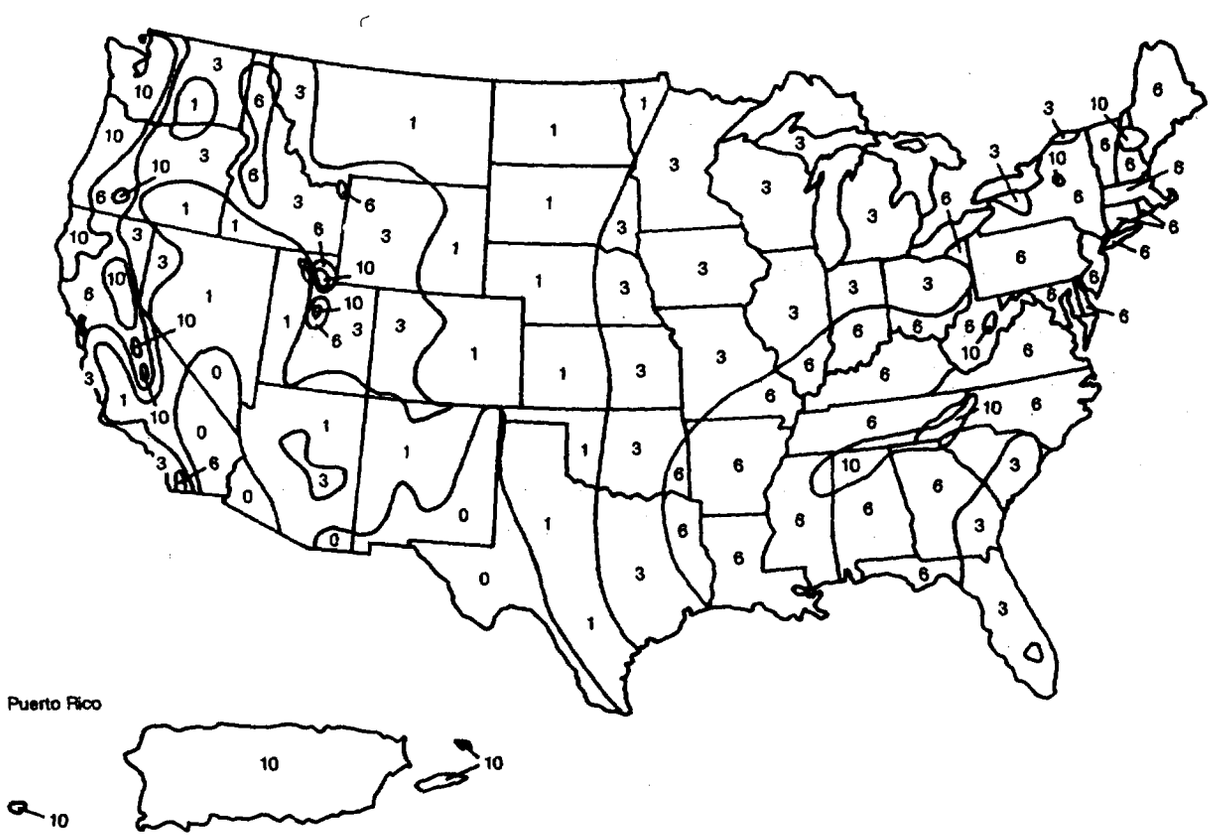

FIGURE 3-2
NET PRECIPITATION FACTOR VALUES

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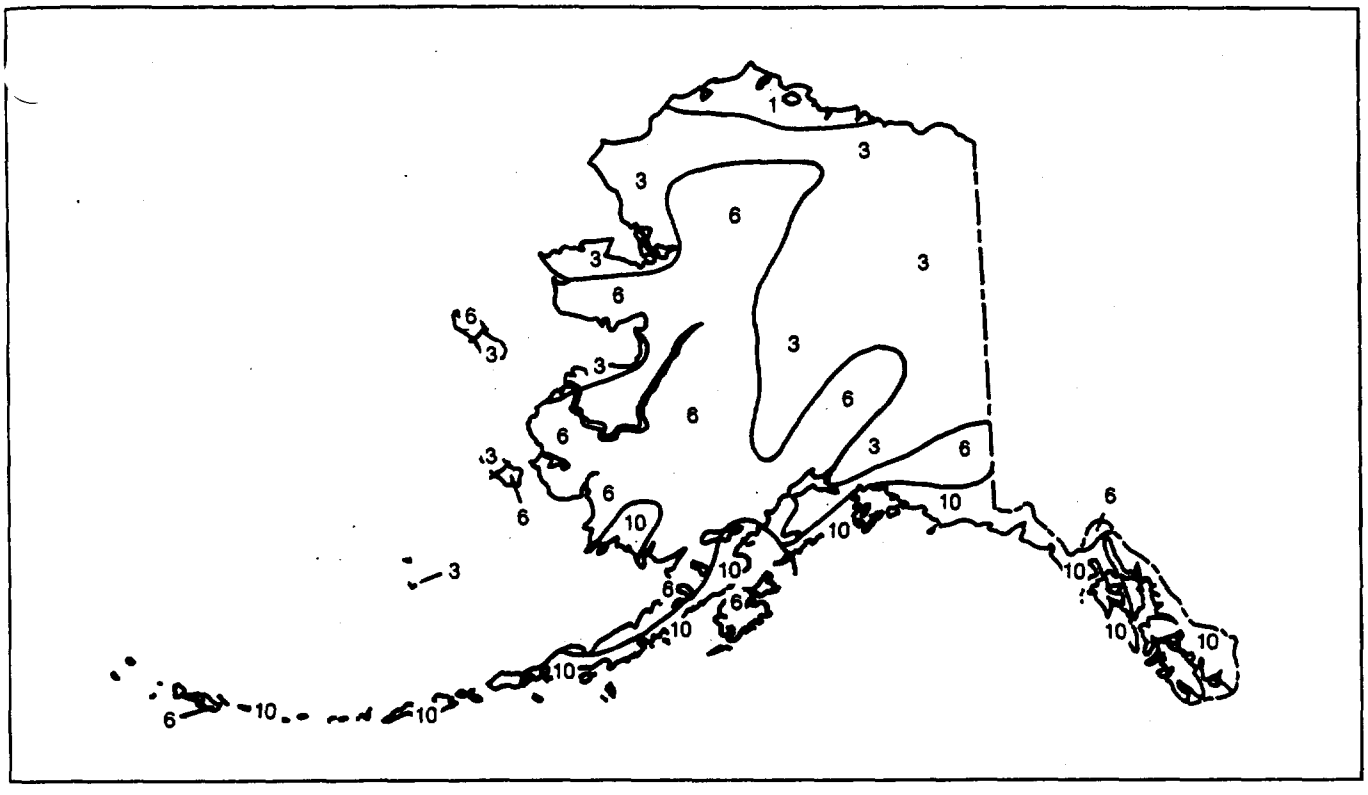

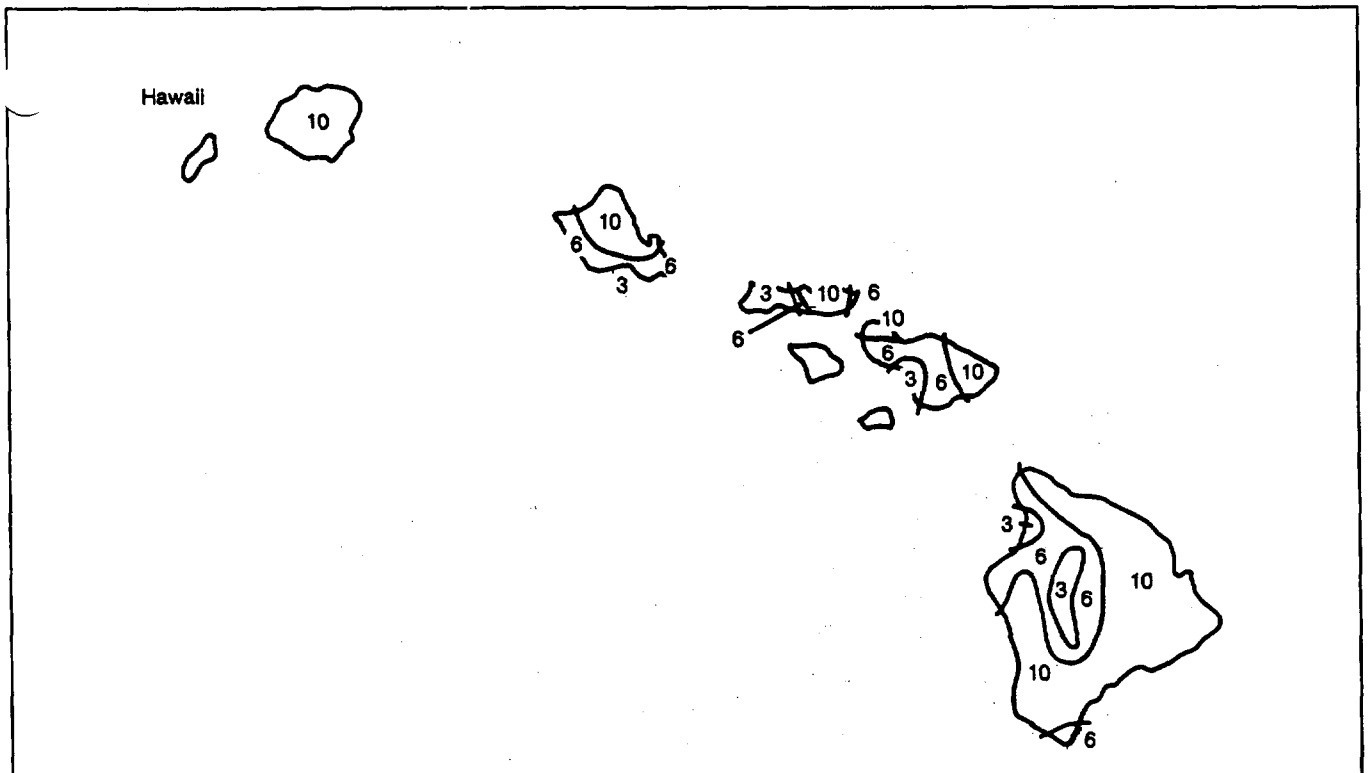

FIGURE 3-2
NET PRECIPITATION FACTOR VALUES—Continued

Select the latitude adjusting value for each month from Table 3-3. For latitudes lower than 50° North or 20° South, determine the monthly latitude adjusting value by interpolation.

TABLE 3-3.—MONTHLY LATITUDE ADJUSTING VALUES[a]

Latitude[b] (degrees)	Month											
	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
≥50 N	0.74	0.78	1.02	1.15	1.33	1.36	1.37	1.25	1.06	0.92	0.76	0.70
45 N	0.80	0.81	1.02	1.13	1.28	1.29	1.31	1.21	1.04	0.94	0.79	0.75
40 N	0.84	0.83	1.03	1.11	1.24	1.25	1.27	1.18	1.04	0.96	0.83	0.81
35 N	0.87	0.85	1.03	1.09	1.21	1.21	1.23	1.16	1.03	0.97	0.89	0.85
30 N	0.90	0.87	1.03	1.08	1.18	1.17	1.20	1.14	1.03	0.98	0.89	0.88
20 N	0.95	0.90	1.03	1.05	1.13	1.11	1.14	1.11	1.02	1.00	0.93	0.94
10 N	1.00	0.91	1.03	1.03	1.08	1.06	1.08	1.07	1.02	1.02	0.98	0.99
0	1.04	0.94	1.04	1.01	1.04	1.01	1.04	1.04	1.01	1.04	1.01	1.04
10 S	1.08	0.97	1.05	0.99	1.00	0.96	1.00	1.02	1.00	1.06	1.05	1.09
20 S	1.14	0.99	1.05	0.97	0.96	0.91	0.95	0.99	1.00	1.08	1.09	1.15

[a]Do not round to nearest integer.

[b]For unlisted latitudes lower than 50° North or 20° South, determine the latitude adjusting value by interpolation.

- Calculate monthly net precipitation by subtracting monthly evapotranspiration (or monthly potential evapotranspiration) from monthly precipitation. If evapotranspiration (or potential evapotranspiration) exceeds precipitation for a month, assign that month a net precipitation value of 0.
- Calculate the annual net precipitation by summing the monthly net precipitation values.
- Based on the annual net precipitation, assign a net precipitation factor value from Table 3-4.

Enter the value assigned from Figure 3-2 or from Table 3-4, as appropriate, in Table 3-1.

TABLE 3-4.—NET PRECIPITATION FACTOR VALUES

Net precipitation (inches)	Assigned value
0	0
Greater than 0 to 5	1
Greater than 5 to 15	3
Greater than 15 to 30	6
Greater than 30	10

3.1.2.3 *Depth to aquifer.* Evaluate depth to aquifer by determining the depth from the lowest known point of hazardous substances at a site to the top of the aquifer being evaluated, considering all layers in that interval. Measure the depth to an aquifer as the distance from the surface to the top of the aquifer minus the distance from the surface to the lowest known point of hazardous substances eligible to be evaluated for that aquifer. In evaluating depth to aquifer in karst terrain, assign a thickness of 0 feet to a karst aquifer that underlies any portion of the sources at the site. Based on the calculated depth, assign a value from Table 3-5 to the depth to aquifer factor.

Determine the depth to aquifer only at locations within 2 miles of the sources at the site, except: if observed ground water contamination attributable to sources at the site extends more than 2 miles beyond these sources, use any location within the limits of this observed ground water contamination when evaluating the depth to aquifer factor for any aquifer that does

TABLE 3-5.—DEPTH TO AQUIFER FACTOR VALUES

Depth to aquifer[a] (feet)	Assigned value
Less than or equal to 25	5
Greater than 25 to 250	3
Greater than 250	1

[a]Use depth of all layers between the hazardous substances and aquifer. Assign a thickness of 0 feet to any karst aquifer that underlies any portion of the sources at the site.

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not have an observed release. If the necessary geologic information is available at multiple locations, calculate the depth to aquifer at each location. Use the location having the smallest depth to assign the factor value. Enter this value in Table 3-1.

3.1.2.4 *Travel time.* Evaluate the travel time factor based on the geologic materials in the interval between the lowest known point of hazardous substances at the site and the top of the aquifer being evaluated. Assign a value to the travel time factor as follows:

- If the depth to aquifer (see section 3.1.2.3) is 10 feet or less, assign a value of 35.
- If, for the interval being evaluated, all layers that underlie a portion of the sources at the site are karst, assign a value of 35.
- Otherwise:
  - — Select the lowest hydraulic conductivity layer(s) from within the above interval. Consider only layers at least 3 feet thick. However, do not consider layers or portions of layers within the first 10 feet of the depth to the aquifer.
  - — Determine hydraulic conductivities for individual layers from Table 3-6 or from in-situ or laboratory tests. Use representative, measured, hydraulic conductivity values whenever available.
  - — If more than one layer has the same lowest hydraulic conductivity, include all such layers and sum their thicknesses. Assign a thickness of 0 feet to a karst layer that underlies any portion of the sources at the site.
  - — Assign a value from Table 3-7 to the travel time factor, based on the thickness and hydraulic conductivity of the lowest hydraulic conductivity layer(s).

TABLE 3-6.—HYDRAULIC CONDUCTIVITY OF GEOLOGIC MATERIALS

Type of material	Assigned hydraulic conductivity[a] (cm/sec)
Clay; low permeability till (compact unfractured till); shale; unfractured metamorphic and igneous rocks	10^{-8}
Silt; loesses; silty clays; sediments that are predominantly silts; moderately permeable till (fine-grained, unconsolidated till, or compact till with some fractures); low permeability limestones and dolomites (no karst); low permeability sandstone; low permeability fractured igneous and metamorphic rocks	10^{-6}
Sands; sandy silts; sediments that are predominantly sand; highly permeable till (coarse-grained, unconsolidated or compact and highly fractured); peat; moderately permeable limestones and dolomites (no karst); moderately permeable sandstone; moderately permeable fractured igneous and metamorphic rocks	10^{-4}
Gravel; clean sand; highly permeable fractured igneous and metamorphic rocks; permeable basalt; karst limestones and dolomites	10^{-2}

[a]Do not round to nearest integer.

TABLE 3-7.—TRAVEL TIME FACTOR VALUES[a]

Hydraulic conductivity (cm/sec)	Thickness of lowest hydraulic conductivity layer(s)[b] (feet)			
	Greater than 3 to 5	Greater than 5 to 100	Greater than 100 to 500	Greater than 500
Greater than or equal to 10^{-3}	35	35	35	25
Less than 10^{-3} to 10^{-5}	35	25	15	15
Less than 10^{-5} to 10^{-7}	15	15	5	5
Less than 10^{-7}	5	5	1	1

[a]If depth to aquifer is 10 feet or less or if, for the interval being evaluated, all layers that underlie a portion of the sources at the site are karst, assign a value of 35.

[b]Consider only layers at least 3 feet thick. Do not consider layers or portions of layers within the first 10 feet of the depth to the aquifer.

Determine travel time only at locations within 2 miles of the sources at the site, except: if observed ground water contamination attributable to sources at the site extends more than 2 miles beyond these sources, use any location within the limits of this observed ground water contamination when evaluating the travel time factor for any aquifer that does not have an observed release. If the necessary subsurface geologic information is available at multiple locations, evaluate the travel time factor at each location. Use the location having the highest travel time factor value to assign the factor value for the aquifer. Enter this value in Table 3-1.

3.1.2.5 *Calculation of potential to release factor value.* Sum the factor values for net precipitation, depth to aquifer, and travel time, and

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Select the latitude adjusting value for each month from Table 3-3. For latitudes lower than 50° North or 20° South, determine the monthly latitude adjusting value by interpolation.

TABLE 3-3.—MONTHLY LATITUDE ADJUSTING VALUES[a]

Latitude[b] (degrees)	Month											
	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
≥50 N	0.74	0.78	1.02	1.15	1.33	1.36	1.37	1.25	1.06	0.92	0.76	0.70
45 N	0.80	0.81	1.02	1.13	1.28	1.29	1.31	1.21	1.04	0.94	0.79	0.75
40 N	0.84	0.83	1.03	1.11	1.24	1.25	1.27	1.18	1.04	0.96	0.83	0.81
35 N	0.87	0.85	1.03	1.09	1.21	1.21	1.23	1.16	1.03	0.97	0.89	0.85
30 N	0.90	0.87	1.03	1.08	1.18	1.17	1.20	1.14	1.03	0.98	0.89	0.88
20 N	0.95	0.90	1.03	1.05	1.13	1.11	1.14	1.11	1.02	1.00	0.93	0.94
10 N	1.00	0.91	1.03	1.03	1.08	1.06	1.08	1.07	1.02	1.02	0.98	0.99
0	1.04	0.94	1.04	1.01	1.04	1.01	1.04	1.04	1.01	1.04	1.01	1.04
10 S	1.08	0.97	1.05	0.99	1.00	0.96	1.00	1.02	1.00	1.06	1.05	1.09
20 S	1.14	0.99	1.05	0.97	0.96	0.91	0.95	0.99	1.00	1.08	1.09	1.15

[a]Do not round to nearest integer.

[b]For unlisted latitudes lower than 50° North or 20° South, determine the latitude adjusting value by interpolation.

- Calculate monthly net precipitation by subtracting monthly evapotranspiration (or monthly potential evapotranspiration) from monthly precipitation. If evapotranspiration (or potential evapotranspiration) exceeds precipitation for a month, assign that month a net precipitation value of 0.
- Calculate the annual net precipitation by summing the monthly net precipitation values.
- Based on the annual net precipitation, assign a net precipitation factor value from Table 3-4.

Enter the value assigned from Figure 3-2 or from Table 3-4, as appropriate, in Table 3-1.

TABLE 3-4.—NET PRECIPITATION FACTOR VALUES

Net precipitation (inches)	Assigned value
0	0
Greater than 0 to 5	1
Greater than 5 to 15	3
Greater than 15 to 30	6
Greater than 30	10

3.1.2.3 *Depth to aquifer.* Evaluate depth to aquifer by determining the depth from the lowest known point of hazardous substances at a site to the top of the aquifer being evaluated, considering all layers in that interval. Measure the depth to an aquifer as the distance from the surface to the top of the aquifer minus the distance from the surface to the lowest known point of hazardous substances eligible to be evaluated for that aquifer. In evaluating depth to aquifer in karst terrain, assign a thickness of 0 feet to a karst aquifer that underlies any portion of the sources at the site. Based on the calculated depth, assign a value from Table 3-5 to the depth to aquifer factor.

Determine the depth to aquifer only at locations within 2 miles of the sources at the site, except: if observed ground water contamination attributable to sources at the site extends more than 2 miles beyond these sources, use any location within the limits of this observed ground water contamination when evaluating the depth to aquifer factor for any aquifer that does

TABLE 3-5.—DEPTH TO AQUIFER FACTOR VALUES

Depth to aquifer[a] (feet)	Assigned value
Less than or equal to 25	5
Greater than 25 to 250	3
Greater than 250	1

[a]Use depth of all layers between the hazardous substances and aquifer. Assign a thickness of 0 feet to any karst aquifer that underlies any portion of the sources at the site.

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not have an observed release. If the necessary geologic information is available at multiple locations, calculate the depth to aquifer at each location. Use the location having the smallest depth to assign the factor value. Enter this value in Table 3-1.

3.1.2.4 *Travel time.* Evaluate the travel time factor based on the geologic materials in the interval between the lowest known point of hazardous substances at the site and the top of the aquifer being evaluated. Assign a value to the travel time factor as follows:

- If the depth to aquifer (see section 3.1.2.3) is 10 feet or less, assign a value of 35.
- If, for the interval being evaluated, all layers that underlie a portion of the sources at the site are karst, assign a value of 35.
- Otherwise:
  - — Select the lowest hydraulic conductivity layer(s) from within the above interval. Consider only layers at least 3 feet thick. However, do not consider layers or portions of layers within the first 10 feet of the depth to the aquifer.
  - — Determine hydraulic conductivities for individual layers from Table 3-6 or from in-situ or laboratory tests. Use representative, measured, hydraulic conductivity values whenever available.
  - — If more than one layer has the same lowest hydraulic conductivity, include all such layers and sum their thicknesses. Assign a thickness of 0 feet to a karst layer that underlies any portion of the sources at the site.
  - — Assign a value from Table 3-7 to the travel time factor, based on the thickness and hydraulic conductivity of the lowest hydraulic conductivity layer(s).

TABLE 3-6.—HYDRAULIC CONDUCTIVITY OF GEOLOGIC MATERIALS

Type of material	Assigned hydraulic conductivity[a] (cm/sec)
Clay; low permeability till (compact unfractured till); shale; unfractured metamorphic and igneous rocks	10^{-6}
Silt; loesses; silty clays; sediments that are predominantly silts; moderately permeable till (fine-grained, unconsolidated till, or compact till with some fractures); low permeability limestones and dolomites (no karst); low permeability sandstone; low permeability fractured igneous and metamorphic rocks	10^{-5}
Sands; sandy silts; sediments that are predominantly sand; highly permeable till (coarse-grained, unconsolidated or compact and highly fractured); peat; moderately permeable limestones and dolomites (no karst); moderately permeable sandstone; moderately permeable fractured igneous and metamorphic rocks	10^{-4}
Gravel; clean sand; highly permeable fractured igneous and metamorphic rocks; permeable basalt; karst limestones and dolomites	10^{-2}

[a]Do not round to nearest integer.

TABLE 3-7.—TRAVEL TIME FACTOR VALUES[a]

Hydraulic conductivity (cm/sec)	Thickness of lowest hydraulic conductivity layer(s)[b] (feet)			
	Greater than 3 to 5	Greater than 5 to 100	Greater than 100 to 500	Greater than 500
Greater than or equal to 10^{-3}	35	35	35	25
Less than 10^{-3} to 10^{-5}	35	25	15	15
Less than 10^{-5} to 10^{-7}	15	15	5	5
Less than 10^{-7}	5	5	1	1

[a]If depth to aquifer is 10 feet or less or if, for the interval being evaluated, all layers that underlie a portion of the sources at the site are karst, assign a value of 35.

[b]Consider only layers at least 3 feet thick. Do not consider layers or portions of layers within the first 10 feet of the depth to the aquifer.

Determine travel time only at locations within 2 miles of the sources at the site, except: if observed ground water contamination attributable to sources at the site extends more than 2 miles beyond these sources, use any location within the limits of this observed ground water contamination when evaluating the travel time factor for any aquifer that does not have an observed release. If the necessary subsurface geologic information is available at multiple locations, evaluate the travel time factor at each location. Use the location having the highest travel time factor value to assign the factor value for the aquifer. Enter this value in Table 3-1.

3.1.2.5 *Calculation of potential to release factor value.* Sum the factor values for net precipitation, depth to aquifer, and travel time, and

Exhibit 37

CERCLA Regulations and Keyword Index

1993 EDITION

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Determine the ground water migration pathway score (S_{gw}) in terms of the factor category values as follows:

$$S_{gw} = \frac{(LR)\,(WC)\,(T)}{SF}$$

where:

LR = Likelihood of release factor category value.

WC = Waste characteristics factor category value.

T = Targets factor category value.

SF = Scaling factor.

Table 3-1 outlines the specific calculation procedure.

TABLE 3-1.—GROUND WATER MIGRATION PATHWAY SCORESHEET

Factor categories and factors	Maximum value	Value assigned	
Likelihood of Release to an Aquifer:			
1. Observed Release	550	___	
2. Potential to Release:			
2a. Containment	10	___	
2b. Net Precipitation	10	___	
2c. Depth to Aquifer	5	___	
2d. Travel Time	35	___	
2e. Potential to Release [lines 2a(2b+2c+2d)]	500	___	
3. Likelihood of Release (higher of lines 1 and 2e)	550		___
Waste Characteristics:			
4. Toxicity/Mobility	(a)	___	
5. Hazardous Waste Quantity	(a)	___	
6. Waste Characteristics	100		___
Targets:			
7. Nearest Well	50	___	
8. Population:			
8a. Level I Concentrations	(b)	___	
8b. Level II Concentrations	(b)	___	
8c. Potential Contamination	(b)	___	
8d. Population (lines 8a+8b+8c)	(b)	___	
9. Resources	5	___	
10. Wellhead Protection Area	20	___	
11. Targets (lines 7+8d+9+10)	(b)		___
Ground Water Migration Score for an Aquifer:			
12. Aquifer Score [(lines 3 x 6 x 11)/82,500][c]	100		___
Ground Water Migration Pathway Score:			
13. Pathway Score (S_{gw}), (highest value from line 12 for all aquifers evaluated)[c]	100		___

[a]Maximum value applies to waste characteristics category.

[b]Maximum value not applicable.

[c]Do not round to nearest integer.

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Exhibit 38

Volume I
Large Production and Priority Pollutants

Handbook of Environmental FATE and EXPOSURE DATA

For Organic Chemicals

Philip H. Howard

LEWIS PUBLISHERS

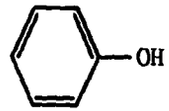
RECEIVED
1996-0160
NEWFIELDS

Phenol

SUBSTANCE IDENTIFICATION

Synonyms: Hydroxybenzene

Structure:



CAS Registry Number: 108-95-2

Molecular Formula: C_6H_6O

Wiswesser Line Notation: QR

CHEMICAL AND PHYSICAL PROPERTIES

Boiling Point: 181.75 °C at 760 mm Hg

Melting Point: 43 °C

Molecular Weight: 94.11

Dissociation Constants: pKa = 9.994 [51]

Log Octanol/Water Partition Coefficient: 1.46 [24]

Water Solubility: 87,000 mg/L at 25 °C [50]

Vapor Pressure: 0.524 mm Hg at 25 °C [10]

Henry's Law Constant: 3.97 x 10^{-7} atm-m^3/mole [28]

ENVIRONMENTAL FATE/EXPOSURE POTENTIAL

Summary: Phenol is a common and important industrial chemical and enters the environment in wastewater and spills connected with its use in resins, plastics, adhesives, or other uses. It is frequently

found in wastewater from other commercial processes. If it is released to the environment, its primary removal mechanism is biodegradation which is generally rapid (days). Since phenol is a benchmark chemical for biodegradability studies, there is a large body of information on its degradation which concludes that phenol rapidly degrades in sewage, soil, freshwater, and sea water. Acclimation of resident populations of microorganisms is rapid. Under anaerobic conditions, degradation is slower and microbial adaptation periods longer. If phenol is released to soil, it will biodegrade in the soil and this degradation will be rapid (2-5 days) and will also occur in subsurface soils. Despite its high solubility and poor adsorption on soil, biodegradation is sufficiently rapid that most ground water is generally free of this pollutant. The exception would be in the cases of spills where high concentrations of phenol destroy degrading microbial populations. One would expect some of the phenol spilled on land to evaporate into the atmosphere. It will not be expected to significantly hydrolyze in water or soil under normal environmental conditions. If phenol is released to water, the primary removal process of it will be biodegradation, which will generally take on the order of hours to days in freshwater systems and up to a few weeks in estuarine waters. Direct photolysis should occur, but appears to be of minor importance compared with biodegradation under most circumstances. Phenols react relatively rapidly in sunlit natural water via reaction with photochemically produced hydroxyl and peroxyl radicals; typical half-lives for hydroxyl and peroxyl radical reactions are on the order of 100 and 19.2 hr of sunlight, respectively. Phenol will not be expected to significantly evaporate, hydrolyze, adsorb to sediment, or bioconcentrate in aquatic organisms. Based on the pKa, phenol will exist in a partially dissociated state in water and moist soils and, therefore, its transport and reactivity may be affected by pH. If phenol is released to the atmosphere, it will exist predominantly in the vapor phase. Phenol absorbs light in the region 290-330 nm and therefore might directly photodegrade. Phenol's estimated half-life by reaction with hydroxyl radicals in air is 0.61 days. Reaction of phenol with nitrate radicals during nighttime may be a significant removal process based on a rate constant of 3.8 x 10^{-12} cm^3/molecule-sec, which corresponds to a half-life of 15 minutes at an atmospheric concentration of 2 x 10^{+8} nitrate radicals per cm^3. It may be subject to removal in rain based on its detection in

rainwater. General exposure will occur through the use of disinfectants and cleaners containing phenol.

Natural Sources: Animal wastes; decomposition of organic wastes [62].

Artificial Sources: Wastewater from its manufacturers [62]; resins, plastics, fibers, adhesives, iron and steel, aluminum, leather, and rubber industries [62]; spills connected with its transport and use [8]. Phenol is also found in cigarette smoke and auto exhaust as well as disinfectants and medicinal products [22].

Terrestrial Fate: If phenol is released to soil, it will biodegrade in the soil and this degradation will be rapid (2-5 days) and will also occur in subsurface soils [3,16]. Degradation will be much slower under anaerobic conditions than under aerobic conditions [3]. Despite its high solubility and poor adsorption on soil, biodegradation is sufficiently rapid that most ground water is generally free of this pollutant [13]. The exception would be in the cases of spills where high concentrations of phenol destroy degrading microbial populations [13,16]. One would expect some of the phenol spilled on land to evaporate into the atmosphere. It will not be expected to significantly hydrolyze under normal environmental conditions.

Aquatic Fate: If phenol is released to water, the primary removal process will be biodegradation which will generally be rapid. Data suggest that degradation will take on the order of hours to days in freshwater systems and up to a few weeks in estuarine waters. Degradation rates are slower under anaerobic conditions [26]. Acclimation of resident microorganisms is rapid in aerobic waters and may take a few weeks under anaerobic conditions [26]. Evaporation is not a significant removal process for phenol. Direct photolysis should occur, but appears to be of minor importance compared with biodegradation under most circumstances. Phenols react relatively rapidly in sunlit natural water via reaction with photochemically produced hydroxyl radicals and peroxy radicals [39]; typical half-lives for hydroxyl and peroxyl radical reactions are on the order of 100 and 19.2 hr of sunlight, respectively [39]. In water, phenol will not be expected to significantly hydrolyze, adsorb to sediment or bioconcentrate in aquatic organisms. Based

on the pKa, phenol will exist in a partially dissociated state in water and moist soils and, therefore, its transport and reactivity may be affected by pH.

Atmospheric Fate: If phenol is released to the atmosphere, it will exist predominantly in the vapor phase [17]. Phenol absorbs light in the region 290-330 nm [45] and therefore might directly photodegrade. Phenol's estimated half-life by reaction with hydroxyl radicals in air is 0.61 days [27]. Reaction of phenol with nitrate radicals during nighttime may be a significant removal process based on a rate constant of 3.8×10^{-12} cm^3/molecule-sec [2], which corresponds to a half-life of 15 minutes at an atmospheric concentration of $2 \times 10^{+8}$ nitrate radicals per cm^3. It may be subject to removal in rain based on its detection in rainwater [35].

Biodegradation: Removal in aerobic activated sludge reactors is frequently better than 90% with retention of 8 hours [56]. Partial inhibition has been noted at concentrations as low as 50 ppm in aerobic reactors using industrial wastewater seed and activated sludge seed [12]. Utilization is also very high in anaerobic reactors although acclimation periods are longer and degradation slower (about 2 weeks) [4,26]. 95% degradation in 1 to 2 days using cultures obtained from garden soil, compost, river mud, and/or sediment from a petroleum refinery waste lagoon; the microorganisms present were common to each of the cultures utilized [59]. Complete degradation in <1 day in water from 3 lakes; rates increase with increase concn phenol and increase trophic levels of water; rate affected by concn of organic and inorganic nutrients [44]. Complete removal in river water after 2 days at 20 °C and after 4 days at 4 °C [36]. Degradation is somewhat slower in salt water and a half-life of 9 days has been reported in an estuarine river [34]. Degradation in soil is completed in 2-5 days even in subsurface soils [3]. Percent mineralization in an alkaline, para-brown soil under aerobic conditions was 45.5%, 48%, and 65% after 3, 7, and 70 days, respectively [23]. Half-lives for degradation of low concn of phenol in 2 silt loam soils were 2.70 and 3.51 hr [46].

Abiotic Degradation: Phenol absorbs light in the region 290-330 nm [45] and therefore might directly photodegrade. Natural sunlight

causes degradation in water [7]. Phenol's estimated half-life by reaction with hydroxyl radicals in air is 0.61 days [27]. It has also been shown to inhibit oxidant formation both in air [20] and in water [14]. It degrades on sand, possibly by a surface catalyzed reaction [3]. The estimated half-life for reaction of phenol with photochemically produced singlet oxygen in surface waters contaminated by humic substances is 83 days (assuming Switzerland summer sunlight and singlet oxygen concn 4 x 10^{-14} M) [49]. As a class, phenols react relatively rapidly in sunlit natural water via reaction with photochemically produced hydroxyl radicals and peroxy radicals [38]; typical half-lives for hydroxyl and peroxyl radical reactions are on the order of 100 and 19.2 hr of sunlight, respectively [38]. Reaction of phenol with nitrate radicals during nighttime may be a significant removal process based on a rate constant of 3.8 x 10^{-12} cm^3/molecule-sec, which corresponds to a half-life of 15 minutes at an atmospheric concentration of 2 x 10^{+8} nitrate radicals per cm^3 [2]. Based on the pKa, phenol will exist in a partially dissociated state in water and moist soils and, therefore, its transport and reactivity may be affected by pH.

Bioconcentration: BCF: Goldfish, (Carassius auratus), 1.9 [32]; water flea (Daphnia magna), 277 [11]; gold orfe, 20; algae (Chlorella fusca), 200 [19]; freshwater phytoplankter (Scenedesmus quadricauda), 3.5 [25]. Using the log Kow, an estimated BCF of 7.6 was calculated [37]. Based on the reported and estimated BCF's, phenol will not be expected to significantly bioconcentrate in aquatic organisms.

Soil Adsorption/Mobility: Low adsorptivity to clay soils and silt loam is reported [1]. Koc values for two silt loams are 39 and 91 [47]. No adsorption to aquifer material was observed [16]. Using the log Kow, an estimated Koc of 148 was calculated [37]. Based on the reported and estimated Koc, phenol will be expected to exhibit high to very high mobility in soil [58], and therefore may leach to ground water.

Volatilization from Water/Soil: Despite its moderate vapor pressure, phenol has a low Henry's Law constant and a low rate of evaporation from water [5,54]. The estimated half-life for evaporation from water is 3.2 months [5]. Using the Henry's Law constant, a half-life of 88 days was calculated for evaporation from

a model river 1 m deep with a current of 3 m/sec and with a wind velocity of 3 m/sec [37]. Volatilization from near-surface soil should be relatively rapid due to its moderate vapor pressure.

Water Concentrations: DRINKING WATER: Not detected in finished drinking water in United States [61]. U.S. avg drinking water, 1 ppb [40]. Great Britain, March-Dec 1976, drinking water, from ground water sources, 4 sites, 50% pos, from surface water, 30% pos [18]. GROUND WATER: Maximum of 1130 ppm in 9 wells in Wisconsin after a spill [13]. 6.5-10,000 ppb in 2 aquifers 15 months after completion of coal gasification project [57]. SURFACE WATER: 0-5 ppb, industrial rivers in United States [52,53]. 3-24 ppb in Lake Huron [33]. Detected, not quantified, in 2 of 110 raw water supplies in 1977, U.S. EPA National Organics Monitoring Survey [61]. USEPA STORET database, 1754 data points, 13.0% pos, 5.0 ppb median concn [55]. RAIN/SNOW: 7 rain events in Portland, OR, Feb-Apr 1984, concn (ppt), in rain, 1200 to >75, avg >280; gas-phase concn (ng/m^3), 220-410, avg 320 [35].

Effluent Concentrations: 0.01-0.30 ppm, chemical specialties manufacturing (mfg) plant [31]; 7.0 ppm, 24-hr composite sample, plant on Delaware River [52]. Industries with mean concentrations >0.1 ppm in treated wastewater (max/avg concn, ppm): iron and steel mfg, 53 ppm max/5.7 ppm avg; leather tanning and finishing, 1.4/0.63; aluminum forming, 9.7/1.3; electrical/electronic components, 3.5/<0.74; foundries, 34/2.2; pharmaceuticals, 4.6/0.75; organics/plastics mfg, not reported/0.110; paint and ink formulation, 1.2/0.14; and rubber processing, 12/3.0 [62]. USEPA STORET database, 2068 data points, 42.1% pos, 10.0 ppb median concn [55]. U.S. Nationwide Urban Runoff Program, as of July 1982, 15 cities, 13.3% pos 86 samples, 4% pos, 3-10 ppb [9]. Ground water at 178 CERCLA hazardous waste sites, 13.6% pos [43].

Sediment/Soil Concentrations: SEDIMENT: Lake Huron, 13 ppm [33]. Not detected in unspecified industrial river in United States [31]. USEPA STORET database, 318 data points, 9% pos, <1000 ppb median concn (dry wt) [55]. Sediment collected 6 km NW of the Los Angeles county wastewater treatment plant discharge zone at Palos Verdes, CA, 10 ppb dry wt [21].

Atmospheric Concentrations: Urban/suburban areas in United States (7 samples), 30 ppt avg [6]. 2 urban areas, 0.05-0.35 ug/m³, <20-289 ug/m³ (with 50% of all observations <30 ug/m³ [48]. Source dominated areas in United States (83 samples), 27,000 ppt avg [6]. Niagara River, Sept 1982, identified, not quantified [30].

Food Survey Values: 7 ppm - smoked summer sausage; 28.6 ppm - smoked pork belly; component of medicinal preparations such as throat lozenges [61]. Identified, not quantified, in: Mountain cheese [15]; fried bacon [29]; fried chicken [60].

Plant Concentrations:

Fish/Seafood Concentrations: Bottomfish, Commencement Bay, Tacoma, WA, June-Dec 1981, 5 sites, highest avg concn, 0.14 ppm, max concn, 0.22 ppm [40].

Animal Concentrations: Natural component of animal matter; rabbit (muscle) 0-1.6 ppm [61].

Milk Concentrations:

Other Environmental Concentrations:

Probable Routes of Human Exposure: Human exposure will be primarily from exposure to waste products and effluents associated with its manufacture and use in resins, plastics, fibers, adhesives, etc., and occurrence in other industries, especially iron and steel, aluminum, foundries, and rubber processing. It is also a normal constituent of animal wastes and the decomposition of organic matter. People will also be exposed to phenol through the use of disinfectants and the ingestion of medicinal products such as throat lozenges. Phenol is also found in cigarette smoke and auto exhaust but there are no data to ascertain the significance of exposure through inhalation of air contaminated by these or other sources [22].

Average Daily Intake: WATER INTAKE: Insufficient data; AIR INTAKE: (assume typical concn 30 ppt [6]) 2.7 ug ; FOOD INTAKE: Insufficient data.

Occupational Exposures: NIOSH (NOES Survey 1981-1983) has statistically estimated that 192,739 workers are exposed to phenol in the United States [42]. Inhalation is largely restricted to occupational environments (e.g., 12.5 mg/m³ in Bakelite factories) [61]. The number of workers exposed in commercial production, formulation of product, or distribution of concentrated products has been estimated by NIOSH to be 10,000 [41].

Body Burdens:

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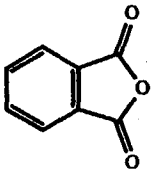
Phthalic Anhydride

SUBSTANCE IDENTIFICATION

Synonyms: 1,2-Benzenedicarboxylic acid anhydride

Structure:



CAS Registry Number: 85-44-9

Molecular Formula: $C_8H_4O_3$

Wiswesser Line Notation: T56 BVOVJ

CHEMICAL AND PHYSICAL PROPERTIES

Boiling Point: 295 °C

Melting Point: 130.8 °C

Molecular Weight: 148.11

Dissociation Constants:

Log Octanol/Water Partition Coefficient: Hydrolyzes rapidly in water [27]

Water Solubility: 6200 ppm at 25 °C [27]

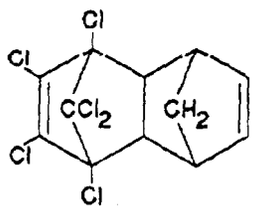
Vapor Pressure: 2 x 10^{-4} mm Hg at 20 °C [28]

Henry's Law Constant: 6.2 x 10^{-9} atm-m^3/mol (calculated) [16]

Exhibit 39

ALDRIN

Synonyms: Aldrec; Aldrex; Aldrex 30; Aldrite; Aldrosol; Altox; Compound 118; Drinox; ENT 15949; Hexachlorohexahydro-*endo,exo*-dimethanonaphthalene; **1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-dimethanonaphthalene;** 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-*endo,exo*-5,8-dimethanonaphthalene; 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-*exo*-1,4-*endo*-5,8-dimethanonaphthalene; 1,4,4a,5,8,8a-Hexahydro-1,4-*endo,exo*-5,8-dimethanonaphthalene; HHDN; NA 2761; NA 2762; NCI-C00044; Octalene; RCRA waste number P004; Seedrin; Seedrin liquid.



CAS Registry No.: 309-00-2
DOT: 2761 (additional numbers may exist and may be provided by the supplier)
DOT label: Poison
Molecular formula: $C_{12}H_8Cl_6$
Formula weight: 364.92
RTECS: IO2100000

Physical state, color and odor
White, odorless crystals when pure; technical grades are tan to dark brown with a mild chemical odor.

Melting point (°C):
104 (Weast, 1986)
107 (Sims et al., 1988)

Boiling point (°C):
145 at 2 mmHg (Hayes, 1982)

Density (g/cm^3):
1.70 at 20/4 °C (Hayes, 1982)

Diffusivity in water (10^5 cm^2/sec):
0.45 at 20 °C using method of Hayduk and Laudie (1974).

Flash point (°C):
Not applicable (NIOSH, 1994)

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Lower explosive limit (%):
Not applicable (NIOSH, 1994)

Upper explosive limit (%):
Not applicable (NIOSH, 1994)

Henry's law constant (10^6 atm·m^3/mol):
1.4 (Eisenreich et al., 1981)
496 at 25 °C (Warner et al., 1987)

Bioconcentration factor, log BCF:
4.09 (algae, Geyer et al., 1984)
4.26 (activated sludge), 3.44 (golden ide) (Freitag et al., 1985)
3.50 (freshwater fish), 3.50 (fish, microcosm) (Garten and Trabalka, 1983)

Soil sorption coefficient, log K_{oc}:
2.61 (Kenaga, 1980)
4.69 (Batcombe silt loam, Briggs, 1981)

Octanol/water partition coefficient, log K_{ow}:
5.52 (Travis and Arms, 1988)
6.496 (de Bruijn et al., 1989)
7.4 (Briggs, 1981)

Solubility in organics:
50 g/L in alcohol at 25 °C (Meites, 1963)

Solubility in water (μg/L):
27 at 25-29 °C (Park and Bruce, 1968)
17 at 25 °C (Weil et al., 1974)
105 at 15 °C, 180 at 25 °C, 350 at 35 °C, 600 at 45 °C (particle size ≤5 μ, Biggar and Riggs, 1974)

Vapor pressure (10^5 mmHg):
7.5 at 20 °C (Windholz et al., 1983)
2.31 at 20 °C (Martin, 1972)
15.2, 17.3 at 25 °C (Hinckley et al., 1990)
24.9 at 25 °C (Bidleman, 1984)

Environmental Fate

Biological. Dieldrin is the major metabolite from the microbial degradation of aldrin by oxidation or epoxidation. Dieldrin may further degrade to photodieldrin (Kearney and Kaufman, 1976). A pure culture of the marine alga, namely *Duna-*

liella sp. degraded aldrin to dieldrin and the diol 23.2 and 5.2%, respectively (Patil et al., 1972). In four successive 7-day incubation periods, aldrin (5 and 10 mg/L) was recalcitrant to degradation in a settled domestic wastewater inoculum (Tabak et al., 1981). Incubation with a mixed anaerobic population resulted in a degradation yield of 87% in 4 days. Two dechlorinated products were reported (Maule et al., 1987).

Soil. Aldrin was found to be very persistent in an agricultural soil. Fifteen years after application at a rate of 20 lb/acre, 5.8% of the applied amount was recovered as dieldrin and 0.2% was recovered as photodieldrin (Lichtenstein et al., 1971). Patil and Matsumura (1970) reported 13 of 20 soil microorganisms were able to degrade aldrin to dieldrin under laboratory conditions.

Plant. Photoaldrin and photodieldrin formed when aldrin was codeposited on bean leaves and exposed to sunlight (Ivie and Casida, 1971a). Dieldrin and 1,2,3,4,7,8-hexachloro-1,4,4a,6,7,7a-hexahydro-1,4-*endo*-methyleneindene-5,7-dicarboxylic acid were identified in aldrin-treated soil on which potatoes were grown (Flein et al., 1973).

Surface Water. Under oceanic conditions, aldrin may undergo dihydroxylation at the chlorine free double bond to produce aldrin diol (Verschueren, 1983). In a river die-away test using raw water from the Little Miami River in Ohio, 26, 60 and 80% of aldrin present degraded after 2, 4 and 6 weeks, respectively (Eichelberger and Lichtenberg, 1971).

Photolytic. Photolysis of 0.33 ppb aldrin in San Francisco Bay water by sunlight produced photodieldrin with a reported photolysis half-life of 1.1 days (Singmaster, 1975). Aldrin on silica gel plates in the presence of photosensitizers and exposed to sunlight produced photoaldrin (Ivie and Casida, 1971). Photoaldrin also formed when a benzene solution containing aldrin and benzophenone as a sensitizer was exposed to UV light (λ = 268-356 nm) (Rosen and Carey, 1968). Photodegradation of aldrin by sunlight yielded the following products after 1 month: dieldrin, photodieldrin, photoaldrin and a polymeric substance (Rosen and Sutherland, 1967). Photolysis of solid aldrin using a high pressure mercury lamp with a pyrex filter (λ >300 nm) yielded a polymeric substance with small amounts of photoaldrin, dieldrin, hydrochloric acid and carbon dioxide (Gäb et al., 1974).

Sunlight and UV light can convert aldrin to photoaldrin (Georgacakis and Khan, 1971). When an aqueous solution containing aldrin was photooxidized by UV light at 90-95 °C, 25, 50 and 75% degraded to carbon dioxide after 14.1, 28.2 and 109.7 hours, respectively (Knoevenagel and Himmelreich, 1976). Aldrin in a hydrogen peroxide solution (5 μM) was irradiated by UV light (λ = 290 nm). After 12 hours, the aldrin concentration was reduced 79.5%. Dieldrin, photoaldrin and an unidentified compound were reported as metabolites (Draper and Crosby, 1984). After a short-term exposure to sunlight (<1 hour), aldrin on silica gel chromatoplates was converted to photoaldrin. Photodecomposition was accelerated by several photosensitizing agents (Ivie and Casida, 1971).

When aldrin vapor in a reaction vessel was irradiated by a sunlamp for 45 hours,

14-34% degraded to dieldrin (50-60 μg) and photodieldrin (20-30 μg). However, when the aldrin vapor concentration was reduced to μg and irradiation time extended to 14 days, 60% degraded to dieldrin (0.63 μg), photodieldrin (0.02 μg) and photoaldrin (0.02 μg) (Crosby and Moilanen, 1974). When an aqueous solution of aldrin (0.07 μM) in natural water samples collected from California and Hawaii were irradiated (λ <220 nm) for 36 hours, 25% was photooxidized to dieldrin (Ross and Crosby, 1985). In an aqueous solution containing peracetic acid maintained in the dark, aldrin was transformed to dieldrin (Ross and Crosby, 1975).

Chemical/Physical. In an aqueous solution containing peracetic acid, aldrin was transformed to dieldrin in the dark (Ross and Crosby, 1975). Oxidation of aldrin by oxygen atoms yielded dieldrin (Saravanja-Bozanic et al., 1977). The hydrolysis rate constant for aldrin at pH 7 and 25 °C was determined to be 3.8×10^{-5}/hour, resulting in a half-life of 760 days (Ellington et al., 1988). At higher temperatures, the hydrolysis half-lives decreased significantly. At 68 °C and pH values of 3.03, 6.99 and 10.70, the calculated hydrolysis half-lives were 1.9, 2.9 and 2.5 days, respectively (Ellington et al., 1986).

Exposure Limits (mg/m^3): Potential occupational carcinogen. NIOSH REL: 0.25, IDLH 25; OSHA PEL: TWA 0.25; ACGIH TLV: TWA 0.25.

Symptoms of Exposure: Inhalation may cause nausea, vomiting, asphyxia and tightness of the chest. Symptoms of ingestion may include gastrointestinal pain, vomiting, nausea, stupor, convulsions and weakness (Patnaik, 1992).

Toxicity: Acute oral LD_{50} for male and female rats: 39, 60 mg/kg (Windholz et al., 1983), wild birds 7.2 mg/kg, cats 10 mg/kg, chickens 10 mg/kg, ducks 520 mg/kg, dogs 65 mg/kg, guinea pigs 33 mg/kg, hamsters 100 mg/kg, mice 44 mg/kg, pigeons 56.2 mg/kg, quail 42.1 mg/kg, rabbits 50 mg/kg (RTECS, 1985); LC_{50} (96-hour) for American eel 5 ppb, mummichog 4-8 ppb, striped killifish 17 ppb, Atlantic silverside 13 ppb, striped mullet 100 ppb, bluehead 12 ppb, northern puffer 36 ppb, fathead minnow 28 μg/L, bluegill sunfish 13 μg/L, rainbow trout 17.7 μg/L, coho salmon 45.9 μg/L, chinook 7.5 μg/L, striped bass 10 μg/L, pumpkinseed 20 μg/L and white perch 42 μg/L; LC_{50} (48-hour) for mos-quito fish 36 ppb (Verschueren, 1985); LC_{50} (48-hour) for red killifish 220 μg/L (Yoshioka et al., 1986); LC_{50} (24-hour) for bluegill sunfish 260 ppb (Verschueren, 1983).

Drinking Water Standard: As of May 1994, no MCLGs or MCLs have been proposed (U.S. EPA, 1994).

Uses: Insecticide and fumigant.

Synonyms: A
Propenol; Pro
2-Propen-1-o
UN 1098; Vin

CAS Registry
DOT: 1098
DOT label: Fla
Molecular form
Formula weigh
RTECS: BA50

Physical state,
Colorless liqui
ppm (Amoore

Melting point
-129 (Weast, 1

Boiling point (
97.1 (Weast, 19

Density (g/cm
0.8540 (Weast,
0.8250 (Versch

Diffusivity in
1.10 at 20 °C u

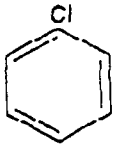
Flash point (°(
23.9, 21.1 (ope

Lower explosi
2.5 (NIOSH, 1

Upper explosi
18.0 (NIOSH,

CHLOROBENZENE

Synonyms: Benzene chloride; Chlorbenzene; Chlorbenzol; Chlorobenzol; MCB; Monochlorbenzene; Monochlorobenzene; NCI-C54886; Phenyl chloride; RCRA waste number U037; UN 1134.



CAS Registry No.: 108-90-7
DOT: 1134
DOT label: Flammable liquid
Molecular formula: C_6H_5Cl
Formula weight: 112.56
RTECS: CZ0175000

Physical state, color and odor
Clear, colorless, watery liquid with a sweet almond odor. Odor threshold in air is 0.21 ppm (Keith and Walters, 1992).

Melting point (°C):
-45.6 (Weast, 1986)

Boiling point (°C):
132 (Weast, 1986)

Density (g/cm^3):
1.1058 at 20/4 °C (Weast, 1986)
1.1009 at 25/4 °C (Kirchnerová and Cave, 1976)

Diffusivity in water (10^5 cm^2/sec):
0.87 at 20 °C using method of Hayduk and Laudie (1974).

Flash point (°C):
27.8 (NIOSH, 1994)

Lower explosive limit (%):
1.3 (NIOSH, 1994)

Upper explosive limit (%):
9.6 (NIOSH, 1994)

Heat of fusion (kcal/mol):
2.28 (Dean, 1987)

Henry's law constant (10^3 atm·m^3/mol):
3.93 at 25 °C (Warner et al., 1987)
3.6 (Pankow and Rosen, 1988)
3.7 (Valsaraj, 1988)
4.45 at 25 °C (Hine and Mookerjee, 1975)
6.21 at 37 °C (Sato and Nakajima, 1979)
2.44, 2.81, 3.41, 3.60 and 4.73 at 10, 15, 20, 25 and 30 °C, respectively (Ashworth et al., 1988)

Interfacial tension with water (dyn/cm at 20 °C):
37.41 (Demond and Lindner, 1993)

Ionization potential (eV):
9.07 (Horvath, 1982)
9.14 (Yoshida et al., 1983)

Bioconcentration factor, log BCF:
3.23 (activated sludge), 1.70 (algae), 1.88 (golden ide) (Freitag et al., 1985)
2.65 (fathead minnow, Veith et al., 1979)

Soil sorption coefficient, log K_{oc}:
1.92 (Woodburn silt loam soil, Chiou et al., 1983)
2.50 (Captina silt loam), 2.17 (McLaurin sandy loam) (Walton et al., 1992)

Octanol/water partition coefficient, log K_{ow}:
2.84 (Fujita et al., 1964; Garst and Wilson, 1984; Mirrlees et al., 1976)
2.81 (Mirrless et al., 1976)
2.98 (Tewari et al., 1982; Wasik et al., 1981, 1983)
2.71 (Schwarzenbach and Westall, 1981)
2.898 (Brooke et al., 1990; de Bruijn et al., 1989)
2.784 (Brooke et al., 1990)
2.83 (Hammers et al., 1982; Yoshida et al., 1983)
2.65 (Campbell and Luthy, 1985)

Solubility in organics:
Soluble in ethanol, benzene, chloroform, ether (U.S. EPA, 1985) and many other organic solvents.

Solubility in water:
502 mg/L at 25 °C (Banerjee, 1984)

295 mg/L at 25 °C (Tewari et al., 1982; Wasik et al., 1981)
4.43 mmol/L at 25 °C (Wasik et al., 1983)
471.7 mg/L at 25 °C (Aquan-Yuen et al., 1979)
500 mg/L at 25 °C, 488 mg/kg at 30 °C (Andrews and Keefer, 1950)
446 mg/kg at 30 °C (Gross and Saylor, 1931)
448 mg/L at 30 °C (Freed et al., 1977)
503 mg/L at 25 °C (Yalkowsky et al., 1979)
534 mg/kg at 25 °C (Chey and Calder, 1972)
0.0512 wt % at 25 °C (Nathan, 1978)
474.0 mg/L at 30 °C (McNally and Grob, 1983, 1984)
0.035 wt % at 25 °C (Lo et al., 1986)
4.11 mmol/kg at 25.0 °C (Vesala, 1974)
3.78 mM at 25.0 °C (Sanemasa et al., 1987)

Vapor density:
4.60 g/L at 25 °C, 3.88 (air = 1)

Vapor pressure (mmHg):
9 at 20 °C (NIOSH, 1994)
11.86 at 25 °C (Mackay et al., 1982)

Environmental Fate

Biological. In activated sludge, 31.5% of the applied chlorobenzene mineralized to carbon dioxide after 5 days (Freitag et al., 1985). A mixed culture of soil bacteria or a *Pseudomonas* sp. transformed chlorobenzene to chlorophenol (Ballschiter and Scholz, 1980). Pure microbial cultures isolated from soil hydroxylated chlorobenzene to 2- and 4-hydroxychlorobenzene (Smith and Rosazza, 1974). Chlorobenzene was statically incubated in the dark at 25 °C with yeast extract and settled domestic wastewater inoculum. At a concentration of 5 mg/L, biodegradation yields at the end of 1 and 2 weeks were 89 and 100%, respectively. At a concentration of 10 mg/L, significant degradation with gradual adaptation was observed. Complete degradation was not observed until after the 3rd week of incubation (Tabak et al., 1981).

Photolytic. Under artificial sunlight, river water containing 2-5 ppm chlorobenzene photodegraded to phenol and chlorophenol. The lifetimes of chloro-benzene in distilled water and river water were 17.5 and 3.8 hours, respectively (Mansour et al., 1989). In distilled water containing 1% acetonitrile exposed to artificial sunlight, 28% of chlorobenzene in solution photolyzed to phenol, chloride ion and acetanilide with reported product yields of 55, 112 and 2%, respectively (Dulin et al., 1986).

Titanium dioxide suspended in an aqueous solution and irradiated with UV light (λ = 365 nm) converted chlorobenzene to carbon dioxide at a significant rate (Matthews, 1986). Products identified as intermediates in this reaction include

three monochlorophenols, chlorohydroquinone and hydroxyhydroquinone as intermediates (Kawaguchi and Furuya, 1990).

Photooxidation of chlorobenzene in air containing nitric oxide in a Pyrex glass vessel and a quartz vessel gave 3-chloronitrobenzene, 2-chloro-6-nitrophenol, 2-chloro-4-nitrophenol, 4-chloro-2-nitrophenol, 4 nitrophenol, 3-chloro-4-nitrophenol, 3-chloro-6-nitrophenol and 3-chloro-2-nitrophenol (Kanno and Nojima, 1979). A carbon dioxide yield of 18.5% was achieved when chlorobenzene adsorbed on silica gel was irradiated with light (λ >290 nm) for 17 hours. The sunlight irradiation of chlorobenzene (20 g) in a 100-mL borosilicate glass-stoppered Erlenmeyer flask for 28 days yielded 1,060 ppm monochlorobiphenyl (Uyeta et al., 1976).

When an aqueous solution containing chlorobenzene (190 μM) and a nonionic surfactant micelle (Brij 58, a polyoxyethylene cetyl ether) was illuminated by a photoreactor equipped with 253.7-nm monochromatic ultraviolet lamps, phenol, hydrogen and chloride ions formed as the major products. Although not measured, it was reported that aromatic aldehydes, organic acids and carbon dioxide would form from the photoreaction of benzene in water under similar conditions. A duplicate experiment was conducted using an ionic micelle (triethylamine, 5 mM), which serves as a hydrogen source. Products identified were phenol and benzene (Chu and Jafvert, 1994).

Chemical/Physical. Anticipated products from the reaction of chlorobenzene with ozone or hydroxyl radicals in the atmosphere are chlorophenols and ring cleavage compounds (Cupitt, 1980).

In the absence of oxygen, chlorobenzene reacted with Fenton's reagent forming chlorophenols, dichlorobiphenyls and phenolic polymers as major intermediates. With oxygen, chlorobenzoquinone, chlorinated and nonchlorinated diols formed (Sedlak and Andren, 1991).

Based on an assumed base mediated 1% disappearance after 16 days at 85 °C and pH 9.70 (pH 11.26 at 25 °C), the hydrolysis half-life was estimated to be >900 years (Ellington et al., 1988).

Exposure Limits: NIOSH REL: Awaiting OSHA ruling to determine if the recommended TWA exposure limit of 75 ppm is protective of human health, IDLH 1,000 ppm; OSHA PEL: TWA 75 ppm (350 mg/m^3); ACGIH TLV: TWA 75 ppm.

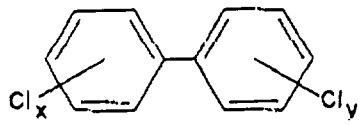
Symptoms of Exposure: Inhalation of vapors may cause drowsiness, incoordination and liver damage. May irritate eyes and skin (Patnaik, 1992).

Toxicity: Acute oral LD_{50} for rats 2,910 mg/kg, guinea pigs 5,060 mg/kg, rabbits 2,250 mg/kg (RTECS, 1985); LC_{50} for goldfish 1.8 mL/kg (Verschueren, 1983).

Drinking Water Standard (final): MCLG: 0.1 mg/L; MCL: 0.1 mg/L (U.S. EPA, 1994).

PCB-1260

Synonyms: Arochlor 1260; Aroclor 1260; Chlorodiphenyl (60% Cl); Clophen A60; Kanechlor; Phenoclor DP6.



x + y = 4 thru 7

CAS Registry No.: 11096-82-5
DOT: 2315
Molecular formula: Not definitive. PCB-1260 is a mixture of many biphenyls with varying degrees of chlorination. According to Hutzinger et al. (1974), the approximate composition of PCB-1260 by weight is as follows: biphenyls (0%), chlorobiphenyls (0%), dichlorobiphenyls (0%), trichlorobiphenyls (0%), tetrachlorobiphenyls (1%), pentachlorobiphenyls (12%), hexachlorobiphenyls (38%) and heptachlorobiphenyls (41%).
Formula weight ranges from 324 to 460 (Nisbet and Sarofim, 1972) with an average value of 370 (Hutzinger et al., 1974)
RTECS: TQ1362000

Physical state, color and odor
Light yellow sticky, soft resin with a weak odor.

Melting point (°C):
31 (HSDB, 1989)

Boiling point (°C):
Distills at 385-420 (Monsanto, 1974)

Density (g/cm^3):
1.566 at 15.5/4 °C, 1.555-1.566 at 90/15.5 °C (Standen, 1964)
1.58 (Mills et al., 1982)

Diffusivity in water (10^5 cm^2/sec):
0.53 at 20 °C using method of Hayduk and Laudie (1974).

Flash point (°C):
None to the boiling point (Hutzinger et al., 1974).

Bioconcentration factor, log BCF:
5.29 (fathead minnow, Veith et al., 1979a)

Henry's law constant (10^4 atm·m^3/mol):
1.7 at 20 °C (Murphy et al., 1987)
0.244, 0.435, 0.754, 1.27, 2.10, 3.36, 5.27, 8.09 and 12.1 at 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.5 and 40.0 °C, respectively (predicted, Burkhard et al., 1985)

Soil sorption coefficient, log K_{oc}:
6.42 (estimated, Montgomery, 1989)

Octanol/water partition coefficient, log K_{ow}:
6.91 (Mackay, 1982)
6.11 (Chiou et al., 1977)

Solubility in organics:
Soluble in most solvents (U.S. EPA, 1985)

Solubility in water (μg/L):
80 at 24 °C (Hollifield, 1979)
2.7 (Monsanto, 1974)
14.4 at 20 °C (Murphy et al., 1987)

Vapor pressure (10^7 mmHg):
405 at 25 °C (Mackay and Wolkoff, 1973)
2 at 38 °C (Nisbet and Sarofim, 1972)
63.1 at 20 °C (Murphy et al., 1987)
130.5 at 25 °C (Foreman and Bidleman, 1985)

Environmental Fate

Biological. Reported degradation products by the microorganism *Alcaligenes* BM-2 for a mixture of polychlorinated biphenyls include monohydroxychlorobiphenyl, 2-hydroxy-6-oxochlorophenylhexa-2,4-dieonic acid, chlorobenzoic acid, chlorobenzoylpropionic acid, chlorophenylacetic acid and 3-chlorophenyl 2-chloropropenic acid (Yagi and Sudo, 1980). When PCB-1260 was statically incubated in the dark at 25 °C with yeast extract and settled domestic wastewater inoculum, no significant biodegradation was observed (Tabak et al., 1981).

Photolytic. PCB-1260 in a 90% acetonitrile/water solution containing 0.2-0.3 M sodium borohydride and irradiated with UV light (λ = 254 nm) reacted to yield dechlorinated biphenyls. After 2 hours, about 75% of the congeners were destroyed. Without sodium borohydride, only 10% of the congeners had reacted. Products identified by GC include biphenyl, 2-, 3- and 4-chlorobiphenyl, six dichlorobiphenyls, three trichlorobiphenyls, 1-phenyl-1,4-cyclohexadiene and 1-

phenyl-3-cyclohexene (Epling et al., 1988).

Chemical/Physical. Zhang and Rusling (1993) evaluated the bicontinuous microemulsion of surfactant/oil/water as a medium for the dechlorination of polychlorinated biphenyls by electrochemical catalytic reduction. The microemulsion (20 mL) used was didodecyldimethylammonium bromide, dodecane and water at 21, 57 and 22 wt %, respectively. The catalyst used was zinc phthalocyanine (4.5 nM). When PCB-1260 (100 mg), the emulsion and catalyst were subjected to a current of mA/cm^2 on 11.2 cm^2 lead electrode for 18 hours, a dechlorination yield of >99.8 % was achieved. Reaction products included minor amounts of mono- and dichloropbiphenyls (0.02 mg), biphenyl and reduced alkylbenzene derivatives.

When PCB-1260-contaminated sand was treated with a poly(ethylene glycol)/potassium hydroxide mixture at room temperature, more than 99% reacted after 2 days forming aryl poly(ethylene glycols) (Brunelle and Singleton, 1985).

Drinking Water Standard (final): For all PCBs, the MCLG and MCL are zero and 0.5 μg/L, respectively (U.S. EPA, 1994).

Toxicity: Suspected human carcinogen. Acute oral LD_{50} for rats 1,315 mg/kg (RTECS, 1985).

Uses: Secondary plasticizer for polyvinyl chloride; in polyester resins to increase strength of fiberglass; varnish formulations to improve water and alkali resistance; as an insulator fluid for electric condensers and as an additive in very high pressure lubricants.

Exhibit 40

PB92963377

United States
Environmental Protection
Agency

Office of Solid Waste
and Emergency
Response

EPA 540-R-92-026
November 1992

Superfund

EPA

Hazard Ranking System Guidance Manual

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
INFORMATION SERVICE
SPRINGFIELD, VA 22161

designed to provide an incentive for rapid response actions by PRPs, reducing risks to the public and the environment and allowing for more timely and cost-effective cleanups. The Agency's waste removal policy is explained in greater detail in *The Revised Hazard Ranking System: Evaluating Sites After Waste Removals* (OSWER Publication 9345.1-03FS, October 1991).

REQUIREMENTS FOR CONSIDERING REMOVAL ACTIONS

In the preamble to the HRS (55 *Federal Register* 51567, December 14, 1990), EPA established three requirements that must be met for the results of a removal action to be considered in scoring a site with the HRS. A removal action that meets these three requirements is referred to as a qualifying removal.

The first requirement is that the removal action physically remove from the site wastes containing hazardous substances. Note that it is not necessary that all wastes from the site or even all wastes from a particular source be removed; partial removals can be considered in scoring. This requirement for actual physical removal ensures that there is no scoring benefit for simply moving the waste and its associated risks to another portion of the same site. A removal action conducted under Superfund's emergency response program does not necessarily involve physical removal of wastes from the site. For example, Superfund removal actions, as defined in CERCLA section 101(23), may include stabilizing or containing waste on-site through engineering controls or limiting exposure potential by erecting fences or providing alternate water supplies. These types of actions do not constitute a qualifying removal.

The second requirement is that the removal must have occurred prior to the cutoff date applicable to the site. The HRS preamble states that EPA will only consider removals conducted prior to the SI. This requirement encourages prompt action and avoids the need to resample or rescore sites due to waste removals conducted after the SI. Because of differences in site assessment activities for different types of sites (e.g., EPA-lead, state-lead, Federal facilities), criteria for determining the appropriate cutoff date differ among sites. The next section provides detailed guidance on determining a site-specific cutoff date.

The third requirement is that all waste removed must be disposed of or destroyed at a facility permitted, as appropriate, under the Resource Conservation and Recovery Act (RCRA) or the Toxic Substances Control Act (TSCA) or by the Nuclear Regulatory Commission (NRC). This requirement encourages proper disposal of the removed waste and discourages simply moving the waste and its associated hazards to another location.

DETERMINING THE CUTOFF DATE

The paragraphs below describe how to determine the cutoff date for non-Federal and Federal facility sites and for sites with more than one SI.

Non-Federal Facility Sites with One SI

An SI for non-Federal facility sites generally begins with development of a workplan, which often includes the sampling strategy for the site. EPA believes it would disrupt SIs to consider the results of removal actions conducted after this point because to do so could require revising sampling plans, resampling, or rescoring the site. Because of variation in the way Regions have historically tracked SIs, it is impossible to define a single event as the cutoff date for sites that had SIs before the removal policy fact sheet was distributed in December 1991. Therefore, the cutoff date for those sites generally is the date development of a workplan for the SI begins. Examples of dates that can be considered analogous to workplan development for purposes of determining the cutoff date include:

- SI start date in CERCLIS;
- Date of Technical Decision Document (TDD) or Technical Decision Memorandum (TDM) issued for work assignment to develop SI workplan;
- Date when EPA approves the site-specific SI workplan; or
- Date of an SI reconnaissance to develop SI workplan.

If no workplan or analogous event is available, the cutoff date is the earliest documented date that EPA conducted SI activities for the site. For all sites with SIs conducted after December 1991, Regions are expected to enter the date of site-specific workplan approval by EPA as the SI start date in CERCLIS, and that date should be used as the cutoff date for determining qualifying removals.

If EPA determines that previous investigations by other parties (e.g., states, EPA's removal program) are suitable for SI purposes, then the date when drafting of a Superfund SI report collating previous analytical data is begun serves as the cutoff date. The cutoff date is not the date of a state or PRP investigation conducted independently of CERCLA; the cutoff is based on the date these data are collated for Superfund SI purposes.

Non-Federal Facility Sites with Multiple SIs

For non-Federal facility sites with more than one SI, the cutoff date for most sites will be keyed to the first SI. However, the Agency may establish a later cutoff date under certain circumstances:

- If a second SI implementing a completely new sampling strategy is conducted, the Agency may consider basing the cutoff date on workplan development for the second SI. In these cases, considering removals prior to the second SI is not likely to unduly disrupt the site assessment process.
- For sites where the first SI was conducted more than four years prior to HRS scoring, the Agency may consider, on a case-by-case basis, changing the cutoff date to a later date. (CERCLA section 116, added by SARA, mandates that EPA conduct site assessment work within four years of CERCLIS listing.)

The transition to the revised HRS and the follow-up sampling needed for some sites may mean that site assessment activities take longer than four years. Follow-up sampling should not be used to determine a new cutoff date in that situation, even if more than four years have elapsed since the first cutoff date, unless a completely new sampling strategy is implemented.

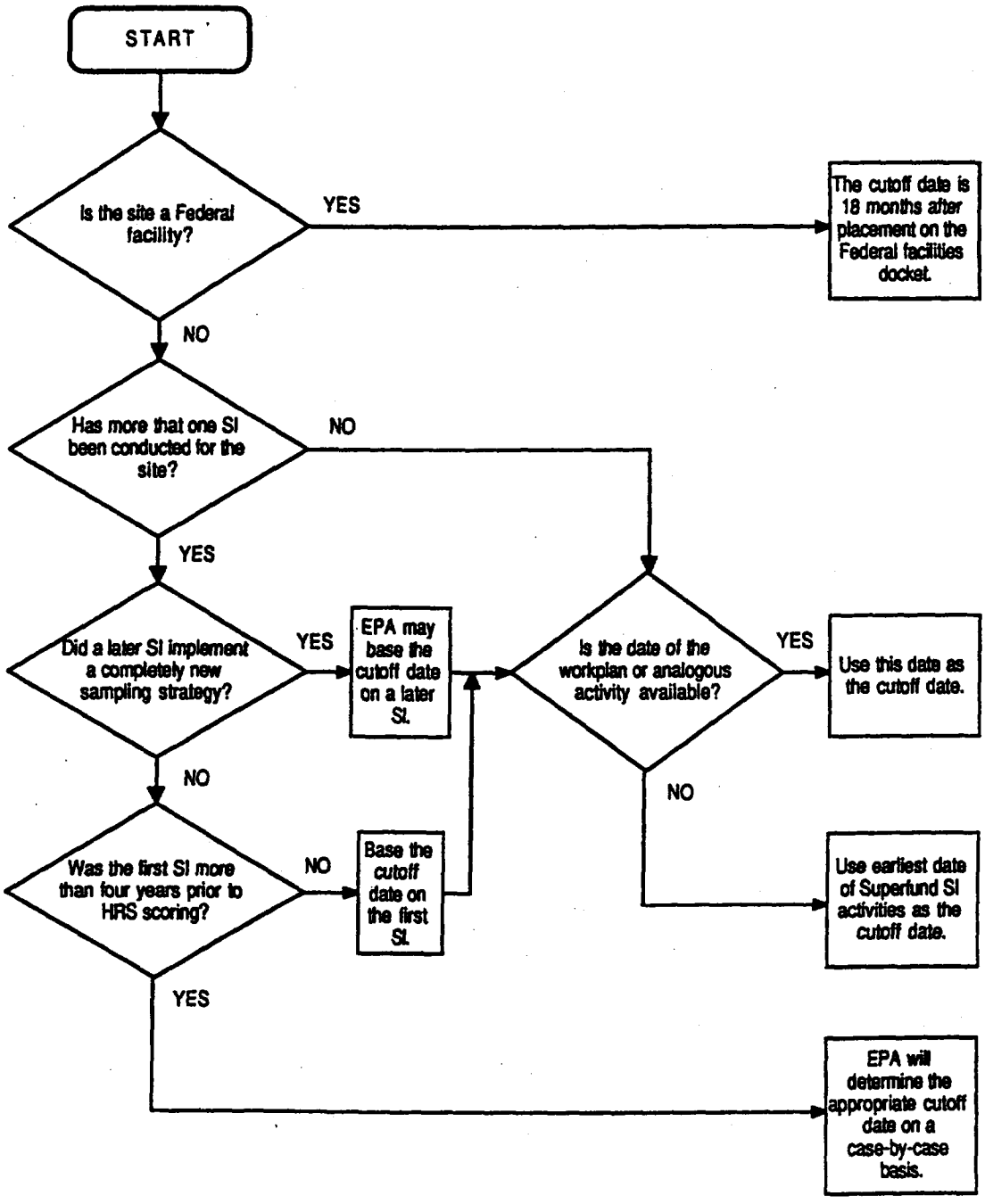
Federal Facility Sites

Federal facility sites undergo a somewhat different site process than other sites. Assessments of Federal facility sites are expected to be conducted within 18 months of their placement on the Federal Agency Hazardous Waste Compliance Docket, set up under CERCLA section 120(c), added by SARA. Therefore, the cutoff date for Federal facility sites is 18 months after the site is placed on the Federal facilities docket.

Summary

Highlight 2-1 is a flowchart for determining a site-specific cutoff date. ***Highlight 2-2*** provides examples of determining the cutoff date for hypothetical sites.

HIGHLIGHT 2-1
FLOWCHART FOR IDENTIFICATION OF THE CUTOFF DATE



HIGHLIGHT 2-2
EXAMPLES OF DETERMINING CUTOFF DATE

SITE #1	
Site Assessment Activities	PA was conducted in May 1988. SI sampling took place in October 1989. The date workplan development for SI began is unknown; however, the date of the Technical Decision Document authorizing the contractor to develop an SI workplan was dated July 1989. HRS package preparation began in January 1991.
Cutoff Date	**July 1989:** Cutoff date is the date analogous to workplan preparation.

SITE #2	
Site Assessment Activities	No PA was conducted. The State conducted an independent (i.e., non-Superfund) investigation of this site, including sampling in May 1988. The State issued a final report of this investigation in December 1988. In May 1990, EPA examined the State's December 1988 report. EPA decided this investigation constituted an SI, and began drafting a Superfund SI report in May 1990. The report was finalized in July 1990. HRS package preparation began in August 1991.
Cutoff Date	**May 1990:** Cutoff date is the date EPA began drafting an SI report using previous analytical data, not the date of the state investigation or report on which EPA's report is based.

SITE #3	
Site Assessment Activities	PA was conducted in January 1989. EPA's emergency response program conducted a removal assessment in June 1989 and removed a number of corroding drums in July 1989. Development of an SI workplan began in November 1989. Sampling took place in March 1990. HRS package preparation began in February 1991.
Cutoff Date	**November 1989:** Cutoff date is based on development of SI workplan, not on the date of the removal assessment.

(continued on next page)

HIGHLIGHT 2-2 (continued)
EXAMPLES OF DETERMINING CUTOFF DATE

SITE #4	
Site Assessment Activities	PA was conducted in March 1986. SI sampling was conducted by an EPA contractor in January 1987. No date for workplan development or analogous date is available. The earliest identified date for Superfund SI activities is December 1986. A second SI with a similar sampling strategy was conducted in September 1989. Limited sampling to collect additional data to support HRS scoring was conducted in April 1991. HRS package preparation began in August 1991.
Cutoff Date	**To be determined:** The cutoff date normally would be December 1986. This date (earliest identified date of Superfund SI activities) is used because the date of workplan development for the first SI is not available. In addition, the September 1989 and April 1991 SI activities did not implement completely new sampling strategies. However, because the first SI was conducted more than four years prior to HRS scoring, EPA may determine a later cutoff date than December 1986 for the site.

SCORING CONSIDERATIONS WHEN A QUALIFYING REMOVAL HAS OCCURRED

A qualifying removal affects scoring of the hazardous waste quantity factor and also may affect the scoring of a number of other HRS factors. Scoring hazardous waste quantity for sites with qualifying removals is discussed in detail in the removal policy fact sheet. For a qualifying removal, do not count the amount of waste removed when scoring hazardous waste quantity. For a non-qualifying removal, score hazardous waste quantity as if the waste was not removed. For a partial qualifying removal, the waste removed generally may be subtracted from the total amount of waste, if the same hazardous waste quantity tier (e.g., both must be based on volume) can be used.

Changes in factors other than hazardous waste quantity caused by a qualifying removal should be considered in scoring a pathway only if all of the following conditions are met.

- Change in the factor was a direct result of a qualifying removal. For example, if during a qualifying removal waste is removed from a surface impoundment and the impoundment is refilled with clean soil, the clean fill can be considered in scoring factors other than hazardous waste quantity (e.g., containment) if the following two conditions are also met.

- No observed release of a hazardous substance associated with the source is established. If an observed release associated with the source involved in the qualifying removal is established, the effects of the removal are not considered in scoring factors other than hazardous waste quantity. This requirement is pathway-specific. If, for example, an observed release is established for ground water but not for air or surface water, then changes in factors other than hazardous waste quantity can be considered in scoring the air and surface water pathways (as long as the other two conditions are also met).

- The removal completely eliminated the source or resulted in a containment factor value of zero for the source. If the removal is partial or if changes that result from the removal would result in a lower, but non-zero, containment factor value, the effects of the removal are not considered in scoring factors other than hazardous waste quantity. Again, this requirement is pathway-specific; the removal may result in a zero containment factor value for air but a non-zero containment factor value for ground water and surface water.

The requirements above apply to all HRS factors other than hazardous waste quantity. Instructions for applying these requirements to specific factors are provided below.

Observed Release

An observed release to a migration pathway, whether documented before or after a qualifying removal, can be used to score likelihood of release. That is, a qualifying removal does not negate the fact that the source has released substances to the environment. However, areas of observed contamination in the soil exposure pathway reflect continuing hazards at the site. Therefore, the soil exposure pathway factor is evaluated based on conditions that exist following a qualifying removal.

Source Containment and Source Type

Scoring of the containment and, for the air pathway, source type factors is affected only by qualifying removals that result in a factor value of 0. Changes in containment or source type that result in a lower but non-zero factor value are not considered in scoring.

Substance-specific Factors

Substance-specific factors cannot be based on a hazardous substance that was completely eliminated from a pathway by a qualifying removal. Such a removal must eliminate all sources of the hazardous substance, and no prior releases of the substance may have occurred. Substance-specific factors include:

- Toxicity
- Mobility
- Persistence
- Bioaccumulation potential
- Gas migration potential.

EPA generally will be unable to document complete elimination of a hazardous substance within the scope of an SI and will rely on PRPs to produce these data. If a portion of a source is eliminated in a qualifying removal, the remaining portion of that source is assumed to contain the same hazardous substances as the removed portion, unless the PRP can document otherwise (e.g., provide analytical results or manifest data that convincingly demonstrate a given hazardous substance is not present in the remaining portion of the source).

Targets Factors

Site-specific TDL (or distance categories) and the distance to nearest targets in migration pathways may change if a qualifying removal meets the three requirements above. In such cases, the source is eliminated from the pathway and, therefore, is not used to measure target distances. If a qualifying removal does not meet the three requirements above (e.g., an observed release of a hazardous substance associated with the source is established or the source containment factor value is non-zero), the source is included when measuring target distances for that pathway.

Exhibit 41

SAUGET AREA 2
ILD000605790

Reference No. 25

150800

RECEIVED
DEC 0 8 1994
IEPA LABORATORIES
Manager's Office

RECEIVED
DEC 0 9 1994
IEPA LABORATORIES
Manager's Office

ARDL Inc.

applied research & development laboratory

CHEMISTRY • BIOLOGY • PHYSIOLOGY
ENGINEERING • ENVIRONMENTAL ANALYSIS

P.O. Box 1566 • Mt. Vernon Airport, Route 15 East • Mt. Vernon, Illinois 62864 • (618) 244-3235 • FAX (618) 244-1149

"Test Everything - Keep The Good" 1 Thes. 5:21

INORGANIC ANALYSIS DATA PACKAGE
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
FACILITY: SAUGET SA 1 & 2
ARDL REPORT NO.: 2343

VOLUME 1 - 1

U.S. EPA - CLP

COVER PAGE - INORGANIC ANALYSES DATA PACKAGE

Lab Name: ARDL, INC. Contract: 2343

Lab Code: ARDL Case No.: BBE SAS No.: _____ SDG No.: X101

SOW No.: ILM02.0

EPA Sample No.	Lab Sample ID.
X101	2343-1
X101D	2343-1D
X101S	2343-1S
X102	2343-2
X103	2343-3
X104	2343-4
X105	2343-5
X106	2343-6
X107	2343-7
X108	2343-8
X109	2343-9
X110	2343-10
X111	2343-11

Were ICP interelement corrections applied? Yes/No YES

Were ICP background corrections applied? Yes/No YES

If yes-were raw data generated before application of background corrections? Yes/No NO

Comments:

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature: Daniel J. Gillespie Name: Daniel J. Gillespie

Date: 12/7/94 Title: Technical Services Manager

U.S. EPA - CLP

COVER PAGE - INORGANIC ANALYSES DATA PACKAGE

Lab Name: ARDL, INC. Contract: 2343
Lab Code: ARDL Case No.: BBE SAS No.: _____ SDG No.: X101
SOW No.: ILMO2.0

Case Narrative

Eleven soil samples were received 9 November 1994 for analysis. The requested analysis included TAL (23) metals, cyanide, sulfide and sulfate .

It is policy at ARDL to follow the guidelines set forth in the SOW relating to the minimum time requirements between analytical samples and CCV's or CCB's. In some cases minor exceptions appear on the Form 14's due to: 1) rounding of the actual times to the nearest minute as required on the forms; and 2) the necessity of reprinting a data page when an incorrect limit checking table was employed.

In accordance with the instructions received from Ron Turpin, IEPA, LCS and CRA analyses need not be in each and every analytical run provided that: 1) the operating software automatically recalibrates and continues sample analysis when an out-of-control situation is reached; and 2) the initial run contained valid analyses of these QC solutions. This occurred in the thallium determination of the subject samples.

The level of the CRI standard for lead is 40 ug/L which is twice the instrument detection limit.

Lead results on ICP run dated 16 November 1994 were used as a basis for determining initial dilutions for GFAA analysis.

Duplication for ICP metals was unusually poor (9 of 19 were outside of control limits). In an attempt to confirm whether sample heterogeneity or poor digestion procedures were responsible for the poor duplication, the 'F' digests for samples X101 and X101D were scanned by ICP. The results of this scan and a comparison table are included in the ICP Raw Data section of this report.

Two cyanide distillation batches were used to obtain requisite data. Both batches were quantitated from the same calibration curve and are presented as two separate analytical runs on Forms 1-14.

As the referenced SOW does not contain any provisions for the requested non-metallic analytes, the following methods were employed:

		Detection Limits (ug/L)
Sulfate	Method 300.0	2000
Sulfide	Method 376.1	1000

The non-CLP analytes were analyzed as close to CLP procedures as possible.

INORGANIC DATA QUALIFIERS

FORM I-IN includes fields for three types of result qualifiers. These qualifiers are completed as follows:

C (Concentration) qualifier:

- **B** - Reported value obtained from a reading between the CRDL and IDL.
- **U** - Analyte was analyzed for but not detected.

Q qualifier -- Specified entries and their meanings are as follows:

- **E** - The reported value is estimated because of the presence of interference. This determination is from: 1) ICP serial dilution results exceeding specified limits; or 2) very low (<40%) GFAA post-digestion spike recovery.
- **M** - Duplicate injection precision not met.
- **N** - Spiked sample recovery not within control limits.
- **S** - The reported value was determined by the Method of Standard Additions (MSA).
- **W** - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.
- ***** - Duplicate analysis not within control limits.
- **+** - Correlation coefficient for the MSA is less than 0.995.

NOTE: Entering 'S', 'W' or '+' is mutually exclusive. No combination of these qualifiers can appear in the same field for an analyte.

M (Method) qualifier -- Enter:

'P' for ICP
'A' for Flame AA
'F' for Furnace AA
'CV' for manual Cold Vapor AA
'C' for Manual Spectrophotometric

ORGANIC ANALYSIS DATA PACKAGE

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
CONTRACT LABORATORY SERVICES
ORGANIC ANALYSIS DATA PACKAGE

Date: 12/07/94

Lab Name: ARDL, Inc.

ARDL Report No.: 2343

Site Inventory No.: 1630200005

Facility Name: Sauget Site Area 1+2

County: St. Clair

Region: Collinsville

SDG NARRATIVE

IEPA ID No.	Lab ID No.	Volatile Analysis Date
X101	2343-1	11/15/94
X101MS	2343-1MS	11/17/94
X101MSD	2343-1MSD	11/16/94
X101RE	2343-1RE	11/17/94
X102	2343-2	11/15/94
X102RE	2343-2RE	11/16/94
X103	2343-3	11/16/94
X103RE	2343-3RE	11/16/94
X104	2343-4	11/15/94
X104RE	2343-4RE	11/16/94
X105	2343-5	11/15/94
X106	2343-6	11/15/94
X106RE	2343-6RE	11/16/94
X107	2343-7	11/16/94
X108	2343-8	11/16/94
X108RE	2343-8RE	11/17/94
X109	2343-9	11/16/94
X109RE	2343-9RE	11/17/94
X110	2343-10	11/16/94
X110RE	2343-10RE	11/17/94
X111	2343-11	11/16/94
X111RE	2343-11RE	11/17/94
VBLKB1	BK2 11/15/94	11/15/94
VBLKB2	BK2 11/16/94	11/16/94
VBLKB3	BK2 11/17/94	11/17/94

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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
CONTRACT LABORATORY SERVICES
ORGANIC ANALYSIS DATA PACKAGE

Date: 12/07/94

Lab Name: ARDL, Inc.

ARDL Report No.: 2343

Site Inventory No.: 1630200005

Facility Name: Sauget Site Area 1+2

County: St. Clair

Region: Collinsville

SDG NARRATIVE

IEPA ID No.	Lab ID No.	Semi-Volatile Extr. Date	Semi-Volatile Analysis Date
X101	2343-1	11/18/94	11/30/94
X102	2343-2	11/18/94	11/30/94
X102RE	2343-2RE	11/18/94	11/30/94
X103	2343-3	11/18/94	11/29/94
X104	2343-4	11/18/94	12/02/94
X105	2343-5	11/18/94	11/30/94
X106	2343-6	11/18/94	11/30/94
X107	2343-7	11/18/94	11/30/94
X107MS	2343-7MS	11/18/94	11/30/94
X107MSD	2343-7MSD	11/18/94	11/30/94
X108	2343-8	11/18/94	11/30/94
X109	2343-9	11/18/94	11/30/94
X110	2343-10	11/18/94	11/30/94
X111	2343-11	11/18/94	11/30/94
SBLKE1	BLANK B4163	11/18/94	11/29/94
SBLKF1	BLANK B4163	11/18/94	11/29/94

ORGANIC ANALYSIS DATA PACKAGE

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
CONTRACT LABORATORY SERVICES
ORGANIC ANALYSIS DATA PACKAGE

Date: 12/07/94

Lab Name: ARDL, Inc.

ARDL Report No.: 2343

Site Inventory No.: 1630200005

Facility Name: Sauget Site Area 1+2

County: St. Clair

Region: Collinsville

SDG NARRATIVE

IEPA ID No.	Lab ID No.	Pesticide/PCB Extr. Date	Pesticide/PCB Analysis Date
X101	2343-1	11/16/94	11/24/94
X101DL	2343-1DL	11/16/94	11/24/94
X102	2343-2	11/16/94	11/23/94
X102DL	2343-2DL	11/16/94	11/23/94
X103	2343-3	11/16/94	11/24/94
X103DL	2343-3DL	11/16/94	11/23/94
X104	2343-4	11/16/94	11/23/94
X105	2343-5	11/16/94	11/24/94
X105DL	2343-5DL	11/16/94	11/24/94
X106	2343-6	11/16/94	11/23/94
X107	2343-7	11/16/94	11/24/94
X107DL	2343-7DL	11/16/94	11/24/94
X107MS	2343-7MS	11/16/94	11/24/94
X107MSD	2343-7MSD	11/16/94	11/24/94
X108	2343-8	11/16/94	11/24/94
X108DL	2343-8DL	11/16/94	11/24/94
X109	2343-9	11/16/94	11/23/94
X110	2343-10	11/16/94	11/23/94
X111	2343-11	11/16/94	11/23/94
PBLK59	BLANK B4159	11/16/94	11/23/94

ORGANIC ANALYSIS DATA PACKAGE

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
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Lab Name: ARDL, Inc.

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Facility Name: Sauget Site Area 1+2

County: St. Clair

Region: Collinsville

SAMPLE SUMMARY

IEPA NUMBER	ARDL NUMBER	LEVEL LOW	LEVEL MED	FRACTION VOA	FRACTION BNA	FRACTION PEST	FRACTION PCB	FRACTION PNA	MS/ MSD	RPT	DIL.	COMMENTS
X101	2343-1	X		X		X	X					
X101	2343-1	X			X						1:1000	
X101DL	2343-1DL	X				X	X				1:500	
X101MS	2343-1MS	X		X					X			
X101MSD	2343-1MSD	X		X					X			
X101RE	2343-1RE	X		X						X		
X102	2343-2	X		X		X	X					
X102	2343-2	X			X						1:10	
X102DL	2343-2DL	X				X	X				1:5	
X102RE	2343-2RE	X		X						X		
X102RE	2343-2RE	X			X						1:10	
X103	2343-3	X		X		X	X					
X103	2343-3	X			X						1:10	
X103DL	2343-3DL	X				X	X				1:10	
X103RE	2343-3RE	X		X						X		
X104	2343-4	X		X		X	X					
X104	2343-4	X			X						1:50000	
X104RE	2343-4RE	X		X						X		
X105	2343-5	X		X		X	X					
X105	2343-5	X			X						1:10	
X105DL	2343-5DL	X				X	X				1:100	
X106	2343-6	X		X		X	X					
X106	2343-6	X			X						1:250	
X106RE	2343-6RE	X		X						X		
X107	2343-7	X		X	X	X	X					
X107DL	2343-7DL	X				X	X				1:100	
X107MS	2343-7MS	X			X	X	X		X			
X107MSD	2343-7MSD	X			X	X	X		X			
X108	2343-8	X		X		X	X					
X108	2343-8	X			X						1:2	
X108DL	2343-8DL	X				X	X				1:100	
X108RE	2343-8RE	X		X						X		
X109	2343-9	X		X	X	X	X					
X109RE	2343-9RE	X		X						X		
X110	2343-10	X		X	X	X	X					
X110RE	2343-10RE	X		X						X		
X111	2343-11	X		X	X	X	X					
X111RE	2343-11RE	X		X						X		

ORGANIC ANALYSIS DATA PACKAGE

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
CONTRACT LABORATORY SERVICES
ORGANIC ANALYSIS DATA PACKAGE

Date: 12/07/94

Lab Name: ARDL, Inc. ARDL Report No.: 2343

Site Inventory No.: 1630200005 Facility Name: Sauget Site Area 1+2

County: St. Clair Region: Collinsville

SAMPLE SUMMARY (Continued)

IEPA NUMBER	ARDL NUMBER	LEVEL LOW	LEVEL MED	FRACTION VOA	FRACTION BNA	FRACTION PEST	FRACTION PCB	FRACTION PNA	MS/ MSD	RPT	DIL.	COMMENTS
VBLKB1	BK2 11/15/94	X		X								METHOD BLK
VBLKB2	BK2 11/16/94	X		X								METHOD BLK
VBLKB3	BK2 11/17/94	X		X								METHOD BLK
PBLK59	2343-B4159	X				X	X					METHOD BLK
SBLKE1	BLANK B4163	X			X							METHOD BLK
SBLKF1	BLANK B4163	X			X							METHOD BLK

ORGANIC ANALYSIS DATA PACKAGE

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
CONTRACT LABORATORY SERVICES
ORGANIC ANALYSIS DATA PACKAGE

Date: 12/07/94

Lab Name: ARDL, Inc. ARDL Report No.: 2343

Site Inventory No.: 1630200005 Facility Name: Sauget Site Area 1+2

County: St. Clair Region: Collinsville

SDG NARRATIVE

VOLATILE FRACTION

Eleven (11) soil samples were received by ARDL, Inc. on November 9, 1994, for VOA analysis by GC/MS. All analyses were performed according to low level protocol.

IEPA Samples X102, X103, X104, X106, X108, X109, X110 and X111 failed to meet internal standard area recovery criteria during the initial analyses and reanalyses. Results of both analyses of these samples are reported herein.

IEPA Sample X101 failed to meet internal standard area recovery criteria during the initial analysis. This internal standard area recovery failure trend was also observed in the matrix spike and matrix spike duplicate evaluations of this sample.

IEPA Sample X101 was rerun due to the discrepancy in the concentration of 1,2-Dichloroethene (total) as compared to the matrix spike and matrix spike duplicate. Both analyses are reported herein.

There were no other unusual problems encountered during the sample analyses.

SEMIVOLATILE FRACTION

Eleven (11) soil samples were received by ARDL, Inc. on November 9, 1994, for BNA analysis by GC/MS. All analyses were performed according to low level protocol.

IEPA Samples X104 and X106 would not pass through the GPC pre-filter. A 200 uL aliquot was filtered for each of these samples. This aliquot was diluted to a volume of 10 mL with methylene chloride. This diluted extract was then GPC cleaned up, with a 500 uL final being obtained per protocol.

IEPA Samples X102 and X106 had dilutions performed to get all target compounds within linear calibration range. A large mass of an apparent non-TCL phthalate was present in these samples. This mass was checked at various retention times, with the mass spectrum remaining constant. The entire mass was integrated and a tentative concentration calculated, as found on the Form 1's.

ORGANIC ANALYSIS DATA PACKAGE

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
CONTRACT LABORATORY SERVICES
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Date: 12/07/94

Lab Name: ARDL, Inc.

ARDL Report No.: 2343

Site Inventory No.: 1630200005

Facility Name: Sauget Site Area 1+2

County: St. Clair

Region: Collinsville

SDG NARRATIVE (Continued)

SEMIVOLATILE FRACTION (Continued)

IEPA Sample X102 failed internal standard recovery failed in the initial analysis and the reanalysis. Results of both analysis are included herein.

There were no other unusual problems encountered during the sample analyses.

PESTICIDE/PCB FRACTION

Eleven (11) soil samples were received by ARDL, Inc. on November 9, 1994, for Pesticide/PCB analysis. The samples were extracted and concentrated per 3/90 protocol.

IEPA Samples X104 and X106 were extremely viscous. The sample extracts would not pass through the 0.45 um GPC pre-filter. The sample extracts were adjusted to 10 mL and 100 uL of this was diluted to 10 mL, filtered and placed on the GPC. This factored in a 50x dilution for these two samples and was notated as such on the Form 1's of these samples.

All samples were identified and confirmed as containing one or more Aroclor compounds. Identification and quantitation of the target compounds was difficult due to the extreme matrix encountered. Identification of specific Aroclor compounds in the sample extracts was made in general agreement with the confirmation procedures employed by GC/MS. Aroclor identification was made by the use of TIC's search in the BNA data for IEPA Samples X103, X105, X107, X108 and X109. This data can be found in the Semi-Volatile portion of this data package. Confirmation by GC/MS was performed on IEPA Samples X101, X102, X110 and X111 by manually extracting the characteristic ions from the BNA data for each sample. This data is submitted in the Pesticide/PCB portion of this data package. Due to the nature of the extraction performed on IEPA Samples X104 and X106, the concentration of Aroclor compounds in the extracts were too low to be confirmed using GC/MS.

Dilutions were necessary on several samples due to concentration of Aroclor present in the extracts. Surrogate recoveries in these diluted could not be calculated and are so noted. Also, retention time data for the surrogate on Form 8 for these diluted samples were notated at 0.00 because they were not detected.

ORGANIC ANALYSIS DATA PACKAGE

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Site Inventory No.: 1630200005

Facility Name: Sauget Site Area 1+2

County: St. Clair

Region: Collinsville

SDG NARRATIVE (Continued)

PESTICIDE/PCB FRACTION (Continued)

The recovery of target compound, DDT, could not be calculated in the matrix spike and matrix spike duplicate samples on the RTx5 column due to the interfering presence of Aroclor compounds present in the sample extract. The PCB compounds completely masked DDT which could not be differentiated from the Aroclor pattern. Dieldrin recovery in the matrix spike and matrix spike duplicate samples was high due to the interfering matrix.

During the sequences used to analyze these samples, two injections of the individual standards were made. This was done as the calibration was run as part of an unattended overnight run, and any bad injection of these standards would have jeopardized the entire calibration.

The MID62 standard initially analyzed in one of the sequences appeared to contain some contamination. This standard was injected overnight. When the analyst reviewed the data the following morning, it was apparent that this standard would not be acceptable. The MIDA62 standard was acceptable when initially analyzed. Another MIDB62 standard from a different standard storage ampule was analyzed immediately that morning. This reanalyzed standard met all criteria and was used to continue the sequence.

No additional problems were encountered in the analyses of these samples.

ORGANIC DATA REPORTING QUALIFIERS

The following organic data reporting qualifiers are used as required.

U - Indicates compound was analyzed for but not detected. The sample quantitation limit must be corrected for dilution and for percent moisture.

J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.

ORGANIC ANALYSIS DATA PACKAGE

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
CONTRACT LABORATORY SERVICES
ORGANIC ANALYSIS DATA PACKAGE

Date: 12/07/94

Lab Name: ARDL, Inc. ARDL Report No.: 2343

Site Inventory No.: 1630200005 Facility Name: Sauget Site Area 1+2

County: St. Clair Region: Collinsville

SDG NARRATIVE (Continued)

ORGANIC DATA REPORTING QUALIFIERS (Continued)

N - Indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds, where the identification is based on a mass spectral library search. It is applied to all TIC results. For generic characterization of a TIC, such as chlorinated hydrocarbon, the N code is not used.

P - This flag is used for a pesticide/Aroclor target analyte when there is greater than 25% difference for detected concentrations between the two GC columns (see Form X). The lower of the two values is reported on Form I and flagged with a "P".

C - This flag applies to pesticide results where the identification has been confirmed by GC/MS. If GC/MS confirmation was attempted but was unsuccessful, do not apply this flag, instead use a laboratory-defined flag.

B - This flag is used when the analyte is found in the blank as well as the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. This flag must by used for a TIC as well as for a positively identified target compound.

E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis. If one or more compounds have a response greater than full scale, except as noted in Exhibit D, the sample or extract must be diluted and re-analyzed according to the specifications in Exhibit D. All such compounds with a response greater than full scale should have the concentration flagged with an "E" on the Form 1 for the original analysis. If the dilution of the extract causes any compounds identified in the first analysis to be below the calibration range in the second analysis, then the results of both analyses shall be reported on separate copies of Form 1. The Form 1 for the diluted sample shall have the "DL" suffix appended to the sample number.

ORGANIC ANALYSIS DATA PACKAGE

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Date: 12/07/94

Lab Name: ARDL, Inc. ARDL Report No.: 2343

Site Inventory No.: 1630200005 Facility Name: Sauget Site Area 1+2

County: St. Clair Region: Collinsville

SDG NARRATIVE (Continued)

ORGANIC DATA REPORTING QUALIFIERS (Continued)

D - This flag identifies all compounds identified in an analysis at a secondary dilution factor. If a sample or extract is re-analyzed at a higher dilution factor, as in the "E" flag above, the "DL" suffix is appended to the sample number on the Form 1 for the diluted sample, and all concentration values reported on that Form 1 are flagged with the "D" flag.

A - This flag indicates that a TIC is a suspected aldol-condensation product.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized for the Laboratory Manager or his designee, as verified by the following signature.

Daniel J. Gillespie
Technical Services Manager

U.S. EPA - CLP

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

X101

Lab Name: ARDL, INC. Contract No.: 2343

Lab Code: ARDL Case No.: BBE SAS No.: _____ SDG No.: X101

Matrix (soil/water) SOIL Lab Sample ID: 2343-1

Level (low/med): LOW Date Received: 11/09/94

% Solids: 74.2

Concentration Units: (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	10700		*	P
7440-36-0	Antimony	157		N *	P
7440-38-2	Arsenic	13.7		N * S	F
7440-39-3	Barium	1220		N *	P
7440-41-7	Beryllium	0.54	B		P
7440-43-9	Cadmium	2260		*	P
7440-70-2	Calcium	13400			P
7440-47-3	Chromium	3650		*	P
7440-48-4	Cobalt	18.7			P
7440-50-8	Copper	324			P
7439-89-6	Iron	63500		*	P
7439-92-1	Lead	7690		*	P
7439-95-4	Magnesium	2940			P
7439-96-5	Manganese	606			P
7439-97-6	Mercury	4.9			CV
7440-02-0	Nickel	153		N *	P
7440-09-7	Potassium	1310	B		P
7782-49-2	Selenium	59.9		* S	F
7440-22-4	Silver	3.3		N	P
7440-23-5	Sodium	268	B		P
7440-28-0	Thallium	0.27	U		F
7440-62-2	Vanadium	7.3	B		P
7440-66-6	Zinc	7290		*	P
	Cyanide	3.3			C

Color Before: BROWN Clarity Before: Texture: MEDIUM

Color After: YELLOW Clarity After: CLEAR Artifacts: YES

Comments: PEBBLES, LEAVES AND ROOTS

U.S. EPA - CLP

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

X101

Lab Name: ARDL, INC. Contract: 2343

Lab Code: ARDL Case No.: BBE SAS No.: _____ SDG No.: X101

Matrix (soil/water): SOIL Lab Sample ID: 2343-1

Level (low/med): LOW Date Received: 11/09/94

% Solids: 74.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
	Sulfate	82.4			
	Sulfide	26.9	U		

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

U.S. EPA - CLP

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

X102

Lab Name: ARDL, INC. Contract No.: 2343

Lab Code: ARDL Case No.: BBE SAS No.: _____ SDG No.: X101

Matrix (soil/water) SOIL Lab Sample ID: 2343-2

Level (low/med): LOW Date Received: 11/09/94

% Solids: 77.2

Concentration Units: (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	5710		*	P
7440-36-0	Antimony	5.2	U	N *	P
7440-38-2	Arsenic	1.4	B	N * S	F
7440-39-3	Barium	141		N *	P
7440-41-7	Beryllium	0.49	B		P
7440-43-9	Cadmium	3.9		*	P
7440-70-2	Calcium	18000			P
7440-47-3	Chromium	12.1		*	P
7440-48-4	Cobalt	7.4	B		P
7440-50-8	Copper	18.7			P
7439-89-6	Iron	11600		*	P
7439-92-1	Lead	152		*	P
7439-95-4	Magnesium	4250			P
7439-96-5	Manganese	372			P
7439-97-6	Mercury	0.13	U		CV
7440-02-0	Nickel	17.6		N *	P
7440-09-7	Potassium	1030	B		P
7782-49-2	Selenium	0.26	U	* W	F
7440-22-4	Silver	1.3	U	N	P
7440-23-5	Sodium	233	U		P
7440-28-0	Thallium	0.26	U		F
7440-62-2	Vanadium	16.0			P
7440-66-6	Zinc	689		*	P
	Cyanide	0.61	U		C

Color Before: GRAY/BROW Clarity Before: Texture: MEDIUM

Color After: YELLOW Clarity After: CLEAR Artifacts: YES

Comments: PEBBLES, LEAVES AND ROOTS

U.S. EPA - CLP

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

X102

Lab Name: ARDL, INC. Contract: 2343

Lab Code: ARDL Case No.: BBE SAS No.: _____ SDG No.: X101

Matrix (soil/water): SOIL Lab Sample ID: 2343-2

Level (low/med): LOW Date Received: 11/09/94

% Solids: 77.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
	Sulfate	51.4	U		
	Sulfide	25.5	U		

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

U.S. EPA - CLP

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

X103

Lab Name: ARDL, INC. Contract No.: 2343

Lab Code: ARDL Case No.: BBE SAS No.: _____ SDG No.: X101

Matrix (soil/water) SOIL Lab Sample ID: 2343-3

Level (low/med): LOW Date Received: 11/09/94

% Solids: 74.4

Concentration Units: (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	3240		*	P
7440-36-0	Antimony	17900		N *	P
7440-38-2	Arsenic	216		N * S	F
7440-39-3	Barium	1680		N *	P
7440-41-7	Beryllium	0.30	B		P
7440-43-9	Cadmium	8.7		*	P
7440-70-2	Calcium	10300			P
7440-47-3	Chromium	142		*	P
7440-48-4	Cobalt	13.3	B		P
7440-50-8	Copper	1630			P
7439-89-6	Iron	80500		*	P
7439-92-1	Lead	195000		*	P
7439-95-4	Magnesium	1350			P
7439-96-5	Manganese	1270			P
7439-97-6	Mercury	0.25			CV
7440-02-0	Nickel	101		N *	P
7440-09-7	Potassium	446	B		P
7782-49-2	Selenium	1.3	U	* E	F
7440-22-4	Silver	30.2		N	P
7440-23-5	Sodium	242	U		P
7440-28-0	Thallium	0.89	B		F
7440-62-2	Vanadium	1.3	U		P
7440-66-6	Zinc	9520		*	P
	Cyanide	2.8			C

Color Before: BROWN Clarity Before: Texture: MEDIUM

Color After: YELLOW Clarity After: CLEAR Artifacts: YES

Comments: PEBBLES, LEAVES AND ROOTS

U.S. EPA - CLP

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INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

X103

Lab Name: ARDL, INC. Contract: 2343

Lab Code: ARDL Case No.: BBE SAS No.: _____ SDG No.: X101

Matrix (soil/water): SOIL Lab Sample ID: 2343-3

Level (low/med): LOW Date Received: 11/09/94

% Solids: 74.4

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
	Sulfate	55.9			
	Sulfide	26.7	U		

Color Before: _____ Clarity Before: _____ Texture: _____

Color After: _____ Clarity After: _____ Artifacts: _____

Comments:

VOLATILES ANALYSIS DATA PACKAGE
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
FACILITY NAME: SAUGET SA 1 & 2
ARDL REPORT NO.: 2343

VOLUME 3

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X101

Lab Name: ARDL, INC. Contract: SAUGET SA 1&2

Lab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

Matrix: (soil/water) SOIL Lab Sample ID: 2343-1

Sample wt/vol: 5.0 (g/mL) G Lab File ID: >D0741

Level: (low/med) LOW Date Received: 11/09/94

% Moisture: not dec. 26 Date Analyzed: 11/15/94

GC column: 1%SP-1000 ID: 2.0 (mm) Dilution Factor: 1.0

Soil Extract Volume: --- (uL) Soil Aliquot Volume: --- (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
74-87-3	Chloromethane	14.	U
74-83-9	Bromomethane	14.	U
75-01-4	Vinyl Chloride	14.	U
75-00-3	Chloroethane	14.	U
75-09-2	Methylene Chloride	15.	
67-64-1	Acetone	14.	U
75-15-0	Carbon Disulfide	14.	U
75-35-4	1,1-Dichloroethene	14.	U
75-34-3	1,1-Dichloroethane	24.	
540-59-0	1,2-Dichloroethene (total)	240.	
67-66-3	Chloroform	14.	U
107-06-2	1,2-Dichloroethane	14.	U
78-93-3	2-Butanone	14.	U
71-55-6	1,1,1-Trichloroethane	10.	J
56-23-5	Carbon Tetrachloride	14.	U
75-27-4	Bromodichloromethane	14.	U
78-87-5	1,2-Dichloropropane	14.	U
10061-01-5	cis-1,3-Dichloropropene	14.	U
79-01-6	Trichloroethene	6.	J
124-48-1	Dibromochloromethane	14.	U
79-00-5	1,1,2-Trichloroethane	14.	U
71-43-2	Benzene	5.	J
10061-02-6	trans-1,3-Dichloropropene	14.	U
75-25-2	Bromoform	14.	U
108-10-1	4-Methyl-2-Pentanone	14.	U
591-78-6	2-Hexanone	14.	U
127-18-4	Tetrachloroethene	14.	U
79-34-5	1,1,2,2-Tetrachloroethane	14.	U
108-88-3	Toluene	8.	J
108-90-7	Chlorobenzene	14.	U
100-41-4	Ethylbenzene	14.	U
100-42-5	Styrene	14.	U
1330-20-7	Xylene (total)	14.	U

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X102

ab Name: ARDL, INC. Contract: SAUGET SA 1&2

ab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

atrix: (soil/water) SOIL Lab Sample ID: 2343-2

ample wt/vol: 5.0 (g/mL) G Lab File ID: >D0742

evel: (low/med) LOW Date Received: 11/09/94

Moisture: not dec. 23 Date Analyzed: 11/15/94

column: 1%SP-1000 ID: 2.0 (mm) Dilution Factor: 1.0

oil Extract Volume: --- (uL) Soil Aliquot Volume: --- (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
74-87-3	Chloromethane	13.	U
74-83-9	Bromomethane	13.	U
75-01-4	Vinyl Chloride	13.	U
75-00-3	Chloroethane	13.	U
75-09-2	Methylene Chloride	6.	J
67-64-1	Acetone	13.	U
75-15-0	Carbon Disulfide	13.	U
75-35-4	1,1-Dichloroethene	13.	U
75-34-3	1,1-Dichloroethane	13.	U
540-59-0	1,2-Dichloroethene (total)	13.	U
67-66-3	Chloroform	10.	J
107-06-2	1,2-Dichloroethane	13.	U
78-93-3	2-Butanone	13.	U
71-55-6	1,1,1-Trichloroethane	13.	U
56-23-5	Carbon Tetrachloride	13.	U
75-27-4	Bromodichloromethane	13.	U
78-87-5	1,2-Dichloropropane	13.	U
10061-01-5	cis-1,3-Dichloropropene	13.	U
79-01-6	Trichloroethene	13.	U
124-48-1	Dibromochloromethane	13.	U
79-00-5	1,1,2-Trichloroethane	13.	U
71-43-2	Benzene	13.	U
10061-02-6	trans-1,3-Dichloropropene	13.	U
75-25-2	Bromoform	13.	U
108-10-1	4-Methyl-2-Pentanone	13.	U
591-78-6	2-Hexanone	13.	U
127-18-4	Tetrachloroethene	13.	U
79-34-5	1,1,2,2-Tetrachloroethane	13.	U
108-88-3	Toluene	13.	U
108-90-7	Chlorobenzene	13.	U
100-41-4	Ethylbenzene	13.	U
100-42-5	Styrene	13.	U
1330-20-7	Xylene (total)	13.	U

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X105

ab Name: ARDL, INC. Contract: SAUGET SA 1&2

ab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

latrix: (soil/water) SOIL Lab Sample ID: 2343-5

ample wt/vol: 5.0 (g/mL) G Lab File ID: >D0745

evel: (low/med) LOW Date Received: 11/09/94

Moisture: not dec. 24 Date Analyzed: 11/15/94

: column: 1%SP-1000 ID: 2.0 (mm) Dilution Factor: 1.0

oil Extract Volume: --- (uL) Soil Aliquot Volume: --- (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
74-87-3	Chloromethane	13.	U
74-83-9	Bromomethane	13.	U
75-01-4	Vinyl Chloride	13.	U
75-00-3	Chloroethane	13.	U
75-09-2	Methylene Chloride	5.	J
67-64-1	Acetone	27.	
75-15-0	Carbon Disulfide	13.	U
75-35-4	1,1-Dichloroethene	13.	U
75-34-3	1,1-Dichloroethane	13.	U
540-59-0	1,2-Dichloroethene (total)	13.	U
67-66-3	Chloroform	13.	U
107-06-2	1,2-Dichloroethane	13.	U
78-93-3	2-Butanone	13.	U
71-55-6	1,1,1-Trichloroethane	13.	U
56-23-5	Carbon Tetrachloride	13.	U
75-27-4	Bromodichloromethane	13.	U
78-87-5	1,2-Dichloropropane	13.	U
10061-01-5	cis-1,3-Dichloropropene	13.	U
79-01-6	Trichloroethene	13.	U
124-48-1	Dibromochloromethane	13.	U
79-00-5	1,1,2-Trichloroethane	13.	U
71-43-2	Benzene	13.	U
10061-02-6	trans-1,3-Dichloropropene	13.	U
75-25-2	Bromoform	13.	U
108-10-1	4-Methyl-2-Pentanone	13.	U
591-78-6	2-Hexanone	13.	U
127-18-4	Tetrachloroethene	5.	J
79-34-5	1,1,2,2-Tetrachloroethane	13.	U
108-88-3	Toluene	14.	
108-90-7	Chlorobenzene	13.	U
100-41-4	Ethylbenzene	13.	U
100-42-5	Styrene	13.	U
1330-20-7	Xylene (total)	14.	

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X106

Lab Name: ARDL, INC. Contract: SAUGET SA 1&2

Lab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

Matrix: (soil/water) SOIL Lab Sample ID: 2343-6

Sample wt/vol: 5.0 (g/mL) G Lab File ID: >D0749

Level: (low/med) LOW Date Received: 11/09/94

% Moisture: not dec. 20 Date Analyzed: 11/15/94

GC column: 1%SP-1000 ID: 2.0 (mm) Dilution Factor: 1.0

Soil Extract Volume: --- (uL) Soil Aliquot Volume: --- (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
74-87-3	Chloromethane	12.	U
74-83-9	Bromomethane	12.	U
75-01-4	Vinyl Chloride	12.	U
75-00-3	Chloroethane	12.	U
75-09-2	Methylene Chloride	12.	U
67-64-1	Acetone	12.	U
75-15-0	Carbon Disulfide	12.	U
75-35-4	1,1-Dichloroethene	12.	U
75-34-3	1,1-Dichloroethane	12.	U
540-59-0	1,2-Dichloroethene (total)	12.	U
67-66-3	Chloroform	12.	U
107-06-2	1,2-Dichloroethane	12.	U
78-93-3	2-Butanone	12.	U
71-55-6	1,1,1-Trichloroethane	18.	
56-23-5	Carbon Tetrachloride	12.	U
75-27-4	Bromodichloromethane	12.	U
78-87-5	1,2-Dichloropropane	12.	U
10061-01-5	cis-1,3-Dichloropropene	12.	U
79-01-6	Trichloroethene	12.	U
124-48-1	Dibromochloromethane	12.	U
79-00-5	1,1,2-Trichloroethane	12.	U
71-43-2	Benzene	12.	U
10061-02-6	trans-1,3-Dichloropropene	12.	U
75-25-2	Bromoform	12.	U
108-10-1	4-Methyl-2-Pentanone	12.	U
591-78-6	2-Hexanone	12.	U
127-18-4	Tetrachloroethene	12.	U
79-34-5	1,1,2,2-Tetrachloroethane	12.	U
108-88-3	Toluene	12.	U
108-90-7	Chlorobenzene	12.	U
100-41-4	Ethylbenzene	12.	U
100-42-5	Styrene	12.	U
1330-20-7	Xylene (total)	12.	U

SEMI-VOLATILES ANALYSIS DATA PACKAGE
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
FACILITY NAME: SAUGET 1 & 2
ARDL REPORT NO. 2343

VOLUME 4-1

1B
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X104

Lab Name: ARDL, INC. Contract: SAUGET SA 1 & 2

Lab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

Matrix: (soil/water) SOIL Lab Sample ID: 2343-4

Sample wt/vol: 30.0 (g/mL) G Lab File ID: >M7294

Level: (low/med) LOW Date Received: 11/09/94

% Moisture: 28 decanted: (Y/N) N Date Extracted: 11/18/94

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/02/94

Injection Volume: 2.0 (uL) Dilution Factor: 50000.0

GPC Cleanup: (Y/N) Y pH: 6.7 Conversion Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	23000000.	U
111-44-4	bis(2-Chloroethyl)ether	23000000.	U
95-57-8	2-Chlorophenol	23000000.	U
541-73-1	1,3-Dichlorobenzene	23000000.	U
106-46-7	1,4-Dichlorobenzene	23000000.	U
95-50-1	1,2-Dichlorobenzene	23000000.	U
95-48-7	2-Methylphenol	23000000.	U
108-60-1	2,2'-oxybis(1-Chloropropane)	23000000.	U
106-44-5	4-Methylphenol	23000000.	U
621-64-7	N-Nitroso-Di-n-propylamine	23000000.	U
67-72-1	Hexachloroethane	23000000.	U
98-95-3	Nitrobenzene	23000000.	U
78-59-1	Isophorone	23000000.	U
88-75-5	2-Nitrophenol	23000000.	U
105-67-9	2,4-Dimethylphenol	23000000.	U
111-91-1	bis(2-Chloroethoxy)methane	23000000.	U
120-83-2	2,4-Dichlorophenol	23000000.	U
120-82-1	1,2,4-Trichlorobenzene	23000000.	U
91-20-3	Naphthalene	23000000.	U
106-47-8	4-Chloroaniline	23000000.	U
87-68-3	Hexachlorobutadiene	23000000.	U
59-50-7	4-Chloro-3-methylphenol	23000000.	U
91-57-6	2-Methylnaphthalene	23000000.	U
77-47-4	Hexachlorocyclopentadiene	23000000.	U
88-06-2	2,4,6-Trichlorophenol	23000000.	U
95-95-4	2,4,5-Trichlorophenol	56000000.	U
91-58-7	2-Chloronaphthalene	23000000.	U
88-74-4	2-Nitroaniline	56000000.	U
131-11-3	Dimethylphthalate	23000000.	U
208-96-8	Acenaphthylene	23000000.	U
606-20-2	2,6-Dinitrotoluene	23000000.	U
99-09-2	3-Nitroaniline	56000000.	U
83-32-9	Acenaphthene	23000000.	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X104

Lab Name: ARDL, INC. Contract: SAUGET SA 1 & 2

Lab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

Matrix: (soil/water) SOIL Lab Sample ID: 2343-4

Sample wt/vol: 30.0 (g/mL) G Lab File ID: >M7294

Level: (low/med) LOW Date Received: 11/09/94

% Moisture: 28 decanted: (Y/N) N Date Extracted: 11/18/94

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 12/02/94

Injection Volume: 2.0 (uL) Dilution Factor: 50000.0

GPC Cleanup: (Y/N) Y pH: 6.7 Conversion Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	56000000.	U
100-02-7	4-Nitrophenol	56000000.	U
132-64-9	Dibenzofuran	23000000.	U
121-14-2	2,4-Dinitrotoluene	23000000.	U
84-66-2	Diethylphthalate	23000000.	U
7005-72-3	4-Chlorophenyl-phenylether	23000000.	U
86-73-7	Fluorene	23000000.	U
100-01-6	4-Nitroaniline	56000000.	U
534-52-1	4,6-Dinitro-2-methylphenol	56000000.	U
86-30-6	N-Nitrosodiphenylamine (1)	23000000.	U
101-55-3	4-Bromophenyl-phenylether	23000000.	U
118-74-1	Hexachlorobenzene	23000000.	U
87-86-5	Pentachlorophenol	56000000.	U
85-01-8	Phenanthrene	23000000.	U
120-12-7	Anthracene	23000000.	U
86-74-8	Carbazole	23000000.	U
84-74-2	Di-n-butylphthalate	23000000.	U
206-44-0	Fluoranthene	23000000.	U
129-00-0	Pyrene	23000000.	U
85-68-7	Butylbenzylphthalate	23000000.	U
91-94-1	3,3'-Dichlorobenzidine	23000000.	U
56-55-3	Benzo(a)anthracene	23000000.	U
218-01-9	Chrysene	23000000.	U
117-81-7	bis(2-Ethylhexyl)phthalate	110000000.	B
117-84-0	Di-n-octylphthalate	23000000.	U
205-99-2	Benzo(b)fluoranthene	23000000.	U
207-08-9	Benzo(k)fluoranthene	23000000.	U
50-32-8	Benzo(a)pyrene	23000000.	U
193-39-5	Indeno(1,2,3-cd)pyrene	23000000.	U
53-70-3	Dibenz(a,h)anthracene	23000000.	U
191-24-2	Benzo(g,h,i)perylene	23000000.	U

(1) - Cannot be separated from Diphenylamine

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X107

Lab Name: ARDL, INC. Contract: SAUGET SA 1 & 2

Lab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

Matrix: (soil/water) SOIL Lab Sample ID: 2343-7

Sample wt/vol: 30.0 (g/mL) G Lab File ID: >W4083

Level: (low/med) LOW Date Received: 11/09/94

% Moisture: 24 decanted: (Y/N) N Date Extracted: 11/18/94

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 11/30/94

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 6.0 Conversion Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	430.	U
111-44-4	bis(2-Chloroethyl)ether	430.	U
95-57-8	2-Chlorophenol	430.	U
541-73-1	1,3-Dichlorobenzene	430.	U
106-46-7	1,4-Dichlorobenzene	430.	U
95-50-1	1,2-Dichlorobenzene	430.	U
95-48-7	2-Methylphenol	270.	J
108-60-1	2,2'-oxybis(1-Chloropropane)	430.	U
106-44-5	4-Methylphenol	280.	J
621-64-7	N-Nitroso-Di-n-propylamine	430.	U
67-72-1	Hexachloroethane	430.	U
98-95-3	Nitrobenzene	430.	U
78-59-1	Isophorone	210.	J
88-75-5	2-Nitrophenol	430.	U
105-67-9	2,4-Dimethylphenol	270.	J
111-91-1	bis(2-Chloroethoxy)methane	430.	U
120-83-2	2,4-Dichlorophenol	430.	U
120-82-1	1,2,4-Trichlorobenzene	430.	U
91-20-3	Naphthalene	430.	U
106-47-8	4-Chloroaniline	430.	U
87-68-3	Hexachlorobutadiene	430.	U
59-50-7	4-Chloro-3-methylphenol	430.	U
91-57-6	2-Methylnaphthalene	430.	U
77-47-4	Hexachlorocyclopentadiene	430.	U
88-06-2	2,4,6-Trichlorophenol	430.	U
95-95-4	2,4,5-Trichlorophenol	1000.	U
91-58-7	2-Chloronaphthalene	430.	U
88-74-4	2-Nitroaniline	1000.	U
131-11-3	Dimethylphthalate	430.	U
208-96-8	Acenaphthylene	430.	U
606-20-2	2,6-Dinitrotoluene	430.	U
99-09-2	3-Nitroaniline	1000.	U
83-32-9	Acenaphthene	430.	U

1C
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X107

Lab Name: ARDL, INC. Contract: SAUGET SA 1 & 2

Lab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

Matrix: (soil/water) SOIL Lab Sample ID: 2343-7

Sample wt/vol: 30.0 (g/mL) G Lab File ID: >W4083

Level: (low/med) LOW Date Received: 11/09/94

% Moisture: 24 decanted: (Y/N) N Date Extracted: 11/18/94

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 11/30/94

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 6.0 Conversion Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	1000.	U
100-02-7	4-Nitrophenol	1000.	U
132-64-9	Dibenzofuran	430.	U
121-14-2	2,4-Dinitrotoluene	430.	U
84-66-2	Diethylphthalate	430.	U
7005-72-3	4-Chlorophenyl-phenylether	430.	U
86-73-7	Fluorene	430.	U
100-01-6	4-Nitroaniline	1000.	U
534-52-1	4,6-Dinitro-2-methylphenol	1000.	U
86-30-6	N-Nitrosodiphenylamine (1)	430.	U
101-55-3	4-Bromophenyl-phenylether	430.	U
118-74-1	Hexachlorobenzene	430.	U
87-86-5	Pentachlorophenol	1000.	U
85-01-8	Phenanthrene	430.	U
120-12-7	Anthracene	430.	U
86-74-8	Carbazole	430.	U
84-74-2	Di-n-butylphthalate	430.	U
206-44-0	Fluoranthene	430.	U
129-00-0	Pyrene	430.	U
85-68-7	Butylbenzylphthalate	120.	J
91-94-1	3,3'-Dichlorobenzidine	430.	U
56-55-3	Benzo(a)anthracene	430.	U
218-01-9	Chrysene	430.	U
117-81-7	bis(2-Ethylhexyl)phthalate	1900.	B
117-84-0	Di-n-octylphthalate	430.	U
205-99-2	Benzo(b)fluoranthene	430.	U
207-08-9	Benzo(k)fluoranthene	430.	U
50-32-8	Benzo(a)pyrene	430.	U
193-39-5	Indeno(1,2,3-cd)pyrene	430.	U
53-70-3	Dibenz(a,h)anthracene	430.	U
191-24-2	Benzo(g,h,i)perylene	430.	U

(1) - Cannot be separated from Diphenylamine

SEMI-VOLATILES ANALYSIS DATA PACKAGE
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
FACILITY NAME: SAUGET 1 & 2
ARDL REPORT NO. 2343

VOLUME 4-2

1B
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X109

Lab Name: ARDL, INC. Contract: SAUGET SA 1 & 2

Lab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

Matrix: (soil/water) SOIL Lab Sample ID: 2343-9

Sample wt/vol: 30.0 (g/mL) G Lab File ID: >W4087

Level: (low/med) LOW Date Received: 11/09/94

% Moisture: 27 decanted: (Y/N) N Date Extracted: 11/18/94

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 11/30/94

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 3.6 Conversion Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	450.	U
111-44-4	bis(2-Chloroethyl)ether	450.	U
95-57-8	2-Chlorophenol	450.	U
541-73-1	1,3-Dichlorobenzene	450.	U
106-46-7	1,4-Dichlorobenzene	450.	U
95-50-1	1,2-Dichlorobenzene	450.	U
95-48-7	2-Methylphenol	450.	U
108-60-1	2,2'-oxybis(1-Chloropropane)	450.	U
106-44-5	4-Methylphenol	450.	U
621-64-7	N-Nitroso-Di-n-propylamine	450.	U
67-72-1	Hexachloroethane	450.	U
98-95-3	Nitrobenzene	450.	U
78-59-1	Isophorone	450.	U
88-75-5	2-Nitrophenol	450.	U
105-67-9	2,4-Dimethylphenol	450.	U
111-91-1	bis(2-Chloroethoxy)methane	450.	U
120-83-2	2,4-Dichlorophenol	450.	U
120-82-1	1,2,4-Trichlorobenzene	450.	U
91-20-3	Naphthalene	450.	U
106-47-8	4-Chloroaniline	450.	U
87-68-3	Hexachlorobutadiene	450.	U
59-50-7	4-Chloro-3-methylphenol	450.	U
91-57-6	2-Methylnaphthalene	450.	U
77-47-4	Hexachlorocyclopentadiene	450.	U
88-06-2	2,4,6-Trichlorophenol	450.	U
95-95-4	2,4,5-Trichlorophenol	1100.	U
91-58-7	2-Chloronaphthalene	450.	U
88-74-4	2-Nitroaniline	1100.	U
131-11-3	Dimethylphthalate	450.	U
208-96-8	Acenaphthylene	450.	U
606-20-2	2,6-Dinitrotoluene	450.	U
99-09-2	3-Nitroaniline	1100.	U
83-32-9	Acenaphthene	450.	U

1C
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X109

Lab Name: ARDL, INC. Contract: SAUGET SA 1 & 2

Lab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

Matrix: (soil/water) SOIL Lab Sample ID: 2343-9

Sample wt/vol: 30.0 (g/mL) G Lab File ID: >W4087

Level: (low/med) LOW Date Received: 11/09/94

% Moisture: 27 decanted: (Y/N) N Date Extracted: 11/18/94

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 11/30/94

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 3.6 Conversion Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	1100.	U
100-02-7	4-Nitrophenol	1100.	U
132-64-9	Dibenzofuran	450.	U
121-14-2	2,4-Dinitrotoluene	450.	U
84-66-2	Diethylphthalate	450.	U
7005-72-3	4-Chlorophenyl-phenylether	450.	U
86-73-7	Fluorene	450.	U
100-01-6	4-Nitroaniline	1100.	U
534-52-1	4,6-Dinitro-2-methylphenol	1100.	U
86-30-6	N-Nitrosodiphenylamine (1)	450.	U
101-55-3	4-Bromophenyl-phenylether	450.	U
118-74-1	Hexachlorobenzene	450.	U
87-86-5	Pentachlorophenol	1100.	U
85-01-8	Phenanthrene	76.	J
120-12-7	Anthracene	450.	U
86-74-8	Carbazole	450.	U
84-74-2	Di-n-butylphthalate	310.	J
206-44-0	Fluoranthene	160.	J
129-00-0	Pyrene	170.	J
85-68-7	Butylbenzylphthalate	450.	U
91-94-1	3,3'-Dichlorobenzidine	450.	U
56-55-3	Benzo(a)anthracene	89.	J
218-01-9	Chrysene	110.	J
117-81-7	bis(2-Ethylhexyl)phthalate	310.	JB
117-84-0	Di-n-octylphthalate	450.	U
205-99-2	Benzo(b)fluoranthene	87.	J
207-08-9	Benzo(k)fluoranthene	96.	J
50-32-8	Benzo(a)pyrene	84.	J
193-39-5	Indeno(1,2,3-cd)pyrene	450.	U
53-70-3	Dibenz(a,h)anthracene	450.	U
191-24-2	Benzo(g,h,i)perylene	450.	U

(1) - Cannot be separated from Diphenylamine

1B
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X110

Lab Name: ARDL, INC. Contract: SAUGET SA 1 & 2

Lab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

Matrix: (soil/water) SOIL Lab Sample ID: 2343-10

Sample wt/vol: 30.0 (g/mL) G Lab File ID: >W4088

Level: (low/med) LOW Date Received: 11/09/94

% Moisture: 29 decanted: (Y/N) N Date Extracted: 11/18/94

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 11/30/94

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 3.7 Conversion Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	460.	U
111-44-4	bis(2-Chloroethyl)ether	460.	U
95-57-8	2-Chlorophenol	460.	U
541-73-1	1,3-Dichlorobenzene	460.	U
106-46-7	1,4-Dichlorobenzene	460.	U
95-50-1	1,2-Dichlorobenzene	460.	U
95-48-7	2-Methylphenol	460.	U
108-60-1	2,2'-oxybis(1-Chloropropane)	460.	U
106-44-5	4-Methylphenol	460.	U
621-64-7	N-Nitroso-Di-n-propylamine	460.	U
67-72-1	Hexachloroethane	460.	U
98-95-3	Nitrobenzene	460.	U
78-59-1	Isophorone	460.	U
88-75-5	2-Nitrophenol	460.	U
105-67-9	2,4-Dimethylphenol	460.	U
111-91-1	bis(2-Chloroethoxy)methane	460.	U
120-83-2	2,4-Dichlorophenol	460.	U
120-82-1	1,2,4-Trichlorobenzene	460.	U
91-20-3	Naphthalene	460.	U
106-47-8	4-Chloroaniline	460.	U
87-68-3	Hexachlorobutadiene	460.	U
59-50-7	4-Chloro-3-methylphenol	460.	U
91-57-6	2-Methylnaphthalene	460.	U
77-47-4	Hexachlorocyclopentadiene	460.	U
88-06-2	2,4,6-Trichlorophenol	460.	U
95-95-4	2,4,5-Trichlorophenol	1100.	U
91-58-7	2-Chloronaphthalene	460.	U
88-74-4	2-Nitroaniline	1100.	U
131-11-3	Dimethylphthalate	460.	U
208-96-8	Acenaphthylene	460.	U
606-20-2	2,6-Dinitrotoluene	460.	U
99-09-2	3-Nitroaniline	1100.	U
83-32-9	Acenaphthene	460.	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X110

Lab Name: ARDL, INC. Contract: SAUGET SA 1 & 2

Lab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

Matrix: (soil/water) SOIL Lab Sample ID: 2343-10

Sample wt/vol: 30.0 (g/mL) G Lab File ID: >W4088

Level: (low/med) LOW Date Received: 11/09/94

% Moisture: 29 decanted: (Y/N) N Date Extracted: 11/18/94

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 11/30/94

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 3.7 Conversion Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	1100.	U
100-02-7	4-Nitrophenol	1100.	U
132-64-9	Dibenzofuran	460.	U
121-14-2	2,4-Dinitrotoluene	460.	U
84-66-2	Diethylphthalate	460.	U
7005-72-3	4-Chlorophenyl-phenylether	460.	U
86-73-7	Fluorene	460.	U
100-01-6	4-Nitroaniline	1100.	U
534-52-1	4,6-Dinitro-2-methylphenol	1100.	U
86-30-6	N-Nitrosodiphenylamine (1)	460.	U
101-55-3	4-Bromophenyl-phenylether	460.	U
118-74-1	Hexachlorobenzene	460.	U
87-86-5	Pentachlorophenol	1100.	U
85-01-8	Phenanthrene	460.	U
120-12-7	Anthracene	460.	U
86-74-8	Carbazole	460.	U
84-74-2	Di-n-butylphthalate	380.	J
206-44-0	Fluoranthene	460.	U
129-00-0	Pyrene	460.	U
85-68-7	Butylbenzylphthalate	460.	U
91-94-1	3,3'-Dichlorobenzidine	460.	U
56-55-3	Benzo(a)anthracene	460.	U
218-01-9	Chrysene	460.	U
117-81-7	bis(2-Ethylhexyl)phthalate	1000.	B
117-84-0	Di-n-octylphthalate	460.	U
205-99-2	Benzo(b)fluoranthene	460.	U
207-08-9	Benzo(k)fluoranthene	460.	U
50-32-8	Benzo(a)pyrene	460.	U
193-39-5	Indeno(1,2,3-cd)pyrene	460.	U
53-70-3	Dibenz(a,h)anthracene	460.	U
191-24-2	Benzo(g,h,i)perylene	460.	U

(1) - Cannot be separated from Diphenylamine

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X111

Lab Name: ARDL, INC. Contract: SAUGET SA 1 & 2

Lab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

Matrix: (soil/water) SOIL Lab Sample ID: 2343-11

Sample wt/vol: 30.0 (g/mL) G Lab File ID: >W4089

Level: (low/med) LOW Date Received: 11/09/94

% Moisture: 29 decanted: (Y/N) N Date Extracted: 11/18/94

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 11/30/94

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 5.8 Conversion Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	460.	U
111-44-4	bis(2-Chloroethyl)ether	460.	U
95-57-8	2-Chlorophenol	460.	U
541-73-1	1,3-Dichlorobenzene	460.	U
106-46-7	1,4-Dichlorobenzene	460.	U
95-50-1	1,2-Dichlorobenzene	460.	U
95-48-7	2-Methylphenol	460.	U
108-60-1	2,2'-oxybis(1-Chloropropane)	460.	U
106-44-5	4-Methylphenol	460.	U
621-64-7	N-Nitroso-Di-n-propylamine	460.	U
67-72-1	Hexachloroethane	460.	U
98-95-3	Nitrobenzene	460.	U
78-59-1	Isophorone	460.	U
88-75-5	2-Nitrophenol	460.	U
105-67-9	2,4-Dimethylphenol	460.	U
111-91-1	bis(2-Chloroethoxy)methane	460.	U
120-83-2	2,4-Dichlorophenol	460.	U
120-82-1	1,2,4-Trichlorobenzene	460.	U
91-20-3	Naphthalene	460.	U
106-47-8	4-Chloroaniline	460.	U
87-68-3	Hexachlorobutadiene	460.	U
59-50-7	4-Chloro-3-methylphenol	460.	U
91-57-6	2-Methylnaphthalene	460.	U
77-47-4	Hexachlorocyclopentadiene	460.	U
88-06-2	2,4,6-Trichlorophenol	460.	U
95-95-4	2,4,5-Trichlorophenol	1100.	U
91-58-7	2-Chloronaphthalene	460.	U
88-74-4	2-Nitroaniline	1100.	U
131-11-3	Dimethylphthalate	460.	U
208-96-8	Acenaphthylene	460.	U
606-20-2	2,6-Dinitrotoluene	460.	U
99-09-2	3-Nitroaniline	1100.	U
83-32-9	Acenaphthene	460.	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X111

Lab Name: ARDL, INC. Contract: SAUGET SA 1 & 2

Lab Code: --- Case No.: --- SAS No.: --- SDG No.: X101

Matrix: (soil/water) SOIL Lab Sample ID: 2343-11

Sample wt/vol: 30.0 (g/mL) G Lab File ID: >W4089

Level: (low/med) LOW Date Received: 11/09/94

% Moisture: 29 decanted: (Y/N) N Date Extracted: 11/18/94

Concentrated Extract Volume: 500.0 (uL) Date Analyzed: 11/30/94

Injection Volume: 2.0 (uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) Y pH: 5.8 Conversion Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
51-28-5	2,4-Dinitrophenol	1100.	U
100-02-7	4-Nitrophenol	1100.	U
132-64-9	Dibenzofuran	460.	U
121-14-2	2,4-Dinitrotoluene	460.	U
84-66-2	Diethylphthalate	460.	U
7005-72-3	4-Chlorophenyl-phenylether	460.	U
86-73-7	Fluorene	460.	U
100-01-6	4-Nitroaniline	1100.	U
534-52-1	4,6-Dinitro-2-methylphenol	1100.	U
86-30-6	N-Nitrosodiphenylamine (1)	460.	U
101-55-3	4-Bromophenyl-phenylether	460.	U
118-74-1	Hexachlorobenzene	460.	U
87-86-5	Pentachlorophenol	1100.	U
85-01-8	Phenanthrene	73.	J
120-12-7	Anthracene	62.	J
86-74-8	Carbazole	460.	U
84-74-2	Di-n-butylphthalate	250.	J
206-44-0	Fluoranthene	140.	J
129-00-0	Pyrene	140.	J
85-68-7	Butylbenzylphthalate	460.	U
91-94-1	3,3'-Dichlorobenzidine	460.	U
56-55-3	Benzo(a)anthracene	460.	U
218-01-9	Chrysene	110.	J
117-81-7	bis(2-Ethylhexyl)phthalate	1500.	
117-84-0	Di-n-octylphthalate	460.	U
205-99-2	Benzo(b)fluoranthene	110.	J
207-08-9	Benzo(k)fluoranthene	88.	J
50-32-8	Benzo(a)pyrene	460.	U
193-39-5	Indeno(1,2,3-cd)pyrene	460.	U
53-70-3	Dibenz(a,h)anthracene	460.	U
191-24-2	Benzo(g,h,i)perylene	460.	U

(1) - Cannot be separated from Diphenylamine

PESTICIDE/PCB ANALYSIS DATA PACKAGE
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
FACILITY NAME: SAUGET 1 & 2
ARDL REPORT NO. 2343

VOLUME 5-1

1D

PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X101

Lab Name: ARDL, INC. Contract: SAUGET SA 1+2
Lab Code: Case No.: 2343 SDG No.: X101
Matrix(soil/water) : SOIL Lab Sample ID : 2343-1
Sample(wt/vol) : 30.0 (g/mL) g Lab File ID :
% Moisture: 26 decanted:(Y/N) N Date Received : 11/09/94
Extraction(Sepf/Cont/Sonc) SONC Date Extracted : 11/16/94
Concentrated Extract Volume:5000(uL) Date Analyzed : 11/24/94
Injection Volume: 1 (uL) Dilution Factor: 200.0
GPC Cleanup:(Y/N) Y pH: 6.6 Sulfur Cleanup : N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/Kg	Q
319-84-6	alpha-BHC	460	U
319-85-7	beta-BHC	460	U
319-86-8	delta-BHC	460	U
58-89-9	gamma-BHC(Lindane)	460	U
76-44-8	Heptachlor	460	U
309-00-2	Aldrin	460	U
1024-57-3	Heptachlor Epoxide	460	U
959-98-8	Endosulfan I	460	U
60-57-1	Dieldrin	880	U
72-55-9	4,4'-DDE	880	U
72-20-8	Endrin	880	U
33213-65-9	Endosulfan II	880	U
72-54-8	4,4'-DDD	880	U
1013-07-8	Endosulfan sulfate	880	U
50-29-3	4,4'-DDT	880	U
72-43-5	Methoxychlor	4600	U
53494-70-5	Endrin ketone	880	U
7421-36-3	Endrin aldehyde	880	U
5103-71-9	alpha-Chlordane	460	U
5103-74-2	gamma-Chlordane	460	U
8001-35-2	Toxaphene	46000	U
12674-11-2	Aroclor 1016	8800	U
11104-28-2	Aroclor 1221	18000	U
11141-16-5	Aroclor 1232	8800	U
53469-21-9	Aroclor 1242	8800	U
12672-29-6	Aroclor 1248	8800	U
11097-69-1	Aroclor 1254	140000	E
11096-82-5	Aroclor 1260	83000	

1D

PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X101DL

Lab Name: ARDL, INC. Contract: SAUGET SA 1+2
Lab Code: Case No.: 2343 SDG No.: X101
Matrix(soil/water) : SOIL Lab Sample ID : 2343-1DL
Sample(wt/vol) : 30.0 (g/mL) g Lab File ID :
% Moisture: 26 decanted:(Y/N) N Date Received : 11/09/94
Extraction(Sepf/Cont/Sonc) SONC Date Extracted : 11/16/94
Concentrated Extract Volume:5000(uL) Date Analyzed : 11/24/94
Injection Volume: 1 (uL) Dilution Factor: 500.0
GPC Cleanup:(Y/N) Y pH: 6.6 Sulfur Cleanup : N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/Kg	Q
319-84-6	alpha-BHC	1200	U
319-85-7	beta-BHC	1200	U
319-86-8	delta-BHC	1200	U
58-89-9	gamma-BHC(Lindane)	1200	U
76-44-8	Heptachlor	1200	U
309-00-2	Aldrin	1200	U
1024-57-3	Heptachlor Epoxide	1200	U
959-98-8	Endosulfan I	1200	U
60-57-1	Dieldrin	2200	U
72-55-9	4,4'-DDE	2200	U
72-20-8	Endrin	2200	U
33213-65-9	Endosulfan II	2200	U
72-54-8	4,4'-DDD	2200	U
1013-07-8	Endosulfan sulfate	2200	U
50-29-3	4,4'-DDT	2200	U
72-43-5	Methoxychlor	12000	U
53494-70-5	Endrin ketone	2200	U
7421-36-3	Endrin aldehyde	2200	U
5103-71-9	alpha-Chlordane	1200	U
5103-74-2	gamma-Chlordane	1200	U
8001-35-2	Toxaphene	120000	U
12674-11-2	Aroclor 1016	22000	U
11104-28-2	Aroclor 1221	45000	U
11141-16-5	Aroclor 1232	22000	U
53469-21-9	Aroclor 1242	22000	U
12672-29-6	Aroclor 1248	22000	U
11097-69-1	Aroclor 1254	110000	P
11096-82-5	Aroclor 1260	72000	

1D

PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

X107

Lab Name: ARDL, INC. Contract: SAUGET 1+2
Lab Code: Case No.: 2343 SDG No.: X101
Matrix(soil/water) : SOIL Lab Sample ID : 2343-7
Sample(wt/vol) : 30.0 (g/mL) g Lab File ID :
% Moisture: 24 decanted:(Y/N) N Date Received : 11/09/94
Extraction(Sepf/Cont/Sonc) SONC Date Extracted : 11/16/94
Concentrated Extract Volume:5000(uL) Date Analyzed : 11/24/94
Injection Volume: 1 (uL) Dilution Factor: 10.0
GPC Cleanup:(Y/N) Y pH: 6.0 Sulfur Cleanup : N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/Kg	Q
319-84-6	alpha-BHC	22	U
319-85-7	beta-BHC	22	U
319-86-8	delta-BHC	22	U
58-89-9	gamma-BHC(Lindane)	22	U
76-44-8	Heptachlor	22	U
309-00-2	Aldrin	22	U
1024-57-3	Heptachlor Epoxide	22	U
959-98-8	Endosulfan I	22	U
60-57-1	Dieldrin	43	U
72-55-9	4,4'-DDE	43	U
72-20-8	Endrin	43	U
33213-65-9	Endosulfan II	43	U
72-54-8	4,4'-DDD	43	U
1013-07-8	Endosulfan sulfate	43	U
50-29-3	4,4'-DDT	43	U
72-43-5	Methoxychlor	220	U
53494-70-5	Endrin ketone	43	U
7421-36-3	Endrin aldehyde	43	U
5103-71-9	alpha-Chlordane	22	U
5103-74-2	gamma-Chlordane	22	U
8001-35-2	Toxaphene	2200	U
12674-11-2	Aroclor 1016	430	U
11104-28-2	Aroclor 1221	880	U
11141-16-5	Aroclor 1232	430	U
53469-21-9	Aroclor 1242	430	U
12672-29-6	Aroclor 1248	4800	P
11097-69-1	Aroclor 1254	11000	E
11096-82-5	Aroclor 1260	8800	PE

Exhibit 42

SAUGET AREA 2
ILD000605790

Reference No. 8

150748

DRAFT FEDERAL ON-SCENE COORDINATOR'S REPORT
FOR
AREA 2 SITE Q
CAHOKIA, ST. CLAIR COUNTY, ILLINOIS
TDD: S05-9909-015
PAN: 9P1501RAXX

July 31, 2000

Prepared for:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Emergency and Enforcement Response Branch
77 West Jackson Boulevard
Chicago, Illinois 60604

Prepared by: _____ Date: _____
Paul Atkociunas, START Project Manager

Reviewed by: _____ Date: 7/31/00
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Dan Sewall, START Program Manager

International Specialists in the Environment

33 North Dearborn Street, Chicago, Illinois 60602
Tel. 312/578-9243, Fax: 312/578-9345

Executive Summary

SITE: Area 2 Site Q

LOCATION: 70 Cargill Elevator Road
Cahokia, Illinois 62206

PROJECT DATES: October 18, 1999 to April 19, 2000

INCIDENT DESCRIPTION: Area 2 Site Q (Site Q) is an inactive industrial and municipal waste disposal area encompassing approximately 90 acres. Site Q was used as a waste disposal area for industrial and municipal wastes between the years of 1966 and 1973 and was operated by Sauget and Company. Site Q is located in west-central St. Clair County, Illinois adjacent to the Mississippi River in the towns of Cahokia and Sauget. The release of hazardous substances at Site Q was from the deliberate burial of wastes (drums, containers, and bulk waste). During previous investigations conducted by the Illinois Environmental Protection Agency and the U.S. Environmental Protection Agency wastes and soils on site were found to be contaminated with high levels of polychlorinated biphenyls (PCBs) and heavy metals (particularly arsenic, lead, chromium, mercury, and cadmium). The site is located on the river side of a flood control levee constructed by the U.S. Army Corps of Engineers. Due to its location, the site is highly vulnerable to flooding from the adjacent Mississippi River. Access to the site is unrestricted and local residents use the site for fishing, hunting and off-road motorcycling. The removal action was undertaken to mitigate threats to the public health and environment posed by the presence of drums at the surface, the possibility of drums beneath the surface, and contaminated soils.

ACTIONS: The United States Environmental Protection Agency (U.S. EPA) initiated this removal action on October 18, 1999. The ERRS contractor began to excavate site wastes on October 26, 1999. Eight excavation areas of various sizes were investigated and have had waste removed. This removal action addressed approximately 25-acres of site property. Based upon analytical results of the separate waste piles, two waste streams were developed. A low level PCB waste stream (soil < 50 ppm) was shipped via truck to the Milam Recycling and Disposal Facility located in East St. Louis, Illinois. One hundred sixty three trucks, each containing approximately 20 tons of low level PCB waste were shipped to the disposal facility. A PCB waste stream (soil/debris containing > 50 ppm of PCBs) was shipped via rail car to the Safety-Kleen Lone & Grassy Mountain facility, located in Waynoka, Oklahoma. One hundred forty one rail cars, each containing approximately 90 tons of PCB waste were shipped to the disposal facility. Drums (3,271) excavated on site have been crushed and added to either waste stream. Excavated drums that were void of waste material were added to either PCB waste stream; and drums that contained waste were added to the > 50 ppm PCB waste stream. On April 5, 2000, removal of site wastes was completed (approximately 17,032 tons of waste was removed from site). Drums/containers with distinguishing marks and labels have been documented and were added to the PCB waste stream or archived for future investigations. On April 13 and 17, 2000, the START contractor collected 24 subsurface soil samples in former excavation areas to determine concentrations of PCBs that remain in soils. Samples were collected below cover material in areas where drums and/or bulk wastes were removed. Analytical results of several of these samples indicate that concentrations of PCBs in site soils exceeds the removal action limit of 50 ppm. Due to lack of

topsoil needed to completely cap the excavation areas. municipal waste is visible on the limited portions of the site. Due to limited resources and the amount of contamination this removal action could not address all the contamination present on the site.

Kevin Turner. OSC
U.S. EPA. Region 5

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Emergency and Enforcement Response Branch
Office of Superfund, U.S. EPA, Region V
OSC Report Standard Appendices List

Site Name:	Area 2 Site Q
Site ID#:	05XX
Contract #:	68-S5-98-01
Delivery Order #:	9801-05-047

1. Operational Files	ID#
- Action Memos/Additional Funding	1-A
- POLREPs	1-B
- Site Entry/Exit Log	1-C
- Hot Zone Entry/Exit Log	1-D
- Site Safety Plan	1-E
- Equipment & Expendables Log	1-F
- Site Logs	1-G
- Site Computer Disks	1-H
- Daily Work Orders	1-I
- Site Monitoring Logs	1-J
- Site Maps	1-K
- Site Contacts/Business Cards	1-L
- Site Photos/Videos	1-M
- General Correspondence/Information	1-N
- Newspaper Articles	1-O
- Enforcement	1-P
- Other: _____	1-Q

2. Financial Files	ID#
- Delivery Orders	2-A
- START Technical Direction Documents	2-B
- Daily Cost Reporting US EPA Form 1900-55's	2-C
- ERCS Invoices	2-D
- RCMS Cost Estimates	2-E
- Subcontractor Bid Sheets	2-F
- START Cost Documentation	2-G
- Other: _____	2-H

3. Technical Files	ID#
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- Other Reports: _____	3A2
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- Compatibility Results	3-F
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* Portions of these OSC Report Appendices may contain confidential business information or enforcement-sensitive information and must be reviewed by the Office of Regional Counsel prior to release to the public.

I. SUMMARY OF EVENTS

A. Site Conditions and Background

1. Initial Situation

Area 2 Site Q (Site Q) is part of the Sauget Area sites that consist of several municipal and industrial waste landfills; surface disposal areas; and past excavation areas suspected to be filled or partially filled with unknown industrial wastes. The entire Sauget Site area is divided into Area 1 and Area 2. Sauget Area 2 is made up of five waste disposal areas (Sites O, P, Q, R, S). Sauget Area 2 is not listed on the NPL; however, listing activities are now underway. Site Q occupies 90 acres and was actively used as a waste disposal area by Sauget and Company for industrial and municipal wastes from the mid 1950's to 1973. Most of Site Q is presently owned by Eagle Marine Industries, Inc. of St. Louis, Missouri.

Site Q is located in west-central St. Clair County, Illinois adjacent to the Mississippi River (latitude 38°34'93.5" N, longitude 90°12'0.6" W) in the towns of Cahokia and Sauget. Across the river lies the city of St. Louis, Missouri. A site location map is included in Attachment A. The site is bordered by Site R and the Old Sauget Power Plant on the north; the United States Corps of Engineers (U.S. COE) flood control levee on the east; agricultural land on the south; and the Mississippi River on the west. A railroad spur divides the site, running northeast from Cargill Elevator Road to the northern one-third of the property. The area of interest for this removal action consists of the area east and south of the railroad spur, north of Cargill Elevator Road. During this removal action, approximately 25 acres of contamination were addressed. A site features map, completed by the United States Environmental Protection Agency (U.S. EPA) Fields Team, is included in Attachment A. An underground 14-inch, high pressure petroleum products Explorer pipeline lies along the western edge of the area of interest. The area of interest contains four ponds (north, south, east, and west) that are filled with water during various times of the year or during flooding. The nearest resident is located approximately 0.75 mile southeast of the site. Local residents use the ponds for fishing, hunting, and off-road motorcycling. The site contains evidence of trespassing (i.e., spent ammunition casings, and evidence of recreational vehicle use).

A number of investigations have taken place at Site Q. In June 1983, as a result of finding buried drums at the northern section of the site, a U.S. EPA Field Investigation Team (FIT) contractor collected 33 subsurface soil samples at the site. A total of 63 of 112 organic compounds from the priority pollutant list were detected. In October of 1984, Illinois Environmental Protection Agency (Illinois EPA) personnel conducted inspections to determine the scope of proposed cleanup work at the site. In March of 1985, the Illinois Attorney General's office reentered a suit against Sauget and Company, ordering a final cover over the site and requesting a civil penalty. As part of an Expanded Site Investigation conducted by Illinois EPA in March of 1987, a monitoring well was installed in the pond area of Site Q (well No. EE-09). A sample

collected from this well showed the presence of benzene at 1J parts per billion (ppb; J=estimated value), chlorobenzene (33 ppb), and di-n-octyl phthalate (4J ppb). As a result of severe flooding on the Mississippi River in the summer of 1993, waste materials including drums were left exposed along the shoreline side of Site Q. In May 1994, samples collected by the U.S. EPA Technical Assistance Team (TAT) contractor, Ecology and Environment Inc. (E & E), detected semivolatile organic compounds and polychlorinated biphenyls (PCBs) from the exposed wastes. One sample contained 260,000 parts per million (ppm) of PCBs. Illinois EPA collected 11 surface soil and waste samples from the east and west ponds in Site Q in November 1994. Analytical results of samples indicated the presence of heavy metals, arsenic (216 ppm), lead (195,000 ppm), and mercury (4.9 ppm). PCBs were also detected at concentrations as high as 223,000 ppb. In 1995, a removal action was conducted by U.S. EPA to remove the waste materials (including exposed drums from the banks of the Mississippi River) and repair the exposed sections of the fill area.

In August 1997, E & E completed a Preliminary Ecological Risk Assessment for the U.S. EPA to evaluate the risks to local wildlife from contamination from the area. The Preliminary Ecological Risk Assessment concluded that elevated concentrations of cadmium, chromium, lead, mercury, and PCBs could decrease species diversity of the area including sensitive species. Heavy metals and PCBs detected on site could also bioconcentrate in fish tissue at high levels. Local fisherman who use the site and consume their catch could be exposed to the high levels of metals and PCBs.

The primary drinking water source for nearby residences is from a water intake along the Mississippi River, located approximately 3 miles north of the site. Groundwater flow is primarily towards the southwest towards the Mississippi River. At least 50 residents in the area obtain drinking water from private wells. The nearest drinking water well is located on Judith Lane, approximately 1 mile east of Site Q. More than eight industrial wells are located within a 3-mile radius of the site. The land surrounding the site is primarily used for agricultural and industrial purposes. Commercial activities are located northeast of the site.

The surface of Site Q is littered with demolition debris, metal wastes, and areas of exposed drums. Surface runoff at the area of interest is primarily toward the four ponds. During the summer of 1993, flood waters from the Mississippi River inundated the entire site. The site is vulnerable to erosion and scouring during flooding because it lies on the river side of the flood control levee.

2. Location of hazardous substance(s)

Bulk waste, contaminated soil, and/or drums were found in eight excavation areas during the removal action. 3,271 drums were removed from the site; the drums contained solvents, paint waste, solidified material, containers, and other various wastes. Miscellaneous containers and medical waste (hypodermic needles) were also documented on site. Additional areas of known contamination or drum burial areas are present on site as well. Drums are visibly protruding from the ground north of the

northwest corner of the site. On-site areas have been excavated based upon visual observations, discussions with witnesses, aerial photographs, and results of surveys with a magnetic locator. On April 13, 2000, the U.S. EPA Fields Team mapped site features using a global positioning system. A map showing removal areas is included in Attachment A. Environmental Restoration (ER) excavated 2 drums from Area A, over 500 from Area 1, over 50 from Area 2, over 300 from Area 3, 454 from Area 4, no drums from Area 5, 1,165 from Area 6, 690 from Area 7, and 92 from Area 8. The four on-site ponds remained dry during the removal action.

3. Cause of the release or discharge

The release of hazardous substances at Site Q was from the deliberate burial of wastes (drums, containers, and bulk waste). Waste was buried in unlined pits and found at and below ground surface. Waste was exposed to groundwater, surface water, and/or air. Over time, buried drums and miscellaneous containers were exposed to varying seasonal temperatures (freeze/thaw), rain, periodic flooding, and snowmelt. These weather conditions resulted in further deterioration of the drums, erosion of surrounding soils, and the continued release of hazardous wastes described herein to the surrounding soil, surface water, and groundwater.

4. Efforts to locate and obtain response by responsible parties

U.S. EPA is investigating Site Q and may initiate cost recovery actions.

B. Organization of the Response

The U.S. EPA removal action began on October 18, 1999. The removal action was conducted in four phases: site setup; waste excavation and sampling; removal and disposal of waste; and pit backfilling, grading, seeding and site demobilization.

Under Contract Number 68-S5-98-01, Delivery Order 9801-05-047, removal activities were awarded to the U.S. EPA Emergency and Rapid Response Services (ERRS) contractor, Environmental Quality Management (EQM), with subcontractor work provided by ER. The actions described in this report were performed by U.S. EPA under authority and funding of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and were completed on April 19, 2000. Attachment B, Table 1 outlines the agencies or parties that provided response, assessment or disposal assistance, and the action(s) and roles each served during the Site Q removal action.

C. Injury or Possible Injury to Natural Resources

1. Content and time of notice to natural resource trustees

The Preliminary Ecological Risk Assessment, completed by E & E in August of 1997, concluded that elevated concentrations of cadmium, chromium, lead, mercury, and PCBs could decrease the species diversity of the area including sensitive species.

Heavy metals and PCBs detected on site could also bioconcentrate in fish tissue at high levels. Local fisherman who use the site and consume their catch could be exposed to high levels of metals and PCBs. During the removal action white-tail deer (*Odocoileus virginianus*) and coyotes (*canis latrans*) were seen on site, while bald eagles (*Haliaeetus leucocephalus*) were seen flying above the site. Natural resource trustees were periodically updated about the U.S. EPA removal action.

2. Trustee damage assessment and restoration activities

No formal damage assessment has been conducted.

D. Chronological Narrative of Removal Activities

1. Threat abatement actions taken

The removal action at Site Q was conducted under the authority of CERCLA Section 104(a). On September 24, 1999, U.S. EPA Emergency Response Branch (ERB) approved the expenditure of up to $2.4 million dollars to complete a removal action at Site Q. The removal action was undertaken to mitigate threats to the public health and environment. U.S. EPA mobilized ERRS under Contract Number 68-S5-98-01, Delivery Order 9801-05-047 and START under Technical Direction Document S05-9909-015. 3,271 drums and 17,032 tons of soil were excavated from the site. 13,772 tons of soil were profiled as a PCB waste, and 3,260 tons of soil were profiled as a low level PCB waste. Approximately 5,400 tons of soil were treated with Enviroblend to bind leachable lead. Drums/containers with distinguishing marks and labels were documented or archived for future investigations.

OCTOBER 1999

On October 18, 1999 ERRS and START mobilized to the site. During the week, ERRS prepped the site by removing weeds and obstacles for the site trailers, brush cut pathways around the site for access, and made entryways down into the two ponds. A storage/break trailer and office trailer arrived on site. On October 25, 1999, OSC Turner, START, ERRS contractor EQM and their subcontractor ER mobilized to the site to begin removal field work. A health and safety plan was prepared by START and reviewed by all site personnel. Excavations began at the southern end of the roadway that divides the two ponds (Area A). Aerial photos had indicated that waste was placed along this roadway, and visual observations confirmed waste at the surface. On October 27 and 29, 1999, START collected six surface soil samples (SS-01, SS-02, SS-03, SS-04, SS-05, and SS-06) and two subsurface soil samples (SB-01 and SB-02) within the west pond. Samples SB-01 and SB-02 were collected at sample SS-02 and SS-03 locations, respectively. Samples collected, dates sampled, and analysis performed during the removal action are summarized on Attachment B, Table 2. Analytical results of samples SS-01 through SS-06, and SB-01 and SB-02 are presented in Attachment B, Table 3. Analytical results indicate the presence of metals, semivolatile organic compounds (SVOCs), and PCBs in the samples. Sample SB-02 contained 7.15 milligrams per liter (mg/L) of toxicity characteristic leaching procedure

check photos

(TCLP) lead. sample SB-01 contained 270 mg/kg of benzo(a)anthracene, 813 mg/kg of benzo(a)pyrene, and 260 mg/kg of benzo(g,h,i)perylene. Aroclor 1254 and 1260 were detected in all eight soil samples with a maximum total PCB concentration of 3,150 micrograms per kilogram (μg/kg) detected in sample SB-01.

ER encountered drum carcasses at depth on the west side of the area between the east and west ponds. START performed Chlor-n-soil PCB screening tests along the area . Three of seven samples indicated PCBs present at concentrations exceeding 50 ppm. Due to the elevated PCB concentrations, excavation was stopped along the roadway. Excavation activities continued in the east pond (Area 1). During the early stages of the removal, drums were individually numbered. However, due to the number of drums excavated, ER ceased numbering individual drums. Many of the drums excavated from the site were severely deteriorated. Excavated drums were empty or filled with solids, liquids and/or earthen material. On October 29, 1999, START collected samples Drum-01 and Drum-02, that consisted of waste material from two separate drums being deposited into the soil. Analytical results of drum samples are summarized in Attachment B, Table 4. ER visually screened and segregated the excavated material. START performed hazard categorization (hazcat) tests to determine if excavated material contained hazardous constituents. Based upon the results or project limitations, the material was either added to waste piles for off-site disposal or backfilled in the excavation pits. During the course of the removal action, drums were stored on a plastic liner. Drums/containers with distinguishing marks and labels were documented and/or archived for future investigations. Much of the excavation in Area 1 was conducted in Level B personal protective equipment (PPE). Based upon discussions with OSC Turner, START, RM Davis, and ERRS health and safety personnel, workers completed excavation activities in the remaining areas in level C PPE providing breakthrough on cartridges did not occur.

NOVEMBER 1999

ERRS continued excavating Area 1, and began excavation on Areas 2 and 3 within the east pond. By the end of the month, approximately 5,000 cubic yards of contaminated soil were excavated from the site. On November 18, 1999, ERRS excavated a ditch through the east pond to direct water from the excavation areas to the southeast portion of the pond. On November 3, 1999, START began to collect samples of waste material staged on site for waste characterization and disposal purposes. A list of waste piles, the area(s) where the waste material was excavated, and the dates the waste was shipped off site is presented in Attachment B, Table 5. Sample Pile-01 was a composite sample collected from waste piles 1 and 2. Analytical results of waste piles 1,2,3 and 8 are presented in Attachment B, Table 6. On November 10, 1999, START collected sample Pile-02, which was collected from waste material staged on site. On November 18, 1999, START collected sample Pile-02A and Pile-03. Sample Pile-02A was a composite sample collected from waste pile 2, sample Pile-03 was collected form waste pile 3. Analytical results indicate the waste material contained volatile organic compounds (VOCs), SVOCs, metals, pesticides, PCBs, and had a flashpoint below 140 degrees Fahrenheit (°F). Analytical results indicate that waste piles 1 and 2 contained trichloroethene (TCE), lead, and PCBs above applicable regulatory levels. Samples

Pile-02 and Pile-02A contained TCLP TCE at 0.620 mg/L and 0.52 mg/L, respectively, which is above the regulatory level of 0.5 mg/L as defined by the 40 Code of Federal Regulations (CFR) 261. Samples Pile-02 and Pile-02A contained TCLP lead above the regulatory level of 5.0 mg/L as defined by the 40 CFR 261. Samples Pile-01, Pile-02, Pile-02A, and Pile-03 contained PCBs above the regulatory level of 50 ppm as defined in the 40 CFR 761. Disposal options of site wastes included incineration or treatment of the wastes on site to below TCLP parameters and disposal of waste at an approved landfill. The most cost-effective option was treatment of the waste piles with Enviroblend to bind leachable lead to levels below 5.0 mg/L.

Due to the site features (one access road on the site property), an alternate route for removal of site wastes was required. Disposal of site wastes was accomplished by staging site wastes to Alton and Southern Railroad property and loading the material onto gondola rail cars or by loading trucks on site property. The trucks required the use of Alton and Southern Railroad property to access and leave the site by entering the rail easement from the south and leaving the site from the rail easement on Cargill Elevator Road. ER obtained permission to use Alton and Southern Railroad property to transfer site wastes. On December 21, 1999, START collected seven composite surface soil samples (RS-01 through RS-07) on areas possibly impacted by the transfer of site wastes; sample results are located in Attachment B, Table 7. A map showing sample locations is presented in Attachment A. On January 3 and 4, 2000, ER built the access road to the rail spur, geofabric was placed along the road and covered with gravel. Transfer of site wastes required heavy equipment to cross the Explorer pipeline. On a letter dated November 18, 1999, Explorer Pipeline agreed to allow ER to cross the pipeline with heavy equipment providing ER used articulated trucks, and prior to crossing the pipeline ER installed 1-foot of soil, geofabric, and wooden mats across the entire 20-foot Explorer easement. ER complied with Explorer Pipeline's request during the removal action.

Based upon concentrations of lead in the waste material, ER collected eight lead air samples (AS-01 through AS-08) using Gillian pumps. Samples AS-01 through AS-04 were collected on November 19, 1999, while samples AS-05 through AS-08 were collected on November 20, 1999. Samples AS-04 and AS-08 were collected in the support zone, while the remainder were collected on ER crew members working in the excavation areas. Results of lead air sampling are presented in Attachment B, Table 8. Samples collected on site workers contained detectable concentrations of lead, while samples collected in the support zone did not. Crew members continued to work in Level C PPE.

ER and START collected samples Drum-03 (from drums 1-75), and sample Drum-04 (from drums 301-400). Sample material consisted of solid waste material, drums that contained liquid were not included in the samples. Analytical results of these drum samples are located in Attachment B, Table 4. Analytical results indicate the presence of VOCs, SVOCs, metals, and PCBs. Samples Drum-03 and Drum-04 contained 0.18 and 0.22J mg/L of TCLP benzene, 4.3 mg/L and 9.07 mg/L of TCLP cresols, 387 mg/L and 5.19 mg/L of TCLP lead, and 1,240 mg/kg and 2,780 mg/kg of total PCBs, respectively.

DECEMBER 1999

Approximately 865 drums and 8,300 cubic yards of material were excavated from the site by the end of December 1999. ER continued excavation of Areas 1 and 2 and began to excavate material in Area 4. START and ERRS inspected the drums that contained waste to determine the type of waste stream present. Seven different waste streams were identified. On December 2 and 6, 1999, START collected seven samples of individual drums excavated from site (drums 246, 102, 052, 112, 615, 775, 395). Each drum sample represented a distinct waste stream. Analytical results are presented in Attachment B, Table 4 with sample designations corresponding to individual drum numbers. Sample results indicate the presence of VOCs, SVOCs, metals, and PCBs. Methylene chloride was detected in six of the seven individual drum samples with a maximum concentration of 3,500 mg/kg detected in D-615. TCE was detected in five of the seven individual drum samples, with a maximum concentration of 17,000 mg/kg in D-112. Lead was detected in the seven individual drum samples with a maximum concentration of 3,110 mg/kg in D-102. PCBs were detected in the seven individual drum samples with a maximum concentration of 4,540 mg/kg of total PCBs detected in sample D-112. Six of the seven individual drum samples displayed a flashpoint below the regulatory level of 140 °F as defined by the 40 CFR 261.

On December 7, 1999, START collected two composite samples Density-01 and Density-02, from waste piles 1 and 2, respectively. Samples were collected to obtain the density of excavated material to determine the appropriate ratio of Enviroblend to waste material. Analytical results of Density-01 indicated that waste pile 1 had a density of 0.881 grams per centimeter cubed (g/m^3), and waste pile 2 had a density of 0.995 g/m^3. A 3% blend was calculated to bind lead to pass TCLP. Treatment of waste piles commenced on December 7, 1999, and was completed on December 20, 1999. Waste piles 1,2,4,5 were treated with Enviroblend. Attachment B, Table 9 presents data regarding the treated waste piles, dates the piles were treated, piles sampled, and sample designations. Analytical results of blend piles sampled are presented in Attachment B, Table 10. Analytical results indicate that sample BP-05 contained TCE (240 mg/L), benzene (20 mg/L), and tetrachloroethene (PCE; 10J mg/L) above the regulatory limits of 0.5 mg/L, 0.5 mg/L, and 0.7 mg/L, respectively; other samples contained TCLP parameters within regulatory limits. On January 6, 2000, START collected sample BP-05A, which was a composite sample from treated pile 5. Analytical results indicate that sample BP-05A contained 0.180 mg/L of TCLP TCE, which is below the regulatory limit. Benzene and PCE concentrations were below detection limits.

On December 14, 1999, START collected groundwater samples GW-01 through GW-06. Samples were collected by excavating to groundwater with a trackhoe, then collecting the water in appropriate laboratory containers. Sample GW-01 was collected on the east side of the east pond, in an attempt to obtain a background sample. Sample GW-02 was collected in Area 3, at the northwest side of the east pond along the bank. Sample GW-03 was collected in an area where drums containing product were excavated in the east pond. Sample GW-04 was collected in the middle of the west

pond. Sample GW-05 was collected at the northern end of the west pond. Sample GW-06 was collected at the southwest corner of the west pond. Samples GW-02 through GW-05 contained product and an odor. Analytical results of groundwater sampling are presented in Attachment B, Table 11. Sample GW-01 contained detectable concentrations of metals and PCBs. Samples GW-02 and GW-03, collected in the east pond, contained metals, VOCs, SVOCs, and PCBs. Sample GW-02 contained 57,000 micrograms per liter (μg/L) of toluene, 5,900 μg/L of methylene chloride, 5,515 μg/L of naphthalene, 0.432 mg/L of lead, 358 μg/L of total PCBs, and 3.8 mg/L of 2,4,5-trichlorophenoxyacetic acid (dilution required). Sample GW-03 contained 94,000 μg/L of toluene, 32,000 μg/L of xylene, 1,355 μg/L of 2,4-dimethylphenol, 0.136 mg/L of lead, 370 μg/L of total PCBs. Samples GW-04, GW-05 and GW-06, collected in the west pond, contained VOCs, SVOCs, and metals. Concentrations of VOCs, SVOCs, and PCBs in these samples were lower than samples GW-02 and GW-03. Sample GW-04 contained 8 μg/L of methylene chloride, 3J μg/L of bis (2-ethylhexyl) phthalate, 0.211 mg/L of lead, and 8.42 μg/L of total PCBs. Sample GW-06 contained 9 μg/L of methylene chloride, 7J μg/L of bis (2-ethylhexyl) phthalate, and 0.385 mg/L of lead. On December 15, 1999, START collected sample Cinders-01 from a former drum staging area on top of the ridge on the west side of the east pond. Analytical results are presented in Attachment B, Table 3. The sample contained 10 mg/kg of arsenic and 60 mg/kg of lead.

On December 20, 1999, START collected samples from drums that contained labels or distinguishing marks. Sample D-200 was collected from a drum labeled Vestal. Sample D-Amchem was collected from a drum labeled Amchem Products Inc., Windsor, Ontario. Sample D-Dow was collected from a drum labeled Dow Chloroethene NU Superior Solvent, that appeared to contain paint waste. Analytical results of labeled drum samples are presented in Attachment B, Table 12. Analytical results indicate that the drums contained VOCs, SVOCs, metals, and had flashpoints below the regulatory level of 140°F. Sample D-Dow contained 120J mg/kg of TCE. The three samples contained xylene, with a maximum concentration of 5,800 mg/kg detected in sample D-Dow. The three samples contained naphthalene, with a maximum concentration of 3,110 mg/kg detected in sample D-Dow. Lead was detected in the three samples, with a maximum concentration of 18,400 mg/kg detected in sample D-Dow. PCBs were detected in the three samples with a maximum concentration of 5,042 mg/kg of total PCBs in sample D-Dow.

JANUARY 2000

By the end of the month, ER excavated approximately 1,450 drums and 9,935 cubic yards of material from the site. ER continued to excavate waste from Areas 1 and 4, and started to excavate waste from Areas 6 and 7. ER excavated approximately 737 drums and 2,560 cubic yards of material during the month. On January 13, 2000, ER investigated Area 5; however no waste material was located and excavation activities ceased.

Analytical results of blend pile samples indicated that the concentrations of RCRA-listed wastes fell below regulatory limits as defined by 40 CFR 261. The excavated

material was profiled as PCB-contaminated soil/debris. On January 5, 2000, ER began to remove wastes from site. A waste disposal summary is presented in Attachment B, Table 13. The PCB waste stream was shipped via rail car to the Safety-Kleen (Lone & Grassy Mountain), Inc. facility located in Waynoka, Oklahoma. During the course of the removal action, one hundred forty one rail cars, each containing approximately 90 tons of PCB waste, were shipped to the facility.

On January 18 and 19, 2000, START collected samples Area-04RoadA and Area-04RoadB. Sample Area-04RoadA was a composite sample collected from black, red, and white waste material excavated from the roadway in Area 4. Sample Area-04RoadB was collected from black waste excavated from the roadway in Area 4. Analytical results are presented in Attachment B, Table 14. Sample Area-04RoadA contained 25.9 mg/kg of total PCBs. Sample Area-04RoadB contained VOCs, metals, and SVOCs.

ER encountered a fibrous material in white waste approximately 3-feet below the ground surface along the west wall of the west pond (Area 4). On January 21, 2000, START collected samples A-4TA (from the north wall of the excavation) and A-4TB (from the south wall of the excavation) of the waste and fiber material. Analytical results of the samples indicated that sample A-4TA did not contain asbestos, while sample A-4TB contained 20-30% chrysotile.

On January 25, 2000, START collected two composite samples (A-4-P-1 and A-4-P-2) from waste pile 8. Waste pile 8 contained material excavated from area 4. Analytical results are presented in Attachment B, Table 15. Samples A-4-P-1 and A-4-P-2 are presented as WP-8-1 and WP-8-2, respectively. Analytical results indicate that the material excavated from area 4 contained PCBs at a concentration lower than 50 mg/kg. The remainder of the sample parameters, excluding the paint filter test, fell within regulatory limits. On February 18, 2000, START collected composite sample WP-08PF from waste pile 8 for a paint filter analysis. Sample WP-08PF passed the paint filter test. Subsequently, a low-level PCB waste stream was developed for waste pile 8. The low-level PCB waste was shipped via truck to the Milam Recycling and Disposal Facility located in East St. Louis, Illinois.

FEBRUARY 2000

All eight excavation areas were partially or fully investigated by the end of the month. Over 2,750 drums were excavated from the site by the end of February 2000. During the month, ER excavated material from Areas 6,7, and 8. ER excavated approximately 1,017 drums and 3,040 cubic yards of waste during the month. START screened material excavated from Area 4 with several results showing PCB concentrations above 50 ppm. Selected amounts of the excavated material were staged for off-site disposal.

On February 7, 2000, START collected composite samples Waste pile-09-01 and Waste pile-09-02 from waste pile 9. Analytical results are located in Attachment B, Table 15. Samples Waste pile-09-01 and Waste pile-09-02 contained 332.0 and 218.1 mg/kg of total PCBs, respectively. The remaining sample parameters fell within

regulatory limits and waste pile 9 was added to the PCB waste stream. On February 7, 2000, START collected composite sample, Waste pile-08, from waste pile 8, which was analyzed for total VOCs, SVOCs, pesticides and target analyte list metals. The sample was collected to obtain data on parameters other than those analyzed through the TCLP method. Analytical results are presented in Attachment B, Table 6. Analytical results indicate that the sample contained VOCs, SVOCs, metals, and pesticides. The sample contained 40 μg/kg of acetone, 13,000 μg/kg of phenanthrene, 6,900 μg/kg of benzo(a)pyrene, 162 mg/kg of lead, 28.5 μg/kg of 4,4-dichlorodiphenyldichloroethylene (4,4-DDE), 16.6 μg/kg of dieldrin, and 34.7 μg/kg of 4,4-dichlorodiphenyldichloroethane (4,4-DDD). On February 23, 2000, START collected two composite samples, Waste pile-10-01 and Waste pile-10-2, from waste pile 10. Samples Waste pile-10-1 and Waste pile-10-2 contained 116.4 and 267.0 mg/kg of total PCBs, respectively. The remaining sample parameters fell within regulatory limits and waste pile 10 was added to the PCB waste stream.

MARCH 2000

ER completed excavation activities by the end of March 2000. A total of 3,271 drums and approximately 15,445 cubic yards of waste were excavated from the site. In March 2000, ER excavated 597 drums and 925 cubic yards of material from Area 6 and 657 drums and 620 cubic yards of waste from Area 8.

On March 1, 2000, START collected two composite samples from waste pile 11 (samples WP-11-1 and WP-11-2). Analytical results are presented in Attachment B, Table 15. Samples WP-11-1 and WP-11-2 contained 183.2 and 283.8 mg/kg of total PCBs, respectively. The remaining sample parameters fell within regulatory limits and waste pile 11 was added to the PCB waste stream.

On March 14, START collected composite samples WP-12-1 and WP-12-2 from waste pile 12. Analytical results are presented in Attachment B, Table 15. Samples WP-12-1 and WP-12-2 contained 34.0 and 34.3 mg/kg of total PCBs, respectively. The remaining sample parameters fell within regulatory limits and waste pile 12 was added to the low-level PCB waste stream. During the course of the removal action approximately 3,260 tons low-level PCB waste was removed from site.

APRIL 2000

On April 13, 2000, the U.S. EPA Fields Team mapped site features using a global positioning system. Maps generated by the team are presented in Attachment A. On April 5 and 6, 2000, ERRS removed surface soil, gravel, and the lining from Alton Southern property used to transfer and stage site wastes for disposal. The excavated soil, gravel, and liner was placed into rail cars for disposal or moved on site. On April 18 and 19, 2000, ERRS seeded and placed straw bales in the former excavation areas to provide vegetative cover and to reduce erosion.

On April 10, 2000, START collected seven composite surface soil samples (RS-01A through RS-07A) on areas impacted by the transfer of site wastes. Sample locations are

presented in Attachment A and sample results are presented in Attachment B, Table 7. On April 10, 2000, START sampled the railroad property mirroring the methodology of samples collected prior to waste transportation through the railroad property. Analytical results indicate that levels do not differ significantly from the original samples (RS-01 through RS-07) collected on December 21, 1999.

April 13 and 17, 2000, START collected 24 subsurface soil samples in former excavation areas to determine concentrations of PCBs that remain in soils. Samples were collected below cover material in areas where drums and/or bulk wastes were removed. A description of samples, sample depths, and sample material is presented in Attachment B, Table 16. Attachment A contains a map showing sample locations and a map showing removal areas in conjunction with sample locations. Analytical results are presented in Attachment B, Table 17. Samples collected in Areas 1 and 2, and samples A3-01 and A3-02 were collected from the bottom of the east pond. These samples, except for sample A2-01, contained concentrations of total PCBs greater than 50 mg/kg. A maximum of 330 mg/kg of total PCBs was detected in sample A1-01. Samples A3-03, A6-01,and A8-01 contained levels of PCBs greater than 50 mg/kg. Samples A6-01 and A8-01 were collected in borings that contained foreign material. Analytical results indicate that concentrations of PCBs in site soils exceed the removal action limit of 50 ppm.

On April 18 and 19, 2000, ER spread seed and placed straw bales and silt fencing on capped areas to prevent erosion. During the week of April 17, 2000, U.S. EPA, ER, EQM, and START demobilized from site. Due to lack of topsoil needed to completely cap the excavation areas, municipal waste is visible on the limited portions of the site. Due to limited resources, the site contains drums protruding from the ground and additional areas of contamination.

2. Treatment, disposal, or alternative technology approaches pursued

Approximately 13,772 tons of PCB contaminated soil and debris, 3,260 tons of low level PCB waste, and 3,271 drums were excavated and removed from site. 5,400 tons of the PCB-contaminated soil were treated on site with Enviroblend to bind leachable lead. The PCB waste was disposed at the Safety-Kleen (Lone & Grassy Mountain), Inc. facility located in Waynoka, Oklahoma, while the low-level PCB waste stream was disposed at the Milam Recycling and Disposal Facility located in East St. Louis, Illinois. A waste disposal summary is included in Attachment B, Table 13.

3. Public information and community relations activities

Throughout the removal action, OSC Turner met with various public officials and private citizens. OSC Turner attended several "town hall" type meetings in Cahokia to give updates in the removal action and answer questions. OSC Turner and other U.S. EPA representatives conducted interviews with various news media to assist with publications on site activities.

E. Resources Committed

Extramural Costs:

Total Cleanup Contractor (e.g, ERRS) Costs	$2,100,000
START	$66,780
TOTAL, EXTRAMURAL COSTS	$2,166,780
Intramural Costs:	
Direct Costs (Region, HQ, ERT)	$51,000
Intramural Indirect Costs	$0
TOTAL, INTRAMURAL COSTS	$51,000
TOTAL SITE COST	**$2,217,780**
Project Ceiling	**$2,400,000**

Any indication of specific costs incurred at the site is only an approximation, subject to audit and final definization by U.S. EPA. The OSC Report is not meant to be a final reconciliation of costs associated with a particular site.

II. EFFECTIVENESS OF REMOVAL ACTIVITIES

A. Actions Taken by PRPs

During the course of the removal action, a consultant for Eagle Marine Industries, Inc. visited the site to discuss site activities with OSC Turner.

B. Actions by State and Local Agencies

Illinois EPA provided historical information on the site. Illinois EPA representatives spoke with OSC Turner regarding technical details of the removal activities.

C. Actions Taken by Federal Agencies and Special Teams

U.S. EPA provided monetary resources, overall response organization, and oversight during all removal activities conducted by ERRS. The United States Coast Guard Atlantic Strike Team provided oversight of activities on several occasions during the removal action. U.S. Fish and Wildlife Service, as a natural resource trustee, visited the site and spoke with OSC Turner.

D. Actions Taken by Contractors, Private Groups, and Volunteers

The U.S. EPA ERRS contractor, Environmental Quality Management provided the subcontractor, Environmental Restoration, who conducted the removal of waste materials at Site Q. Environmental Restoration excavated bulk waste, drums, and contaminated soil; staged waste; assisted with sampling; assisted with the organization of the response; backfilled excavation areas; and graded/seeded former excavation areas. Environmental Quality Management provided subcontractors to analyze samples and transport and dispose of site wastes. Environmental Restoration provided the personnel and equipment necessary to complete field operations.

U.S. EPA START contractor, E & E, provided continuous assistance in documenting on-site activities and costs incurred; conducted contractor oversight (both general and health and safety); completed air monitoring; conducted soil, product, and groundwater sampling; and completed necessary reports.

III. DIFFICULTIES ENCOUNTERED

A. Items That Affected the Response

Transportation: Rail cars provided a quick and efficient means of removing contaminated material off-site.
Amount of contamination: After the removal action was completed, levels of PCBs in site soils still exceed removal action limits.

B. Issues of Intergovernmental Coordination

Not applicable.

C. Difficulties Interpreting, Complying With, or Implementing Policies and Regulations

Not applicable.

IV. RECOMMENDATIONS FOR NEW POLICY OR REGULATIONS, AND CHANGES IN CURRENT REGULATIONS AND RESPONSE PLANS

A. Means to Prevent a Recurrence of the Discharge or Release

Routine audits: Audits should be conducted routinely for companies that are producers or users of large quantities of hazardous substances, and these companies should be required to dispose of wastes produced and materials used. Companies that fall into these categories could be required to carry and maintain liability insurance to pay for potential environmental damage or threats that result from operations.

B. Means to Improve Removal Activities

None.

C. Recommendations for New Policy or Regulations, and Changes in Current Regulations and Response Plans

None.

Exhibit 43

PB92963377

United States
Environmental Protection
Agency

Office of Solid Waste
and Emergency
Response

EPA 540-R-92-026
November 1992

Superfund

EPA

Hazard Ranking System Guidance Manual

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
INFORMATION SERVICE
SPRINGFIELD, VA 22161

- SI start date in CERCLIS;
- Date of Technical Decision Document (TDD) or Technical Decision Memorandum (TDM) issued for work assignment to develop SI workplan;
- Date when EPA approves the site-specific SI workplan; or
- Date of an SI reconnaissance to develop SI workplan.

If no workplan or analogous event is available, the cutoff date is the earliest documented date that EPA conducted SI activities for the site. For all sites with SIs conducted after December 1991, Regions are expected to enter the date of site-specific workplan approval by EPA as the SI start date in CERCLIS, and that date should be used as the cutoff date for determining qualifying removals.

If EPA determines that previous investigations by other parties (e.g., states, EPA's removal program) are suitable for SI purposes, then the date when drafting of a Superfund SI report collating previous analytical data is begun serves as the cutoff date. The cutoff date is not the date of a state or PRP investigation conducted independently of CERCLA; the cutoff is based on the date these data are collated for Superfund SI purposes.

Non-Federal Facility Sites with Multiple SIs

For non-Federal facility sites with more than one SI, the cutoff date for most sites will be keyed to the first SI. However, the Agency may establish a later cutoff date under certain circumstances:

- If a second SI implementing a completely new sampling strategy is conducted, the Agency may consider basing the cutoff date on workplan development for the second SI. In these cases, considering removals prior to the second SI is not likely to unduly disrupt the site assessment process.
- For sites where the first SI was conducted more than four years prior to HRS scoring, the Agency may consider, on a case-by-case basis, changing the cutoff date to a later date. (CERCLA section 116, added by SARA, mandates that EPA conduct site assessment work within four years of CERCLIS listing.)

The transition to the revised HRS and the follow-up sampling needed for some sites may mean that site assessment activities take longer than four years. Follow-up sampling should not be used to determine a new cutoff date in that situation, even if more than four years have elapsed since the first cutoff date, unless a completely new sampling strategy is implemented.

Federal Facility Sites

Federal facility sites undergo a somewhat different site process than other sites. Assessments of Federal facility sites are expected to be conducted within 18 months of their placement on the Federal Agency Hazardous Waste Compliance Docket, set up under CERCLA section 120(c), added by SARA. Therefore, the cutoff date for Federal facility sites is 18 months after the site is placed on the Federal facilities docket.

Summary

Highlight 2-1 is a flowchart for determining a site-specific cutoff date. ***Highlight 2-2*** provides examples of determining the cutoff date for hypothetical sites.

Exhibit 44

Data Sources

Ecology and Environment, Inc. July 1986. *Description of Current Situation at the Dead Creek Project Sites.*

Ecology and Environment, Inc. July 29, 1994. *Removal Action Report for Sauget Area 2: Site Q, Sauget, St. Clair County, Illinois.*

Ecology and Environment, Inc. February 1998. *Sauget Area 1 and 2 Data Tables/Maps.*

Geraghty & Miller, Inc. December 1986. *Assessment of Ground-Water Conditions at the Village of Sauget Treatment Plant Sites, Sauget, Illinois.*

Geraghty & Miller, Inc. April 1988. *Assessment of an Old Lagoon at the American Bottoms Treatment Site.* Sauget Sanitary Development and Research Association, Sauget, Illinois.

Geraghty & Miller, Inc. February 1993a. *Remedial Investigation at Sauget Site R, Monsanto Company, Sauget, Illinois.*

Geraghty & Miller, Inc. February 1993b. *Remedial Investigation for the Expanded Study Area, Sauget, Illinois.*

Illinois Environmental Protection Agency. April 1981. *A Preliminary Hydrogeologic Investigation in the Northern Portion of Dead Creek and Vicinity.*

Illinois Environmental Protection Agency. May 1988. *Expanded Site Investigation, Dead Creek Project Sites at Cahokia/Sauget, Illinois, Final Report.*

Illinois Environmental Protection Agency. 1993. *CERCLA Screening Site Inspection Report. Sites O, Q, R, and Monsanto W.G. Krummrich.*

Illinois Environmental Protection Agency. 1993. *CERCLA Expanded Site Investigation Report. Sites O, P, Q, and R.*

Illinois Environmental Protection Agency. March 2000. *Trip Report for: Sauget Area 2, Sauget, Illinois, ILD 000605790.*

Illinois Environmental Protection Agency. March 2000. Trip Report for: *Solutia/W.G. Krummrich Plant, Sauget Illinois, ILD 980498059.*

Solutia, Inc. September 1, 2000. *Description of Current Conditions, W.G. Krummrich Plant, Sauget, Illinois.*

USEPA. July 31, 2000. *Draft Federal On-Scene Coordinator's Report for Area 2 Site Q, Cahokia, St. Clair County, Illinois.*

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December 13, 2001

Docket Coordinator, Headquarters
U.S. Environmental Protection Agency
CERCLA Docket Office
1235 Jefferson Davis Highway
Crystal Gateway #1, First Floor
Arlington, VA 22202

Re: Comments on the Proposed Listing of Sauget Area 2, in Sauget and Cahokia, Illinois, on the CERCLA National Priorities List

Dear Docket Coordinator:

These comments are submitted by Union Electric Company d/b/a AmerenUE ("UE") in response to the proposal by the United States Environmental Protection Agency ("EPA") to list the "Sauget Area 2" sites on the National Priorities List (NPL). *See* 66 Fed. Reg. 47,618 (September 13, 2001). Sauget Area 2 is an aggregation of five parcels of land that are referred to as "sites" in the listing documents, the combined area of which totals 312 acres. Area 2 is located in Sauget and Cahokia, Illinois.

The EPA has notified UE that it is a Potentially Responsible Party at the proposed Area 2. UE has a significant interest in the proposed NPL listing because it is presently the owner of a portion of what the Agency has designated "Site P," within Area 2, and because it formerly owned and operated an electrical generating facility in Sauget, Illinois and leased a portion of one of the sites for the storage of fly ash. The ash ponds were located in a narrow corridor within the middle-section of a parcel that EPA has designated "Site Q."

The original Federal Register notice for this proposed listing set a deadline of November 13, 2001 for the filing of comments. By letter dated October 22, 2001, Mr. Dave Evans, Director of the State, Tribal and Site Investigation Center at EPA's OSWER granted UE a 30-day extension of the comment period, through December 13, 2001. A copy of the letter granting UE this extension is attached as Exhibit 1.

As part of these comments we attach and incorporate by reference as Exhibit 2 a technical report of Newfields, Inc., entitled *Comments on Sauget Area 2 Hazard Ranking System Listing Document* ("Newfields Report"); the 45 exhibits to the Newfields Report are in a separate 3-ring binder. In these comments, we refer to exhibits using the same numbers as those used by

Newfields. A list of exhibits appears at the end of the Newfields Report, and an additional copy of these comments, including the Newfields Report, appears at Tab 45 of the exhibit binder.

In proposing Area 2 for listing on the NPL, EPA made a series of fundamental errors:

1. when it aggregated "Site P" with other Sites in Area 2;

2. when it chose an inappropriate conceptual site model for Area 2;

3. when it aggregated three contiguous but distinct areas into a single parcel now identified as "Site Q";

4. when it disregarded its own 1994 performance of a CERCLA time-critical removal action on the southern portion of what the Agency refers to as Site Q;

5. when it incorrectly determined the length of wetland shorelines within Site Q;

6. when it assumed the presence of endangered species on Site Q without any verification for that assumption; and

7. when it relied on inappropriate sampling techniques in collecting groundwater data in Site Q.

All these errors were made in disregard of established legal authority; or of the Agency's own Hazard Ranking System (HRS) regulations, 40 C.F.R. Part 300; or of the Agency's own published guidance, *The Hazard Ranking System Guidance Manual* (November 1992) ("HRS Guidance") As such, the Agency actions are arbitrary, capricious and unreasonable, or not otherwise in accordance with the law. *Tex Tin Corporation v. EPA*, 992 F.2d 353, 354 (D.C. Cir. 1993).

In these comments, UE will present an abbreviated introduction, followed by an itemized discussion of the significant conceptual and regulatory errors made in characterizing and scoring the properties that comprise "Area 2."

I. BACKGROUND

The five properties that are collectively identified as "Area 2" in the Agency's proposed NPL listing notice all lie within the vicinity of Sauget and Cahokia, Illinois. Only two of these five properties are contiguous, but all were nevertheless aggregated by EPA in its proposed listing.

The five properties or "sites" that make up Area 2 have been designated by EPA as Sites O, P, Q, R and S, for a total of 312 acres. Four of the five sites have a distinct and rather singular history of use for various forms of waste disposal. A more detailed description of each site's history is found in the Newfields Report at pages 6-7.

Briefly, Site O, at 20 acres, is presently inactive, but from 1966 to 1978 it was used to contain sludge dewatering lagoons. Site P, at 28 acres, is inactive but at one time was operated as a permitted non-chemical landfill. As stated above, UE is an owner of a portion of Site P. Site R, at 25 acres, was operated as a landfill from 1957 to 1977 and was known as the Sauget Toxic Dump. The fourth site, Site S, is believed to have been operated as a chemical drum disposal site in the 1970s.

The fifth site, Site Q, at 255 acres, is the largest of the sites. Given its size, it is not surprising that the site was never devoted to a single use. Two parcels in Site Q — one at the site's northern end ("Northern Q") and the other at its southern end ("Southern Q") — both have a history of use for waste disposal. The very northern "dogleg" parcel, which is directly adjacent to Site R but which has boundaries distinct from Site R, was operated as the Sauget Municipal Landfill. The southern region of Site Q was put to an entirely different use unrelated to the northern portion; various portions of southern Q were used at different times for drum disposal. The central portion of Site Q ("Central Q"), according to aerial photographs and other documents, was used for neither landfilling nor waste disposal. A few areas within central-Q were used to store fly ash; more recently, the central parcel of Q has been used to store coal. Some areas within central Q have never been used for anything other than farming.

The five sites comprising "Area 2," then, have little or nothing in common historically and nothing in common at present except for the aggregation sought by EPA in the proposed listing. As will be shown in the discussion that follows, this lack of commonality is a fundamental and unavoidable shortcoming in EPA's proposal to cobble together a much larger Superfund site than is allowed under federal law, the HRS, or the EPA's own HRS Guidance.

II. EPA HAS NO BASIS FOR INCLUDING "SITE P" IN AREA 2.

Of all the errors committed by EPA in the proposed listing, its inclusion of Site P in Area 2 is the most obvious and it is unsupported by <u>any</u> authority.

EPA has the authority to list a release on the NPL if the HRS score for that release exceeds 28.5. But a review of the administrative record shows that here EPA did not score any single release. Instead, EPA aggregated all of the alleged "releases" at each of the sites it has identified – O, P, Q, R and S – into a single release, and then calculated a score for the aggregation. In doing so, EPA used toxicity values for contaminants found not at Site P, but at <u>Site R</u> (e.g., PCBs, VOCs) and assigned these values to all the sites rather than quantifying the true toxicity value for contaminants at each individual site. Had EPA used contaminant toxicity

values for materials actually found at Site P (only manganese and phenol), the Site P HRS score would be, as shown by Newfields, dramatically lower. Newfields Report, p. 23.

EPA does not have the statutory authority to aggregate releases from geographically distinct areas for purposes of scoring them collectively under the HRS. Authority for such site aggregation cannot be found in CERCLA itself, 42 U.S.C. § 9601 *et seq.*, nor in the regulations adopted under CERCLA, 40 C.F.R. Part 300. EPA has, in the past, claimed such authority under CERCLA, and has even cited to its so-called "Aggregation Policy" as support for its right to combine distinct, non-contiguous properties, but both those claims were squarely refuted by the Appellate Court in *Mead Corp. v. Browner*, 100 F.3d 152, 153 (D.C. Cir. 1996).

As will be further discussed below, EPA may not include Site P in its listing proposal for Area 2 unless Site P is independently scored under the HRS and it receives a sufficiently high HRS score on its own. Because EPA did not even bother to score Site P independently, there is no factual or legal support on which to base EPA's proposed inclusion of Site P in Area 2. Moreover, even were the Agency to have scored Site P under the HRS, it would have obtained a very low score. Site P simply should not be part of the Agency's Area 2 listing proposal.

1. The Agency Must Separately Score Non-Contiguous Sites.

Of the five "sites" proposed by EPA for inclusion and listing as "Area 2," only two bear designated boundaries that are contiguous.[1] The other three, Sites O, P, and S, are not contiguous, and of these, Site P is most distant from the others. A review of the HRS Documentation Record shows that EPA aggregated all of the sites within Area 2 when it calculated the HRS score for this area. The record contains no HRS scoring for Site P alone.

EPA's authority both to establish the NPL and to develop risk-based criteria for placing a facility on the NPL derives from Section 105(a)(8)(B), 42 U.S.C. § 9605(a)(8)(B). The appropriate risk-based criteria are set forth at CERCLA Section 105(a)(8)(A). Pursuant to this authority and using this fundamental criteria, EPA developed the Hazard Ranking System, 40 C.F.R. Part 300, App. A.

Under the CERCLA regulations, EPA may list a facility on the NPL only if it meets any one of three criteria: The facility scores sufficiently high under the HRS; or the facility is designated as being of "highest priority" by a state; or if (i) the Agency for Toxic Substances and Disease Registry (ATSDR) has issued a "health advisory" for the facility, and (ii) the EPA finds that the site poses a significant threat, and (iii) EPA determines that a remediation is the most cost effective response method. 40 C.F.R. § 300.425(c).

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[1] UE disputes EPA's designation of Site Q as a single "site," and contends that based on history and sampling data, Site Q should be treated as three distinct sites for listing purposes. See *infra* at pages 9-10.

Here, EPA is basing its recommendation to list Site P on the NPL based on an HRS score, but not an HRS score developed for Site P. Indeed, an examination of the scoring documents in the administrative record shows that the Agency performed only a single "scoring," and that scoring was based on all of the sites proposed to constitute Area 2.

The record itself contains no discussion of EPA's aggregation of the five sites. But EPA's authority to aggregate two or more non-contiguous areas into a single area for NPL listing purposes is subject to a single, clear, and well established rule of law: EPA may not list a discrete parcel of land on the NPL unless that discrete parcel qualifies under EPA's "statutorily warranted criteria." *Mead Corp. v. Browner*, 100 F.3d 152, 153 (D.C. Cir. 1996). Under this rule, unless EPA establishes that Site P meets the listing criteria set forth in the HRS, it cannot include Site P in Area 2.

As the EPA well knows, in *Mead* the petitioner challenged EPA's attempt to aggregate three separate, non-contiguous land parcels into a single site for listing on the NPL. Two of the sites to be aggregated met the listing criteria set forth in CERCLA, but the third site – not contiguous with the other two – had not been scored by the EPA and did not otherwise qualify for listing under Section 105 of CERCLA. EPA claimed that under Section 105 it had authority to aggregate sites for NPL listing, but the court flatly rejected this contention.

In rejecting the applicability of EPA's "Aggregation Policy," the court noted that the policy on its face applies to Section 104(d)(4) of CERCLA, not Section 105, and it further noted that Congress gave EPA no authority under CERCLA to aggregate non-qualifying, non-contiguous sites for purposes of NPL listing. 100 F.3d 152, 155. In completely rejecting both the authority for and the application of EPA's Aggregation Policy for purposes of NPL listing, the court stated:

> Because EPA lacks statutory authority to use its Aggregation Policy to list on the NPL a site that would not otherwise qualify, we vacate EPA's inclusion of [Petitioner's property] within its...listing.

100 F.3d 152, 157.

In light of the unequivocal language in *Meade*, a case with facts nearly identical to those in this matter, EPA may not propose Site P for the NPL unless it can demonstrate that Site P, standing alone, exceeds the HRS listing threshold.

2. Site P Is A Low-Risk Site

Given the clear authority contained in *Meade,* little more need be said about the impropriety of EPA's inclusion of Site P in this proposed listing, except to note that had the EPA scored Site P independently, it would have derived a score for Site P of 0.60 – a far cry from the score needed to qualify Site P as a "high risk" site such that it should be listed on the NPL. Accordingly, even if EPA had followed the requirements of CERCLA Section 105 and the law set out in the *Meade* decision and had scored Site P, there would be no basis to include Site P in Area 2. For all these reasons, the Agency must remove Site P from this proposed listing.

3. Illinois EPA Has Concluded That Site P Should Not Be Included in Area 2.

As noted in the Newfields Report at page 5, the Illinois EPA, which is well familiar with all of the "sites" and with "Area 2," does not believe that Site P should be aggregated with the other Area 2 sites. Expanded Site Inspection Report (IEPA), Ecology & the Environment, Inc., Vol. 1 of 2, Exhibit 3 to Newfields Report, p. 14.[2]

III. EPA'S CONCEPTUALIZATION OF AREA 2 IS SKEWED AND INACCURATE

The Agency's purpose in specifying any geographic area for listing on the NPL is to efficiently and correctly address sites that propose a significant risk of harm to human health and the environment, and indeed, this is the whole point of the NPL and the Hazard Ranking System. Reference to the Agency's own guidance on HRS scoring makes clear that the Agency seeks to properly investigate and characterize contamination at any given location to ensure proper and complete remediation. 40 C.F.R. § 300.430(b)(2). But a technical review of the HRS Documentation in the case of Sauget Area 2, suggests that EPA has not correctly characterized the conditions that exist in this area, and has committed other fundamental errors in the proposed listing.

The fundamental flaw in EPA's approach to its evaluation of this site is its failure to consider contributions to the groundwater contamination in Area 2 from sources outside of any of the proposed Area 2 sites. Had EPA given any consideration to external sources, it could never have developed the surrealistic plume definition shown in the listing documentation. HRS Documentation Record, p. 10. And were EPA to adopt a plume definition that fit the known data about Area 2 (and Area 1), its initial view and ultimate handling of Area 2 may fundamentally change. If Area 2 is suspected to be a high-priority site under CERCLA, then at the very least the Agency should apply itself to actual conditions in this area before it proposes any Area or any site within the area for listing on the NPL.

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[2]Although EPA made Volume 2 of this report part of the administrative record, it did not include Volume 1 of the report. Accordingly, the relevant portion of the report is included as Exhibit 3 to the Newfields Report.

1. The Centerpiece Of EPA's Model Is A Plume With No Source

Page 10 of the HRS Documentation Record depicts what EPA has determined to be the "Ground Water Plume" under Area 2. This plume purportedly originates at the eastern boundary of Site O and extends both westerly and southwesterly from O. The plume also supposedly exists under the southern end of Site P, from which it flows southwesterly towards Site R and ultimately to the Mississippi River. Thus depicted, the plume lies under all of the sites in proposed Area 2. EPA comments on this plume, stating, "The ground water below the Sauget Area 2 site appears to be contaminated from sources located on-site." HRS Documentation Record, p. 60.

UE's environmental consultants, Newfields, have studied the technical materials that comprise the HRS Documentation Record, with particular study of the References listed in that record. HRS Documentation Record, pp. 11-12. As a result of their study of the available data, plus such additional sampling data as was also available to EPA for Area 1, Newfields has also identified the true "plume" of contamination that likely exists in Area 2.[3]

The Newfields Report depicts a plume of groundwater contamination that is vastly different than that proposed by EPA. Newfields Report, p. 11, Figure 12. Unlike the EPA's proposed groundwater plume, which appears to spring from nowhere, the true plume noted by Newfields drew itself – its appearance is a product of the groundwater contamination data available for a single chemical, chlorobenzene, and is simply a graphical representation of that data. Notably, this data shows no groundwater flow component to the southwest. More notably, the true initial source of the groundwater plume is (among other nearby sources) the Monsanto Krummrich facility – it does not magically spring into existence at the eastern boundary of Area 2. Finally, the available data indicates that there is no so-called "plume" under Site P. Newfields Report, p. 8-14.

2. The Initial Sources of Area 2 Groundwater Contamination Are Off-Site Industrial Sources, Including The Krummrich Plant

The Newfields Report demonstrates quite clearly that the initial source of the contaminant plume across a portion of proposed Area 2 emanates from sources outside of Area 2; among these sources is the Krummrich plant, but there may be other sources. *See*, Newfields Report, p. 4. Although UE recognizes that EPA has not included the area comprising the Krummrich facility (or other facilities in the vicinity of Krummrich) as part of "Area 2" because that facility

[3] In order to depict the true plume affecting Area 2, Newfields utilized groundwater sampling data for chlorobenzene, obtained in 1999 and earlier. Included with the Newfields exhibits at Tab 44 is a CD containing each data point and referencing the documentary source for each point. *See*, Newfields Report, p. 3, discussion after Table of Contents.

is being addressed separately under a RCRA-based Administrative Order, UE believes that EPA's failure to acknowledge the contribution of Krummrich (or other off-site sources) to the contaminant plume that flows under portions of proposed Area 2 has fundamentally flawed its approach to all of Area 2. UE believes that unless the EPA acknowledges the significant groundwater contribution flowing under Area 2 from upgradient areas, the investigation and characterization of Area 2 will continue to be inaccurate and fundamentally unfair to parties that had no connection with upgradient sources of contamination.

3. Groundwater Flow Across Area 2 is Due West

Another notable flaw in EPA's conception of Area 2 is best depicted at Figures 12 and 14 of the Newfields Report. Newfields Report, p. 11, 14. These figures demonstrate that, contrary to EPA's depiction of the "groundwater plume" in the HRS Documentation Record, the real groundwater "plume" under Area 2 moves not to the southwest, but to the west. This conclusion is also supported through Newfields' variographic analysis of the data for Area 2, and its discussion of that data. Newfields Report, pp. 9-13.

As stated above, the graphical presentation of available chlorobenzene data for Area 2 demonstrates that EPA has ignored a significant source of groundwater contamination and that the contaminated groundwater plume under Area 2 flows due west (and not southwest). These two facts, in turn, call to question other unstated, but clearly erroneous conclusions about the site implied by EPA's inclusion and characterization of the sites that make up proposed Area 2. First, EPA's "groundwater plume" diagram, which graphically suggests that contaminated groundwater moves from the Source O area southwest under the middle-section of Site Q, is simply not correct, and UE challenges and questions any implied conclusion by EPA that the mid-section of Site Q overlies a contaminant plume moving from some contaminated site outside of Area 2 or otherwise. The southwestern movement of groundwater across Area 2 is inconsistent with the available information about Area 2. Second, the Newfields characterization of groundwater flow as being due west also challenges EPA's inclusion of Site P in Area 2. As will be discussed below, the available data does not show any plume of contamination underlying Site P; the information presented in the Newfields Report simply underscores the fact that Site P is hydraulically isolated from the other Sites.

When the groundwater conditions at Area 2 are analyzed based on actual data and not hopeful speculation, two conclusions become apparent: First, the only portion of Site Q that is likely affected by upgradient groundwater contamination is that portion that is due west of the Krummrich Facility, and this portion is identified and discussed below as "Northern Q" or the "dogleg" portion of Q. Second, Site P has no connection with any groundwater plume – neither the actual plume nor even the one suggested by EPA in the HRS Documentation Record.

IV. PORTIONS OF SITE Q HAVE BEEN MIS-CHARACTERIZED AND INCORRECTLY SCORED AND SHOULD NOT BE PART OF AREA 2

Initially, it is difficult to discuss Site Q because the HRS Documentation Record and other reference documents that are part of the administrative record leave the intended boundaries of Q in doubt. From the record and other materials pertaining to so-called "Site Q," UE cannot determine whether the Site was intended by EPA to include the former UE ash ponds located near or on the western boundary of Site Q, as shown in Figures 27-30 at pages 24-25 of the Newfields Report. EPA should clarify the Site Q boundaries if and when it proposes a final rule on this listing.

Whatever the intended boundaries of Site Q, the Agency mischaracterizes the Site's history when it treats Site Q as a single site. Site Q, as described in both the HRS Documentation Record (at page 13) and at page 6 of the Newfields Report, at 225 acres, is by far the largest of the parcels comprising Area 2, being more than seven times the area of the next largest site. The history of Site Q shows that various parts of this site have been put to at least three uses in the past, each use being different and occurring in a distinctly different portion of Site Q from the other two. The Newfields Report at page 6 states that the northern portion of Q (the Newfields Report refers to the "dogleg" portion due east of Site R as "Northern Q") was used for landfilling, while the very southern area of Site Q was used as a drum storage area. The middle portion of Q, however, may have only been used for the disposal of fly ash and, possibly, domestic garbage. Newfields Report, p. 6. Thus, "Site Q" is not truly a single parcel, and each of the wastes found in the three sections bear no relationship to the others. Pursuant to the HRS Guidance, EPA should not have aggregated and then scored northern, middle and southern Site Q; these sites should have been scored separately.

1. The Agency Has Not Clearly Defined Site Q

The HRS Documentation Record contains no legal description of Site Q, and the only means by which it is identified is by drawing dated March 1, 2001. HRS Documentation Record, p. 9. This drawing leaves doubt as to the intended western boundary of Site Q, because it appears that the Agency's description of Site Q does not include certain portions of the shoreline. Earlier documents pertaining to this area, generated by the Illinois EPA, suggest that the Site Q shoreline should not be included in Area 2; an Illinois EPA drawing of Site Q shows that the western shoreline of Site Q is not included in the definition of the site. *See*, Newfields Report, pp. 24-25, Figures 27-31. The EPA should clarify the intended boundaries of Site Q.

2. The Ash Ponds on Middle-Q Should Not Be Aggregated With Northern and Southern Site Q

Even if the Agency contends that Site Q includes the former UE ash ponds, the "middle-Q" parcel should not have been aggregated with the distinctly separate sources in the north and south of Site Q. Section 4.2 of the HRS Guidance provides in pertinent part, "If sources are similar in type and have similar target populations, the scorer should consider aggregating them into one source." HRS Guidance at 49. There is no dispute that the "source type" in northern Q is a landfill, and in southern Q it is drums. HRS Guidance, p. 42. And there is no data to show that middle Q is a source at all, but it is clearly neither a landfill nor a drum storage area. Therefore, the three areas of Site Q do not meet the most basic aggregation criteria in the HRS Guidance: The "source type" of northern and southern Q are not the same.

The HRS Guidance also provides a "checklist" in order to determine whether separate sources should be aggregated. HRS Guidance, Highlight 4-6, p. 51. The checklist contains a list of six items, and the Guidance provides that only if the answer to each checklist question is "yes" should the sources be aggregated. As noted above, when considered for aggregation the sources in northern and southern Q fail the test of source type, because the areas are different source types. But the checklist comparison also shows that the sites fail a second item — "similar waste characteristics." HRS Guidance, Highlight 4-6, p. 51. As noted in the Newfields Report, the waste characteristics of the sources found at northern and southern Q are not similar. Newfields Report, p.29.

Even if the northern and southern Q sources are considered to be "overlapping sources," they still fail the EPA's test for aggregation. According to Agency guidance, overlapping sources should be aggregated only when there is a similarity or identity between the sources for site-specific disposal operations, the type of hazardous substances found in each source, and the containment characteristics of the sources. HRS Guidance, Highlight 4-7, p. 52. Here, it is abundantly clear that there is no identity of disposal operations among the three parts of Site Q, and it has already been shown that the hazardous wastes are different between southern and northern Site Q.[4]

Finally, the Agency is reminded of Section 125(b) of CERCLA itself, 42 U.S.C. § 9626(b), in which Congress provided special commentary on fly ash waste, and considerations respecting such waste when EPA is engaged in an HRS scoring. To be sure, this section does not preclude listing of a property that is otherwise contaminated with other hazardous wastes, but in this case, "middle-Q" has no wastes to speak of, save for the fly ash ponds, if in fact Site Q does

[4] Middle Site Q may contain nominal amounts of hazardous substances, but this contamination bears no relationship to the contamination at northern and southern Q.

contain those ponds. Given the precautionary language of SARA and the subsequent revision of the HRS to comply with the dictates of Congress in Section 125(b), the Agency should give special consideration to aggregating "middle-Q" with other areas on Q that have completely different histories and wastes.

For all these reasons, central Site Q should not have been included as part of Site Q, and southern Site Q also should not have been aggregated with the northern "dogleg" area of Q. The only portion of "Site Q" that warrants inclusion in Area 2 is the northern-most section, adjacent to Site R. Newfields Report, p. 29.

V. EPA FAILED TO CORRECTLY SCORE FOUR ELEMENTS OF RISK AT SITE Q

In employing the scoring methods and making its assumptions about Site Q, the Agency either ignored its own guidance or it ignored the HRS regulations, and in both cases these errors resulted in an incorrect HRS score. These errors included the Agency's failure to consider the 1994 removal action that was conducted by IEPA on southern Site Q; the EPA's failure to correctly apply the HRS regulations to a determination of wetland perimeter; the assumption, based on flimsy support, that wildlife species were endangered by Site Q; and the failure to take proper groundwater samples at Site Q, contrary to legal precedent that has established the appropriate procedure for collecting such samples. For all of these reasons, the EPA's underlying methodology for conducting the scoring should be reconsidered, abandoned, and the HRS score it derived recalculated.

1. EPA Erroneously Ignored The 1994 Removal Action in Southern Q

Just as there is no doubt that the Agency here failed or refused to consider a prior removal action at the southern part of Site Q, there is also no doubt that in 1994 the Illinois EPA performed a CERLCA time-critical removal action on the southern portion of Site Q to remove drums that were leaking hazardous substances. *See*, Newfields Report, Exhibit 41. In the 1994 removal, the Illinois EPA's contractor removed hazardous wastes from Southern Q. *supra*, at Exhibit 41.

Under the Agency's HRS Guidance, the results of a qualifying removal action must be considered if the removal meets three tests: it must have resulted in the removal of hazardous substances, it must have occurred prior to the "site cutoff date," and the waste must have been disposed of at a proper RCRA facility. Application of this test leaves no doubt that the 1994 removal on southern Q is a qualifying removal, because the IEPA-led removal obviously complied with the first and third elements. As to the cutoff date, although the Agency has not stated such a date, it is clear from the materials referenced by the EPA in the HRS Documentation Record that it considered data much of much more recent vintage than the 1994

removal, even data from as late as 1999. Accordingly, the Agency had no basis for disregarding the affect of the 1994 removal, and as a result of this, the HRS score calculated by the Agency was obtained in violation of HRS regulations and Guidance.[5]

2. EPA Wetland Perimeter Calculations Are Erroneous

In developing a "targets" score, the HRS provides for estimating a score for sensitive areas such as wetlands. Regardless of the concentrations of hazardous substances under consideration, the HRS provides the same method for determining the proper score, and the method requires the scorer to determine the total length of wetlands that lie along the hazardous substance migration path, and assign a risk-based number from a table. HRS Regulations §§ 4.1.4.3.1.1 and 4.1.4.3.1.2; 40 C.F.R. §§ 4.1.4.3.1.1-4.1.4.3.1.2; HRS Guidance, p. 331-333. These same regulations also provide that for rivers, the scorer should use the length of the wetland frontage along the shoreline. The HRS Guidance manual is in agreement with this. HRS Guidance, Highlight 8-61, p. 333.

UE's consultant, Newfields, using the same photographic materials and drawings as the EPA, performed this calculation for the wetland areas on Site Q, calculating the total length of the wetland frontage lying along the Mississippi River. The total obtained was 1.45 miles. *See*, Newfields Report, p. 33. But the Agency used another approach, and instead of totaling total river frontage miles, EPA calculated the total perimeter of all wetlands in Site Q, whether that perimeter fell along river frontage or not. The result obtained through disregard of the regulations and the guidance was 3.6 miles, or more than two times the appropriate number. This improper doubling of the wetland length resulted in the improper doubling of the HRS score for potential sensitive environments. *See*, Newfields Report, p. 32.

The only possible conclusion from reviewing the Agency's doubling method for computing wetland frontage is that the Agency assumes that contamination from Site Q itself enters the wetlands within Q. For central Site Q, however, there is no evidence that any contaminants in this area would enter the wetlands in Q. Accordingly, EPA should re-calculate the incorrectly computed sensitivity factor for wetlands, and utilize one-half of the value that presently contributes to the HRS score for this site.

3. Site Q Is Not A Wildlife Habitat

The Agency actually scored Site Q as if it were a habitat for endangered species. Site Q has been studied extensively to evaluate its potential to provide habitat for endangered species,

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[5] As noted in the Newfields Report, EPA has already considered a significant quantity of data generated well after the 1994 removal action, and even after the initial IEPA Site Investigation. Newfields Report, p. 31.

and there have been found several features in Site Q that could make the site suitable for such species, except that Site Q lacks both breeding and feeding habitat areas, making the EPA's assumption suspect and highly unlikely. Moreover, Site Q and even central Site Q are at the heart of significant commercial activity, rendering the EPA's conclusion about endangered species even more remote. Site Q was not properly scored as a wildlife habitat. *See*, Newfields Report, pp. 34-35.

4. EPA's Groundwater Sampling Was Improper and The Results Are Demonstrably Inconsistent

Two sets of groundwater monitoring data have been taken by the governments at Site Q. One set was taken in 1987, and the other in 1999. The earlier set was taken using conventional groundwater sampling techniques which included 1) establishment and development of an enclosed, permanent groundwater well and 2) proper development of the well through installation, bailing and observation; 3) the filtration of the well sample, to avoid spurious results from particulate matter entrained in the sample. All of the these steps were taken as a recognized and customary precaution against inaccurate results due to the inadvertent sampling of a soil particle that is not really part of the groundwater regime. And all of these steps relate directly to minimizing agitation of the water column when sampling, followed by a further precaution – filtration – to assure that soil particles don't result in an unnecessary remediation because of incorrectly "high" results. Analysis of the 1987 samples showed that groundwater levels of PCBs, Aldrin and Dieldrin were either zero or beyond the detection limit used in the test.

EPA again took groundwater samples in 1999, analyzing the samples for the same constituents. In this later round of sampling, it appears EPA did everything in its power to skew these test results high. EPA abandoned the traditional means of obtaining groundwater samples, selecting instead a sampling that is the antithesis of quiescence: A "GeoProbe" sampler was used, a device designed for speed, not accuracy, in sample-taking. This device is advanced through the soil into the groundwater in a continuous series of "pushes," and is known to cause contaminated soil from horizons above the groundwater to enter the groundwater that is to be tested, while at the same time agitating the groundwater itself and causing the entrainment of additional soil particles. Nor is there any period for well development, nor for allowing the groundwater regime to return to an uninterrupted state, because the groundwater sample is taken without any waiting period. Finally, to further assure capturing a soil particle in the ultimate tested sample, no filtration was performed.

The use of unfiltered samples by EPA for purposes of HRS scoring has been rejected by two courts that reviewed nearly identical issues on the same day. *Anne Arundel County v. U.S. EPA*, 963 F.2d 412 (D.C. Cir. 1992); and *Kent County v. U.S. EPA*, 963 F.2d 391 (D.C. Cir. 1992). In both cases, EPA had utilized unfiltered groundwater results to score and propose a site for listing on the NPL, and in both cases the Court of Appeals rejected EPA's attempt to do so,

recognizing that testing via unfiltered means may skew the results upwards. And while both courts allowed for the Agency to develop internal guidance on appropriate sampling techniques, the courts did not go so far as to allow EPA to adopt the routine use of a GeoProbe coupled with a sampling method prone to error. Here the sampling data and text showing the results fails to contain any documentation to justify the unconventional means of sampling, much less the failure to filter the groundwater samples. Accordingly, the Agency's data that contributed to a score representing this data should be disregarded, and recalculated based upon the 1987 testing results. *See*, Newfields Report, pp. 36-37.

VI. CONCLUSION

For all of the reasons specified in these comments and in the Newfields Report, the listing of Sauget Area 2, as it is presently described by EPA, would be arbitrary and capricious, and an abuse of discretion by the Agency. AmerenUE therefore requests that EPA reject the proposed rule for NPL listing, and remove Sauget Area 2 from the proposed list of NPL sites.

Respectfully submitted,

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Enclosures

COMMENTS ON SAUGET AREA 2 HAZARD RANKING SYSTEM LISTING DOCUMENT

December 13, 2001

Prepared for AmerenUE, St. Louis, MO

Prepared by NewFields

NEWFIELDS

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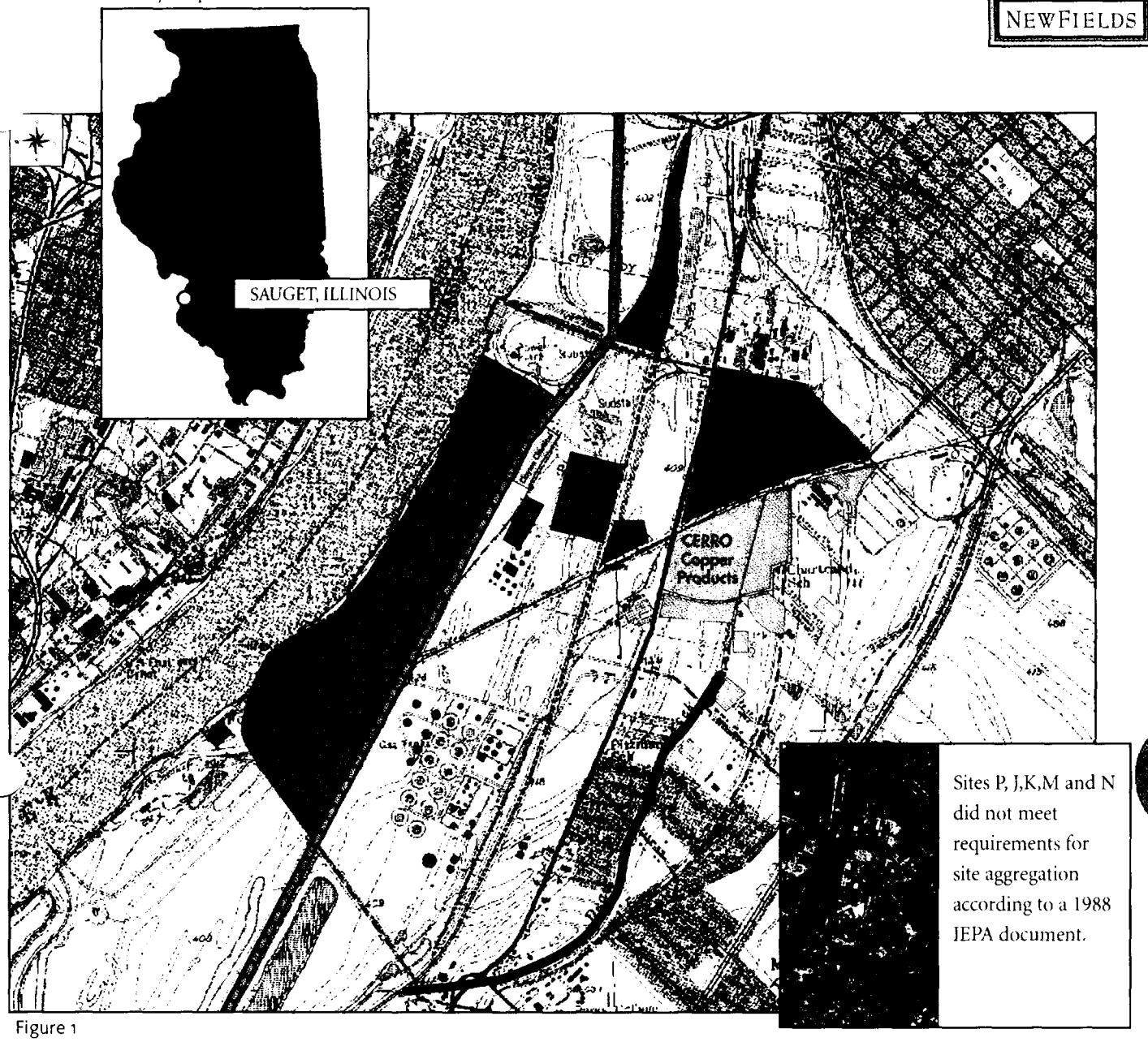
The review provided in this report is based in large part on a comprehensive electronic data base developed from documents from the US EPA files. This includes all the data available in the Administrative Record for the NPL Listing document as well as data from other US EPA actions in the area. The data sources are listed below.

Mapping of the pattern of chlorobenzene contamination throughout Area 1 and 2 is included in this report to demonstrate critical points regarding potential inaccuracies in the US EPA's assumptions. Chlorobenzene was used as an indicator parameter that demonstrates relevant patterns of groundwater contamination.

A CD attached to this report contains an Access database. (Exhibit 44) A list of data sources is also included. The CD contains the coordinates for each sampling point, the chlorobenzene concentrations, and the reference from which the data was obtained.

Vicinity Map

NEWFIELDS



Sites P, J,K,M and N did not meet requirements for site aggregation according to a 1988 IEPA document.

Figure 1

Site Divisions

The scope of work submitted to the IEPA by Ecology and Environment in August of 1986 suggested grouping various disposal sites together into two areas for Hazard Ranking System (HRS) scoring purposes. (Exhibit 3) A brief description of each area is provided below. Five of the sites, J, K, M, N, and P, did not meet requirements for site aggregation and, as of 1988, were referred to as peripheral sites by IEPA.

Area 1 comprises the eastern part of the Cerro Copper Products property (Site I), sections of Dead Creek and three disposal areas south of the Cerro Copper Products (Sites G, H, and L). (Exhibit 3)

Area 2 includes sludge lagoons, waste disposal facilities and industrial landfills lying between the Krummrich Plant and the Mississippi River. Area 2 aggregates sites O, P, Q, R and S. (Exhibit 2)

DESCRIPTION OF SOURCES AGGREGATED BY THE U.S. EPA INTO AREA 2

R

Site R: (25 acres) (also known as the Sauget Toxic Dump and Krummrich Landfill) This area is an inactive industrial waste landfill bordered by the Mississippi River (Figure 2). (Exhibit 3) From 1957 to 1977, Monsanto disposed of liquid and chemical wastes including chlorinated compounds such as PCBs. (Exhibit 5) Sauget and Company operated the Krummrich Landfill on behalf of Monsanto. Site R is currently covered with a clay cap and vegetation with drainage directed to ditches around the perimeter of the site. (Exhibit 1) Access has been restricted by a fence and 24-hour camera surveillance since 1978.

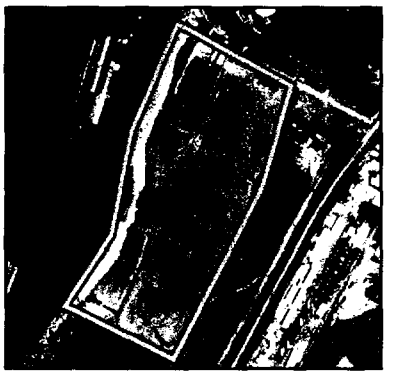


Figure 2

Q

Site Q: (225 acres) The boundary of Site Q, as defined by US EPA in the NPL listing document, is shown in Figure 3. (Exhibit 1) Site Q is located south of the former Cahokia Power Plant and west of an Army Corps of Engineers (ACOE) flood control levee. From approximately 1949 to 1974, Union Electric Company operated, on the western edge of Site Q, a series of ash impoundments. (Exhibit 6) The ash ponds covered approximately 32 acres along the Mississippi Riverbank. Union Electric operated the ponds as a monofill, accepting only combustion related wastes from the Cahokia Power Plant. No landfilling occurred within the ash ponds.

Commencing in 1966 and continuing until the mid-1970s, Sauget and Company conducted unpermitted landfill operations in Northern Site Q, an area immediately east of Site R know as the dogleg or panhandle of Site Q. (Exhibit 1,2) This landfill has been referred to alternatively as the Sauget Municipal Landfill (Exhibit 6) or the Sauget Landfill. (Exhibit 2) In addition, Sauget and Company apparently operated an unpermitted landfill in the southern region of Site Q near the Alton and Southern Railroad lines. The ash ponds and the landfill areas were operated separately and are geographically discrete. Aerial photography reflects that vast portions of Central Site Q were not used for disposal activities. (Exhibit 7) Site Q should be subdivided into separate regions to more accurately reflect its operational and disposal history. It is not, as described by US EPA, an inactive, 225 acre landfill.

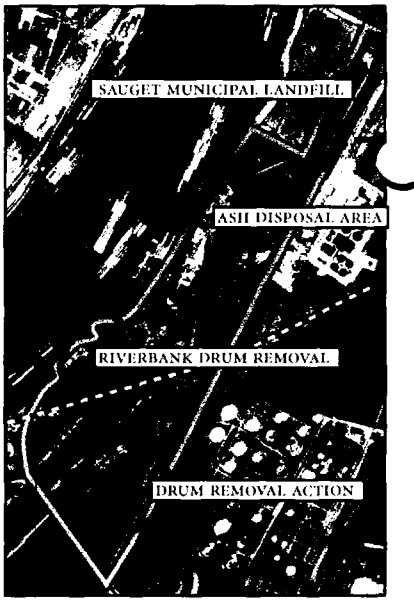


Figure 3

Alton & Southern Railroad Company

US EPA's characterization of Site Q is based on mistaken assumptions that lack appropriate supporting data. For example, The Ecology and Environmental Report states that "Contamination was detected across the entire area investigated, which suggests that disposal of large quantities of chemical wastes occurred specifically in the northern portion of Site Q and probably over the entire area." (Exhibit 8, page 80, 87) Neither the administrative record nor the empirical data support such a conclusion. In fact, the Central Site Q samples did not detect contamination approximating that detected in the Sauget Municipal Landfill in the northern portion of Site Q. (Exhibit 9) Moreover, historical aerial photographs dating from the early 1950's to the present confirm that there were no significant waste disposal activities within most of Central Site Q. (Exhibit 17) Without data to support the above statement, the conclusion can be described only as baseless speculation. This speculation led to unrelated areas being erroneously combined into a single large site (Figure 4).

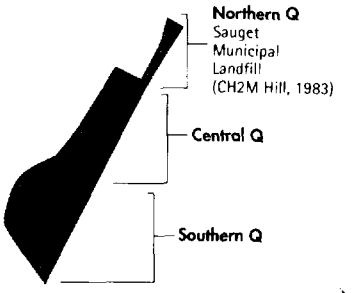


Figure 4

Figure 5

Site P: (28 acres) This region is an inactive, permitted sanitary landfill known as the Sauget-Monsanto Landfill. In 1988, IEPA determined Site P did not meet the requirements for aggregation. (Exhibit 3) Site P is a triangular parcel located east of the 500-year ACOE flood control levee and north of the other Sauget Area 2 sites (Figure 5). (Exhibit 1) Site P began operating as a non-chemical solid waste disposal facility for Monsanto in 1973. In 1974, Sauget and Company was granted a permit to also accept diatomaceous earth filter cake from Edwin Cooper, Inc. Site P is bordered on the west by the Illinois Central Gulf Railroad and on the east by the Terminal Railroad Association.

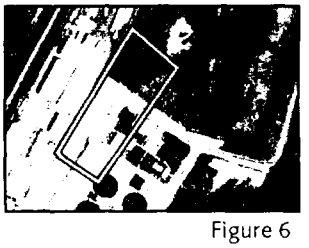


Figure 6

Site S: (11 acres) This area is located approximately 100 feet west-southwest of Site O (Figure 6). (Exhibit 1) The site is covered primarily with gravel but a small portion is covered by an asphalt parking lot and driveway. Aerial photographs available from 1973 and 1975 show drum disposal operations occurring in this area. There is no specific information on the contents of the drums seen in the aerial photographs, but sampling has detected pesticides and volatile organic compounds (VOCs) in soil.

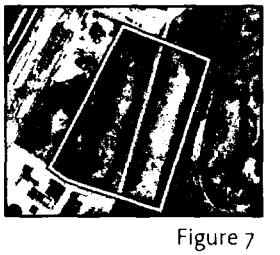


Figure 7

Site O: (20 acres) This area consists of four inactive sludge dewatering lagoons used by the Village of Sauget Wastewater Treatment Plant (WWTP) from 1966 to 1978. (Exhibit 5) Ninety-five percent of the wastewater was generated by local industries with Monsanto contributing approximately 80% of the industrial volume. Site O is located west of the Krummrich plant and east of the ACOE flood control levee (Figure 7). In 1978 the lagoons were closed and covered with two feet of clay and subsequently vegetated.

US EPA'S CONCEPTUAL SITE MODEL IS INACCURATE.

The aggregation of alleged sources into Area 2 is not justified by the data. Sources in the Dead Creek Project area are related along an east-west axis. The primary source of alleged risk to the Mississippi River is a groundwater contaminant plume that extends from the Krummrich plant to the Mississippi River.

The concept of grouping several sites and creek sectors together for future Hazard Ranking System (HRS) scoring purposes was introduced in a scope of work revision submitted to IEPA by Ecology and Environment in August 1986. (Exhibit 3) The criteria used for their Conceptual Site Model (CSM) grouping, according to the Ecology & Environment Expanded Site Investigation Report of 1988, was geographical relationship, ownership and operation, waste types, and common exposure pathways. Each subsequent US EPA and IEPA report used the 1986 CSM without reassessing the model's validity relative to new data.. The CSM currently used by the US EPA consists of the two separate CERCLA sites (Area 1 and Area 2).

The Agency criteria provide guidance for grouping sites in a manner that enhances the management of contamination, risk pathways, and remediation. (Exhibit 10) The goals of the NPL are best served if common pathways, components, and/or threats are grouped and examined in a comprehensive manner. US EPA has identified the pathways of concern as surface water overland/flood migration and/or groundwater to surface water migration. (Exhibit 1) As such, the CSM should be based on knowledge of the source, the target of these risk pathways and should thoroughly describe the pathways.

The US EPA's CSM fails to satisfy its own stated criteria for grouping sites, and it fails IEPA criteria as well. Some of the sources grouped into Area 2 are geographically separate, the waste types are not common among all the sources, and all the sources do not share common exposure pathways and targets.

The US EPA's attempt to combine and portray these sites as a single area, and their delineation of a pathway of concern (groundwater), is included in the NPL listing document and reproduced here (Figure 8). (Exhibit 1) However, the US EPA representation of the "groundwater plume" does not correctly describe actual contaminant distribution.

The contaminant distribution data demonstrate that the principal risk pathway to be managed is in fact a groundwater plume migrating from east to west from the Krummrich Plant, under a drum disposal area and then under Sites O, S, Northern Site Q and Site R (Figure 9). (Exhibit 11) Contaminants from each of these locations commingle as groundwater migrates toward the Mississippi River. There is no factual basis for US EPA's apparent suggestion of a southwestern groundwater migration path.

The true characteristics of the groundwater plume can be demonstrated with the indicator parameter, chlorobenzene. A post plot of chlorobenzene concentrations is shown in Figure 9. (Exhibit 11)

Based on the information provided in the Area 2 NPL listing document, and the figures included within the listing document, it does not appear the US EPA has ever performed a comprehensive analysis and visualization of groundwater contaminant distribution throughout the DCP. As such, the US EPA CSM of contaminant distribution is an artificial construction based on untested assumptions that date back to 1986 or earlier. Superimposing the US EPA-defined groundwater plume onto the contaminant plume data illustrates the inadequacy and inappropriateness of the US EPA delineation and CSM (Figure 9). The discrepancy between the US EPA CSM and the true conditions at the site is apparent on the following pages.

The distribution of contamination shown in Figure 9 does not support the US EPA estimate of the plume shape or dimensions shown in Figure 8. This US EPA groundwater plume is drawn to connect each of the source areas combined fifteen years ago into Sauget Area 2.

The following pages provide additional support for the conclusion that the US EPA CSM and resultant grouping of sites into Area 2 is fundamentally flawed for NPL listing assessment, effective risk management, and remedial decision-making.

Figure 9

US EPA plume boundary estimate

EPA NATIONAL PRIORITIES LISTING DOCUMENT

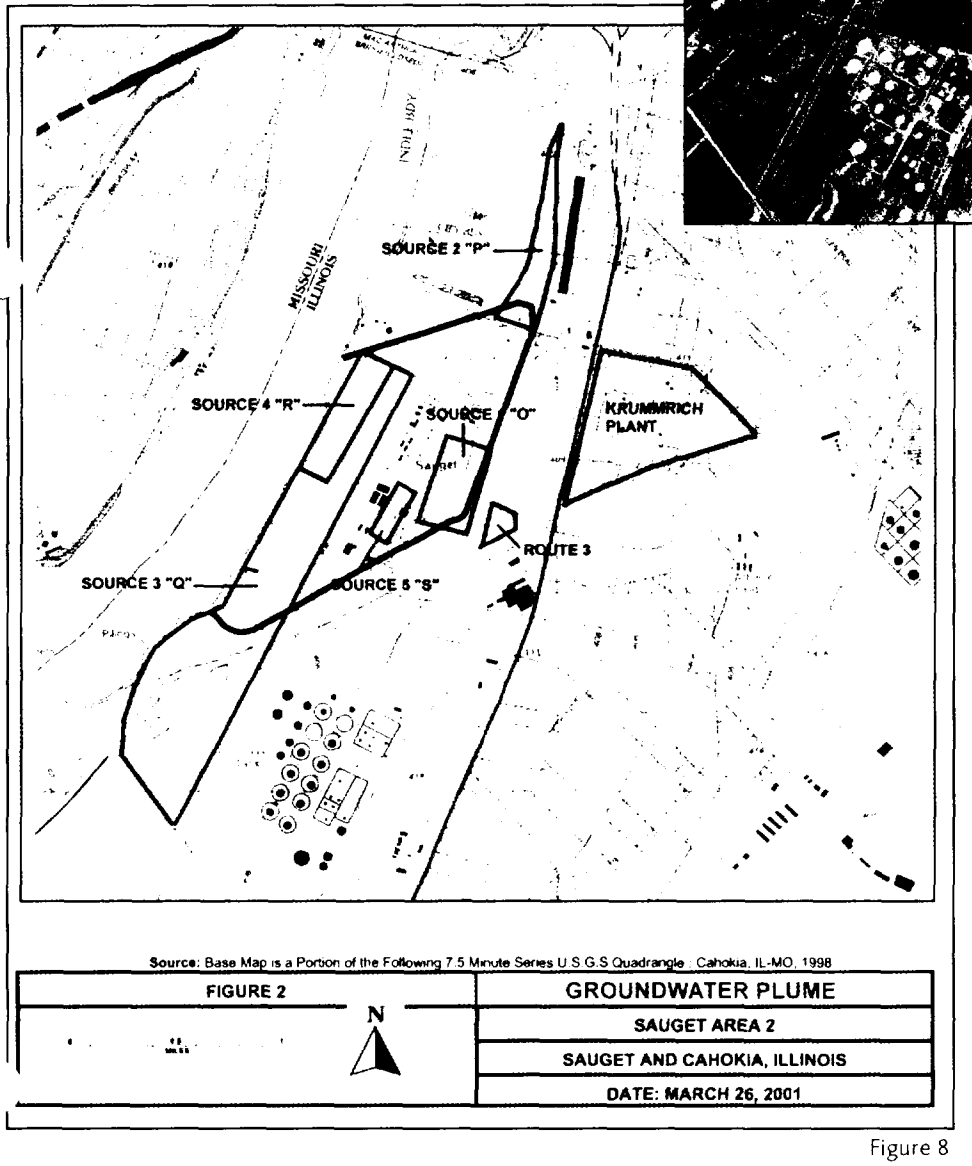


Figure 8

LEGEND:
GW-Chlorobenzene (ug/l)

- < MCL**
- > MCL
- Dead Creek

**Chlorobenzene is utilized as an indicator parameter
MCL = 100 ppb

A close analysis of the vertical distribution of the groundwater contaminants supports the conclusion that the US EPA CSM is inappropriate. The data demonstrate that multiple disconnected shallow contaminant sources are leaching into and commingling in a continuous deeper groundwater plume. This deeper groundwater plume is bounded on the north and south by the approximate limits of Site R (Figure 11). (Exhibit 11) Several alleged sources currently grouped into Area 2 are south and north of the plume. These alleged sources (Central Site Q, Southern Site Q and Site P, respectively) are completely unrelated to the principal groundwater to surface water risk pathway.

The commingling of contamination is apparent from deep groundwater data obtained between the Krummrich plant and Sauget Area 2. In this area, surficial groundwater samples contain lower contaminant concentrations than the deeper samples. These data show that the contamination found in deep groundwater beneath the Area 2 sites has a source other than the soils directly above. The presence of contamination in the deep groundwater samples indicates a plume extending west from the Krummrich plant to the Mississippi River. (Exhibit 11)

A geostatistical methodology called variography is used to determine the relationship, if any, between spatially distributed contaminants. (Exhibit 12) This spatial relationship can be graphically presented to show the extent of contaminant source influence in surrounding areas.

Variography performed on the DCP area chlorobenzene data illustrates an east-west plume of influence in the deep groundwater layer extending from the Krummrich plant to Site R. The variography also demonstrates that surface contaminant sources are distinct and isolated. (Exhibit 13) The contaminant commingling occurring at depth is shown in Figures 10 through 12.

The concentration gradient in deep groundwater from the Krummrich plant to the river indicates that there are multiple commingling sources originating from the Krummrich chlorobenzene facility and the associated disposal activities to the west and southwest of Krummrich. The data demonstrate that the groundwater contamination is primarily related to lateral groundwater flow from the vicinity of the Krummrich plant coupled with a significant vertical contribution from Site R. (Exhibit 11)

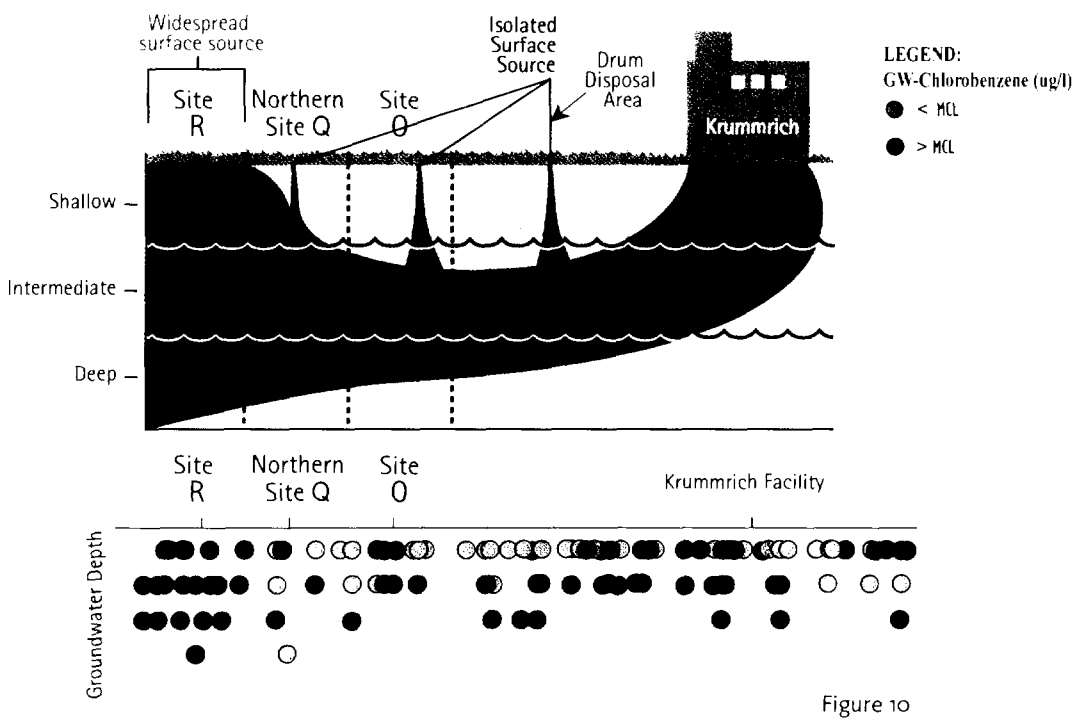


Figure 10

US EPA'S SITE CONCEPTUAL MODEL

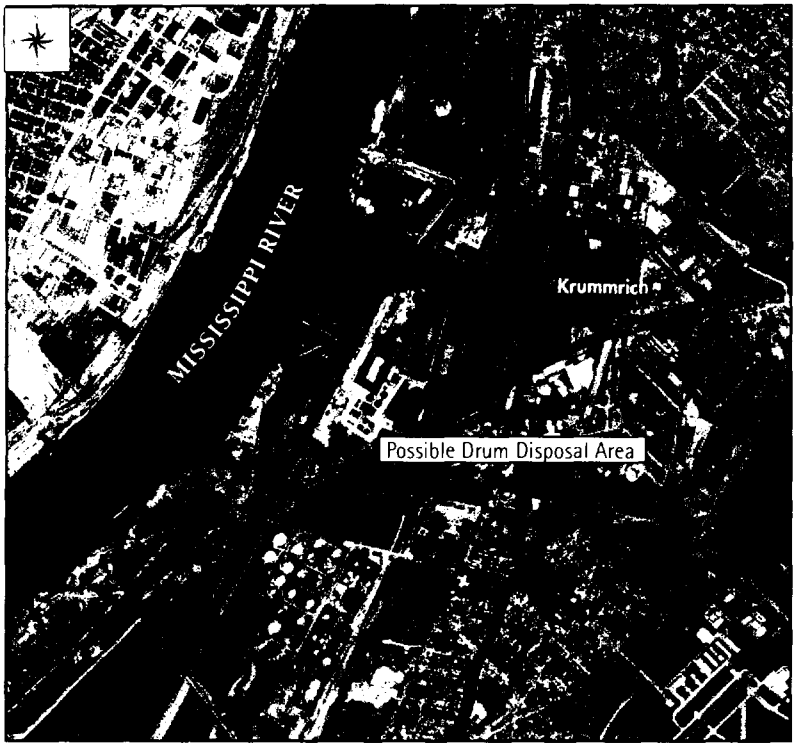


Figure 11

The US EPA's site conceptual model does not address the directional characteristics of the groundwater plume from the Krummrich plant towards the Mississippi River.

APPROPRIATE SITE CONCEPTUAL MODEL

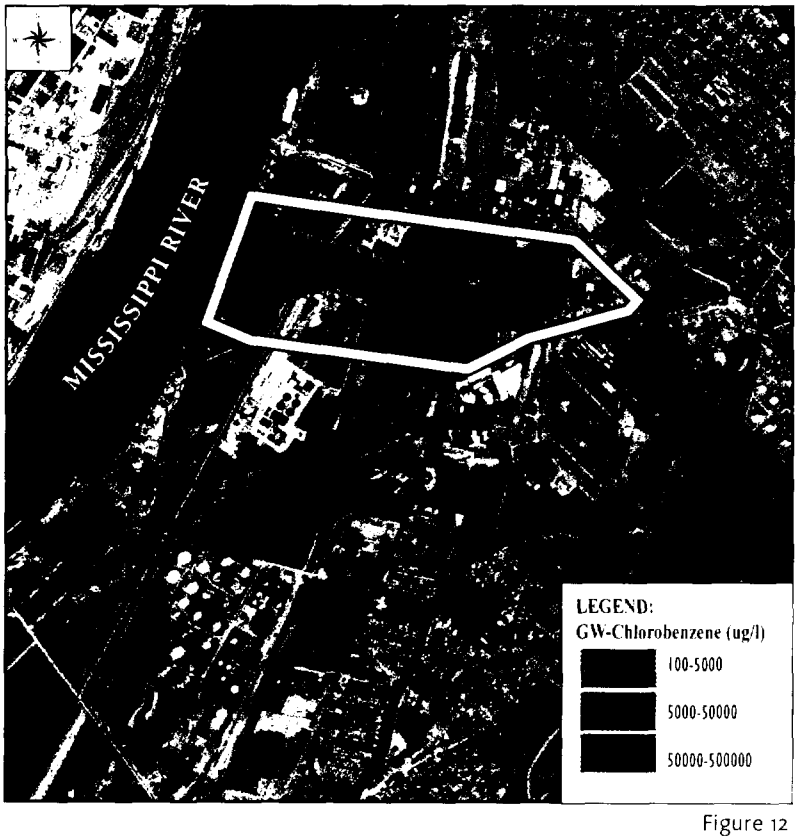


Figure 12

The appropriate site conceptual model addresses the directional flow of the groundwater contaminant plume.

The hydrogeology in the area also supports the conclusion that the US EPA CSM is not appropriate for either hazard ranking purposes or risk pathway management.

SURFACE WATER

Figure 13

Surface water east of the levee generally flows towards Dead Creek and west of the levee it flows towards the river.

The US EPA grouping of sources and analysis of risk is based on the stated concern that the direct and/or indirect discharge of groundwater to the Mississippi River represents the primary environmental and human health risk. (Exhibit 1) However, the boundaries established by the US EPA in the source grouping are illogical from the standpoint of ultimate remediation requirements. The boundaries chosen for Area 2 would seem to eliminate from consideration the natural surface and groundwater flow pathways.

As noted in the US EPA's NPL listing document (Exhibit 1), an ACOE 500-year flood control levee prohibits surface water flow in a westward direction from areas east of the levee (Figure 13). The surface water runoff east of the levee within Area 2 is either directed to the east or toward depressions with no runoff potential. The latter occurs within Site P.

GROUNDWATER TO SURFACE WATER MIGRATION

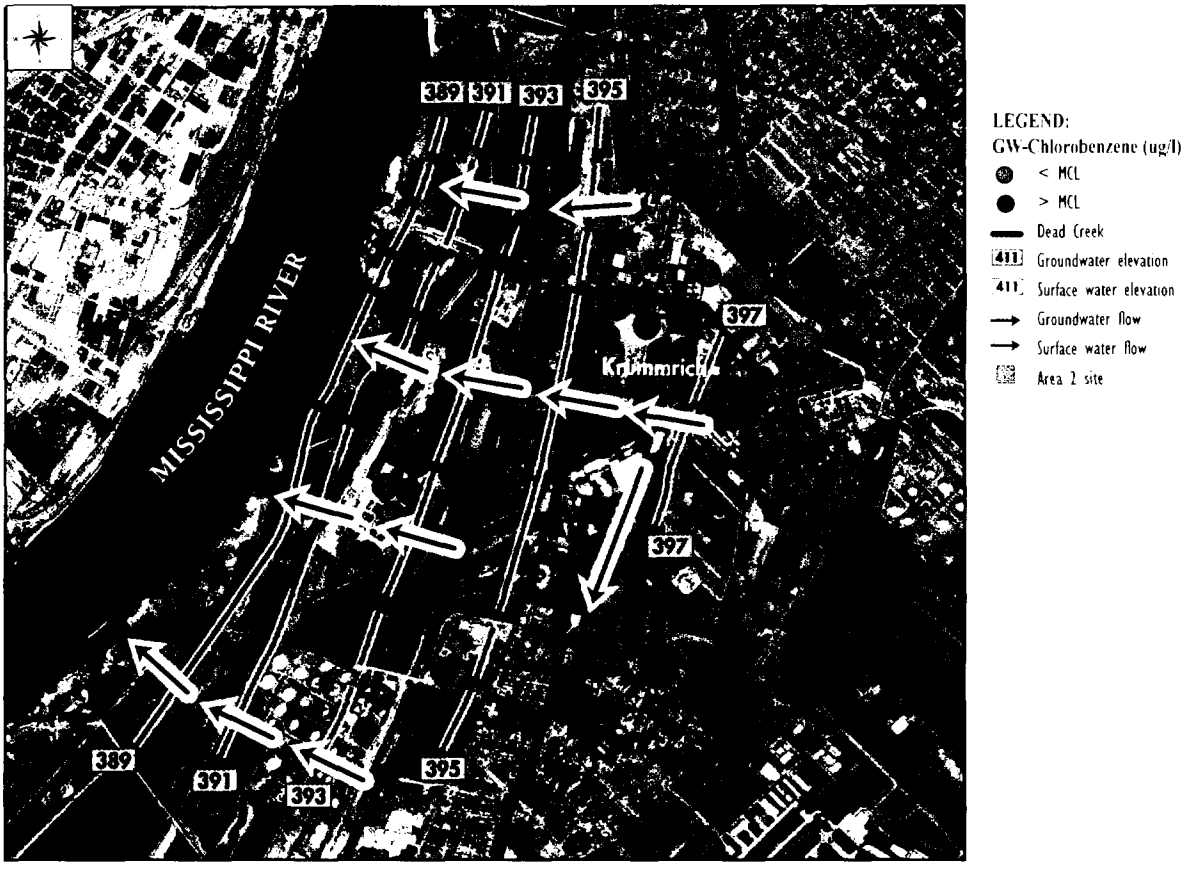


Figure 14

Groundwater flows to the west across the entire region toward the Mississippi River. This groundwater flow ensures that groundwater contamination at the Krummrich plant will flow beneath portions of Area 2, including Sites O, Northern Site Q and Site R, as it continues toward the Mississippi River. Because groundwater flows from east to west, groundwater contaminants discharged from the Krummrich plant and related facilities commingle in the groundwater in the direction of groundwater flow. However, because conditions in the Mississippi River are dominant in the groundwater flow regime, there is no groundwater gradient north or south. As a result, there is no commingling of groundwater contaminants from Site P, Central Site Q, or Southern Site Q with the primary groundwater plume beneath Site R. Dead Creek diverts groundwater to the south when the groundwater elevation intersects the creek invert. (Exhibit 9)

The pattern of surface and groundwater flow in the Sauget area divides the area into distinct spheres of influence inconsistent with the current US EPA's CSM. The NPL listing document recognized this physical constraint, "The levee, which splits this site from north to south, may act as an impedance to surface water flow, it does not stop contaminants in the ground water from flowing beneath it to surface water via seeps or direct communication between groundwater and the river." (Exhibit 1, page 34)

The aggregation of alleged sources into Area 2 is not justified by the analytical data. Sources in the Dead Creek Project area are related along an east-west axis. The primary source of risk to the Mississippi River is a groundwater contaminant plume that extends from the Krummrich plant to the Mississippi River.

SITE P SHOULD NOT BE AGGREGATED INTO AREA 2

Site P should not be aggregated with other Area 2 sites because the disposal practices (both waste material and method of disposal) were not the same as those at the other sites. Site P is geographically and hydrologically separate from the other sites. The groundwater contaminants associated with Site P are of significantly lower toxicity and environmental persistence and thus pose less potential risk to human health and the environment.

Site P has been inappropriately aggregated into Area 2 according to IEPA and US EPA HRS guidance criteria. IEPA originally used four criteria to group sites, and Site P fails all four of the criteria. IEPA acknowledged this fact in the 1988 Expanded Site Investigation. (Exhibit 3) US EPA uses six specific criteria to group sites for scoring purposes. (Exhibit 14) All criteria must be satisfied to group sites (sources) for HRS scoring. Site P does not satisfy at least five of the six US EPA criteria.

In general, both the IEPA and US EPA guidance identifies common exposure pathways, ownership, types of operation, waste types, and geographic relationships as the factors governing grouping of sites (or sources) into a single area for scoring a particular pathway. The factors demonstrating that Site P should not be aggregated into Area 2 are as follows:

1) There is definitive geographic separation between Site P and the other sites in the proposed Area 2.
2) The activities at Site P (landfilling only) were different from the activities at the other sites in Area 2.
3) There is no common exposure pathway between Site P and the other sites in Area 2. Neither surface water nor groundwater from Site P commingles with water from the remaining sites or sources within Area 2.
4) No plume of any significance has been identified as emanating from Site P and thus Site P is not a source. The only contaminants that could potentially have been released from Site P, phenol and manganese, are unrelated to the primary contaminants at the other Area 2 sites.

   The detection of phenol at 12 ppb in a single groundwater sampling point is three orders of magnitude below the US EPA Region 9 health-based screening level of 22,000 ppb. (Exhibit 15).

   The manganese is likely natural background material from soil pulled into the groundwater sample by turbid GeoProbe sampling. This latter conclusion is based on the fact that the soil manganese concentration in Site P (280 ppm at sample X107) is less than the soil manganese concentration in the US EPA background sample (331 ppm at sample X101). (Exhibit 1)

   Low levels of PCBs (0.087 ppb in well G110) were identified in the groundwater underlying the site. However, the concentrations of PCBs at Site P were below the concentrations in US EPA's background well (1.29 ppb in well G109). (Exhibit 1)
5) There is no new information or data that warrants modification of the 1988 IEPA decision to handle Site P as a peripheral site. The IEPA position was as follows:

   Site P "[does] not meet requirements for site aggregation and will be referred to henceforth as peripheral." (Exhibit 3, page 2-1)

The following figures provide additional support for the absence of an appropriate rationale for grouping Site P with the remainder of Area 2 sites and sources.

Geographic proximity

Site P is physically isolated from the other Area 2 sites.

Site P is surrounded by railroad embankments on either side and a ridge (Monsanto Avenue) along the southern border, essentially isolating the site from impact or contribution to the other Area 2 sites. (Figure 15) (Exhibit 2)

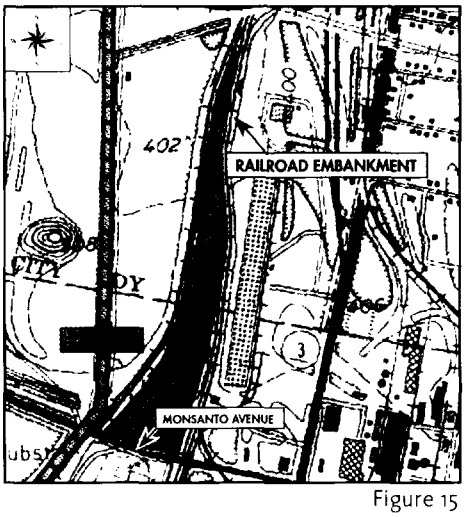


Figure 15

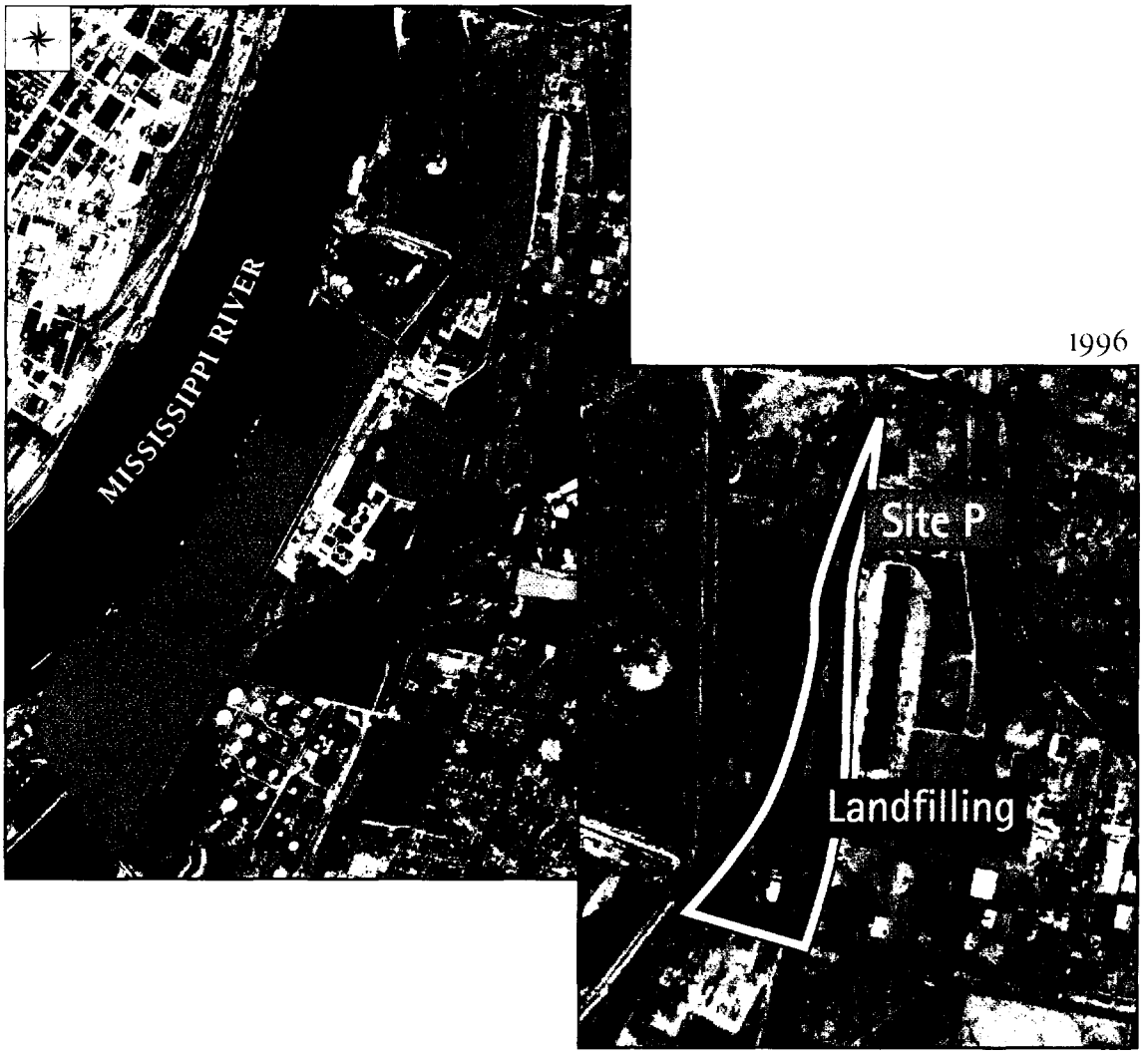


Figure 16

Source types/Waste types

US EPA has defined source types for determination of surface area or volume of disposed material as:

- Landfill
- Surface Impoundment
- Drums
- Tanks and Containers
- Contaminated Soil
- Piles

Site P is a small IEPA-permitted landfill that accepted primarily non-hazardous and non-chemical industrial solid waste. (Exhibit 1) Other sites in Area 2 include drum disposal areas, sludge ponds and unpermitted landfills (Figure 16). Although landfilling activities were performed, soil and groundwater data demonstrate that Site P is not a source area and the contaminants present in the identified groundwater plume in Area 2 are not attributable to Site P.

Exposure Pathways

Site P has different potential targets than the other sites within Area 2. Unlike Sites Q and R, which are subject to periodic flooding, Sit P is located behind the ACOE 500-year flood control levee and is not subject to flooding by the Mississippi River. (Exhibit 1) During periods of heavy rainfall, water may pond on Site P. However, due to the presence of elevated railroads and roadways surrounding the site, the surface water does not leave the site by overland flow (Figures 17 and 18). (Exhibit 2) The only areas potentially impacted by the presence of surface water are the onsite wetlands defined as temporarily, seasonally or semi-permanently flooded wetlands (Figure 19). (Exhibit 16) These very definitions are based on the presence of ponded surface water during periods of high precipitation (Figure 20).

Surface Water

Surface water does not discharge from Site P to the Mississippi River, but remains onsite. (Exhibit 2)

"Surface drainage will not leave the site due to the presence of railroad embankments along the perimeter and the depression in the central portion of the site. Surface drainage is to the south-central portion of the site, which was not landfilled due to the presence of a potable water line in this area." (Exhibit 2, page 12)

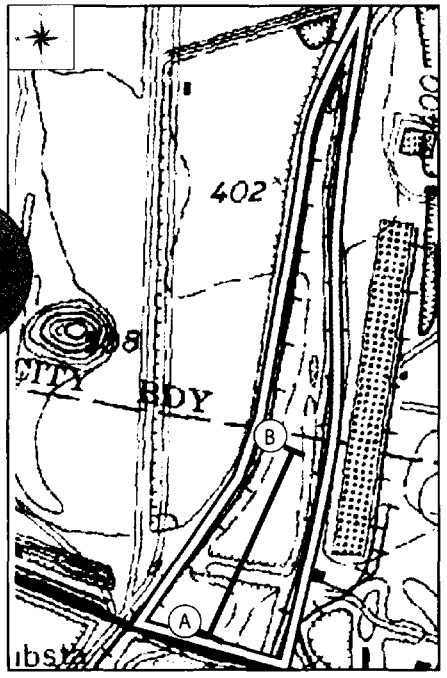


Figure 17

Figure 18

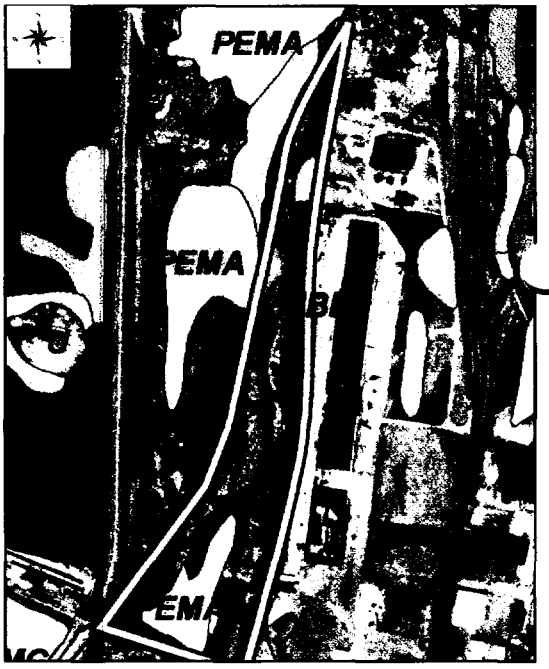
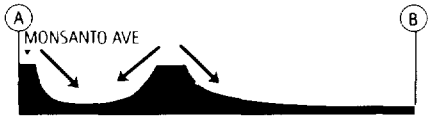


Figure 19



The low areas of Site P are defined on the United States Geological Survey (USGS) map as brown lines with small "teeth" indicating the downward slope. (Exhibit 17) *The cross-section AB illustrates the surface water flow direction based on ground surface elevation.*

The arrows depict the surface water flow direction within Site P. The areas of lower elevation and the direction of surface water flow are consistent with the wetland areas identified via aerial photography in the National Wetlands Inventory. (Exhibit 16)

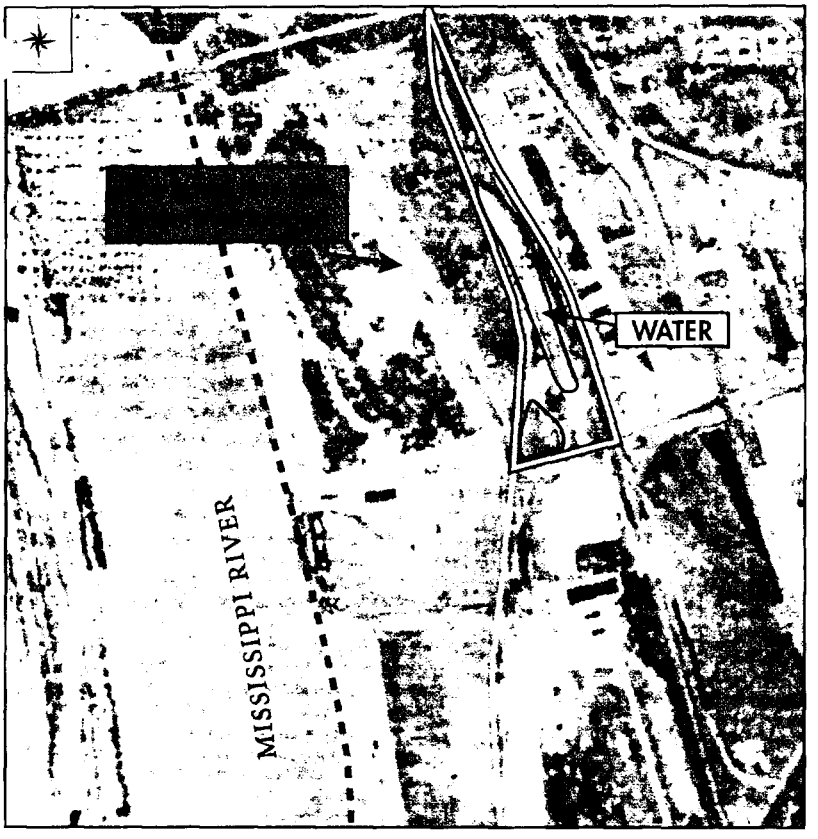


Figure 20

Even during the flood event of 1993, which was one of the largest floods in decades, Site P was not inundated by the Mississippi River. The ponding in the immediate area around Site P was a consequence of more than 14 inches of rainfall occurring over the prior two-month period (Exhibit 18) and the lack of drainage from the area, and is not indicative of flooding across the levee. The absence of drainage from Site P is evident in the aerial photograph taken during the 1993 flood. (Exhibit 19) Extensive ponding is obvious within Site P although the levee has not been overtopped.

The ponded water visible in Site P could not be a result of levee underflow because of the extended travel time from the river side of the levee to Site P during periods of reversed groundwater flow (Mississippi River flood conditions). Normal westward non-flood condition groundwater flow would resume before Site P would be impacted by the reverse flow. (Exhibit 20)

"A 500-year flood control levee protects Site P from direct Mississippi River flood events." (Exhibit 5, page 2)

Figure 21

Groundwater

Groundwater from all of the sites in Area 2 discharges toward the Mississippi River (Figure 21). (Exhibit 1) However, because Site P is significantly north of the other Area 2 sites, groundwater discharging from Site P does not commingle with groundwater from the other sites. There is no commingling of the contaminant plume before or after discharge into the Mississippi River because no plume from Site P has been identified.

LEGEND:
GW-Chlorobenzene (ug/l)

- < MCL
- > MCL
- Dead Creek
- Groundwater Flow
- Area 2 Site
- Area 1 Site

According to the guidance criteria established by US EPA in the Hazard Ranking System Guidance Manual (HRSGM), Site P should not have been aggregated with the other Area 2 sites.

Figure 22 is the source aggregation HRSGM guidance checklist. (Exhibit 14) A summary of the response to each of the six questions is provided on the facing page

HIGHLIGHT 4-6
CHECKLIST FOR SOURCE AGGREGATION

Questions on this checklist should be used to determine whether to aggregate two or more sources for each pathway being evaluated

(1)	Can the sources be classified as the same source type for the pathway? (e.g., drums, landfills, piles)	Yes	No
(2)	Do the sources affect similar target populations for the pathway? (i.e., target populations significantly overlap)	Yes	No
(3)	Do the sources have similar containment for the pathway? (e.g., liner, run-on and runoff controls, cover)	Yes	No
(4)	Do the sources contain substances with similar waste characteristic factor values available to the pathway? (e.g., toxicity, persistence, mobility)	Yes	No
(5)	Are the sources in the same watershed and floodplain? (surface water only)	Yes	No
(6)	Are the sources overlying the same aquifer system(s)? (ground water only)	Yes	No

If the answer to each of these questions is "Yes" then the sources should be aggregated and treated as one source for the pathway.

If the answer is "No" to one or more of these questions, then the sources should be treated separately for the pathway.

Figure 22

Site P should not be aggregated with other Area 2 sites because the disposal practices (both waste material and method of disposal) were not the same as those at the other sites. Site P is geographically and hydrologically separate from the other sites, which prevents the commingling of groundwater and runon/runoff of surface water from other sites. The groundwater contaminants associated with Site P are of significantly lower toxicity and environmental persistence and thus pose less potential risk to human health and the environment. Site P should be scored independent of the other Area 2 sites.

1. Can sources be classified as the same source type?

No

Other Area 2 sites were used for drum disposal, sludge lagoons and hazardous waste disposal. Site P was used principally for the disposal of non-hazardous waste. There are significant differences in soil and groundwater contaminants and concentrations at Site P and the other Area 2 sites. Site P contaminants are limited to phenol, manganese and PCB. The phenol concentration is orders of magnitude below any level of concern and the other two constituents are below levels found at US EPA Sauget Area 2 background locations. Site P is not a contaminant source.

2. Do the sources affect similar target populations for the pathway?

No

Surface water flows into wetland areas on Site P and does not flow towards the Mississippi River. Groundwater from Site P does not commingle with that of other Area 2 (or Area 1) sites. There is no identified groundwater plume migrating from Site P toward the Mississippi River and thus Site P is not a source...

3. Does the site have similar containment?

No

Site P is the only site in Area 2 that possesses hydrologic containment due to the absence of surface runon/runoff pathways from other areas. Site P is surrounded by railroad embankments on either side and a ridge (Monsanto Avenue) along the southern border, essentially isolating the site from impact or contribution to the other Area 2 sites.

4. Does the site have similar waste characteristics

No

The primary contaminants that affect the risk pathways for Area 2 are not present at Site P above background concentrations. The mobility, persistence, bioaccumulation and toxicity of contaminants present at Site P are significantly different than those present at other Area 2 sites.

5. Are the sites located on the same watershed <u>and</u> floodplain?

No

As noted above, Site P is not truly a source. Site P is located behind the ACOE 500-year flood control levee, and thus is not in the floodplain east of the levee where Sites Q and R are located. Site P is within the same watershed and floodplain as the Area 2 sites located on the west side of the levee.

6. Are the sources overlying the same aquifer system?

As discussed above, there is no contamination source at Site P. The aquifer system is, however, continuous at both Areas 1 and 2. Groundwater beneath Site P does not commingle with groundwater from other Area 2 sites or with Area 1 sites due to Site P's location north of the identified east-west groundwater contaminant plume.

SITE P DOES NOT QUALIFY FOR THE NPL

The US EPA determined that the use of groundwater as a drinking water source in the vicinity of Sauget Areas 1 and 2 was not likely due to the availability of municipal water. (Exhibit 1) Based on this determination, the drinking water pathway was not scored by US EPA during the Area 2 HRS site scoring process; scoring of Area 2 was based on the surface water overland/flood migration pathway and the groundwater to surface water migration pathway.

As noted above, US EPA's own policy does not support Site P's aggregation with the other Area 2 sites for calculating an HRS site score for NPL listing consideration. When Site P is considered as an independent site, it clearly presents no risk to human health and the environment. The following tables display the US EPA procedure used to calculate the HRS site score for the entirety of Area 2 and the more detailed worksheets for calculating the surface water overland/flood migration and groundwater to surface water migration components of site risk. (Exhibit 21) The scoring of Site P, as an independent entity, and the resulting total scores are presented in the right-hand column within each table.

TABLE 4-1
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET

Factor Categories and Factors	Maximum Value	EPA Value Assigned	Site P Value Assigned
HUMAN FOOD CHAIN THREAT			
Likelihood of Release			
14. Likelihood of Release (same value as line 5)	550	550	100
Waste Characteristics			
15. Toxicity/Persistence/Bioaccumulation	a	5×10^8	5
16. Hazardous Waste Quantity	a	100	
17. Waste Characteristics	1,000	320	3
Targets			
18. Food Chain Individual	50	45	1
19. Population			
19a. Level I Concentrations	b	0	
19b. Level II Concentrations	b	0.03	
19c. Potential Human Food Chain Contamination	b	0	
19d. Population (lines 19a + 19b + 19c)	b	0.03	
20. Targets (lines 18 + 19d)	b	45.03	1.03
Human Food Chain Threat Score			
21. Human Food Chain Threat Score ([lines 14 x 17 x 20]/82,500, subject to a maximum of 100)	100	96.06	.0037
ENVIRONMENTAL THREAT			
Likelihood of Release			
22. Likelihood of Release (same value as line 5)	550	550	100
Waste Characteristics			
23. Ecosystem Toxicity/Persistence/Bioaccumulation	a	5×10^8	5
24. Hazardous Waste Quantity	a	100	
25. Waste Characteristics	1,000	320	3
Targets			
26. Sensitive Environments			
26a. Level I Concentrations	b	0	
26b. Level II Concentrations	b	425	75
26c. Potential Contamination	b	0	
26d. Sensitive Environments (lines 26a + 26b + 26c)	b	425	75
27. Targets (value from 26d)	b	425	75
Environmental Threat Score			
28. Environmental Threat Score ([lines 22 x 25 x 27]/82,500, subject to a maximum of 60)	60	60	.2727
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORE FOR A WATERSHED			
29. Watershed Score[c] (lines 13 + 21 + 28, subject to a maximum of 100)	100	100	.2764
SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORE			
30. Component Score (S_{sw}) (highest score from line 29 for all watersheds evaluated, subject to a maximum of 100)	100	100	.2764

[a]Maximum value applies to waste characteristics category [b]Maximum value not applicable [c]Do not round to nearest integer

Figure 23

Likelihood of Release:

The potential to release is based on the potential for overland flow to impact surface water, and the potential for flooding which would impact surface water bodies. The values for the two release potentials are added to obtain the assigned value. (Exhibit 22)

The US EPA Area 2 assigned value is based on the potential for surface water to flow across Sites Q and R and into the Mississippi River and on the potential of these two sites to flood during Mississippi River flood events. US EPA assigned the maximum value of 550 because drums were exposed at Sites Q and R following two flood events, which is sufficient evidence of an observed release to surface water. In addition, these two sites typically experience annual flooding. (Exhibit 1)

The Site P likelihood of release value is 100 based on total site area less than 50 acres, and the maximum (worst case) assumptions for soil type and rainfall. The potential for flooding is zero based on the presence of the ACOE 500-year flood control levee and the US EPA conclusion that runoff does not leave Site P. (Exhibit 1)

Target/Food Chain:

The potential overland flow/flood migration pathway from Site P does not impact a fishery (there is no overland flow from the site to the Mississippi River). However, since a potential fishery is located within 15 miles downgradient of Site P (Exhibit 2), the surface water dilution (Exhibit 27) was determined and an assigned value of 1.0 was used to assess the food chain individual. (Exhibit 28) US EPA assigned a value of 45 based on the detection of contaminants at concentrations below screening levels and the presence of a fishery. (Exhibit 28)

Waste Characteristics:

The toxicity/persistence/bioaccumulation factor is significantly less for Site P (assigned value of 5) (Exhibit 23, 24, 25, 26) due to the characteristics of the identified contaminants (phenol and manganese) as compared to those of the Area 2 contaminants (PCBs and pesticides) (assigned value of 500,000,000). Low concentrations of PCBs were detected in groundwater at Site P; these concentrations were less than the background concentrations and thus are not considered attributable to the site. The following specific values illustrate the difference:

Factors	Site P	Area 2
Toxicity	10	
Persistence	0.0007	
Bioaccumulation	0.5	

Target/Environmental:

The US EPA determined that for the entirety of Area 2, six endangered species were potentially impacted. Site P, as an independent site, potentially impacts only the Common Moorhen (Exhibit 29) (assigned value of 50) (Exhibit 30) and the perimeter of the wetland areas is less than one mile (assigned value of 25) (Exhibit 31) resulting in a total sensitive environment assigned value of 75. (Exhibit 30) US EPA assigned a sensitive environment value of 425 based on six endangered species (325) and a total length of wetland between three and four miles (assigned value of 100).

TABLE 4-25
GROUND WATER TO SURFACE WATER MIGRATION PATHWAY SCORESHEET

Factor Categories and Factors	Maximum Value	EPA Value Assigned	Site P Value Assigned
HUMAN FOOD CHAIN THREAT			
Likelihood of Release			
12. Likelihood of Release (same value as line 3)	550	550	430
Waste Characteristics			
13. Toxicity/Mobility/Persistence/Bioaccumulation	(a)	5×10^9	5
14. Hazardous Waste Quantity	(a)	10,000	100
15. Waste Characteristics	1,000	1,000	3
Targets			
16. Food Chain Individual	50	45	1
17. Population			
17a. Level I Concentrations	(b)	0	
17b. Level II Concentrations	(b)	0.03	
17c. Potential Human Food Chain Contamination	(b)	0	
17d. Population (lines 17a + 17b + 17c)	(b)	0.03	
18. Targets (lines 16 + 17d)	(b)	45.03	1.03
Human Food Chain Threat Score			
19. Human Food Chain Threat Score ([lines 12 x 15 x 18] / 82,500, subject to a maximum of 100)	100	100	.0161
ENVIRONMENTAL THREAT			
Likelihood of Release			
20. Likelihood of Release (same value as line 3)	550		430
Waste Characteristics			
21. Ecosystem Toxicity/Mobility/Persistence/Bioaccumulation	(a)	5×10^8	5
22. Hazardous Waste Quantity	(a)	10,000	100
23. Waste Characteristics	1,000	1,000	3
Targets			
24. Sensitive Environments:			
24a. Level I Concentrations	(b)	0	
24b. Level II Concentrations	(b)	425	75
24c. Potential Contamination	(b)	0	
24d. Sensitive Environments (lines 24a + 24b + 24c)	(b)	425	75
25. Targets (value from line 24d)	(b)	425	75
Environmental Threat Score			
26. Environmental Threat Score ([lines 20 x 23 x 25] / 82,500, subject to a maximum of 60)	60	60	1.1727
GROUNDWATER TO SURFACE WATER MIGRATION COMPONENT SCORE FOR A WATERSHED			
27. Watershed Score (lines 11 + 19 + 26, subject to a maximum of 100)	100	100	1.1888
28. Component Score (S_{gw}) (highest score from line 27 for all watersheds evaluated, subject to a maximum of 100)	100	100	1.1888

Figure 24

Likelihood of Release:

There is no observed release of contaminants attributable to Site P and thus the scoring is based on the potential to release. (Exhibit 32) The potential to release considers containment (Exhibit 33) net precipitation (Exhibit 34), depth to the aquifer (Exhibit 35), and travel time of groundwater to surface water. (Exhibit 36) The maximum values (worst case scenario) were assigned with the exception of the net precipitation value. The net precipitation value was determined by the monthly precipitation and evaporatranspiration based on geographic location. (Exhibit 34) US EPA assigned a maximum value of 550 based on an observed release to surface water (exposed drums at Sites Q and R following Mississippi River flood event) (Exhibit 1). A value of 430 was assigned for Site P, based on the potential to release and the site characteristics. (Exhibit 37)

Target/Environmental:

The US EPA determined that for the entirety of Area 2, six endangered species were potentially impacted. (Exhibit 1) Site P, as an independent site, potentially impacts only the Common Moorhen (Exhibit 29) (assigned value of 50) (Exhibit 30) and the perimeter of the wetland areas is less than one mile (assigned value of 25) (Exhibit 31) resulting in a total sensitive environment assigned value of 75. (Exhibit 30) US EPA assigned a sensitive environment value of 425 based on six endangered species (325) and a total length of wetland between three and four miles (assigned value of 100).

Target/Food Chain:

The food chain individual value for Site P, even when considering the presence of a fishery in the Mississippi River, is significantly less than that when evaluating the entirety of Area 2 because the contaminants in Site P groundwater do not present a risk of bioaccumulation in organisms. (Exhibit 38) However, since a potential fishery is located within 15 miles downgradient of Site P, the surface water dilution (Exhibit 27) was determined and an assigned value of 1.0 was used to assess the food chain individual. (Exhibit 28) US EPA assigned a value of 45 based on the detection of contaminants at concentrations below screening levels and the presence of a fishery. (Exhibit 1)

Waste Characteristics:

The toxicity/persistence/bioaccumulation factor is significantly less for Site P (assigned value of 5) (Exhibit 23, 24, 25, 26) due to the characteristics of the identified contaminants (phenol and manganese) as compared to those of the Area 2 contaminants (PCBs and pesticides) (assigned value of 500,000,000) (Exhibit 26). Low concentrations of PCBs were detected in groundwater at Site P; these concentrations were less than the background concentrations and thus are not considered attributable to the site. The following specific values illustrate the difference:

Factors	Site P	Area 2
Toxicity	10	[redacted]
Persistence	0.0007	[redacted]
Bioaccumulation	0.5	[redacted]

WORKSHEET FOR COMPUTING HRS SITE SCORE

		EPA Scoring S	EPA Scoring S^2	Site P Scoring
1.	Ground Water Migration Pathway Score (S_{gw}) (from Table 3-1, line 13)	NS		NS
2a.	Surface Water Overland/Flood Migration Component (from Table 4-1, line 30)	100		0.28
2b.	Ground Water to Surface Water Migration Component (from Table 4-25, line 28)	100		1.2
2c.	Surface Water Migration Pathway Score (S_{sw}) Enter the larger of lines 2a and 2b as the pathway score.	100	10,000	1.2^2
3.	Soil Exposure Pathway Score (S_s) (from Table 5-1, line 22)	NS		NS
4.	Air Migration Pathway Score (S_a) (from Table 6-1, line 12)	NS		NS
5.	Total of $S_{gw}^2 + S_{sw}^2 + S_s^2 + S_a^2$		10,000	1.44
6.	**HRS Site Score** Divide the value on line 5 by 4 and take the square root	50.00		0.6

Figure 25

- There has been no observed contaminant release at Site P. The levee between Site P and the Mississippi River minimizes the likelihood of any release.
- Manganese and phenol are the only contaminants found in the groundwater at Site P. These two pollutants represent only a minimal risk to human health or the environment.
- Site P has not been documented to provide a habitat for bald eagles, herons, or egrets. The only endangered species seen in the region is the common moorhen

The HRS score of Site P, independent of the other Area 2 sites, is well below the threshold value for NPL listing of 28.5. (Exhibit 10) The difference in the HRS score is primarily due to the characteristics of the groundwater contaminants associated with Site P and the small area of potential surface water impact (wetlands within Site P).

Site P, when evaluated separately, does not qualify for National Priorities List consideration.

SITE Q HAS NOT BEEN CONSISTENTLY OR ADEQUATELY DEFINED

The boundaries of Site Q as defined in the NPL listing document do not correlate with available data and earlier US EPA or IEPA designations. As a result, the boundaries are not based on fact but instead arbitrary dimensions governed by site features (i.e. roads, riverbank) that are not related to waste disposal practices. These five photographs demonstrate how the definition of Site Q has changed over time.

1962

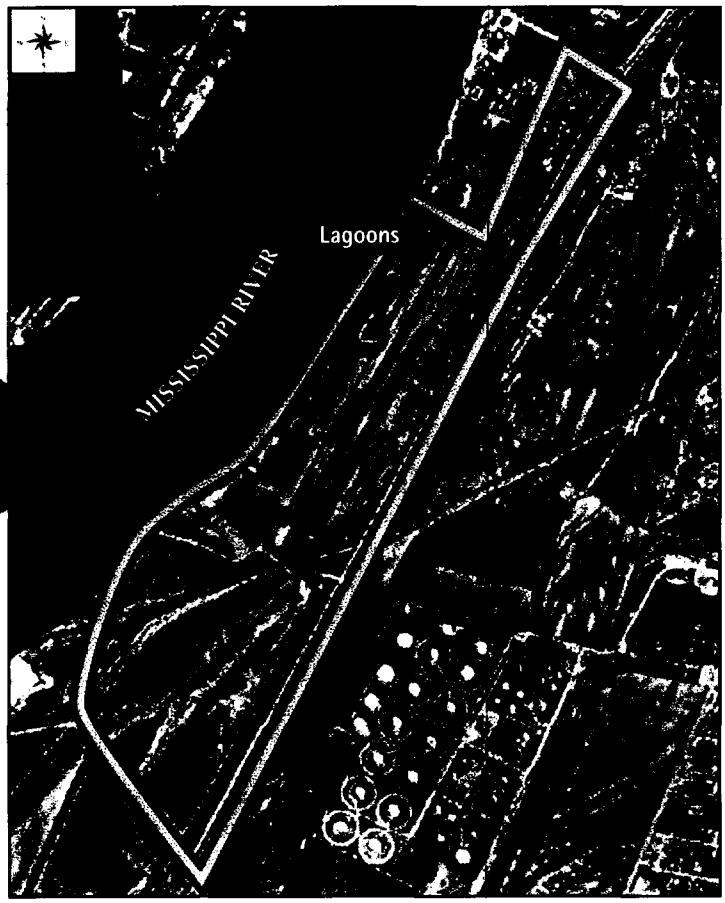


Figure 26

Location of ash lagoons identified by AERODATA. (Exhibit 7)

MAY 1988

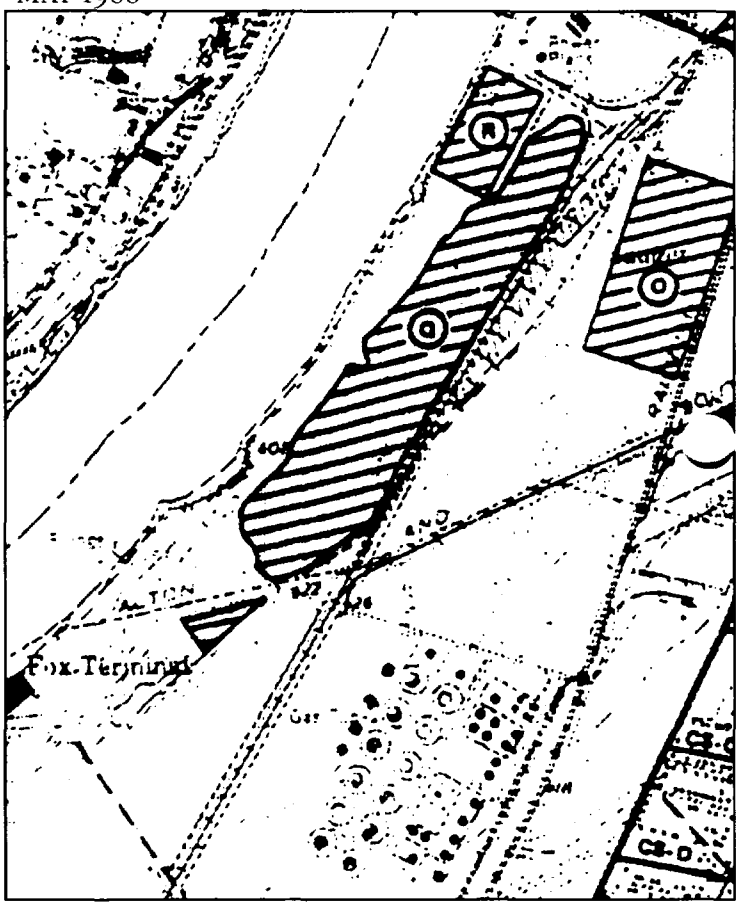


Figure 27

"The site is approximately 90 acres in size, including a southern extension as delineated by the Alton and Southern Railroad tracks."

---Ecology and the Environment, Inc. Expanded Site Investigation Dead Creek Project Sites at Cahokia/Sauget, Illinois, Volume 1 of 2. May 1988. (Exhibit 3)

NEWFIELDS

MARCH 2000

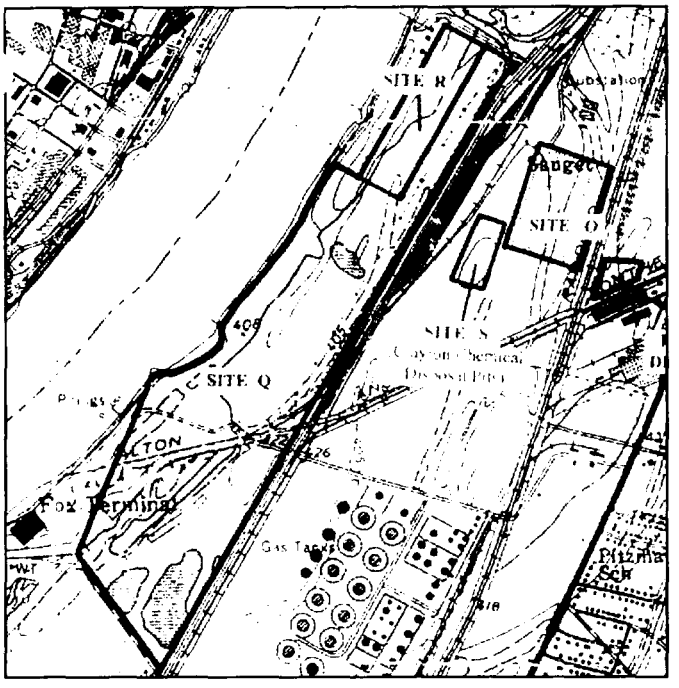


Figure 28

"The individual site acreage is as follows:...Site Q (225.1 acres)"

---Ecology and the Environment (CH2M Hill). Soil Sample Results for Chemical Contamination below Sauget/Sauget Landfill in Sauget, Illinois. December 16, 1983. (Exhibit 5)

JULY 2000

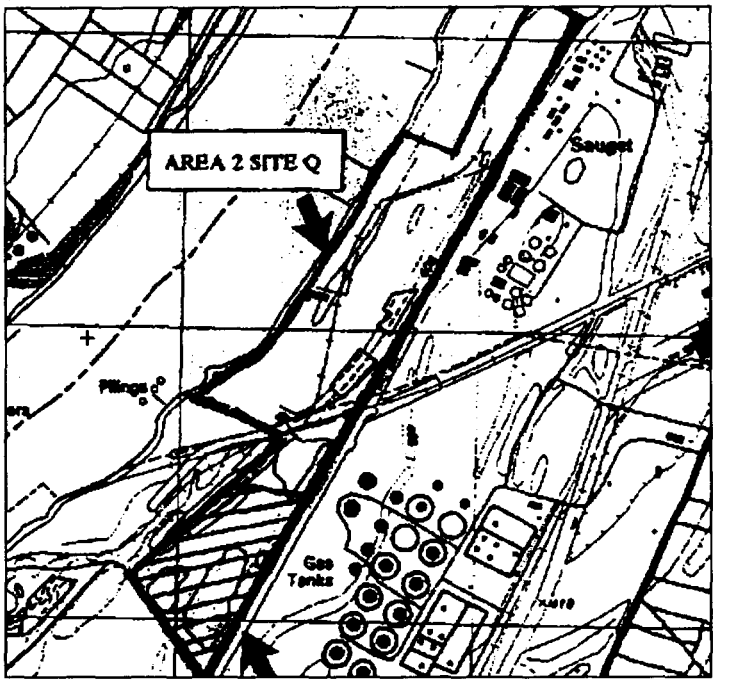


Figure 29

No definitive statement on acreage of Site Q (references 90 acres and the 25 acres of contamination addressed in removal action)

---Ecology and the Environment, Inc. Draft of Federal On-scene Coordinator's Report for Area 2 Site Q, Cahokia, St. Clair County, Illinois. July 31, 2000. (Exhibit 42)

MARCH 2001

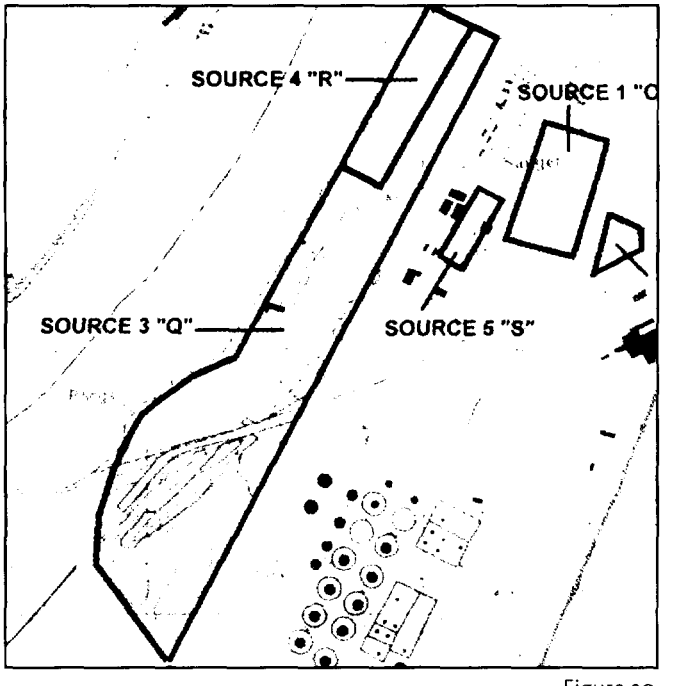


Figure 30

"Source Q is an inactive waste landfill in Sauget, Illinois that covers approximately 225 acres."

---US Environmental Protection Agency (US EPA). Hazard Ranking System Listing Document, Sauget Area 2, 2001(Exhibit 5)

THE ASH PONDS IN CENTRAL SITE Q SHOULD NOT BE AGGEGRATED WITH NORTHERN AND SOUTHERN SITE Q.

A small portion of Central Site Q was used for disposal of combustion-related materials (ash). There is no evidence of disposal operations similar to those conducted in Northern and/or Southern Site Q having occurred in the ash pond area within Central Site Q.

The Hazard Ranking System Guidance Manual (HRSGM) provides criteria for designating overlapping sources as a single source. (Exhibit 14) **The following conditions are necessary to aggregate such sources:**

- **Same source type (landfill, surface impoundment, pile, etc.)**
- **Similar characteristics (E.G., proximity of units, hazardous substances associated with the units)**

The three distinct areas in Site Q do not satisfy these criteria and should not be aggregated into a single source.

There is no evidence that there is similarity in operational history throughout Site Q. As shown in Figure 31, the Sauget Municipal landfill was defined as the portion of Site Q immediately east of Site R in a CH2M Hill report in 1983. (Exhibit 6)The referenced report describes the Sauget/Sauget Landfill as a municipal landfill directly adjacent to the Krummrich Sauget/Toxic Landfill. The toxic landfill shown in Figure 31 is the area now described as Site R.

Site Q is not, as suggested by US EPA, a 225 acre landfill operated by Sauget and Company. In conjunction with its operation in Site R, Sauget and Company operated a landfill in the dogleg section of Northern Site Q. In addition, Sauget and Company operated a landfill in Southern Site Q near the Alton and Southern Railroad lines. Unrelated and separate from those activities, Union Electric operated ash ponds in a small, 32 acre portion of Central Site Q. (Exhibit 2) There is simply no evidence of similarity in operational history throughout Site Q.

The descriptions of the landfilling activities and the geophysical and intrusive sampling data all demonstrate that the Sauget/Sauget Landfill is limited to the area immediately east of Site R. A geophysical survey described in a 1983 report identified the probable limits of landfilling and burial zones of relatively large concentrations of iron-bearing material such as drums or car bodies. (Exhibit 6) Following the geophysical investigation, a drilling sampling program was conducted to determine if subsurface soils were contaminated. The extent of the sampling program is shown on Figure 32. As shown in Figure 32, the sampling program, which was designed to define the landfill footprint, was conducted only in the same small area east of Site R.

There is no evidence that there was a continuous, similar disposal operation between the northern and southern areas of landfilling in Site Q. The southern area was a definite target area for drum disposal as there were large borrow pits available for disposal. These pits were created when the ACOE levee was constructed. (Exhibit 2) By contrast the central portion of Site Q contained ash impoundments. In addition, random dumping of household-type waste was reported in this area. (Exhibit 3)

The data further demonstrate that the contaminant conditions in the three portions of Site Q are unrelated. The following pages provide additional support for the necessity of considering Site Q as three distinct sources.

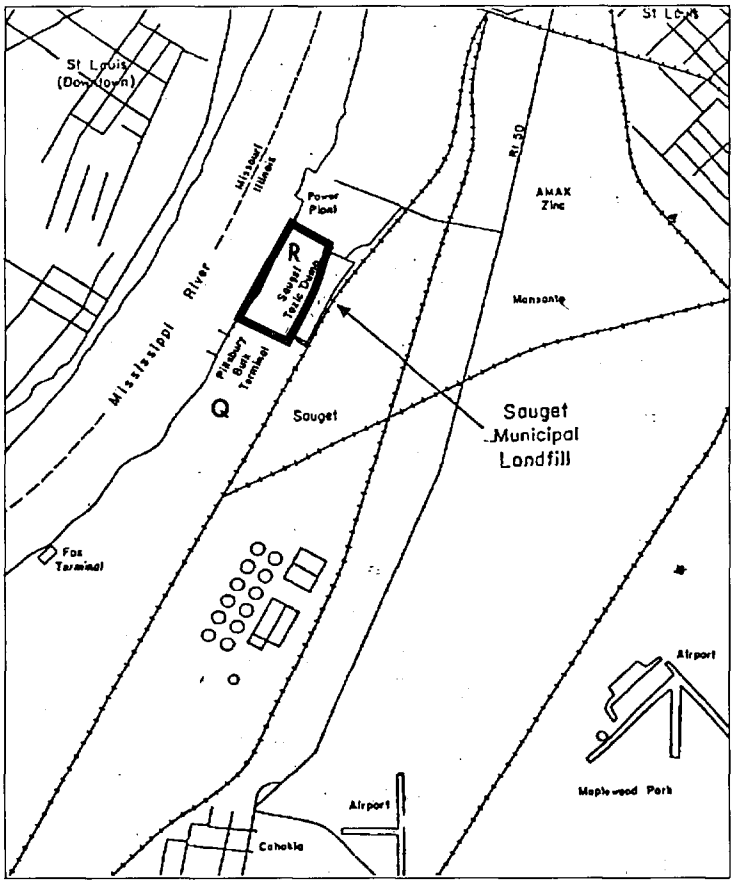


Figure 31

Only green lines are added.

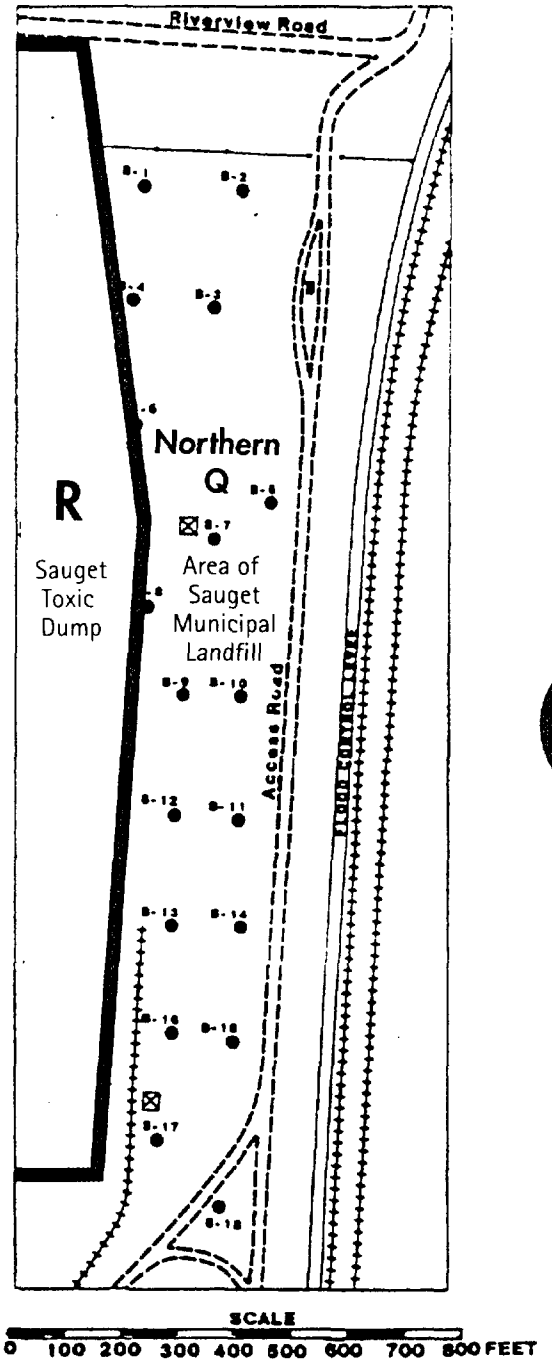


Figure 32

1. Site-specific disposal areas

Various borrow pits in the southern part of Site Q were utilized for direct drum burial during the 1960s and 70s. (Exhibit 2)

In contrast, a small section of Northern Site Q was used by Sauget and Company as a municipal landfill. (Exhibit 3) The central portion was used only for ash disposal. (Exhibit 2)

1962

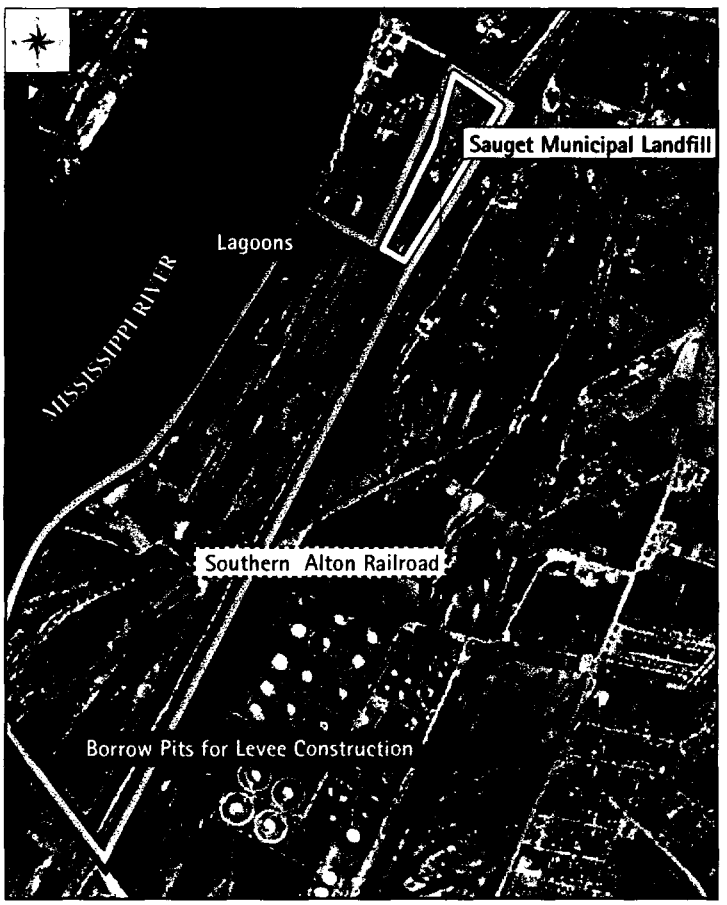


Figure 33

1971

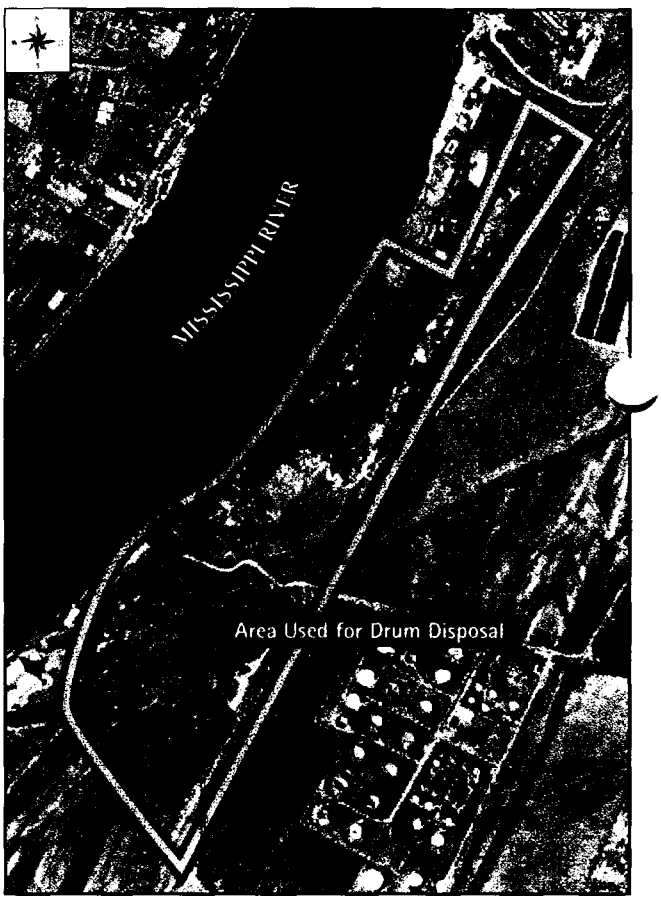
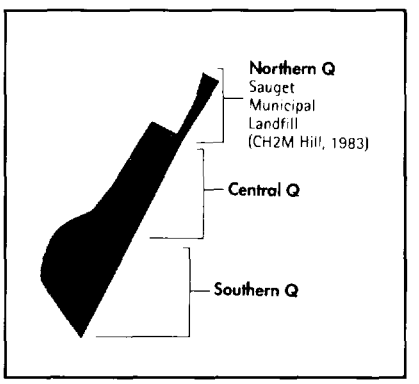


Figure 34



Hazardous substances found in the overlapping sources

Average Groundwater Concentrations in Referenced Area (ug/l)

Average PCB Concentrations	0.015	0	0.37	84	0
Average Nitrobenzene Concentrations	286	2,892	0	0	512
Average Chloroaniline Concentrations	31,872	9475	102	0	68,688

Figure 35

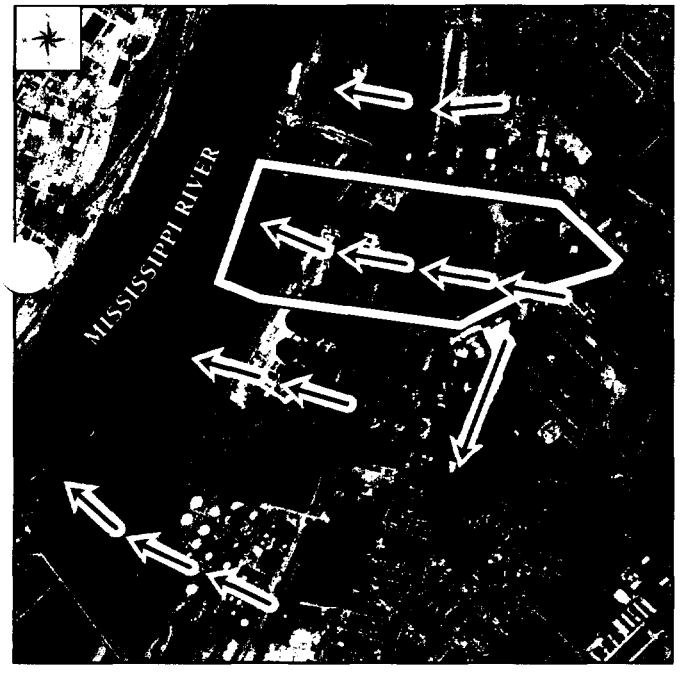


Figure 36

LEGEND:
GW-Chlorobenzene (ug/l)

- < MCL
- > MCL
- Dead Creek
- Appropriate Groundwater Plume Conceptual Model
- Groundwater flow

The groundwater quality under Northern Site Q is affected by the plume that extends east to west from the vicinity of the Krummrich facility to the Mississippi River. This includes impacts from Site R. Between 1957 and 1977, Site R was used to dispose of liquid and solid industrial waste, including solvents, pesticides and heavy metals. (Exhibit 3)Liquid chemical wastes were pumped from tank trucks and drums into several hazardous waste ponds. (Exhibit 2) The contaminant characteristics of Northern Q are indistinguishable from those of Site R and the surrounding groundwater plume. However, Northern and Southern Q show very different contaminant characteristics.

Figures 35 and 36 demonstrate the distinct difference between Northern Site Q and Central and Southern Site Q. Figure 35 presents the average groundwater concentration of three indicator parameters—PCBs, nitrobenzene, and chloroaniline—within five different areas. (Exhibit 9) Figure 36 provides a post plot of the chlorobenzene data throughout the subject area. (Exhibit 11)

As shown in Figure 31, groundwater under Northern Site Q contains high levels of chloroaniline. The concentrations are the same order of magnitude as those found within the east-west plume and beneath Site R. By contrast, the chlorobenzene concentrations within Southern and Central Site Q are two orders of magnitude lower. A similar discrepancy exists between Northern Site Q and Southern and Central Site Q with respect to nitrobenzene. Northern Site Q groundwater contains an average nitrobenzene concentration of 2,892 µg/l, whereas there is no nitrobenzene in the Southern and Central portions of Site Q. (Exhibit 9)

The groundwater pattern is reversed with the PCB compounds. PCBs are present in the groundwater in Central and Southern Site Q (primarily Southern Site Q except for one detection in Central Site Q), whereas there are no detectable PCBs in Northern Site Q groundwater. Likewise, there are only very low detections throughout the east-west plume that passes beneath Northern Site Q. (Exhibit 9)

The same pattern of distinctive difference between Northern Site Q and the central and southern portions of Site Q is demonstrated clearly by the groundwater chlorobenzene data. As shown in Figure 36, the chlorobenzene data demonstrates that a groundwater plume extending from east to west under Northern Site Q and Site R is not commingling with groundwater under Central and Southern Site Q. (Exhibit 11) The chlorobenzene is a mobile contaminant that provides a tracer function for indicating groundwater flow direction. (Exhibit 39) There is virtually no chlorobenzene south of the Site R southern boundary. The absence of this contaminant, coupled with the groundwater elevation data, demonstrates conclusively that groundwater issues between Northern Site Q the central and southern portions of Site Q should not be considered together.

A small portion of Central Site Q was used by Union Electric for disposal of combustion-related materials (ash). There is no evidence, based on contaminant data and historical information that disposal operations similar to those conducted in Northern and/or Southern Site Q ever occurred in the ash pond area within Central Site Q.

SITE Q WAS NOT APPROPRIATELY SCORED ACCORDING TO US EPA'S HAZARDOUS RANKING SYSTEM GUIDANCE.

The US EPA's scoring of Site Q involved errors that increased the HRS score. These errors included:

1. Failure to consider a removal action.
2. Incorrect delineation of wetland perimeters.
3. Assumption of endangered species presence without verification.
4. Inappropriate characterization of current site use.
5. Reliance on inappropriate sampling techniques for data collection.

1. Removal Action

The Agency has established the position that if an extended period of time elapses between site investigations and the execution of HRS scoring altered conditions at the site may be considered as long as the action physically removes waste from the site and the removed waste is disposed of properly. (Exhibit 40) Changing conditions at Site Q, principally the CERCLA time-critical removal action in 1994 (Figure 37) (Exhibit 41) and the removal in 1999 (Exhibit 42), should have been taken into account when determining the HRS score.

1996

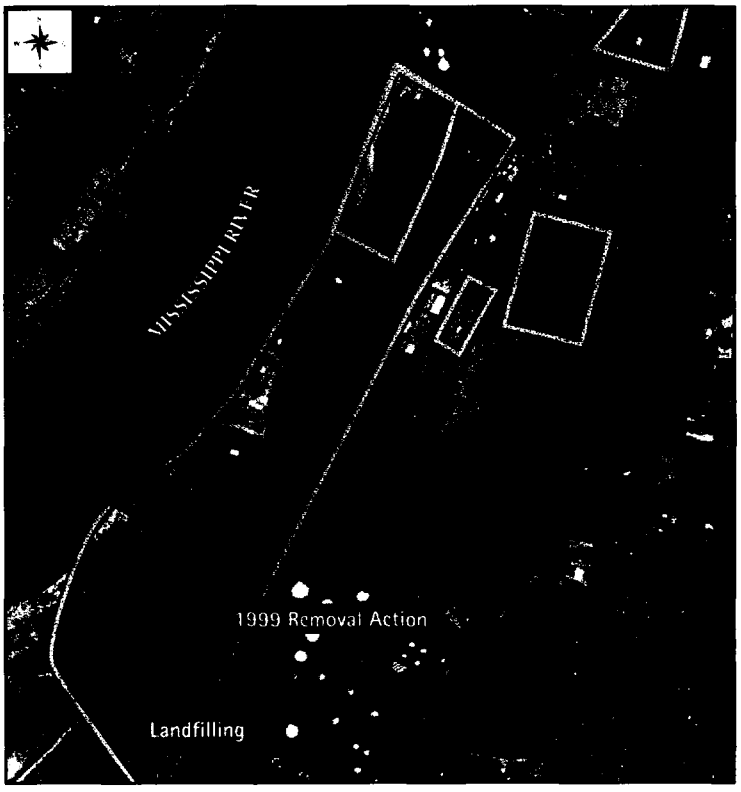


Figure 37

"For sites where the first SI was conducted more than four years prior to HRS scoring, the Agency may consider, on a case-by-case basis, changing the cut-off date to a later date. (CERCLA section 116, added by SARA, mandates that US EPA conduct site assessment work within four years of CERCLIS listing.)" (Exhibit 43, page 13)

The US EPA's use of post-remediation data (Figure 38) (Exhibit 1) demonstrates that their cutoff date for data collection is after the date of the removal action. Therefore, post-1994 data should be considered when scoring Southern Site Q.

REFERENCES

Ref. No.	Description of the Reference
1.	U.S. Environmental Protection Agency (EPA). Hazard Ranking System. 55 FR 51533 (40 CFR Part 300, Appendix A). December 14, 1990. 165 pages.
2.	EPA. Superfund Chemical Data Matrix (SCDM). Publication #9345.1-22, EPA 540/R-96/029, PB96-963541. June 1996. Publicly Available Document - relevant pages included. 42 pages.
3.	U.S. Geological Survey (USGS). Cahokia, Illinois; Webster Groves, Missouri; and Oakville, Missouri Quadrangles. 7.5 Minute Series. Topographic Maps. 1998. 3 Maps.
4.	EPA. Latitude and Longitude Calculation Worksheet. 1 page; 1 map.
5.	Ecology and Environment, Inc. Sauget Area 1 and 2 Sites, St. Clair County, Illinois, Volume 2 - Sauget Area 2 Data Tables/Maps. ARCS Contract No. 68-W8-0086, Work Assignment No. 47-5N60. February 1998. 572 pages.
6.	Illinois EPA, Pre-Remedial Unit. CERCLA Screening Site Inspection (SSI). Sauget Sites Area 62. 1991. 161 pages.
7.	Ecology and Environment, Inc. Expanded Site Investigation: Dead Creek Project Sites at Cahokia Sauget, Illinois. Final Report Volume 2. 4/2. May 1998. 59 pages.
8.	Ecology and Environment, Inc. Draft of Federal On-Scene Coordinator's Report for Area 2 Site Q, Cahokia, St. Clair County, Illinois. July 31, 2000. 88 pages.
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10.	Army Corps of Engineers, St. Louis District. Excerpts from 1979 Flood Manual and photos of the 1993 flood. February, 2000. 15 pages.
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Figure 38

2. Wetland Delineation

US EPA determined the extent of the target sensitive environment (wetlands) within Site Q by 1) calculating the perimeter of all wetlands regardless of frontage on the Mississippi River and by 2) calculating the entire perimeter of each small wetland in Site Q, even when their borders were contiguous which results in considering the same wetland boundaries multiple times (Figure 39). As a result of the above calculations of wetland extent, US EPA estimated the length of wetlands within Site Q as 3.6 miles rather than 1.45 miles as measured when appropriately delineated (Exhibit 31). This results in a doubling of the HRS score for potential sensitive environments. The US EPA assumes that the potential point of contaminant entry to each wetland is within the wetland itself (Figure 40). There is no evidence in Central Site Q that contamination exists which would result in a potential release of contaminants into the wetlands. There is a potential that contamination may enter the wetlands bordering the Mississippi River from sources located upstream of Site Q (particularly Site R).

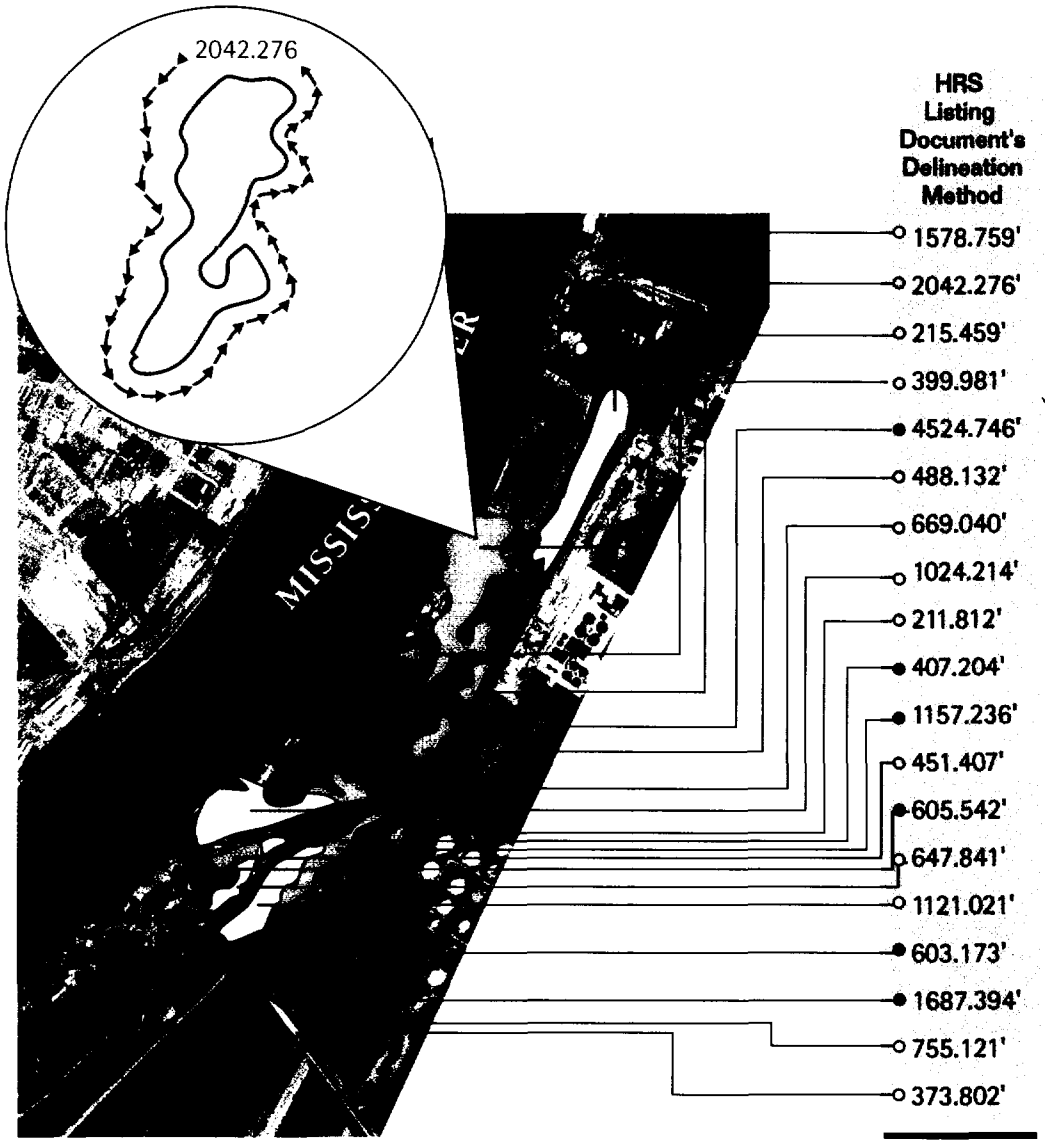
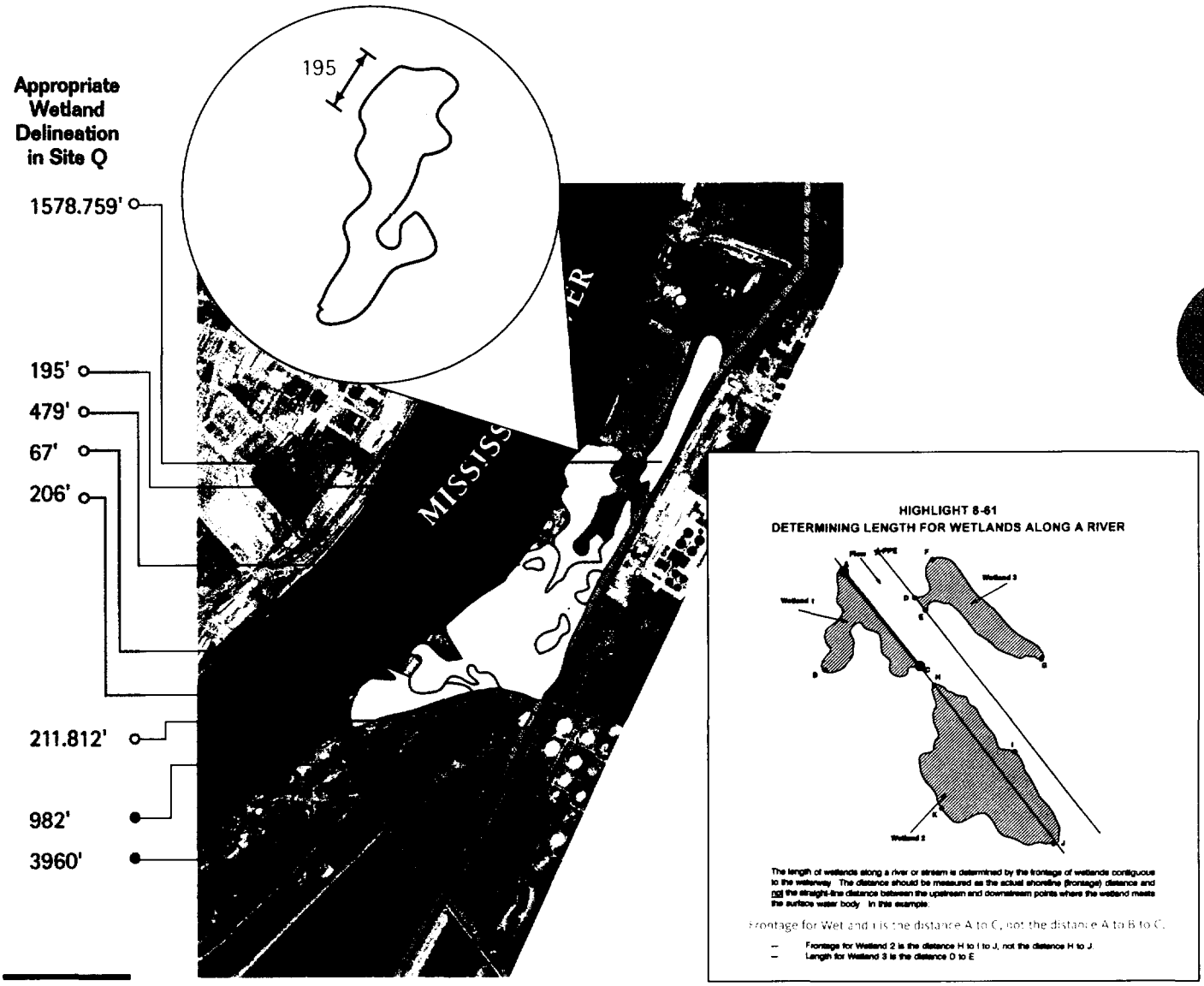


Figure 39



7679.571'
(1.45 miles)

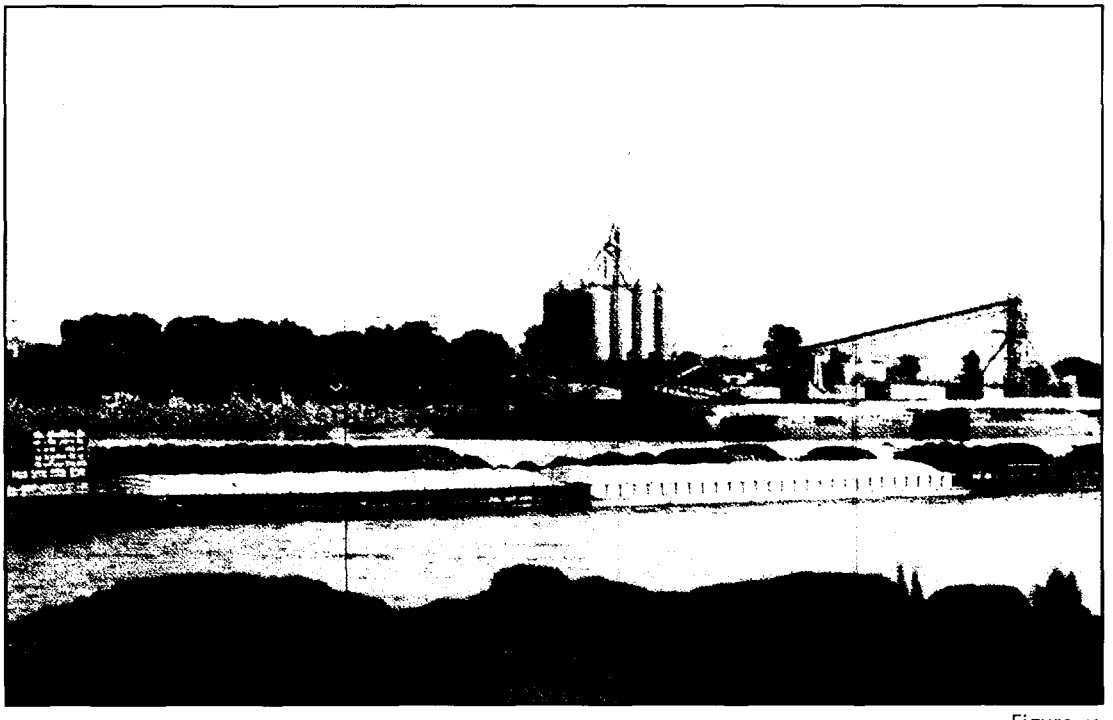
Figure 40

3. Endangered Species

US EPA identified six endangered species habitats located within Site Q. (Exhibit 8) An evaluation of the habitats for each of these species has been performed as well as an assessment of historical aerial photographs and current site use (Exhibit 29). Information was also obtained from the Illinois Natural History Survey in regard to threatened and endangered species that may be present in the vicinity of the site.

All the identified species require wetlands and/or large water bodies for their survival. The Bald Eagle, as well as the herons and egrets, require large trees for nesting which are not available at Site Q. The herons and egrets also require shallow water (depth of 1-50 cm) at the edge of vegetated areas for feeding. The Common Moorhen requires large expanses of cattail and bulrush for nesting, but the invasive species present in the marshy area is not generally conducive to nesting.

There is a potential for threatened and endangered species to utilize the site in some form. However, the likelihood of these species actually using the site is minimal because of the lack of breeding and feeding habitat and the commercial/industrial activities in the vicinity. At most, only one endangered speicies (the Common Moorhen) may be present at Site Q, not the six endangered species sited by US EPA. (Exhibit 29)



View of southern Site R and Central Site Q from across the Mississippi River.

Figure 41

4. Current Site Use

Site Q has been inappropriately characterized as an inactive industrial site that is largely covered with wetlands that provide a habitat for endangered birds. (Exhibit 1) Site Q, particularly Central Site Q, has been in active commercial use since approximately 1979. (Exhibit 8)

Figure 42

A large portion of Central Site Q is currently being used for a commodity unloading and transfer facility. (Exhibit 8) *Large coal piles can clearly be seen on the 1996 aerial photograph (Figure 42). The Pillsbury Bulk Terminal is identified on figures provided in a 1988 IEPA document.*

Figure 43

Large containers and other commercial equipment currently occupy the Eagle Marine facility, located within Central Site Q south of the Pillsbury Bulk Terminal (Figure 43). (Exhibit 7)

The commercial activities in Central Site Q are not conducive to maintenance of natural habitat for endangered bird species.

5 Inappropriate sampling techniques

The US EPA HRS listing document for Area 2 relied on GeoProbe® groundwater samples collected in 1999 (Exhibit 5) to characterize contamination in Site Q. (Exhibit 1) US EPA did not consider groundwater data collected from established monitoring wells in 1987 and filtered prior to analysis. (Exhibit 3)

GeoProbe® sampling techniques by their very nature can result in significant soil particulate matter being present in groundwater samples. The GeoProbe® technique does not result in the installation of well casing or allow for the development of a well prior to sampling. The lack of well development results in soil particles disturbed during the drilling technique to remain suspended in the groundwater during sample collection. These soil particles may contain contamination that is adsorbed (bound) to the soil surface. The analytical results are therefore representative of both dissolved and adsorbed contaminant concentrations.

The distinction between adsorbed and dissolved contaminant concentrations is extremely important when assessing contaminants with low water solubility and a strong affinity for organic material present in soil. Persistent environmental contaminants (PCBs and pesticides such as aldrin, dieldrin and DDT) are examples of contaminants with low water solubility and high affinity for soil adsorption. (Exhibit 39) The very basis for the persistence, and therefore the efficacy, of the pesticides is their strong adsorption to soil particles and low water solubility. (Exhibit 39) These contaminants are not typically detected as dissolved concentrations in groundwater, rather their detection is generally associated with the presence of soil particles.

The groundwater samples collected from monitoring wells (cased wells) in 1987 were filtered prior to analysis. (Exhibit 3) These samples, which are representative of dissolved concentrations, did not contain detectable concentrations of these contaminants.

PCBs, aldrin and dieldrin were attributed to Site Q based on the use of GeoProbe® sample data representative of adsorbed rather than dissolved contamination.

As shown in Figure 44, the results of the 1999 GeoProbe® sampling (locations represented in yellow) indicate the presence of PCBs, aldrin and dieldrin in groundwater. The 1987 samples (shown in red) did not detect these contaminants and are in similar locations to the 1999 samples.

For inorganics, water solubility is used as a surrogate for bioaccumulation in the HRS scoring. (Exhibit 25) Contaminants such as PCBs, pesticides and metals have low water solubility and are thus considered to be a greater threat to human health and the environment. The detection of these same contaminants in groundwater is counter-intuitive to the determination that they are not mobile in the environment and are therefore persistent.

Central Site Q should not be aggregated with Northern and Southern Site Q because there is no evidence of similar operational history throughout Site Q. The potential risks associated with Central Site Q were not evaluated in conformance with US EPA guidance and as a result, the HRS score does not appropriately reflect the potential human health and environmental risks of the site.

Figure 44

○ Collected May1999

	PCBs (ug/l)	Aldrin (ug/l)	Dieldrin (ug/l)
G106(99)	4.06	0.0	0.0024
G116(99)	0.0	0.12	0.0
G107(99)	82.8	0.0	0.0
G117(99)	18.9	0.72	0.0
G108(99)	1.3	0.0	0.0

● Collected March 1987

	PCBs (ug/l)	Aldrin (ug/l)	Dieldrin (ug/l)
EE-08	0.0	0.0	0.0
EE-06	0.0	0.0	0.0
EE-10	0.0	0.0	0.0
EE-07	0.0	0.0	0.0
EE-09	0.0	0.0	0.0

INDEX OF EXHIBITS

1. US Environmental Protection Agency (US EPA). Hazard Ranking System Listing Document, Sauget Area 2, 2001

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