Area Completion Projects

Lower Three Runs Integrator Operable Unit Overview

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Federal Facility Agreement Project Manager

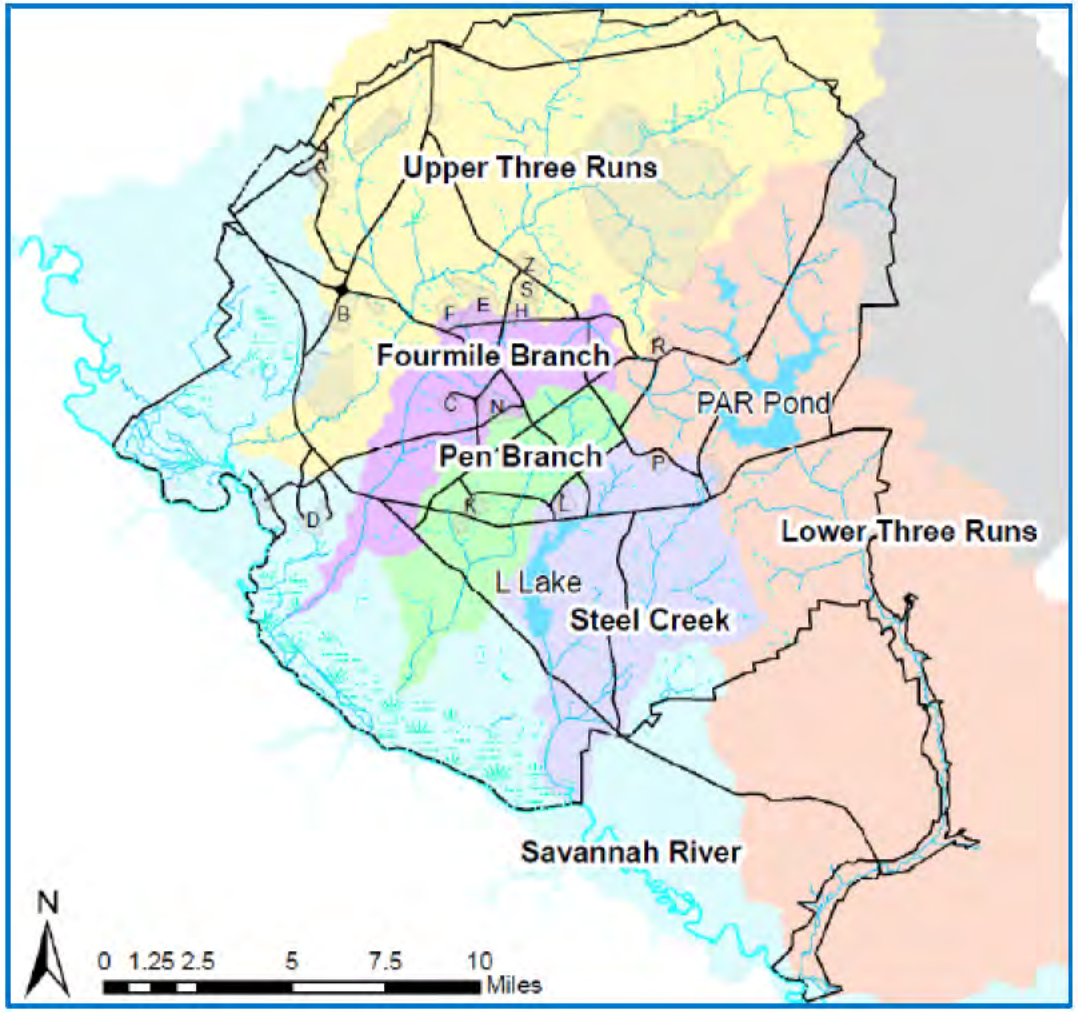
July 2022

Overview

- **Introduction to the Lower Three Runs (LTR) Integrator Operable Unit (IOU)**
  - SRS Watersheds and IOUs
  - LTR Canal and Pond System
  - Reactor Operations and Current Use
- **Current Status**
  - Record of Decision
    - Issued 12/21/2021
    - Remedial Action
    - Monitoring Plan/Reporting
- **Schedule**

SRS Watersheds

- SRS stream systems were added to the Federal Facility Agreement (FFA) in FY 1997
- SRS is divided into 6 watersheds that align with the IOUs
- A watershed is the land area that drains into the IOU
- IOUs include surface water, sediment, floodplain soils and biota (plants and animals)



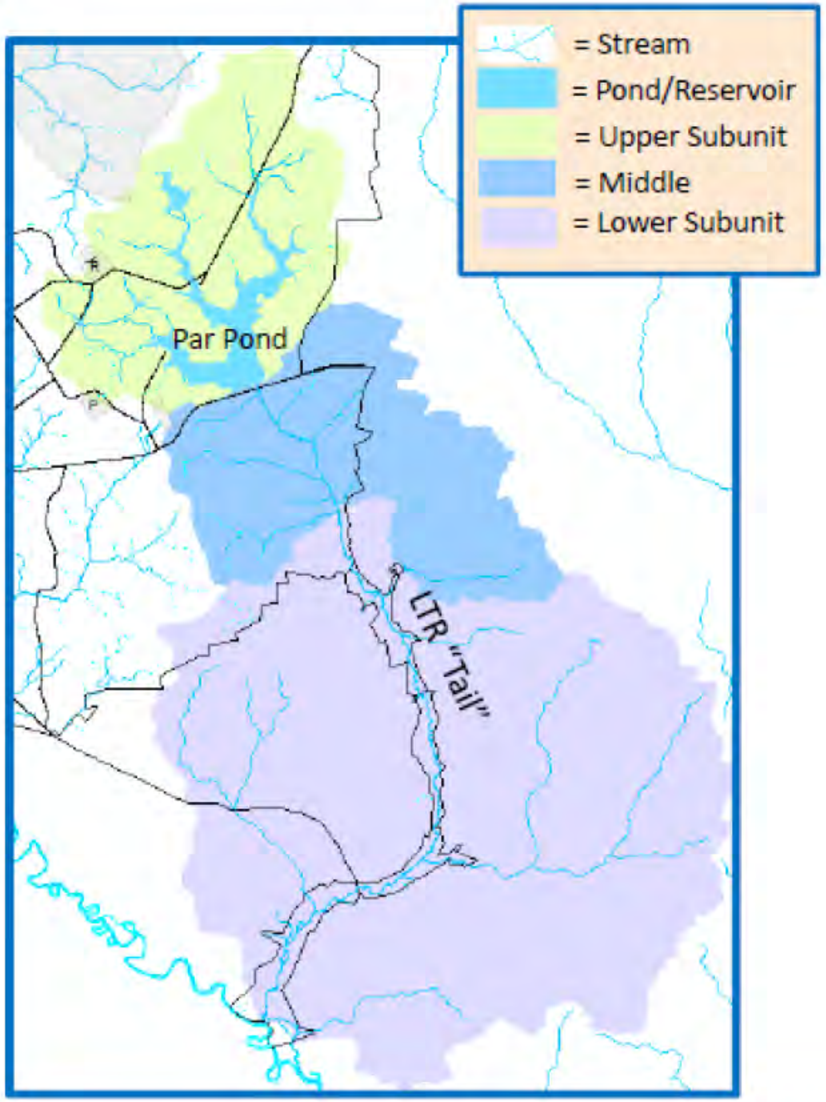
Purpose of the IOU Program

- Evaluate contaminants in SRS stream systems
  - Assess human health risk (onsite worker, recreational fisherman, adolescent trespasser, hypothetical resident) from exposure to environmental media
  - Assess the health of the stream system (habitat quality, biota)
  - Determine if remedial actions are needed to protect human health or the environment
- Final IOU cleanup decisions can be made when all Operable Unit cleanup actions within the watershed are complete (i.e., no more sources of contamination)
- LTR is the first IOU to reach Phase III of the IOU program (final decision / remedial action)

Canal Outlet Structure to Joyce Branch (Old Discharge Canal)

LTR Watershed and Subunit

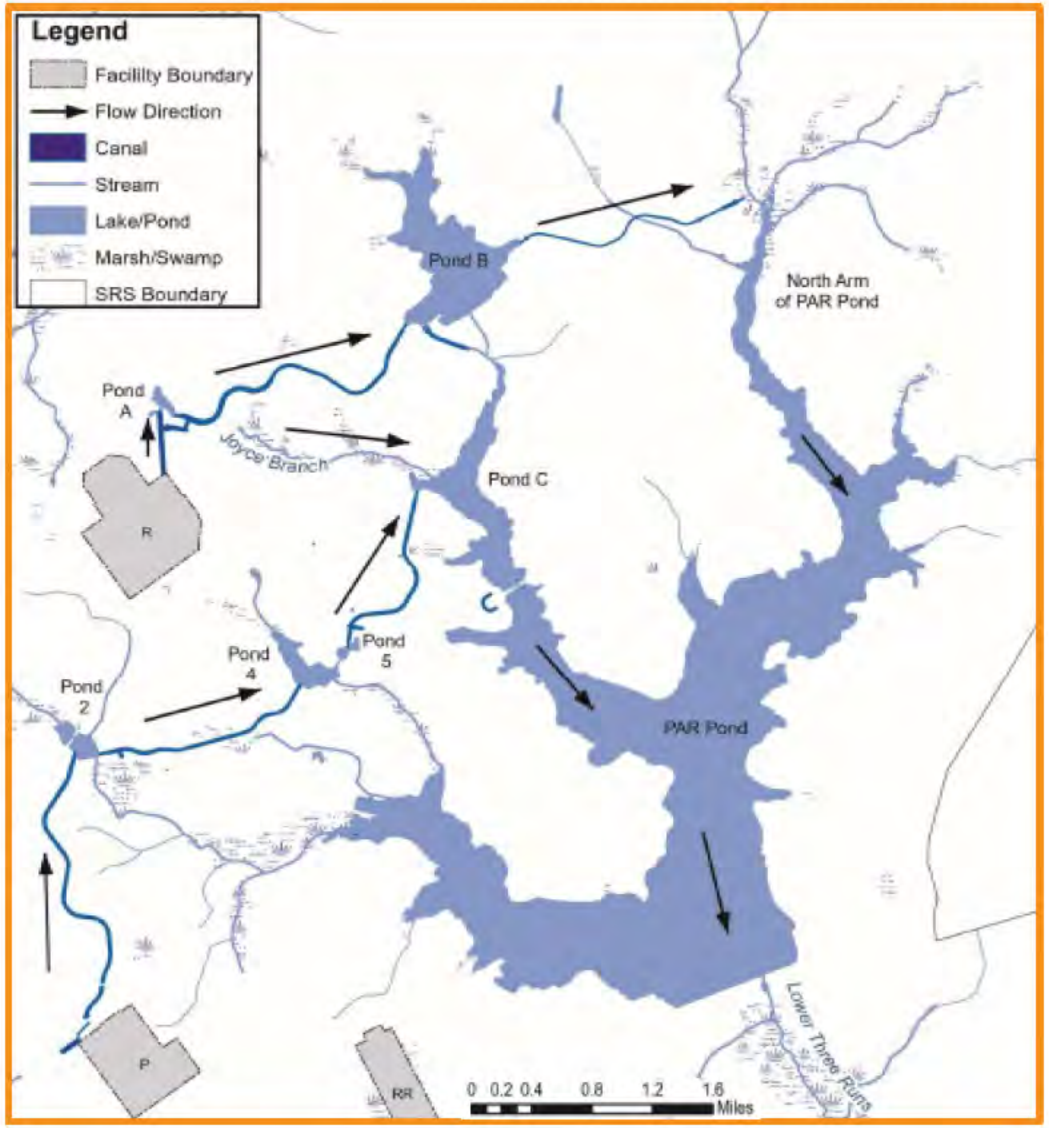
- The LTR watershed is administratively divided into three subunits (Upper, Middle, and Lower)
- The watershed contains
  - R-Reactor
  - P-Reactor
  - Pre-cooler ponds and canal system
  - PAR Pond
  - Operable Units within the watershed, which are “complete” in terms of Remedial Action (or No Further Action)
- LTR is a large black water (coastal plain) stream system
- PAR Pond is ~ 2,640-acre reservoir (over 4 square miles!) that received cooling water from R- and P-Area Reactors during operation



- R-Reactor began operations in 1953; P-Reactor in 1954
  - Prior to creation of PAR Pond, R-Reactor discharged heated water directly into Joyce Branch (the “Old Discharge Canal”)
  - In 1958, PAR Pond was created by constructing an earthen dam across the LTR creek, and the pre-cooler ponds and canal system were constructed
  - Effluent from R-Reactor discharged through a series of canals and pre-cooler ponds prior to release into the north arm of PAR Pond
  - Effluent discharges ceased in 1964
- PAR Pond also served as a cooling reservoir for P-Reactor until 1988
  - Heated water was released through a second series of canals and smaller pre-cooler impoundments into Pond C and then released into the “hot arm” (middle arm) of PAR Pond.
  - Prior to creation of PAR Pond, P-Reactor discharges were sent to Steel Creek
  - Effluent discharges from P-Reactor ceased in 1987

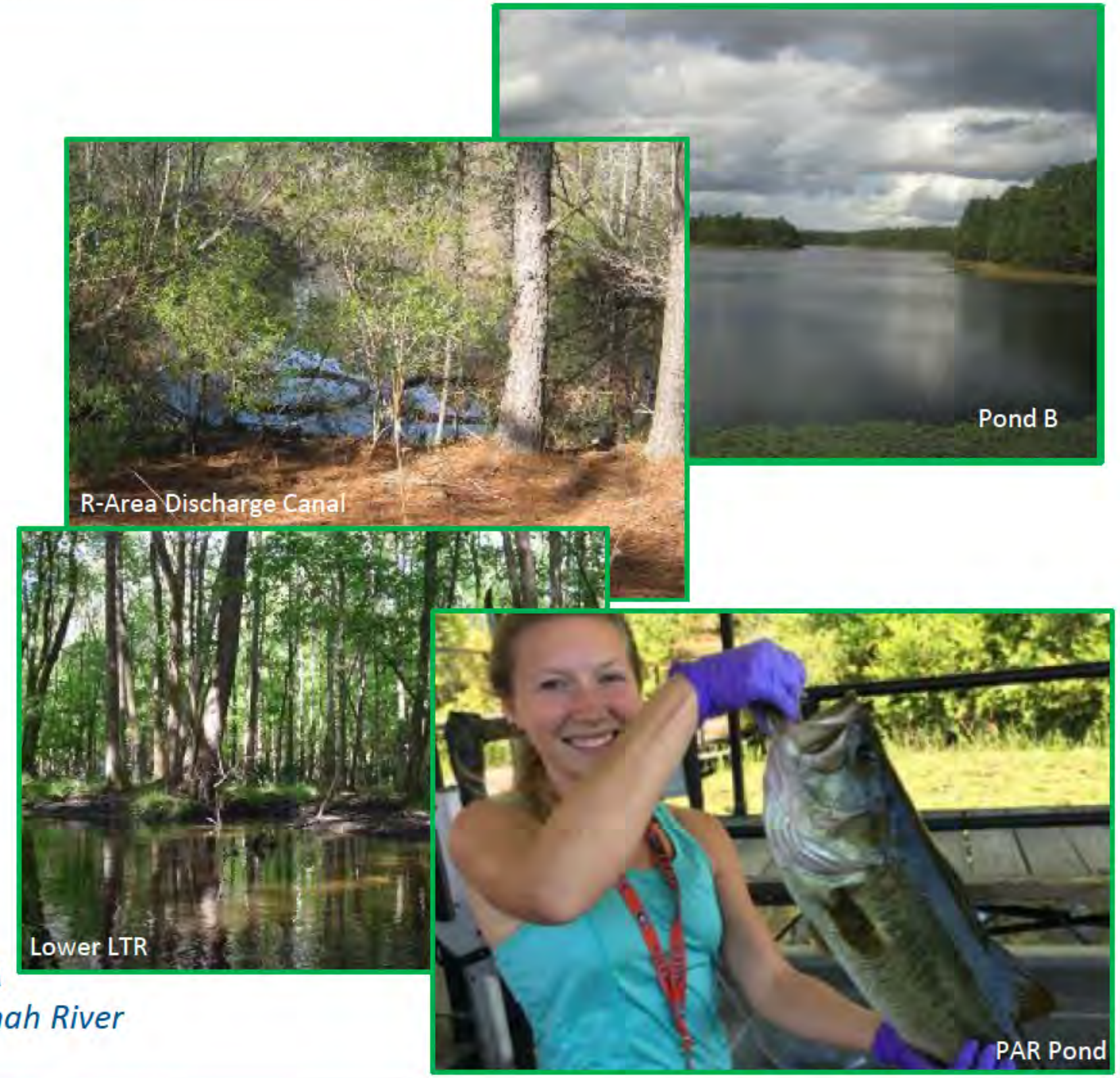
Reactor Flow Direction for Canal/PAR Pond System

- Effluent from R-Reactor was routed through R Discharge Canal, Pond A, Pond B, and into the north arm of PAR Pond
- Effluent from P-Reactor was routed to Pond 2, Pond 4 and 5 into Pond C and released into the middle arm of PAR Pond



Background: SRS NERP and the LTR IOU

- The SRS was designated as a National Environmental Research Park (NERP) in 1972.
  - DOE maintains a network of research reserves (Set-Asides)
  - SREL, USFS-SR, and SRNL are the primary entities that conduct research on SRS
- The LTR system is used for ecological research and has been studied since the pond/canal system was created.
- The LTR IOU system is still educating and training our future radio-ecologists / scientists *(photo of SREL graduate student)*



SREL = Savannah River Ecology Laboratory-UGA
USFS-SR = United States Forest Service – Savannah River
SRNL = Savannah River National Laboratory

Aerial View of LTR Canal/Pond System – Birds' Eye View

Portion of LTR Canal/Pond System – Pond 2 Layout

Record of Decision (ROD) for the Lower Three Runs IOU

- **The ROD for the LTR IOU was issued in December 2021**
  - Covers the remedy selected for the Upper LTR Subunit (P & R Areas to the PAR Pond dam)
  - Documents the Remedial Action for the Middle/Lower subunits (below PAR dam) that have already been completed

Upper Subunit

Savannah River NUCLEAR SOLUTIONS

Record of Decision
Remedial Alternative Selection for the
Lower Three Runs Integrator Operable Unit (U)

SEMS Number: 35

SRNS-RP-2020-00542

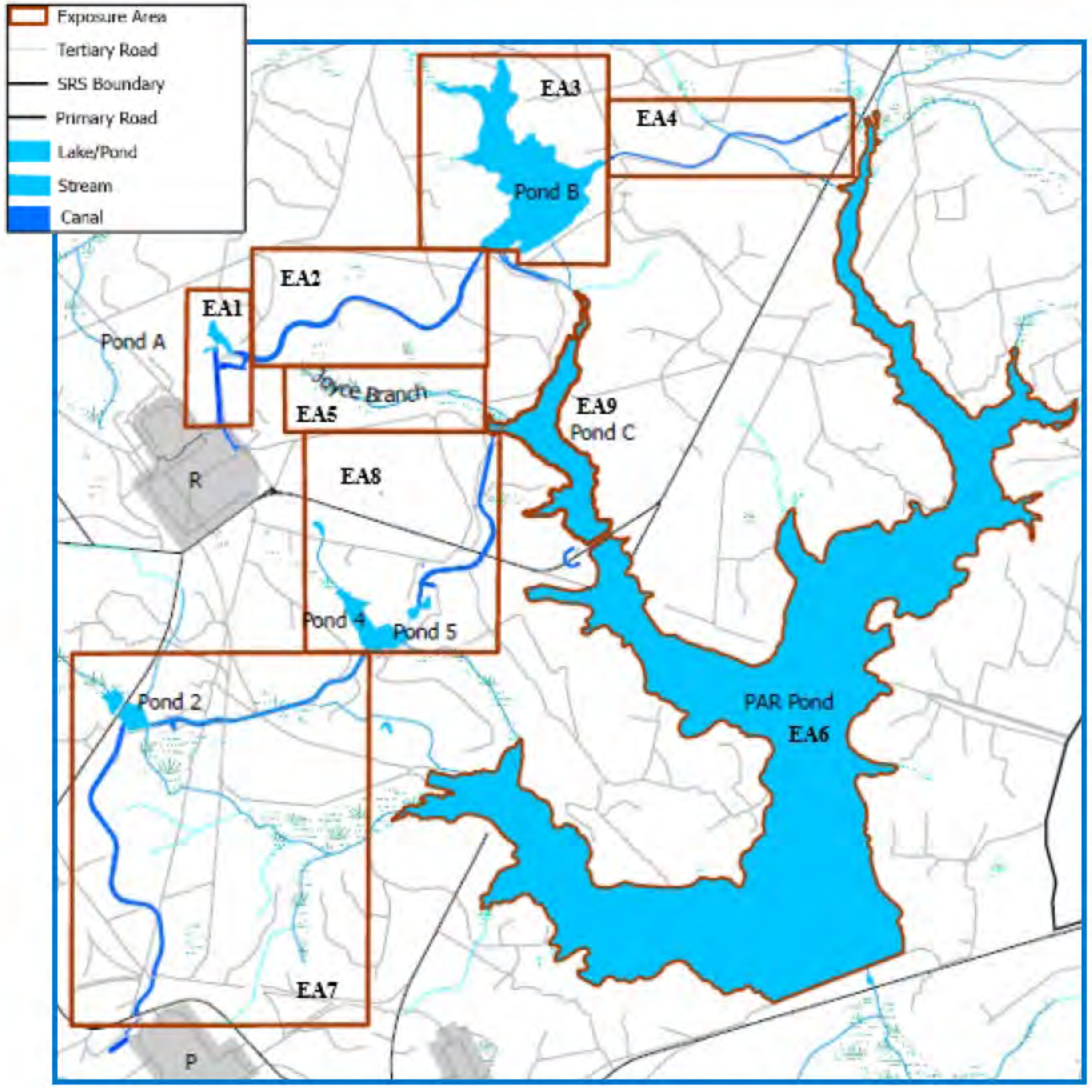
Revision 1

August 2021

SAVANNAH RIVER SITE • AIKEN, SOUTH CAROLINA

The LTR Upper Subunit – Exposure Areas (EAs)

- **Due to the variability of environmental conditions and large scale of the LTR IOU, the LTR Upper subunit is segregated into nine Exposure Areas (EAs)**
  - EA1: Pond A and the R-Area Discharge Canal
  - EA2: section of the canal system between Pond A and Pond B
  - EA3: Pond B and the overflow canal connecting Pond B to Pond C
  - EA4: section of the canal system between Pond B and the North Arm of PAR Pond
  - EA5: Joyce Branch (also known as the Old R-Area Discharge Canal)
  - EA6: PAR Pond
  - EA7: Pond 2 and the Discharge Canal between P-Area and Ponds 4 and 5
  - EA8: Ponds 4 and 5 and the Discharge Canal between Ponds 4 and 5 to Pond C.
  - EA9: Pond C

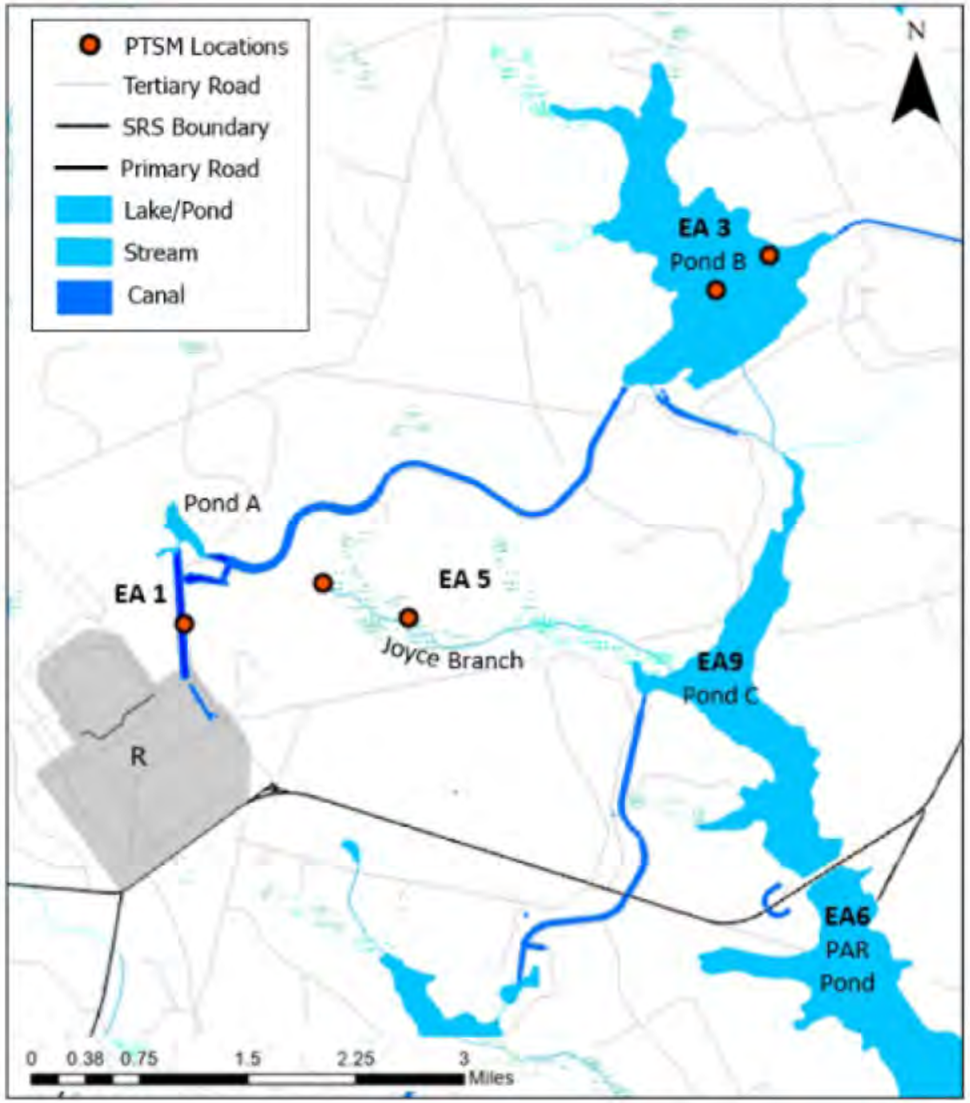


Radioisotopes – Radioactive Forms of an Element

- Radioisotopes can occur naturally or can be man-made.
- Cesium-137 (Cs-137) exists at low levels in the environment due to “fallout” from nuclear weapons testing, nuclear accidents (e.g., Chernobyl and Fukushima) and operations at some nuclear reprocessing facilities
- At SRS, Cs-137 is a byproduct of our nuclear reactor operations.
  - Water in the P- and R-Reactor disassembly basins contained cesium-137; it was discharged to PAR Pond and Lower Three Runs through the canal system.
- Radioisotope levels in the environment decrease over time naturally due to radioactive decay.
  - Cesium-137’s half-life is 30 years (radioactivity decreases by 50% every 30 years)
- Cs-137 binds strongly to soil and does not travel very far below the land surface.
- Plants and animals growing/living in or near contaminated soil may take up small amounts of Cs-137.
- Exposure to Cs-137 can increase the risk for cancer because of the presence of high-energy gamma radiation. Shielding and distance reduce exposure.
- Cancer risk is expressed as the estimated number of additional cancers in a population from exposure to the carcinogen (in this case, Cs-137) at the measured concentrations in the environment (1 in 10,000; 1 in 1 million, etc. additional cancers)
  - Cancer risk (estimated using EPA methodology) is a key factor in environmental cleanup decisions

Cs-137, Mercury, and Principal Threat Source Material (PTSM)

- Contamination from reactor discharges resulted in **Cs-137** in sediment/soil
- **Mercury** was also introduced in surface water due to pumping river water from the Savannah River
  - **Fish** contain levels of Cs-137 and mercury that pose a potential threat to the recreational fishermen
  - Fishing is prohibited on SRS except for monitoring/research purposes
- Sample locations with sediment/soil levels above **PTSM** for Cs-137 have been identified in EA1, EA3, and EA5

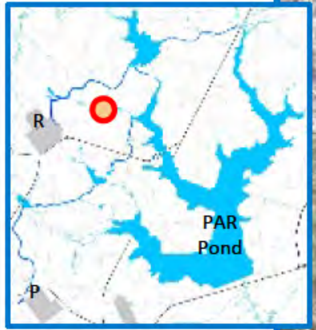


The Level of risk for PTSM: potential for 1 additional cancer in 1,000

R-Area Discharge Canal – PTSM Location

Pond B – PTSM Locations

Joyce Branch (Old R-Area Discharge Canal) – PTSM Locations



ROD - Selected Remedy

- The ROD (2021) identified the selected remedies for the LTR IOU Upper subunit as:
  - *Land Use Controls (LUCs) with Monitored Natural Recovery (MNR)* for all nine EAs (EA1 through EA9),
  - *Excavation, Treatment and Disposal of Principal Threat Source Material (PTSM) Sediment/Soil* in EA1 (Pond A – Including R-Area Discharge Canal), and
  - *Maintain Water in Ponds* for EA3 (Pond B) and EA6 (PAR Pond).
- The future land use specified for the LTR IOU will be non-residential and primarily used for environmental/ecological research with USDOE maintaining control of the land.
- Five-year remedy reviews will be conducted.

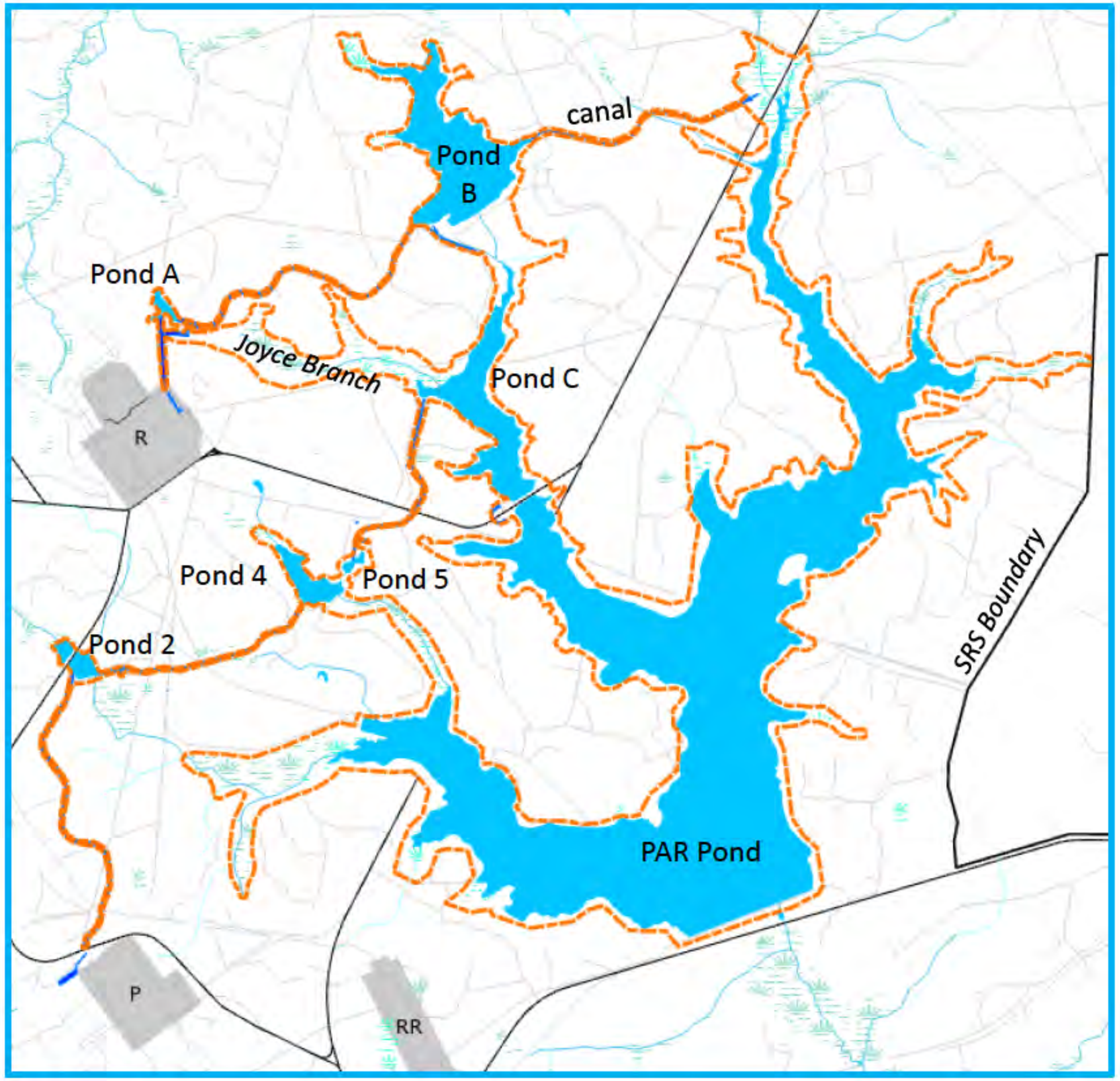
ROD - Selected Remedy

- *LUCs with Monitored Natural Recovery (MNR)* for all nine EAs (EA1 through EA9)
- *Excavation, Treatment and Disposal of Principal Threat Source Material (PTSM) Sediment/Soil* in EA1 (Pond A – Including R-Area Discharge Canal)
- *Maintain Water in Ponds* for EA3 (Pond B) and EA6 (PAR Pond)

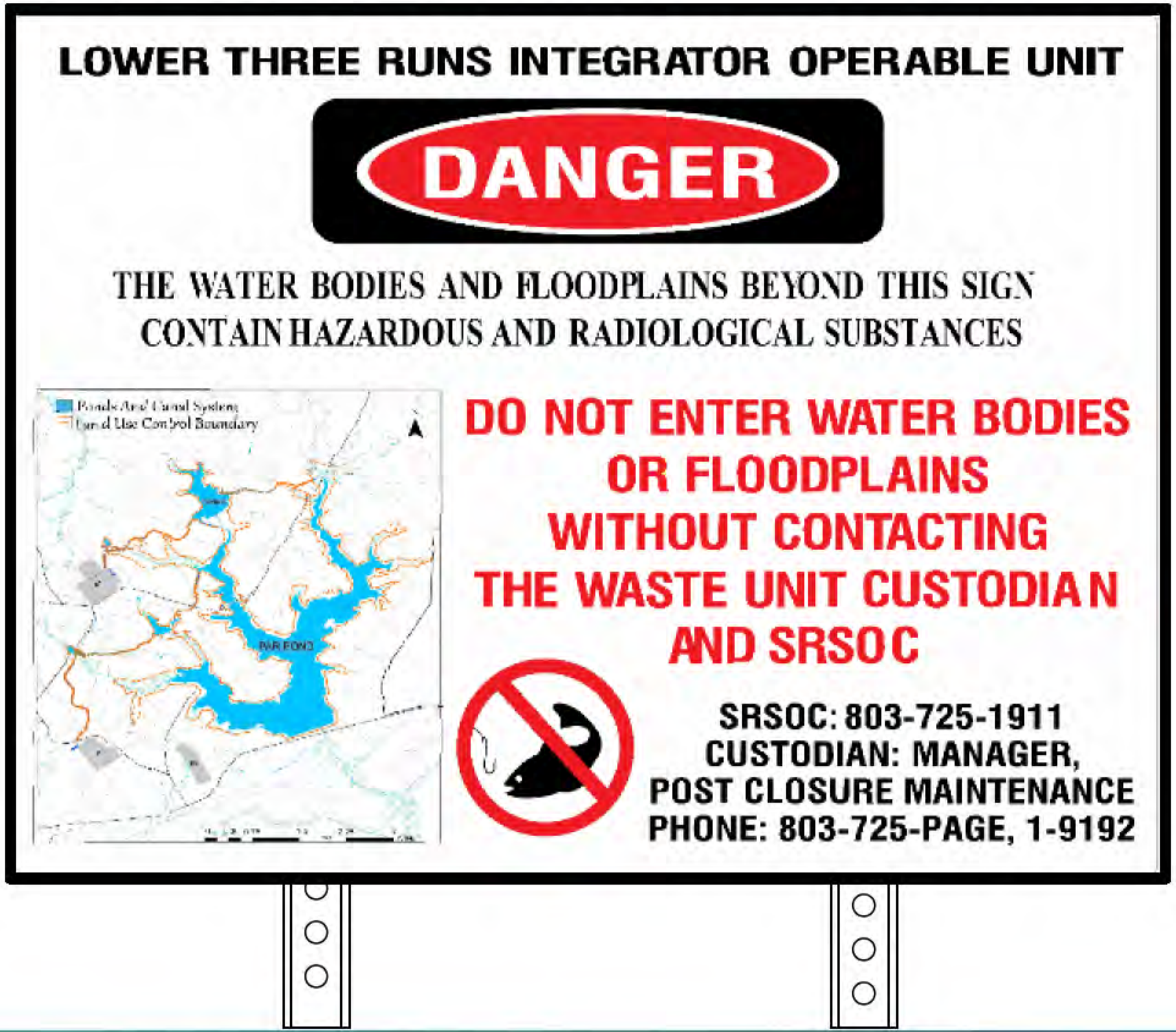
Land Use Control (LUC)

LUC Boundary

- = *LUC Boundary*
- = *Stream*
- = *SRS Boundary*
- = *Road*
- = *Facility Boundary*



Land Use Controls (LUCs) - Signage



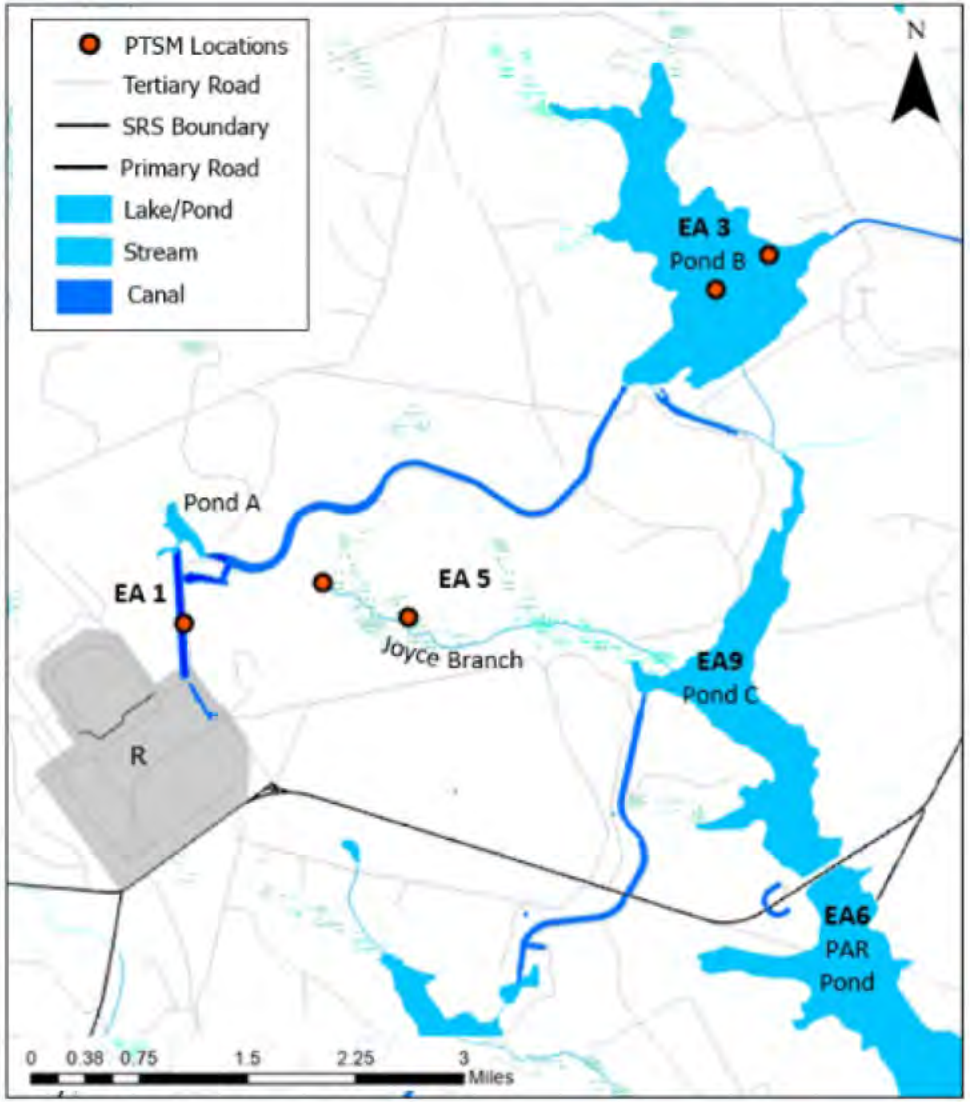
Monitored Natural Recovery (MNR)

- Monitored Natural Recovery (MNR) was identified to address the long-term monitoring component for the Upper subunit.
- MNR is a remedy that uses ongoing, naturally occurring processes that reduce the bioavailability or toxicity of contaminants in sediment/soil (e.g., radiological decay and ongoing deposition).
  - Physical half-life for Cs-137 is 30.2 years. Effective (biological) half-life can be much shorter
  - Cs-137 strongly binds (adsorbed) with clay soil minerals (e.g., kaolinite, illite minerals)
- The land use for the LTR IOU is compatible with natural recovery: non-residential and primarily used for environmental/ecological research with USDOE maintaining control of the land.
- With contamination left in place, a five-year remedy review will be conducted.

MNR Monitoring

- Monitoring consists of:
  - Aerial gamma survey for Cs-137 for the entire Upper subunit
  - Fish Collections for Cs-137 and mercury
    - *Pond B*
    - *PAR Pond*
    - *Pond C*

  - Sediment/Soil Sampling (based on aerial surveys) for Cs-137
- Monitoring will support the five-year remedy review reports for *SRS OUs with Native Soil Covers and/or Land Use Controls.*
- The monitoring plan will be re-evaluated after Cs-137 activities decay below PTSM levels.

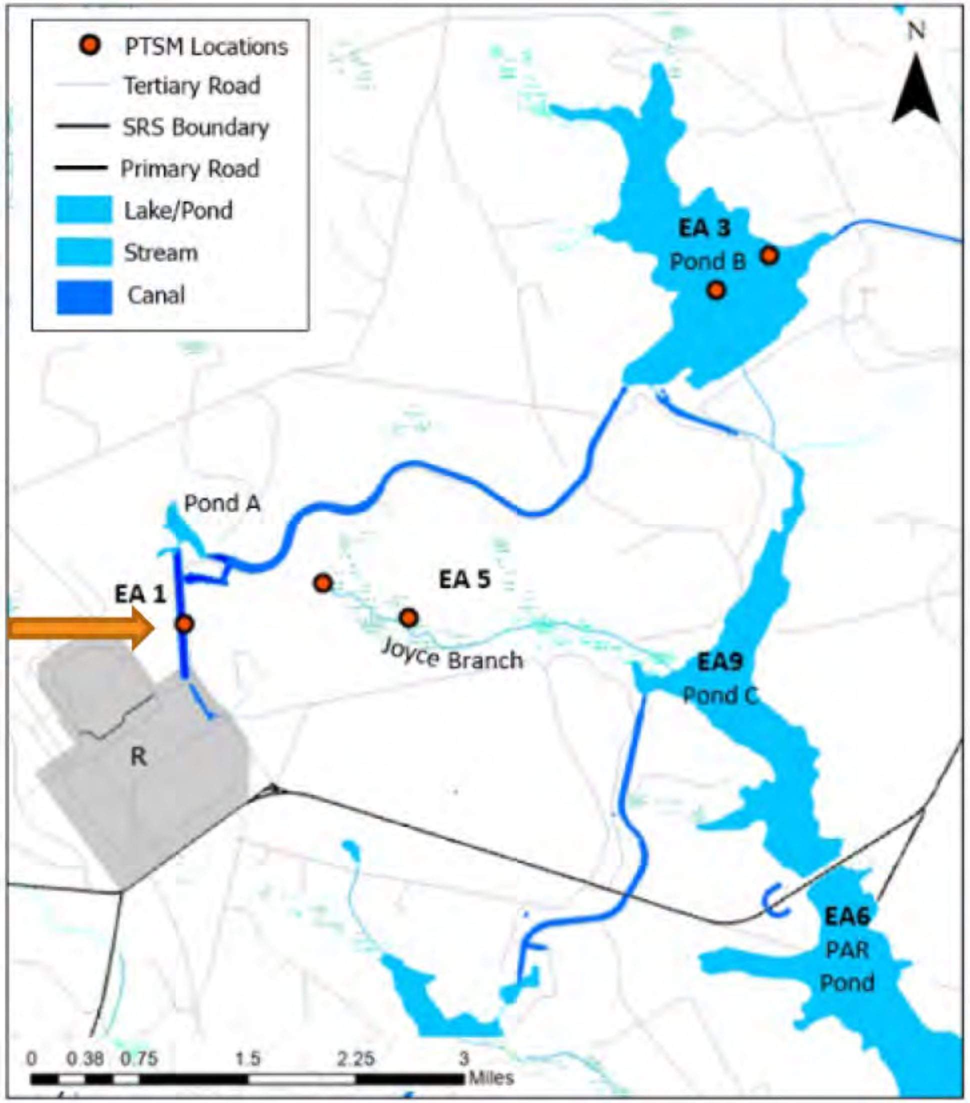


ROD - Selected Remedy

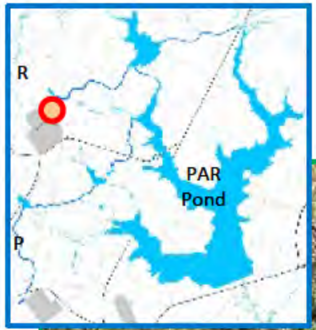
- *LUCs with Monitored Natural Recovery (MNR)* for all nine EAs (EA1 through EA9)
- *Excavation, Treatment and Disposal of Principal Threat Source Material (PTSM) Sediment/Soil* in EA1 (Pond A – Including R-Area Discharge Canal)
- *Maintain Water in Ponds* for EA3 (Pond B) and EA6 (PAR Pond)

Principal Threat Source Material (PTSM)

- The Remedial Action for EA1 is **Excavation, Treatment and Disposal of PTSM Sediment/Soil**
  - Sediment/soil will be removed from the one location in EA1 with samples that exceed the PTSM threshold for Cs-137
  - This Remedial Action will shorten the timeframe for radioactive decay to reach cleanup levels



R-Area Discharge Canal – Location of PTSM samples



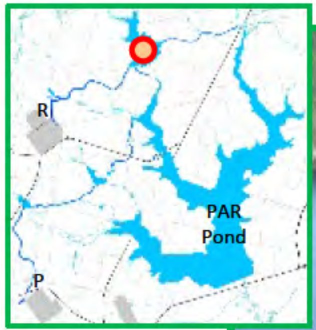
Location of Remedial Action (Removal of Sediment/Soil)

ROD - Selected Remedy

- *LUCs with Monitored Natural Recovery (MNR)* for all nine EAs (EA1 through EA9)
- *Excavation, Treatment and Disposal of Principal Threat Source Material (PTSM) Sediment/Soil* in EA1 (Pond A – Including R-Area Discharge Canal)
- *Maintain Water in Ponds* for EA3 (Pond B) and EA6 (PAR Pond)

  Water serves as a natural shield against radiation exposure

Pond B



Pond B

Boat dock and floating sampling
enclosures for tadpoles/fish to assess bio-uptake

Pond C and PAR Pond (North Arm)

PAR Pond

Schedule

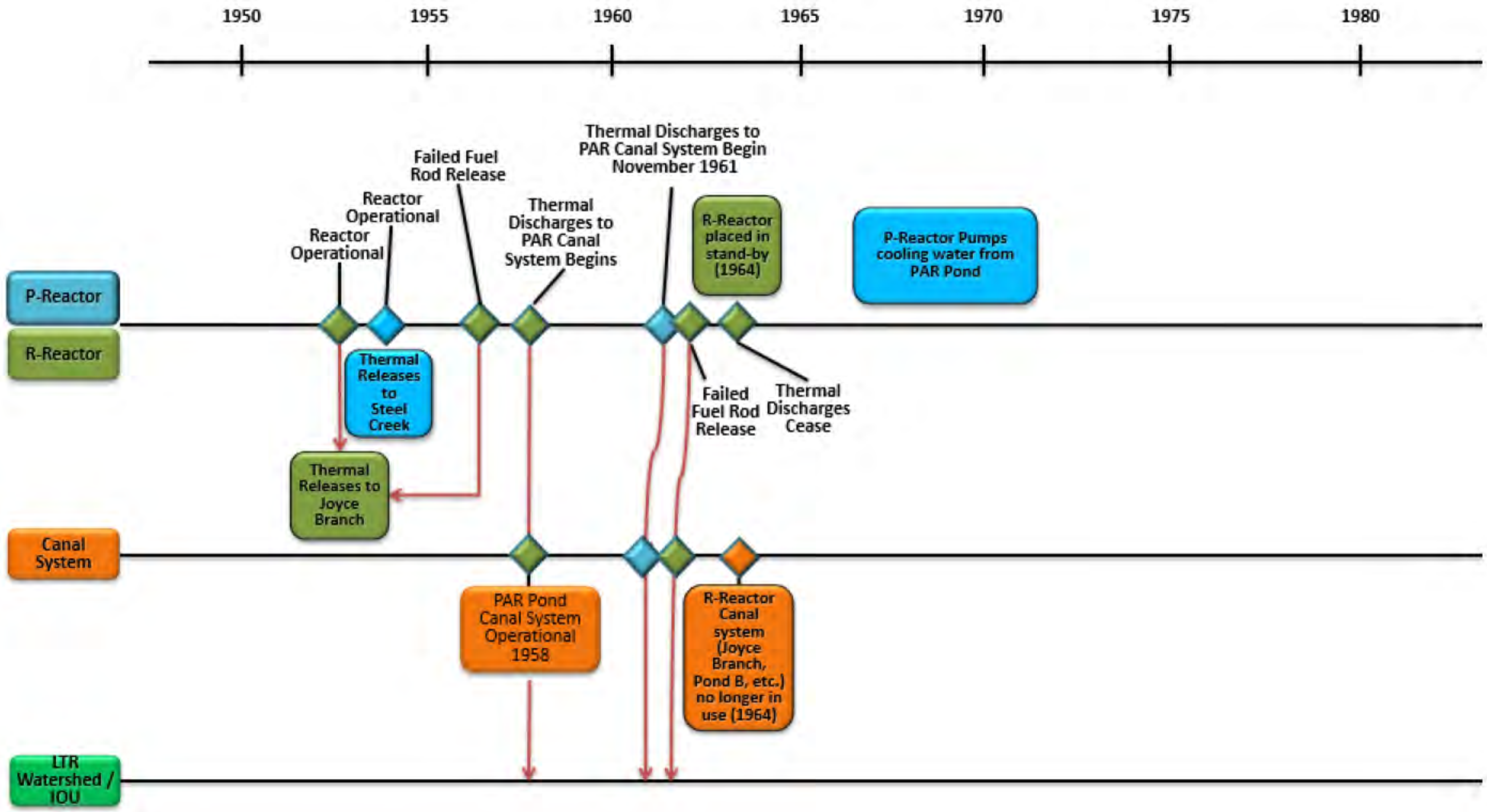
Scheduled Item	
Remedial Action Start	April 24, 2023
Submit Rev. 0 Post Construction Report/ Remedial Action Completion Report	January 21, 2025

Questions?

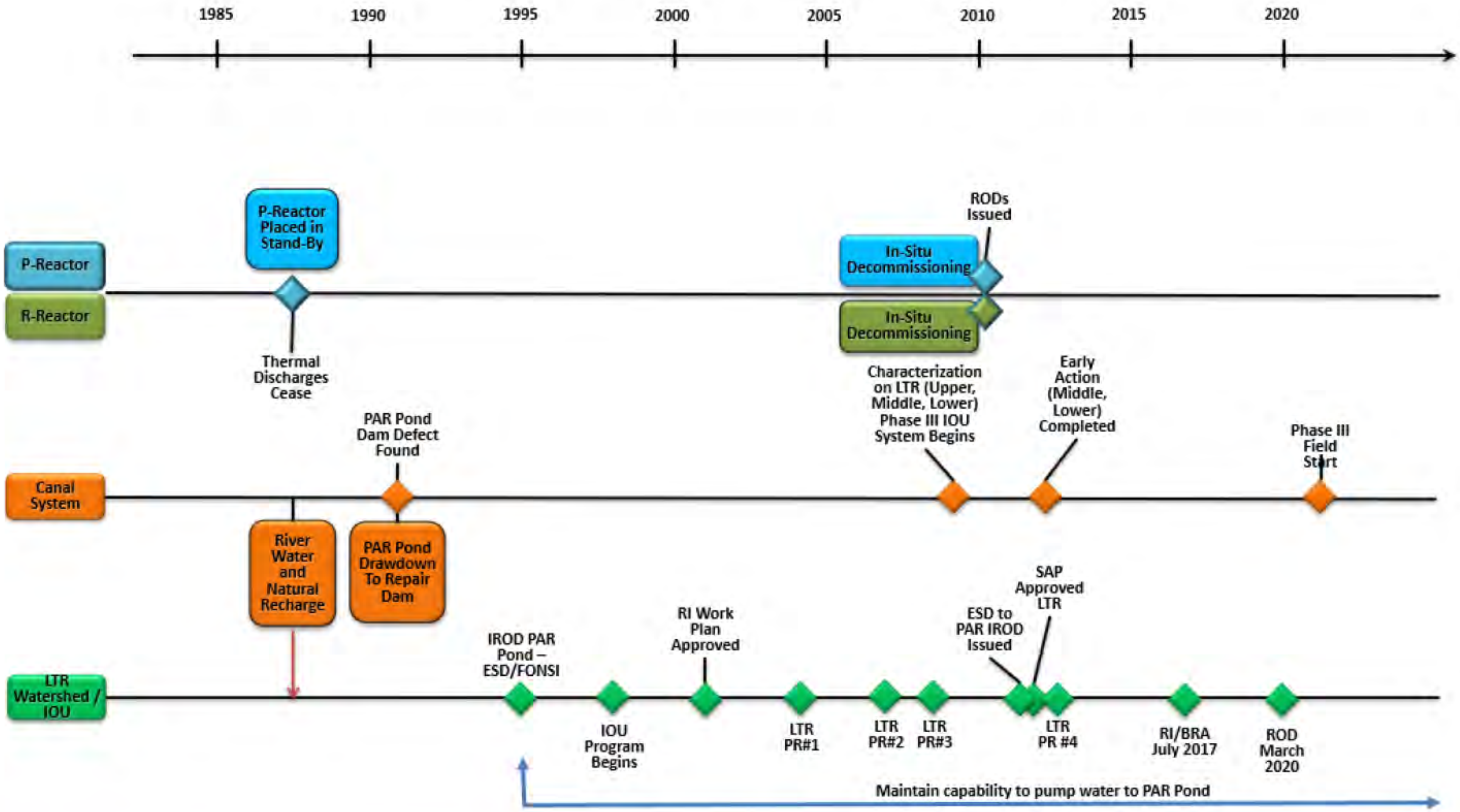
Great blue heron
Ardea herodias

Extra Slides

Lower Three Runs Timeline



LTR Timeline, continued



PAR Pond/LTR system is used to train future radio-ecologists/scientists

COMPARISON OF CONTAMINANT ACCUMULATION IN RESERVOIR FISHES OF DIFFERENT TROPHIC LEVELS AND HABITATS

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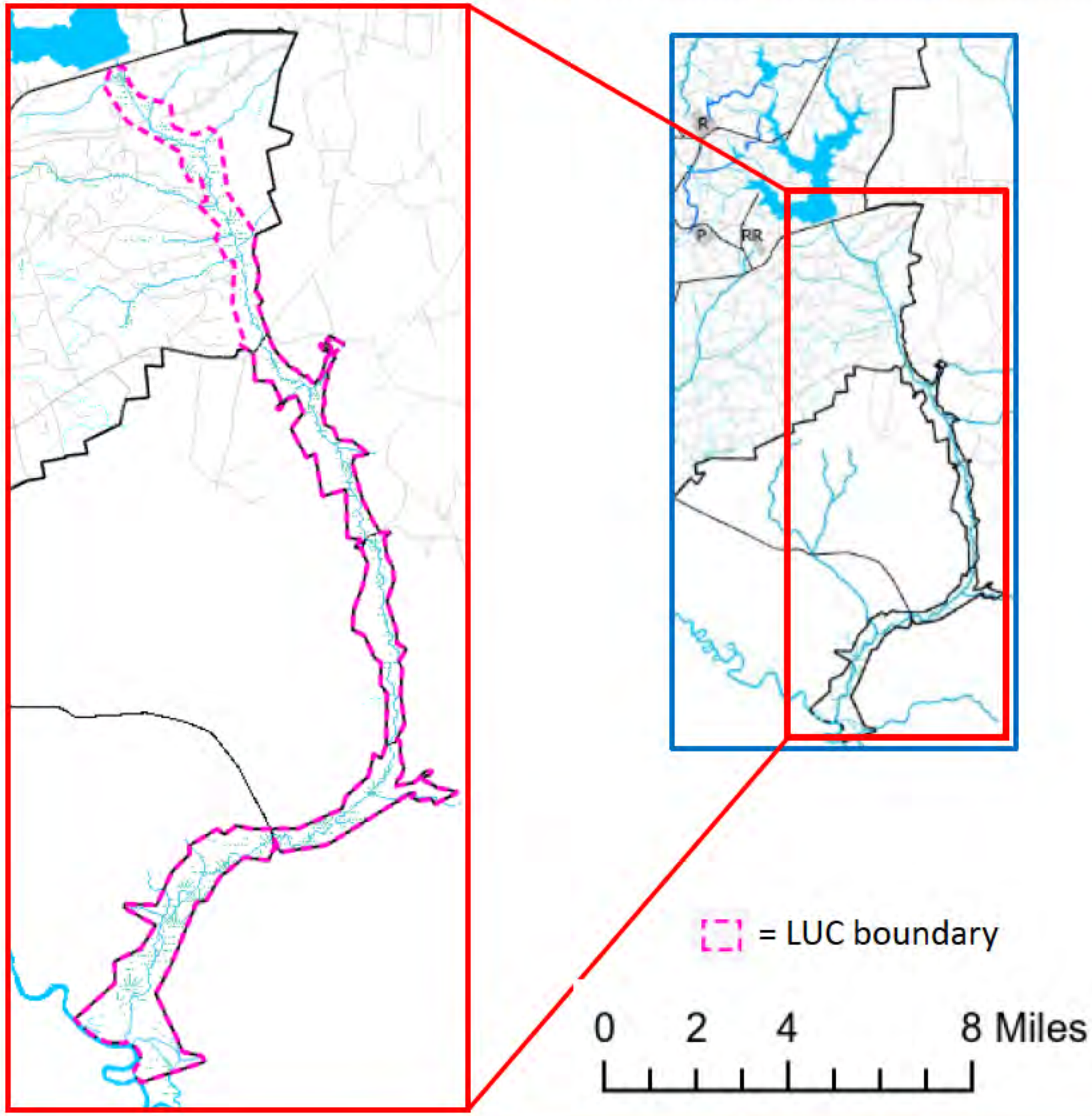
Par Pond is a former nuclear reactor-cooling reservoir on the U.S Department of Energy's Savannah River Site in South Carolina. Reactor operation resulted in the reservoir being contaminated with radiocesium. Additional contaminants such as mercury were introduced in Savannah River water that was pumped through the system. Although the reservoir is not open to public fishing, study of contaminant accumulation among Par Pond fishes could lead to better understanding of contaminant dynamics in reservoir systems. Diverse species of fish reside in Par Pond, many of which differ in habitat use, feeding strategies, and trophic levels. We hypothesized these differences to produce significant variability in accumulation among various fish species. Fish were collected from the reservoir by boat-electrofishing and shoreline seining. Muscle samples were collected from larger fish and whole eviscerated body composites used for smaller fish. Subsamples were analyzed for 20 major/trace elements and radiocesium. Mercury and radiocesium accumulated highest in large predatory fish which also differed in accumulation. In contrast, mercury was lowest in the omnivore that had much

Jessica in the field.

algae in its gut. Mercury accumulation was similar among most, but not all species of small predators, whereas radiocesium varied little among these taxa. Mercury concentration positively correlated to total length and body weight in most fish species, while radiocesium less frequently correlated with body size. Mercury accumulation appears to increase with trophic level both among and within species. Radiocesium was only higher in larger predators. Many trace elements accumulated in relatively few fish and often to only low levels. Based on these data, contamination of Par Pond by these elements does not appear to be a concern. Much variability was observed among genera that could not be explained by body size, habitat use, or expected trophic position. Future work should evaluate differences in diet within a trophic level.

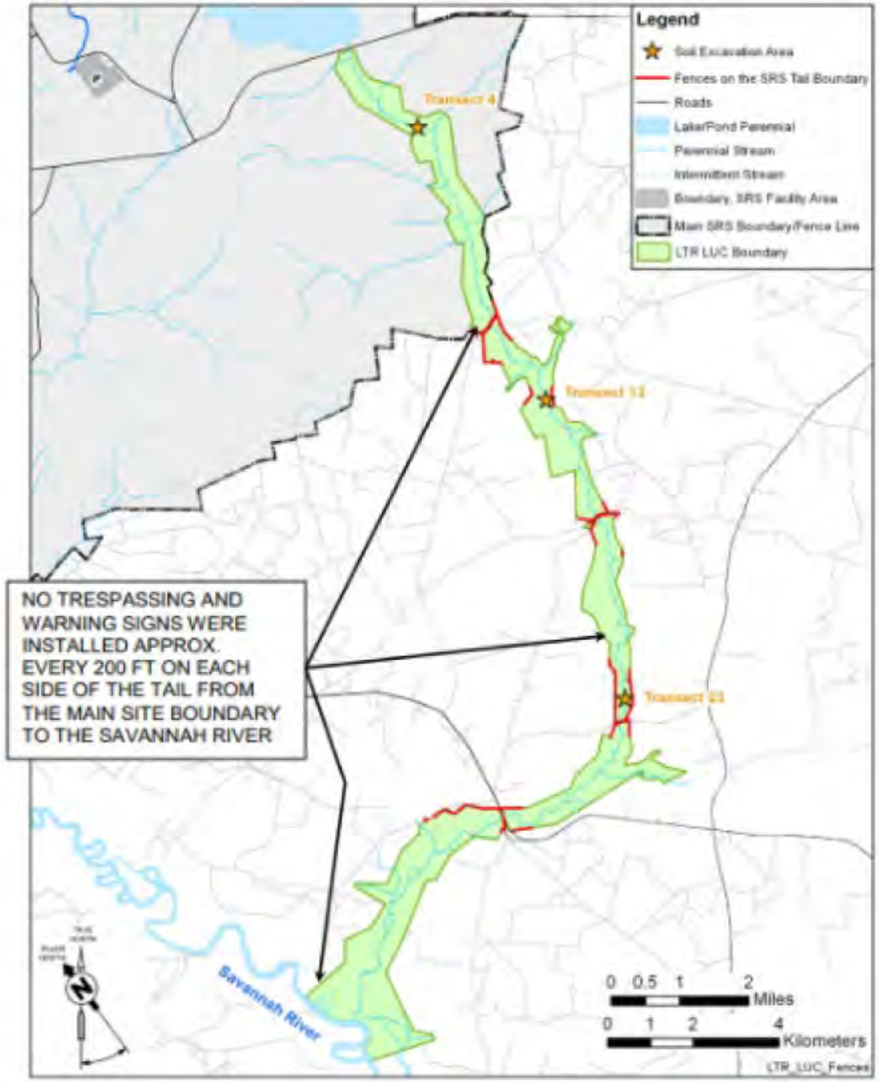
Middle and Lower LTR Subunits

- The removal action has already been implemented in Lower/Middle LTR (below PAR Pond dam)
  - Land Use Controls (LUCs)
  - Removal of sediment from three locations



Middle/Lower LTR - Removal Action

- The RA, due to Cs-137 sediment/soil contamination, was *Removal and Off-Unit Disposal with Land Use Controls*
- Soil was excavated in three transect locations where the Cs-137 concentrations exceeded the 23.7 pCi/g (1 x 10-4 risk level for the adolescent trespasser) action level; cleanup goal of 12 pCi/g; 5 x 10-5 risk level).
- Fencing and signs were installed to control access at selected locations along DOE's LTR IOU property boundary (road crossings, power line rights-of-way).



Description of CERCLA Evaluation Criteria

Threshold Criteria:	
•	Overall Protectiveness of Human Health and the Environment determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.
•	Compliance with ARARs evaluates whether the alternative meets Federal and State environmental statutes, regulations, and other requirements that pertain to the site. ARARs may be waived under certain circumstances. ARARs are divided into chemical-specific, location-specific, and action-specific criteria.
Primary Balancing Criteria:	
•	Long-Term Effectiveness and Permanence considers the ability of an alternative to maintain protection of human health and the environment over time. It evaluates magnitude of residual risk and adequacy of reliability of controls.
•	Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.
•	Short-Term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.
•	Implementability considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.
•	Cost includes estimated capital and annual operations and maintenance costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.
Modifying Criteria:	
•	State Support/Agency Acceptance considers whether USEPA and SCDHEC agree with the analyses and recommendations by the USDOE. Approval of the Record of Decision constitutes approval of the selected alternative by the regulatory agencies.
•	Community Acceptance considers whether the local community agrees with the Preferred Alternative. Comments received on the Proposed Plan during the public comment period are an important indicator of community acceptance. Comments from the public are considered in the final remedy selection in the Record of Decision.

Summary of the Comparative Analyses of the Alternatives

LTR IOU Alternatives		Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness	Reduction of Toxicity, Mobility, and Volume through Treatment	Short-term Effectiveness	Implementability	Cost
Alternatives That Apply to Entire Upper Subunit of the LTR IOU (EA1 through EA9)								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	$17,321,141
EA by EA evaluation								
EA1: Pond A – Including R-Area Discharge Canal								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
A-3	Capping of PTSM Sediment/Soil[1]	High	Yes	High	Yes	High	Moderate Level of Effort	$416,566
A-5	Excavation of PTSM Sediment/Soil[1]	High	Yes	High	Yes	Medium	High Level of Effort	$485,986
EA2: Canal from Pond A to Pond B								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
EA3: Pond B – Including Canal to Pond C								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
A-3	Capping of PTSM Sediment/Soil[1]	High	Yes	High	Yes	High	High Level of Effort	$2,678,707
A-5	Excavation of PTSM Sediment/Soil[1]	High	Yes	High	Yes	Medium	High Level of Effort	$1,990,626
A-6	Maintain Pond Level[1]	High	Yes	High	None	High	Low Level of Effort	2,082,616
EA4: Canal from Pond B to North Arm of PAR Pond								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit

LTR IOU Alternatives		Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness	Reduction of Toxicity, Mobility, and Volume through Treatment	Short-term Effectiveness	Implementability	Cost
EA5: Joyce Branch (Old Discharge Canal)								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR[1]	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
A-3	Capping of PTSM Sediment/Soil[1]	High	Yes	High	Yes	High	Moderate Level of Effort	$805,190
A-5	Excavation of PTSM Sediment/Soil[1]	High	Yes	High	Yes	Medium	High Level of Effort	$795,537
EA6: PAR Pond								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
A-6	Maintain Pond Level[1]	High	Yes	High	None	High	Low Level of Effort	$2,835,922
EA7: Canal from P-Area to Ponds 4 and 5 – Including Pond 2								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
EA8: Ponds 4 and 5 – Including Canal from Ponds 4 and 5 to Pond C								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
EA9: Pond C								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
A-6	Maintain Pond Level[1]	High	Yes	High	None	High	Low Level of Effort	$591,176

[1] Alternative is evaluated under the condition that LUCs with MNR is also applied.
Note: Range is Low to High, where Low = worst and High = best.
ARAR = applicable or relevant and appropriate requirement.