National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 7, 2022

Reply to Attn of: AS10

Mr. Stephen A. Cobb
Alabama Department of Environmental Management
Governmental Hazardous Waste Branch, Land Division
1400 Coliseum Blvd.
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SUBJECT: MSFC-004 Deluge Pond, RCRA Closure Plan
Marshall Space Flight Center – U.S. EPA ID AL 1800013863

In response to the communications between the Alabama Department of Environmental Management (ADEM) and the National Aeronautics and Space Administration (NASA) on March 10, 2022 and April 22, 2022, NASA is submitting a revised Closure Plan for the MSFC-004 Deluge Pond. The Closure Plan, developed in accordance with the applicable ADEM regulations under the Resource Conservation and Recovery Act (RCRA) and the Alabama Hazardous Wastes Management and Minimization Act (AHWMMA), outlines NASA's plan for closure of MSFC-004 Deluge Pond.

We look forward to ADEM's review of this closure plan. If you have any questions, please contact me at 256-714-4151 or farley.davis@nasa.gov.

Farley Davis
Manager
Environmental Engineering & Occupational Health Office
NASA Marshall Space Flight Center

Enclosure

MSFC-004 Deluge Pond Closure Plan

10 June 2022

Prepared for

National Aeronautics and Space Administration
George C. Marshall Space Flight Center

Huntsville, Alabama
EPA I.D. # AL 1800013863

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Contents

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Acronyms and Abbreviations

Acronym	Definition
ADEM	Alabama Department of Environmental Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
HDPE	high-density polyethylene
mgd	million gallons per day
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NPDES	National Pollutant Discharge Elimination System
NTCRA	non-time-critical removal action
OU	operable unit
RCRA	Resource Conservation and Recovery Act
TCE	tricholoroethene
VOC	volatile organic compound

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1. Introduction

This Closure Plan describes the procedures that will be followed to close the MSFC-004 Deluge Pond at Marshall Space Flight Center (MSFC) in Huntsville, Alabama. Historically, the National Aeronautics and Space Administration (NASA) used MSFC-004 to manage the discharge of deluge cooling water from rocket testing operations and discharge of groundwater extracted from the basement of the West Test Stand building (Building 4670). NASA is requesting approval from the Alabama Department of Environmental Management (ADEM) for the closure activities, as well as ADEM's concurrence on the future use of the impoundment, as outlined in the following sections.

This Closure Plan was developed in accordance with the applicable ADEM regulations under the Resource Conservation and Recovery Act (RCRA) and the Alabama Hazardous Wastes Management and Minimization Act. It satisfies NASA's requirement to submit a revised draft Closure Plan as an alternative to submitting a RCRA Hazardous Waste Permit application for operation of the MSFC-004 Deluge Pond as a RCRA unit. Based on discussions with ADEM and prior remedial decisions made under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the intent of this Closure Plan is to address the use of the deluge pond since the 1997 completion of the agency-approved CERCLA non-time-critical removal action (NTCRA) (NASA 2001).

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2. General Facility Description and History

The MSFC-004 Deluge Pond is a surface water impoundment at MSFC, the general vicinity of which is shown on Figure 1. The approximate latitude and longitude of the MSFC-004 Deluge Pond is 34.630956° N, 86.673562° W. Figure 2 shows an overview of the area around the MSFC-004 Deluge Pond, including the topography, 100- and 500-year flood zones, and CERCLA remedial areas. There are no water injection or withdrawal wells, seismic zones or fault lines in the area.

The MSFC-004 Deluge Pond encompasses approximately 12 acres in the southwestern portion of MSFC. The area consists of the MSFC-004 Deluge Pond and adjacent buildings, including the West Test Stand, as shown on Figure 3. The main channelized portion of the MSFC-004 Deluge Pond generally covers approximately 1 acre with an average depth of approximately 3 feet.

The MSFC-004 Deluge Pond was constructed in 1963 of native soil. The physical area of the pond can fluctuate from 1 acre to 12 acres, measuring approximately 1,200 feet long and 400 feet wide, with a maximum depth of approximately 10 to 15 feet; however, the fluctuation in pond level is predominantly the result of stormwater runoff and deluge/cooling water from engine test operations, not the accumulation of extracted groundwater pumped from the basement of Building 4670.

2.1 Coordination with CERCLA Units

The MSFC-004 Deluge Pond is designated under NASA's CERCLA program as MSFC-004 and has been included in the CERCLA investigation work for its associated operable unit (OU)—OU-1 for surface media. The groundwater beneath this area is designated as Source Area 6 (SA-6) in OU-3, which consists of contaminated groundwater, saturated soil, and the capillary fringe across the MSFC Superfund Site.

As part of the CERCLA program, NASA conducted an NTCRA on the sediments in the MSFC-004 Deluge Pond from May through October 1997 (NASA 2001). The impoundment sediments were stabilized with lime, and a 60-mil high-density polyethylene (HDPE) geomembrane cover was installed over the stabilized sediments to minimize the effects of the detected metals on a sensitive ecosystem (e.g., downgradient wetlands) and the migration of contaminated sediments to the receiving stream. The area of sediment stabilization and cover installation is shown on Figure 3 and is considered the outer limits of the unit.

2.2 Current Use

Currently, no extracted groundwater is routed to the MSFC-004 Deluge Pond and temporary engineering provisions (refer to Figure 4) have been put in place to prevent such flow to the pond, even during high flow events. Permanent and even more robust engineering provisions are currently under design and will further enhance the potential to prevent any groundwater flow from reaching the basin.

2.3 Historical Use

The MSFC-004 Deluge Pond was constructed to receive cooling water used to quench exhaust gases during engine testing operations, as well as groundwater pumped from the Building 4670 basement sump.

Continuous dewatering operations are required to keep the Building 4670 basement dry and usable. Groundwater from dewatering operations in the basement of Building 4670 is extracted at a rate of

approximately 1.5 million gallons per day (mgd). Historically, groundwater also was pumped out of the basement sump in Building 4696, the former F-1 Test Stand, until its demolition in 2013. Approximately 500,000 gallons per day of groundwater was extracted from the basement of Building 4696. Because SA-6 is known to contain elevated concentrations of chlorinated volatile organic compounds (VOCs), including trichloroethene (TCE), the pumped groundwater is routed from the Building 4670 sumps to a packed-tower aeration stripping process unit for treatment. The treatment system has been operated since 1998 but was shut down between 2003 and 2013 in accordance with a CERCLA directive on the basis that the groundwater did not pose significant risk to human health and the environment. Historically, treated groundwater flowed from the treatment system through a channel and into the deluge pond prior to discharge (refer to Figure 3 for historical discharge paths).

Historically, after significant rainfall events, groundwater flow into the basement of Building 4670 would increase to the point that the continuous pumping system could not manage the flow. In these cases, the excess groundwater could not be pumped to the treatment system because of capacity restraints in the pumping system. Instead, it was discharged directly to the deluge pond; the excess extracted groundwater traversed the deluge pond to outfall DSN019, as shown on Figure 3. Similar discharges historically occurred during stripper maintenance.

2.4 Waste Determination

Contaminated environmental media are not hazardous waste and generally are not subject to regulation under RCRA (EPA 1998a). Under the U.S. Environmental Protection Agency (EPA) Contained-In Policy (EPA 1996, 1998b), however, contaminated environmental media can become subject to regulation under RCRA when actively handled if they "contain" hazardous waste—that is, when they exhibit a characteristic of hazardous waste or when they are contaminated with concentrations of hazardous constituents from listed hazardous waste that are above health-based levels (EPA 1998a).

TCE has been detected in the groundwater beneath the MSFC West Test Area. It has been documented through the MSFC CERCLA process that the TCE in the groundwater beneath the West Test Area resulted from the historical release of spent solvent during former operations when TCE was used to flush the rocket engines upon completion of testing activities. Use of TCE at MSFC was discontinued in the 1970s. Spent halogenated solvents used in degreasing that contain TCE are classified as RCRA-listed hazardous waste F001 under Title 40 Code of Federal Regulations 261.31. Accordingly, based on EPA's Contained-In Policy (EPA 1996, 1998b), the groundwater pumped from the Building 4670 sumps is presumed to contain listed waste F001 and must be managed as hazardous waste.

Because the TCE contamination in groundwater is documented as being from an F001 waste, NASA discontinued the discharge of extracted groundwater to the MSFC-004 Deluge Pond in May 2022.

2.5 Maximum Waste Managed

Based on a groundwater flow rate of 2 mgd from 1997 to 2013, when Building 4696 was demolished, and 1.5 mgd from 2013 to the present, approximately 16,600 million gallons of groundwater may have passed through the MSFC-004 Deluge Pond between 1997 and 2022, The groundwater passing through the deluge pond was untreated for about half of this time period. Currently, no extracted groundwater is being routed to the MSFC-004 Deluge Pond.

3. Closure Process

Based on historical and ongoing sampling of the sediment in the MSFC-004 area, NASA believes that the MSFC-004 Deluge Pond qualifies for clean closure in its current state.

3.1 Closure Performance Standard

This Closure Plan was developed to meet the closure performance standards specified in ADEM Administrative Code r. 335-14-5-.07(2). Specifically, the activities completed to date, or proposed as described in the following sections, successfully control, minimize, or eliminate post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the extent needed to protect human health and the environment. In addition, minimal maintenance will be required following closure of the deluge pond.

Clean closure will be based on the results of site-specific ecological and human health risk assessments using analytical results from previously collected and scheduled soil/sediment samples. Figures 5 and 6 show the locations of previous and proposed discrete soil/sediment samples that will be used to support the ecological and human health risk assessments.

Constituents selected for analysis were based on the land disposal restrictions for waste codes F001 and F002. Historically, the only F-listed solvent discharged in this vicinity would have been TCE, which is present in both F001 and F002 listed wastes. Because of this historical contamination, contaminated groundwater carries the F001 listing when it is pumped out of the ground (generated). These constituents are VOCs.

For each sample location, three 5-gram aliquots will be collected and placed into separate 40 milliliter vials. The samples in two of the vials will be preserved with methanol and one will be preserved with sodium bisulfate. The samples will be analyzed for VOCs in accordance with SW-846 Method 8260B. Table 1 presents the sampling plan. The risk assessment will include comparison of the soil/sediment analytical results to action levels for F001 constituents of concern that are protective of a residential scenario, as outlined in ADEM's *RCRA Closure Handbook,* the *Alabama Risk-Based Corrective Action Manual*, and the *Alabama Environmental Investigation and Remediation Guidance*.

In addition to the soil/sediment sampling for the ecological and human health risk assessments, sediment samples also will be collected to support a contained-in determination of sediment in the MSFC-004 Deluge Pond. The Soils Contained-In Determination Sampling Plan for the MSFC-004 Deluge Pond Closure in Appendix A outlines the proposed methods and procedures that will be used to accomplish the sediment sampling and contained-in determination.

3.2 Waste Inventory and Removal

The waste inventory addressed in this section is for the period of time following completion of the NTCRA in 1997 to the present. Specifically, the groundwater discharged to the MSFC-004 Deluge Pond and accumulated sediment are discussed.

Note that the MSFC-004 Deluge Pond also manages deluge/cooling water used to quench exhaust gases during engine tests; however, management of this wastewater is specifically permitted by NASA's National Pollutant Discharge Elimination System (NPDES) permit and is not addressed in this Closure Plan. Future use of the impoundment for this purpose will continue.

3.2.1 Groundwater

Based on a groundwater flow rate of 2 mgd from 1997 to 2013, when Building 4696 was demolished, and 1.5 mgd from 2013 to the present, approximately 16,600 million gallons of groundwater may have passed through the deluge pond. NASA discontinued discharging groundwater to the deluge pond on May 27, 2022. Currently, the groundwater passes through a treatment system and is discharged through a temporary line directly to outfall DSN019 as authorized by NPDES Permit No. AL0000221. Therefore, no waste is currently inventoried at the site.

3.2.2 Sediments

Based on historical sampling results, comparison to EPA's regional screening levels, and risk assessment, NASA believes that the sediments currently present in the impoundment can be clean closed without additional treatment. Results of the proposed sampling efforts (refer to Section 3.1 and Appendix A) and the subsequent risk assessment will be presented in the Closure Certification Report. If the residential risk criteria cannot be met, NASA will coordinate with ADEM regarding additional sampling, the closure procedures for sediment removal, or revision of this Closure Plan, as appropriate.

3.3 Closure Schedule

MSFC-004 will be closed in several phases, including:

1) Constructing a temporary discharge line from the groundwater treatment system directly to Outfall DSN0019—Completed May 27, 2022
2) Additional soil/sediment sampling to support the ecological and human health risk assessments—June 2022
3) Sampling sediments above the HDPE liner installed during the CERCLA NTCRA per the Sampling Plan included in Appendix A—June 2022
4) Conducting Human Health and Ecological Risk Assessment—June 2022
5) Submittal of Closure Certification Report—July 2022
6) Upgrading the groundwater treatment system, including construction of a permanent discharge line—July 2023
7) Upgrading the groundwater pumping system—July 2023

3.4 Cover System Installation

As part of the 1997 NTCRA conducted at the MSFC-004 Deluge Pond following lime stabilization of the sediment, which provided a dry subgrade, NASA installed a 6.5-acre cover system over the stabilized sediment in the impoundment.

The cover system, which was installed as a physical barrier to protect ecological receptors from potential exposure to metals in underlying sediments, consists of a 60-mil HDPE geomembrane placed on the prepared subgrade, overlain by 10 inches of compacted soil and 2 inches of compacted topsoil.

The HDPE cover was anchored in a trench dug at the toe of each berm and at the construction limits. The soil covers and protects the HDPE geomembrane from weather and damage, and the topsoil provided a basis for the vegetative cover, which helps control erosion. The vegetative cover consisted of placing geotextile (fiber mat) over all areas to be vegetated, then sodding in the more-susceptible center drainage

ditch and seeding new grass in the remaining areas. Cover system installation was completed on October 9, 1997. Full documentation of the cover system installation, including HDPE manufacturer and installer quality assurance procedures, as-built drawing, and warranties, is provided in the draft *Performance Verification Report Non-Time-Critical Removal Action MSFC-004 Deluge Pond* (NASA 2001).

The cover system was designed for minimum maintenance and long-term reliability. The ultimate life expectancy of HDPE membranes (material) is unknown; however, when properly protected from environmental stresses, such as sunlight and freezing temperatures, there should be virtually no deterioration.

Based on the projected life expectancy of the cover system, no other activities are proposed for closure of the MSFC-004 Deluge Pond. NASA will evaluate the need to place additional soil cover on exposed sections of the HDPE cover to protect it from environmental stresses.

3.5 Groundwater Monitoring

Since 1998, NASA has been conducting voluntary periodic monitoring of groundwater plumes that have been identified through ongoing site investigations at MSFC. NASA made the decision to develop and implement the monitoring program as a means of: (1) tracking the migration of the groundwater plumes; and (2) monitoring key water quality trends and significant changes in the trends beneath the main source areas of contamination, within the plume areas, and at groundwater discharge locations.

Contaminated groundwater, including sources of groundwater contamination beneath the water table, has been identified at MSFC through numerous investigations. Based on these investigations, groundwater, saturated soil, and the capillary fringe at MSFC have been designated as Operable Unit 3 (OU-3) under the CERCLA remedial activities. Additionally, there are multiple source areas at MSFC that include a high concentration of chlorinated volatile organic compounds (VOCs), including trichloroethene (TCE). SA-6, which is adjacent to and beneath the MSFC-004 Deluge Pond, is one of these areas. Plans for an Interim Remedial Action consisting of in situ treatment via pneumatic fracture injections of zero valent iron are already in place for SA-6 and are scheduled to begin in late 2022.

Monitoring wells associated with the groundwater plumes were sampled quarterly in 1998 and semiannually from 1999 through 2014. Beginning in 2015, monitoring wells have been sampled annually. Samples are analyzed for VOCs; groundwater samples from some plumes also are analyzed for metals and/or natural attenuation biodegradation indicator parameters. Monitoring wells in the southwest plume (OU-3) (including the three monitoring wells closest to the MSFC-004 Deluge Pond: MW01-001, MW00-102, and MW00-104 in the West Test Area) have been analyzed for VOCs and metals. The southwest plume area also was sampled for natural attenuation parameters during three monitoring events in 1998.

Technical memorandums have been prepared for each of the groundwater monitoring events from 1998 through 2020. The monitoring reports, which are secondary documents under the Federal Facilities Agreement (FFA), are provided to EPA and ADEM.

NASA proposes that the groundwater monitoring conducted to meet the requirements of the FFA is sufficient to satisfy the compliance monitoring program requirements specified by ADEM Administrative Code r. 335-14-5-.06. Because groundwater monitoring and remediation is part of the ongoing CERCLA program and groundwater at the MSFC-004 Deluge Pond is part of OU-3, no additional groundwater monitoring requirements are proposed as part of this Closure Plan.

3.6 Future Use of the Impoundment

Upon completion of the activities discussed in this Closure Plan and obtaining a contained-in determination for soil/sediment in the MSFC-004 Deluge Pond from ADEM, the deluge pond will be placed back into service. The MSFC-004 Deluge Pond will be used to collect nonpotable deluge water used to cool liquid oxygen and hydrogen-fueled rocket engines during testing operations at the West Test Stand, when testing operations recommence in late 2022. The deluge water will discharge through outfall DSN019, as discussed in NPDES Permit No. AL0000221. Groundwater pumped from the West Test Stand will be processed through the groundwater treatment system and discharged through a hard-piped effluent line to the NPDES outfall.

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4. References

National Aeronautics and Space Administration. 2001. *Performance Verification Report Non-Time-Critical Removal Action MSFC-004 Deluge Pond.* Draft.

U.S. Environmental Protection Agency (EPA). 1996. *Requirements for Management of Hazardous Contaminated Media, Proposed Rule. Federal Register*, Vol. 61, No. 83. April. https://www.epa.gov/sites/production/files/2016-04/documents/01_12cntdin_1.pdf.

U.S. Environmental Protection Agency (EPA). 1998a. *Management of Remediation Waste under RCRA*. EPA/530/F-98/026. October. https://www.epa.gov/sites/production/files/2016-04/documents/01_12cntdin_1.pdf.

U.S. Environmental Protection Agency (EPA). 1998b. *Hazardous Remediation Waste Management Requirements (HWIR-Media) Final Rule*. *Federal Register*, Vol. 63, No. 229. November.

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Table

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Table 1. Soil/Sediment Sampling Approach, Rationale, and Sample Analytical Plan

MSFC-004 Deluge Pond Closure Plan

NASA MSFC, Huntsville, Alabama

Sample ID	Sampling Depth Interval (feet bgs)	Sample Type	Analytical Method VOC 8260B	Purpose
2020 Soil Samples				
SD01-098	Surface Sediment	Normal, Grab	X	Conduct ecological and human health risk assessments
SD01-099	Surface Sediment	Normal, Grab	X	
SD01-100	Surface Sediment	Normal, Grab	X	
SD01-101	Surface Sediment	Normal, Grab	X	
SD01-102	Surface Sediment	Normal, Grab	X	
SD01-103	Surface Sediment	Normal, Grab	X	
SD01-104	Surface Sediment	Normal, Grab	X	
SD01-105	Surface Sediment	Normal, Grab	X	
SD01-106	Surface Sediment	Normal, Grab	X	
SD01-107	Surface Sediment	Normal, Grab	X	
SD01-108	Surface Sediment	Normal, Grab	X	
SD01-109	Surface Sediment	Normal, Grab	X	
SD01-110	Surface Sediment	Normal, Grab	X	
SD01-111	Surface Sediment	Normal, Grab	X	
SD01-112	Surface Sediment	Normal, Grab	X	
SD01-113	Surface Sediment	Normal, Grab	X	
SD01-114	Surface Sediment	Normal, Grab	X	
SD01-115	Surface Sediment	Normal, Grab	X	
2022 Soil Samples				
SS01-281	0 - 1	Normal, Grab	X	Conduct ecological and human health risk assessments
	3 - 5	Normal, Grab	X	
SS01-282	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SS01-283	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SS01-284	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SS01-285	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	

Sample ID	Sampling Depth Interval (feet bgs)	Sample Type	Analytical Method VOC 8260B	Purpose
SS01-286	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SB01-756	Surface Sediment	Normal, Grab	X	Conduct ecological and human health risk assessments
	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SB01-757	Surface Sediment	Normal, Grab	X	
	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SB01-758	Surface Sediment	Normal, Grab	X	
	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SB01-759	Surface Sediment	Normal, Grab	X	
	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SB01-760	Surface Sediment	Normal, Grab	X	
	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SB01-761	Surface Sediment	Normal, Grab	X	
	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SB01-762	Surface Sediment	Normal, Grab	X	
	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SB01-763	Surface Sediment	Normal, Grab	X	
	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SB01-764	Surface Sediment	Normal, Grab	X	
	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SB01-765	Surface Sediment	Normal, Grab	X	
	0 - 1	Normal, Grab	X	

Sample ID	Sampling Depth Interval (feet bgs)	Sample Type	Analytical Method VOC 8260B	Purpose
	3 - 5	Normal, Grab	X	
SB01-766	Surface Sediment	Normal, Grab	X	
	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	
SB01-767	Surface Sediment	Normal, Grab	X	Conduct ecological and human health risk assessments
	0 - 1	Normal, Grab	X	
	3 - 5	Normal, Grab	X	

Notes:

Trip blanks will be added to each cooler with samples for VOCs

ID = identification

VOC = volatile organic compound

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Figures

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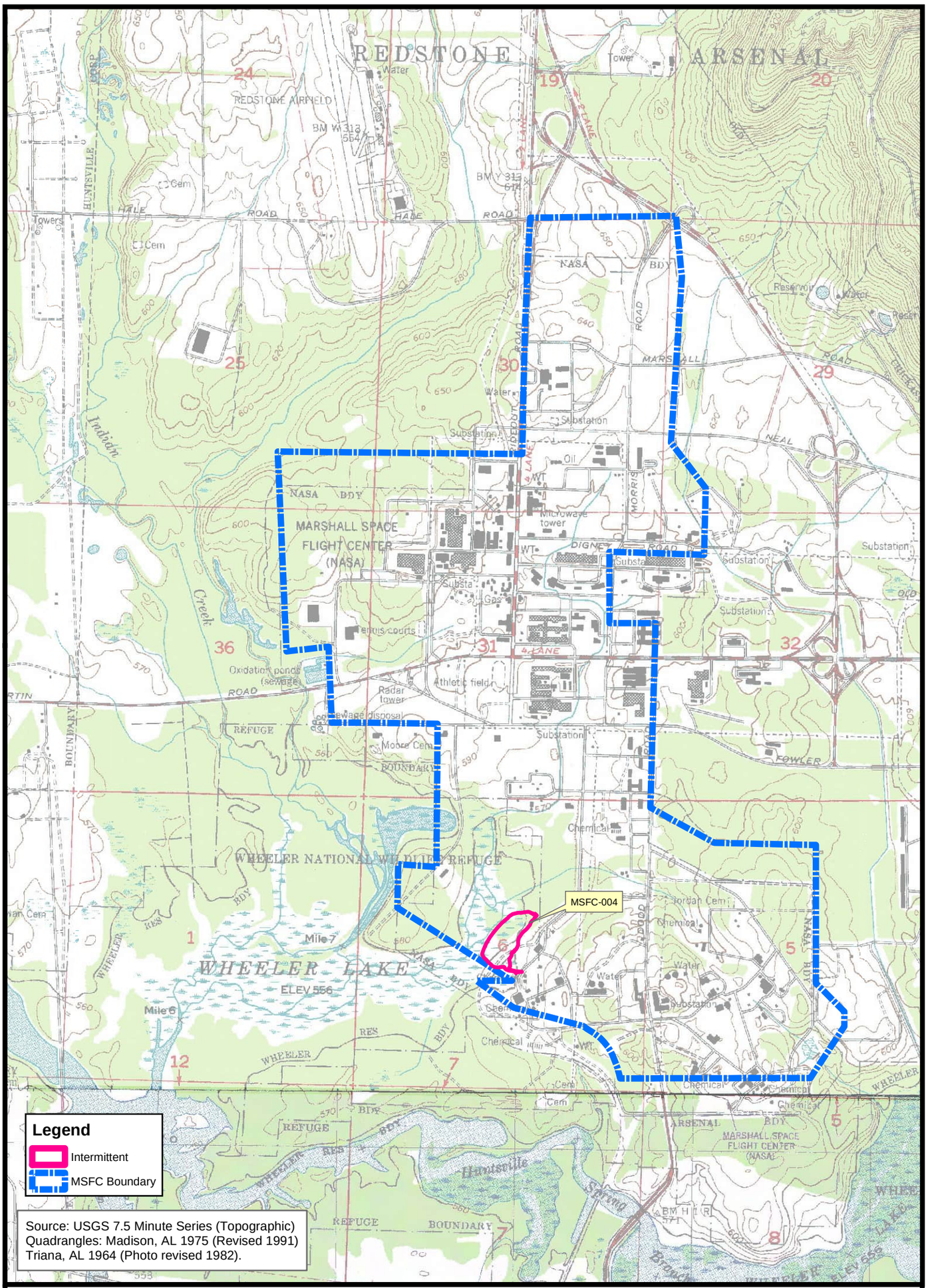

31-May-2022
Drawn By:
Erin Eppling

Figure 1
Topographic Map MFSC-004
NASA MSFC

Map Document: G:\maps\OU1\DelugePond22\MSFC004_QuadsTopo_Sitemap.mxd

402704.284189
403704.284189
1504858.365385
1503858.365385
1502858.365385

Map Extent
MSFC Boundary

Saturn Road
Lem Road
DSN-020
DSN-019
DSN-035
125
126
4
B
4693B
4693
4693A
4651
4688
4688A
4670B
4670
4671B
4671A
4671
4658
4675
4645
4676
4676A
4679
4672
4672
4685
4626
4699A
4697
4699
4630
4630A
4630B
4699B
570
572
574
580
582
584
586
588
590
592
594
566
568
564
560
576

OU-1: Test Areas

MSFC-004 Deluge Pond – West Test Area
MSFC-125 Surface Drainage northwest of Former Building 4696
MSFC-126 Surface Drainages near Building 4670
MSFC-B Containment Area for Old Storable Propellant Building 4688

Legend

- OU1 AREA ACTIVITIES
- MSFC Boundary
- Wheeler Wildlife Refuge
- NPDES permitted outfall
- Major Contour
- Minor Contour (2 ft. interval)
- Drainages
- Sanitary Sewer
- Storm Sewer
- Ponds
- Roads & Sidewalks
- MSFC SUPERFUND (CERCLA) Sites (Areas)
- Buildings
- Wetlands
- Department of Army (DA) Responsible Sites (Areas)

Floodplain

- 100 Year
- 500 Year

HUNTSVILLE INTL AP JONES FIELD (AL) Wind Rose
July 1, 1988 – July 30, 2019
Sub-Interval: Jan. 1 - Dec. 31, 9 – 17

Wind Speed (mph)
1.3 – 4
4 – 8
8 – 13
13 – 19
19 – 25
25 – 32
32 – 39
39 – 47
47 –

Click and drag to zoom

Coordinate System: NAD 1983 StatePlane Alabama East FIPS 0101 Feet
Projection: Transverse Mercator
Datum: North American 1983

0 150 300 600 Feet
0 50 100 200 300 400 Meters

01-Jun-2022
Drawn By:
Erin Eppling

NOTE: The following components are not applicable to this site: injection/withdrawal wells, AOCs, seismic areas, fault zones.

Figure 2
Overview Map
NASA MSFC-004 Area

Map Document: G:\maps\OU1\DelugePond22\MSCC004_Overview.mxd

Index Map

Map Extent

MSFC Boundary

DSN-020

DSN-019

Air Stripper (Building 4651)

Current channelized area

4696-1

4693B

4693

4651

4688

4658

4671A

4671B

4671

4670B

4670

4679

4672

4672

Saturn Road

4685

4626

4699A

4697

4697

4699

Legend

- NPDES permitted outfall
- Historic Air Stripper Discharge Flow
- Sump Overflow
- MSFC-004 Normal Water Level
- Pond Cover

City of Huntsville, Alabama

0 50 100 200 300 Feet

0 25 50 100 Meters

01-Jun-2022
Drawn By:
Erin Eppling

Figure 3
Historical Discharge Locations
NASA MSFC-004 Area

Map Document: G:\maps\OU1\DelugePond22\MSCC004_Historic_Discharge.mxd

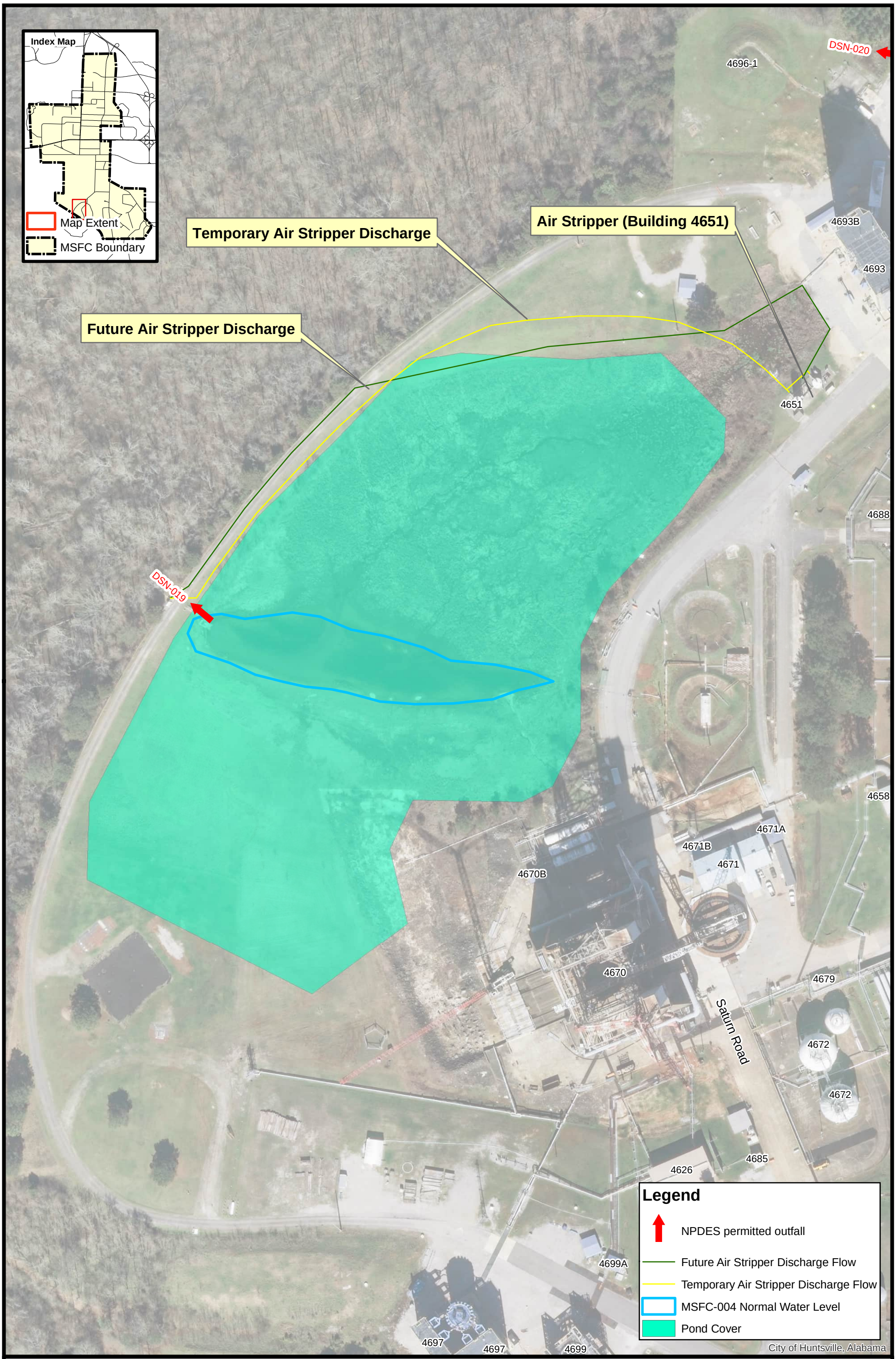

Figure 4
New Discharge Locations
NASA MSFC-004 Area

Map Document: G:\maps\OU1\DelugePond22\MSCC004_New_Discharge.mxd

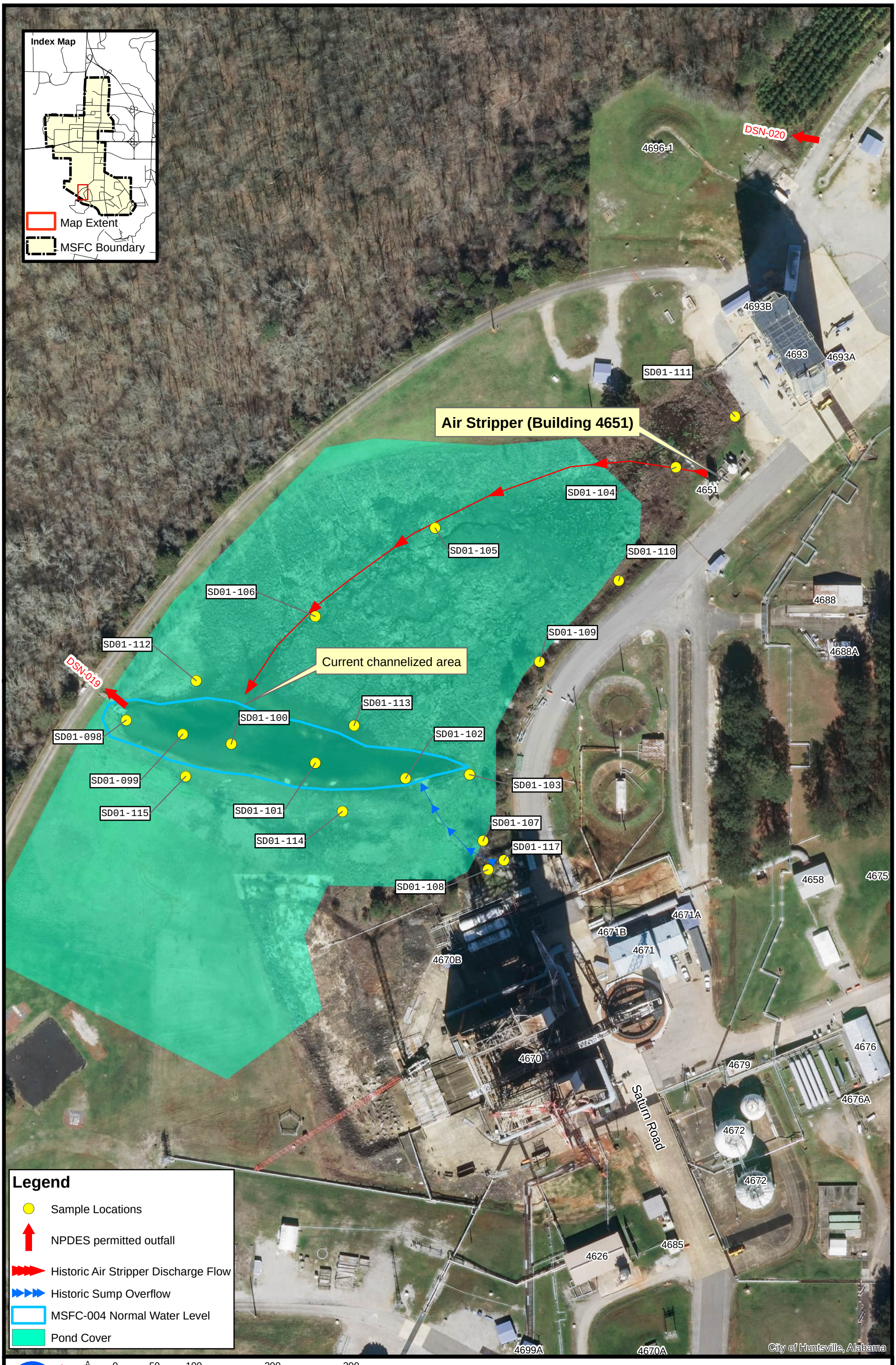

Figure 5
2020 Sample Locations
NASA MSFC-004 Area

Map Document: G:\maps\OU1\DelugePond22\MSCC004_SampLocs22_Fig5.mxd

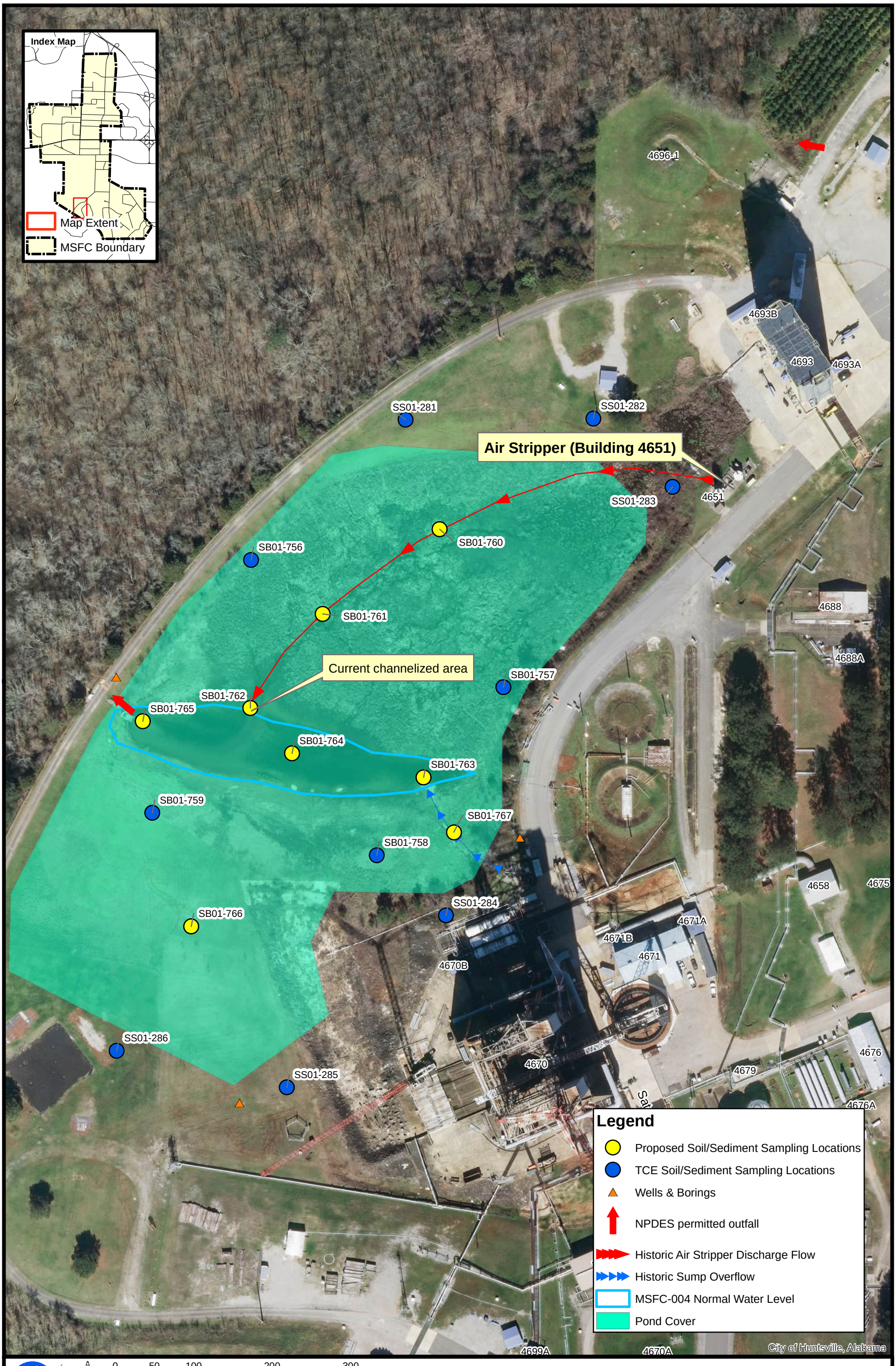

Figure 6
2022 Sampling Locations
NASA MSFC-004 Area

Map Document: G:\maps\OU1\DelugePond22\MSCC004_SampLocs22_Fig6.mxd

Appendix A
Soils Contained-In Determination Sampling Plan for the MSFC-004 Deluge Pond Closure

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Soils Contained-In Determination Sampling Plan for the MSFC-004 Deluge Pond Closure

June 2022

Prepared for

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Contents

Tables

Figures

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Acronyms and Abbreviations

Acronym	Definition
ADEM	Alabama Department of Environmental Management
AEIRG	Alabama Environmental Investigation and Remediation Guidance
AHWMMA	Alabama Hazardous Wastes Management and Minimization Act
ARBCA	Alabama Risk-Based Corrective Action
ASTM	ASTM International
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DU	decision unit
EPA	U.S. Environmental Protection Agency
HDPE	high-density polyethylene
ISM	incremental sampling methodology
mL	milliliter
MS	matrix spike
MSD	matrix spike duplicate
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NPDES	National Pollutant Discharge Elimination System
NTCRA	non-time-critical removal action
OU	Operable Unit
QC	quality control
RCRA	Resource Conservation and Recovery Act
SA	Source Area
TCE	trichloroethene
UCL	upper confidence limit
VOC	volatile organic compound
WTA	West Test Area

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1. Background Information

1.1 Project Background

In February 2016, the National Aeronautics and Space Administration (NASA) received a request from the Alabama Department of Environmental Management (ADEM) to submit a Resource Conservation and Recovery Act/Alabama Hazardous Wastes Management and Minimization Act (RCRA/AHWMMA) Hazardous Waste Permit Application for operation and closure/post-closure of the Marshall Space Flight Center (MSFC) Deluge Pond (MSFC-004) (Figure 1) (ADEM 2016). The basis for ADEM's request was that groundwater pumped from the dewatering sump in the basement of Building 4670 at MSFC contains an RCRA-listed hazardous waste (waste code F001), which is generated when the groundwater is pumped out of the sump. This pumped water was originally discharged to the MSFC-004 Deluge Pond; however, it is currently being pumped to an air stripper system and discharged through an outfall permitted under the National Pollutant Discharge Elimination System (NPDES) program. Instead of applying for a Hazardous Waste Permit, NASA submitted an RCRA closure plan for the MSFC-004 Deluge Pond for ADEM approval in October 2016. ADEM provided comments on the draft closure plan in a September 2020 letter to NASA. NASA responded to ADEM's comments and subsequently submitted a revised draft closure plan in April 2021. ADEM commented on the revised closure plan in a March 2022 letter to NASA and, subsequently, NASA responded to those comments in an April 22,2022 letter to ADEM. NASA is currently in the process of revising the closure plan for the MSFC-004 Deluge Pond based on ADEM's comments and discussions between NASA and ADEM during a series of follow-up meetings.

ADEM informed NASA that, to obtain a clean closure of the MSFC-004 Deluge Pond, a contained-in determination must be conducted on the soils to remove the F001 listing from soil/sediment in the deluge pond. Therefore, NASA developed this Waste Characterization Sampling Plan to evaluate the presence of F001 constituents in the MSFC-004 Deluge Pond and support the contained-in determination.

This Contained-In Soil/Sediment Sampling Plan, which describes the site settings and proposed sampling and analytical approaches, was developed in accordance with the ADEM *Alabama Environmental Investigation and Remediation Guidance* (AEIRG) (ADEM 2017 and subsequent updates) and the methodology required by the ASTM International (ASTM) *Standard E1903-11, Practice for Environmental Site Assessments: Waste Profile Sampling Plan Process* (ASTM 2011).

1.2 Project Objectives and Scope

The objective of this Contained-In Soil/Sediment Sampling Plan is to investigate potential contaminants in soil/sediment in the MSFC-004 Deluge Pond and support a contained-in determination for potential soil/sediment in the deluge pond. The plan outlines the rationales and methods that will be followed to conduct sampling and analysis of approximately 1 foot of soil/sediment above the high-density polyethylene (HDPE) cover of the MSFC-004 Deluge Pond.

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2. Site Description and Physical Settings

2.1 General Site Description and Site History

The MSFC-004 Deluge Pond is part of the West Test Area (WTA) in the southwestern portion of MSFC. In addition to the MSFC-004 Deluge Pond, the WTA consists of the Saturn Test Stand (Building 4670), the former F-1 Test Stand (Building 4696), and other adjacent and ancillary buildings. NASA has constructed a new test stand (Building 4693) at the location of the former F-1 Test Stand.

Continuous dewatering operations are required to keep the Building 4670 test stand foundation dry and operable. Groundwater from dewatering operations in the basement of Building 4670 is extracted at a rate of approximately 1.5 million gallons per day. Historically, groundwater also was pumped out of the basement sump in Building 4696, the former F-1 Test Stand, until its demolition in 2013. Approximately 500,000 gallons per day of groundwater was extracted from the basement of Building 4696. Because the extracted groundwater is known to contain elevated concentrations of chlorinated volatile organic compounds (VOCs), including trichloroethene (TCE), pumped groundwater is routed from the WTA sumps to a packed-tower aeration stripping tower process unit for treatment. The treatment system has been operated since 1998 but was shut down between 2003 and 2013 in accordance with a CERCLA directive on the basis that the groundwater did not pose significant risk to human health and the environment. Historically, treated groundwater flowed from the treatment system through a more channelized area of the MSFC-004 surface impoundment that normally holds water before final discharge via outfall DSN019. The discharge of extracted groundwater into the MSFC-004 Deluge Pond was discontinued in May 2022.

After significant rainfall events, groundwater flow into the basement of Building 4670 can increase to the point that the continuous pumping system cannot handle the flow. Historically, the excess groundwater that could not be pumped to the stripping tower based on capacity restraints has been discharged directly to the deluge pond; the excess extracted groundwater traverses the deluge pond to outfall DSN019. Extracted groundwater also was discharged directly in the MSFC-004 Deluge Pond during the period from 2003 to 2013 when the treatment system was shut down.

The MSFC-004 Deluge Pond generally covers approximately 12 acres, with the main channel that normally contains water covering approximately 1 acre at an average depth of approximately 3 feet. The MSFC-004 surface impoundment manages deluge and cooling water used to quench exhaust gases during engine tests. Discharge from the surface impoundment is to an unnamed tributary to Indian Creek via outfall DSN019 as authorized by NPDES Permit No. AL0000221.

As part of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program, NASA conducted a Non-Time-Critical Removal Action (NTCRA) on the sediments in the MSFC-004 surface impoundment from May through October 1997 (NASA 2001). The impoundment sediments were stabilized with lime and a 60-mil HDPE geomembrane cover was installed over the stabilized sediments to minimize (1) the effects of the detected metals on a sensitive ecosystem (such as downgradient wetlands), and (2) the migration of contaminated sediments to the receiving stream. Following placement of the liner, the area was filled with 10 inches of compacted soil and 2 inches of topsoil. The area of sediment stabilization and cover installation is shown on Figure 1.

2.2 Future Site Use

Upon clean closure of the MSFC-004 Deluge Pond, it will be placed back into service. New operations at the Building 4670 test stand will require deluge water to cool rocket engines being tested. This non-

potable water will come from the Tennessee River and will discharge through outfall DSN019 in NPDES Permit No. AL0000221.

Pumped groundwater from the dewatering sump in the basement of Building 4670 will continue to be directed through the air stripper system and then through an NPDES-permitted outfall; an additional air stripper will be installed to provide redundancy so that no F001-contaminated groundwater will discharge to the pond.

3. Source and Extent of Contamination

Because the extracted groundwater historically discharged to the MSFC-004 Deluge Pond contained an F001 listed waste (TCE) and based on historic fluctuations in the deluge pond water level, there is the potential for elevated concentrations of TCE to exist in shallow soil/sediment (0-1 foot below ground surface (bgs)) across the 12-acre footprint of the MSFC-004 Deluge Pond. Deeper soil/sediment, particularly soil/sediment below the HDPE cover in the MSFC-004 Deluge Pond, is exposed to contaminated groundwater in SA-6 and is part of CERCLA OU-3.

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4. Sampling Approach and Methods

4.1 Soil/Sediment Sampling

In accordance with Appendix C.2.1(c) of the AEIRG (ADEM 2017 and subsequent updates), an incremental sampling methodology (ISM) will be used to collect soil/sediment samples from the MSFC-004 Deluge Pond. To accomplish this, the MSFC-004 Deluge Pond was divided into 18 decision units (DUs), as shown on Figure 1. The DUs were established by first identifying the three areas suspected of exhibiting the highest potential contaminant concentrations and designating those as individual DUs. These three areas included the main channel of the MSFC-004 Deluge Pond (DU #3), the flow channel from the intermediate pump station overflow to the main pond channel (DU #6), and the flow channel from the air stripper discharge to the main pond channel (DU #18). After establishing these DUs, the remainder of the MSFC-004 Deluge Pond area was divided into DUs ranging in size from 0.30 acre to 1.00 acre. In accordance with Appendix B.2.2 of the Alabama Risk-Based Corrective Action (ARBCA) guidance, "Considerations When Establishing EDs/DUs," the DUs were established to be similar in size to a residential size lot, approximately 1/3 acre to 1 acre.

Constituents selected for analysis were based on the land disposal restrictions for waste codes F001 and F002. Historically, the only F-listed solvent discharged in this vicinity would have been TCE, which is present in both F001 and F002 listed wastes. Because of this historical contamination, contaminated groundwater carries the F001 listing when it is pumped out of the ground (generated). These constituents are VOCs.

ADEM guidance *RCRA Closure Handbook* (ADEM 2004) also discusses the need for contaminants remaining in place to be below a residential risk scenario if the site is to be clean closed. Therefore, method detection limits are being requested from the laboratory to meet residential action levels—specifically, U.S. Environmental Protection Agency (EPA) Residential Screening Levels.

A representative sample will be collected from each of the 18 DUs following a systematic random approach. A random starting point will be selected within each DU from which 30 increment (sampling) locations per DU will be selected following a systematic, uniform spacing throughout the DU. A Gator Step Sampler and Terra Core plunger will be used to collect 5-gram soil/sediment samples at each of the 30 increment locations, for a total representative sample of 150 grams per DU. The laboratory will provide six 4-ounce jars and six vials with 25 mL of methanol for each DU. Five 5-gram aliquots will be placed into each 4-ounce jar, then 25 mL of methanol will be added to each jar preserving the sample with a 1:1 ratio of soil/sediment to methanol. The lab will take an equal aliquot of methanol from each of the six 4-ounce jars for each DU, combine analyze for VOCs in accordance with SW-846 Method 8260B. Tables 1 and 2 present the Soil/Sediment Sampling Approach and Rationale and Sample Analytical Plan, respectively.

Quality control (QC) samples also will be collected during sampling. These will include replicate sample sets at a minimum 10% frequency and matrix spike/matrix spike duplicate (MS/MSD) sets at a 5% frequency. Trip blank samples also will be analyzed for each cooler containing samples at a rate of one trip blank per cooler. QC samples will be analyzed for the same constituents as the associated normal samples. Replicate sample sets will be collected along the same DUs as parent samples. Dedicated sampling equipment (such as core plungers) will be used when collecting replicate ISM samples.

The analytical results for the 18 samples from the DUs and the replicate samples will be used to calculate a 95% Upper Confidence Limit (UCL) concentration. The 95% UCL concentration and analytical results for individual samples will be compared to the corresponding Residential Screening Levels for VOCs. The

results of the comparison will be used to support a contained-in determination for the soil/sediment in the pond potentially contacted by the F001-containing groundwater that was pumped out of the ground and discharged to the pond.

In addition to the soil/sediment samples, representative samples of the HDPE liner below the base of the MSFC-004 Deluge Pond also will be collected. So as to not compromise the integrity of the liner and facilitate repair of the sample locations, sampling of the liner will be limited to the eight approximate locations indicated in Figure 2. Each HDPE liner sample will be cut into small pieces and approximately 5 grams will be placed in a 4-ounce glass jar. The exact sample weight for each liner sample will be noted on the COC. Upon receipt, the laboratory will extract the liner sample with methanol and analyze for VOCs in accordance with SW-846 Method 8260B. The sample analytical plan for the HDPE liner samples is shown in Table 2.

Samples will be maintained under chain-of-custody procedures and shipped in a cooler with wet ice via overnight delivery to the laboratory for extraction, processing, and analysis.

4.2 Decontamination Procedures

Decontamination of field sampling equipment will be performed in accordance with the AEIRG Appendix E (ADEM 2017 and subsequent updates). If nondisposable, nondedicated soil sampling equipment is used during sampling, equipment will be decontaminated before initial use and between collection of each sample to minimize cross contamination of samples and potential impacts to sample integrity.

Dedicated sampling equipment (such as Terra Core plungers) will be used for soil/sediment sampling. Wherever practical, soil cores will be collected with Gator Step Samplers. A dedicated Terra Core plunger then will be used to collect 5-gram aliquots from the cores within each DU. Dedicated sampling equipment also will be used to collect each replicate sample. No sampling equipment decontamination will be necessary between subsequent soil increment locations within the DU during soil ISM. Decontamination of the step samplers will be conducted only between sampling points and whenever grossly contaminated soil is found.

For the nondedicated, reusable Gator Step Samplers, decontamination will be conducted as follows:

- Scraping off gross contamination of equipment at the sampling site
- Washing with potable water and nonphosphate, laboratory-grade detergent (e.g., Liquinox) mix, using a bristle brush or similar utensil
- Rinsing equipment thoroughly with ASTM Type II deionized water

Different spray bottles containing potable water, water-detergent mix, and ASTM Type II deionized water will be used during the different steps of decontamination. Equipment will be decontaminated at the sample collection site and the decontamination fluid will be containerized and properly disposed offsite.

To confirm that decontamination procedures are properly conducted with no carry-over of potential contamination between sampling points, equipment blank samples will be collected at a rate of one sample per sampling event. One equipment rinsate blank sample will be collected by pouring ASTM Type II water on the core sampler. Rinsate water will be containerized for analysis of the same parameters analyzed during soil sampling.

5. Analytical Plan

The analytical plan will be implemented as follows:

Soil – Soil samples will be collected using pre-weighed TerraCore sample kits provided by the laboratory and analyzed for VOCs in accordance with SW-846 Method 8260B. Analyses will be performed with an expedited turnaround time for results.

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6. References

Alabama Department of Environmental Management (ADEM). 2016. Request for AHWMMA Permit Application. February.

Alabama Department of Environmental Management (ADEM). 2017. *Alabama Risk-Based Corrective Action Guidance Manual. Alabama Department of Environmental Quality.* Revision 3. February.

National Aeronautics and Space Administration (NASA). 2001. *Performance Verification Report Non-Time-Critical Removal Action MSFC-004 Deluge Pond*. Draft.

Tables

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Table 1. Soil/Sediment Sampling Approach and Rationale

Contained-In Soil/Sediment Sampling Plant Work Plan

NASA MSFC-004 Deluge Pond, Huntsville, Alabama

DU	Approximate DU Area		Vertical DU Layer	Depth Interval (feet bgs)	DU Layer Thickness (feet)	Soil Sample Type	# of Increments	Purpose
	square feet	square acres						
1	13,265	0.30	A	0 - 1	1	Multi-Increment	30	Evaluate presence/absence of VOCs for waste characterization
2	19,162	0.44	A	0 - 1	1	Multi-Increment	30	
3	36,187	0.83	A	0 - 1	1	Multi-Increment	30	
4	39,605	0.91	A	0 - 1	1	Multi-Increment	30	
5	40,486	0.93	A	0 - 1	1	Multi-Increment	30	
6	1,831	0.04	A	0 - 1	1	Multi-Increment	30	
7	33,510	0.77	A	0 - 1	1	Multi-Increment	30	
8	34,516	0.79	A	0 - 1	1	Multi-Increment	30	
9	39,635	0.91	A	0 - 1	1	Multi-Increment	30	
10	27,717	0.64	A	0 - 1	1	Multi-Increment	30	
11	29,191	0.67	A	0 - 1	1	Multi-Increment	30	
12	34,882	0.80	A	0 - 1	1	Multi-Increment	30	
13	43,601	1.00	A	0 - 1	1	Multi-Increment	30	
14	29,650	0.68	A	0 - 1	1	Multi-Increment	30	
15	35,497	0.81	A	0 - 1	1	Multi-Increment	30	
16	36,324	0.83	A	0 - 1	1	Multi-Increment	30	
17	36,691	0.84	A	0 - 1	1	Multi-Increment	30	
18	8,535	0.19	A	0 - 1	1	Multi-Increment	30	

Notes:

bgs = below ground surface

DU = decision unit

Soil/sediment samples for waste characterization will be collected from the approximately one-foot of compacted soil and top soil placed on top of the HDPE liner during the NTCRA.

Multi-increment samples for waste characterization will be collected following a systematic random approach.

The actual number and spatial distribution of increment locations may need to be adjusted in the field based on access (e.g., access and/or logistical constraints) and core refusal due to consolidated or hard subsurface conditions.

Table 2. Sample Analytical Plan

Contained-In Soil/Sediment Sampling Plant Work Plan

NASA MSFC-004 Deluge Pond, Huntsville, Alabama

Decision Unit	Sample ID	Sampling Depth Interval (feet bgs)	Sample Type	Analytical Method VOC 8260B
Incremental Soil/Sediment Sampling in MSFC-004 Deluge Pond				
1	K22C001	0 - 1	Normal	X
2	K22C002	0 - 1	Normal	X
3	K22C003	0 - 1	Normal	X
3	K22C004FD, K22C005FD	0 - 1	Triplicate	X
4	K22C006	0 - 1	Normal	X
5	K22C007	0 - 1	Normal	X
6	K22C008	0 - 1	Normal	X
6	K22C009FD, K22C010FD	0 - 1	Triplicate	X
7	K22C011	0 - 1	Normal	X
8	K22C012	0 - 1	Normal	X
9	K22C013	0 - 1	Normal	X
10	K22C014	0 - 1	Normal	X
11	K22C015	0 - 1	Normal	X
12	K22C016	0 - 1	Normal	X
13	K22C017	0 - 1	Normal	X
14	K22C018	0 - 1	Normal	X
15	K22C019	0 - 1	Normal	X
16	K22C020	0 - 1	Normal	X
17	K22C021	0 - 1	Normal	X
18	K22C022	0 - 1	Normal	X
18	K22C023FD, K22C024FD	0 - 1	Triplicate	X

Notes:
Trip blanks will be added to each cooler with samples for VOCs
ID = identification
RCRA = Resource Conservation and Recovery Act
VOC = volatile organic compound

Table 2. Sample Analytical Plan (Continued)

Contained-In Soil/Sediment Sampling Plant Work Plan

NASA MSFC-004 Deluge Pond, Huntsville, Alabama

Decision Unit	Sample ID	Sampling Depth Interval (feet bgs)	Sample Type	Analytical Method VOC 8260B
HDPE Liner Samples				
1	K22B061	N/A	Normal	X
2	K22B062	N/A	Normal	X
3	K22B063	N/A	Normal	X
4	K22B064	N/A	Normal	X
5	K22B065	N/A	Normal	X
6	K22B066	N/A	Normal	X
7	K22B067	N/A	Normal	X
8	K22B068, K22B069FD	N/A	Normal	X

Notes:
Trip blanks will be added to each cooler with samples for VOCs
ID = identification
RCRA = Resource Conservation and Recovery Act
VOC = volatile organic compound

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Figures

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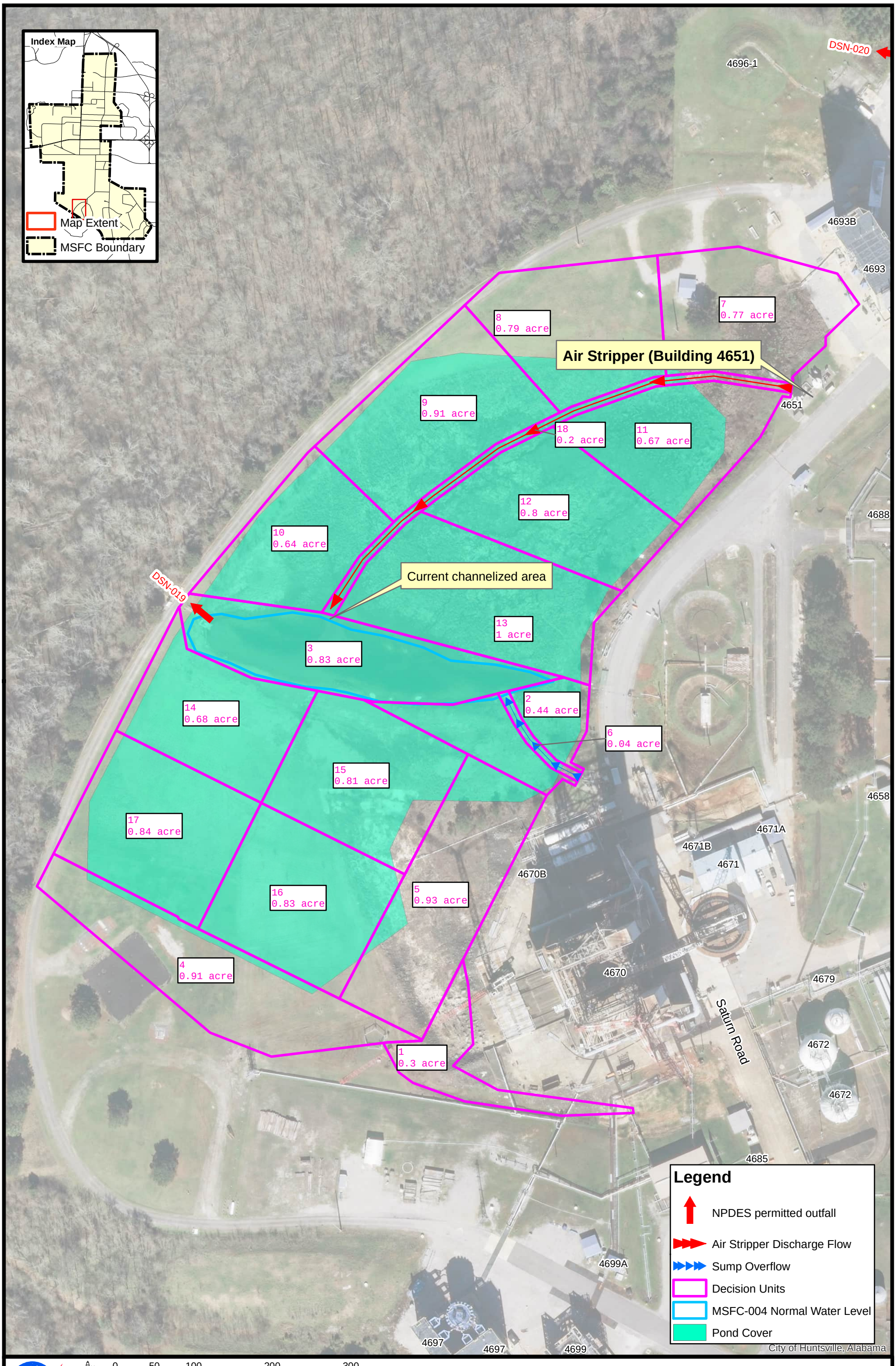

26-May-2022
Drawn By:
Erin Eppling

Figure 1
Contained-In Determination Decision Units
NASA MSFC-004 Area

Map Document: G:\maps\OU1\DelugePond22\Deluge_WasteProf22.mxd

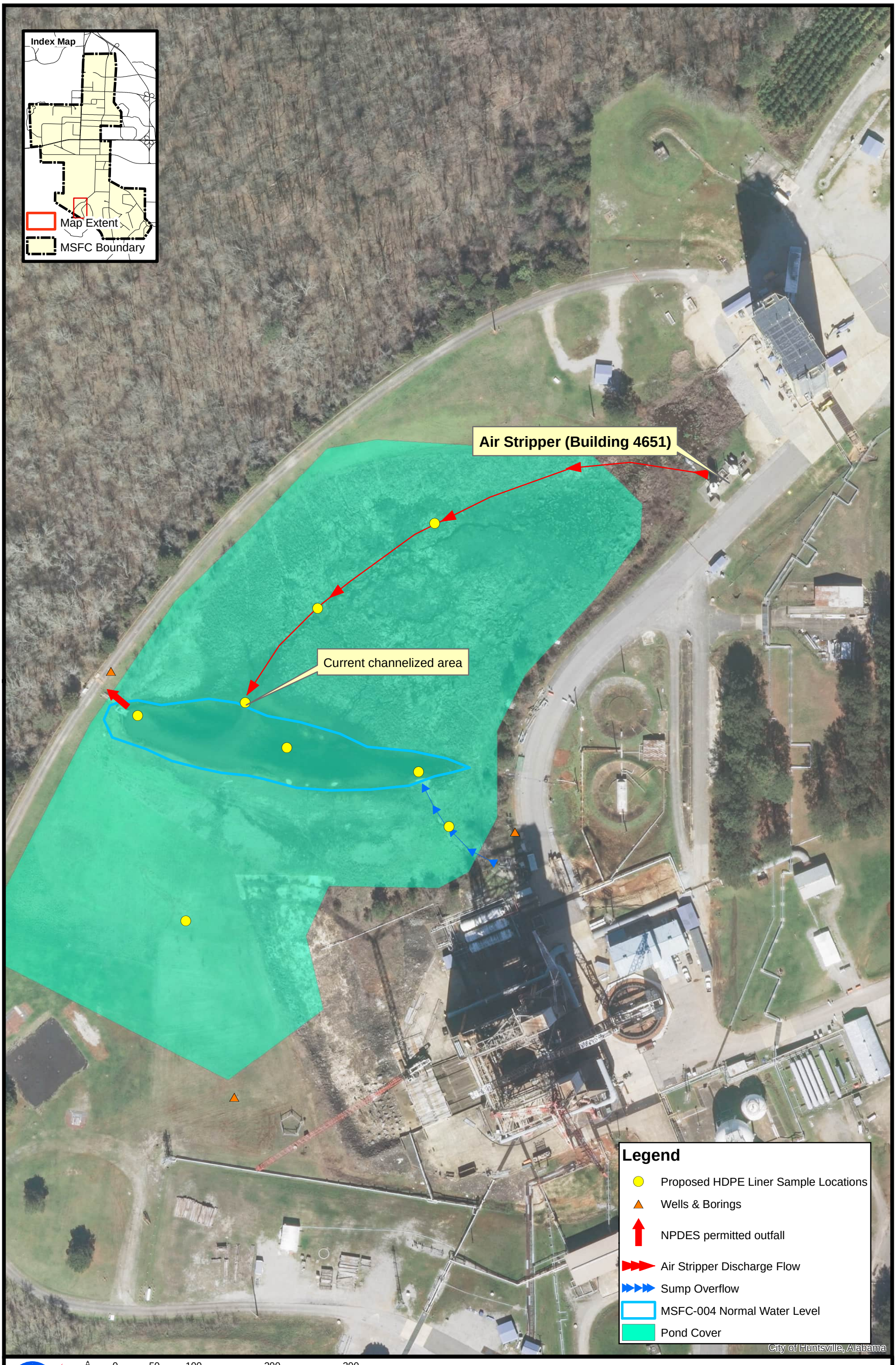

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Figure 2
Proposed HDPE Liner Samples
NASA MSFC-004 Area

Map Document: G:\maps\OU1\DelugePond22\Deluge_WasteProf22_Liner_Samp.mxd