YANKEE NUCLEAR POWER STATION
FINAL STATUS SURVEY REPORT

REPORT NO.: YNPS-FSS-NOL-06-00

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List of Abbreviations and Acronyms

AL	Action Level
ALARA	As Low As Reasonably Achievable
c/d	Counts per Disintegration
DCGL	Derived Concentration Guideline Level
$DCGL_{EMC}$	DCGL for small areas of elevated activity
$DCGL_W$	DCGL for average concentration over a wide area, used with statistical tests
DQO	Data Quality Objectives
EMC	Elevated Measurement Comparison
ETD	Easy-to-Detect
FSS	Final Status Survey
FSSP	Final Status Survey Plan
GPS	Global Positioning System
H_o	Null Hypothesis
HSA	Historical Site Assessment
HTD	Hard-to-Detect
ISOCS	*In-situ* Object Counting System®
LBGR	Lower Bound of the Grey Region
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
PAB	Primary Auxiliary Building
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCA	Radiological Controlled Area
RP	Radiation Protection
RSS	Reactor Support Structure
SFP	Spent Fuel Pool
VC	Vapor Container
VCC	Vertical Concrete Cask
VSP	Visual Sample Plan
YNPS	Yankee Nuclear Power Station

1.0 EXECUTIVE SUMMARY

A Final Status Survey (FSS) was performed of Survey Area NOL-06 in accordance with Yankee Nuclear Power Station's (YNPS) License Termination Plan (LTP). This FSS was conducted as an open land area FSS with soil DCGLs.

1.1 Identification of Survey Area and Units

NOL-06 Survey Area is comprised of 3 Survey Units. Survey unit NOL-06-01 is bounded by OOL-02-01 on the north, NOL-06-02 on the south, NOL-01-01 on the east, and NOL-06-02 to the west. Portions of the RSS ring and mat foundations were present in, but were not part of, Survey Unit NOL06-01. NOL-06-01 was a part of the RCA, and is classified as a MARSSIM Class 1 area. NOL-06-01 is open land area consisting of a surface area of approximately 397 m2.

Survey Unit NOL-06-02 is located within the RCA, as delineated in years 2004-2005, and is bounded by OOL-10-03 on the north, OOL-10-01 on the west, NOL-05-01 on the south and NOL-06-01 on the east. Survey Area NOL-06-02 is located west of the former Reactor Support Structure and had been subjected to extensive remediation. A steel reinforced concrete duct bank had fallen within the footprint of NOL-06-02 however; management decision called for the complete removal of this structure, which was completed. The majority of NOL-06-02 was within the RCA during plant operations and is classified as a MARSSIM Class 1 area. NOL-06-02 is open land area consisting of a surface area of approximately 1,024 m2.

Survey Unit NOL06-03 consists of a small soil area that surrounds the concrete base for TK-1, located in the northeast section of the RSS footprint. The area was initially part of survey unit NOL06-01, but was delineated as a separate survey unit to serve as a buffer zone between Survey Unit NOL06-01 and the decommissioning work in NSY-01 (the north and south decon pads which have been removed). Survey Unit NOL06-01 forms the west boundary, the turbine building foundation forms the north boundary, and survey unit NOL01-04 forms the east and south boundaries. NOL-06-03 was part of the RCA and is classified as a MARSSIM Class 1 area. NOL-06-03 is open land area consisting of a surface area of approximately 45 m2. A map of the Survey Area and Survey Units in relation to the site is found in Attachment A.

1.2 Dates of Surveys

Table 1 Date of Surveys and DQOs

Survey Unit	Survey Start Date	Survey End Date	DQA Date
NOL-06-01	8/27/2005	9/12/2005	10/11/2006
NOL-06-02	6/21/2006	6/23/2006	8/17/2006
NOL-06-03	11/28/2005	11/29/2005	10/12/2006

1.3 Number and Types of Measurements Collected

Final Status Survey Plans were developed for these Survey Units in accordance with YNPS LTP and FSS procedures using the MARSSIM protocol. The planning and design of the survey plan employed the Data Quality Objective (DQO) process, ensuring that the type, quantity and quality of data gathered was appropriate for the decision making process and that the resultant decisions were technically sound and defensible. A total of 52 statistical soil samples were taken in the Survey Area, providing data for the non-parametric testing of the Survey Area. In addition to the soil samples, 100% of the area was scanned.

1.4 Summary of Survey Results

Following the survey, the data were reviewed against the survey design to confirm completeness and consistency, to verify that the results were valid, to ensure that the survey plan objectives were met and to verify Survey Unit classification. Soil sample surveys indicated that two of the systematic measurement Sum of Fractions exceeded the $DCGL_W$, but not the DCGLemc. The sign test was performed, and the areas passed. The DQA charts are depicted in Attachment B. Retrospective power curves were generated and demonstrated that an adequate number of samples were collected to support the Data Quality Objectives. Therefore, the null hypothesis (H_o) (that the Survey Unit exceeds the release criteria) is rejected.

1.5 Conclusions

Based upon the evaluation of the data acquired for the FSS, NOL-06 meets the release requirements set forth in the YNPS LTP. The Total Effective Dose Equivalent (TEDE) to the average member of the critical group does not exceed 25 mRem per year, including that from groundwater. 10CFR20 Subpart E ALARA requirements have been met as well as the site release criteria for the administrative level DCGLs that ensure that the Massachusetts Department of Public Health's 10 mRem per year limit will also be met.

2.0 FSS PROGRAM OVERVIEW

2.1 Survey Planning

The YNPS FSS Program employs a strategic planning approach for conducting final status surveys with the ultimate objective to demonstrate compliance with the DCGLs, in accordance with the YNPS LTP. The DQO process is used as a planning technique to ensure that the type, quantity, and quality of data gathered is appropriate for the decision-making process and that the resultant decisions are technically sound and defensible. Other key planning measures are the review of historical data for the Survey Area and the use of peer review for plan development.

2.2 Survey Design

In designing the FSS, the questions to be answered are: "Does the residual radioactivity, if present in the Survey Area, exceed the LTP release criteria?" and "Is the potential dose from this radioactivity ALARA?" In order to answer these questions, the radionuclides present in the Survey Area must be identified, and the Survey Units classified. Survey Units are classified with respect to the potential for contamination: the greater the potential for contamination, the more stringent the classification and the more rigorous the survey.

The survey design additionally includes the number, type and locations of soil samples (as well as any judgmental assessments required), scanning requirements, and instrumentation selection with the required sensitivities or detection levels. DCGLs are developed relative to the surface/material of the Survey Unit and are used to determine the minimum sensitivity required for the survey. Determining the acceptable decision error rates, the lower bound of the gray region (LBGR), statistical test selection and the calculation of the standard deviation and relative shift allows for the development of a prospective power curve plotting the probability of the Survey Unit passing FSS.

2.3 Survey Implementation

Once the planning and development has been completed, the implementation phase of the FSS program begins. Upon completion of remediation and final characterization activities, a final walk down of the Survey Unit is performed. If the unit is determined to be acceptable (i.e. physical condition of the unit is suitable for FSS), it is turned over to the FSS team, and FSS isolation and control measures are established. After the Survey Unit isolation and controls are in place, grid points are identified for the soil samples, using Global Positioning System (GPS) coordinates whenever possible, consistent with the Massachusetts State Plane System, and the area scan grid is identified. Data is collected and any required investigations are performed.

2.4 Survey Data Assessment

The final stage of the FSS program involves assessment of the data collected to ensure the validity of the results, to demonstrate achievement of the survey plan objectives, and to validate Survey Unit classification. During this phase, the DQOs and survey design are reviewed for consistency between DQO output, sampling design and other data collection documents. A preliminary data review is conducted to include: checking for problems or anomalies, calculation of statistical quantities and preparation of graphical representations for data comparison. Statistical tests are performed, if required, and the assumptions for the tests are verified. Conclusions are then drawn from the data, and any deficiencies or recommendations for improvement are documented.

2.5 Quality Assurance and Quality Control Measures

YNPS FSS activities are implemented and performed under approved procedures, and the YNPS Quality Assurance Project Plan (QAPP) assures plans, procedures and instructions have been followed during the course of FSS, as well as providing guidance for implementing quality control measures specified in the YNPS LTP.

3.0 SURVEY AREA INFORMATION

3.1 Survey Area Description

NOL-06 Survey Area is comprised of 3 Survey Units. A map of the Survey Area and Unit divisions are found in Attachment A.

3.1.1 NOL-06-01 Description

NOL-06 Survey Area is comprised of 3 Survey Units. Survey unit NOL-06-01 is bounded by OOL-02-01 on the north, NOL-06-02 on the south, NOL-01-01 on the east, and NOL-06-02 to the west. Portions of the RSS ring and mat foundations were present in, but were not part of, Survey Unit NOL06-01. NOL-06-01 was a part of the RCA and is classified as a MARSSIM Class 1 area. NOL-06-01 is open land area consisting of a surface area of approximately 397 m2.

3.1.2 NOL-06-02 Description

Survey Unit NOL-06-02 is located within the RCA, as delineated in years 2004-2005, and is bounded by OOL-10-03 on the north, OOL-10-01 on the west, NOL-05-01 on the south and NOL-06-01 on the east. Survey Area NOL-06-02 is located west of the former Reactor Support Structure and had been subjected to extensive remediation. A steel reinforced concrete duct bank had fallen within the footprint of NOL-06-02 however; management decision called for the complete removal of this structure, which was completed. The majority of NOL-06-02 was within the RCA during plant operations and is classified as a MARSSIM Class 1 area. NOL-06-02 is open land area consisting of a surface area of approximately 1,024 m2.

3.1.3 NOL-06-03 Description

Survey Unit NOL06-03 consists of a small soil area that surrounds the concrete base for TK-1, located in the northeast section of the RSS

footprint. The area was initially part of survey unit NOL06-01, but was delineated as a separate survey unit to serve as a buffer zone between Survey Unit NOL06-01 and the decommissioning work in NSY-01 (the north and south decon pads which have been removed). Survey Unit NOL06-01 forms the west boundary, the turbine building foundation forms the north boundary, and survey unit NOL01-04 forms the east and south boundaries. NOL-06-03 was part of the RCA and is classified as a MARSSIM Class 1 area. NOL-06-03 is open land area consisting of a surface area of approximately 45 m2.

3.2 History of Survey Area

From the beginning of plant operations, Survey Area NOL-06 was posted and controlled as an RCA. The bounds of NOL-06 were established based on a history of travel of personnel and material within the lower (elevation 1022') west end of the RCA. The RCA was expanded, over time, to accommodate the need for additional space and, when appropriate, to include identified contamination. NOL-06 was adjacent to the PAB, safety injection and diesel building furthermore it was the travel path for access to the upper RCA. The area was potentially impacted by migration of contamination due to personnel and material travel into and out of the west end of the RCA. Additionally, personnel who, unknowingly became contaminated while working in the RCA may have traveled across NOL-06 to get to the control point, where contamination would have been identified.

Operational events and activities that are relevant to the contamination of Survey Area NOL-06 include:

- PIR 75-07, Yard Area Contamination
- PIR 81-09, Contamination of Yard during Reactor Head Removal

3.3 Division of Survey Area into Survey Units

The NOL-06 Survey Area is divided into 3 Class 1 Survey Units. A map of the Survey Area and Unit divisions are found in Attachment A.

4.0 SURVEY UNIT INFORMATION

4.1 Summary of Radiological Data Since Historical Site Assessment (HSA)

4.1.1 Chronology and Description of Surveys Since HSA

The Table below provides a summary of surveys performed during the Final Status Survey of NOL-06.

Table 2 Dates of Surveys since HSA

Survey Unit	Survey Start Date	Survey End Date	Description
NOL-06-01	8/27/2005	9/12/2005	FSS Survey
NOL-06-02	6/21/2006	6/23/2006	FSS Survey
NOL-06-03	11/28/2005	11/29/2005	FSS Survey

4.1.2 Radionuclide Selection and Basis

4.1.2.1 NOL-06-01 Radionuclides of Concern

Characterization data (post-remediation soil samples) from areas NOL-01 and NOL-06 were used in the FSS planning for unit NOL06-01. Cesium-137 and Co-60 were the only easy-to-detect plant-related radionuclides identified in the characterization (post-remediation) surface soil samples. The average Cs-137 concentration was 0.17 pCi/g and the average Co-60 concentration was 0.064 pCi/g, both average values were below the respective 10-mrem/y DCGLs. The average Cs-137 concentration represented 73% of the identified plant-related activity and the average Co-60 concentration represented 27%.

4.1.2.2 NOL-06-02 Radionuclides of Concern

Radionuclides-of-Concern, Co-60 and Cs-137, were determined from the sample results for the FSS of NOL-01-04 (The survey unit across from NOL-06-02 and considered to be the most representative of NOL-06-02). The average Cs-137 concentration was 0.041 pCi/g and the average Co-60 concentration was 0.106 pCi/g, both average values were below the respective 10-mrem/y DCGLs.

4.1.2.3 NOL-06-03 Radionuclides of Concern

Nine characterization samples were collected from the NOL-06-03 area. Co-60 and Cs-137 were the only plant-related gamma-emitting radionuclides identified in the samples, although not consistently at concentrations that were greater than the MDCs for the analyses. The average soil concentrations of Co-60 and Cs-137 were 0.096 pCi/g and 0.13 pCi/g respectively. The Co-60 and Cs-137 concentrations were all well below the respective 10-mrem/y DCGLs.

4.1.3 Scoping & Characterization

Characterization surveys were performed in NOL-06 from 5/17/93 to 11/12/99 in which a total of 40 soil samples were analyzed. Since 11/99 however, extensive remediation occurred in the Survey Area thus rendering the characterization data inappropriate for use in the development of the DQOs for the FSS plans. Post-remediation sample results within the area (a total of 11 samples) and FSS results of adjacent units were deemed more appropriate for the generation of the FSSPs.

4.2 Basis for Classification

Based upon the radiological condition of this Survey Area identified in the operating history and as a result of the decommissioning activities performed to date, Survey Unit NOL-06-01, NOL-06-02, and NOL-06-03 were identified as Class 1 areas.

4.3 Remedial Actions and Further Investigations

4.3.1 NOL-06-01 Remedial Actions and Further Investigations

67 elevated areas were investigated via SPA-3. Two of the 67 elevated areas required remediation. No elevated areas remained in NOL-06-01 in excess of DCGLemc.

4.3.2 NOL-06-02 Remedial Actions and Further Investigations

There were no elevated areas to investigate or remediate in NOL-06-02.

4.3.3 NOL-06-03 Remedial Actions and Further Investigations

13 elevated areas were investigated via SPA-3. None of the 13 elevated areas required remediation. No elevated areas remained in NOL-06-03.

4.4 Unique Features of Survey Area

Survey Units NOL-06-01, NOL-06-02 and NOL-06-03 consisted of open excavations with sloping to steep banked sides. NOL-06-02 had an 8-12 foot deep trench running through the center of the unit along the entire length.

4.5 ALARA Practices and Evaluations

The generic ALARA evaluation for soils is documented in Appendix C, Technical Report YA-REPT-00-003-05, "Generic ALARA Review for Final Status Survey of Soil at YNPS". The report is augmented by individual evaluations which are found

in Appendix D, which concludes that no further remediation of soil below the DCGL is warranted.

5.0 SURVEY UNIT FINAL STATUS SURVEY

5.1 Survey Planning

5.1.1 Final Status Survey Plan and Associated DQOs

The FSS for NOL-06 Survey Area was planned and developed in accordance with the LTP using the DQO process. Form DPF-8856.1, found in YNPS Procedure 8856, "*Preparation of Survey Plans*," was used to provide guidance and consistency during development of the FSS Plans. The FSS Plans can be found in Appendix A. The DQO process allows for systematic planning and is specifically designed to address problems that require a decision to be made in a complex survey design and, in turn, provides alternative actions.

The DQO process was used to develop an integrated survey plan providing the Survey Unit identification, sample size, selected analytical techniques, survey instrumentation, and scan coverage. The Sign Test was specified for non-parametric statistical testing for this Survey Unit, if required. The design parameters developed are presented below.

Table 3 Survey Area NOL-06 Design Parameters

Survey Unit	Design Parameter	Value	Basis
NOL-06-01	Survey Unit Area	397 m2	Class 1, Soil, ≤ 2,000 m2
	Number of Direct Measurements	16 (calculated) + 1 (added) Total: 17	α (Type I) = 0.05 β (Type II) = 0.05 σ: 0.1 Relative Shift: 2 DCGLw (Unity): 1 LBGR: 0.8 (adjusted)
	Critical Value	12 for Sign test.	(17/2)+(1.645/2)*Square Root (17)
	Gridded Sample Area Size Factor	23.4m2	Area / Number of Samples (397 m2/17)
	Sample Grid Spacing:	Triangular: 5.21m	Square Root (397 m2/(0.866*25))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area: > DCGLemc or > DCGLw + 3 Sigma
	Scanning Coverage Requirements	397 m2	Class 1 Soil Area: 100%
	Scan Investigation Level	> Background Audible	SPA-3 Scan
NOL-06-02	Survey Unit Area	1024 m2	Class 1, Soil, ≤ 2,000 m2
	Number of Direct	15 (calculated)	α (Type I) = 0.05

Survey Unit	Design Parameter	Value	Basis
	Measurements	+ 5 (added) Total: 20 14 biased samples	β (Type II) = 0.05 σ: 0.181 Relative Shift: 2.77 DCGLw (Unity): 1 LBGR: 0.5
	Critical Value	14 for Sign test.	(20/2)+(1.645/2)*Square Root (20)
	Gridded Sample Area Size Factor	51.2m2	Area / Number of Samples (1024 m2/20)
	Sample Grid Spacing:	Triangular: 7.7m	Square Root (1024 m2/(0.866*20))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area: > DCGLemc or > DCGLw + 3 Sigma
	Scanning Coverage Requirements	1024 m2	Class 1 Soil Area: 100%
	Scan Investigation Level	Co-60: 0.18pCi/gm, Cs-137 : 0.7pCi/gm, or SOF >1	1m 180° ISOCS
NOL-06-03	Survey Unit Area	45 m2	Class 1, Soil, ≤ 2,000 m2
	Number of Direct Measurements	15 (calculated) + 0 (added) Total: 15 1 biased sample	α (Type I) = 0.05 β (Type II) = 0.05 σ: 0.126 Relative Shift: 2 (adjusted) DCGLw (Unity): 1 LBGR: 0.5
	Critical Value	11 for Sign test.	(15/2)+(1.645/2)*Square Root (15)
	Gridded Sample Area Size Factor	3 m^2	Area / Number of Samples (45 m2/15)
	Sample Grid Spacing:	Triangular: 1.9m	Square Root (45 m2/(0.866*20))
	Direct Measurement Investigation Level	> DCGLemc or > DCGLw + 3 Sigma	Class 1 Area: > DCGLemc or > DCGLw + 3 Sigma
	Scanning Coverage Requirements	45 m2	Class 1 Soil Area: 100%
	Scan Investigation Level	> Background Audible	SPA-3 Scan

5.1.2 Deviations from the FSS Plan as Written in the LTP

The FSSP design was performed to the criteria of the LTP; therefore, no LTP deviations with potential impact to this Survey Area need to be evaluated.

5.1.3 DCGL Selection and Use

For the final evaluation of the NOL-06 Survey Area and throughout this report, the administrative acceptance criterion of 8.73 mRem per year has been set for Soil LTP-listed radionuclides.

Table 4 Soil DCGL Values

Nuclide	Soil 8.73 mr per year (pCi/g)	Nuclide	Soil 8.73 mr per year (pCi/g)
Co-60	1.4E+00	H-3	1.3E+02
Nb-94	2.5E+00	C-14	1.9E+00
Ag-108m	2.5E+00	Fe-55	1.0E+04
Sb-125	1.1E+01	Ni-63	2.8E+02
Cs-134	1.7E+00	Sr-90	6.0E-01
Cs-137	3.0E+00	Tc-99	5.0E+00
Eu-152	3.6E+00	Pu-238	1.2E+01
Eu-154	3.3E+00	Pu-239	1.1E+01
Eu-155	1.4E+02	Pu-241	3.4E+02
Am-241	1.0E+01	Cm-243	1.1E+01

5.1.4 Measurements

Error tolerances and characterization sample population statistics drove the selection of the number of statistical measurements. The quantity of statistical measurements collected for each unit is listed above in the table titled "Survey Area NOL-06 Design Parameters". Split samples and recounts are addressed under the quality control section 6.2. The NOL-06-01, NOL-06-02 and NOL-06-03 soil sampling grid was developed as a systematic grid with spacing consisting of a triangular pitch pattern with a random starting point. Sample measurement locations are provided in Attachment A.

NOL-06-02 was scanned 100% with ISOCS. The results are listed in the table below titled "ISOCS Scan Summary". NOL-06-01 and NOL-06-03 were scanned 100% with a SPA-3. Areas identified for investigation were either reconciled or successfully remediated.

5.2 Survey Implementation Activities

The Table below provides a summary of daily activities performed during the Final Status Survey of NOL-06.

Table 5 FSS Activity Summary for NOL-06

Survey Unit	Date	Activity
NOL-06-01	8/24/2005	Performed walk-down of Survey Unit
	8/25/2005	Established Isolation and Controls
	8/24/2005	Performed Job Hazard Analysis
	8/09/2005	Performed Unit Classification
	8/24/2005	Performed Sample Quantity Calculations, established DQOs
	8/25/2005 & 8/29/2005	Generated FFS Sample Plans
	8/27/2005 to 9/12/2005	Initiated Scans, and Direct measurements.
	10/11/2006	Performed DQA, FSS Complete
NOL-06-02	5/25/2006	Performed walk-down of Survey Unit
	6/23/2006	Established Isolation and Controls
	6/29/2006	Performed Job Hazard Analysis
	5/25/2006	Performed Unit Classification
	6/2/2006	Performed Sample Quantity Calculations, established DQOs
	5/25/06, 6/23/2006, 6/29/2006	Generated FFS Sample Plans
	6/21/2006 to 6/23/2006	Initiated Scans, and Direct measurements.
	8/17/2006	Performed DQA, FSS Complete
NOL-06-03	11/22/2005	Performed walk-down of Survey Unit
	11/22/2005	Established Isolation and Controls
	11/16/2005	Performed Job Hazard Analysis
	10/26/2005	Performed Unit Classification
	11/23/2005	Performed Sample Quantity Calculations, established DQOs
	11/23/2005	Generated FFS Sample Plans
	11/28/2005 to 11/29/2005	Initiated Scans, and Direct measurements.
	10/12/2006	Performed DQA, FSS Complete

5.3 Surveillance Surveys

5.3.1 Periodic Surveillance Surveys

Upon completion of the FSS of Survey Area NOL-06, the Survey Area was placed into the program for periodic surveillance surveys on a quarterly basis in accordance with YNPS procedure DP-8860, "*Area Surveillance Following Final Status Survey*." These surveys provide assurance that areas with successful FSS remain unchanged until license termination.

An Area Surveillance Plan (ASP) (YNPS-ASP-NOL-06-01-00) was performed on 10/20/05 due to potential impact of rainfall, run-off and decommissioning activities. All six of the ASP soil samples were below the DCGLw and the sum-of-fractions were less than one. The mean of the ASP was less than the mean of the original FSS plus three standard deviations.

5.3.2 Resurveys

No resurveys were performed in NOL-06.

5.3.3 Investigations

No additional investigations were required for this Survey Area due to surveillance surveys.

5.4 Survey Results

Soil sample surveys indicated that two of the systematic measurement Sum of Fractions exceeded the $DCGL_W$, but not the DCGLemc. The sign test was performed, and the areas passed. The DQA charts are depicted in Attachment B. Retrospective power curves were generated and demonstrated that an adequate number of samples were collected to support the Data Quality Objectives. Therefore, the null hypothesis (H_o) (that the Survey Unit exceeds the release criteria) is rejected.

Table 6 Soil Sample Summary

Sample Description	SOF	Sample Description	SOF	Sample Description	SOF
NOL-06-01-001-F	0.07	NOL-06-02-001-F	0.03	NOL-06-03-001-F	0.06
NOL-06-01-002-F	0.21	NOL-06-02-002-F	0.04	NOL-06-03-002-F	0.83
NOL-06-01-003-F	0.02	NOL-06-02-003-F	0.07	NOL-06-03-003-F	0.18
NOL-06-01-004-F	0.07	NOL-06-02-004-F	0.05	NOL-06-03-004-F	0.05
NOL-06-01-005-F	0.64	NOL-06-02-005-F	0.09	NOL-06-03-005-F	0.38
NOL-06-01-006-F	0.14	NOL-06-02-006-F	0.08	NOL-06-03-006-F	0.06
NOL-06-01-007-F	1.35	NOL-06-02-007-F	0.05	NOL-06-03-007-F	0.16
NOL-06-01-008-F	0.39	NOL-06-02-008-F	0.06	NOL-06-03-008-F	0.19
NOL-06-01-009-F	0.09	NOL-06-02-009-F	0.05	NOL-06-03-009-F	1.16
NOL-06-01-010-F	0.04	NOL-06-02-010-F	0.04	NOL-06-03-010-F	0.10
NOL-06-01-011-F	0.10	NOL-06-02-011-F	0.05	NOL-06-03-011-F	0.13
NOL-06-01-012-F	0.14	NOL-06-02-012-F	0.12	NOL-06-03-012-F	0.15
NOL-06-01-013-F	0.02	NOL-06-02-013-F	0.06	NOL-06-03-013-F	0.15
NOL-06-01-014-F	0.05	NOL-06-02-014-F	0.04	NOL-06-03-014-F	0.10
NOL-06-01-015-F	0.07	NOL-06-02-015-F	0.08	NOL-06-03-015-F	0.05
NOL-06-01-016-F	0.05	NOL-06-02-016-F	0.07		
NOL-06-01-017-F	0.15	NOL-06-02-017-F	0.02		
		NOL-06-02-018-F	0.06		
		NOL-06-02-019-F	0.06		
		NOL-06-02-020-F	0.06		
Max	1.35		0.12		1.16
Average	0.21		0.06		0.25
Standard Deviation	0.33		0.02		0.32

Sample Description	SOF	Sample Description	SOF	Sample Description	SOF
		NOL-06-02-021-F-B	0.2		
		NOL-06-02-022-F-B	0.2		
		NOL-06-02-023-F-B	0.2		
		NOL-06-02-024-F-B	0.0		
		NOL-06-02-025-F-B	0.1		
		NOL-06-02-026-F-B	0.0		
		NOL-06-02-027-F-B	0.1		
		NOL-06-02-028-F-B	0.1		
		NOL-06-02-029-F-B	0.0		
		NOL-06-02-030-F-B	0.0		
		NOL-06-02-031-F-B	0.1		
		NOL-06-02-032-F-B	0.0		

SPA-3s were used for scan surveys of NOL-06-01 and NOL-06-03. Areas identified for investigation were either reconciled or successfully remediated. ISOCS systems were used to perform scan surveys for NOL-06-02. Measurement results listed below are reported in sum of fraction of the investigation levels. A number less than one indicates that no investigation was warranted.

$$Investigation\ level\ (I_{LV}) = {}^{1}DCGL_W \times {}^{2}AF \times Adjustment Factor$$

[1] Soil $DCGL_W$ from Appendix 6E of YNPS LTP
[2] Area Factor for 1 m^2 taken from Appendix 6Q of YNPS LTP

$$\frac{C_1}{I_{LV_1}} + \frac{C_2}{I_{LV_2}} + ... + \frac{C_n}{I_{LV_n}} \leq 1$$

Where:
C_n = Concentration of radionuclide n
I_{LV} = Investigation level for radionuclide n

Table 7 ISOCS Scan Summary

Sample Title	SOF	Sample Title	SOF	Sample Title	SOF
NOL-06-02-101-F-G	0.00	NOL-06-02-137-F-G	0.00	NOL-06-02-171-F-G	0.00
NOL-06-02-102-F-G	0.00	NOL-06-02-138-F-G	0.00	NOL-06-02-172-F-G	0.00
NOL-06-02-103-F-G	0.00	NOL-06-02-139-F-G	0.00	NOL-06-02-173-F-G	0.00
NOL-06-02-104-F-G	0.00	NOL-06-02-140-F-G	0.00	NOL-06-02-174-F-G	0.00
NOL-06-02-105-F-G	0.00	NOL-06-02-141-F-G	0.00	NOL-06-02-175-F-G	0.00
NOL-06-02-106-F-G	0.00	NOL-06-02-142-F-G	0.00	NOL-06-02-176-F-G	0.00
NOL-06-02-107-F-G	0.00	NOL-06-02-143-F-G	0.00	NOL-06-02-177-F-G	0.00
NOL-06-02-108-F-G	0.00	NOL-06-02-144-F-G	0.00	NOL-06-02-178-F-G	0.00
NOL-06-02-109-F-G	0.00	NOL-06-02-145-F-G	0.00	NOL-06-02-179-F-G	0.00
NOL-06-02-110-F-G	0.00	NOL-06-02-146-F-G	0.00	NOL-06-02-180-F-G	0.00
NOL-06-02-111-F-G	0.05	NOL-06-02-147-F-G	0.00	NOL-06-02-181-F-G	0.00
NOL-06-02-112-F-G	0.00	NOL-06-02-148-F-G	0.00	NOL-06-02-182-F-G	0.00
NOL-06-02-113-F-G	0.00	NOL-06-02-149-F-G	0.00	NOL-06-02-183-F-G	0.00
NOL-06-02-114-F-G	0.00	NOL-06-02-150-F-G	0.00	NOL-06-02-184-F-G	0.00

Sample Title	SOF	Sample Title	SOF	Sample Title	SOF
NOL-06-02-115-F-G	0.00	NOL-06-02-151-F-G	0.00	NOL-06-02-185-F-G	0.00
NOL-06-02-116-F-G	0.00	NOL-06-02-152-F-G	0.00	NOL-06-02-186-F-G	0.00
NOL-06-02-117-F-G	0.00	NOL-06-02-153-F-G	0.00	NOL-06-02-187-F-G	0.00
NOL-06-02-118-F-G	0.00	NOL-06-02-154-F-G	0.00	NOL-06-02-188-F-G	0.00
NOL-06-02-119-F-G	0.00	NOL-06-02-155-F-G	0.00	NOL-06-02-189-F-G	0.00
NOL-06-02-120-F-G	0.07	NOL-06-02-156-F-G	0.00	NOL-06-02-190-F-G	0.00
NOL-06-02-121-F-G	0.00	NOL-06-02-157-F-G	0.00	NOL-06-02-191-F-G	0.00
NOL-06-02-122-F-G	0.00	NOL-06-02-158-F-G	0.00	NOL-06-02-192-F-G	0.00
NOL-06-02-123-F-G	0.00	NOL-06-02-159-F-G	0.00	NOL-06-02-194-F-G	0.00
NOL-06-02-124-F-G	0.00	NOL-06-02-160-F-G	0.00	NOL-06-02-195-F-G	0.00*
NOL-06-02-125-F-G	0.00	NOL-06-02-161-F-G	0.00	NOL-06-02-196-F-G	0.00*
NOL-06-02-126-F-G	0.00	NOL-06-02-162-F-G	0.07	NOL-06-02-197-F-G	0.00*
NOL-06-02-127-F-G	0.00	NOL-06-02-163-F-G	0.00	NOL-06-02-198-F-G	0.00*
NOL-06-02-128-F-G	0.00	NOL-06-02-164-F-G	0.00	NOL-06-02-199-F-G	0.00*
NOL-06-02-129-F-G	0.00	NOL-06-02-164-F-G	0.00	NOL-06-02-200-F-G	0.00*
NOL-06-02-130-F-G	0.00	NOL-06-02-165-F-G	0.00	NOL-06-02-201-F-G	0.00*
NOL-06-02-131-F-G	0.00	NOL-06-02-166-F-G	0.00	NOL-06-02-202-F-G	0.00*
NOL-06-02-132-F-G	0.17	NOL-06-02-167-F-G	0.00	NOL-06-02-203-F-G	0.00*
NOL-06-02-133-F-G	0.00	NOL-06-02-168-F-G	0.00	NOL-06-02-204-F-G	0.00*
NOL-06-02-134-F-G	0.00	NOL-06-02-169-F-G	0.00	NOL-06-02-205-F-G	0.00*
NOL-06-02-135-F-G	0.00	NOL-06-02-170-F-G	0.00	NOL-06-02-206-F-G	0.00*
NOL-06-02-136-F-G	0.00				

Max	0.17
Average	0.00
Standard Deviation	0.02

* Investigation levels reduced by 20% (C0-60 = 0.14 and Cs-137 = 0.56) accounting for saturated soil.

Note: During the course of scan surveying NOL-06-02, attempts made to totally remove the standing water at the bottom of the trench excavation were unsuccessful. Although the standing water was limited to a narrow path at the bottom of the trench it was determined that this water could compromise the ISOCS scan results. To account for these conditions each ISOCS scan was supplemented with a biased soil sample. A biased soil sample was collected at each ISOCS location where standing water was identified and an adjustment (i.e. reduction of the investigation level by 20%) was made to the affected ISOCS assays. Additionally, ISOCS Scans identified as obstructed by interference from the Service Water Lines exposed during remediation efforts were scanned using ISOCS at the 2m, 90° collimation geometry. The ISOCS scans were positioned perpendicular to the reference plane under the service water lines.

5.5 Data Quality Assessment

The Data Quality Assessment phase is the part of the FSS where survey design and data are reviewed for completeness and consistency, ensuring the validity of the

results, verifying that the survey plan objectives were met, and validating the classification of the Survey Unit.

The sample design and the data acquired were reviewed and found to be in accordance with applicable YNPS procedures DP-8861, "*Data Quality Assessment*"; DP-8856, "*Preparation of Survey Plans*"; DP-8853, "*Determination of the Number and Locations of FSS Samples and Measurements*"; DP-8857, "*Statistical Tests*"; DP-8865, "*Computer Determination of the Number of FSS Samples and Measurements*" and DP-8852, "*Final Status Survey Quality Assurance Project Plan*".

The Data Quality Assessment power curves, scatter, quantile and frequency plots are found in Attachment B. Posting Plots are found in Attachment A.

5.5.1 NOL-06-01 Data Quality Assessment

All fixed point sample concentrations analyzed on site for ETDs were below the DCGLw and the sum-of-fractions for the samples were less than one. Two elevated areas, indicated by scans (both failed DCGLemc), were investigated and remediated. All post-remediation samples were below the DCGLw and the sum-of-fractions were less than one. All elevated readings were resolved. One sample analyzed for Hard-to-Detects was reported positive for C-14 - greater than DCGLw, but less than DCGLemc. Another sample analyzed for Hard-to-Detects was reported as greater than MDA for C-14, but the sum-of-fractions for that sample was less than one. All the remaining sample results reported from GEL were <MDA for Hard-to-Detects. Since the sum-of-fractions for one sample was >1 the sign test was used. The Survey Unit passed the sign test. With the exception of the one data point, the data set was within approximately two standard deviations with normal dispersion about the arithmetic mean. The data posting plot does not clearly reveal any systematic spatial trends. The quantile plot exhibits some asymmetry in the lower quartile and the frequency plot is skewed slightly to the left. The survey maintained sufficient power to pass the unit and the data set verified the assumptions of the statistical test.

5.5.2 NOL-06-02 Data Quality Assessment

All fixed point sample concentrations were below the DCGLw and the sum-of-fractions for the samples were less than one. No scan investigations were required. Biased samples taken to account for saturated soil were less than DCGLw and no sum-of-fractions were greater than or equal to one. HTD sample results were <DCGLw. The data set was within approximately three standard deviations with normal dispersion about the arithmetic mean. The data posting plot does not clearly reveal any systematic spatial trends. The quantile plot exhibits no

noticeable asymmetry and the frequency plot demonstrates a normal Poisson distribution. The survey maintained sufficient power to pass the unit and the data set verified the assumptions of the statistical test.

5.5.3 NOL-06-03 Data Quality Assessment

One fixed point sample concentration was greater than the DCGLw but less than the DCGLemc prompting the use of the sign test. The Survey Unit passed the sign test. Scans requiring investigation were investigated and the elevated readings were resolved. HTD sample results were <DCGLw. The data set was within approximately three standard deviations with normal dispersion about the arithmetic mean. The quantile plot exhibits a slight asymmetry in the lower quartile and the frequency plot demonstrates a slight skew to the right however, the data posting plot does not clearly reveal any systematic spatial trends The survey maintained sufficient power to pass the unit and the data set verified the assumptions of the statistical test.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

6.1 Instrument QC Checks

Operation of the portable ISOCS was in accordance with DP-8871,"*Operation of the Canberra Portable ISOCS System*," with QC checks performed in accordance with DP-8869,"*In-situ (ISOCS) Gamma Spectrum Assay System Calibration Procedure*" and DP-8871, "*Operation of the Canberra Portable ISOCS System.*" Operation of the E-600 w/SPA-3 was in accordance with DP-8535,"*Setup and Operation of the Eberline E-600 Digital Survey Instrument,*" with QC checks preformed in accordance with DP-8540, "*Operation and Source Checks of Portable Friskers.*" Instrument response checks were performed prior to and after use for the E-600 w/SPA-3 and once per shift for the Portable ISOCS. . Any flags (i.e. anomalies in the QC results) encountered during the ISOCS QC Source Count were corrected/ resolved prior to surveying. All instrumentation involved with the FSS of NOL-06 satisfied the above criteria for the survey. QC records are found in Attachment C.

6.2 Split Samples and Recounts

6.2.1 NOL-06-01 Split Samples and Recounts

Four split and two recount 'QC" samples were gathered and within tolerable limits in accordance with DP-8864,"*Split Sample Assessment for Final Status Survey*".

6.2.2 NOL-06-02 Split Samples and Recounts

Two split and two recount "QC" samples were gathered and within tolerable limits in accordance with DP-8864,"*Split Sample Assessment for Final Status Survey*".

6.2.3 NOL-06-03 Split Samples and Recounts

Four split and two recount "QC" sample were gathered and within tolerable limits in accordance with DP-8864,"*Split Sample Assessment for Final Status Survey*".

6.3 Self-Assessments

No self-assessments were performed during the FSS of NOL-06.

7.0 CONCLUSION

The FSS of NOL-06 has been performed in accordance with YNPS LTP and applicable FSS procedures. Soil sample surveys indicated that two of the systematic measurement Sum of Fractions exceeded the $DCGL_W$, but not the DCGLemc. The sign test was performed, and the areas passed, as depicted in Attachment B. Retrospective power curves were generated and demonstrated that an adequate number of samples were collected to support the Data Quality Objectives. Therefore, the null hypothesis (H_o) is rejected.

NOL-06 meets the objectives of the Final Status Survey.

Based upon the evaluation of the data acquired for the FSS, NOL-06 meets the release requirements set forth in the YNPS LTP. The Total Effective Dose Equivalent (TEDE) to the average member of the critical group does not exceed 25 mRem per year, including that from groundwater. 10CFR20 Subpart E ALARA requirements have been met as well as the site release criteria for the administrative level DCGLs that ensure that the Massachusetts Department of Public Health's 10 mRem per year limit will also be met.

List of Appendices

List of Attachments

(In the electronic version, every Table of Contents, Figures, Appendices and Attachments, as well as every mention of a Figure, Appendix or Attachment is a hyperlink to the actual location or document.)