

**YANKEE NUCLEAR POWER STATION  
FINAL STATUS SURVEY REPORT**

REPORT NO.: YNPS-FSS-OOL-01-00

Prepared by:   
Michael D. Rennhack, FSS Radiological Engineer

Date: 1-3-07

Reviewed by:   
Robert Tozzie, FSS Radiological Engineer

Date: 1/3/07

Approved by:   
Martha Erickson, FSS Manager

Date: 1/3/07

Section	<b>Table of Contents</b>	Page
<b>1.0</b>	<b>EXECUTIVE SUMMARY .....</b>	<b>1</b>
1.1	IDENTIFICATION OF SURVEY AREA AND UNITS .....	1
1.2	DATES OF SURVEYS .....	1
1.3	NUMBER AND TYPES OF MEASUREMENTS COLLECTED .....	1
1.4	SUMMARY OF SURVEY RESULTS .....	2
1.5	CONCLUSIONS .....	2
<b>2.0</b>	<b>FSS PROGRAM OVERVIEW .....</b>	<b>2</b>
2.1	SURVEY PLANNING .....	2
2.2	SURVEY DESIGN .....	2
2.3	SURVEY IMPLEMENTATION .....	3
2.4	SURVEY DATA ASSESSMENT .....	3
2.5	QUALITY ASSURANCE AND QUALITY CONTROL MEASURES .....	3
<b>3.0</b>	<b>SURVEY AREA INFORMATION.....</b>	<b>4</b>
3.1	SURVEY AREA DESCRIPTION.....	4
3.1.1	<i>OOL-01-01 Description</i> .....	4
3.1.2	<i>OOL-01-02 Description</i> .....	4
3.1.3	<i>OOL-01-03 Description</i> .....	5
3.1.4	<i>OOL-01-04 Description</i> .....	5
3.1.5	<i>OOL-01-05 Description</i> .....	5
3.1.6	<i>OOL-01-06 Description</i> .....	6
3.2	HISTORY OF SURVEY AREA.....	6
3.3	DIVISION OF SURVEY AREA INTO SURVEY UNITS .....	7
<b>4.0</b>	<b>SURVEY UNIT INFORMATION.....</b>	<b>7</b>
4.1	SUMMARY OF RADIOLOGICAL DATA SINCE HISTORICAL SITE ASSESSMENT (HSA).....	7
4.1.1	<i>Chronology and Description of Surveys Since HSA</i> .....	7
4.1.2	<i>Radionuclide Selection and Basis</i> .....	7
4.1.2.1	<i>OOL-01-01 Radionuclides of Concern</i> .....	8
4.1.2.2	<i>OOL-01-02 Radionuclides of Concern</i> .....	8
4.1.2.3	<i>OOL-01-03 Radionuclides of Concern</i> .....	8
4.1.2.4	<i>OOL-01-04 Radionuclides of Concern</i> .....	8
4.1.2.5	<i>OOL-01-05 Radionuclides of Concern</i> .....	8
4.1.2.6	<i>OOL-01-06 Radionuclides of Concern</i> .....	8
4.1.3	<i>Scoping &amp; Characterization</i> .....	9
4.2	BASIS FOR CLASSIFICATION .....	9
4.3	REMEDIAL ACTIONS AND FURTHER INVESTIGATIONS.....	9
4.3.1	<i>OOL-01-01 Remedial Actions and Further Investigations</i> .....	9
4.3.2	<i>OOL-01-02 Remedial Actions and Further Investigations</i> .....	10
4.3.3	<i>OOL-01-03 Remedial Actions and Further Investigations</i> .....	10
4.3.4	<i>OOL-01-04 Remedial Actions and Further Investigations</i> .....	10
4.3.5	<i>OOL-01-05 Remedial Actions and Further Investigations</i> .....	10
4.3.6	<i>OOL-01-06 Remedial Actions and Further Investigations</i> .....	13
4.4	UNIQUE FEATURES OF SURVEY AREA.....	13
4.5	ALARA PRACTICES AND EVALUATIONS .....	13
<b>5.0</b>	<b>SURVEY UNIT FINAL STATUS SURVEY .....</b>	<b>13</b>
5.1	SURVEY PLANNING .....	13
5.1.1	<i>Final Status Survey Plan and Associated DQOs</i> .....	13
5.1.2	<i>Deviations from the FSS Plan as Written in the YNPS LTP</i> .....	16
5.1.3	<i>DCGL Selection and Use</i> .....	16
5.1.4	<i>Measurements</i> .....	17
5.2	SURVEY IMPLEMENTATION ACTIVITIES .....	17
5.3	SURVEILLANCE SURVEYS .....	18

5.3.1	<i>Periodic Surveillance Surveys</i> .....	18
5.3.2	<i>Resurveys</i> .....	19
5.3.3	<i>Investigations</i> .....	19
5.4	<b>SURVEY RESULTS</b> .....	19
5.5	<b>DATA QUALITY ASSESSMENT</b> .....	20
5.5.1	<i>OOL-01-01 Data Quality Assessment</i> .....	21
5.5.2	<i>OOL-01-02 Data Quality Assessment</i> .....	21
5.5.3	<i>OOL-01-03 Data Quality Assessment</i> .....	22
5.5.4	<i>OOL-01-04 Data Quality Assessment</i> .....	22
5.5.5	<i>OOL-01-05 Data Quality Assessment</i> .....	22
5.5.6	<i>OOL-01-06 Data Quality Assessment</i> .....	23
6.0	<b>QUALITY ASSURANCE AND QUALITY CONTROL</b> .....	23
6.1	<b>INSTRUMENT QC CHECKS</b> .....	23
6.2	<b>SPLIT SAMPLES AND RECOUNTS</b> .....	23
6.2.1	<i>OOL-01-01 Split Samples and Recounts</i> .....	23
6.2.2	<i>OOL-01-02 Split Samples and Recounts</i> .....	23
6.2.3	<i>OOL-01-03 Split Samples and Recounts</i> .....	24
6.2.4	<i>OOL-01-04 Split Samples and Recounts</i> .....	24
6.2.5	<i>OOL-01-05 Split Samples and Recounts</i> .....	24
6.2.6	<i>OOL-01-06 Split Samples and Recounts</i> .....	24
6.3	<b>SELF-ASSESSMENTS</b> .....	24
7.0	<b>CONCLUSION</b> .....	25

Table	List of Tables	Page
TABLE 1	DATE OF SURVEYS AND DQOS .....	1
TABLE 2	DATES OF SURVEYS SINCE HSA.....	7
TABLE 3	OOL-01-01 INVESTIGATION SAMPLES.....	10
TABLE 4	INPUTS TO $f(\text{DCGL}_{\text{EMC}})$ CALCULATION.....	11
TABLE 5	SUMMARY OF ELEVATED AREA SAMPLES IN SURVEY UNIT OOL-01-05.....	11
TABLE 6	SURVEY AREA OOL-01 DESIGN PARAMETERS.....	14
TABLE 7	SOIL DCGL VALUES.....	16
TABLE 8	FSS ACTIVITY SUMMARY FOR OOL-01.....	17
TABLE 9	SOIL SAMPLE SUMMARY.....	19

---

### List of Appendices

- Appendix A – YNPS-FSSP-OOL-01, “*Final Status Survey Planning Worksheets*”  
Appendix B – YA-REPT-00-003-05, “*Generic ALARA Review for Final Status Survey of Soil at YNPS*”  
Appendix C – ALARA Evaluations, OOL-01

---

### List of Attachments

- Attachment A – Maps and Posting Plots  
Attachment B – Data Quality Assessment Plots and Curves  
Attachment C – ORTEC Direct Measurement Data  
Attachment D – CR-06-419

*(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.)*

## 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 <sub>EMC</sub> .....	DCGL for small areas of elevated activity
DCGL <sub>w</sub> .....	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 <sub>o</sub> .....	Null Hypothesis
HSA .....	Historical Site Assessment
HTD .....	Hard-to-Detect
ISOCS .....	<i>In-situ</i> Object Counting System <sup>®</sup>
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 .....	Radiologically 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 OOL-01 in accordance with Yankee Nuclear Power Station's (YNPS) License Termination Plan (LTP). This FSS was conducted as an open land area FSS with reservoir sediments (treated as soil to satisfy a dredging scenario) at 10-mRem/y Derived Concentration Guideline Levels.

### 1.1 Identification of Survey Area and Units

The OOL-01 Survey Area is divided into 6 Survey Units. OOL-01-01, OOL-01-02, OOL-01-04 and OOL-01-05 are Class 2 Survey Units. OOL-01-03 and OOL-01-06 are Class 1 Survey Units. A map of the Survey Area and Unit divisions are 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
OOL-01-01	8/01/2006	8/01/2006	11/13/2006
OOL-01-02	8/25/2005	8/25/2005	10/04/2005
OOL-01-03	7/31/2006	7/31/2006	9/19/2006
OOL-01-04	7/07/2006	7/07/2006	10/10/2006
OOL-01-05	7/06/2006	7/06/2006	12/08/2006
OOL-01-06	7/31/2006	7/31/2006	11/02/2006

### 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 106 statistical soil samples were taken in the Survey Area, providing data for the non-parametric testing of the Survey Area. Since the majority of OOL-01 was underwater, no scanning was performed in any of the survey units. Scanning is not required per section 5.6.3.2.5 of the YNPS LTP; therefore, the FSSP requirements meet the Data Quality Objectives for this survey area.

## 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 five of the systematic measurements sum-of-fractions exceeded unity; based on the Massachusetts Department of Public Health 10 mRem per year release criteria, depicted in Attachment B. WRS test and  $DCGL_{EMC}$  were performed where applicable. 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 ( $H_0$ ) (that the Survey Unit exceeds the release criteria) is rejected.

## 1.5 Conclusions

Based upon the evaluation of the data acquired for the FSS, OOL-01 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. 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 License Termination Plan. 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 YNPS 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 sediment samples (as well as any judgmental assessments required) 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. Survey Area OOL-01 is unique in the fact that the area comprises the sediment within Sherman Reservoir; therefore, a physical walk down was not performed in the Survey Area. If the unit is determined to be acceptable (i.e. divers inspected the bottom of the Reservoir at the sample locations for obstructions), it is turned over to the FSS team, and FSS isolation and control measures are established (e.g. FSS signs are posted along the shoreline of the Reservoir). After the Survey Unit isolation and controls are in place, grid points are identified for the sediment samples, using Global Positioning System (GPS) coordinates consistent with the Massachusetts State Plane System. 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

OOL-01 is described in the YNPS LTP as Sherman Pond Sediment. OOL-01 Survey Area has been further subdivided into six distinct Survey Units encompassing the Sherman Reservoir, the Seal Pit Cove, the East Storm Drain System Discharge, and Circulating Water System Discharge and up to and including part of the shoreline of the reservoir. The entire Survey Area OOL-01 is situated underwater. A map of the Survey Area and Unit divisions are found in Attachment A.

##### 3.1.1 OOL-01-01 Description

Survey Unit 01 is the section of OOL-01 originally approximately 391m<sup>2</sup> in size. Unit 01 is bound by the seal pit cove. The shorelines of survey area OOL-03 form the West and East boundaries, and OMB-06 (the former seal pit) creates the southern boundary. Originally, the most recent sediment results from seal pit characterization data were used for planning this FSS survey package. Survey Unit OOL-01-01 was reclassified to a Class 2 from a Class 3 based on the review of applicable characterization data. During the initial FSS of Survey Unit 01, an area of elevated activity (186m<sup>2</sup> in size) was identified by sample results in excess of the Massachusetts Department of Public Health 10 mRem per year release criteria. The original Survey Unit was sub-divided; the elevated portion was reclassified to a Class 1 Survey Unit and renamed OOL-01-06. OOL-01-01 remained a Class 2 Survey Unit – this portion contains approximately 204.7m<sup>2</sup> of surface area. Characterization data along with data from the initial FSS of OOL-01-01 were used for planning this FSS survey package. Since scanning is not required per section 5.6.3.2.5 of the YNPS LTP, the original classification requirements (Class 2) met the Data Quality Objectives for this survey unit.

Note: Had the Survey Unit been originally surveyed to the YNPS LTP mandated 25 mRem per year criteria, the highest sum-of-fraction would have been 0.59 and therefore a subdivision of OOL-01-01 would not have been required.

##### 3.1.2 OOL-01-02 Description

Survey Unit 02 is the section of OOL-01 approximately 401m<sup>2</sup> in size. OOL-01-02 is located at the tip of the peninsula (OOL-03-03) north of the Screenwell Pump House and bound to the south by the shoreline of Survey Area OOL-03 and GPS coordinates in the Sherman Reservoir. The area of this unit represents the location within which rip rap will be positioned upon completion of FSS survey activities. The most recent sediment

results from seal pit characterization data were used for planning this FSS survey package. Survey Unit OOL-01-02 was reclassified to a Class 2 from Class 3 based on the review of the characterization data.

### **3.1.3 OOL-01-03 Description**

Survey Unit 03 is the section of OOL-01 approximately 751m<sup>2</sup> in size. Unit 03 is bound to the south by the seal pit cove. The shorelines of survey area OOL-03 form the eastern and western boundaries, and survey unit OOL-01-04 forms the northern boundary. Sediment results from the seal pit characterization and most recent FSS effort were used for planning this FSS survey package. Survey Unit OOL-01-03 was reclassified to a Class 1 from a Class 3 based on the review of this data.

### **3.1.4 OOL-01-04 Description**

Survey Unit 04 is the section of OOL-01 approximately 67,120 m<sup>2</sup> in size. OOL-01-04 is bound on the south by the northern boundary of Survey Unit OOL-01-05 (West Reservoir Cove). The shorelines of Survey Area OOL-03 and non-impacted property owned by TransCanada form the southern and western boundaries. The shoreline of Survey Area OOL-15 and non-impacted property owned by TransCanada form the eastern boundary. The northern boundary is defined by non-impacted property owned by TransCanada. Characterization and FSS results from sediment samples collected within the seal pit discharge cove were used for planning the FSS survey package. Survey Unit OOL-01-04 was reclassified from a Class 3 to a Class 2 as a very conservative measure since the seal pit discharge cove is at a distance and is non-contiguous to OOL-01-04. Due to shoreline features, OOL-01-04 has exceeded the MARSSIM suggested size for a Class 2 Survey Unit in order to conform to YNPS site configuration, however, the number of samples collected in OOL-01-04 provides a reasonable sampling density for the Unit.

### **3.1.5 OOL-01-05 Description**

Survey Unit 05 is the section of OOL-01 approximately 4,540m<sup>2</sup> in size. Survey Unit OOL-01-05 consists of sediment on the bottom of Sherman Reservoir. The Survey Unit is bound by OOL-01-04 to the north, OOL-03-03 and OOL-03-02 to the west, OOL-03-02, OOL-02-05 and OOL-13-01 to the south and OOL-15-01 to the east. Characterization and FSS results from sediment samples collected within the seal pit discharge cove (OOL-01-01, which is not directly adjacent) were used for planning this FSS survey package. Survey Unit OOL-01-05 was reclassified to a Class 2 based on the review of the data.

### 3.1.6 OOL-01-06 Description

Survey Unit 06 is the subdivided section that was once part of survey unit OOL-01-01, consisting of approximately 186m<sup>2</sup> of Sherman Reservoir sediments. This portion of the original OOL-01-01 was sub-divided and reclassified from Class 2 to a Class 1 as a result of investigating an elevated area, based on the Massachusetts Department of Public Health criteria of 10 mRem per year, identified during the initial FSS. The results of the investigation survey confirmed the result of the original FSS survey and bounded the extent of the elevated area of residual radioactivity. As a result of the investigation, OOL-01-01 was partially reclassified and subdivided into two Survey Units. The newly sub-divided Survey Unit (OOL-01-06) was classified as a Class 1 unit based on review of data from previous FSS and investigation results.

## 3.2 History of Survey Area

OOL-01 Survey Area includes the East Storm Drain System Discharge, the Circulating Water System intake and the Circulating Water Discharge. Sherman Reservoir provided the cooling water to the YNPS steam condensers through the circulating water system and was the source of water for the plant service water system. It was also the source of water for the fire protection system and provided raw water feedstock to the water treatment facility to be processed into primary grade (demineralized) water.

Water was discharged back to OOL-01 from the service water system through the circulating water system. The permitted monitored radioactive liquid release pathway was through the service water system to the circulating water system and then to Sherman Reservoir. Survey Area OOL-01 was potentially impacted as a result of this release pathway, depositing radioactivity in the sediment layer at the bottom of the reservoir.

Contamination of Survey Area OOL-01 may have resulted from run-off of low levels of radioactive contamination present on the yard area surface into the east storm drain system, which discharged in OOL-01. Additionally low levels of surface contamination that migrated out of the Radiologically Controlled Area (RCA) along the railroad tracks may have washed into OOL-01 in the area of Wheeler Brook.

Events and activities that may have led to the contamination of Survey Area OOL-01 include:

- AOR 66-07, Spent Fuel Pit Water Spill.
- AOR 66-09, Hose Failure. (Fuel Chute Pump-back System draining in progress).
- PIR 81-09, Contamination of the Yard Area during Reactor Head Removal.

- Demolition and load out of the Spent Fuel Pit Building and Decontamination Facilities.

Modifications to the YNPS site and surrounding environs include:

- Raising the height of Sherman Dam and spillway.
- Change to the layout of the east storm drain system, which diverted the east storm drain flow into OOL-01.
- Washout and repair of the Wheeler Brook railroad crossing.

### 3.3 Division of Survey Area into Survey Units

The OOL-01 Survey Area is divided into 6 Survey Units. OOL-01-01, OOL-01-02, OOL-01-04 and OOL-01-05 are class 2 Survey Units. OOL-01-03 and OOL-01-06 are 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 OOL-01.

**Table 2 Dates of Surveys since HSA**

<b>Survey Unit</b>	<b>Survey Start Date</b>	<b>Survey End Date</b>	<b>Description</b>
OOL-01-01	8/01/2006	8/01/2006	FSS Survey
OOL-01-02	8/25/2005	8/25/2005	FSS Survey
OOL-01-03	7/31/2006	7/31/2006	FSS Survey
OOL-01-04	7/07/2006	7/07/2006	FSS Survey
OOL-01-05	7/06/2006	7/06/2006	FSS Survey
OOL-01-06	7/31/2006	7/31/2006	FSS Survey

#### 4.1.2 Radionuclide Selection and Basis

Since multiple radionuclides are identified as the nuclides of concern, the unity rule (i.e. sum-of-fractions) will be employed to show compliance with the release criteria for Survey Area OOL-01.

**4.1.2.1 OOL-01-01 Radionuclides of Concern**

During the initial DQO process, Co<sup>60</sup>, Cs<sup>137</sup>, Sr<sup>90</sup> and C<sup>14</sup> were identified as the radiological nuclides of concern for OOL-01-01. However, soil samples were evaluated for all YNPS LTP listed nuclides.

**4.1.2.2 OOL-01-02 Radionuclides of Concern**

During the initial DQO process, Co<sup>60</sup>, Cs<sup>137</sup>, Sr<sup>90</sup> and C<sup>14</sup> were identified as the radiological nuclides of concern for OOL-01-02. However, soil samples were evaluated for all YNPS LTP listed nuclides.

**4.1.2.3 OOL-01-03 Radionuclides of Concern**

During the initial DQO process, Co<sup>60</sup>, Cs<sup>137</sup>, Sr<sup>90</sup> and C<sup>14</sup> were identified as the radiological nuclides of concern for OOL-01-03. However, soil samples were evaluated for all YNPS LTP listed nuclides.

**4.1.2.4 OOL-01-04 Radionuclides of Concern**

During the initial DQO process, Co<sup>60</sup>, Cs<sup>137</sup>, Sr<sup>90</sup> and C<sup>14</sup> were identified as the radiological nuclides of concern for OOL-01-04. However, soil samples were evaluated for all YNPS LTP listed nuclides.

**4.1.2.5 OOL-01-05 Radionuclides of Concern**

During the initial DQO process, Co<sup>60</sup>, Cs<sup>137</sup>, Sr<sup>90</sup> and C<sup>14</sup> were identified as the radiological nuclides of concern for OOL-01-05. However, soil samples were evaluated for all YNPS LTP listed nuclides.

**4.1.2.6 OOL-01-06 Radionuclides of Concern**

During the initial DQO process, Co<sup>60</sup>, Cs<sup>137</sup>, Sr<sup>90</sup> and C<sup>14</sup> were identified as the radiological nuclides of concern for OOL-01-06. However, soil samples were evaluated for all YNPS LTP listed nuclides.

### **4.1.3 Scoping & Characterization**

Characterization data used to develop the DQOs for OOL-01 surveys came from a variety of sources including the HSA, post HSA characterization surveys and review of FSS data.

## **4.2 Basis for Classification**

Based upon the historical use and radiological conditions associated with Survey Area OOL-01, the area was designated, in the YNPS LTP, as MARSSIM Class 3. After review of data and information obtained during the course of demolition, characterization and interviews with personnel, OOL-01-01, OOL-01-02, OOL-01-04 and OOL-01-05 were reclassified to Class 2 Survey Units because of data indicating concentrations, or the potential of concentrations, of activity present in these Survey Units. OOL-01-03 and OOL-01-06 (the subdivided Unit of OOL-01-01) were reclassified to Class 1 based on concentrations present in these Units approaching or exceeding the 10 mRem per year criteria. The YNPS LTP allows for different classifications of Survey Units within a Survey Area.

## **4.3 Remedial Actions and Further Investigations**

### **4.3.1 OOL-01-01 Remedial Actions and Further Investigations**

Investigations of two of the original FSS statistical data points in OOL-01-01 were performed. The original measurements OOL-01-01-001-F-SD and OOL-01-01-002-F-SD were investigated with OOL-01-01-01-036-F-SD-I and OOL-01-01-01-037-F-SD-I respectively, and did not confirm the residual activity concentrations from the original FSS sampling effort; however, sample OOL-01-01-023-F-SD-I did have a sum of fractions greater than unity based on the Massachusetts Department of Public Health criteria of 10 mRem per year. The investigation samples are summarized in Table 3 below. OOL-01-01 was subdivided into two survey units with notification provided to the NRC. During subdivision and reclassification, Survey Unit OOL-01-06 was created, designed and planned as a Class 1 Survey Unit. The remainder of OOL-01-01 was resurveyed as Class 2 under a revision to the FSSP (YNPS-FSSP-OOL-01-01-02). Based on concentrations obtained during investigative sampling (the bounds of the elevated area were established and the origin of the elevated area was determined to be the permitted monitored radioactive liquid release pathway), no remedial actions were required.

**Table 3 OOL-01-01 Investigation Samples**

Sample Number	Co <sup>60</sup> pCi/g	Cs <sup>137</sup> pCi/g	Sr <sup>90</sup> pCi/g	C <sup>14</sup> pCi/g	SOF
OOL-01-01-001-F-SD	0.95	1.11	0.07	0.23	1.35
OOL-01-01-002-F-SD	1.11	1.38	0.10	<CL <sup>1</sup>	1.47
OOL-01-01-01-036-F-SD-I	0.06	0.18	0.01	0.15	0.19
OOL-01-01-01-037-F-SD-I	0.38	0.54	0.01	0.36	0.63
OOL-01-01-023-F-SD-I	1.14	1.14	<CL <sup>1</sup>	0.40	1.30

<sup>1</sup> Less than the Critical Level

#### 4.3.2 OOL-01-02 Remedial Actions and Further Investigations

No investigations or remedial actions were required in OOL-01-02.

#### 4.3.3 OOL-01-03 Remedial Actions and Further Investigations

No investigations or remedial actions were required in OOL-01-03; however, an elevated measurement comparison was performed as outlined in Section 5.5.3 of this report.

#### 4.3.4 OOL-01-04 Remedial Actions and Further Investigations

No investigations or remedial actions were required in OOL-01-04.

#### 4.3.5 OOL-01-05 Remedial Actions and Further Investigations

Survey Unit OOL-01-05 contained an elevated area identified during the investigation survey performed in OOL-03-02. The elevated area was found to include a surface area (20.2m<sup>2</sup>) inside Survey Unit OOL-03-02 that extended into Survey Unit OOL-01-05 (14m<sup>2</sup>). Through the use perimeter sediment samples (gamma-specific boundary sediment samples identified in Table 4); the boundaries of the 14m<sup>2</sup> elevated area within OOL-01-05 were established. Once the boundaries were established, investigative samples were taken within the area. The results of the analysis of the investigative samples were then averaged to give the average elevated concentration within the elevated area and a fractional DCGL<sub>EMC</sub> was performed for OOL-01-05. The following calculation along with the information contained in Table 4 demonstrates the elevated measurement comparison.

Note: The 14m<sup>2</sup> area within the boundary of OOL-01-05 was rounded up to 25m<sup>2</sup> for the determination of the AF in Appendix 6Q of the YNPS LTP for conservatism.

**Table 4 Inputs to  $f(\text{DCGL}_{\text{EMC}})$  Calculation**

	$\text{Co}^{60}$	$\text{Cs}^{137}$	$\text{Sr}^{90}$
Average Elevated Area Concentration ( $\bar{C}_{\text{elevated}}$ ):	0.653 pCi/g	1.654 pCi/g	0.17 pCi/g
$\text{DCGL}_W$	1.6	3.4	0.7
Area Factor for 25m <sup>2</sup>	1.8	3.7	54
Mean of OOL-01-05 ( $\delta$ )	0.025 pCi/g	0.264 pCi/g	0.01 pCi/g

Note: The non-elevated area Mean is identical to the Mean of the Survey Unit (i.e. the mean of the FSS data for the unit).

$$\frac{\delta}{\text{DCGL}_W} + \frac{\bar{C}_{\text{elevated}} - \delta}{(\text{AreaFactor}) \times \text{DCGL}_W} < 1$$

$$\frac{0.03}{1.6} + \frac{0.65 - 0.03}{(1.8) \times 1.6} = 0.24 \text{ Co}^{60};$$

$$\frac{0.26}{3.4} + \frac{1.65 - 0.26}{(3.7) \times 3.4} = 0.19 \text{ Cs}^{137};$$

$$\frac{0.01}{0.7} + \frac{0.17 - 0.01}{(54) \times 0.7} = 0.02 \text{ Sr}^{90}$$

$$\text{Total } f(\text{DCGL}_{\text{emc}}) = 0.45$$

Samples taken inside Survey Unit OOL-01-05 were labeled as OOL-03-02-xxx-F-I (as part of the investigation in Survey Unit OOL-03-02) and used in assessing the extent of the impact of the elevated area which migrated from the East Storm Drain Outfall into both survey units. OOL-03-02-041-F-I and OOL-03-02-042-F-I were taken at the boundary between Survey Units OOL-03-02 and OOL-01-05. Samples inside the OOL-01-05 elevated area and boundary samples are summarized in Table 5 below. Maps depicting the posting plots for the elevated area are found in Attachment A.

**Table 5 Summary of Elevated Area Samples in Survey Unit OOL-01-05**

Sample Number	$\text{Co}^{60}$ pCi/g	$\text{Cs}^{137}$ pCi/g	$\text{Sr}^{90}$ pCi/g
OOL-03-02-041-F-I <sup>1</sup>	0.13	0.38	N/A <sup>2</sup>
OOL-03-02-042-F-I	0.57	2.65	0.21
OOL-03-02-060-F-I	0.84	1.89	N/A <sup>2</sup>
OOL-03-02-061-F-I <sup>1</sup>	0.28	1.12	N/A <sup>2</sup>
OOL-03-02-062-F-I	1.05	0.94	N/A <sup>2</sup>
OOL-03-02-066-F-I <sup>1</sup>	0.06	0.34	N/A <sup>2</sup>
OOL-03-02-067-F-I <sup>1</sup>	0.08	0.45	N/A <sup>2</sup>
OOL-03-02-079-F-I	0.20	0.68	N/A <sup>2</sup>
OOL-03-02-080-F-I	0.43	1.10	N/A <sup>2</sup>

Sample Number	Co <sup>60</sup> pCi/g	Cs <sup>137</sup> pCi/g	Sr <sup>90</sup> pCi/g
OOL-03-02-081-F-I	1.03	2.86	0.13
OOL-03-02-082-F-I	0.45	1.46	N/A <sup>2</sup>
Elevated Area Avg.	0.65	1.65	0.17

<sup>1</sup> These samples are not used in determination of the average concentrations within the elevated area. They were used in determining the boundaries of the elevated area (14m<sup>2</sup>).

<sup>2</sup> Radionuclide Not Detected

Note: The FSS of OOL-01-05 employed the conservative DCGL<sub>w</sub> from the Massachusetts Department of Public Health criteria of 10 mRem per year. Per the YNPS LTP mandated DCGL, the highest reading in the elevated area would not have exceeded 30% of DCGL<sub>w</sub> and therefore would not have warranted any investigations.

After analyzing the statistical data and performing the elevated measurement comparison, no further investigations or remedial actions are required. The methodology behind this determination is as follows:

- Because of the shape of the elevated area and the concentrations in both OOL-03-02 and OOL-01-05, the source of the elevated area can be attributed to activity coming from the east storm drain outfall. Therefore it can be determined, with confidence, that no other elevated areas exist in Survey Unit OOL-01-05.
- The boundaries have been accurately defined by sediment sampling reinforcing the assurance that no other elevated areas exist in Survey Unit OOL-01-05.

Note: The above two points provide a logical assurance that the movement of contamination from a known source location, within the local environment (i.e. OOL-01-05), has been defined therefore providing reasonable confidence that no other areas of elevated activity exist in the Survey Unit.

Throughout the planning of OOL-01-05 a significant amount of conservatism has been built into the survey plan. Since scanning is not required in this Survey Unit, it would not be logical to subdivide the small area of this Survey Unit when, with the exception of the suggested size criteria of a Class 1 unit, the survey planning of the subdivided unit would not differ from that of the original survey plan.

#### **4.3.6 OOL-01-06 Remedial Actions and Further Investigations**

No investigations or remedial actions were required in OOL-01-06; however, an elevated measurement comparison was performed as outlined in Section 5.5.6 of this report.

#### **4.4 Unique Features of Survey Area**

The Survey Unit is covered with water (Sherman Reservoir), and the samples were composites of sediment from the seal pit cove, and the reservoir shoreline and floor. The majority of the samples were taken underwater and scanning was not required per section 5.6.3.2.5 of the YNPS LTP.

#### **4.5 ALARA Practices and Evaluations**

The generic ALARA evaluation for soils is documented in [Appendix B](#), 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 C](#), 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 OOL-01 Survey Area was planned and developed in accordance with the YNPS LTP using the DQO process. Form DPF-8856.1, found in YNPS Procedure DP-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 and survey instrumentation. The WRS Test was specified for non-parametric statistical testing for the Survey Unit, if required. The data contained in the reference area background technical report, YA-REPT-00-019-05, “*Harriman Reservoir Area Background Study*” was applied in performance of the WRS test. The design parameters developed are presented below.

**Table 6 Survey Area OOL-01 Design Parameters**

Survey Unit	Design Parameter	Value	Basis
OOL-01-01	Survey Unit Area	204.7 m <sup>2</sup>	Class 2, Sediment, > 2,000 m <sup>2</sup> , ≤ 10,000 m <sup>2</sup>
	Number of Direct Measurements	15 (calculated) + 0 (added) Total: 15	$\alpha$ (Type I) = 0.025 $\beta$ (Type II) = 0.05 $\sigma$ : 0.22 Relative Shift: 2.3 DCGL <sub>w</sub> (Unity): 1 LBGR: 0.5
	Area Factor:	N/A	Class 2: N/A
	Gridded Sample Area Size Factor	Class 2: 13.7m <sup>2</sup>	Area / Number of Samples (204.7 m <sup>2</sup> /15)
	Sample Grid Spacing:	Triangular 3.97m	Square Root (204.7 m <sup>2</sup> /(0.866*15))
	Direct Measurement Investigation Level	> DCGL <sub>w</sub>	Class 2 Area: > DCGL <sub>w</sub>
	Scanning Coverage Requirements	Scanning not required	N/A per Section 5.6.3.2.5 of YNPS LTP
	Scan Investigation Level	N/A	N/A
OOL-01-02	Survey Unit Area	401m <sup>2</sup>	Class 2, Sediment, > 2,000 m <sup>2</sup> , ≤ 10,000 m <sup>2</sup>
	Number of Direct Measurements	16 (calculated) + 0 (added) Total: 16	$\alpha$ (Type I) = 0.05 $\beta$ (Type II) = 0.05 $\sigma$ : 0.3 Relative Shift: 1.667 DCGL <sub>w</sub> (Unity): 1 LBGR: 0.5
	Area Factor:	N/A	Class 2: N/A
	Gridded Sample Area Size Factor	Class 2: 25m <sup>2</sup>	Area / Number of Samples (401 m <sup>2</sup> /16)
	Sample Grid Spacing:	Triangular: 5.4m	Square Root (401 m <sup>2</sup> /(0.866*16))
	Direct Measurement Investigation Level	> DCGL <sub>w</sub>	Class 2 Area: > DCGL <sub>w</sub>
	Scanning Coverage Requirements	Scanning not required	N/A per Section 5.6.3.2.5 of YNPS LTP
	Scan Investigation Level	N/A	N/A
OOL-01-03	Survey Unit Area	751 m <sup>2</sup>	Class 1, Sediment, <2,000m <sup>2</sup>
	Number of Direct Measurements	13 (calculated) + 7 (added) Total: 20	$\alpha$ (Type I) = 0.05 $\beta$ (Type II) = 0.05 $\sigma$ : 0.22 Relative Shift: 2.3 DCGL <sub>w</sub> (Unity): 1 LBGR: 0.5
	<i>a-priori</i> area of source:	50m <sup>2</sup> (Adjusted from 37.6)	Class 1: Appendix 6Q of the YNPS LTP
	Gridded Sample Area Size Factor	Class 1: 37.6m <sup>2</sup>	Area / Number of Samples (751 m <sup>2</sup> /20)
	Sample Grid Spacing:	Triangular: 6.6m	Square Root (751 m <sup>2</sup> /(0.866*20))
	Direct Measurement Investigation Level	> DCGL <sub>emc</sub> or > DCGL <sub>w</sub> + 3 Sigma	Class 1 Area: > DCGL <sub>emc</sub> or > DCGL <sub>w</sub> + 3 Sigma
	Scanning Coverage Requirements	Scanning not required	N/A per Section 5.6.3.2.5 of YNPS LTP

Survey Unit	Design Parameter	Value	Basis
	Scan Investigation Level	N/A	N/A
OOL-01-04	Survey Unit Area	67,120 m <sup>2</sup>	Class 2, Sediment
	Number of Direct Measurements	13 (calculated) + 7 (added) Total: 20	$\alpha$ (Type I) = 0.05 $\beta$ (Type II) = 0.05 $\sigma$ : 0.24 Relative Shift: 2.08 DCGL <sub>w</sub> (Unity): 1 LBGR: 0.5
	Area Factor:	N/A	Class 2: N/A
	Gridded Sample Area Size Factor	3356 m <sup>2</sup>	Area / Number of Samples (67,120 m <sup>2</sup> /20)
	Sample Grid Spacing:	Triangular: 62.3m	Square Root (67,120 m <sup>2</sup> /(0.866*20))
	Direct Measurement Investigation Level	> DCGL <sub>w</sub>	Class 2 Area: > DCGL <sub>w</sub>
	Scanning Coverage Requirements	Scanning not required	N/A per Section 5.6.3.2.5 of YNPS LTP
	Scan Investigation Level	N/A	N/A
OOL-01-05	Survey Unit Area	4,540 m <sup>2</sup>	Class 2, Sediment, > 2,000 m <sup>2</sup> , ≤ 10,000 m <sup>2</sup>
	Number of Direct Measurements	13 (calculated) + 7 (added) Total: 20	$\alpha$ (Type I) = 0.05 $\beta$ (Type II) = 0.05 $\sigma$ : 0.24 Relative Shift: 2.08 DCGL <sub>w</sub> (Unity): 1 LBGR: 0.5
	Area Factor:	N/A	Class 2: N/A
	Gridded Sample Area Size Factor	Class 2: 227 m <sup>2</sup>	Area / Number of Samples (4,540 m <sup>2</sup> /20)
	Sample Grid Spacing:	Triangular: 16.2 m	Square Root (4,540 m <sup>2</sup> /(0.866*20))
	Direct Measurement Investigation Level	> DCGL <sub>w</sub>	Class 2 Area: > DCGL <sub>w</sub>
	Scanning Coverage Requirements	Scanning not required	N/A per Section 5.6.3.2.5 of YNPS LTP
	Scan Investigation Level	N/A	N/A
OOL-01-06	Survey Unit Area	186m <sup>2</sup>	Class 1, Sediment, < 2,000 m <sup>2</sup>
	Number of Direct Measurements	13 (calculated) + 2 (added) Total: 15	$\alpha$ (Type I) = 0.05 $\beta$ (Type II) = 0.05 $\sigma$ : 0.22 Relative Shift: 2.3 DCGL <sub>w</sub> (Unity): 1 LBGR: 0.5
	<i>a-priori</i> area of source:	25m <sup>2</sup> (Adjusted from 12.4)	Class 1: Appendix 6Q of the YNPS LTP
	Gridded Sample Area Size Factor	12.4m <sup>2</sup>	Area / Number of Samples (186 m <sup>2</sup> /15)
	Sample Grid Spacing:	Triangular: 3.8m	Square Root (186 m <sup>2</sup> /(0.866*15))
	Direct Measurement Investigation Level	> DCGL <sub>emc</sub> or > DCGL <sub>w</sub> + 3 Sigma	Class 1 Area: > DCGL <sub>emc</sub> or > DCGL <sub>w</sub> + 3 Sigma
	Scanning Coverage Requirements	Scanning not required	N/A per Section 5.6.3.2.5 of YNPS LTP

Survey Unit	Design Parameter	Value	Basis
	Scan Investigation Level	N/A	N/A

### 5.1.2 Deviations from the FSS Plan as Written in the YNPS LTP

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

The FSSP for OOL-01-02 designated OOL-01-02-002-F-SD as a QC Recount sample. This sample was not recounted. However, Sample OOL-01-02-009-F-SD, a spiked sample, was recounted and constitutes the 5% FSS QAPP requirement for sample recounts. The deviation from the OOL-01-02 FSSP is documented in Attachment D, CR 06-419.

### 5.1.3 DCGL Selection and Use

The YNPS LTP DCGLs for soil were calculated using the resident farmer scenario. For the resident farmer scenario, the residual radioactive material was assumed to be in the top 2.89 m soil layer, available for use in residential and light farming activities. The average member of the critical group is the resident farmer who lives on the site, grows all of his/her diet onsite and drinks water from a groundwater source onsite. The YNPS LTP DCGL determinations were performed using RESRAD version 6.21 analyses and based upon a resulting dose of 25 mRem per year. Since the sediments associated with this Survey Area are located underwater in Sherman Pond, they are outside the influence of groundwater or building debris. In the unlikely event that, after the ISFSI is removed, the sediments were dredged and dispersed across the site, the dose contribution would be small enough to account for the groundwater and building debris.

For the final evaluation of the OOL-01 Survey Area and throughout this report, the administrative acceptance criterion of 10 mRem per year has been set for Soil YNPS LTP-listed radionuclides.

Note: The media collected in OOL-01 was predominantly sediment but conservatively treated as soil at the 10 mRem per year DCGLs.

**Table 7 Soil DCGL Values**

Nuclide	Soil 10 mRem per year (pCi/g)	Nuclide	Soil 10 mRem per year (pCi/g)
Co <sup>60</sup>	1.6E+00	H <sup>3</sup>	1.5E+02
Nb <sup>94</sup>	2.9E+00	C <sup>14</sup>	2.2E+00
Ag <sup>108m</sup>	2.9E+00	Fe <sup>55</sup>	1.2E+04
Sb <sup>125</sup>	1.3E+01	Ni <sup>63</sup>	3.2E+02

Nuclide	Soil 10 mRem per year (pCi/g)	Nuclide	Soil 10 mRem per year (pCi/g)
Cs <sup>134</sup>	2.0E+00	Sr <sup>90</sup>	7.0E-01
Cs <sup>137</sup>	3.4E+00	Tc <sup>99</sup>	5.6E+00
Eu <sup>152</sup>	4.1E+00	Pu <sup>238</sup>	1.3E+01
Eu <sup>154</sup>	3.8E+00	Pu <sup>239</sup>	1.2E+01
Eu <sup>155</sup>	1.6E+02	Pu <sup>240</sup> /Pu <sup>241</sup>	3.9E+02
Am <sup>241</sup>	1.2E+01	Cm <sup>243</sup> /Cm <sup>244</sup>	1.3E+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 OOL-01 Design Parameters". Split samples and recounts are addressed under the quality control section 6.2. The OOL-01-01, OOL-01-02, OOL-01-03, OOL-01-04, OOL-01-05 and OOL-01-06 sediment sampling grids were developed as systematic grids with spacing consisting of a triangular pitch pattern with a random starting point. In locations where sample points were inaccessible (i.e. sample point located over rip rap), alternate sample locations were identified in accordance with DP-8856, "Preparation of Survey Plans". Sample measurement locations are provided in Attachment A.

Scanning is not required per section 5.6.3.2.5 of the License Termination Plan. The survey plan possessed sufficient power with the number of samples required.

#### 5.2 Survey Implementation Activities

The Table below provides a summary of daily activities performed during the Final Status Survey of OOL-01.

**Table 8 FSS Activity Summary for OOL-01**

Survey Unit	Date	Activity
OOL-01-01	9/23/2005	Performed walk-down of Survey Unit
	9/23/2005	Established Isolation and Controls
	7/31/2006	Performed Job Hazard Analysis
	6/28/2005	Performed Unit Classification
	8/1/2006	Performed Sample Quantity Calculations, established DQOs
	7/31/2006	Generated FSS Sample Plans
	8/1/2006	Performed sediment sampling.
	11/13/2006	Performed DQA, FSS Complete
OOL-01-02	8/25/2005	Performed walk-down of Survey Unit
	8/25/2005	Established Isolation and Controls

Survey Unit	Date	Activity
	8/25/2005	Performed Job Hazard Analysis
	8/25/2005	Performed Unit Classification
	8/17/2005	Performed Sample Quantity Calculations, established DQOs
	8/18/2005	Generated FSS Sample Plans
	8/25/2005	Performed sediment sampling.
	10/4/2005	Performed DQA, FSS Complete
OOL-01-03	7/30/2006	Performed walk-down of Survey Unit
	7/31/2006	Established Isolation and Controls
	7/31/2006	Performed Job Hazard Analysis
	7/20/2006	Performed Unit Classification
	7/20/2006	Performed Sample Quantity Calculations, established DQOs
	7/20/2006	Generated FSS Sample Plans
	7/31/2006	Performed sediment sampling.
9/19/2006	Performed DQA, FSS Complete	
OOL-01-04	7/7/2006	Performed walk-down of Survey Unit
	7/7/2006	Established Isolation and Controls
	7/7/2006	Performed Job Hazard Analysis
	5/1/2006	Performed Unit Classification
	6/30/2006	Performed Sample Quantity Calculations, established DQOs
	6/30/2006	Generated FSS Sample Plans
	7/7/2006	Performed sediment sampling.
	10/10/2006	Performed DQA, FSS Complete
OOL-01-05	7/5/2006	Performed walk-down of Survey Unit
	7/5/2006	Established Isolation and Controls
	7/5/2006	Performed Job Hazard Analysis
	5/1/2006	Performed Unit Classification
	6/29/2006	Performed Sample Quantity Calculations, established DQOs
	6/29/2006	Generated FSS Sample Plans
	7/6/2006	Performed sediment sampling.
	12/8/2006	Performed DQA, FSS Complete
OOL-01-06	7/30/2006	Performed walk-down of Survey Unit
	7/31/2006	Established Isolation and Controls
	7/31/2006	Performed Job Hazard Analysis
	7/20/2006	Performed Unit Classification
	7/20/2006	Performed Sample Quantity Calculations, established DQOs
	7/20/2006	Generated FSS Sample Plans
	7/31/2006	Performed sediment sampling.
	11/2/2006	Performed DQA, FSS Complete

### 5.3 Surveillance Surveys

#### 5.3.1 Periodic Surveillance Surveys

Upon completion of the FSS of Survey Area OOL-01, 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.

### 5.3.2 Resurveys

No resurveys were performed in OOL-01.

### 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 OOL-01 had five systematic measurements that exceeded unity, 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 ( $H_0$ ) (that the Survey Unit exceeds the release criteria) is rejected. A summary of the soil samples are contained in Table 9 below.

**Table 9 Soil Sample Summary**

Sample Description	SOF						
OOL-01-01-009-F-SD	0.40	OOL-01-02-001-F-SD	0.07	OOL-01-03-001-F-SD	0.07	OOL-01-04-001-F-SD	0.11
OOL-01-01-010-F-SD	0.28	OOL-01-02-002-F-SD	0.13	OOL-01-03-002-F-SD	0.05	OOL-01-04-002-F-SD	0.07
OOL-01-01-011-F-SD	0.35	OOL-01-02-003-F-SD	0.10	OOL-01-03-003-F-SD	0.14	OOL-01-04-003-F-SD	0.53
OOL-01-01-012-F-SD	0.54	OOL-01-02-004-F-SD	0.13	OOL-01-03-004-F-SD	0.37	OOL-01-04-004-F-SD	0.17
OOL-01-01-013-F-SD	0.65	OOL-01-02-006-F-SD	0.10	OOL-01-03-005-F-SD	0.26	OOL-01-04-005-F-SD	0.13
OOL-01-01-014-F-SD	0.15	OOL-01-02-007-F-SD	0.07	OOL-01-03-006-F-SD	0.46	OOL-01-04-006-F-SD	0.05
OOL-01-01-015-F-SD	0.07	OOL-01-02-008-F-SD	0.07	OOL-01-03-007-F-SD	1.71	OOL-01-04-007-F-SD	0.23
OOL-01-01-016-F-SD	0.17	OOL-01-02-010-F-SD	0.09	OOL-01-03-008-F-SD	0.76	OOL-01-04-008-F-SD	0.04
OOL-01-01-038-F-SD	0.25	OOL-01-02-011-F-SD	0.07	OOL-01-03-009-F-SD	0.63	OOL-01-04-009-F-SD	0.33
OOL-01-01-039-F-SD	0.12	OOL-01-02-012-F-SD	0.05	OOL-01-03-010-F-SD	0.16	OOL-01-04-010-F-SD	0.08
OOL-01-01-040-F-SD	0.12	OOL-01-02-013-F-SD	0.08	OOL-01-03-011-F-SD	0.15	OOL-01-04-011-F-SD	0.29
OOL-01-01-041-F-SD	0.14	OOL-01-02-014-F-SD	0.08	OOL-01-03-012-F-SD	0.18	OOL-01-04-012-F-SD	0.06
OOL-01-01-042-F-SD	0.04	OOL-01-02-015-F-SD	0.07	OOL-01-03-013-F-SD	1.18	OOL-01-04-013-F-SD	0.34
OOL-01-01-043-F-SD	0.15	OOL-01-02-016-F-SD	0.05	OOL-01-03-014-F-SD	0.05	OOL-01-04-014-F-SD	0.31
OOL-01-01-044-F-SD	0.57	OOL-01-02-018-F-SD	0.08	OOL-01-03-015-F-SD	0.07	OOL-01-04-015-F-SD	0.42
		OOL-01-02-019-F-SD	0.07	OOL-01-03-016-F-SD	0.44	OOL-01-04-016-F-SD	0.30
				OOL-01-03-017-F-SD	0.93	OOL-01-04-017-F-SD	0.14
				OOL-01-03-018-F-SD	0.43	OOL-01-04-018-F-SD	0.18
				OOL-01-03-019-F-SD	0.12	OOL-01-04-019-F-SD	0.17
				OOL-01-03-020-F-SD	0.24	OOL-01-04-020-F-SD	0.07
Max	0.65	Max	0.13	Max	1.71	Max	0.53
Average	0.27	Average	0.08	Average	0.42	Average	0.20
Standard Deviation	0.19	Standard Deviation	0.02	Standard Deviation	0.44	Standard Deviation	0.14

Sample Description	SOF	Sample Description	SOF
OOL-01-05-001-F-SD	0.06	OOL-01-06-001-F-SD	0.19
OOL-01-05-002-F-SD	0.08	OOL-01-06-002-F-SD	0.24
OOL-01-05-003-F-SD	0.09	OOL-01-06-003-F-SD	0.67
OOL-01-05-004-F-SD	0.07	OOL-01-06-004-F-SD	0.83
OOL-01-05-005-F-SD	0.34	OOL-01-06-005-F-SD	1.16
OOL-01-05-006-F-SD	0.05	OOL-01-06-006-F-SD	0.08
OOL-01-05-007-F-SD	0.04	OOL-01-06-007-F-SD	0.82
OOL-01-05-008-F-SD	0.23	OOL-01-06-008-F-SD	0.14
OOL-01-05-009-F-SD	0.16	OOL-01-06-009-F-SD	0.93
OOL-01-05-010-F-SD	0.04	OOL-01-06-010-F-SD	2.68
OOL-01-05-011-F-SD	0.06	OOL-01-06-011-F-SD	0.22
OOL-01-05-012-F-SD	0.36	OOL-01-06-012-F-SD	1.51
OOL-01-05-013-F-SD	0.12	OOL-01-06-013-F-SD	0.93
OOL-01-05-014-F-SD	0.32	OOL-01-06-014-F-SD	0.10
OOL-01-05-015-F-SD	0.08	OOL-01-06-015-F-SD	0.20
OOL-01-05-016-F-SD	0.20		
OOL-01-05-017-F-SD	0.20		
OOL-01-05-018-F-SD	0.05		
OOL-01-05-019-F-SD	0.14		
OOL-01-05-020-F-SD	0.08		
Max	0.36	Max	2.68
Average	0.14	Average	0.71
Standard Deviation	0.10	Standard Deviation	0.70

Note: Samples OOL-01-02-005-F-SD, OOL-01-02-009-F-SD and OOL-01-02-017-F-SD were QC samples of material with known activity and were not part of the statistical sample set.

Note: If the highest average concentration in OOL-01 (the average concentration of OOL-01-06) were dredged and spread over a Survey Unit the dose contribution would be about 7 mRem which is below the 8.73 mRem criteria when accounting for groundwater and building debris.

## 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 OOL-01-01 Data Quality Assessment

Two of the original sixteen fixed point sample concentrations had sum-of-fraction concentrations greater than unity based on the Massachusetts Department of Public Health criteria of 10 mRem per year. The original measurements OOL-01-01-001-F-SD and OOL-01-01-002-F-SD were investigated with OOL-01-01-036-F-SD-I and OOL-01-01-037-F-SD-I respectively and did not confirm the residual activity concentrations from the original FSS sampling effort. Sample OOL-01-01-023-F-SD-I (taken between OOL-01-02-002-F-SD and OOL-01-02-007-F-SD) did have a sum-of-fractions greater than unity. The decision to partially reclassify and subdivide the survey unit into two units was based upon the results of the investigation and to provide assurance that the elevated area was bounded. Survey Unit OOL-01-06 was designed as a Class 1 survey unit and was surveyed against the decision criteria of that plan. The remainder of the survey unit was resurveyed as a Class 2 survey unit under a new revision to the FSSP (YNPS-FSSP-OOL-01-01-02). The Type I error was adjusted from 0.05 to 0.025 and seven (7) additional samples were collected to satisfy the sampling statistics in accordance with section 5.5.1 of the License Termination Plan. The revised OOL-01-01 measurements (15 total) were below the  $DCGL_w$  and no sum-of-fractions were equal to or greater than one. HTD sample results were less than  $DCGL_w$ . 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. Review of the quantile plot for OOL-01-01 indicates no significant variability in the data set and the frequency plot demonstrates a normal distribution. The survey maintained sufficient power to pass the unit and the data set verified the assumptions of the statistical test.

### 5.5.2 OOL-01-02 Data Quality Assessment

Fixed point sample concentrations were below the  $DCGL_w$  and no sum-of-fractions were equal to or greater than one. HTD sample results were less than  $DCGL_w$ . 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. Review of the quantile plot for OOL-01-01 indicates no significant variability in the data set and the frequency plot demonstrates a slight skew to the right. The survey maintained sufficient power to pass the unit and the data set verified the assumptions of the statistical test.

### 5.5.3 OOL-01-03 Data Quality Assessment

The mean of the sum of fractions for the statistical data set was less than  $DCGL_w$  (unity). Two of the fixed point sample concentrations had sum-of-fraction concentrations greater than unity. An Elevated Measurement Comparison was made on the two sample concentrations and both were below the investigation criteria outlined in Section 5.5.3 of the YNPS LTP. The WRS statistical test was performed in accordance with DP-8857, “*Statistical Tests*” and the survey unit meets the acceptance criterion (some Survey Unit sum-of-fractions may exceed some reference area measurements by more than the  $DCGL_w$  and still meet the release criteria in accordance with MARSSIM). 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 a slight asymmetry in the lower quartile and the frequency plot exhibits a slight skew to the left. The retrospective standard deviation was larger than the prospective standard deviation however; the survey maintained sufficient power to pass the unit and the data set verified the assumptions of the statistical test.

### 5.5.4 OOL-01-04 Data Quality Assessment

Fixed point sample concentrations were below the  $DCGL_w$  and no sum-of-fractions were equal to or greater than one. HTD sample results were less than  $DCGL_w$ . 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 a slight asymmetry in the outer quartiles and the frequency plot demonstrates a slight skew to the left. The survey maintained sufficient power to pass the unit and the data set verified the assumptions of the statistical test.

### 5.5.5 OOL-01-05 Data Quality Assessment

Fixed point sample concentrations were below the  $DCGL_w$  and no sum-of-fractions were equal to or greater than one.  $DCGL_{EMC}$  was calculated for the 14m<sup>2</sup> elevated area identified in the survey unit and passed the Massachusetts Department of Public Health criteria of 10 mRem per year. The data set outside of the elevated area 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 a slight asymmetry in the inner quartile and the frequency plot demonstrates a slight skew to the left. The survey maintained sufficient power to pass the unit and the data set verified the assumptions of the statistical test.

### 5.5.6 OOL-01-06 Data Quality Assessment

OOL-01-06 was created in response to the investigation of elevated measurements identified in Survey Unit OOL-01-01. Three of the fifteen fixed point sample concentrations sum-of-fractions were greater than one based on the Massachusetts Department of Public Health criteria of 10 mRem per year. One of the fixed point samples had a HTD result greater than  $DCGL_w$  for  $Sr^{90}$ . The WRS Test was performed in accordance with DP-8857, “*Statistical Tests*” and met the acceptance criterion (some Survey Unit sum-of-fractions may exceed some reference area measurements by more than the  $DCGL_w$  and still meet the release criteria in accordance with MARSSIM). An Elevated Measurement Comparison was made on the three sample concentrations and all were below the investigation criteria outlined in Section 5.5.3 of the YNPS LTP.

The data set was within approximately two logarithmic standard deviations with normal dispersion about the logarithmic mean. Review of the quantile plot for OOL-01-06 indicates no significant variability in the data set and the frequency plot demonstrates a Log Normal distribution. The retrospective logarithmic standard deviation was approximately two times larger than the prospective standard deviation reducing the power of the survey; however, the Survey Unit passed the statistical test (i.e. Wilcoxon Rank Sum Test). The data set verified the assumptions of the statistical test.

## 6.0 QUALITY ASSURANCE AND QUALITY CONTROL

### 6.1 Instrument QC Checks

Scanning is not required per section 5.6.3.2.5 of the YNPS LTP.

### 6.2 Split Samples and Recounts

#### 6.2.1 OOL-01-01 Split Samples and Recounts

One split and one recount “QC” samples were gathered and within tolerable limits in accordance with DP-8864, “*Split Sample Assessment for Final Status Survey*”.

#### 6.2.2 OOL-01-02 Split Samples and Recounts

One split and one recount “QC” sample were gathered and within tolerable limits in accordance with DP-8864, “*Split Sample Assessment for Final Status Survey*”.

#### **6.2.3 OOL-01-03 Split Samples and Recounts**

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

#### **6.2.4 OOL-01-04 Split Samples and Recounts**

One split and one recount “QC” samples were gathered and within tolerable limits in accordance with DP-8864, “*Split Sample Assessment for Final Status Survey*”.

#### **6.2.5 OOL-01-05 Split Samples and Recounts**

One split and one recount “QC” samples were gathered and within tolerable limits in accordance with DP-8864, “*Split Sample Assessment for Final Status Survey*”.

#### **6.2.6 OOL-01-06 Split Samples and Recounts**

One split and one recount “QC” samples 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 OOL-01.

## 7.0 CONCLUSION

The FSS of OOL-01 has been performed in accordance with YNPS LTP and applicable FSS procedures. Evaluation of the sediment sample data has shown none of the systematic sediment samples exceeded the  $DCGL_W$  in Survey Units OOL-01-01, OOL-01-02, OOL-01-04 and OOL-01-05. The WRS test was applied to OOL-01-03 and OOL-01-06 as the statistical test with the Survey Units passing the test. An Elevated Measurement Comparison calculation was performed on OOL-01-05 resulting with an  $fDCGL_{EMC}$  sum-of-fractions (unity) less than one. Elevated Measurement Comparisons were made in OOL-01-03 and OOL-01-06 with all results below the investigation criteria outlined in Section 5.5.3 of the YNPS LTP. Sample results and the statistical tests for OOL-01 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 ( $H_0$ ) is rejected.

OOL-01 meets the objectives of the Final Status Survey.

Based upon the evaluation of the data acquired for the FSS, OOL-01 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. 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

---

Appendix A – YNPS-FSSP-OOL-01, “*Final Status Survey Planning Worksheets*”

Appendix B – YA-REPT-00-003-05, “*Generic ALARA Review for Final Status Survey of Soil at YNPS*”

Appendix C – ALARA Evaluations, OOL-01

---

List of Attachments

---

Attachment A – Maps and Posting Plots

Attachment B – Data Quality Assessment Plots and Curves

Attachment C – ORTEC Direct Measurement Data

Attachment D – CR-06-419

*(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.)*