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NORTHNAVFACENGCOM 4335/3 (Rev. 6/80)

CONTROL NO. 38

CONTRACT NO.	DELIVERY ORDER #	ACTIVITY LOCATION
N62472-94-D-0398	0034	Naval Weapons Station (NWS) @ Earle, Colts Neck, NJ

PROJECT TITLE:
Draft Final Report for Remedial Action at Operable Unit 1

FROM:	DATE
Foster Wheeler Environmental Corp. Program QC Manager: Mark Miller	February 18, 1999
TO:	DATE
COTR: S. LEHMAN (3 COPIES)	February 18, 1999

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ITEM NO.	SUBMITTAL DESCRIPTION	PREPARED/ SUBMITTED BY	APPROVED	DISAPPROVED	REMARKS
63	SD-18, Draft Final Report for Remedial Action at Operable Unit 1, February 19, 1999.	Janis Hottinger for Mark Miller			

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DRAFT

U.S. NAVY NORTHERN DIVISION
REMEDIAL ACTION CONTRACT (RAC)
CONTRACT NO. N62472-94-D-0398
DELIVERY ORDER NO. 0034
FOSTER WHEELER ENVIRONMENTAL CORPORATION

DRAFT FINAL REPORT

FOR

REMEDIAL ACTION AT OPERABLE UNIT 1 (LANDFILL SITES 4 AND 5)
AT
NAVAL WEAPONS STATION EARLE

COLTS NECK, NEW JERSEY

FEBRUARY 1999

Prepared for

U.S. Navy Northern Division

Revision	Date	Prepared By	Approved By	Pages Affected
0	2/19/99	B. Conley	C. Tippmann	All

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LIST OF ACRONYMS

RAC	Remedial Action Contract
NWS Earle	Naval Weapons Station Earle
OU-1	Operable Unit 1
RI	Remedial Investigation
FS	Feasibility Study
NPL	National Priorities List
ROD	Record of Decision
CEA	Classification Exemption Area
NorthDiv	U.S. Navy Northern Division
FWENC	Foster Wheeler Environmental Corporation
USEPA	United States Environmental Protection Agency
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
RPM	Remedial Project Manager
Construction NTR	Construction Navy Technical Representative
Design NTR	Design Navy Technical Representative
COTR	Contracting Officer's Technical Representative
SQCR	Site Quality Control Representative
SHSO	Site Health and Safety Officer
CQC	Construction Quality Control
QC	Quality Control
QA/QC	Quality Assurance / Quality Control
ROICC	Resident Officer In Charge of Construction
RFI	Request for Information
FCR	Field Change Request
LDPE	Low Density Polyethylene
VFPE	Very Flexible Polyethylene
EOD	Explosive Ordnance Disposal
ASTM	American Society of Testing and Materials
psi	Pounds Per Square Inch

1.0 INTRODUCTION

This document is the Final Report for the Remedial Action conducted at Operable Unit 1 (Landfill Sites 4 and 5) located at the Naval Weapons Station Earle (NWS Earle) in Colts Neck, New Jersey. This report is considered part of the contract documents for the project as described in Delivery Order No. 34 under the Remedial Action Contract No. N62472-94-D-0398.

1.1 PURPOSE

The purpose of this report is to document and certify that the construction procedures, inspection activities, field and laboratory test results, and as-built survey conducted during the remedial action at Landfill Sites 4 and 5 were performed in accordance with the Technical Specifications, Construction Drawings, Construction Work Plan, Soil Erosion and Sediment Control Plan, and the Construction Quality Control Plan. The data collected during the project were used as the primary basis for the Certifying Engineer to certify that the remedial action was completed in accordance with the above referenced documents.

1.2 BACKGROUND

NWS Earle is located in Monmouth County, New Jersey, approximately 47 miles south of New York City. NWS Earle consists of a 10,248-acre Main Base located in the Colts Neck Township approximately 10 miles inland from the Atlantic Ocean at Sandy Hook, and a 706-acre Waterfront Area. Sites 4 and 5 are both located on the Main Base area within Operable Unit 1 (OU-1). Site 4 covers approximately 5 acres and is located to the west of "D" group. Site 5 covers approximately 8 acres and is located west of the Army barricades. Access to both sites is from Esperance Road. Maps of the general area, the site vicinity and the project location are provided in Figures 1-1, 1-2 and 1-3 respectively.

Site 4 is a sanitary landfill that received approximately 10,200 tons of mixed domestic and industrial wastes from 1943 to 1960. The material disposed of in the landfill included scrap metal, construction debris, pesticide and herbicide containers, paint residues, and rinsewaters. It was reported that containers of paint, paint thinners, varnishes, shellacs, acids, alcohols, caustics, and asbestos may also have been disposed of at Site 4. The landfill was covered with a thin layer of sandy soil upon completion of its use. Site 5 is also a sanitary landfill that received approximately 6,600 tons of mixed domestic and industrial wastes between 1968 and 1978. The waste stream at Site 5 included paper, glass, plastics, construction debris, pesticide and herbicide containers,

containers of paint, paint thinners, varnishes, shellacs, acids, alcohols, caustics, and small amounts of asbestos. Once the landfill was closed, the landfilled wastes were covered by a sand and vegetative layer ranging in thickness between 1 and 3-feet. Approximately 1-acre of the site was then used as a skeet shooting range.

In 1990, NWS Earle was placed on the National Priorities List (NPL). The nature and extent of the contamination at Sites 4 and 5 was addressed by the Phase II Remedial Investigation (RI) in 1995. The RI was completed in July 1996 and was used as the basis for performing a Feasibility Study (FS) of potential remedial alternatives.

1.3 RECORD OF DECISION

The Record of Decision (ROD) for Landfill Sites 4 and 5, which documents the selected remedial alternatives for the site, was developed from the findings of the FS and signed by the Navy, U.S. EPA and NJDEP in August 1997. The major components of the ROD for Landfill Sites 4 and 5 included:

1. Re-grading and re-consolidation of waste materials.
2. Capping of the two sites with a RCRA Subtitle D multi-layer cap.
3. Passive gas venting system to manage landfill gas migration and build-up under cap.
4. Surface controls to minimize erosion and manage runoff.
5. Upland revegetation.
6. Establish a Classification Exemption Area (CEA) adjacent to the landfills to bar the use of groundwater during the remediation period.
7. Provide long-term periodic groundwater monitoring.

1.4 CERTIFICATION REQUIREMENTS

The construction of the multi-layered landfill cap included a passive gas collection system, a low density polyethylene (LDPE) geomembrane, a granular drainage layer, and a vegetative support layer. The construction and installation of these systems required verification of the materials delivered to the landfill, the proper placement of the material, and field and laboratory testing of the construction materials. In accordance with requirements of Contract No. N62472-94-D-0398, Delivery Order No. 34, the Final Report certifies the quality control processes and describes the construction activities by including the following documentation: daily and weekly summary reports; field inspection data forms; quality control data provided by manufacturers; laboratory test results; as-built drawings; and design changes approved during construction.

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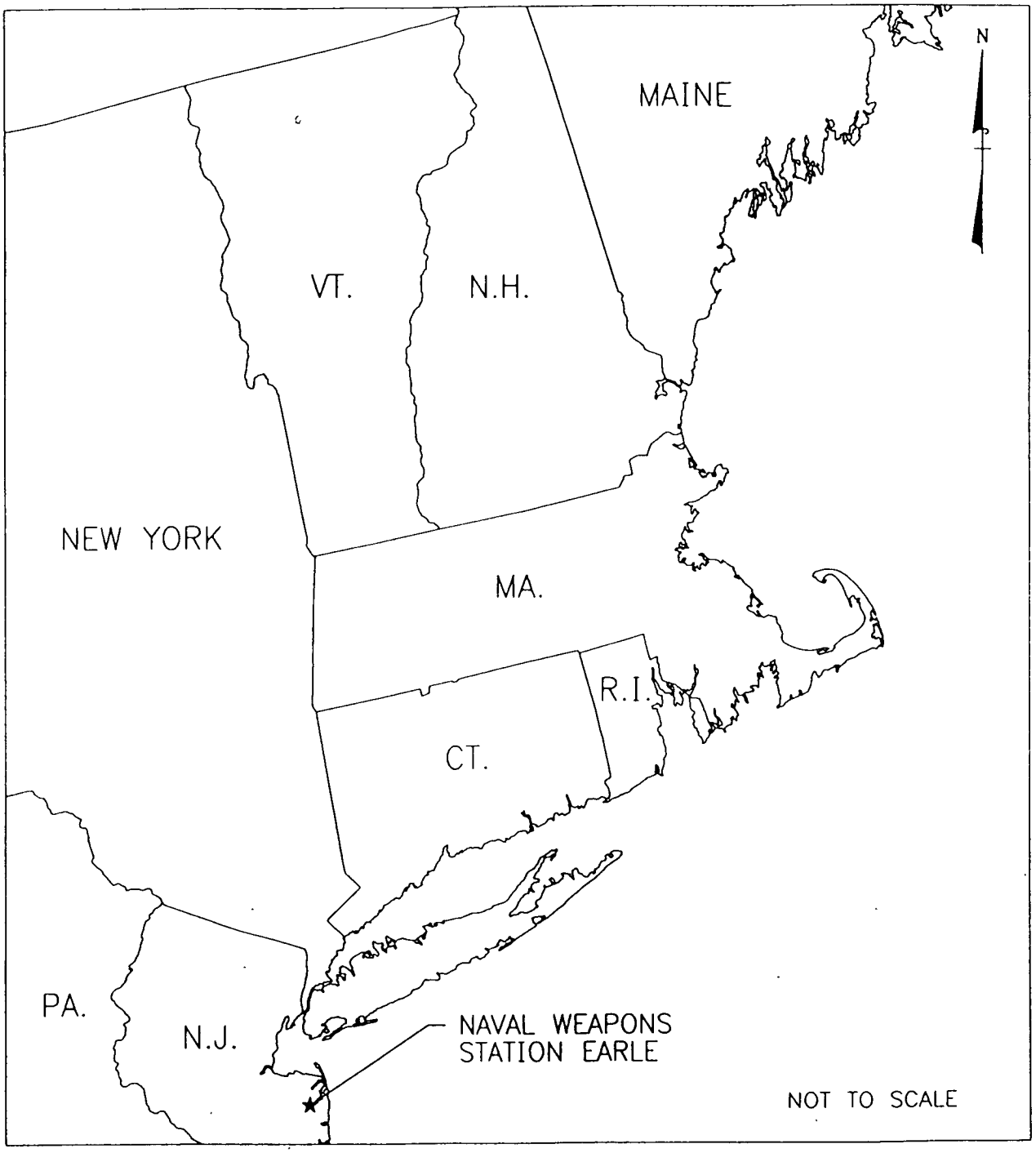

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FOSTER WHEELER ENVIRONMENTAL CORPORATION

AREA MAP
Naval Weapons Station Earle
Colts Neck, New Jersey

Figure 1 – 1

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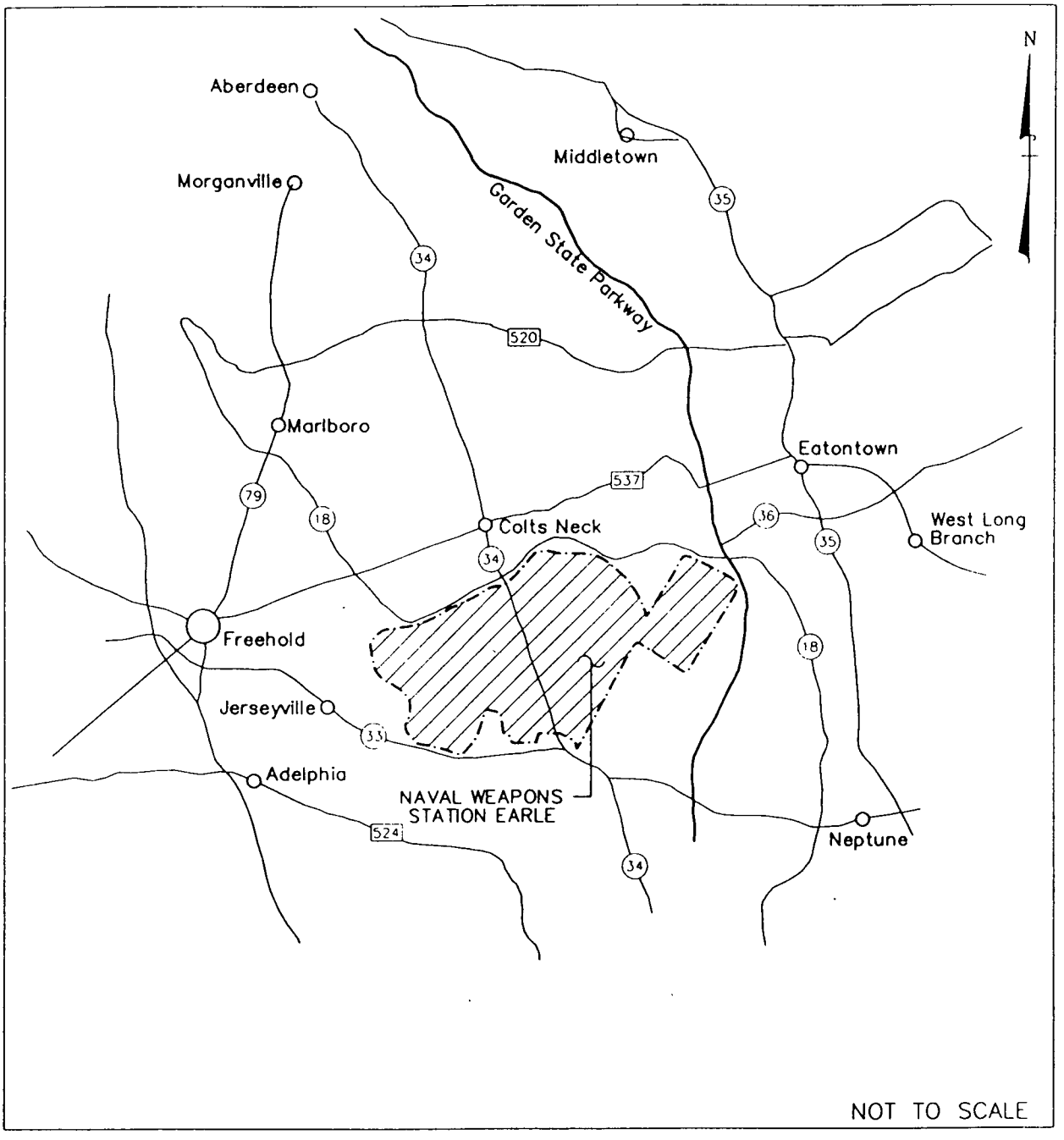

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FOSTER WHEELER ENVIRONMENTAL CORPORATION

VICINITY MAP
Naval Weapons Station Earle
Colts Neck, New Jersey

Figure 1-2

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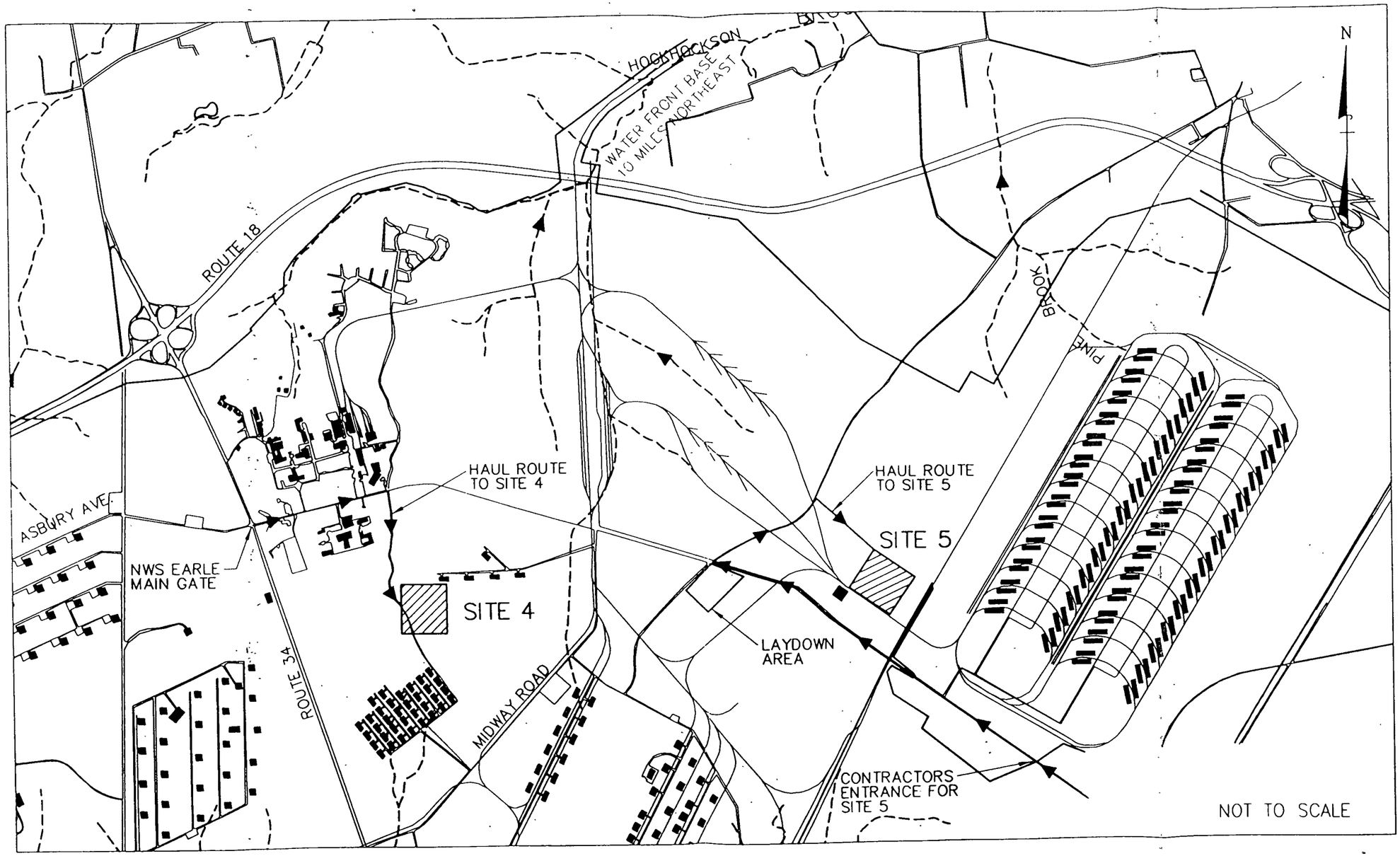

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT LOCATION MAP
Naval Weapons Station Earle
Colts Neck, New Jersey

Figure
1-3

PLOT DATE OCT 23, 1998 D:\Earle\Fig-1-3

2.0 PROJECT ORGANIZATION AND STRUCTURE

Several federal and state organizations were involved in carrying out the remedial action at Landfill Sites 4 and 5. At times, representatives of the various organizations changed; however, the responsibilities and duties of the organizations and personnel positions remained consistent throughout the construction.

2.1 GENERAL

The organizations involved in remedial action at Landfill Sites 4 and 5 included the regulatory agencies, the U.S. Navy Northern Division (NorthDiv) and Foster Wheeler Environmental Corporation (FWENC). The regulatory agencies are the United States Environmental Protection Agency Region II (U.S. EPA) and the New Jersey Department of Environmental Protection (NJDEP). Representatives of the Navy acted as Remedial Project Manager (RPM), Construction Navy Technical Representative (Construction NTR), Design Navy Technical Representative (Design NTR), and Contracting Officer's Technical Representative (COTR). Representatives of the FWENC acted as Program Manager, Project Manager, Certifying Engineer, Site Superintendent, Project Engineer, Site Quality Control Representative (SQCR), QC Manager, Health and Safety Officer, and Project Controls Engineer.

2.2 ORGANIZATION AND RESPONSIBILITIES

The following section describes the responsibilities and lines of authority within each organization involved in the project and construction quality assurance. A project organization list is provided in Table 2-1.

2.2.1 U.S. Navy Northern Division

The U.S. Navy Northern Division (NorthDiv), as facility owner, designated an employee of NWS Earle's office of the Resident Officer In Charge of Construction (ROICC) as the Construction NTR to manage FWENC on the project. NorthDiv also designated employees of their civil design and environmental groups to act as Design NTR, COTR, RPM, and Environmental Coordinator for the project. NorthDiv had the authority to select and dismiss organizations charged with design, quality control, and construction activities, and to accept or reject Construction Drawings and

TABLE 2-1
PROJECT ORGANIZATIONAL LIST
REMEDIAL ACTION AT LANDFILL SITES 4 AND 5
NAVAL WEAPONS STATION EARLE
COLTS NECK, NEW JERSEY

Department of the Navy, Northern Division (NorthDiv)	
Design Navy Technical Representative (NTR)	Paul Briegel/Steve Lehman
RAC Contracting Officer Technical Representative (COTR)	Paul Briegel
Remedial Project Manager (RPM)	John Kolicius
Department of the Navy, Naval Weapons Station Earle	
Construction Navy Technical Representative (NTR)	Tom Dunn
Environmental Coordinator	Greg Goepfert
Regulatory Agencies	
U. S. EPA Region II	Sharon Jaffess/William Roach
NJDEP	Robert Marcolina
FWENC	
Program Manager	Art Holcomb
Project Manager	Carl Tippmann
Site Superintendent	Dan Sullivan/John Carroll
Project Engineer	Lyn Stewart/Bryan Conley
Site Quality Control Representative (SQCR)	Mark Miller
Quality Control (QC) Manager	Akram Aziz
Site Health and Safety Officer	John Carroll/Tom Brennan
Project Controls Engineer	Margaret Olson

Technical Specifications and reports, recommendations of the Certifying Engineer, and the materials and workmanship of the FWENC.

2.2.1.1 Design Navy Technical Representative (NTR)

The Design NTR was an employee of NorthDiv's Civil Design Department and was the Navy's technical point-of-contact for the project. Specifically, the Design NTR was responsible for coordinating the resolution of design engineering issues brought forth by FWENC.

2.2.1.2 Contracting Officer's Technical Representative (COTR)

The Contracting Officer's Technical Representative (COTR) was an employee of NorthDiv who served as a liaison between NorthDiv's Contracting Officer and FWENC. The COTR was responsible for reviewing FWENC's scope of work, schedule, and budget to ensure that they were adequate to meet the requirements of the project.

2.2.1.3 Remedial Project Manager (RPM)

The RPM was an employee of NorthDiv's Environmental Department and was the Navy's environmental point-of-contact for the project. In particular, the RPM was responsible for interacting with regulatory agencies (U. S. EPA and NJDEP) and for coordinating the resolution of environmental issues brought forth by FWENC.

2.2.1.4 Construction Navy Technical Representative (NTR)

The Construction NTR was an employee of NWS Earle's ROICC office and was the Navy's local representative for the project. The Construction NTR was responsible for coordinating construction and QC activities so that they were conducted in accordance with the Construction Drawings and Technical Specifications. He interfaced with the Project Manager, Site Superintendent and SQCR regarding daily operations and conformance of construction activities with the Construction Drawings and Technical Specifications. His responsibilities included the following:

- Ensuring that the project scope and objectives were defined and that procedures, schedules, budgets, and manpower requirements were established.

- Establishing project procedures, instructions, including lines of communication, working relationships, controls, and reporting requirements within the project.

- Providing direction and guidance to the site project team with respect to their individual project responsibilities.

- Processing submittals, Requests for Information (RFIs) and Field Change Requests (FCRs) generated by FWENC.

- Reviewing CQC documentation to verify that corrective action had been satisfactorily completed when deviations were made from the Construction Drawings and Technical Specifications.

2.2.1.5 Environmental Coordinator

The Environmental Coordinator was a member of NWS Earle's base environmental office. The Environmental Coordinator was responsible for providing pertinent information to FWENC regarding environmental issues at NWS Earle and for assisting FWENC in resolving any such issues. The Environmental Coordinator would conduct routine inspections of the work being performed during the project, and would attend the weekly progress meeting. He interfaced with the Project Manager, Site Superintendent and SQCR regarding daily operations and conformance of construction activities with the Construction Drawings and Technical Specifications.

2.2.2 Regulatory Agencies

The regulatory agencies involved with the project were the U. S. EPA and the NJDEP. Representatives from these agencies would contact NorthDiv's RPM to request updates on the progress of the project and to relay any questions or comments regarding the overall activities at Landfill Sites 4 and 5. The regulatory agencies were also responsible for reviewing any Field Change Requests (FCRs) submitted by FWENC that resulted in a modification to the approved Construction Drawings and Technical Specifications.

2.2.3 Foster Wheeler Environmental Corporation (FWENC)

FWENC was responsible for ensuring that construction activities were implemented in strict accordance with design criteria, Construction Drawings, and Technical Specifications using the

necessary construction procedures and techniques. FWENC was also responsible for formulating and implementing the Construction Quality Control (CQC) Plan, which addressed the rules and responsibilities of CQC personnel, and outlined inspection and testing procedures to be conducted by CQC personnel and/or subcontractors.

Other responsibilities of FWENC included:

- Preparing and submitting to the Construction NTR monthly status reports containing information regarding: 1) percentage of work completed, 2) unresolved delays (encountered or anticipated) that could affect the schedule and a description of efforts made to mitigate those delays or anticipated delays, 3) revisions to the construction schedule, 4) a list of activities scheduled for the next month, and 5) other information relating to the progress of construction.

- Initiating, maintaining, and supervising all health and safety procedures and programs in connection with the work.

- Notifying the Construction NTR in writing of any subsurface or latent physical conditions encountered that differed materially from those specified or indicated.

- Implementing the CQC Plan and establishing the chain of command.

- Assigning to the project the Site Superintendent, who was responsible for the field construction operations, and the SQCR who was responsible for the implementation of the CQC Plan.

- Furnishing or utilizing materials or equipment, specific means, methods, techniques, sequence, or procedure of construction as required by the contract documents or a substitute acceptable to NorthDiv, if needed.

- Preparing Daily Reports and submitting them to the ROICC for review and transmission to the Construction NTR.

- Procuring subcontractor services; submitting the proposed vendors to the Navy for acceptance prior to commencing work.

- Maintaining at the site two record copies of all as-built drawings, one copy of specifications, addenda, written amendments, change orders, work directive changes, field test records, field orders, and written interpretations and clarifications. Upon completion of the work, delivering these records to the Navy.

2.2.3.1 Project Manager

The responsibility of the Project Manager was to provide general oversight of all facets of the project. The Project Manager allocated the necessary resources to the project, monitored the construction schedule and budget, and provided oversight of the quality control activities for the duration of the project.

2.2.3.2 Certifying Engineer

The Certifying Engineer was responsible for determining if all construction operations were conducted in accordance with the approved Construction Drawings and Technical Specifications and for reporting deviations from these plans and procedures to the Construction NTR. The Certifying Engineer was also responsible for ensuring that QC inspections and/or sampling and testing activities were conducted as specified in the CQC Plan. He reported to the Construction NTR regarding QC data documented by the SQCR. Specific tasks performed by the Certifying Engineer included:

- Preparing the CQC Plan and providing on-site training to the Construction NTR on project-specific CQC requirements and procedures.

- Providing technical review of the relevant submittals listed in the submittal register.

- Reviewing all RFIs, FCRs, and Non-Conformance Reports affecting the cap design and construction methods.

- Conducting on-site inspections during critical construction sequences, such as installation of the geomembrane, to verify that construction was proceeding in accordance with the Construction Drawings, Technical Specifications, and the CQC Plan.

- Providing technical direction and support to the SQCR on a daily basis and discussing the overall project status and the status of QC field activities.

- Attending or participating in weekly project QA/QC and management team review meetings, either in person, if present in the field, or via teleconferencing.

- Preparing weekly reports to document the completed construction activities and forecast the upcoming activities.

- Certifying that the project was completed in accordance with the Technical Specifications, Construction Drawings, and approved design changes by means of the Final Report.

2.2.3.3 Site Superintendent

The Site Superintendent was responsible for all on-site construction activities including supervising craft labor and subcontractors, and monitoring construction materials and equipment. The Site Superintendent reported to the Project Manager and interfaced with the Construction NTR and the SQCR.

2.2.3.4 Project Engineer

The Project Engineer was responsible for providing guidance and assistance to the field construction staff relating to compliance with the Technical Specifications and drawings. The Project Engineer was also responsible for drafting technical plans for subcontracts and preparing project submittals. The Project Engineer reported to the Site Superintendent and the Project Manager.

2.2.3.5 Site Quality Control Representative (SQCR)

The SQCR was independent of FWENC's project chain of command, and worked in conjunction with the Construction NTR and the QC Manager. The SQCR was responsible for coordinating inspection and surveillance activities on a full-time basis. The results of inspections and surveillance were documented in the Daily Reports. The SQCR was also responsible for:

- Implementing the CQC Plan.

- Performing CQC inspection and field tests and preparing inspection and testing reports.

- Collecting samples for CQC laboratory testing and reviewing the test results.
- Preparing Non-Conformance Reports.
- Maintaining the latest applicable copy of the Construction Drawings and Technical Specifications with amendments and/or approved modifications at the job site and ensuring that they were used for shop drawings, fabrication, construction, inspections, and testing.
- Maintaining the red-line drawings at the site to depict the as-built conditions of the project.
- Maintaining the Submittal Register for the duration of the contract.
- Reviewing shop drawings and/or other submittals for compliance with the contract requirements prior to their submission to the QC Manager for review, action, and transmission to the Construction NTR.
- Establishing and maintaining in conjunction with the QC Manager a Rework Item List for work that did not conform to the Construction Drawings and/or Technical Specifications.
- Tracking and monitoring items on the rework list to ensure the rework inspection and testing activities and frequencies were in accordance with the contract requirements.
- Attending and assisting the Construction NTR, Certifying Engineer, and QC Manager at the pre-final inspection and final acceptance inspection.

2.2.3.6 Quality Control (QC) Manager

The QC Manager was responsible for monitoring all of the testing and inspection performed by the SQCR as outlined in the CQC Plan. Additionally, the QC Manager performed random testing and inspection to verify the results obtained by the SQCR during the routine QC testing and inspection. The QC Manager was also responsible for reviewing and approving the technical submittals and FCRs prepared by the SQCR, monitoring the progress of the as-built construction drawings, participating in routine inspections conducted during critical phases of construction, and providing technical assistance to the SQCR throughout the project. The QC Manager reported directly to the Certifying Engineer and the RAC program manager.

2.2.3.7 Site Health and Safety Officer (SHSO)

The SHSO was responsible for implementing the protocols outlined in the site specific Health and Safety Plan on a daily basis. The SHSO was also responsible for conducting daily health and safety briefings, performing routine inspections of the construction activities, conducting periodic air monitoring in the work areas, and maintaining a daily health and safety log book. The SHSO reported directly to the Program Health and Safety Manager.

2.2.3.8 Project Controls Engineer

The Project Controls Engineer was responsible for monitoring the schedule and budget of the project using the Resource Planning and Control System for costing and Primavera Scheduling software. Other responsibilities included preparing budgetary cost analyses, submitting monthly project updates to NorthDiv, and providing monthly budget and schedule forecasts to track the progress of the project. The Project Controls Engineer reported to the Site Superintendent and the Project Manager.

2.2.4 Subcontractors

FWENC employed various subcontractors to complete the construction activities at Landfill Sites 4 and 5. It was the responsibility of FWENC to ensure that each subcontractor met the technical requirements of the Construction Drawings, Technical Specifications, and CQC Plan applicable to their scope of work. The SQCR conducted daily inspections of the work performed by subcontractors to ensure compliance with the Technical Specifications and Construction Drawings.

2.3 PROJECT MEETINGS

Weekly progress meetings were held throughout the project to review current project status and enhance coordination and communication among all parties. The weekly progress meetings were coordinated and facilitated by the Construction NTR and attended by the Site Superintendent, SQCR, Project Engineer, and Project Manager, and occasionally by various other parties involved with the project. The Construction NTR prepared and distributed the minutes of the weekly progress meetings to all parties involved with the project. Weekly progress meetings included discussions of the following, as applicable:

- Review of the previous week's activities and accomplishments.
- Review of the planned activities for the upcoming week.
- Discussion of any potential problems associated with the project.
- Review of the current schedule versus the baseline schedule.
- Update on the cost status of the project.
- Discussion of quality issues related to the construction activities.
- Discussion of the status of submittals, RFIs, and FCRs.
- Notification to U.S. EPA and NJDEP of upcoming construction activities.
- Revisions to previous meeting minutes.

2.4 DAILY SUMMARY REPORTS

Daily summary reports were prepared by FWENC during construction activities at Landfill Sites 4 and 5. The reports were submitted to the Construction NTR for review and verification of their contents. Information in the reports included:

- Description of the work performed
- Equipment used during the day
- Labor hours of the field crew and FWENC's subcontractors
- Quality control documentation that was submitted to QC Manager
- Summary of the quality control testing and inspection performed
- Rework items that had been identified or corrected
- Summary report of the subcontractors activities

3.0 CONSTRUCTION DOCUMENTS

As part of the remedial activities at Landfill Sites 4 and 5, several documents were developed to specify the procedures and materials to be used during the construction of the landfill cover system. These documents were maintained at the site and were readily available for reference.

3.1 DESIGN ANALYSIS REPORT

The Design Analysis Report was prepared by B&R Environmental and submitted to NorthDiv in November 1997. The report included a summary of the geologic and hydrogeologic information for each of the landfill sites, detailed geotechnical evaluations of slope stability and settlement, and other design calculations related to the basis of design for Landfill Sites 4 and 5. Conclusions drawn from the Design Analysis Report was used to generate the project Technical Specifications and Construction Drawings.

3.2 TECHNICAL SPECIFICATIONS AND CONSTRUCTION DRAWINGS

The 100 percent design Technical Specifications and Construction Drawings for the remedial action at Landfill Sites 4 and 5 were prepared by B&R Environmental and submitted to NorthDiv in November 1997. The Technical Specifications and Construction Drawings were used by FWENC to perform construction activities at the Landfill Sites 4 and 5. Changes or modifications that were made to these documents throughout the project were documented through RFIs and FCRs. A copy of the updated red-line drawings was kept on site by the SQCR, and periodically reviewed by the QC Manager, to document all changes to the Construction Drawings.

3.3 SOIL EROSION AND SEDIMENT CONTROL PLAN

The Soil Erosion and Sediment Control Plan was drafted by B&R Environmental and submitted to the Navy in January 1998. The Soil Erosion and Sediment Control Plan provides details regarding the erosion and sediment controls that were utilized during the construction of the landfill caps at Sites 4 and 5. The plan also includes calculations that estimate the storm water runoff from the two landfill sites, calculations that size the sediment and detention basins, and other miscellaneous erosion and sediment control calculations.

3.4 CONSTRUCTION WORK PLAN

The Construction Work Plan was drafted by Foster Wheeler Environmental Corporation (FWENC) and submitted in final version to the Navy in February 1998. The Construction Work Plan provides an overview of the personnel involved in the construction of the landfill cap, the tasks, equipment, and manpower required to complete the project, and a general approach as to how the construction would be performed. Documents accompanying the Construction Work Plan included the Site Health and Safety Plan and the Site CQC Plan.

3.5 CONSTRUCTION QUALITY CONTROL (CQC) PLAN

The CQC Plan was prepared by FWENC and submitted to NorthDiv in February 1998. This plan identified the testing and inspection methods used to document that the cap construction materials were manufactured and installed as specified in the Technical Specifications and Construction Drawings. The plan also outlined the frequency of testing and inspection for each construction material to be performed by the CQC personnel to assure compliance with the Technical Specifications. The CQC Plan also provided a description of the roles and responsibilities of each party involved with the project.

4.0 LANDFILL CAP CONSTRUCTION ACTIVITIES

Construction activities at Landfill Sites 4 and 5 were completed in several stages, beginning on February 8, 1998, with mobilization, and concluding on July 18, 1998, with completion of the landfill cover system construction. The stages of construction at Landfill Sites 4 and 5 included site preparation, subgrade preparation, final cover system construction, storm water management system installation, and revegetation. FWENC conducted construction activities concurrently at both sites to effectively utilize the construction resources and to accelerate the construction schedule.

4.1 SITE PREPARATION

Site preparation activities were conducted by FWENC beginning in February 1998. The following sections provide a description of the site preparation activities.

4.1.1 Mobilization

FWENC mobilized to Landfill Sites 4 and 5 on February 8, 1998, to begin site preparation activities for construction of the landfill cover systems. Mobilization activities included installation of temporary facilities (office trailers, electrical service, telephone service, etc.), delivery of heavy equipment, construction of site entrances, installation of temporary erosion and sediment controls, and posting of the appropriate warning signs at all site entry points. As construction activities progressed, additional equipment and personnel were mobilized to the project to meet the demands of the schedule.

4.1.2 Structure Demolition and Debris Removal

Structure demolition and debris removal was required at Landfill Site 5 in order to prepare the subgrade surface for construction of the final cover system. Structure demolition was performed in accordance with Section 02220 of the Technical Specifications. The surface of Landfill Site 5 contained the former skeet range which included a trailer, high house, low house, a metal building, and several light posts. Some components of the skeet range structures were retrieved by base personnel for re-use on the base, but the majority of the structures were demolished by FWENC and placed in roll-off containers for scrap metal recycling and solid waste disposal. Underground telephone and electrical utilities that serviced the former skeet range were terminated at their outlets and abandoned in place.

4.1.3 Clearing and Grubbing

Clearing and grubbing activities were conducted by FWENC in accordance with Section 02231 of the Technical Specifications. All of the trees, vegetation, and large root masses within the limit of work were cut or removed as required by Section 02231. Material that was cleared above the ground surface was chipped and sent offsite for recycling. All of the below grade material was chipped and spread over its respective landfill subgrade.

4.1.4 Monitoring Well Abandonment and Modification

Abandonment and modification of the existing monitoring wells at Landfill Sites 4 and 5 was conducted in accordance with Section 02524 of the Technical Specifications. Modification of the monitoring wells was also performed in accordance with the modified version of Detail 24 as depicted on Sheet C-21 of the As-Built Construction Drawings. One of the existing monitoring wells was abandoned at Landfill Site 5 (MW5-04), and no wells required abandonment at Landfill Site 4. Five (5) of the wells at Landfill Site 5 required modification, while none of the wells at Landfill Site 4 were modified.

4.2 SUBGRADE PREPARATION

Subgrade preparation activities included proof rolling of the landfill surface, construction of sediment and detention basins, and relocating landfill material soil in accordance with Sections 02315 of the Technical Specifications and the Soil Erosion and Sediment Control Plan.

4.2.1 Proof Rolling

Upon completion of the clearing and grubbing activities and prior to placing any waste material or common/select fill, the landfill surface was proof rolled in accordance with Section 02315 of the Technical Specifications. The proof rolling activity was performed using a 15-ton smooth drum vibratory roller to achieve the required uniform subgrade compaction. In areas where excavation was required, the excavation was completed to the subgrade elevation prior to proof rolling the surface. In areas where soft or unsuitable material was encountered in the subgrade, the material was excavated and replaced with select fill.

4.2.2 Sediment and Detention Basins

Sediment and detention basins were constructed at Landfill Sites 4 and 5 in the locations specified by the Soil Erosion and Sediment Control Plan as depicted on Sheets C-4 and C-11 of the Construction Drawings. Two sediment basins were constructed at Landfill Site 4 and three were constructed at Landfill Site 5. Each of the sediment and detention basins was constructed outside the existing landfill subgrade utilizing approved existing material that was supplemented with imported structural fill when the existing material did not meet the requirements of the specifications. The three basins at Landfill Site 5 were upgraded to permanent structures at the completion of the cap construction activities, while the two basins at Landfill Site 4 were decommissioned.

4.2.3 Relocation of Landfill Material

In order to construct the landfill cover systems at Landfill Sites 4 and 5 to the lines and grades indicated on the Construction Drawings, the majority of the existing landfill was re-configured using conventional cut and fill methods. In addition to the re-configuration of the existing landfill material, fill material from a variety of locations was placed over the two landfill subgrades to achieve the specified lines and grades. All of the material excavated from within the limit of the landfill was designated as landfill material. Material that came from sources outside of the limit of the landfill, either on site of off site, was designated as common fill. Compaction testing was performed on all of the landfill material and common fill that was placed over the subgrade as discussed in Section 6. Results of the CQC compaction testing are discussed in Section 6 and are presented in Appendix D.

The landfill regrading plan at Landfill Site 4 called for a minimum 4 percent slope to be carried from north to south over the plateau, and transitioning to a 4H:1V maximum sideslope to Wetland Area A located immediately east of the landfill. The existing conditions of the landfill were such that the majority of the excavated material was generated from the eastern slope of the landfill and the three designated excavation areas outside of the cap footprint. Landfill material was excavated from these locations and placed in 12-inch thick lifts within the limit of the cap footprint to lines and grades specified on Sheet C-5 of the Construction Drawings. Compaction of the landfill material was performed with a 15-ton vibratory roller and the compacted lifts were tested in accordance with the CQC Plan. The limit of the three excavation areas generally conformed to the Construction Drawings with the exception of the western area. Excavation of this area showed that the landfill material extended further north than indicated on the Construction

Drawings. Additional excavation was performed until it was visually determined that all of the landfill material had been removed.

The landfill regrading plan at Landfill Site 5 called for a minimum 3.5 percent slope to be carried to the west and south from the high point in the northeast section of the cap footprint. The majority of the excavation at Landfill Site 5 occurred in the designated excavation areas along the perimeter of the cap footprint, and over the southeast section of the site. Landfill material was excavated from these areas and placed in 12-inch thick lifts according to the lines and grades shown on Sheet C-12 of the Construction Drawings. In addition to the excavation and regrading activities performed at Landfill Site 5, approximately 5,000 cubic yards of screened soil from Area E at NWS Earle also required placement over the Landfill Site 5 subgrade. In order to accommodate the additional volume of material in the landfill subgrade, FWENC was required to re-design the subgrade contours. The re-design generally consisted of raising the elevation of the landfill high point and reconfiguring the existing subgrade contours. Although the high point elevation of the landfill was raised, the subgrade contours remained consistent with the 3.5 percent minimum slope requirement. All of the material that was placed at Landfill Site 5 was compacted with a 15-ton vibratory roller and was tested in accordance with the CQC Plan.

4.3 FINAL COVER SYSTEM CONSTRUCTION

The final cover system that was constructed at Landfill Sites 4 and 5 was comprised of two different configurations: one for the 3.5 and 4 percent minimum grade areas, and one for the 4H:1V sideslope at Landfill Site 4. The final cover system was constructed such that the full thickness of the cap cross section extended to the limit of the regraded waste. Beyond this point, the cap components tapered such that the toe intersected the existing grade.

The final cover system for the 3.5 and 4 percent minimum grade areas was comprised of the following components in ascending order:

- A 12-inch layer of bedding/gas management material
- A 40-mil smooth, very flexible polyethylene (VFPE) geomembrane
- A 12-ounce/square yard non-woven cushion material
- A 12-inch layer of granular drainage material

- A 6-ounce/square yard non-woven geotextile
- A 12-inch layer of select fill
- A 6-inch layer of topsoil

The final cover system for the 4H:1V sideslope at Landfill Site 4 was comprised of the following components in ascending order:

- A 12-inch layer of bedding/gas management material
- A 40-mil textured, VFPE geomembrane
- A 12-ounce/square yard non-woven cushion material
- A 12-inch layer of granular drainage material
- A 6-ounce/square yard non-woven geotextile
- A 12-inch layer of select fill
- A 6-inch layer of topsoil

Around the perimeter of the final cover system, a layer of structural fill was installed. The structural fill served as a clean layer of material in which the VFPE liner could be anchored, and a structurally sound layer on which the perimeter drainage feature could be constructed. The structural fill layer was installed concurrently with the bedding/gas management layer.

Construction of the final cover systems began upon completion of the subgrade preparation over a given section of the landfill. The final cover system at Landfill Site 4 was the first to be completed. Testing and inspection of the borrow materials and geosynthetics used to construct the final cover systems was performed by the SQCR in accordance with the Technical Specifications and CQC Plan as discussed in Sections 6 and 7. The following sections describe in detail the placement of the individual components of the landfill cover system.

4.3.1 Passive Gas Management System

The passive gas management system was designed to protect the final cover system against potential pressure buildup of gases generated from the decomposition of putrescible materials within the landfill. The system consisted of a 12-inch thick layer of poorly graded sand and randomly spaced passive gas vents constructed of 4-inch diameter Schedule 80 PVC pipe. Should any landfill gases be generated, they will be collected in the sand layer and discharged to the atmosphere through the gas vents.

All of the bedding/gas management sand used during the project was obtained from a single off-site source. Pre-construction phase testing was conducted to demonstrate that the physical properties conformed to Section 02315 of the Technical Specifications prior to being accepted for use at the landfill. The physical properties of the material were also tested throughout its placement, as discussed in Sections 6 and 7. The bedding/gas management sand was typically delivered to the location in which it was being placed, however, an on-site stockpile of the material was kept at all times. The sand was spread by a bulldozer into the required lift thickness for the given cover system. Survey stakes were maintained during installation of the sand to allow for accurate layer thickness. Compaction of the sand was usually achieved by normal tracking of the material by heavy equipment. Approximately 38,000 tons of bedding/gas management sand was installed during the project. The in-place sand was tested consistent with the CQC Plan, as described in Sections 6 and 7.

The passive gas vents were constructed in accordance with Detail 23 on Sheet C-21 of the Construction Drawings. Three gas vents were installed at Landfill Site 4 and eight were installed at Landfill Site 5. Perforated 4-inch diameter ADS pipe was used to construct the gas collection portion of the vents and solid Schedule 80 PVC pipe was used to extend the vents through the geomembrane to the landfill surface. A geomembrane boot was placed around each gas vent to seal the penetration through the geomembrane. The vents were then extended 48 inches above the final landfill surface using solid Schedule 80 PVC pipe.

4.3.2 Geomembrane

The geomembrane layer consisted of a thin continuous sheet of plastic material that was placed over the entire landfill to prevent infiltration of surface water. This layer comprised the low permeability portion of the composite landfill cover system. The geomembrane selected for use at Landfill Sites 4 and 5 was Solmax 840 40-mil VFPE. The 40-mil VFPE material was selected because of its ability to elongate and retain its strength should the landfill settle. Both textured

and smooth surfaced versions of the VFPE geomembrane were used on the project for the two cover systems. Textured geomembrane was used in the sideslope cover system at Landfill Site 4 because it provides increased shear resistance against slope failure. Smooth geomembrane was used over the 4 and 3.5 percent minimum slope areas at Landfill Sites 4 and 5 because the gradual slopes did not require a high degree of shear strength interface friction from the geomembrane. Each delivery of geomembrane was inspected by the SQCR prior to being accepted for use at the landfill. The material was staged off of the ground surface to prevent damage prior to installation.

Installation of the VFPE geomembrane was performed by FWENC's geosynthetic crew. One member of the crew was designated as the installer and another member was designated as QC representative. The installer was responsible for overseeing that the geomembrane was installed in accordance with Section 02142 of the Technical Specifications and with the manufacturer's recommendations on a daily basis. The QC representative was responsible for documenting that all of the required destructive and non-destructive testing of the geomembrane was completed prior to beginning construction of the next cover layer. This person was also responsible for documenting the location where each section of geomembrane was installed, the location of all pipe penetrations, and all destructive samples. The QC representative and the SQCR would jointly inspect the geomembrane installation prior to final approval. CQC inspection and testing of the geomembrane is discussed in Sections 6 and 7.

Installation of the VFPE geomembrane occurred only during dry weather periods and only over approved sections of bedding/gas management material. The installation procedures followed by the geosynthetic crew conformed to Section 02142 of the Technical Specifications. Geomembrane seams were overlapped a minimum of 4 inches for fusion welds and 3 inches for extrusion welds. Repairs to damaged sections of the geomembrane were completed in accordance with Section 02142 of the Technical Specifications prior to final acceptance. The geomembrane was anchored at the toe of all slopes in a 12-inch deep by 12-inch wide trench. The QC representative inspected each panel of geomembrane during the installation to verify that proper installation techniques were employed. A total of 65,792 square feet of smooth geomembrane and 47,206 square feet of textured geomembrane were installed at Landfill Site 4, and 371,174 square feet of smooth geomembrane was installed at Landfill Site 5. The CQC installation reports for the geomembrane are contained in Appendix E. At the completion of the geomembrane installation, the geomembrane was warranted by Solmax in accordance with Section 02142 of the Technical Specifications.

Upon completion of the geomembrane installation, a cushion geotextile was installed to protect the geomembrane from damage while installing the overlying granular drainage material. The cushion geotextile was a 12-ounce non-woven material that conformed to the properties outlined in Section 02272 of the Technical Specifications. The cushion geotextile was tested for conformance with Section 02272 of the Technical Specifications prior to being accepted for use at the two landfill sites. The geotextile was typically installed parallel to the maximum slope direction. Adjacent panels of geotextile were overlapped a minimum of 12-inches in areas where the slope was flatter than 4H:1V, and field sewn in areas with a steeper slope. Installation of the cushion geotextile was monitored daily by the QC representative of the liner crew and inspected by the SQCR prior to constructing the next layer of the landfill cover system. CQC testing of the cushion geotextile is discussed in Section 6.

4.3.3 Drainage Layer Material

The drainage layer of the composite landfill cover system was designed to collect, convey, and provide an outlet for surface water that infiltrates the surface layer. The granular drainage layer material that was selected for use at Landfill Sites 4 and 5 was NJDOT #57 stone. The stone was tested for conformance with Section 02315 of the Technical Specifications, as modified by FCR #1, prior to being accepted for use at the landfill. The material was also tested throughout its use on the project consistent with the CQC Plan to demonstrate that the stone remained in conformance with the Technical Specifications. The CQC testing of the drainage layer is further discussed in Sections 6 and 7. A description of FCR #1 is presented in Section 5.

All drainage material used during the project was acquired from a single source. The material was typically delivered to the site location at which it was installed; however, a stockpile of drainage material was maintained on site. Low ground pressure bulldozers were used to spread the stone over the geomembrane into a 12-inch lift. The low ground pressure machines maintained a minimum of 12 inches of stone below the tracks at all times to protect the underlying geomembrane. Control of the lift thickness was maintained by the crew working with its installation and was verified by the SQCR by field measurements. Precautions were taken during installation of the drainage layer to avoid the formation of wrinkles in the underlying geomembrane. Some of these precautions included hand spreading of stone over the geomembrane to cool the geomembrane and limit the formation of wrinkles, physically pulling wrinkles to one area of the geomembrane and dispersing them out over a large area, and halting stone placement during sunny periods. The SQCR and liner QC representative routinely

performed visual inspections of the drainage sand installation to verify that wrinkle formation in the liner was minimized.

Compaction and consolidation of the drainage stone was achieved by normal tracking of the material with heavy equipment. The in-place density requirement for the drainage stone was omitted from the Technical Specifications as documented in FCR # 1 and discussed in Section 5. Approximately 35,000 tons of drainage stone was used to complete the drainage layer.

Upon achieving the required thickness of drainage stone over the geomembrane, a layer of 6 ounce/square yard non-woven geotextile was installed over the drainage sand to prevent the migration of stones and fine-grained particles from the overlying select fill and topsoil layers. A non-woven geotextile was selected for use because of its proven filtering properties. The non-woven geotextile was tested for conformance with Section 02272 of the Technical Specifications prior to being accepted for use at the two landfill sites. Installation of the geotextile was completed according to Section 02272 of the Technical Specifications. The 12-inch minimum overlap at each of the geotextile field seams and the general layout of the geotextile were inspected and approved by the SQCR prior to the construction of the next cover layer. Inspection of the geotextile is discussed in Section 6.0.

4.3.4 Select Fill Layer

The select fill layer was installed over the 6-ounce non-woven geotextile on both the plateau and sideslope cover systems at Landfill Sites 4 and 5. The 12-inch layer of select fill combined with the 6-inch topsoil layer comprised the landfill vegetative layer. The combined 18-inch thickness of the vegetative layer was evaluated by Rutgers University and was determined as being of adequate thickness to support the vegetative growth.

All 36,000 tons of the select fill material used for the project was obtained from a single off-site source. The material was delivered to the site location at which it was being installed. Placement of the select fill into a 12-inch lift was performed with low ground pressure bulldozers. Care was taken not to tear the underlying geotextile during placement of the select fill layer. Cardboard cones with painted lines were used to control the thickness of the lift. Testing of the material prior to its arrival on site was performed to demonstrate conformance with Section 02315 of the Technical Specifications. The material was also tested in the laboratory and in the field throughout its use at the project to verify that conformance to the specifications was maintained. CQC testing of the base course material is discussed in Sections 6.

4.3.5 Topsoil Layer

The topsoil layer was the final layer of cover material installed at Landfill Sites 4 and 5. The 6-inch layer consisted of an off-site, non-acid producing soil that conformed to Section 02921 of the Technical Specifications. Approximately 24,000 tons of topsoil was obtained from a single off-site source to construct the topsoil layer. The material was typically delivered to the site location at which it was being installed. Placement of the topsoil into a 6-inch lift was performed with low ground pressure bulldozers.

Upon completion of the topsoil placement, the surface of the landfill cover systems was revegetated using the seed mixture specified on Sheet C-2 of the Construction Drawings. A sample of the topsoil was sent to Rutgers University prior to revegetating the landfill surfaces to determine the precise mixture of soil amendments required to sustain the specified vegetative growth. Results of the topsoil testing are provided in Appendix D. The soil amendments and the seed were installed by a landscaping subcontractor by sowing them into the topsoil layer. Upon completion of the seeding activities, loose straw was placed over the topsoil layer to improve the ability of the seed mixture to thrive. The loose straw was either sprayed with a tackifier or mechanically crimped in place to ensure adhesion to the top of the landfill.

4.3.6 RipRap

Type I and Type II riprap were installed at Landfill Sites 4 and 5 in the locations specified in the Construction Drawings. Both types of riprap conformed to the New Jersey Department of Transportation Standard Highway Specification Section 901.17 and Section 02315 of the Technical Specifications. Type I riprap was of 4-inch nominal diameter and was placed around the perimeter of the granular drainage layer to serve as an outlet for water that will be conveyed through the drainage layer. The Type I riprap was installed in accordance with Details 1 and 2 on Sheet C-17 of the Construction Drawings. Type II riprap was of 6-inch nominal diameter and was used in the construction of the spillways for the sediment and detention basins. Type II riprap was installed in accordance with Detail 38 on Sheet C-19 of the Construction Drawings. Both types of riprap were also used in the construction of the perimeter storm water drainage swale at Landfill Site 4 and a portion of Landfill Site 5 as indicated in Construction Drawings. Riprap was installed with excavators to the thickness indicated on the Construction Drawings. The thickness of the riprap layer was randomly measured by the SQCR as a means of quality control. Both types of riprap were tested for conformance with the Technical Specifications in accordance with the CQC Plan prior to being accepted for use on site. CQC testing of the riprap is discussed in Section 6.

A total of 1,500 tons of Type I riprap and 800 tons of Type II riprap was used in the landfill cover systems.

4.4 STORM WATER MANAGEMENT SYSTEM

The storm water management system at Landfill Sites 4 and 5 consisted of temporary and permanent measures designed to collect the storm water run-on and run-off during and at the completion of the construction activities. Temporary storm water controls were used during the construction at both of the landfill sites and permanent structures were installed at the completion of the construction activities. The storm water management systems at the two landfill sites consisted of riprap and grass lined drainage swales, and sediment/detention basins. Management of the storm water was an essential element in reducing the overall flow and potential leaching of contaminants within the landfill

4.4.1 Landfill Site 4

Storm water management at Landfill Site 4 was conducted in two phases: temporary management during the construction activities, and permanent management after the completion of the construction activities. The temporary storm water management system was designed to handle the flow resulting from a 2-year, 24-hour Type III storm event. A surface water drainage ditch was constructed around the perimeter of the landfill to collect storm water run-on and run-off and transport it to two sediment basins that were constructed at the ditch's discharge points. The sediment basins were designed to detain the peak run-off during the design storm event such that the majority of the sediments would be able to settle out of the accumulated water.

Once the construction activities were completed, the permanent storm water management system was installed to handle the flow from a 25-year, 24-hour Type III storm event. The permanent storm water management system consisted of a series of riprap lined drainage ditches to collect surface water run-on and run-off and transport it to the Wetland Area A. One of the storm water drainage ditches was constructed around the perimeter of the final landfill cover system in accordance with Sheet C-20 of the Construction Drawings. Non-woven geotextile was installed over the subgrade of the drainage ditch, and Type I and Type II riprap was used to line the drainage ditch. The second drainage ditch constructed in the middle of the 4H:1V sideslope to break the flow coming down the east slope and convey it to the perimeter drainage ditches. This drainage ditch consisted of a grass lined surface that conformed to Detail 7 on Sheet C-18 of the Construction Drawings.

4.4.2 Landfill Site 5

Storm water management at Landfill Site 5 was also conducted in two phases: temporary management during the construction activities, and permanent management after the completion of the construction activities. The temporary storm water management system was designed to handle the flow resulting from a 2-year, 24-hour Type III storm event. A surface water drainage ditch was constructed around the perimeter of the landfill to collect storm water run-on and run-off and transport it to three sediment basins that were constructed at the ditch's discharge points. The sediment basins were designed to detain the peak run-off during the design storm event such that the majority of the sediments would be able to settle out of the accumulated water.

Once the construction activities were completed, the permanent storm water management system was installed to handle the flow from a 25-year, 24-hour Type III storm event. The permanent storm water management system consisted of riprap, topsoil and grass lined drainage ditches to collect surface water run-on and run-off and transport it to the three sediment basins. Unlike Landfill Site 4, the three sediment basins at Landfill Site 5 remained part of the permanent storm water management system since there was not a surface water outlet for the collected storm water. The varying types of drainage ditches were constructed in accordance with Details 17, 18 and 19 on Sheet C-20 of the Construction Drawings. The specific location of each type of channel is shown on Sheet C-13 of the Construction Drawings.

4.4.3 Storm Water Culverts

There were two locations along the perimeter drainage swale at Landfill Site 5 where it was necessary to install 18-inch diameter corrugated plastic pipe culverts to maintain vehicular access to the completed landfill surface. These locations include Culvert A, which was installed at the access road at the southeast corner of the site, and Culvert B, which was installed at the site access road by the EOD range. The culverts were transitioned into the channels by concrete head and end walls installed after the culverts were installed. The head and end walls were cast-in-place structures constructed of 3,000 psi concrete and steel reinforcing bars. The function of the head walls was to funnel the surface water flow from the channels directly into the culverts and to prevent water from flowing beneath the culverts. The end walls served the purpose of minimizing scour and long-term erosion of the outlet, and stabilizing the surrounding grade. All of the cast-in-place concrete was tested and inspected according to Section 3300 of the Technical Specifications.

4.5 WETLAND ENHANCEMENT

During the construction of the final cover system at Landfill Site 4, portions of the delineated wetland areas were disturbed by the construction activities. In order to restore the wetlands to their original condition, a wetland enhancement plan was implemented to plant trees, shrubs, and grass over the disturbed wetland areas. These areas are designated as Areas 1, 2 and 3 and are shown on Sheet C-9 of the Construction Drawings. Restoration of the disturbed wetland areas was performed in accordance with Section 02951 of the Technical Specifications and Sheet C-9 of the Construction Drawings.

4.6 ELECTRICAL INSTALLATION

The original Construction Drawings for the Landfill Site 5 final cover system called for reconstructing the demolished skeet range over a portion of the final cover system. However, plans to reconstruct the skeet range were abandoned by the Navy during the course of the project. Although reconstruction of the skeet range was no longer required, installation of an underground electrical line to the EOD range was required since power to the trailer at the EOD range was going to be connected by means of the new skeet range. FWENC revised the Construction Drawings to reflect the changes, and the underground electrical line was installed as indicated on Sheet E-2 of the Construction Drawings. Details of the electrical connection to utility pole #FL-85 SPP2-50 are provided on Sheet E-4 of the Construction Drawings. In addition to the electrical connection for the EOD range, an electrical connection was installed at the transformer to provide electricity to the skeet range if it is built in the future.

5.0 DESIGN CHANGES

Throughout the construction at Landfill Sites 4 and 5, instances arose when clarifications or changes to the design were required by FWENC in order to complete the project. If a clarification on a construction issue was required that was not provided by the contract documents, FWENC was to submit an RFI to the Construction NTR for review. If a change to the design was required, FWENC presented the proposed change to the Construction NTR using the FCR form. Proposed changes to the design were reviewed by the Certifying Engineer, the Design NTR, and the Regulatory Agencies if necessary. Although several issues required clarification during the project, only one such issue required formal submission and review by means of the FCR form. The review and approval process for RFIs and FCRs is shown in Figure 5-1.

5.1 FCR FORM

The FCR form was developed to allow field changes to the methods outlined in the project documents to be proposed for implementation on the project. FCR forms were submitted by the SQCR for review from the Certifying Engineer, the Design NTR, the RPM, and the Construction NTR. If the RPM determined that the proposed change required review and approval from the U.S. EPA and NJDEP, the RPM would direct the SQCR to transmit the FCR to them. Recommendations regarding the FCR then were conveyed to the Construction NTR prior to a request being approved or denied. All FCR forms required the signature of the Construction NTR for final approval. The FCR discussed in this section is the only one that was submitted during the project. A complete copy of the FCR is provided in Appendix B.

5.1.2 FCR # 1

FCR #1 was submitted in response to a change in the granular drainage material as defined by Section 02315 of the Technical Specifications. The granular drainage material was originally required to contain a specific grain size distribution that was not available from any of the material vendors. The vendors could instead provide a standard NJDOT #57 stone that contained a similar grain size distribution to the one specified. Use of this material was agreed to in a meeting that was held on April 7, 1998 and was confirmed in a letter from the Navy dated April 20, 1998. As a result of the change in material, the in-place density testing requirement outlined in Section 02315 of the Technical Specifications and the CQC Plan was no longer necessary. FCR #1 requested to eliminate the density testing of the granular drainage material because of the inapplicability of the test to the material, and because of information provided in the EPA's

guidance document on landfill closures. The FCR was reviewed and approved by NorthDiv's Design NTR prior to final signature and approval by the Construction NTR.

6.0 QUALITY CONTROL TESTING / INSPECTION

All of the QC testing and inspection for the project was performed and coordinated by the SQCR in accordance with the CQC Plan. The SQCR was directly responsible for conducting all field inspections of the landfill cover system construction activities, coordinating the on-site and laboratory testing of the construction materials, coordinating inspections with the QC representative of the geosynthetic crew, and reviewing the manufacturer's certifications of materials delivered to the site. The SQCR was also responsible to implement and maintain the three phases of quality control over each definable feature of work as discussed in the CQC Plan. Results of the QC field inspections were submitted in the daily production report for review by the ROICC. Results of the on-site and laboratory QC testing were reviewed by the SQCR prior to submittal to the QC Manager for review, and approval by the Construction NTR. The QC testing and inspection performed during implementation of the three phases of control over the work were conducted for the borrow materials, geosynthetics and cast-in-place concrete is presented in this section.

6.1 BORROW MATERIALS

The borrow materials used to construct the final landfill cover system underwent three types of QC testing to ensure conformance with the Technical Specifications and the CQC Plan. The three types included: Pre-Construction Testing, Construction Phase Testing, and In-Place Field Testing. The borrow materials that went through these testing phases included: Bedding/Gas Management Material, Granular Drainage Material, Select Fill, Structural Fill, and Riprap. The on-site and laboratory geotechnical testing of the borrow materials was performed by French & Parrello Associates under subcontract to FWENC.

6.1.1 Pre-Construction Testing

Prior to a borrow source being approved to supply components of the final landfill cover system to Landfill Sites 4 and 5, FWENC was required to perform pre-construction testing of the material to demonstrate conformance with the Technical Specifications. The SQCR visited the borrow source to inspect the material, evaluated the quantity of material available, and assessed the manner in which the material was processed or derived. If it was visually determined that the material may be acceptable for use on the project, a sample of the material was taken for subsequent laboratory analysis. Analysis of the borrow materials was conducted by French & Parrello Associates in accordance with the CQC Plan. All of the borrow materials were

demonstrated to conform with the Technical Specifications prior to their use on the project. The testing requirements and frequencies for the pre-construction testing are provided in Table 6-1. Results of the pre-construction testing are presented in Appendix D.

6.1.2 Acid Producing Soils

Any of the soils used construct the subgrade and final cover systems at Landfill Sites 4 and 5 were required by Section 02315 of the Technical Specifications to be non-acid producing. Prior to being approved for use on the project, soils suspected as being acid producing were tested using the Iron Sulfide Test, or Rutgers Soil Test #6. Although none of the soils used during the project were suspected as being acid producing, testing was performed on the select fill, structural fill, bedding/gas management soil, and topsoil as a precautionary measure to demonstrate that these soils were indeed non-acid producing. The results of the iron sulfide testing performed by French & Parrello Associates are presented in Appendix D.

TABLE 6-1
PRE-CONSTRUCTION PHASE
TESTING REQUIREMENTS AND FREQUENCIES
LANDFILL SITES 4 AND 5 REMEDIAL ACTION
NWS EARLE COLTS NECK, NEW JERSEY

	Gradation ASTM D422 or D5519	Fine-Grained Gradation ASTM D1140	Soil Classification ASTM D2487	Moisture Density ASTM D698	Iron Sulfide Test – Rutgers Soil Test # 6	Atterberg Limits ASTM D4318
Common, Select, and Restricted Fill	1 per source	1 per source	1 per source	1 per source	3 per source if suspected to be acid producing	1 per source
Bedding/Gas Management Soil	1 per source	1 per source	1 per source	1 per source	3 per source if suspected to be acid producing	N/A
Granular Drainage Material	1 per source	N/A	N/A	N/A	N/A	N/A
Riprap	1 per source[a]	N/A	N/A	N/A	N/A	N/A

Note a: Test was performed at the stone quarry. The test results and material stockpiles were inspected by the SQCR prior to use of the material on the project.

6.1.3 Construction Phase Testing

Once a borrow material was accepted for use on the project, QC testing of the material proceeded to the construction phase to verify that conformance to the Technical Specifications was maintained. This phase of testing was implemented so that variations in the material that affected the placement and compaction efforts could be observed and the construction activities modified accordingly. In addition, visual inspection of the borrow materials was routinely performed by the SQCR to check their consistency throughout the project. The construction phase testing requirements and frequencies for the borrow materials are provided in Table 6-2. Results of the construction phase testing were found to be in conformance with the Technical Specifications and are presented in Appendix D.

6.1.4 In-Place Field Testing

In-place QC field testing was performed by FWENC to verify that the density and moisture content of the completed subgrade and cover layers was in conformance with the Technical Specifications and the CQC Plan. In-place density and moisture content testing were performed for the following borrow materials: common fill, bedding/gas management sand, structural fill, and select fill. The in-place field testing was performed by French & Parrello Associates and was monitored by the SQCR.

In-place testing for each one-foot lift of the borrow material layers was conducted by the QC laboratory at a frequency of one test for every 10,000 square foot area, or approximately four tests per acre. The density of the borrow materials was reported as a percentage of the maximum dry density or percentage of the relative density, as determined during the construction phase testing of these materials. Testing of the in-place density and moisture content were performed by the nuclear method, as outlined in ASTM D2922 and D3017. Verification of the nuclear test method was performed with the sand cone method (ASTM D1556) at a rate of one test for every ten nuclear tests. Results of the testing were reviewed by the SQCR prior to submittal to the QC Manager for review, and approval by the Construction NTR. Test locations with failing results were either re-compacted or loosened accordingly and

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TABLE 6-2
CONSTRUCTION PHASE
TESTING REQUIREMENTS AND FREQUENCIES
LANDFILL SITES 4 AND 5 REMEDIAL ACTION
NWS EARLE, COLTS NECK, NEW JERSEY

	Gradation ASTM D422 or C136	Fine-Grained Gradation ASTM D1140	Soil Classification ASTM D2487	Moisture Density ASTM D698 or D1557	Atterberg Limits ASTM D4318
Common, Select, and Restricted Fill	1 per 2000 cy	1 per 2000 cy	1 per 2000 cy	1 per 2000 cy	1 per 2000 cy
Bedding/Gas Management Soil	1 per 2000 cy	1 per 2000 cy	1 per 2000 cy	1 per 5000 cy	N/A
Granular Drainage Material	1 per 2000 cy	N/A	N/A	N/A	N/A
Riprap	1 per 2000 cy[a]	N/A	N/A	N/A	N/A

Note a: Test was performed at the stone quarry. The test results and material stockpiles were inspected by the SQCR prior to use of the material on the project.

re-tested prior to approval of the borrow material layer. The results of the in-place field testing are presented in Appendix D.

The depth of the subgrade and cover layers at each test location was measured during the in-place testing as part of the quality control of the layer thickness. The results of the layer thickness verification were recorded by the SQCR and appropriate action was taken in deficient locations.

Field testing and inspection of the Type I and Type II riprap was also performed throughout their use on the project. Testing of these materials involved determining the gradation of the riprap at the stone quarry using the methods outlined in ASTM D5519. The SQCR would periodically review the test documentation provided by the quarry and perform visual inspections of the riprap stockpiles. QC testing and inspection of the riprap demonstrated that the material met or exceeded the requirements of the Technical Specifications. The test results were compared by the SQCR to the values specified in the NJDOT regulations prior to using the material at the two landfill sites.

6.2 GEOSYNTHETIC MATERIALS

QC testing and inspection of the geosynthetic materials involved reviewing the testing certificates provided by the manufacturer, conducting laboratory testing of the materials to demonstrate conformance with the Technical Specifications, and performing field tests on the material to verify that they were properly installed. The geosynthetic materials that were subject to QC testing on the project include: smooth and textured VFPE geomembrane, 12-ounce non-woven cushion material and 6-ounce non-woven geotextile.

6.2.1 Geomembrane

The geomembrane installed at Landfill Sites 4 and 5 was Solmax's 40-mil 840 VFPE. The smooth version of the geomembrane was installed over the 3.5 and 4 percent slope areas of the landfill cover systems and the textured version was installed over the sideslope cover system at Landfill Site 4. QC testing and inspection of the material was conducted by the manufacturer, an independent laboratory and the SQCR.

6.2.1.1 Manufacturer's Certifications

Solmax was required by Section 02142 of the Technical Specifications to provide certification that the 40-mil VFPE geomembrane was manufactured to meet the specified physical and mechanical

properties. Providing the certification involved QC testing of the geomembrane at the manufacturing facility prior to its delivery to the landfill. Results of the QC testing were reviewed by the SQCR for conformance with the Technical Specifications prior to submittal to the QC Manager for review, and approval by the Construction NTR. All of the geomembrane rolls delivered to the landfill were inspected by the SQCR upon arrival to verify that the proper rolls were delivered and that no damage occurred during transport. The manufacturer's QC testing reports on the geomembrane met or exceeded the requirements of the Technical Specifications and are presented in Appendix E.

6.2.1.2 Borrow Material/Geomembrane Interface Testing

The interface friction between the geomembrane and the borrow material or geosynthetic components above and below the geomembrane were tested prior to installation of the materials to verify that the shear resistance between them was acceptable. The test, referred to as a direct shear test, provided the resulting friction angle which was subsequently used to determine the maximum slope angle on which the subject material can be installed while minimizing the potential for slope failure. The three interfaces that were tested for the project include: textured geomembrane to non-woven cushion geotextile, smooth geomembrane to non-woven cushion geotextile, and non-woven cushion geotextile to granular drainage material.

The direct shear testing was conducted by an independent laboratory under subcontract to FWENC in accordance with ASTM D5321 as outlined in Section 02142 of the Technical Specifications. The minimum angle required by the Technical Specifications for the textured geomembrane-cushion geotextile and cushion geotextile-granular drainage material interfaces was 25 degrees and the minimum angle for the smooth geomembrane-cushion geotextile interface was 8 degrees. All of the interface testing was performed under the anticipated field conditions. The results of the interface testing were reviewed by the SQCR prior to submittal to the QC Manager, and approval by the Construction NTR. All results of interface testing were acceptable. Results of the direct shear testing are presented in Appendix E.

6.2.1.3 Field Test Seams

Each day prior to deployment of the geomembrane, a field test seam was prepared by the geosynthetic crew with each machine that would be used that day. Seam testing consisted of welding together two strips of geomembrane, either by fusion or extrusion welding, followed by strength testing of the weld to demonstrate that the test conditions were adequate to meet the

requirements of the Technical Specifications. Test seams were also prepared every 4 hours during seaming operations to verify that the welding machines remained calibrated.

All of the test seams were a minimum of 36-inches long and were divided between the geosynthetic QC representative for field and laboratory testing, and the SQCR for archiving. The QC representative cut ten samples from each of the test seams and field tested them for shear and peel strength in accordance with ASTM D4437 and Section 02142 of the Technical Specifications. Test seams that did not meet the strength requirements of the Technical Specifications were rejected and a new test seam was welded after adjustments were made by the welder. The results of the field test seaming are presented in Appendix E.

6.2.1.4 Non-Destructive Seam Testing

Non-destructive seam testing was performed daily on each of the welded geomembrane seams to verify the continuity of the weld. Both seaming methods, fusion and extrusion welding, required testing of the entire seam prior to approval for the next phase of testing.

Fusion welding involved thermally bonding adjoining sheets of geomembrane with two welds separated by an air channel. The continuity of the weld was tested by inserting a manometer into the air channel and pumping air throughout the channel. The weld was judged to be acceptable if the air pressure in the channel did not drop more than 3 psi over a 5-minute period. Any larger pressure drop was assumed to be indicative of a leak in the channel caused by a break in one of the two welds. Leaks in the geomembrane seams were located by the geosynthetic crew, repaired with an extrusion weld or a cap strip, and vacuum tested prior to approval of the seam.

Extrusion welding of the geomembrane seams was performed when fusion welding was not practical. An extrusion weld involved thermally bonding two overlapped pieces of geomembrane at the surface with a continuous bead of VFPE welding rod. Each extrusion weld was tested using the vacuum box method. This method involved spreading a soapy solution over the weld and applying an external vacuum to each section of the weld. The vacuum pressure of 5 psi was applied to the weld using a 12-inch square box with a clear window at the top. Leaks in the weld were detected by the appearance of bubbles at the edge of the weld during the vacuum application. Any leaks that were detected in the weld were repaired by re-extrusion welding and testing the deficient areas. All of the non-destructive test records are presented in Appendix E.

6.2.1.5 Destructive Seam Testing

Destructive seam testing of the geomembrane was performed upon completion of the non-destructive seam testing. This type of testing was performed on the in-place VFPE geomembrane to verify that the continuous geomembrane welds met the strength requirements of the Technical Specifications. The destructive geomembrane samples were 36-inches long and 12-inches wide and were taken at the rate of one every 500-linear feet of completed seam. The holes created in the geomembrane by the destructive sampling were patched by extrusion welding a piece of geomembrane over the hole. The samples were labeled with specified seaming information (e.g., seamer, date, temperature, etc.) and were cut into three 12-inch by 12-inch sections that were used for field testing, laboratory testing, and archiving, respectively.

The first section of the destructive sample was cut into ten 1-inch specimens and field tested by the QC Representative for shear and peel strength using a field tensiometer. Five of the samples were tested for shear strength and five for peel-strength. If four of the five samples met or exceeded the specified strength values, the seam was deemed acceptable and the second section of the destructive sample was sent for laboratory testing.

Laboratory testing of the second section of the destructive sample was performed in accordance with ASTM D 4437. The sample was shipped to an independent QC laboratory under subcontract to FWENC upon completion of the field destructive testing. As occurred in the field test, ten specimens were cut from the sample and were tested for shear and peel strength. All of the destructive samples sent to the independent QC laboratory were in conformance with the Technical Specifications. The results of the field and QC laboratory destructive sample testing are presented in Appendix E.

6.2.2 Geotextiles

The different geotextiles used to construct the cover systems at Landfill Sites 4 and 5 included: 12-ounce non-woven cushion geotextile and 6-ounce non-woven geotextile. All of the quality QC testing of the geotextiles was performed at the various manufacturing facilities where the materials were produced. The testing that was performed on the geotextile was in conformance with Section 02272 of the Technical Specifications. The SQCR reviewed all of the test results prior to submitting them to the QC Manager for review, and approval by the Construction NTR. Field inspection of the geotextile installation was performed daily by the SQCR to verify that the materials were being installed in accordance with the Technical Specifications. The QC testing results are presented in Appendix E.

6.3 CAST-IN-PLACE CONCRETE

Cast-in-place concrete was used to construct the head and end walls for Culverts A and B at Landfill Site 5. Both field and laboratory QC testing of the concrete was performed throughout the project to demonstrate that the material being supplied conformed to Section 03300 of the Technical Specifications. Samples of the concrete were taken by French & Parrello Associates during the construction operations and were tested for air content, temperature and slump. French & Parrello Associates also took samples of the concrete for laboratory strength testing. All of the QC testing conducted on the cast-in-place concrete met or exceeded the requirements of the Technical Specifications. The results of the cast-in-place concrete QC testing are presented in Appendix C.

7.0 QUALITY CONTROL MANAGER TESTING/INSPECTION

The QC Manager testing and inspection at Landfill Sites 4 and 5 was performed by the QC Manager and the SQCR. The QC Manager was responsible for periodically inspecting the work performed by FWENC and performing random testing of the construction materials to verify the results obtained by the SQCR. The QC Manager testing and inspection documentation prepared during the project included field inspection reports, borrow material testing results, and geosynthetic material testing results.

7.1 BORROW MATERIALS

QC Manager testing of the borrow materials was performed to verify the results of the QC testing performed by the SQCR. Laboratory testing of the borrow materials was coordinated by the QC Manager and performed by Lippincott, Jacobs & Gouda under subcontract to FWENC. Laboratory testing of the borrow soils was performed at a rate of one QC Manager test for every ten SQCR tests. A sample of the borrow soil was collected on site by the QC Manager or the SQCR and sent to the laboratory for geotechnical analysis of the properties outlined in the CQC Plan. Results of the laboratory testing were compared with the QC test results to verify that the test results were similar. In cases where the test results were not similar, the QC Manager and the SQCR evaluated the test results to determine if the material in question continued to meet the intent of the design. In all such cases, the test results were found to be acceptable. Results of the QC Manager testing are presented in Appendix F.

7.2 GEOSYNTHETICS

QC Manager testing and inspection of the different geosynthetic layers used to construct the final cover systems at Landfill Sites 4 and 5 was performed throughout their installation. Field inspection and laboratory testing were performed on the geotextiles and geomembrane.

7.2.1 Geotextiles

Two different types of geotextile were used to construct the final cover systems at Landfill Sites 4 and 5. Both of the materials, 12-ounce non-woven cushion geotextile and 6-ounce non-woven geotextile, were routinely sampled by the manufacturer and the results were reviewed by the QC Manager at the frequencies specified in the CQC Plan. All of the geotextile testing was found to be in conformance with the Section 02272 of Technical Specifications.

Installation of the geotextiles was periodically monitored by the QC Manager throughout their use on the project. The QC Manager would inspect the layout of the material with the SQCR to verify that its placement was parallel to the line of maximum slope, to the extent practicable. In cases where field seaming of the geotextile was required, the field seams were inspected throughout their lengths for continuity and sufficient seam overlap.

7.2.2 Geomembrane

QC Manager testing of the geomembrane involved laboratory testing and field inspection to verify that the material conformed to Section 02142 of the Technical Specifications and to verify the results of the QC testing. Samples of the smooth and textured geomembrane were sent to the QA laboratory for physical properties testing upon their arrival on site. The samples were tested for thickness and specific gravity in accordance with the CQC Plan at a rate of one sample for every 20 rolls of geomembrane. All of the laboratory test results from the QC Manager testing conformed to the specified physical property values.

Installation of the geomembrane was also periodically monitored by the QC Manager. The layout of each geomembrane panel and the seams adjoining the panels were monitored during installation and inspected upon completion to verify that the installation was performed in accordance with Section 02142 of the Technical Specifications. In addition to the visual inspection of the geomembrane installation, destructive samples of the field welded seams were sent off site for laboratory testing. Ten percent of the QC destructive samples (one sample every 5,000 linear feet of seam) were sent to the QA laboratory for peel and shear testing of the seam strength in accordance with ASTM D4437. A total of five destructive samples were sent off site for laboratory testing. Each of the destructive test results yielded results that met or exceeded the requirements of the Technical Specifications. The laboratory results of the destructive sample testing performed by the QC Manager are presented in Appendix F.

8.0 SURVEY CONTROL

Construction of the final cover systems at Landfill Sites 4 and 5 required extensive survey control to verify that the cover system was constructed according to the lines and grades indicated on the Construction Drawings. Geod Corporation and French & Parrello Associates were the licensed surveying companies subcontracted by FWENC to perform all of the critical surveying activities. Geod Corporation was contracted to perform the initial site survey at Landfill Sites 4 and 5, and French & Parrello Associates performed the construction layout surveying. In addition to the surveying conducted by the licensed surveyors, a member of FWENC's construction crew performed routine surveys to assist in controlling the lift thickness of the cover layers during installation.

8.1 CONSTRUCTION LAYOUT

The construction layout was established using the project baseline and the survey control points shown on Sheet C-3 and C-10 of the Construction Drawings. The coordinates of random survey points were checked at the start of the project to verify the accuracy of the Construction Drawings. The survey crew was responsible for establishing the lines and grades for the subgrade and final grade elevations, and for locating various features throughout the landfill. Some of the features that the survey crew was responsible for locating and establishing grades for included:

- Limit of work boundary
- Final limit of landfill material
- Limit of the final cover system
- Cuts and fills for the relocation of landfill material
- Top and toe of the 4H:1V slope
- Centerline of storm water drainage channels and culverts
- Gas vents, monitoring wells, perimeter fencing, and the crane test pad.

The survey crew worked closely with FWENC to ensure that proper grades were maintained throughout the project.

8.2 AS-BUILT DOCUMENTATION

An as-built survey of the subgrade and final grade layers was performed by French & Parrello Associates in accordance with the CQC Plan. The survey was performed on cross-sections at 50-foot intervals along the baseline and was submitted to the SQCR as a set of cross-section drawings. The as-built cross-sections were used to verify that the thickness of the completed landfill cover system conformed to the requirements set forth in the Construction Drawings.

In addition to the cross-sections, topographical drawings of the final grade at Landfill Sites 4 and 5 was submitted. The topographical drawings depicted the final grades of the completed landfill surfaces along with the locations of all the features visible on the final landfill surfaces including:

- Gas vents
- Monitoring wells
- Surface water channels
- Storm water culverts
- Head and end walls for the storm water culverts.

The SQCR was required by the CQC Plan to keep and maintain a copy of the red-line drawings on site at all times to document the changes to the Construction Drawings. The red-line drawings were maintained in the field to reflect the actual construction of the landfill versus the designed construction. At the completion of the construction activities, the changes to the drawings were made on the CAD version of the drawings and are included as as-built drawings in both the O&M Plan and the Final Report. The red-line drawings, as-built cross-sections, and topographic drawings are presented in Appendix H.

9.0 CERTIFICATION

The final cover systems at Landfill Sites 4 and 5 were constructed by Foster Wheeler Environmental Corporation (FWENC) during the period from February 3, 1998 through July 18, 1998. FWENC provided the Certifying Engineer, the SQCR and the QC Manager to provide weekly reports of the construction quality and reports of independent QC testing to the Construction NTR. FWENC also provided QC testing by the SQCR, independent laboratories, and their geosynthetic installation personnel in accordance with the Operations Work Plan, CQC Plan, Construction Drawings, and Technical Specifications.

FWENC was responsible for reviewing all CQC testing submittals and all material submittals required by the Technical Specifications, and performing all independent QC Manager testing. In addition, FWENC reviewed all minor changes and FCRs applicable to the final cover system construction.

Changes in the design, materials, construction methods, and quality control were reviewed and approved by FWENC, NorthDiv, and the Regulatory Agencies prior to implementation. FWENC attended weekly construction meetings and site inspections, and made periodic additional inspections at critical stages (e.g., geomembrane placement) of the cap construction process. Representatives of FWENC were in attendance at every weekly progress meeting, with periodic attendance by the NorthDiv, U.S. EPA, and NJDEP. All parties received copies of the weekly progress meeting minutes and discussions that affected design and quality control.

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals under my supervision, I believe the submitted information is true, accurate and complete. I am aware that here are significant penalties for submitting false information, including the possibility of fine and imprisonment. I understand that, in addition to criminal penalties, I may be liable for civil administrative penalty pursuant to N.J.A.C. 7:26-5 and that submitting false information may be grounds for denial, revocation or termination of any solid waste facility permit or vehicle registration for which I may be seeking approval or now hold.

_____

Carl Tippmann, P.E.
Certifying Engineer
NJ License No. GE38152

10.0 REFERENCES

Specifications and Construction Drawings for Final Design Submission Remedial Action at Operable Unit 1 (Sites 4 and 5), Naval Weapons Station Earle, Colts Neck, New Jersey, Brown & Root Environmental, November 1997.

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