N00164.AR.000360
NSWC CRANE
5090.3a

DEPARTMENT OF THE NAVY
CRANE DIVISION
NAVAL SURFACE WARFARE CENTER
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CRANE, INDIANA 47522-5000

IN REPLY REFER TO
5090
Ser 095/8190

25 SEP 1998
1 SEP 1998

U.S. Environmental Protection Agency, Region V
Waste, Pesticides, & Toxics Division
Waste Management Branch
Illinois, Indiana, and Michigan Section
Attn: Ms. Carol Witt-Smith (DRP-8J)
77 West Jackson Blvd.
Chicago, IL 60604

Dear Ms. Witt-Smith:

Crane Division, Naval Surface Warfare Center (NAVSURFWARCENDIV Crane) submits for review two copies of the Draft Pilot Scale Treatability Test Report for operations conducted at the NAVSURFWARCENDIV Crane Bioremediation Facility, as enclosure (1). Enclosure (2) is the required certification statement.

NAVSURFWARCENDIV Crane point of contact is Ms. Christine D. Freeman, Code 09511, telephone 812-854-4423.

Sincerely,

Thomas J. Brent, acting

[illegible] M. [illegible]
[illegible], Environmental Protection Department
Division of
the Commander

Encl:
(1) Draft of the Pilot Scale Treatability Test Report
(2) Certification Statement

Copy to:
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I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thomas J. Brent

SIGNATURE

Environmental Protection Specialist

TITLE

25 SEP 1998

DATE

Enclosure (2)

REVISION #1

Pilot-Scale Treatability Test Report
SWMU 33/00, Bioremediation Facility
Bioremediation of Explosives-Contaminated Soil

NSWC Crane
Crane, Indiana

Unit Identification Code: N00164
Contract No. N62467-93-D-1106

September 1998

Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina
29419-9010

REVISION #1

PILOT-SCALE TREATABILITY TEST REPORT
SWMU 33/00, BIOREMEDIATION FACILITY
BIOREMEDIATION OF EXPLOSIVES-CONTAMINATED SOIL

NSWC CRANE
CRANE, INDIANA

September 02, 1998

CONTRACT N62467-93-D-1106
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EXECUTIVE SUMMARY

Bioremediation by composting has proven to be successful in remediating soil contaminated with explosives, including trinitrotoluene (TNT), cyclonite (RDX), and cyclotetramethylenetetranitramine (HMX), in pilot- and full-scale testing at several Department of Defense sites (Weston, 1993; U.S. Army, 1993; EPA 1993a). Based on these past successes, on-site bioremediation is the preferred treatment for explosives-contaminated soils from solid waste management units at Naval Surface Warfare Center (NSWC) Crane. On-site bioremediation of contaminated soil is preferred because it provides the capability to treat material on site, requiring only limited transportation, at a lower cost and at a high treatment efficiency.

A pilot-scale test has been completed at NSWC Crane to determine which compost mix provides the optimum environment for microorganism growth and degradation of explosives in contaminated soil. The results of pilot testing are presented in this report and will be used to plan full-scale treatment operations.

Nine mixes were selected for clean soil testing; seven mixes were selected for contaminated soil testing. All contaminated soil mixes, with the exception of Mix 1 (based on water-treatment plant sludge), met all preliminary remedial goals within the test period. The test results showed that Mix 7B (25 percent soil, 15 percent chicken manure, and 60 percent straw) met the remedial goals most rapidly (within 10 days), indicating that it provides a better environment for the remediation of explosives-contaminated soil than the other mixes tested.

Mix 7B is recommended for full-scale treatment. Increasing soil loading to 30 percent with the second full-scale treatment cycle is also recommended, subject to evaluation and approval of the 20-day data from the first full-scale cycle. Further increases in soil loading should be considered after evaluating 3 to 6 months of treatment at 30 percent soil loading. Increasing soil loading from 25 percent to 30 percent will reduce the operational period by 15 to 20 percent and therefore offer proportional operational cost savings.

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ACRONYMS AND ABBREVIATIONS

µg	microgram
µm	micrometer
A	average
ACGIH	American Conference of Governmental Industrial Hygienists
ADNT	aminodinitrotoluene
AIHA	American Industrial Hygiene Association
APR	air purifying respirator
BOD	biological oxygen demand
C	centigrade
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfu	colony forming units
cm^3	cubic centimeter
C:N	carbon to nitrogen (ratio)
dBA	decibels on the A-weighted scale
DNB	dinitrobenzene
DNT	dinitrotoluene
EPD	Environmental Protection Department
EPA	U.S. Environmental Protection Agency
FCR	field clarification request
g	gram
G	good
HEPA	high efficiency particulate air (filter)
HMX	cyclotetremethylenetetranitramine
HPLC	high-pressure liquid chromatography
IH	industrial hygiene
kg	kilogram
L	liter
LC	laboratory control sample
LCS	laboratory control sample duplicate
LEL	lower explosive limit
m^3	cubic meter
MCE	cellulose ester membrane
MFA	Mine Fill A
mg	milligram
MK	Morrison Knudsen Corporation
mm	millimeter
MRL	method reporting limit
MS	matrix spike

ACRONYMS AND ABBREVIATIONS (Continued)

MSD	matrix spike duplicate
NAD	Naval Ammunition Depot
NB	nitrobenzene
NSWC	Naval Surface Warfare Center
NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
OVS	OSHA versatile sampler
P	poor
PARCC	precision, accuracy, representativeness, completeness, and comparability
PDA	potato dextrose agar
PEL	permissible exposure limit
PID	photoionization detector
PMS	percent moisture at saturation
PNOC	particulates not otherwise classified
PNOR	particulates not otherwise regulated
POTW	publicly owned treatment works
ppb	parts per billion
PPE	personal protective equipment
ppm	parts per million
PRG	preliminary remedial goal
QC	quality control
RCRA	Resource Conservation and Recovery Act
RDX	cyclotrimethylene trinitramine
RPD	relative percent difference
SAN	styrene acrylonitrile
SMA	standard methods agar
SSHP	Site Safety and Health Plan
SWMU	solid waste management unit
TCLP	toxicity characteristic leaching procedure
TKN	total Kjeldahl nitrogen
TLV	threshold limit value
TNB	trinitrobenzene
TNT	2,4,6-trinitrotoluene
TOC	total organic carbon
TWA	time-weighted average
VG	very good
WES	U.S. Army Corps of Engineers Waterways Experiment Station
WHC	water-holding capacity
yd^3	cubic yard

1.0
INTRODUCTION

1.1 SITE DESCRIPTION AND HISTORY OF OPERATIONS

1.1.1 Naval Surface Warfare Center

NSWC Crane, located in southwestern Indiana, provides support for equipment, shipboard weapons systems, and ordnance (Figure 1-1). In addition, NSWC Crane supports the Crane Army Ammunition Activity which includes production and renovation, storage, shipment, and demilitarization and disposal of conventional ammunition.

Congress authorized construction of a Naval Ammunition Depot (NAD) in southern Indiana in 1940, and in late 1941, the Burns City Ammunition Depot was commissioned. In 1943, NAD Burns City was renamed NAD Crane, and the Town of Crane was built to house civil service employees. NAD Crane's mission was to load, prepare, renovate, receive, store, and issue ammunition to the fleet (Halliburton NUS, 1992a).

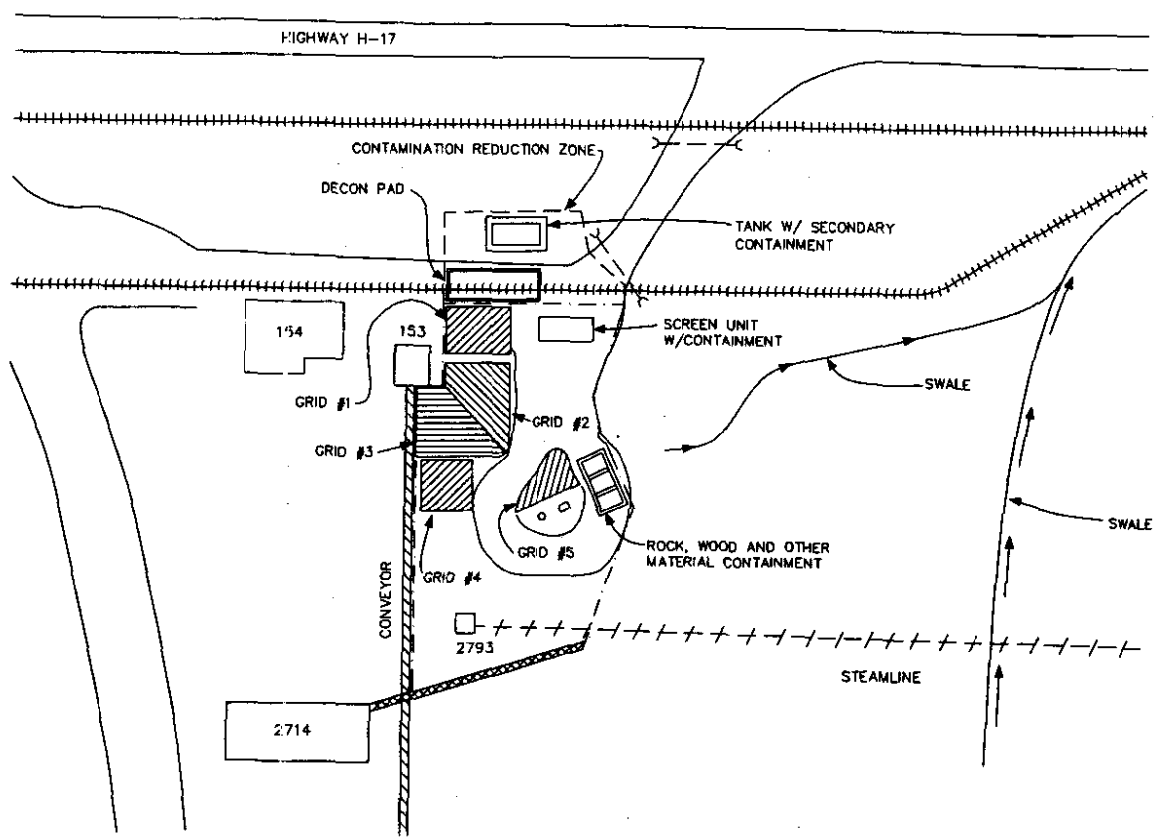
During World War II, NAD Crane's mission expanded to include pyrotechnics production, mine filling, rocket assembly, field storage, torpedo storage, and ordnance spare parts and mobile equipment storage. NAD Crane continued to supply ammunition to the fleet during the Korean and Vietnam wars (Halliburton NUS, 1992a). NAD Crane was renamed Naval Weapons Support Center Crane in 1976, and renamed again in 1992 to NSWC Crane.

In 1977, the Crane Army Ammunition Activity was created, and the Army assumed ordnance production, storage, and related responsibilities as a tenant organization. Other functions remained under control of the Navy, and the Navy currently retains ownership of all real estate and facilities at NSWC Crane. Overall responsibility for station safety, security, and environmental protection remains with the Commanding Officer, NSWC Crane (Halliburton NUS, 1992a).

Until the early 1980s, a variety of liquid wastes were disposed of on site without treatment. Explosives-contaminated wastewater was discharged into unlined ponds or into storm drains and ditches; wastewater generated from cleaning operations was discharged into an unlined pond; oily waters, battery acids, paint thinner, acetone, boiler blowdown, and solvents were dumped behind buildings or into ravines; and waste hydraulic oil was spread on dirt roads. Since the early 1980s, treatment plants have been built; wastewater streams have been connected to the sanitary sewer; and oils and solvents have been collected, segregated, and either recycled, sold, or disposed of properly (Halliburton NUS, 1992a).

1.1.2 Mine Fill A

Solid Waste Management Unit (SWMU)-12/14, Mine Fill A (MFA), which was the source of soil used in the contaminated-soil pilot test, is located in the west-central portion of NSWC Crane along Highway H-17, as shown in Figure 1-2. MFA consists of 29 buildings that have been and continue to be used to assemble mines, depth charges, rocket heads, aerial bombs, and projectiles. MFA began operation in 1942 with the loading of depth charge bombs. The area was also used during the Korean and Vietnam wars. MFA continued to produce ordnance until 1975, when production was suspended. Production was resumed in 1980, and MFA currently produces 2,000-pound aerial bombs. Production rates are not available for other periods, but over six million bombs were manufactured at MFA and Mine Fill B during the Vietnam War (Hallibuton NUS, 1992b). Demilitarization activities, which include ordnance disassembly and decommissioning, are also performed in the area. The major sources of contamination were wash-down operations and the exhaust ventilation systems.



LEGEND

- BUILDING
- CONVEYOR
- STEAMLINE
- RAILROAD
- EXCLUSION ZONE LIMIT
- STRAW BALE SILT FENCE
- CONTAMINATION REDUCTION ZONE LIMIT

NOTE: SOIL FOR THE PILOT SCALE TEST WAS EXCAVATED *FROM GRIDS 1 AND 2*

NOT TO SCALE

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES

PILOT SCALE
TREATABILITY TEST REPORT
NSWC CRANE
CRANE, IN

FIGURE 1-2
MINE FILL A AREA

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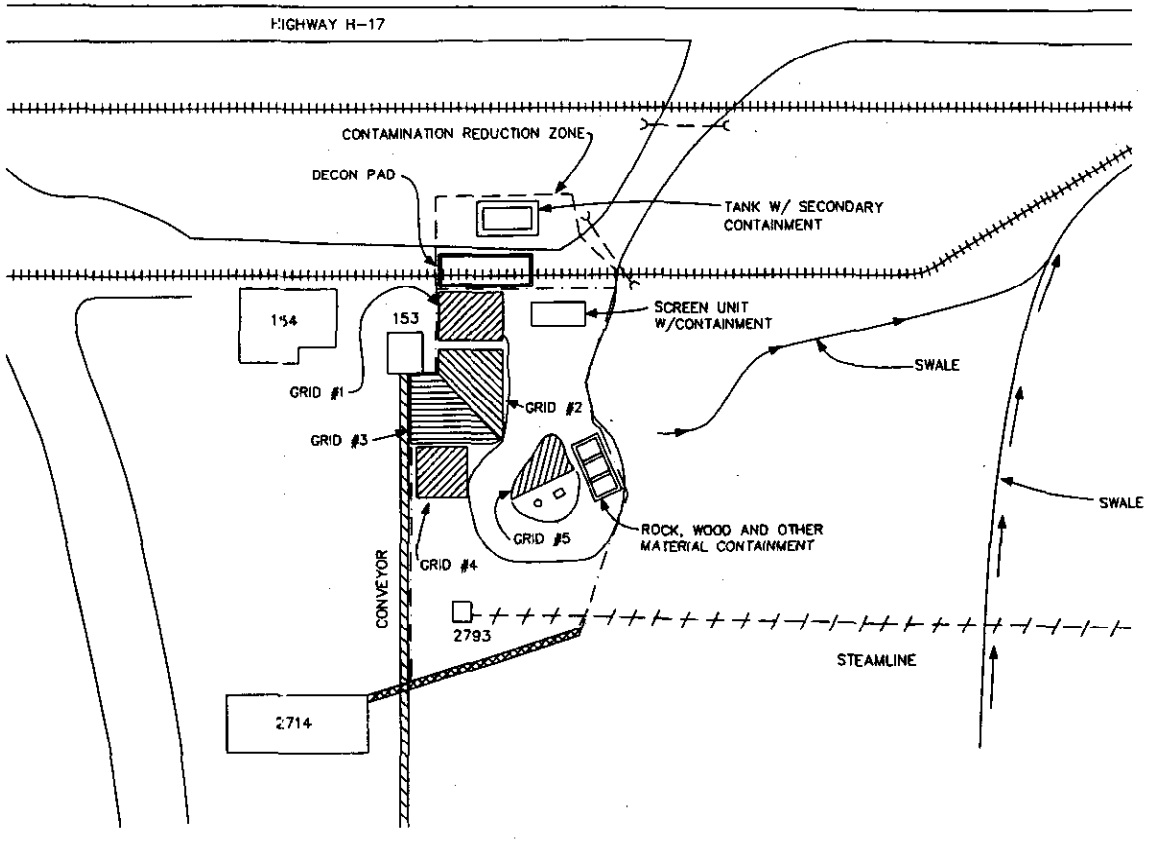

NOT TO SCALE

LEGEND

- BUILDING
- CONVEYOR
- STEAMLINE
- RAILROAD
- EXCLUSION ZONE LIMIT
- STRAW BALE SILT FENCE
- CONTAMINATION REDUCTION ZONE LIMIT

NOTE: SOIL FOR THE PILOT SCALE TEST WAS EXCAVATED FROM GRIDS 1 AND 2

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PILOT SCALE
TREATABILITY TEST REPORT
NSWC CRANE
CRANE, IN

FIGURE 1-2
MINE FILL A AREA

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TABLE 1-1 SUMMARY OF SOIL BORING RESULTS - MINE FILL A			
Sample I.D.	**TNT (ppm)**	**HMX (ppm)**	**RDX (ppm)**
MFA-1	69	292	2,620
MFA-2	3,790	1,340	15,300
MFA-3	8	908	8,150
MFA-4	<3.6	64	374
MFA-5	64	99	906
MFA-7	<3.6	<5.0	<7.2
MFA-8	5.2	52	349

Soil samples were collected from 20 inches below ground surface.
Source: Halliburton NUS (1992b)

1.2 DOCUMENT ORGANIZATION

This report is organized into fifteen sections and includes eight appendices. Section 1.0 provides a brief introduction of the site and characterization of the test soil. A brief description of the treatment technology and a summary of previous treatability studies are also provided in Section 1.0. Section 2.0 provides the objectives of the pilot-scale test and the treatability test design. A summary of pilot-scale test operations is provided in Section 3.0. Data collection and management is presented in Section 4.0. Changes to the pilot-scale operational plan are discussed in Section 5.0. Results of the clean soil tests are discussed in Section 6.0. Results of the contaminated soil tests are discussed in Section 7.0. Details of cost and time requirements are discussed in Section 8.0. A summary of safety and industrial hygiene sampling and monitoring is provided in Section 9.0. Conclusions and recommendations of this study are summarized in Section 10.0. A list of reference documents is provided in Section 11.0.

Data charts and other pertinent information are provided in the following appendices:

Appendix A: FIELD CLARIFICATION REQUESTS (FCRs)
Appendix B: CLEAN SOIL RECORD OF RECIPE
Appendix C: CLEAN SOIL TEMPERATURE DATA AND PROFILES
Appendix D: CLEAN SOIL MOISTURE DATA AND PROFILES
Appendix E: CLEAN SOIL OXYGEN DATA AND PROFILES
Appendix F: CLEAN SOIL pH DATA AND PROFILES
Appendix G: CLEAN SOIL C:N DATA AND PROFILES
Appendix H: CLEAN SOIL AMBIENT TEMPERATURE AND HUMIDITY PROFILES
Appendix I: CONTAMINATED SOIL RECORD OF RECIPE
Appendix J: CONTAMINATED SOIL TEMPERATURE DATA AND PROFILES
Appendix K: CONTAMINATED SOIL MOISTURE DATA AND PROFILES
Appendix L: CONTAMINATED SOIL OXYGEN DATA AND PROFILES
Appendix M: CONTAMINATED SOIL pH DATA AND PROFILES
Appendix N: CONTAMINATED SOIL C:N PROFILES
Appendix O: CONTAMINATED SOIL AMBIENT TEMPERATURE AND HUMIDITY PROFILES
Appendix P: CONTAMINATED SOIL EXPLOSIVES DEGRADATION DATA AND PROFILES
Appendix Q: SAFETY AND INDUSTRIAL HYGIENE REPORT

1.3 TEST SOIL CHARACTERIZATION

1.3.1 Clean Soil Characterization

Soil for the clean-soil pilot-scale testing was excavated during construction of the Soils Bioremediation Facility and stockpiled at the NSWC Crane landfill. The soil, a light brown silty clay with trace to small amounts of sand and gravel, was similar in texture to the contaminated soil from MFA. Approximately 120 cubic yards were used in the clean soil testing.

1.3.2 Contaminated Soil Characterization

SWMU-12/14, MFA, was selected as the source of contaminated soil for the pilot-scale operation. This area was selected because of its high concentrations of 2,4,6-trinitrotoluene (TNT), cyclotrimethylene trinitramine (RDX), and other explosives, and because access was easy and did not impact ongoing facility activities.

The soil at MFA is mixed clay, silt, and silty clay. Contaminants include TNT, RDX, and cyclotetremethylenetetranitramine (HMX). Soil samples collected during the 1985 site investigation (Halliburton NUS, 1992b) contained up to 3,790 milligrams per kilogram (mg/kg) TNT, 15,300 mg/kg RDX,

and 1,340 mg/kg HMX. Analytical results from the site investigation are shown in Table 1-1. Samples collected from excavated MFA soil for the Dewars tests contained higher levels—up to 3,770 mg/kg TNT, 28,100 mg/kg RDX, and 2,440 mg/kg HMX (see Section 1.5.5). Samples collected from excavated MFA soil for the pilot test contained lower contaminant levels, at up to 727 mg/kg TNT, 8,600 mg/kg RDX, and 1,100 mg/kg HMX (see in Section 7).

The area around Building 153 was selected as the excavation site for the pilot-scale operation. Approximately 120 cubic yards of contaminated soil were excavated at the MFA area for pilot-scale testing from Grids 1 and 2 (see Figure 1-2).

1.4 TREATMENT TECHNOLOGY DESCRIPTION

1.4.1 Fundamentals of Bioremediation by Composting

Composting, the process of microbial degradation of organic material, results in the production of residual organic and inorganic material. Heat is generated and contained in the compost matrix, leading to self-heating of the compost pile, which further stimulates microbial activity. In bioremediation by composting, organic material is mixed with contaminated soil, which initially contains very little or no organic material. The added organic material acts as a carbon source for microorganisms that are also capable of degrading organic contaminants, such as the explosives present in contaminated soils at NSWC Crane.

Microbial activity in a compost pile is controlled by the availability of organic material and inorganic nutrients (such as nitrogen and phosphorous), temperature, moisture content, pH, and oxygen availability. The texture of the compost is important because it controls porosity, which helps determine aeration and moisture-holding capacity. The nature of the organic amendments determines nutrient concentration and availability. For example, cow and chicken manure contain high levels of readily available nitrogen, and straw contains high levels of readily available carbon and contributes to an open, porous structure.

Bioremediation by composting may be performed at one of three general levels of technology. These levels are described below.

- The first and simplest level of technology is the windrow system, which was used in this pilot test. The material is mixed and shaped into long narrow rows and allowed to self-heat. Water may be added, and the rows may be tilled or turned periodically or at intervals dictated by a monitored parameter such as temperature.

- The second level of technology is the static pile system, which includes the addition of an aeration and heat control system. For aeration and heat control, perforated pipe normally underlies the compost. A blower moves air through the compost to provide aeration and heat control.

- The third level is the in-vessel system, which uses a system of enclosed reactor vessels and automated process control equipment.

The results of previous testing has shown that windrow composting is the most cost-effective method of successfully remediating explosives-contaminated soil. Several of those studies are summarized in Section 1.5 below.

1.5 SUMMARY OF PREVIOUS TREATABILITY STUDIES

1.5.1 Umatilla Army Depot

Composting was the remedial technology selected to treat approximately 14,000 cubic yards of explosives-contaminated soil at the Umatilla Army Depot in Hermiston, Oregon. The decision to compost and the design of the composting operation were based on trial studies, which included bench- and pilot-scale tests (Weston, 1993). Temperature was considered a primary indicator, with a process goal of maintaining 55° centigrade (C). Moisture content was maintained at a water-holding capacity (WHC) of 50 to 60 percent. Although oxygen levels were observed to drop to less than 5 percent within 10 to 30 minutes following turning, the pilot-scale windrows were turned once daily after it was determined that higher turning frequencies were not practical for a full-scale operation. A summary of the test results are as follows:

- Conventional (un-aerated) windrow composting can effectively reduce TNT, RDX, and HMX concentrations to below their respective cleanup levels in less than 40 days.
- The conventional (un-aerated) windrow performed as well as or better than the mechanically aerated windrow.
- Seeding studies showed that recycling a fraction of acclimated, active compost from one treatment cycle to the next did not produce any measurable improvement in composting efficiency.
- Soil loading rates of 30 weight percent (the highest tested) can be successfully remediated by windrow composting.

1.5.2 United States Naval Submarine Base, Bangor, Washington

Composting was the selected remedial technology to treat approximately 2,200 cubic yards of explosives-contaminated soil at the United States Naval Submarine Base in Bangor, Washington. The decision and the design of the composting operation was based on trial studies that included bench- and pilot-scale tests.

Two pilot-scale windrows of 30 cubic yards each were assembled with 30 percent soil and an amendment mix of cow manure, sawdust, alfalfa hay, and potato waste (Remediation Technologies Inc., 1996). The windrows were turned three to ten times weekly and moisture content maintained a minimum of 40 percent. The soil was from two sites: site D, which was an ordnance burning area, and site F, which received explosives-contaminated water. The site F windrow met treatment goals of 33 mg/kg TNT and 9.1 mg/kg RDX in 9 days, while the site D windrow, at 41 mg/kg TNT, did not meet the goal for TNT, possibly because discrete specks or nuggets of TNT at the ordnance burn area were more difficult to degrade.

1.5.3 Waterways Experiment Station Bench-Scale Tests

NSWC Crane Environmental Protection Department (EPD) tasked U.S. Army Corps of Engineers Waterways Experiment Station (WES) with conducting laboratory testing in order to develop recommendations on recipes for composting. Soils from the Rockeye site were collected and transported to the WES laboratories for use in preliminary composting studies. The studies consisted of two-phases. The first phase was a respirometric study designed to optimize the compost mix. The second phase evaluated the compost mix's effectiveness in treating contaminated soil. Following these trials, WES

conducted toxicity experiments in an attempt to qualify hazardous ecosystem effects of the composted material. Results of these studies are detailed in a WES report (Preston *et al*, 1998)

The respirometric study evaluated eight different compost mixtures (see Table 1-2). These mixtures were based upon a survey of locally available sources of amendments and bulking agents and calculated Carbon to Nitrogen ratios. An oxygen sensing respirometer was used as an isothermic compost reactor to determine optimal substrate utilization of each mixture.

Following the respirometric study, selection of a mixture for further testing in the bench-scale study was based upon the explosive analytes degradation rate (expressed in terms of half-life of explosive compound concentration degradation determined by assuming a first-order equation), system efficiency, and system simplicity. WES Mix 7, (40% Cow Manure, 40% Alfalfa, and 20% soil) was chosen for the bench-scale tests. The bench-scale composting tests were intended to provide preliminary feasibility data by simulating field composting conditions. The bench-scale systems reached thermophilic temperature (50° C) and returned to ambient temperatures after 10 days of composting. The compost activity was allowed to continue for 30 days. Samples for explosives analysis were taken on days 0, 15, and 30. The results showed that the majority of the explosives and transformation products were removed within the first 15 days of composting.

Toxicity tests were conducted on the composted material of Mix 7 of the Rockeye soil. Two assays were used to evaluate the potential ecosystem toxicity: the Mutatox™ assay and the earthworm acute toxicity test. The Mutatox™ assay is a proprietary assay that determines the mutagenic potential of sample extracts. The earthworm acute toxicity test estimates the acute toxicity of the composted material to earthworms (*Eisenia foetida*) in a 14-day static test. The bench-scale compost tests apparently reduced the bacterial acute toxicity as demonstrated by the Mutatox™ test. The earthworm study likewise demonstrated a reduction in toxicity.

TABLE 1-2
BENCH-SCALE RECIPES

MIX #	AMENDMENTS AND BULKING AGENTS	
1	30% Turkey manure	50% Sawdust
2	30% Turkey manure	50% Recycled Paper
3	40% Swine Manure	40% Sawdust
4	40% Swine Manure	40% Recycled Paper
5	40% POTW Sludge	40% Sawdust
6	40% POTW Sludge	40% Recycled Paper
7	40% Cow Manure	40% Alfalfa
8	13% Swine Manure, 22% Turkey Manure	22.5% Sawdust, 22.5% Recycled Paper

Numerous problems were encountered in interpreting the results from the WES studies. For example, in the respirometric study, the initial explosive concentrations of each mix differed by as much as 2,717 mg/kg, creating difficulties in comparing results (see Table 1-3). As such, the mixes that demonstrated the shortest half-lives were not necessarily the ones that had the greatest overall degradation nor necessarily the lowest final concentration. Furthermore, based on these observations, additional mixes should have been tested in the bench-scale studies.

TABLE 1-3 BENCH-SCALE EXPLOSIVES RESULTS												
Mix #	TNT				RDX				HMX			
	Initial Conc. (mg/kg)	Final Conc. (mg/kg)	Conc. Diff.	Half-Lives (day)	Initial Conc. (mg/kg)	Final Conc. (mg/kg)	Conc. Diff.	Half-Lives (day)	Initial Conc. (mg/kg)	Final Conc. (mg/kg)	Conc. Diff.	Half-Lives (day)
1	1054	0.2	1053.8	0.83	121	2.8	118.2	1.84	3913	1.18	3911.8	5.78
2	1140	1.6	1138.4	1.05	163	1.6	161.4	1.49	5797	3.88	5793.1	17.26
3	2747	10.7	2736.3	1.25	184	0.3	183.7	1.05	5620	3.32	5616.7	13.17
4	1897	0.9	1896.1	0.91	164	0.3	163.7	1.07	5420	3.26	5416.7	13.63
5	828	0.4	827.6	0.9	121	0.3	120.7	1.12	3743	2.31	3740.7	14.36
6	925	1.6	923.4	1.09	152	8.7	143.3	2.43	5607	4.7	5602.3	39.29
7	975	0.8	974.2	0.97	186	0.3	185.7	1.05	6227	3.71	6223.3	13.38
8	996	0.5	995.5	0.92	99	2.2	96.8	1.82	3510	3.25	3506.8	90.05
Max.	2747	10.7	2736.3	1.25	186	8.7	185.7	2.43	6227	3.88	6223.3	90.05
Min.	828	0.2	827.6	0.83	99	0.3	96.8	1.05	3510	1.18	3506.8	5.78
Diff.	1919	10.5			87	8.4			2717	2.70		

Although the results and the conclusions reached by WES of each phase of these studies were subject to varied interpretations, it was however, evident from the respirometric and bench-scale studies that composting could successfully treat explosives contamination in soils. This fact, combined with research done at other facilities provided the impetus for the Navy to proceed with the full-scale operations.

1.5.4 NSWC Crane Dry Run Tests

At the point NSWC Crane was ready to begin pilot-scale tests, winter weather had set in. As such, the Navy felt it was prudent to conduct tests with clean soil prior to the use of contaminated soils. Therefore, the purpose of the Dry Run Piles was to test the ability of locally available amendments to perform during cold weather and test general operating procedures (i.e., mechanics of creating and turning piles). The mixes were based on bench-scale testing and C:N ratios - deemed essential at the time. Each dry run pile was approximately 60 cubic yards in size consisting of 25% clean soil. The percentage of amendments making up each dry run mix can be found in Table 1-4.

TABLE 1-4 DRY RUN MIXES								
Amendment (wt %)	Mix							
	1	2	3	4	5	6	7	8
Alfalfa						36	7.5	18
Chicken Manure		3.2		1.5	1			3.7
Corn Stalks			57	73.5				11.3
Cow Manure	19		18		4.5	19.5	12	22.5
Soil	25	25	25	25	25	25	25	25
Straw	56	71.8			69.5	19.5	48	
Wood Chips							7.5	19.5

Deciding factors were temperature (i.e., would the mix reach thermophilic temperatures), texture (e.g., dense, cold piles indicate a lack of porosity, and hence, oxygen transport within the pile, and cost. Texture and temperature determined which piles were considered successful and would be used for the contaminated soil phase of the pilot-scale study. A relationship exists between temperature, oxygen, and moisture. Increasing the turning frequency of a pile decreases temperature and moisture while increasing oxygen within the pile. Adding water to the pile increases the moisture of the pile while simultaneously decreasing temperature and oxygen. Ranges specified in Table 1-3 for each of these parameters are indicated for a healthy microbial population in order to have successful biodegradation of the contaminants. Temperature, however, is an independent variable, in that, if the oxygen and moisture conditions of the pile are optimized (along with the other recommended parameters), then temperature will vary according to the aerobic activity of the microbes – indicating a healthy pile. In addition to the parameters specified in Table 1-3, the physical condition of the pile is tantamount to determining the success or failure. In general, if a pile is unworkable (i.e., shape not maintained, difficult to turn, phase separation, forms clumps, etc.) then that pile will not be considered successful.

Results of the dry run tests are provided in the *Interim Progress Report for Pilot Scale Clean Soil Testing* (MK, 1997a). Mixes 1, 2, 5, and 7 were considered the most acceptable of the eight mixes. The three mixes containing cornstalks (Mixes 3, 4, and 8) became dense after moisture was added, therefore lowering the oxygen content, and did not meet expected temperature ranges. Mixes 6 and 7 were representative of the bench-scale. Discussions with the WES investigators revealed that the manure used in the bench-scale contained a significant amount of straw. The WES investigators also recommended the addition of wood chips as a bulking agent for a large-scale test (Mix 7). Mix 7 had a higher temperature and a lower overall cost than Mix 6, therefore Mix 6 was also considered unsuccessful (MK, 1997c). Figures 1-3 to 1-6 provides the temperature profiles for Mixes 1, 2, 5, and 7 respectively.

1.5.5 Dewar Tests

The Navy and the U.S. EPA Region V desired to test as many amendments as possible in order make a judicious decision on a full-scale mix. Since half of the mixes failed to perform adequately in the Dry Run Test, the Navy elected to test additional mixes, with less emphasis on C:N ratio and focusing instead on increasing the manure percentages. The opinion of the Navy and the U.S. EPA Region V was that the organics, nutrients, and microbial populations inherent in the manures were critical in establishing an active windrow. The Navy and the U.S. EPA Region V elected to conduct additional mix testing on a smaller scale to reduce costs and to ensure treatment success using contaminated soil. The test method selected was the Dewar self-heating test (Brinton *et al*, 1995). The purpose of the Dewar testing was to evaluate the temperature achieved by the four acceptable mixes from the dry run tests and other selected mixes on a smaller scale this time using contaminated soil. Analysis for explosives concentrations were also conducted before and after the Dewar self-heating test to quantify explosive degradation.

Mixes 1, 2, 5, & 7 resulted from Dry Run testing and the other mixes were derived from the remaining Dry Run mixes and other Navy and U.S. EPA recommended mix combinations. The percentage of amendments making up each Dewar test mixes can be found in Table 1-5. Dewar self-heating tests were performed during April and May of 1997, under the direction of the NSWC Crane EPD by Woods End Research Laboratory (Woods End, 1997).

Note that Mix 10 was the recipe used during explosive contaminated soils composting demonstrations at Umatilla Army Depot Activity, Hermiston, Oregon. Mix 8 was a variant of the bench-scale. Dewar testing was conducted in two rounds. Two rounds of testing were required because of the size of the lab; Mixes 1 to 4 and 8 to 10 were tested during the first round. All mixes were tested in duplicate. Table 1-6 shows the temperature profiles of the mixes tested.

FIGURE 1-3 TEMPERATURE PROFILE FOR DRY RUN -- MIX 1

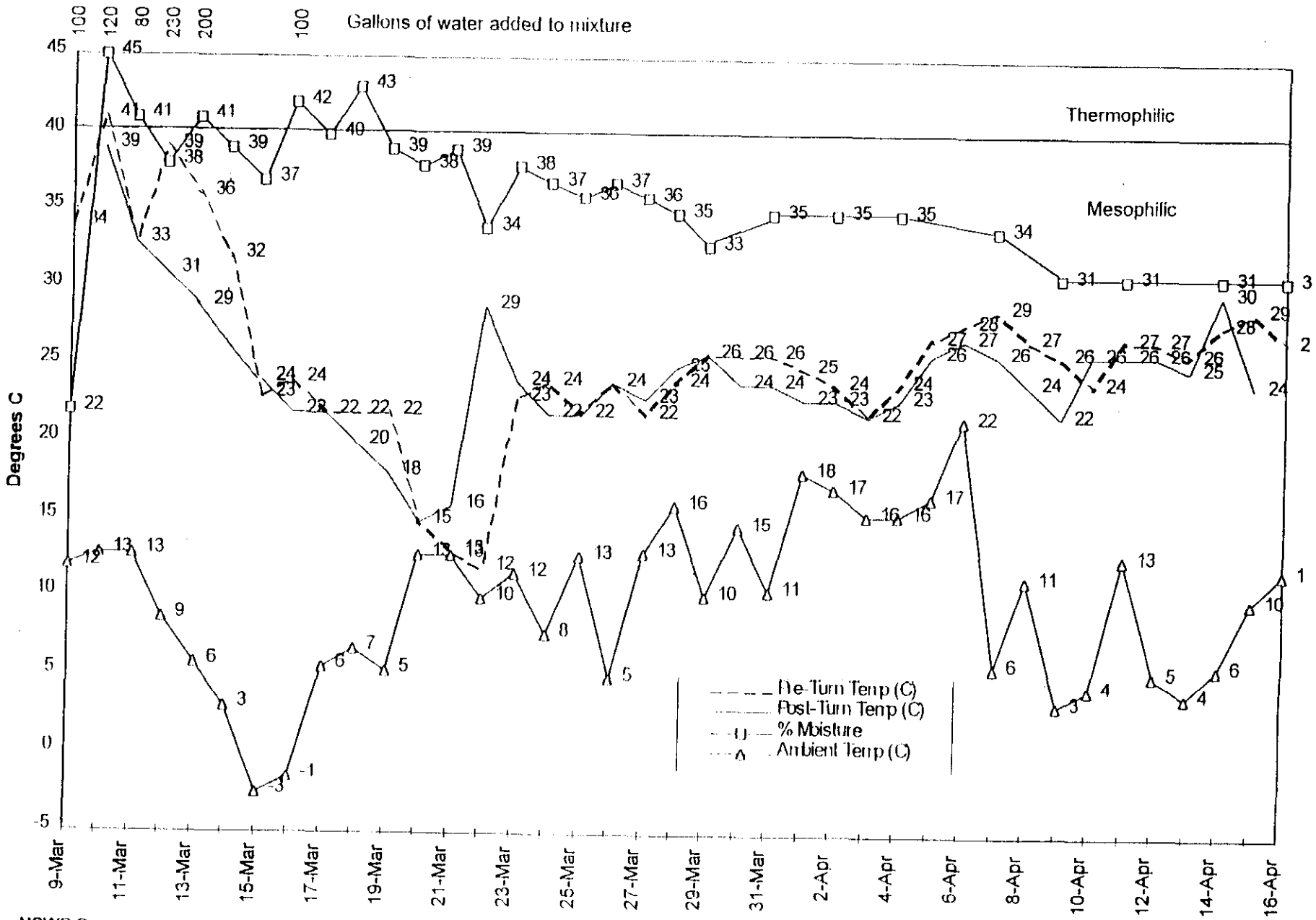

FIGURE 1-4 TEMPERATURE PROFILE FOR DRY RUN -- MIX 2

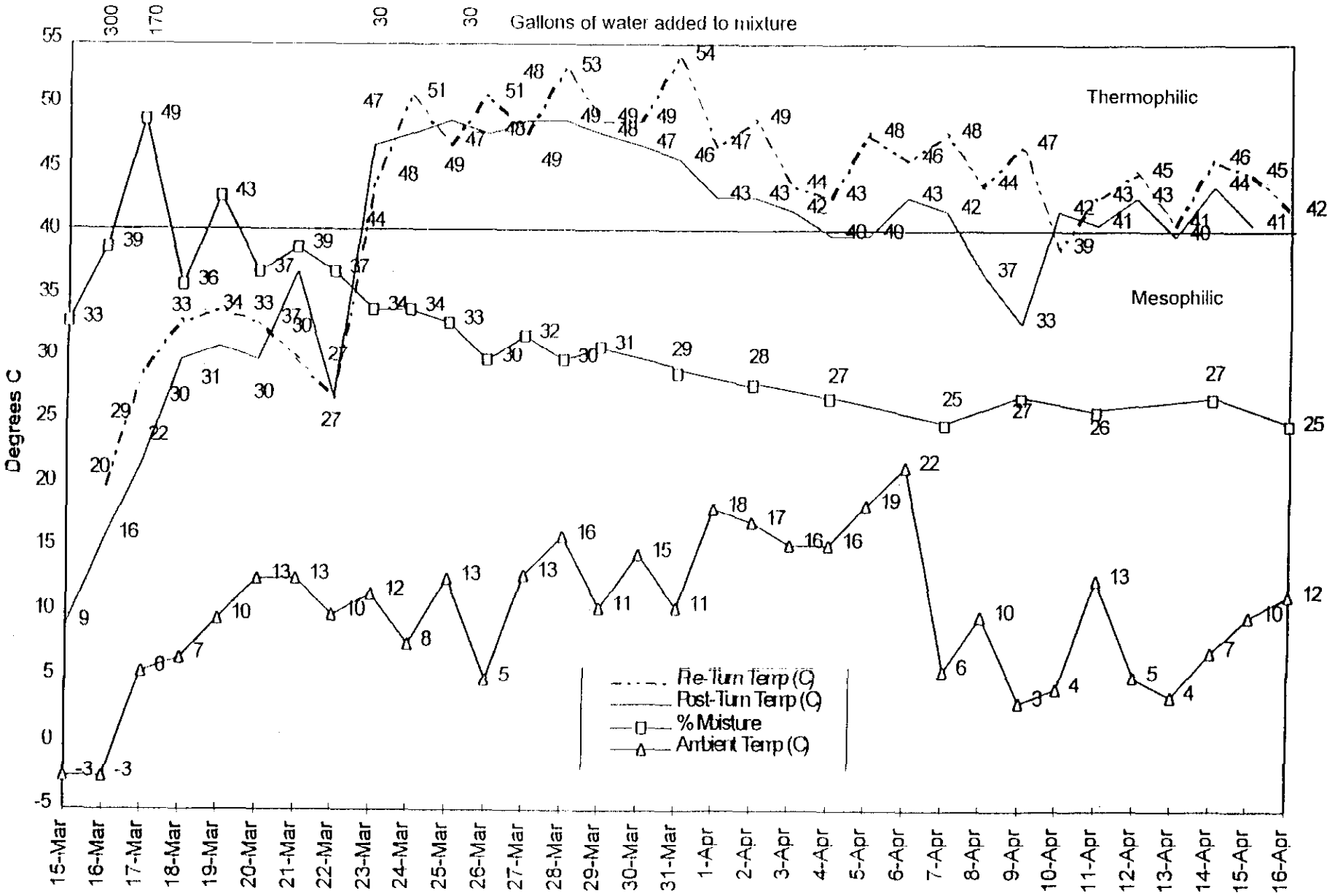

FIGURE 1-5 TEMPERATURE PROFILE FOR DRY RUN -- MIX 5

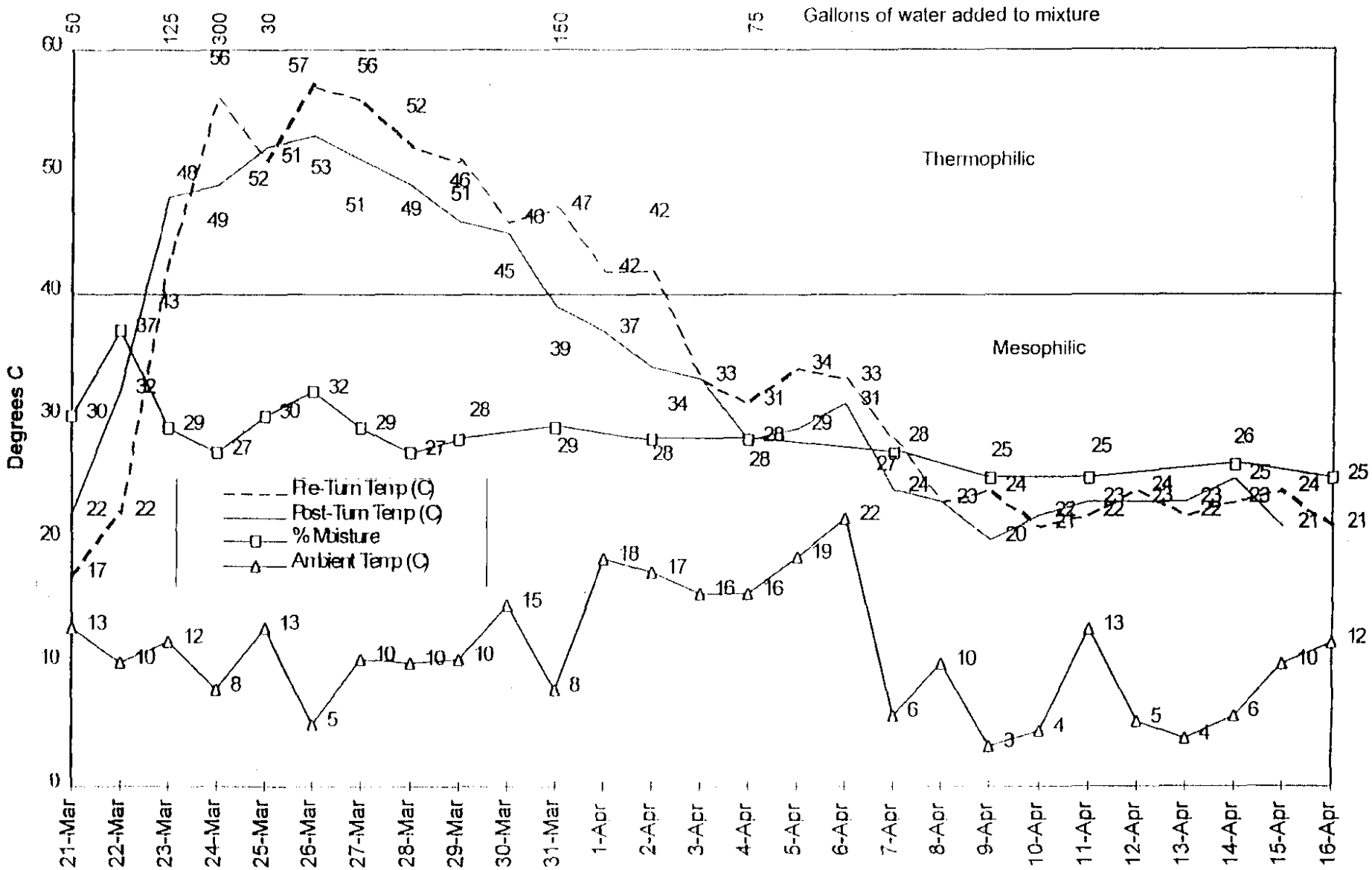

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FIGURE 1-6 TEMPERATURE PROFILE FOR DRY RUN -- MIX 7

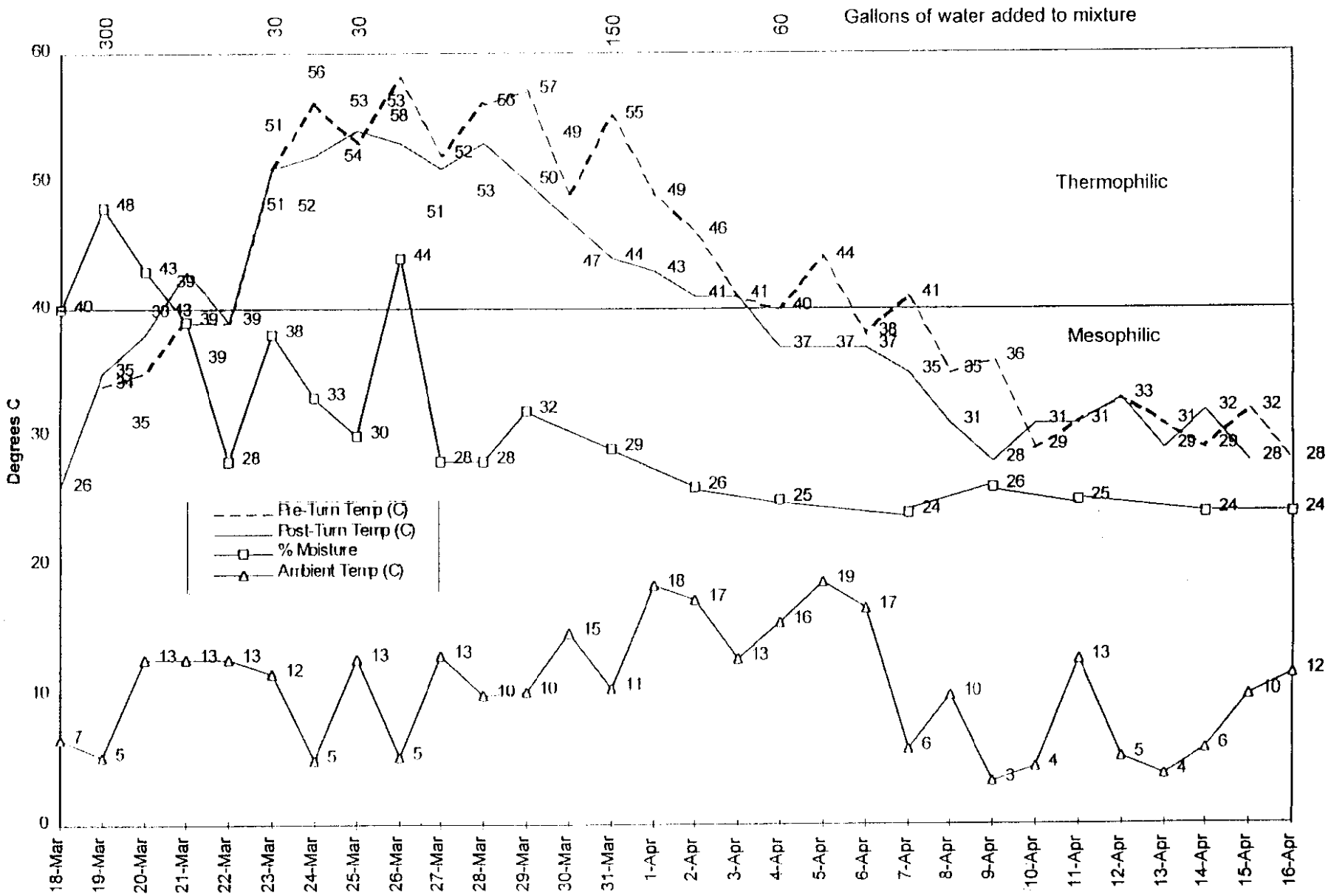


TABLE 1-5
PROPOSED DEWAR SELF-HEATING MIXES

Amendment (wt %)	Mix 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Cow Manure	19				4.5	25	12	25		22.5	25			25
Chicken Manure		3.2		35	1	15				3.3				15
Turkey Manure									25			25		
POTW Sludge			25										40	
Potato Waste										10.8				
Alfalfa			25				7.5	25	25	19.3				
Straw	56	71.8			69.5		48				15	15		
Wood Chips			12.5	40		35	7.5	25	25		35	35	17.5	35
Sawdust			12.5							19.3			17.5	
Soil	25	25	25	25	25	25	25	25	25	25	25	25	25	25

TABLE 1-6
COMPOST SELF-HEATING RESULTS
(Temparature, Degrees Centigrade)

Mix	Days After Set-up 2	3	4	5	6	7	10*
1 A	22	22	26	27	26	24	22
1 B	22	24	27	28	27	25	22
2 A	22	23	26	26	26	23	22
2 B	22	25	26	25	24	24	22
3 A	22	22	22	23	23	22	22
3 B	22	22	22	22	22	22	22
4 A	22	27	27	26	26	24	22
4 B	22	25	27	26	26	24	22
5 A	26	25			22		22
5 B	30	32			24		22
6 A	27	25			22		22
6 B	27	27			23		22
7 A	30	30			24		22
7 B	31	29			24		22
8 A	22	24	29	27	26	25	22
8 B	30	35	37	33	32	29	25
9 A	31	38	40	33	32	29	27
9 B	30	36	39	34	34	30	29
10 A	35	56	63	45	35	27	25
10 B	34	42	44	41	39	34	28
11 A	25	24			23		23
11 B	26	25			24		23
12 A	26	25			24		24
12 B	28	29			29		25
13 A	22	22			22		22
13 B	22	22			22		22
14 A	29	28			24		23
14 B	31	27			24		23
Ambient	22	22	22	22	22	22	22

*** indicates 9 days for Mixes 5, 6, 7, 11, 12, 13, & 14**

Mixes 5, 6, 7, 11, 12, 13, & 14 tested on 2, 3, 6, and 9 days only.

Table 1-7 presents the results of initial and final explosives analyses from the duplicate Dewar mixes, as well as the percentage change from the initial to the final concentrations. Initial samples for explosives for Mixes 1 to 4 and 8 to 10 were taken post excavation and prior to mixing with the amendments. As such, one value was reported for the initial concentrations of HMX, RDX, and TNT for those mixes. The Navy subsequently requested that the initial samples for explosives analyses for Mixes 5 to 7 and 11 to 14 be taken after the addition of amendments, thus providing more representative initial concentrations. Several of the samples showed increases in concentrations from the initial to the final. Some of this may be explained by the questionable representativeness of the initial concentrations during the first round of tests. Additionally, lack of uniformity in the material being sampled (i.e., poor homogeneity), sample contamination, or sampling or analytical errors may be at fault. It is not possible for HMX, RDX, or TNT to be formed during the Dewar tests. Mixes 2, 3, 4, 9, and 10 demonstrated greater than 70% reduction in TNT.

TABLE 1-7
INITIAL AND FINAL EXPLOSIVE RESULTS FROM DEWAR TESTING

Mix	HMX			RDX			TNT		
	Initial (mg/kg)	Final (mg/kg)	% Reduction	Initial (mg/kg)	Final (mg/kg)	% Reduction	Initial (mg/kg)	Final (mg/kg)	% Reduction
1 A	2440	1800	26.23%	28100	20600	26.69%	3770	2380	36.87%
1 B	2440	4160	70.49%	28100	42000	49.47%	3770	4160	10.34%
2 A	2440	2850	16.80%	28100	34000	21.00%	3770	850	77.45%
2 B	2440	4760	95.08%	28100	50200	78.65%	3770	3900	3.45%
3 A	2440	884	63.77%	28100	9350	66.73%	3770	671	82.20%
3 B	2440	1140	53.28%	28100	11800	58.01%	3770	243	93.55%
4 A	2440	600	75.41%	28100	6160	78.08%	3770	157	95.84%
4 B	2440	513	78.98%	28100	5410	80.75%	3770	48	98.73%
5 A	1760	2230	26.70%	18700	21800	16.58%	2700	2910	7.78%
5 B	2040	1130	44.61%	25400	11200	55.91%	3580	1450	59.50%
6 A	1260	1280	1.59%	13900	12700	8.63%	1840	637	65.38%
6 B	924	787	14.83%	10100	7880	21.98%	709	241	66.01%
7 A	1620	2720	67.90%	18600	27600	48.39%	2600	2860	10.00%
7 B	1650	1090	33.94%	18400	12100	34.24%	2680	1710	36.19%
8 A	2440	1040	57.38%	28100	13200	53.02%	3770	1760	53.32%
8 B	2440	1200	50.82%	28100	13600	51.60%	3770	1770	53.05%
9 A	2440	823	66.27%	28100	9540	66.05%	3770	668	82.28%
9 B	2440	475	80.53%	28100	5540	80.28%	3770	353	90.64%
10 A	2440	1180	51.64%	28100	13200	53.02%	3770	24	99.36%
10 B	2440	2520	3.28%	28100	29200	3.91%	3770	94	97.51%
11 A	1890	1710	9.52%	22500	18200	19.11%	3380	1790	47.04%
11 B	1680	525	68.75%	21200	6900	67.45%	2700	499	81.52%
12 A	1630	885	45.71%	18700	13200	29.41%	2900	1029	64.52%
12 B	2560	1450	43.36%	29200	17800	39.04%	3960	2046	48.33%
13 A	1210	2120	75.21%	14500	25500	75.86%	2170	2760	27.19%
13 B	1990	1640	17.59%	18700	18360	1.82%	2480	1880	24.19%
14 A	1340	11000	720.90%	15300	2170	85.82%	1760	1250	28.98%
14 B	1290	11000	752.71%	13600	9690	28.75%	982	1250	27.29%

Mixes were ranked based upon their temperature, percent of explosives degradation, and cost, as shown in Table 1-8. The top five mixes were chosen to the next phase of testing.

TABLE 1-8
MIX RANKINGS

Mix	Temperature	Explosive Degradation	Cost
1	7	12	$6.71
2	11	13	$5.26
3	13	3	$10.15
4	9	1	$8.55
5	6	9	$5.35
6	9	8	$8.52
7	4	11	$8.21
8	3	5	$13.49
9	2	2	$14.29
10	1	4	$19.32
11	12	6	$6.75
12	7	7	$7.54
13	14	14	$6.00
14	5	10	$8.49

Mixes 3, 4, 9, and 10 were selected principally based upon their temperature and explosives degradation performance. Mix 2 was selected as a fifth mix based primarily on cost. Although Mix 5 provided better temperature, explosives degradation, and cost results, Mix 2 was a simpler operating recipe, using only one manure instead of two.

Of the 14 mixes tested, five mixes (2, 3, 4, 9, and 10) showed successful temperature increases and explosives degradation and were chosen to continue to the pilot-scale testing. In the pilot-scale, the numbers identifying the mixes changed as follows:

Testing Stage	Mix				
Dewar	2	3	4	9	10
Pilot-Scale	7A	1	2	3	4

2.0
PILOT TEST STRATEGY

2.1 OBJECTIVES

The objective of pilot testing is to determine which compost mix provides the optimum environment for microorganism growth and degradation of explosives in contaminated soil. The results of pilot testing will be used to plan full-scale treatment operations. The overall objective is met by evaluating mix performance with respect to the process and performance goals described below.

2.1.1 Process Goals

The process parameters subject to control by operating procedures and their corresponding goals are listed in Table 2-1. These parameters are monitored as described in Section 4.1. These goals are designed to provide optimal conditions for contaminant degradation and meet the performance goals established in the *Pilot Scale Operational Plan for Soils Bioremediation Facility* (MK, 1997b).

TABLE 2-1
PROCESS GOALS

Process Parameter	Operating Goal
Temperature	25 to 60°C
Moisture	40 to 60 percent maximum WHC
Oxygen	5 to 20 percent

A secondary goal was to verify standard operating procedures and identify improvements in operations where necessary. These observations and improvements are presented in Section 5. The significance of individual parameters is described below.

2.1.1.1 Temperature

Temperature is a primary indicator of successful thermophilic composting. The process goal is to maintain average windrow temperatures near 55°C for at least 2 weeks. The average pile temperature should rise to 25 to 40°C within the first few days of formation, continue rising to within the temperature range of 40 to 60°C, and maintain that temperature range for at least 2 weeks. This temperature profile indicates a healthy, metabolically active windrow. Temperatures greater than 65°C can kill many microbes. Temperature decrease over time below 50°C is viewed as an indicator that a pile is nearing the end of its operation (Weston, 1993).

2.1.1.2 Moisture Content

The operating goal for composting moisture content is 40 to 60 percent maximum WHC. If moisture levels are excessively low or high, proper composting and explosives degradation may be affected. Too little moisture inhibits microbial movement and nutrient availability. Excessive moisture fills the void spaces needed for proper aeration, thus reducing oxygen levels.

2.1.1.3 Oxygen

Oxygen levels of up to ambient atmospheric or about 20 percent are preferred in a compost windrow, and 5 percent is considered the minimum for rapid compost degradation. Oxygen levels below 1 percent indicate anaerobic conditions. If sufficient oxygen levels are not maintained, proper microbial degradation may not occur, thermophilic temperatures may not be maintained, and putrefaction of organic matter may occur. As described in Sections 6 and 7, however, anaerobic conditions commonly exist in a compost windrow throughout most of each day, and aerobic conditions may occur only for only 1 to 2 hours following turning.

2.1.2 Performance Goals

During the pilot test, the performance goals were the primary remediation goals for the contaminants of concern. However, a secondary goal was to provide data to evaluate treatment efficiency using Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remediation criteria for innovative treatment technologies.

Preliminary remedial goals (PRGs) developed by the U.S. Environmental Protection Agency (EPA) Region IX (EPA, 1996b) were used as initial cleanup levels for the pilot testing, with the exception of TNT and RDX, as described below. The National Contingency Plan specifies a 90 to 99 percent reduction of toxicity and mobility (or leachability) to demonstrate effective treatment. Previous studies have indicated that reductions in contaminant concentrations result in proportional reductions in toxicity and leachability (EPA, 1996a). Therefore, a 90 to 99 percent reduction in contaminant concentration, including toxic breakdown products, corresponds to a 90 to 99 percent reduction in toxicity and leachability and meets the National Contingency Plan guidelines. The PRGs meet this criteria. The constituents of concern and PRGs are shown in Table 2-2, with corresponding method reporting limits.

A performance goal of 30 mg/kg each for TNT and RDX was used during the pilot-scale testing, as PRGs had yet to be established. The soil PRG at the Bangor site was set at 30 mg/kg for TNT, which corresponded to *lifetime excess cancer risks between 10E-5 and 10E-6 under CERCLA and is protective for non-carcinogenic effects* (EPA, 1993b). This level has been applied at CERCLA sites to minimize the phytotoxic effects of explosives (EPA 1996a), and is especially applicable to areas which may be backfilled with treated soil and revegetated. Goals for other constituents have been reduced from the PRG level such, as 2,4- and 2,6-dinitrotoluene (DNT), based on previous studies (EPA, 1996b).

Table 2-2 lists PRGs for all applicable compounds and metals. Only indicator compounds were measured in the pilot test, as described in Section 4.

2.2 EXPERIMENTAL DESIGN

2.2.1 Scale of the Pilot Test

The pilot test was performed in two phases. The first phase involved the treatment of clean soil; contaminated soil was treated during the second phase. The clean soil pilot test was performed simulating explosives-contaminated soil to verify that the process goals could be met, develop standard operating procedures, and identify potential improvements. Windrows of approximately 60 cubic yards each were constructed to simulate the material handling procedures and thermal conditions required for full-scale operations.

TABLE 2-2
PRELIMINARY REMEDIAL GOALS AND METHOD REPORTING LIMITS

Parameter	Analytical Method	Soil Remedial Goal (mg/kg)	Method Reporting Limit (mg/kg) soil	Method Reporting Limit (µg/L) aqueous
Explosives				
TNT	8330	30	0.25	6.4
RDX	8330	30	1	14.0
HMX	8330	34,000[a]	2.2	13.0
Tetryl	8330	6,800[a]	0.65	10.0
1,3,5-Trinitrobenzene (TNB)	8330	34	0.25	7.3
1,3-Dinitrobenzene (DNB)	8330	68[a]	0.25	4.0
Nitrobenzene (NB)	8330	94[a]	0.26	7.0
4-Aminodinitrotoluene (ADNT)	8330	2.8[b]	0.25	20
2-ADNT	8330	2.8[b]	0.25	14
2,4-DNT	8330	2.8[b]	0.25	5.7
2,6-DNT	8330	2.8[b]	0.26	9.4
2-Nitrotoluene	8330	6,800[c]	0.25	12.0
3-Nitrotoluene	8330	6,800[c]	0.25	7.9
4-Nitrotoluene	8330	6,800[c]	0.25	8.0
Total Metals (site-specific)				
Barium	6010	100,000[a]	0.5	5
Cadmium	6010	850[a]	0.4	4
Chromium (total)	6010	450[a]	0.5	5
Lead	6010	1,000[a]	0.3	3
Toxicity Characteristic Leaching Procedure (TCLP) metals (mg/L)				
Arsenic	1311, 6010	5.0	N/A	100
Barium	1311, 6010	100	N/A	5
Cadmium	1311, 6010	1.0	N/A	5
Chromium	1311, 6010	5.0	N/A	5
Lead	1311, 6010	5.0	N/A	40
Mercury	1311, 7470	0.2	N/A	1.5
Selenium	1311, 6010	1.0	N/A	100
Silver	1311, 6010	5.0	N/A	5
Volatile Organic Compounds				
Dichloromethane (methylene chloride)	8240	18[a]	5	5
Acetone	8240	8,800[a]	10	10
Methyl ethyl ketone	8240	27,000[a]	10	10
Methyl isobutyl ketone	8240	2,800[a]	10	10
Toluene	8240	880[a]	5	5
Xylene (total)	8240	320[a]	5	5

TABLE 2-2 PRELIMINARY REMEDIAL GOALS AND METHOD REPORTING LIMITS				
Parameter	Analytical Method	Soil Remedial Goal (mg/kg)	Method Reporting Limit (mg/kg) soil	Method Reporting Limit (µg/L) aqueous
Ethanol	8015	NV	4	2,000
Isopropanol	8015	NV	4	2,000
Methanol	8015	100,000[a]	4	2,000
Naphtha	8015	NV	25	2,000
TCLP Volatile Organic Compounds (mg/L)				
Benzene	8240	0.5	N/A	5
Carbon tetrachloride	8240	0.5	N/A	5
Chlorobenzene	8240	100.0	N/A	5
Chloroform	8240	6.0	N/A	5
1,2-Dichloroethane	8240	0.5	N/A	5
1,1-Dichloroethene	8240	0.7	N/A	5
Methyl Ethyl Ketone	8240	200.0	N/A	10
Tetrachloroethylene	8240	0.7	N/A	5
Tetrachloroethene	8240	0.5	N/A	5
Vinyl chloride	8240	0.2	N/A	10

Notes:
1. Analytical methods listed above are SW-846 methods, unless otherwise indicated
2. Method reporting limits will vary depending on sample dilution factors
3. NV = no value available
4. N/A = not applicable

[a] Source: U.S. EPA (1996b)
[b] Value for total DNT (EPA, 1996b)
[c] Value for total nitrotoluene

2.2.2 Clean Soil Tests

Eight mixes based on the previous test programs (described in Section 1.5) were selected for the clean soil tests. Composting of clean soil was performed between June 28 and July 29, 1997. Seven of the eight mixes were generated and treated for 30 days. Mix 1 was not tested because the publicly owned treatment works (POTW) sludge at 20 percent solids was not available. A ninth mix, identified as Mix 7A, was included for comparison, although it was generated during the March 1997 dry run tests (Section 1.5.4). The data from Mix 7A is included here because it developed a favorable temperature profile and is a low-cost mix. The nine clean soil test mixes are listed in Table 2-3.

Mixes 1, 2, 3, 4, 5, and 6 were based on the temperature profile and explosives degradation results from the Dewars tests. Mixes 1, 2, 3, and 4 were the same as mixes used for the Dewars tests. Mix 4 was based on the successful Umatilla mix. Mix 5 was the same as Mix 4, except that turkey manure was substituted for cow and chicken manure. Mix 6 was similar to Mix 5, except for the addition of wood chips and variations in bulking agent proportions. Mix 7A was based on the dry run tests. Mix 7B was the same as Mix 7A, with 15 percent chicken manure rather than 3.5 percent, and 60 percent straw rather than 71.5

percent. Mix 7C was the same as 7A, with the addition of 10 percent potato waste and corresponding adjustments to chicken manure and straw.

TABLE 2-3
CLEAN SOIL WINDROW MIXES

Amendment (wt %)	Mix								
	1*	2	3	4	5	6	7A**	7B	7C
POTW Sludge	25.00								
Alfalfa	25.00		25.00	19.25	19.25	15.00			
Sawdust	12.50			19.25	19.25	10.00			
Wood Chips	12.50	40.00	25.00			10.00			
Soil	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Turkey Manure			25.00		25.75	25.00			
Chicken Manure		35.00		3.25			3.50	15.00	10.00
Cow Manure				22.50					
Vegetable Waste				10.75	10.75	15.00			10.00
Straw							71.50	60.00	55.00
Total	100	100	100	100	100	100	100	100	100

* Mix 1 was not tested, but included in this table for completeness.
** Mix 7A was evaluated during the dry run test of March 1997.

2.2.3 Contaminated Soil Tests

Using the results of the clean soil tests, which are presented in Section 3, the mix selection was refined for the contaminated soil tests. The seven contaminated soil mixes are listed in Table 2-4. In summary, Mix 2 was eliminated due to poor performance, Mix 6 was eliminated due to high cost (although performance was good) and similarity to Mix 5, and Mix 7C was modified to include 10 percent cow manure with corresponding decreases of 3 percent less chicken manure and 7 percent less straw and designated Mix 8. Mix 1 was also tested because, although the POTW sludge could not be obtained for the clean soil tests, the Dewars tests (Section 1.5.5) indicated it to be a potentially effective amendment.

TABLE 2-4 CONTAMINATED SOIL WINDROW MIXES							
Amendment (wt %)	Mix						
	1	3	4	5	7A	7B	8
POTW Sludge	25.00						
Alfalfa	25.00	25.00	19.25	19.25			
Sawdust	12.50		19.25	19.25			
Wood Chips	12.50	25.00					
Soil	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Turkey Manure		25.00		25.75			
Chicken Manure			3.25		3.50	15.00	7.00
Cow Manure			22.50				10.00
Vegetable Waste			10.75	10.75			10.00
Straw					71.50	60.00	48.00
Total	100	100	100	100	100	100	100

3.0
PILOT TEST OPERATIONS

3.1 BIOREMEDIATON FACILITY LAYOUT

The following descriptions are supported by design drawings and technical specifications provided in the approved *Work Plan for Soils Bioremediation Facility* (MK, 1997c). The NSWC Crane Soils Bioremediation Facility consists of the following basic features:

- Three 70-foot-wide by 300-foot-long compost buildings
- Amendment storage area
- Amendment haul road
- Equipment and personnel decontamination areas
- Office and laboratory trailer area
- Storm water diversion and retention controls
- Basic services and utilities, including a water supply source for dust suppression and compost moisture additions

The compost building area is located in the south central and western portions of the Soils Bioremediation Facility, as shown in Figure 3-1. The compost structures consist of a metal structural frame with a light-weight roof designed to accomodate both local climatological conditions and the height of equipment selected for composting operations. The compost building side walls are constructed of 6-inch-thick concrete to a height of 4 feet, with metal siding extending to the roof line. The concrete floors slope to an epoxy- coated fluid collection sump. Ventilation is provided for each compost building through the open ends by means of ridge vents.

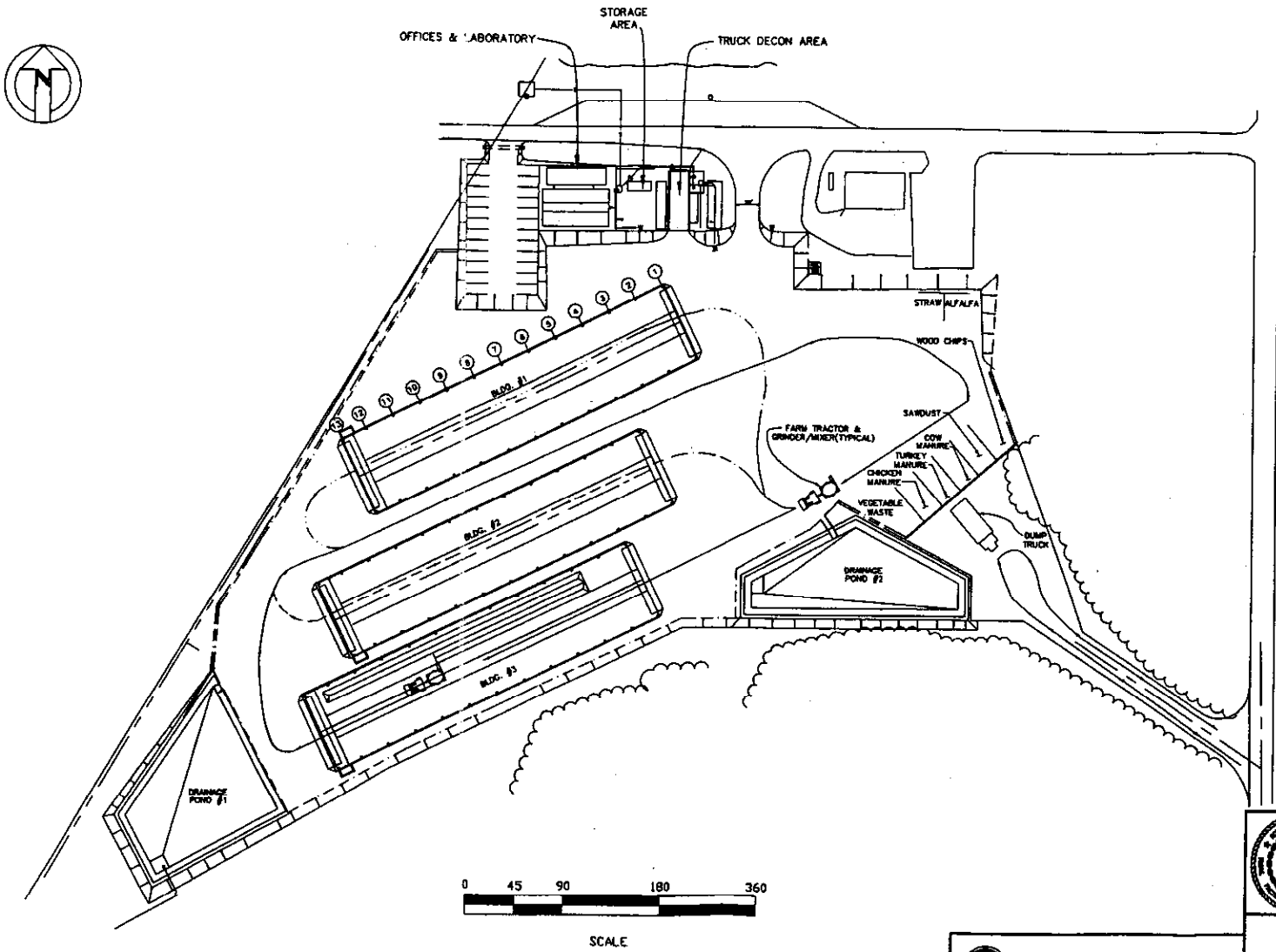
The entrance and exit ends of the buildings are open with 6-inch-high entrance/exit ramps to control runoff. Asphalt pavement coated with a sealant surrounds the buildings. A 6-inch-high asphalt curb at the outer perimeter of the pavement controls run-on and runoff. Storm water runoff is directed by topography and site drainage controls to two lined storm water retention basins, each sized for a 10-year, 24-hour storm. They allow control of on-site storm water retention and off-site storm water discharge. Water that does not meet off-site discharge requirements is transported to the water treatment facilities located at MFA or Rockeye. Although evaporation is the preferred method of decreasing retention pond volumes, water may also be discharged in accordance with the site National Pollution Discharge Elimination System permit, as required.

An equipment decontamination facility is used to clean trucks and equipment that have come into contact with contaminated soil within the Bioremediation Facility. Trucks and equipment are cleaned using a high-pressure, low-volume water spray system. After washing, the equipment is visually inspected and recleaned, if necessary, until no visual signs of residual soil remain. The equipment decontamination area consists of a vehicle wash area and a 4,000-gallon epoxy-coated collection sump. All decontamination fluids collected in the sump are containerized and sampled. Results from the samples determine disposal requirements.

3.2 BIOREMEDIATION FACILITY OPERATIONS

The pilot-scale composting operation consists of eight major steps to be performed for each windrow. The steps are listed in sequence below and are described in the following subsections.

1. Excavate, screen, and transport soil to Soils Bioremediation Facility
2. Receive and store amendments
3. Load amendments into grinder/mixer



LEGEND

- DENOTES DRAINAGE FLOW
- DENOTES ASPHALT BERM
- DENOTES EXISTING POWER POLE
- DENOTES EXISTING SANITARY SEWER MANHOLE
- DENOTES NEW WATER LINE (INSTALL 3' BELOW GRADE)
- SANITARY SEWER LINE

NOTE: COLUMN LINES TYPICAL BUILDINGS 1, 2, AND 3.

PILOT SCALE
TREATABILITY TEST REPORT
NSWC CRANE
CRANE, IN

FIGURE 3-1
BIOREMEDIATION FACILITY LAYOUT

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES

SOURCE: JACOBS ENGINEERING GROUP

DRAWING DATE: 02/10/98 | FILE NAME: F:\PROJ\RIVAT\ACAD\CRANE\FIG3-1.DWG

4. Load amendment blend into windrow
5. Load soil received from excavation into windrow
6. Add moisture (if necessary) and turn/mix windrow
7. Continue daily turning and monitoring for 60 days
8. Unload windrow and transport the finished compost for disposition

3.2.1 Soil Excavation, Screening, and Disposition of Oversized Materials

3.2.1.1 Soil Excavation

Clean soil pilot testing used clean soil that was excavated during construction of the Soils Bioremediation Facility and stockpiled at the NSWC Crane landfill. Clean soil from the foundation excavation was screened and transported to the Soils Bioremediation Facility, as described in the following sections, simulating a contaminated soil operation. Approximately 120 cubic yards were used in the clean soil testing.

Contaminated soil was excavated at SWMU-12/14, MFA, using a backhoe/loader and a Bobcat steer skid loader, as described in the *Pilot Scale Operational Plan* (MK, 1997b). The areas of excavation included Grids 1 and 2 located near Buildings 153 (see Figure 1-2). Soil was excavated from depths of 0 to 3 feet. The excavation was covered as required during periods of precipitation. Upon completion, the area was sampled and backfilled. Approximately 120 cubic yards were used for contaminated soil testing.

3.2.1.2 Soil Screening

Both clean and contaminated soil was screened to remove oversized material (1½ inch or larger) prior to transport to the Soils Bioremediation Facility. Excavated soil was loaded into the soil screening equipment using the backhoe/loader. Screening was performed using a trommel screener with a 50-ton/hour capacity. The screen was a standard portable design with a feed hopper and grizzly bars, fines stacking conveyor, and a reject (oversized material) discharge conveyor.

After screening, the fines were dropped from the fines stacking conveyor into a loader and placed into a live-bottom truck bed for transport to the Soils Bioremediation Facility. Ten to twenty percent of excavated material was rejected as oversized.

3.2.1.3 Disposition of Oversized Materials

Oversized clean material was used as cover material at the NSWC Crane landfill. Oversized contaminated material was separated into soil clods (10 to 15 cubic yards), vegetation (1 cubic yard), and rock (1 cubic yard), and handled as described below.

The soil clods were spread out in a 4- to 6-inch-thick layer and allowed to dry sufficiently prior to pulverization by excavating equipment. The soil was then segregated and stockpiled for later disposition.

The vegetation was stockpiled on site and then relocated to the Soils Bioremediation Facility where it will be incorporated into windrows during full-scale operations.

The rocks were placed in a single layer on bermed 60-mil plastic and sprayed with potable water using a high-pressure sprayer. The rocks were individually turned over, sprayed again, and placed in metal baskets. The water that accumulated on the plastic was transferred to a holding tank.

Additional water was run through each basket of rocks, draining through the bottom. When the water ran clear, two samples were collected. The rinse water was collected and transferred to the holding tank. The collected rinse water was transported to the MFA water treatment plant. The rocks were stockpiled.

Analytical results of the rock rinse water sample exceeded method reporting limits for HMX, RDX, TNT, and 4-ADNT at 34.1, 396, 52, and 12.8 parts per billion (ppb), respectively. The stockpiled rocks will be re-rinsed using a new procedure during full-scale operations.

3.2.1.4 Backfilling and Site Restoration

The extent of the MFA excavation and post-excavation sampling locations were surveyed to determine the volume of the excavation, to record the extent of the excavation, and to record the location of the samples. The excavation was backfilled or covered with plastic at the end of each day during periods of predicted precipitation. The excavation was backfilled to grade with clean fill from an on-site borrow source following completion of excavation.

Backfilled areas were covered with a minimum of 3 inches of topsoil (defined as having a minimum of 5 percent organic matter), seeded with native grasses, fertilized, and watered. Erosion control measures were maintained until the grasses were well established. Additional details on backfilling and restoration are specified in the *Pilot Scale Operational Plan* (MK, 1997b).

3.2.2 Amendment Supply and Storage

The amendments were brought on site and stored in the asphalt-paved amendment storage bins, as shown in Figure 3-1. All amendment suppliers are identified on the Record of Recipe forms (Appendices B and I). The cow manure originates from a free-stall dairy and is essentially pure manure (i.e., free of bedding material). This manure has been processed through a separator to remove most free liquid, leaving the cow manure at approximately 80 percent moisture content. The chicken manure was from layer hens and contains approximately 1 percent feathers, eggs, or other natural impurities. It is also free of bedding material. All manures were delivered in bulk to the amendment storage area.

Manures were delivered within one week prior to loading the windrows to ensure quality and freshness of the amendment and to avoid potential odor and leaching problems. The alfalfa hay and straw were supplied in bales bound with a plastic mesh baling material which was removed prior to mixing. Vegetable waste was delivered in bulk at approximately 65 to 70 percent moisture. Wood chips and sawdust were also delivered in bulk. Amendments were covered to minimize adding nitrate and suspended solids to storm runoff during rainy periods.

3.2.3 Load and Blending Amendments

Amendments were loaded on a volume basis using a center-pivot loader into a tractor-powered grinder/mixer unit, in the proportions specified in Tables 2-3 and 2-4. The mixer then homogenized each mix by mixing for 10 to 15 minutes. Water was added for dust control to mixes containing large fractions of straw, alfalfa, or sawdust.

3.2.4 Load Amendment Blends into Windrows

Amendment blends were unloaded from the grinder/mixer unit through a side-mounted discharge conveyor forming a windrow approximately 6 feet high, 12 feet wide, and approximately 20 to 25 feet long. A second windrow adjacent to and partially overlapping the first windrow was then loaded into the building, forming a single, larger windrow approximately 20 feet wide with two peaks 6 feet high.

Subsequent windrows were loaded by the same process. The windrow turner then turned and shaped each windrow until it was about 20 feet wide and 4½ feet tall.

3.2.5 Load Soil into Windrow

After each amendment blend was loaded in the building and shaped, stockpiled screened soil was delivered to the compost windrow in covered trailers. The soil was unloaded from the trailer into a self-powered hopper/conveyor, which placed the soil on top of the amendment blend windrow to complete the formation of the windrow. The soil was loaded on a volume basis. No additional contaminated sediments, soils, or water were added to the windrows following initial mixing of the windrow.

3.2.6 Turn/Mix Windrow

After the soil was loaded into the windrows, the windrow/compost turning machine (Scarab) mixed and reformed the windrows. The travel speed of the windrow turner is adjusted automatically based on the density of the material being turned to maintain a constant load on the rotating drum. The windrow turner normally made at least three passes during initial windrow construction to assure thorough mixing.

The windrows were normally turned once a day, but the turning frequency was increased as necessary to maintain proper aeration, temperature, and moisture, as described in Section 2. Moisture addition took place during the windrow mixing stage to maintain optimum moisture conditions as described in Section 2. Moisture was added to the windrows either by a spray manifold on the windrow turning machine or manually, using a hose.

General building cleanliness was maintained by using the front-end loader and/or the skid steer loader to collect stray compost materials and reform the piles, if necessary. Brooms and shovels were used in areas that were inaccessible to the larger equipment. Any ponded liquid on the floor around windrows was manually moved to the sump within 24 hours. The windrows were kept segregated, well-formed, and identified with signs containing the mix number, quantities of ingredients, and date formed.

3.2.7 Disposition of Compost Following Test Completion

The finished clean soil compost was delivered to the NSWC Crane golf course and Ordnance Test Area for use as soil amendment. The finished contaminated soil compost is intended to be used as landfill daily cover material at the NSWC Crane landfill, located adjacent to the Soils Bioremediation Facility. A letter containing an Insignificant Modification to the existing landfill permit will be submitted to the Indiana Department of Environmental Management to obtain approval for using finished compost material as landfill cover material.

4.0
DATA COLLECTION AND MANAGEMENT

4.1 PROCESS MONITORING AND DATA COLLECTION

The following process parameters were monitored during both the clean and contaminated soil tests using field instruments, as described in the *Pilot Scale Operational Plan* (MK, 1997b).

- Temperature
- Oxygen level
- Moisture content
- pH
- Carbon and nitrogen

Monitoring locations and frequencies for each of these parameters are described in the following sections. Calibration of all field instrumentation was performed daily prior to use as specified in the *Pilot Scale Operational Plan* (MK, 1997b).

All in situ measurements (i.e., temperature, oxygen level) were taken prior to removing sample material for other measurements or analyses to avoid disturbing the compost pile and potentially biasing the in situ measurement.

To evaluate performance goals, contaminated soils testing samples were also collected and analyzed for metals and explosives.

4.1.1 Temperature

Windrow temperature was normally monitored twice daily, before and after turning, although additional monitoring was performed if the windrow was turned a second time in one day. Temperature readings were taken using a hand-held temperature probe at the six sampling/monitoring locations at each of the four cross sections (A, B, C, and D as shown in Figure 4-1). These locations were selected to provide representative temperature profiles for the inner core and outer near-surface conditions. Ambient air temperature and humidity inside the buildings were monitored daily using an alcohol or mercury thermometer and a hygrometer.

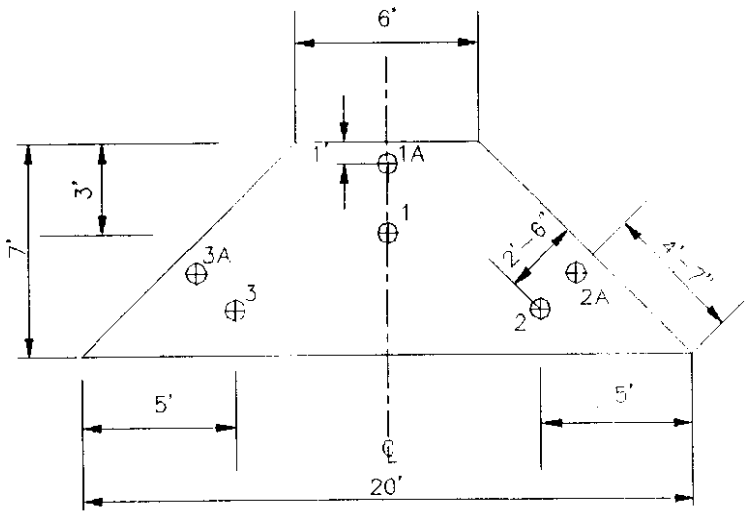
4.1.2 Oxygen Level

Oxygen level was normally monitored twice daily, before and after turning, although additional monitoring was performed if the windrow was turned a second time in a single day. Oxygen level measurements were collected using a hand-held probe at the same locations as the temperature measurements.

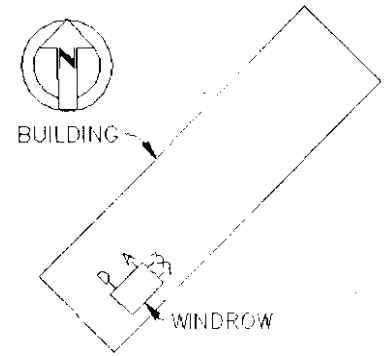
4.1.3 Moisture Content

Moisture level monitoring was performed three times per week, prior to windrow turning, to determine moisture addition requirements. Water was then added as required during windrow turning. Moisture levels were rechecked again after windrow turning if water was added. Moisture level samples were collected from each of the four cross sections (A, B, C, and D, as shown in Figure 4-1). At each cross-section, samples from locations 1, 2, and 3 (Figure 4-1) were composited for a total of four composited samples per windrow. Moisture content data was used to determine maximum WHC and percent moisture at saturation (PMS), as described in the *Pilot Scale Operational Plan* (MK, 1997b).

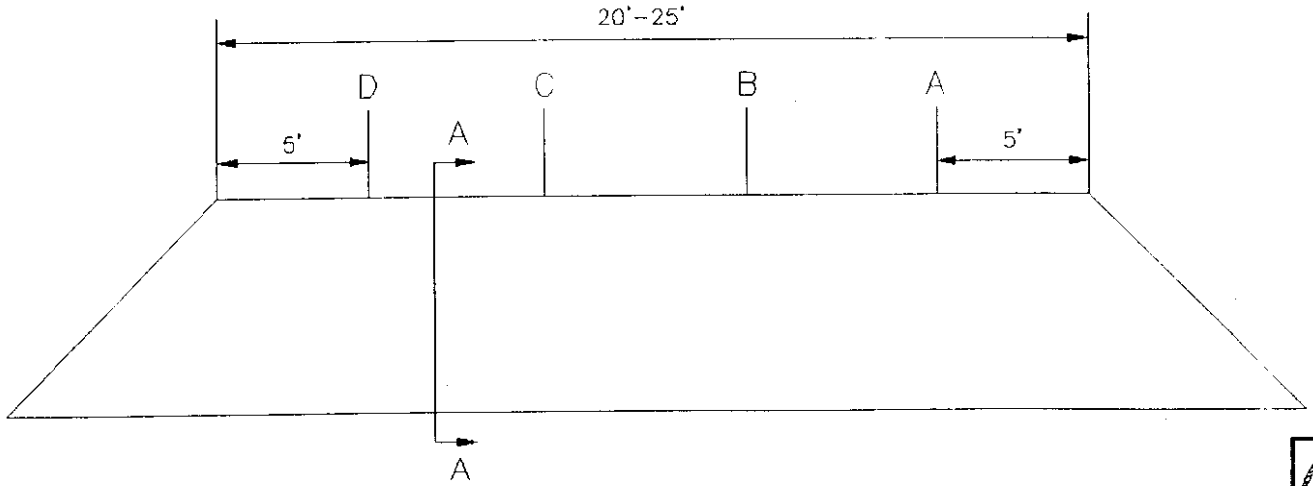
NOTE: ALL SAMPLE NUMBERS FOLLOWED BY AN "A" WILL BE TAKEN AT 1' BELOW THE SURFACE.



SECTION A–A



KEY PLAN



PILOT SCALE
WINDROW SAMPLE LOCATIONS

PILOT SCALE
TREATABILITY TEST REPORT
NSWC CRANE
CRANE, IN

FIGURE 4-1
TYPICAL WINDROW LAYOUT
AND SAMPLE LOCATIONS

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES

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4.1.4 pH

Samples for pH monitoring were collected weekly as a composite of locations 1, 2, and 3 at each of the four cross sections, prior to turning, as shown in Figure 4-1. pH was not adjusted during treatment.

4.1.5 Carbon and Nitrogen

Carbon and nitrogen are the primary nutrient sources for microbial growth. Total organic carbon (TOC) and total Kjeldahl nitrogen (TKN) are monitored to track the carbon-to-nitrogen (C:N) ratio during the composting process. Samples from both the clean and contaminated soil testing were collected for TOC analysis (EPA Method 9060) and nitrogen analysis (EPA Method 351.3, as TKN) at the locations shown in Figure 4-1, after windrow turning. Samples were collected using a hand auger. The C:N ratio was not adjusted.

4.1.6 Metals and Explosives

Samples of the contaminated soil from MFA were collected for metals analysis (EPA Methods 6010 and 7470) before the soil was mixed with amendments. Samples were collected for explosives analysis (EPA Method 8330) at the locations shown in Figure 4-1, after windrow turning. Samples were collected using a hand auger, as described in the *Quality Assurance Project Plan for Pilot Scale Operations at the Biofacility* (MK, 1997d).

4.2 SAMPLE COLLECTION FOR OFF-SITE ANALYSIS

Analyses for TOC, TKN, explosives, and metals were performed by an off-site laboratory. Samples slated for off-site analysis were collected from cross sections A through D along each windrow. At each cross section, six sampling/monitoring points were established, as shown in Figure 4-1. The sampling schedule and EPA analytical methods (EPA, 1983; EPA, 1995) in Table 4-1 for clean soil testing and in Table 4-2 for contaminated soil testing.

Samples were promptly containerized, placed in a cooler or refrigerator, and shipped to:

Southwest Laboratory of Oklahoma Inc.
1700 West Albany, Suite C
Broken Arrow, Oklahoma 74012
918-251-2858

Shipping and handling procedures are detailed in the *Quality Assurance Project Plan for Pilot Scale Operations at the Biofacility* (MK, 1997d).

TABLE 4-1
WINDROW SAMPLING SCHEDULE - CLEAN SOIL TESTING

Parameter	Analytical Method	Number of Samples per Sampling Event	Volume Required per Sample	Schedule
TOC	9060	3 per cross section (12 total) from depth of 2.5 feet	8 ounces (all 3 analyses may be performed using 8 ounces of soil)	Day 0, 5, 10, 20, and 30
TKN	EPA 351.3			

TABLE 4-2 WINDROW SAMPLING SCHEDULE - CONTAMINATED SOIL TESTING				
Parameter	**Analytical Method**	**Number of Samples per Sampling Event**	**Volume Required per Sample**	**Schedule**
Metals (barium, cadmium, total chromium, lead)	6010	3 per cross section (12 total) from a depth of 2.5 feet	8 ounces (both analyses may be performed using 8 ounces)	Day 0 and 60
TOC	9060	3 per cross section (12 total) from a depth of 2.5 feet	8 ounces (all 3 analyses may be performed using 8 ounces of soil)	Day 0, 5, 10, 20, 30, 40, and 60
TKN	EPA 351.3	3 per cross section (12 total) from a depth of 2.5 feet		
Explosives (TNT, RDX, HMX, 2-ADNT, and 4-ADNT)	8330	3 per cross section (12 total) from a depth of 2.5 feet		

5.0
FIELD CLARIFICATIONS TO THE WORK PLAN

As the pilot-test proceeded, methods of improving operations and clarifying documentation were identified. Field clarifications to the *Work Plan*, field clarification requests (FCRs), were written and incorporated into the pilot-test operations to document the changes. The FCRs are summarized below. Copies of the FCRs are provided in Appendix A.

FCR No.	Description
1	Modified the operational plan to allow the use of a wheeled tractor to transport sampling equipment and samples because of the amount of equipment required, the distance from the lab, and the number of samples required. Updated drawings to reflect the trailer configuration and revised versions of Tables 4-1 and 4-2, which incorporated the latest density and cost information, were inserted. The bacteriological tests were deferred until equipment was arranged for or obtained.
2	Health and Safety Plan improved based on the results of sampling conducted during the clean run. The tests were run to determine if hazards that could have been present were actually were present. Occupational exposure to hazards was determined to be far less than originally theorized.
3	Improved the operational plan to make it easier to train personnel to comply with the plan.
4	Improved the Health and Safety Plan based on biological and chemical analytical results received from the laboratory for air samples taken during the clean run.
5	Allows for soil stockpiling in a biofacility building to allow more timely mix production. Addition of the Wiley Mill and sample splitter for sample collection. Allow amendment mixtures to be generated no more than two days prior to soil addition.
6	More detail was added to the QAPP to explain how to calculate Relative Percent Differences and to explain when additional duplicates were required for temperature or oxygen monitoring.
7	Replaced draft hazard analysis report with the final report, added MK letter documenting report recommendations, and added report entitled *Hazard Review of Wiley Mill.*
8	Improved noise monitoring and equipment decontamination procedures.
9	Consolidated samples to improve analytical performance.
10	Changed the arrangement of equipment in the excavation area exclusion zone to reduce the size of the zone, based on the amount of area necessary to obtain approximately 200 cubic yards of material.
11	Submitted request to remove duplicate entries, items that did not occur at the same time with the subject actions, and items that were completed but required no follow-up on the Field Inspection Checklists. Improvements were deferred to the full-scale plan.
12	Revised Health and Safety Plan to include a direct phone number for emergency response crews.

13 Recommended use of some site systems to improve wastewater management. No action will be taken until experience has been gained to assure the improvements were warranted.

14 Modified SOP 10.0 to facilitate training.

15 Updated the QAPP by inserting latest Southwest Laboratory Procedures. Approval of the FCR would be granted with the approval of the Full-Scale QAPP.

16 Clarified air sampling procedures to facilitate training.

17 Updated the Soil Excavation Plan to allow excavation during the period between the pilot- and full-scale tests.

18 Voided (replaced by FCR 19).

19 Established rock washing procedures to facilitate training and allowed oversight of rock washing. Approval of the FCR would be granted with the approval of the Full-Scale Operational Plan.

20 Proposed that all plans be updated to establish more efficient sampling grids at MFA.

6.0
RESULTS AND DISCUSSION - CLEAN SOIL TESTS

6.1 DATA ANALYSIS AND EVALUATION

Process parameters were measured and monitored as described in Section 4.1. Texture was also evaluated due to its influence on the process parameters and for aiding the review of the parameter monitoring results.

6.1.1 Texture

Texture of the compost material has significant influence on the process parameters, i.e., moisture content, oxygen content, and temperature. If the final amendment and soil mix is too dense, bulking of the material does not occur and oxygen levels may be too low to sustain high bacteria growth, which results in lower temperatures and lowered explosive degradation rates. If the final mix is extremely high in bulking agents, such as straw, wood chips, or alfalfa, the mix may be stringy or clumpy. Thorough mixing of the recipe does not occur and results in a nonhomogeneous mass that may be difficult to sample. To allow comparison between the various mixes, the following categories of texture were used to classify and grade each mix at the initiation, mid-cycle, and end of cycle conditions.

- **VG (Very Good).** The mixture is well mixed and appears to be homogenous. There is minimal or no clumping of materials. The mix appears to be uniformly moist and samples are easily collected.

- **G (Good).** The mixture is well mixed, appears to be homogenous with minor clumping, uniformly moist, and samples are fairly easily collected.

- **A (Average).** The mixture is fairly well mixed with some segregation, noticeably high level of fines or significant clumping with noticeable moisture differences (spots of wet and dry areas). Sample collection may become more difficult.

- **P (Poor).** The mixture is difficult to turn. It is not very well mixed and exhibits signs of segregation or increased density. Clumping may be highly visible, and wet and dry spots are easily identified. Sample collection may be very difficult.

Based upon the texture observations described below, Mixes 3, 4, 5, 6, 7A, 7B, and 7C appear to be more conducive to maintaining optimum bulking and aeration for enhancing biodegradation.

6.1.1.1 Mix 2 Texture

The overall texture rating of Mix 2 is A. The initial mixing of the Mix 2 of amendments yielded a very moist, clumpy, non-homogeneous product. The amendments were discharged from the grinder/mixer in 10-inch-diameter and larger lumps due to its very dense, sticky and difficult-to-handle characteristics. Ammonia vapors were present in excess of 100 parts per million (ppm) in the immediate area of the windrow impacting health and safety. As soil was added and the mixture turned with the windrow machine, the consistency improved, but the mixture continued to appear very dense when compared to other mixes. At day 15 the consistency continued to improve but as the moisture level dropped, the wood chips appeared to segregate from the chicken manure. At day 26 the wood chips were very prominent at the surface and segregation was evident. Below the surface, the soil and chicken manure mix appeared very fine and varied from dry to moist.

6.1.1.2 Mix 3 Texture

The overall texture rating of Mix 3 is G. The initial mixing of amendments yielded a well-mixed, moist product. The material appeared homogeneous and fluffy. As soil was added, the mixture changed very little and remained homogeneous. At day 25, the wood chips were more prominent and appeared to be slightly segregated. The other material in the mix was very fine and slightly moist.

6.1.1.3 Mix 4 Texture

The overall texture rating of Mix 4 is VG. The initial mixing of amendments yielded a well-mixed, moist product. The material appeared to be homogeneous and fluffy. The odor of potato waste and ammonia was evident but not severe. As soil was added, the mix appeared to remain homogeneous. At day 25, the mix was much finer, moist, and remained homogeneous.

6.1.1.4 Mix 5 Texture

The overall texture rating of Mix 5 is VG. The initial mixing of amendments yielded a well-mixed, moist product. The material appeared to be homogeneous and fluffy. As soil was added, the mix appeared to remain homogeneous. At day 25, the mix was much finer, moist, and remained homogeneous.

6.1.1.5 Mix 6 Texture

The overall texture rating of Mix 6 is VG. The initial mixing of amendments yielded a well-mixed, moist product. The material appeared to be homogeneous and fluffy. As soil was added appearance remained homogeneous and moist. At day 25, the mix was very fine, moist, and remained homogeneous. Wood chips were evident but not prominent or segregated.

6.1.1.6 Mix 7A Texture

Mix 7A texture data was not available from the dry run tests performed in April 1997; however, because the recipe is similar to Mix 7B, the overall texture rating of Mix 7A is estimated to be VG.

6.1.1.7 Mix 7B Texture

The overall texture rating of Mix 7B is VG. The initial mixing of amendments yielded a well-mixed, extremely fluffy, and slightly dry product. The material appeared to be homogeneous. Ammonia odor was evident but not severe. As soil was added, the appearance of the mix remained homogeneous. The mix was difficult to sample and probe during the middle stages of composting, due to low moisture content. At day 25, the mix was moist, and remained homogeneous. Straw was prominent but not segregated. Sampling and probing improved with additional passes of windrow.

6.1.1.8 Mix 7C Texture

The overall texture rating of Mix 7C is VG. The initial mixing of amendments yielded a well-mixed, extremely fluffy, and slightly dry product. The material appeared to be homogeneous. Ammonia odor was evident but not severe. As soil was added, the appearance of the mix remained homogeneous. During the middle stages of composting, the mix was difficult to sample and probe due to low moisture content. At day 25, the mix was moist and remained homogeneous. Sampling and probing improved with additional passes of windrow.

6.1.2 Temperature

Temperature is the primary indicator of successful thermophilic composting. The normal thermal operating range for composting is 25 to 65°C. Previous studies of explosives-contaminated soil composting indicate that average temperature should rise to 25 to 40°C within the first few days of formation, continue rising to within the temperature range of 40 to 65°C, and maintain that range for at least 2 weeks, provided adequate moisture, nutrients, and oxygen are available. The process goal was to maintain the average windrow temperature near 55°C. Temperature decrease over time below 50°C is viewed as an indicator of a pile that is nearing the end of its operation (Weston, 1993). Temperature measurements were recorded before and after each windrow turning event. However, Mixes 4, 5, 7B, and 7C were generated late on day 0 and did not receive post turn temperature and oxygen testing until the following day. Pre-turn temperatures are more useful for evaluation and comparison because they represent heat development over time. "Average" temperature is defined as the average of the 24 monitoring locations in each windrow. Complete individual temperature profiles are provided in Appendix C, and include post-turn measurements. The figures have been annotated with process adjustments, such as water addition and number of windrow machine passes per turning event, which may impact temperatures.

The following categories of temperature are used to classify each mix at the initiation, mid-cycle, and end of cycle conditions.

- **VG**. The mixture exhibits a rapid temperature increase to 40°C within 2 days. Temperatures continue to rise above 55°C and maintain for approximately 2 weeks. Temperatures often exceed 65°C but are readily reduced with aeration and/or moisture addition to within the optimum operating range.

- **G**. The mixture exhibits temperatures of 40° to 50°C within 5 days. Temperatures continue to rise to 55°C, are maintained for 2 weeks, and may exceed 60°C occasionally.

- **A**. The mixture exhibits temperatures of 40° to 50°C within 7 days. Temperatures of 55°C are not maintained for 2 weeks and rarely or never exceeds 60°C.

- **P.** The mixture does not exhibit temperatures of 50°C within 10 days. Temperatures do not rise to 55°C and are not maintained.

Based upon the results of temperature monitoring described below, Mixes 3, 4, 5, 6, 7B and 7C appear to be more conducive to maintaining optimum temperatures for enhancing biodegradation. Temperature readings throughout these piles were consistent and showed minimal variability and deviation. Mix 7A's temperature profile may be biased, however, because of the colder ambient temperatures.

6.1.2.1 Mix 2 Temperature

The overall temperature rating of Mix 2 is A. The initial average pre-turn temperatures of Mix 2 increased to above 40°C during the first day of formation. Average pre-turn temperatures continued to increase above 55°C within 5 days and only maintained 55°C or higher for 6 days. The maximum average pre-turn temperature was 58.5°C. The remaining average temperatures fluctuated between 45°C and 50°C.

6.1.2.2 Mix 3 Temperature

The overall temperature rating of Mix 3 is G. The initial average pre-turn temperatures of Mix 3 increased to above 40°C during the first day of formation. Average pre-turn temperatures continued to increase above 55°C within 3 days and maintained 55°C or higher for 14 days with periods occasionally dropping to 51°C due to low moisture content. The maximum average pre-turn temperature was 61.88°C.

6.1.2.3 Mix 4 Temperature

The overall temperature rating of Mix 4 is A. The initial average pre-turn temperatures of Mix 4 increased to above 40°C during the first day of formation. Average pre-turn temperatures increase above 55°C only occasionally (4 non-consecutive days). The maximum average pre-turn temperature was 58.33°C.

6.1.2.4 Mix 5 Temperature

The overall temperature rating of Mix 5 is G. The initial average pre-turn temperatures of Mix 5 increased to 40°C during the first day of formation. Average pre-turn temperatures continued to increase above 55°C within 4 days, and maintained 55°C or higher for 17 days with periodic drops as low as 52°C due to low moisture. The maximum average pre-turn temperature was 60.58°C.

6.1.2.5 Mix 6 Temperature

The overall temperature rating of Mix 6 is G. The initial average pre-turn temperatures of Mix 6 increased to above 40°C during the first 2 days of formation. Average pre-turn temperatures continued to increase above 55°C within 5 days, and maintained 55°C or higher for more than 20 days with an occasional drop to 52.33°C. The maximum average pre-turn temperature was 59.42°C.

6.1.2.6 Mix 7A Temperature (from Dry Run tests)

The overall temperature rating of Mix 7A is P; however, this temperature profile may be biased because of the colder ambient temperatures. Temperature information was extracted from the dry run tests performed in March and April of 1997. Ambient temperatures ranged from -3°C to 22°C, with the lowest temperatures recorded on days 0 and 1. The initial average pre-turn temperatures of Mix 7A increased to above 40°C during the first 9 days of composting. Average pre-turn temperatures continued to increase, but never reached 55°C. The maximum average pre-turn temperature was 54°C.

6.1.2.7 Mix 7B Temperature

The overall temperature rating of Mix 7B is VG. The initial average pre-turn temperatures of Mix 7B increased to above 40°C during the first day of formation. Average pre-turn temperatures continued to increase above 55°C within 2 days and maintained 55°C or higher for 16 days, with three drops below 55°C when water was added. The pile repeatedly reached temperatures above 60°C. The maximum average pre-turn temperature was 66.92°C.

6.1.2.8 Mix 7C Temperature

The overall temperature rating of Mix 7C is VG. The initial average pre-turn temperatures of Mix 7C increased to above 40°C during the first 2 days of formation. Average pre-turn temperatures continued to increase above 55°C within 4 days and maintained 55°C for more than 20 days, except when water was added. The mix repeatedly reached temperatures above 60°C. The maximum average pre-turn temperature was 65.42°C.

6.1.3 Moisture Content

Microbial biodegradation is most efficient at moisture contents of 40 to 60 percent maximum WHC, with 50 percent WHC being considered optimum. Reduced moisture content may inhibit microbial movement and nutrient availability, while excessive moisture content will cause the moisture to fill the void spaces needed for proper aeration, thus reducing the oxygen level and retarding aerobic microbial growth. At no time during the process was leachate observed from any of the mixes. Moisture level monitoring was

performed three times per week. If moisture was added to the windrows, moisture levels were checked again after windrow turning. Average WHC data and figures for individual recipes are provided in Appendix D.

Due to high levels of evaporation during the composting cycle and a procedural restriction that limited water addition to 100 gallons per day, the moisture content of the mixtures began to drop. The surface of the piles became dusty during high winds. With the EPD's concurrence, as much as 300 gallons per day were added in order to obtain the appropriate moisture levels. Appendix D includes plots that show moisture added for individual windrows. The moisture content of all mixes was brought up to and maintained at approximately 50 percent maximum WHC. No further dust was evident during the test period.

The percent of maximum WHC is the ratio of the mass of water retained in the mix sample compared to the mass of water retained in the sample at saturation. However, each mix has a different WHC, depending on the amendment mix, which may change as degradation proceeds. The PMS is the ratio of the maximum amount of water retained in the mix sample at saturation compared to the total weight of the mix sample at saturation. To provide a better comparison between different mixes, the PMS is used here for comparison.

The following categories of moisture condition were used to grade each mix at the initiation, mid-cycle, and end of cycle conditions.

- **VG.** The mixture exhibits excellent moisture holding capabilities. The PMS consistently is greater than 50 percent.
- **G.** The mixture exhibits good moisture holding capabilities. The average PMS is greater than 42 percent but less than 50 percent. May exceed 50 percent at times.
- **A.** The mixture exhibits fair moisture holding capabilities. The average PMS is less than 42 percent but greater than 35 percent. May exceed 42 percent at times.
- **P.** The mixture does not exhibit good moisture holding capabilities. The average PMS is less than 35 percent.

Based upon the results described below, Mixes 3, 4, 5, 6, 7A, 7B, and 7C appear to be more conducive to maintaining optimum moisture conditions for enhancing biodegradation. The moisture data and profiles provided in Appendix D show the monitoring results of the average moisture measurements. The graphs have been annotated with process adjustments which may cause a fluctuation in moisture content such as water addition and number of windrow machine passes per turning event.

6.1.3.1 Mix 2 Moisture

The average PMS for Mix 2 is rated A. Throughout the 30-day cycle, Mix 2 required the addition of 550 gallons of water to maintain optimum WHC conditions. The average PMS for Mix 2 throughout its cycle is slightly above 40 percent.

6.1.3.2 Mix 3 Moisture

The average PMS for Mix 3 is rated G. Mix 3 required the addition of 900 gallons of water throughout the 30-day cycle to maintain optimum WHC conditions. The average PMS for Mix 3 throughout its cycle is slightly above 45 percent.

6.1.3.3 Mix 4 Moisture

The average PMS for Mix 4 is rated G. Mix 4 required the addition of 400 gallons of water throughout the 30-day cycle to maintain optimum WHC conditions. The average PMS for Mix 4 throughout its cycle is slightly above 47 percent.

6.1.3.4 Mix 5 Moisture

The average PMS for Mix 5 is rated G. Mix 5 required the addition of 1,000 gallons of water throughout the 30-day cycle to maintain optimum WHC conditions. The average PMS for Mix 5 throughout its cycle is slightly above 47 percent.

6.1.3.5 Mix 6 Moisture

The average PMS for Mix 6 is rated G. Mix 6 required the addition of 750 gallons of water throughout the 30-day cycle to maintain optimum WHC conditions. The average PMS for Mix 6 throughout its cycle is slightly above 45 percent.

6.1.3.6 Mix 7A Moisture

The average PMS for Mix 7A is not available; however due to its similarity to Mix 7B, the average PMS is assumed to be similarly rated VG. Mix 7A required the addition of 530 gallons of water throughout the dry run test cycle (33 days).

6.1.3.7 Mix 7B Moisture

The average PMS for Mix 7B is rated VG. Midway through the composting cycle (July 11, 1997), Mix 7B became extremely difficult to sample and probe with the instruments due to low moisture content resulting from moisture evaporation. Significant quantities of water were added and an increase in the number of windrow passes at each turning event alleviated the problem. Both conditions were corrected and are not expected to occur during the contaminated soil operation. Mix 7B required the addition of 1,000 gallons of water throughout the 30-day cycle to maintain optimum WHC conditions. The average PMS for Mix 7B throughout its cycle is slightly above 56 percent.

6.1.3.8 Mix 7C Moisture

The average PMS for Mix 7C is rated G. Mix 7C required the addition of 700 gallons of water throughout the 30-day cycle to maintain optimum WHC conditions. The average PMS for Mix 7C throughout its cycle is slightly above 45 percent.

6.1.4 Oxygen Levels

Oxygen levels of up to ambient atmospheric or about 20 percent are preferred in a compost windrow, and 5 percent is considered the minimum for rapid compost degradation. Oxygen levels below 1 percent indicate anaerobic conditions. If sufficient oxygen levels are not maintained, proper microbial degradation may not occur, thermophilic temperatures may not be maintained, and putrefaction of organic matter may occur. However, anaerobic conditions commonly exist in a compost windrow throughout most of each day, and depending on the density of the compost, aerobic conditions occur only for 1 to 2 hours following turning, as described below.

The oxygen available to microbes in a windrow is the result of aeration by turning; oxygen diffusion from the atmosphere into the windrow is negligible (Biocycle, 1991). Therefore, oxygen availability is a function

of the air-filled pore volume, which is in turn a function of porosity and moisture content. As compost is turned and degrades, the porosity is reduced, which in turn reduces available oxygen. Similarly, increasing the moisture content also reduces available oxygen.

For example, consider a compost with a dry density of 1,000 pounds per cubic yard (lbs/yd^3) or 0.6 grams per cubic centimeter (g/cm^3). At 50 percent porosity and 50 percent maximum WHC, each cm^3 of compost contains 0.25 cm^3 of air (0.5 cm^3 x 0.5). Because air is about 21 percent oxygen, which has a density of 1.43 mg/cm^3, each cm^3 of compost contains 0.075 mg of oxygen (0.25 cm^3 x 0.21 x 1.43 mg/cm^3) and 0.6 grams of solids. Therefore, about 0.13 mg of oxygen are available for each gram of solids (0.075 mg/0.6 g).

Literature values of oxygen consumption rates from municipal waste composting operations vary over a wide range, from 1.0 mg/g-hr to 14 mg/g-hr (Biocycle, 1991). From the example above which indicates that only about 0.13 mg oxygen is available for each gram of solids, it should be expected that oxygen levels are rapidly depleted, and that anaerobic conditions exist through at least part of each day. This is supported by data from the Umatilla windrows where oxygen was measured every minute for one hour following turning (Weston, 1993). Oxygen levels were observed to decrease to 5 percent in 10 to 30 minutes, and to 1 percent in 30 minutes to 1 hour.

Furthermore, even under oxygen levels of 5 to 20 percent, anaerobic microsites exist throughout a compost windrow. As a result of the restricted oxygen diffusion through soil and organic matter particles, saturated aggregates and crumbs larger than a few mm will have no oxygen at their center (Paul and Clark, 1989). The presence of aerobic microbes can create localized anaerobic conditions as they consume oxygen (Paul and Clark, 1989, p.17). Microbiological counts of the compost were not performed during this project. However, counts of aerobic, anaerobic, obligate anaerobic, and thermophilic bacteria were performed at Umatilla as part of the compost seeding studies (Weston, 1993). The results showed that total aerobic and total anaerobic bacteria counts were equivalent, and suggest that both anaerobic and aerobic bacteria play an important role in compost degradation. This is supported by the observation at Umatilla that unaerated windrows performed equal to or better than aerated windrows in terms of contaminant degradation.

Oxygen levels were observed to decline rapidly during the clean soil tests to low levels (less than 5 percent) within 2 to 3 hours after mixing. Oxygen levels of less than 1 percent indicate the process is approaching anaerobic conditions, and aeration is required. Prior to July 12, 1997 (days 14 and 15), all post-turn oxygen and temperatures were monitored up to one hour after turning. To obtain a more accurate indication of post-turn oxygen content, the procedure was changed to perform oxygen monitoring as soon as practical, which was normally within about 15 minutes. Only the oxygen levels measured after July 12, 1997 are considered in the discussions below. The oxygen monitoring data and profiles are provided in Appendix E.

The following categories are used to grade each mix at the initiation, mid-cycle, and end of cycle conditions.

- **VG.** The mixture exhibits an excellent oxygenation level. Levels of oxygen greater than 12 percent are indicated after two or three passes of the turning machine.

- **G.** The mixture exhibits a good oxygenation level. Levels of oxygen greater than 8 percent are indicated after two or three passes of the turning machine.

- **A.** The mixture exhibits a fair oxygenation level with some difficulty and irregularity in increasing oxygen levels. Levels of oxygen greater than 5 percent require three passes of the windrow machine.

- **P.** The mixture does not exhibit very good oxygenation levels after three passes of the windrow machine. *Levels of oxygen are less than 5 percent after three passes.*

Based upon the results described below, Mixes 3, 7A, 7B, and 7C appear to be more conducive to maintaining optimum oxygen conditions for enhancing biodegradation. Oxygen data and profiles are provided in Appendix E and show the monitoring results of the average oxygen measurements. The graphs have been annotated with process adjustments, such as number of windrow machine passes per turning event, which may cause a fluctuation in oxygen content.

6.1.4.1 Mix 2 Oxygen Content

The oxygenation rating of Mix 2 is A. The average post-turn oxygen levels were recorded at less than 3 percent with two passes of the windrow turner and between 5 and 10 percent with three passes.

6.1.4.2 Mix 3 Oxygen Content

The oxygenation rating of Mix 3 is G. The average post-turn oxygen levels were recorded from 1.88 to 14 percent with two passes of the windrow turner and between 7 and 11 percent with three passes.

6.1.4.3 Mix 4 Oxygen Content

The oxygenation rating of Mix 4 is A. The average post-turn oxygen levels were recorded at less than 4 percent with two passes of the windrow turner and greater than 10 percent with three passes.

6.1.4.4 Mix 5 Oxygen Content

The oxygenation rating of Mix 5 is A. The average post-turn oxygen levels were recorded at less than 5 percent with two passes of the windrow turner and between 3 and 12 percent with three passes.

6.1.4.5 Mix 6 Oxygen Content

The oxygenation rating of Mix 6 is A. The average post-turn oxygen levels were recorded at less than 3 percent with two passes of the windrow turner and between 5 and 10 percent with three passes.

6.1.4.6 Mix 7A Oxygen Content

The oxygenation rating of Mix 7A is estimated to be very similar to Mix 7B and therefore is VG. Based on the data extracted from the dry run tests performed in March and April of 1997, the average post-turn oxygen levels were recorded at more than 6 percent and as high as 18 percent during the periods measured. The number of windrow turner passes was not recorded.

6.1.4.7 Mix 7B Oxygen Content

The oxygenation rating of Mix 7B is VG. The average post-turn oxygen levels were recorded at more than 8 percent with one pass, greater than 17 percent with two passes of the windrow turner and as high as 18 percent with three passes.

6.1.4.8 Mix 7C Oxygen Content

The oxygenation rating of Mix 7C is G. The average post-turn oxygen levels were recorded between 6 and 11 percent with two passes of the windrow turner and between 3 and 11 percent with three passes.

6.1.5 pH Monitoring

pH of a compost pile normally remains within the range of 5.5 to 9. Samples for pH monitoring were collected at location 1 for each of the four cross sections, once per week, prior to turning, as described in the Section 4.1. pH was not adjusted during treatment.

The pH in samples from Mixes 4, 5, and 6 decreased to below 7 in the first week, then increased up to 8.7. The low pH was probably the result of organic acid generated by the degradation of potato waste in the mixes. A slight vinegar odor was noted as well. Samples from the remaining mixes resulted in pHs of 7.43 to 8.88, which were within the anticipated range. pH monitoring data are presented in Appendix F.

6.1.6 Carbon and Nitrogen Monitoring

Carbon and nitrogen are the primary nutrient sources for microbial growth. Typical municipal and yard waste composting operations are thought to be most efficient when the C:N ratio is near 30:1. This may be partly a reflection of the elemental composition of microbial matter, which generally ranges between 6:1 and 25:1 (Biocycle, 1991). However, carbon in excess of that incorporated in cellular matter is required, because a large fraction (up to ⅔) of available carbon is converted to carbon dioxide (CO_2) through cellular respiration. This implies that the optimum C:N ratio is on the order of 18:1 to 75:1. The optimum C:N ratio for a given mix will also depend on the availability of the carbon and nitrogen. The carbon in wood byproducts, for example, is less readily available than that in vegetable waste or manure. Additionally the optimum 30:1 is based on municipal and yard waste composting, which is not entirely equivalent to bioremediation by composting.

Excess carbon may cause microbial growth to be nitrogen-limited, while excess nitrogen may result in the production of ammonia. While the C:N ratio is an important parameter controlling microbial growth, good growth can occur over a wide range of C:N ratios, and in many cases other factors such as moisture content or oxygen infiltration are limiting. This is clearly illustrated by comparing Mixes 7A and 7B, which performed the best, yet had initial C:N values of 71 and 8.2, respectively.

TOC and TKN levels were monitored for the purpose of tracking (but not adjusting) the C:N ratio during composting. C:N data are provided in Appendix G.

6.1.6.1 Mix 2 Carbon:Nitrogen Ratio

The initial average C:N ratio was 6.5, reflecting the high nitrogen content of the chicken manure. Ammonia vapors up to 100 ppm were recorded near the windrow during the early stages of composting. Ammonia vapors as high as 200 ppm were recorded at the chicken manure storage area. The C:N ratio decreased slightly to 6.0 on day 10, decreased to 3.5 on day 20, and increased to 8.4 by day 30.

6.1.6.2 Mix 3 Carbon:Nitrogen Ratio

The initial average C:N ratio was 9.2, reflecting the high nitrogen content of the alfalfa and turkey manure. The C:N ratio increased to 12.2 on day 10, decreased to 10.6 on day 20, and decreased slightly to 10.4 by day 30.

6.1.6.3 Mix 4 Carbon:Nitrogen Ratio

The initial average C:N ratio was 27.9. The C:N ratio decreased to 14.7 on day 10, 13.0 on day 20, and increased slightly to 16.4 by day 30.

6.1.6.4 Mix 5 Carbon:Nitrogen Ratio

The initial average C:N ratio was 14.8, reflecting the high nitrogen content of alfalfa and turkey manure. The C:N ratio decreased to 11.5 on day 10, increased slightly to 12.1 on day 20, and increased to 14.4 by day 30.

6.1.6.5 Mix 6 Carbon:Nitrogen Ratio

The initial average C:N ratio was 10.8 which indicates high nitrogen content also due to the high percentage of alfalfa and turkey manure. The C:N ratio increased to 13.5 on day 10, decreased to 10.2 on day 20, and increased to 15.4 by day 30.

6.1.6.6 Mix 7A Carbon:Nitrogen Ratio

The initial average C:N ratio was 71. The C:N ratio decreased to 31 on day 7, decreased to 16 on day 20, and remained constant at 16 to day 30.

6.1.6.7 Mix 7B Carbon:Nitrogen Ratio

The initial average C:N ratio was 8.2. The C:N ratio increased to 9.7 on day 10, decreased to 7.9 on day 20, and increased slightly to 10 by day 30.

6.1.6.8 Mix 7C Carbon:Nitrogen Ratio

The initial average C:N ratio was 11. The C:N ratio decreased to 8.0 on day 10, decreased to 7.3 on day 20, and increased slightly to 8.9 by day 30.

6.1.7 Ambient Temperature and Humidity Monitoring

The ambient temperature and relative humidity were monitored daily. Average daily ambient temperatures ranged between 20° and 28° C with the average daily relative humidity varying from 67 to 92 percent. Results of the ambient temperature and humidity monitoring are included in Appendix H.

6.2 COMPARISON TO TEST OBJECTIVES

To rank the overall results, the performance ratings presented above were assigned numerical values, 1 being the most desirable or Very Good and 4 being most undesirable or Poor. The categories are then totaled for each recipe. The ranking for each recipe is summarized below, and Table 6-1 lists the mixes and the overall score (the lower total being the most desirable and the highest total being the least desirable).

6.2.1 Mix 2

Mix 2 is the most undesirable of the mixes tested with clean soil. Mix 2 exhibited poor mixing and homogeneity, lower temperature profiles (less than 55°C), low moisture holding capacity, and poor oxygenation characteristics due to its dense composition. Based on the data available, Mix 2 was eliminated from contaminated soil testing.

6.2.2 Mix 3

Mix 3 exhibited good texture, temperature, moisture, and oxygenation characteristics; however, slight segregation of wood chips did occur and the remaining material was very fine. In addition, since the wood

chips do not represent a readily available carbon source, the C:N ratio is very low and may inhibit explosives degradation. Mix 3 is similar to Mixes 5 and 6, with the addition of potato waste and sawdust, and maintained an average temperature profile near 55°C for 9 continuous days and 13 days total. Mix 3 was selected for contaminated soil testing.

6.2.3 Mix 4

Mix 4 has the second most undesirable overall rating. However, this mix exhibited very good texture and homogeneity characteristics and good moisture holding qualities. Mix 4 also has proved effective in explosives degradation in full-scale operations at other facilities. Mix 4 was selected for contaminated soil testing.

6.2.4 Mix 5

Mix 5 has an overall rating at the midpoint of the recipes, exhibited very good texture and homogeneity characteristics, and maintained a temperature profile near 55°C for 17 days. The Mix 5 performance rating is the same as Mix 6, which is also a variation of a turkey manure recipe. Mix 5 is also a slight variation of Mix 4, with the chicken manure replaced by turkey manure. This may prove to be a key element in the final recipe, should the manure type impact explosives degradation. Mix 5 is less costly than Mix 6 and was selected for contaminated soil testing.

6.2.5 Mix 6

Similar to Mix 5, Mix 6 exhibited very good texture and homogeneity characteristics and maintained a temperature profile of 55°C for 20 days. Based on slightly higher cost and similar performance to Mix 5, Mix 6 was not used in contaminated soil testing.

6.2.6 Mix 7A

Mix 7A data were difficult to compare to the pilot-scale clean soil test data, because the dry run tests were conducted in the early spring months, and different monitoring frequencies were used. Ambient temperatures were as low as 3°C and as high as 19°C, with an average over the testing period of 11°C. Temperature, oxygen and moisture measurements were reported at different stages of the compost cycle; however, moisture content was presented as percent moisture versus WHC. Mix 7A exhibited very good oxygenation and economic characteristics. However, Mix 7A also exhibited the worst temperature profile of the recipes tested. Mix 7A took 9 days to increase to above 40°C and never reached 55°C; the lower ambient temperatures, however, may have kept the temperature profile at a lower range. Texture and percent moisture at saturation data 4was not recorded for Mix 7A. However, because Mix 7A is very similar to Mix 7B, but with less chicken manure, the texture and moisture ratings can be assumed to be similar. Based on lowest cost and an estimated rating of the third most desirable, Mix 7A was selected for contaminated soil testing.

6.2.7 Mix 7B

Mixes 7B and 7C were the highest performers, exhibiting very good temperature, texture and homogeneity characteristics. Mix 7B was the more suitable recipe and outperformed Mix 7C in the moisture, oxygenation, and economic ratings. Mix 7B was selected for contaminated soil testing.

6.2.8 Mix 7C

Mix 7C was rated the second most desirable recipe tested. Since Mix 7C is the same as Mix 7B, except that it has been adjusted for the addition of the vegetable waste, Mix 7C was modified and included in the

contaminated soil testing as Mix 8. Mix 8 adds 10 percent cow manure (considered to be a key ingredient in degradation of explosives-contaminated soil), has volume adjustments of 3 percent less chicken manure and 7 percent less straw, and has the same volume of potato waste and soil as 7C. Mix 8 uses the same amendments in different proportions as Mix 4, except for the replacement of the alfalfa and sawdust with straw, an increase in chicken manure to account for the loss of alfalfa nitrogen content, and a reduction in cow manure.

TABLE 6-1
SUMMARY OF MIX RATINGS

Mix	Category				
	Texture	Temperature	Moisture	Oxygenation	Total Rating
2	3	3	3	3	12
3	2	2	2	2	8
4	1	3	2	3	9
5	1	2	2	3	8
6	1	2	2	3	8
7A	1	4	1	1	7
7B	1	1	1	1	4
7C	1	1	2	2	6

6.3 DATA QUALITY CONTROL SUMMARY

Data quality for analytical data was evaluated through assessment of precision, accuracy, completeness, comparability, and representiveness (PARCC's). Analytical quality assurance objectives were established to insure the quality of the analytical data produced by the contract laboratory.

Precision is the degree to which the measurement is reproducible. This was determined by comparison of samples/duplicates, laboratory control spikes/control spike duplicates or designated sample matrix spike/ matrix spike duplicates. Precision was calculated as the relative percent difference (RPD) between these duplicates according to the procedures.

Accuracy was expressed as the percent recovery of a compound from a sample spiked with known concentrations of target compounds for each analytical method. The determination of the accuracy of a measurement requires a knowledge of the true or accepted value for the parameter being measured and the value of the parameter for the unspiked sample.

The representativeness of the data is the degree to which data represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Data were considered representative if the sampling was in accordance with the sampling programs outlined in the *Quality Assurance Project Plan for Pilot Scale Operations at the Biofacility* (MK, 1997d).

Completeness is a measure of the amount of valid data obtained from an analytical data set compared with the amount that would be expected to be obtained under normal sampling and analytical conditions. Completeness is based on only those samples collected and submitted for laboratory analysis and was established at 90 percent for this project.

Comparability expresses the confidence with which one data set can be compared to another. Samples from the same media (i.e., soil, water) were considered comparable if the procedures for collecting and analyzing the samples are complied with and consistent.

Comparability was assured through the use of established and approved analytical methods and protocols. The laboratory's quality control program was designed to establish consistency in the performance of the analytical process. The program includes traceability of measurements to standardized reference materials to establish comparability with other laboratory results, and internal controls to verify consistency of the contract laboratory's performance.

Laboratory quality control (QC) samples were analyzed in order to evaluate the PARCC parameters and include where appropriate, method blanks, laboratory matrix spike/matrix spike duplicate samples, laboratory control sample/laboratory control sample duplicates, etc. These were run concurrently with the analytical batch to which the samples were assigned.

The laboratory method blanks were carried through each step of the analytical method to examine the potential for cross-contamination. A method blank for laboratory analysis consists of deionized water or sterile soil (or equivalent). All laboratory method blanks were free from target compounds and interferences above the reporting limit and results are acceptable based upon the project data quality objectives for TKN and TOC analysis.

The laboratory control sample and duplicate (LCS/LCSD) are samples prepared in the laboratory, consisting of clean soil or water spiked with known amounts of target analytes which are processed through the sample preparation as field samples. Evaluation of the spike recoveries, and the variability between the LCS and LCSD, gives and indication of analysis accuracy and precision in a clean matrix. All LCS/LCSD precision and accuracy results met acceptable laboratory criteria for TKN and TOC analysis.

The laboratory designated matrix spike and duplicate (MS/MSD) are samples spiked with known concentrations of target analytes which were taken through the entire analytical procedure and the recovery of the analytes calculated. The laboratory matrix spike was used to evaluate the accuracy of the method for different matrices. Additionally, the two spiked aliquots (MS/MSD) were processed separately and the results compared to evaluate the effects of the matrix on the precision of the method. Precision results are expressed as Relative Percent Differences (RPD) between the percent recovery for duplicate spiked samples analyzed.

The MS/MSD precision was acceptable for most of the analytical batches. Three soil MS/MSD pairs exhibited elevated levels for RPD's for TKN, and four soil MS/MSD pairs exhibited elevated RPD's for TOC.

Acceptable TKN and TOC accuracy criteria were met for most MS/MSD's prepared with the samples. Two soil TKN MS/MSD samples exhibited high percent recoveries and three exhibited low percent recoveries. TKN recoveries ranged from 60-130 percent recovery. Nine soil TOC MS/MSD samples exhibited high percent recoveries and three analytical batches had low recoveries. TOC recoveries ranged from 60-150 percent recovery. Based upon the corresponding LCS/LCD recoveries and method blank results it is likely that the slight exceedences are attributable to sample matrix.

Reporting limits were based on method detection limits for inorganics and method quantitation limits for organics. The method detection limit is defined as minimum concentration of a substance that can be identified, measured, and reported with a 99 percent confidence level that the analyzed concentration is greater than zero.

The method quantitation limit is defined as equivalent to a fixed multiple of the method detection limit or lowest standard as outlined in SW846. It should be recognized that detection and quantitation limits are sample matrix dependent and were elevated as a result of matrix interferences and/or dilution factors.

Based on the review of the PARCC'S parameters, analytical data packages and data verifications performed, data is felt to be acceptable to meet the intended data quality objective as outlined in the *Quality Assurance Project Plan for Pilot Scale Operations at the Biofacility* (MK, 1997d).

7.0
RESULTS AND DISCUSSION - CONTAMINATED SOIL TESTS

7.1 DATA ANALYSIS AND EVALUATION

Process parameters were measured and monitored as described in Section 4.1. Texture was also evaluated due to its influence on the process parameters and for aiding the review of the parameter monitoring results.

7.1.1 Texture

Texture of the compost material has significant influence on the process parameters, i.e., moisture content, oxygen content, and temperature. If the final amendment and soil mix is too dense, bulking of the material does not occur and oxygen levels may be too low to sustain high bacteria growth, which results in lower temperatures and lowered explosive degradation rates. If the final mix is extremely high in bulking agents, such as straw, wood chips, or alfalfa, the mix may be stringy or clumpy. Thorough mixing of the recipe does not occur and results in a nonhomogeneous mass that may be difficult to sample. Non-homogeneity may reduce degradation of explosives because optimum conditions for the moisture and nutrients may not be available for microbial growth. To allow comparison between the various mixes, the following categories of texture were used to classify and grade each mix at the initiation, mid-cycle, and end of cycle conditions.

Of particular importance is the texture of the pile in the first 1 to 2 weeks, when microbial populations are undergoing rapid growth. An open, porous structure during this stage helps assure that growth is not oxygen or moisture limited.

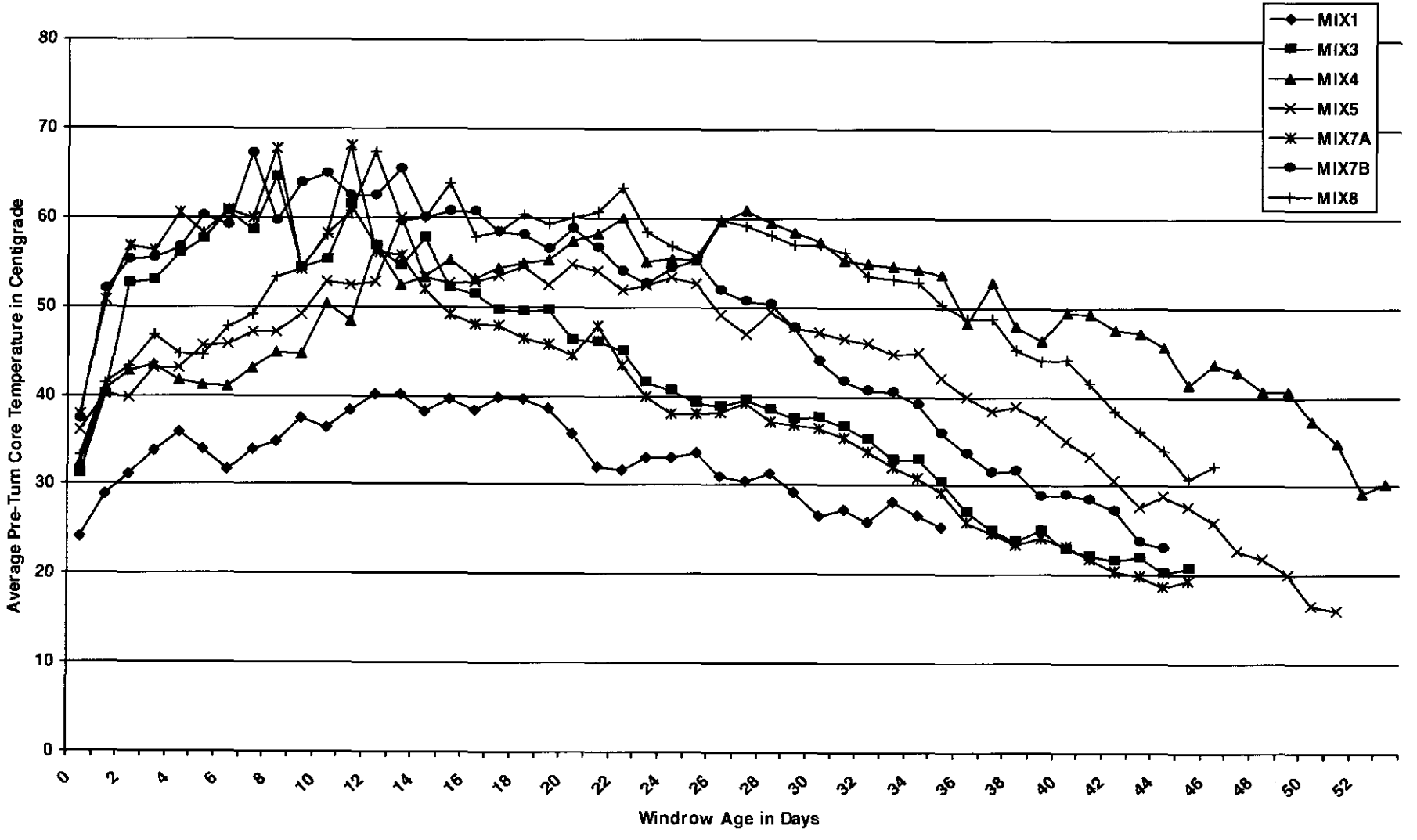
The straw content of Mixes 7A and 7B provided a more porous structure than in the other mixes during the first 7 to 10 days, which is reflected in oxygen measurements discussed in Section 7.1.5. After the first 1 to 2 weeks, all mixes became progressively more dense due to degradation and turning, and no significant textural differences were noted.

7.1.2 Temperature

Temperature is the primary indicator of successful thermophilic composting. The normal thermal operating range for composting is 25 to 65°C. Previous studies of explosives-contaminated soil composting indicate that average temperature should rise to 25 to 40°C within the first few days of formation, continue rising to within the temperature range of 40 to 65°C, and maintain that range for at least 2 weeks, provided adequate moisture, nutrients, and oxygen are available. The process goal was to maintain the average windrow temperature near 55°C. Temperature decrease over time below 50°C is viewed as an indicator of a pile that is nearing the end of its operation (Weston, 1993). Temperature measurements were recorded before and after each windrow turning. Pre-turn temperatures are more useful for evaluation and comparison because they represent heat development over time. "Average" temperature is defined as the average of the 24 monitoring locations in each windrow. Figure 7-1 shows average pre-turn temperature versus time for all mixes. Temperature development for each mix is described below. Complete individual temperature profiles are included in Appendix J, and include post-turn measurements.

In summary, Mixes 7A and 7B heated more rapidly and peaked at higher temperatures. Mix 7B maintained temperatures greater than 55°C for 25 days, while Mix 7A decreased more rapidly, maintaining temperatures above 55°C for only 13 days. Mix 3 also heated rapidly, but the temperature dropped relatively quickly, similar to Mix 7A. Mix 4 and Mix 8 heated more slowly, but remained above 55°C for a relatively long period--23 and 27 days, respectively.

Figure 7-1 Summary of Temperature Profile for Contaminated Soil Testing



7.1.2.1 Mix 1 Temperature

Because the creation of the Mix 1 windrow was delayed due to availability of the POTW sludge, ambient temperatures were approximately 10°C lower than when the other windrows were created. It took 10 days for average pre-turn temperatures to reach 40°C, which was considerably slower than the other mixes, even considering the difference in ambient temperatures. This is illustrated by comparing the slopes of temperature increase shown in Figure 7-1.

Average pre-turn temperature increased to a maximum of 43°C by day 20, after which the temperature declined. Mix 1 never reached the thermophilic temperature range.

7.1.2.2 Mix 3 Temperature

Average pre-turn temperatures of Mix 3 increased to approximately 40°C within 2 days, and approximately 50°C within 3 days. Average pre-turn temperatures continued to increase to about 65°C in 10 days, and then began to decline more slowly. Average temperatures reached approximately 40°C by day 30, and continued to decline to 23°C on day 40. Mix 3 maintained temperatures of 55°C or higher for 13 days.

7.1.2.3 Mix 4 Temperature

Average pre-turn temperature of Mix 4 increased to approximately 40°C within 2 days, and approximately 50°C within 10 days. Average pre-turn temperatures continued to increase to 64°C by day 22, and then began to decline. Average temperatures reached approximately 60°C by day 30, and continued to decline to 50°C on day 40. Mix 4 maintained temperatures of 55°C or higher for 23 days.

7.1.2.4 Mix 5 Temperature

Average pre-turn temperature of Mix 5 increased to approximately 40°C within 2 days, and approximately 50°C within 9 days. Average pre-turn temperatures continued to increase to about 56°C in 14 days, and then began to decline slowly. Average temperatures reached approximately 49°C by day 30, and continued to decline to 38°C on day 40. Mix 5 maintained temperatures of 55°C or higher for 12 days.

7.1.2.5 Mix 7A Temperature

Average pre-turn temperature of Mix 7A increased to almost 40°C within the same day as it was created, and quickly reached 57°C within 2 days. Average pre-turn temperatures continued to increase to 65°C in 11 days, and then began to decline. Average temperatures reached approximately 39°C by day 30, and continued to decline to 24°C on day 40. Mix 7A maintained temperatures of 55°C or higher for 13 days.

7.1.2.6 Mix 7B Temperature

Average pre-turn temperature of Mix 7B increased to almost 40°C within the same day as it was created, and quickly reached 56°C, within 2 days. Average pre-turn temperatures continued to increase to 72°C in 10 days, and then began to decline. Average temperatures reached approximately 47°C by day 30, and continued to decline to 31°C on day 40. Mix 7a maintained temperatures of 55°C or higher for 25 days.

7.1.2.7 Mix 8 Temperature

Average pre-turn temperature of Mix 8 increased to over 40°C within 1 day, and reached 50°C within 6 days. Average pre-turn temperatures continued to increase to 65°C in 12 days, and then began to decline.

Average temperatures reached approximately 58°C by day 30, and continued to decline to 48°C on day 40. Mix 8 maintained temperatures of 55°C or higher for 27 days.

7.1.3 Moisture Capacity

Microbial biodegradation is most efficient at moisture contents of 40 to 60 percent maximum WHC, with 50 percent WHC considered optimum. Reduced moisture content may inhibit microbial movement and nutrient availability, while excessive moisture content will fill void spaces, reducing aeration and oxygen levels and retarding aerobic microbial growth. Moisture level monitoring was performed three times per week. Moisture levels were rechecked after windrow turning if moisture has added. A maximum of 300 gallons per day were added.

Average WHC data and figures for individual mixes are provided in Appendix K, which also includes plots showing moisture added for individual windrows. The moisture content of all mixes was generally maintained at 40 to 60 percent maximum WHC, with the exception of Mix 1. Mix 1 remained between 60 and 80 percent for the first 20 days because of the high moisture content of the POTW sludge.

7.1.4 Oxygen Levels

Oxygen levels of up to ambient atmospheric, or about 20 percent, are preferred in a compost windrow, and 5 percent is considered the minimum for rapid compost degradation. Oxygen levels below 1 percent indicate anaerobic conditions. If sufficient oxygen levels are not maintained, aerobic microbial degradation is retarded, thermophilic temperatures may not be maintained, and putrefaction of organic matter may occur. However, anaerobic conditions exist in a compost windrow throughout most of each day, and depending on the density of the compost, aerobic conditions occur only for 1 to 2 hours following turning, as described below.

The oxygen available to microbes in a windrow is the result of aeration by turning; oxygen diffusion from the atmosphere into the windrow is negligible (Biocycle, 1991) Therefore oxygen availability is a function of the air-filled pore volume, which is in turn a function of porosity and moisture content. As compost is turned and degrades, the porosity is reduced, which in turn reduces available oxygen. Similarly, increasing the moisture content also reduces available oxygen.

For example, consider a compost with a dry density of 1,000 lbs/yd^3 or 0.6 g/cm^3. At 50 percent porosity and 50 percent maximum WHC, each cm^3 of compost contains 0.25 cm^3 of air (0.5 cm^3 x 0.5). Because air is about 21 percent oxygen, which has a density of 1.43 mg/cm^3, each cm^3 of compost contains 0.075 mg oxygen (0.25 cm^3 x 0.21 x 1.43 mg/cm^3) and 0.6 grams of solids. Therefore, about 0.13 mg oxygen are available for each gram of solids (0.075 mg/0.6 g).

Literature values of oxygen consumption rates from municipal waste composting operations vary over a wide range, from 1.0 mg/g-hr to 14 mg/g-hr (Biocycle, 1991). From the example above, which indicates that only about 0.13 mg oxygen is available for each gram of solids, it should be expected that oxygen levels are rapidly depleted, and that anaerobic conditions exist through at least part of each day. This is supported by data from the Umatilla windrows where oxygen was measured every minute for one hour following turning (Weston, 1993). Oxygen levels were observed to decrease to 5 percent in 10 to 30 minutes, and to 1 percent in 30 minutes to 1 hour.

Furthermore, even under oxygen levels of 5 to 20 percent, anaerobic microsites exist throughout a compost windrow. As a result of the restricted oxygen diffusion through soil and organic matter particles, saturated aggregates and crumbs larger than a few mm will have no oxygen at their center (Paul and Clark, 1989). The presence of aerobic microbes can create localized anaerobic conditions as they consume oxygen (Paul and Clark, 1989, p.17). Microbiological counts of the compost were not performed

during this project. However, counts of aerobic, anaerobic, obligate anaerobic, and thermophilic bacteria were performed at Umatilla as part of the compost seeding studies (Weston, 1993). The results showed that total aerobic and total anaerobic bacteria counts were equivalent, and suggest that both anaerobic and aerobic bacteria play an important role in compost degradation. This is supported by the observation at Umatilla that unaerated windrows performed equal to or better than aerated windrows in terms of contaminant degradation. However, the data from windrows 7A and 7B, discussed below, suggest that improved aeration results in more rapid contaminant degradation.

Samples were collected as soon as possible following windrow turning, which was generally within 15 minutes. The data shows considerable variation from day to day, which is partly the result of differences in sample collection times. The Umatilla data (Weston, 1993) shows that differences in post-turn sample collection times of 5 to 10 minutes can result in differences of almost 10 percent in oxygen measurements.

Figure 7-2 shows pre-turn oxygen measurements for all mixes, which shows oxygen depletion approximately 24 hours after turning. Complete pre- and post-turn data for individual mixes is included in Appendix L.

The oxygen level data reflects both the aeration of a pile, which is due to texture and the effects of turning, and the microbial activity of a pile. Oxygen levels were observed to decline rapidly during the contaminated soil tests, just as in the clean soil tests.

Oxygen levels in Mixes 7A and 7B remained relatively high between pre- and post-turn measurements for approximately the first 10 days. Pre-turn measurements did not drop below 5 percent until after day 10. This indicates that the high straw contents of these mixes provided structure and pore space for effective aeration, and that sufficient oxygen was available to support aerobic degradation all day. All other mixes (except Mix 1) had post-turn oxygen levels of from <1 percent to about 6 percent until about day 30.

All mixes, with the exception of Mixes 1 and 4, showed generally increasing oxygen levels, both pre- and post-turn, after about day 30. This reflects the decline in microbial activity as the piles mature.

7.1.5 pH Monitoring

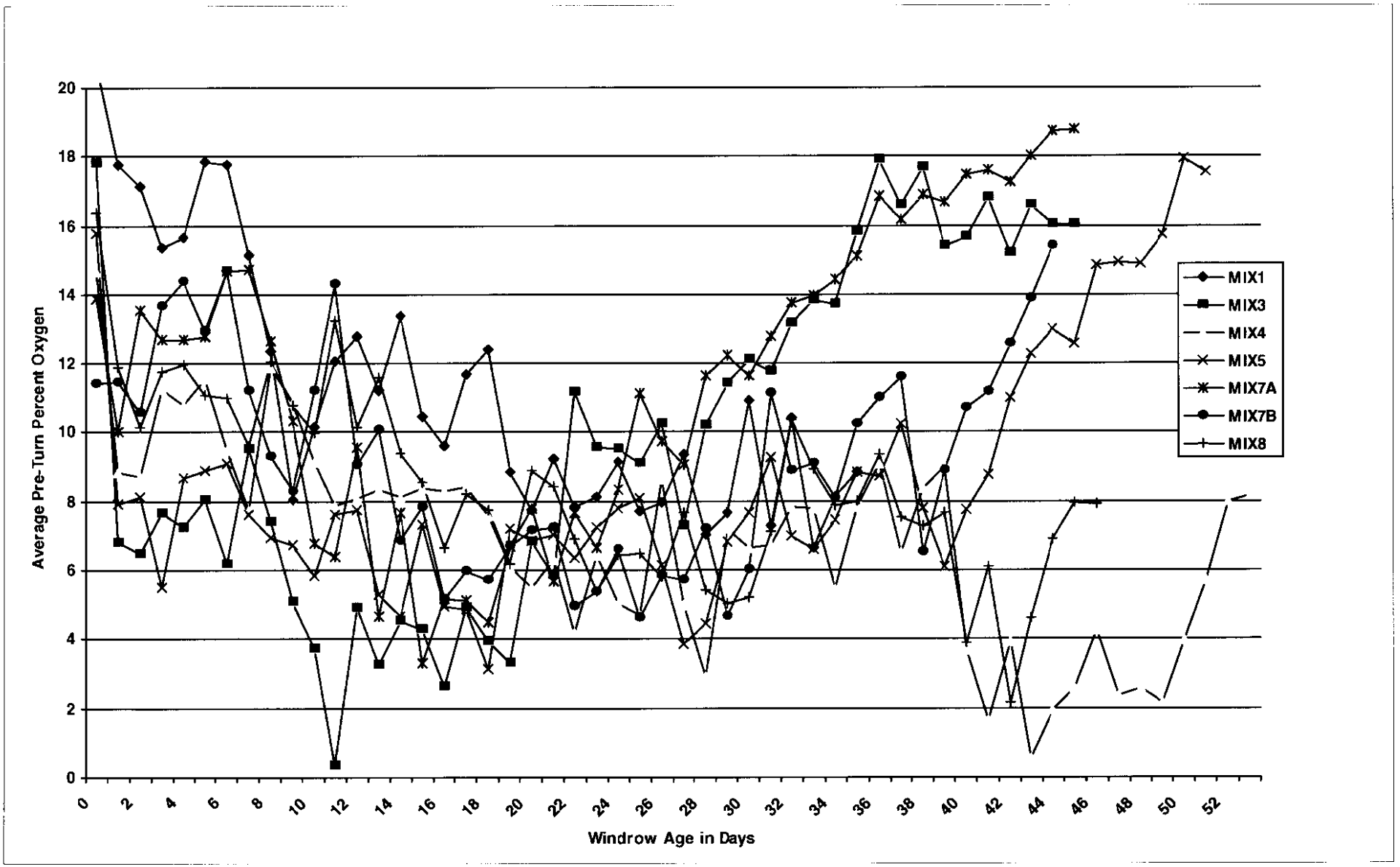
Samples for pH monitoring were collected at location 1 for each of the four cross-sections, once per week, prior to turning, as described in Section 4.1. pH was not adjusted during treatment.

The pH in samples from Mixes 4, 5, and 8 decreased to approximately 5.5 for the first 1 to 2 weeks, then increased to the 7 to 9 range. The low pH was probably the result of organic acid generated by the degradation of potato waste in the mixes. Samples from the remaining mixes resulted in pHs from 7 to 9, which were within the acceptable range. pH monitoring data are included in Appendix M.

7.1.6 Carbon and Nitrogen Monitoring

Carbon and nitrogen are the primary nutrient sources for microbial growth. Typical municipal and yard waste composting operations are thought to be most efficient when the C:N ratio is near 30:1. This may be partly a reflection of the elemental composition of microbial matter, which generally ranges between 6:1 and 25:1 (Biocycle, 1991). However, carbon in excess of that incorporated in cellular matter is required, because a large fraction (up to ⅔) of available carbon is converted to CO_2 through cellular respiration. This implies that the optimum C:N ratio is on the order of 18:1 to 75:1. The optimum C:N ratio for a given mix will also depend on the availability of the carbon and nitrogen. The carbon in wood byproducts, for

Figure 7-2 Summary Oxygen Depletion for Contaminated Soil Testing



example, is less readily available than that in vegetable waste or manure. Additionally, the optimum 30:1 is based on municipal and yard waste composting, which is not entirely equivalent to bioremediation of soil by composting.

Excess carbon may cause microbial growth to be nitrogen-limited, while excess nitrogen may result in the production of ammonia. While the C:N ratio is an important parameter controlling microbial growth, good growth can occur over a wide range of C:N ratios, and in many cases other factors such as moisture content or oxygen infiltration are limiting.

TOC and TKN levels were monitored for the purpose of tracking the C:N ratio during composting. No relationship between C:N ratios and explosives degradation was found. The C:N ratio was not intended to be adjusted, and it was not. C:N data are provided in Appendix N.

7.1.7 Ambient Temperature and Humidity Monitoring

The ambient temperature and relative humidity were monitored daily. Average daily ambient temperatures ranged between 10° and 20°C for the first 30 days. Temperatures then began to fall, with average temperatures of 5° to 10°C from day 35 on. Average daily relative humidity varied from 70 to 95 percent. Ambient temperature and humidity monitoring results are included in Appendix O.

7.1.8 Metals

Samples were collected from the MFA soil before the soil was mixed with amendments and were analyzed for total metals. The metals content was confirmed to be below RCRA levels for the Soils Bioremediation Facility; therefore, futher metals analysis was not required.

7.1.9 Explosives Degradation

Explosives degradation for each mix is described in the following sections. The explosives data evaluation considers that much of the analytical results fell below method reporting limits (MRLs). Furthermore, the MRLs varied based on the sample dilution required to perform the analyses. Earlier samples containing higher contaminant levels required greater dilution, and consequently the MRLs were higher. Apparent trends based on reported MRLs are a reflection of variable (usually decreasing) dilution factors, and are not otherwise meaningful.

Nearly all 2-ADNT and 4-ADNT results were below MRLs throughout the pilot test. However, MRLs for 2-ADNT and 4-ADNT were below PRGs after day 10 or 20.

In most cases TNT and RDX fell below their MRLs after day 20 or 30. However, all MRLs for TNT, RDX, and HMX were below PRGs throughout the test.

The data from most windrows also showed variation that indicated an occasional systematic bias. The explosives degradation versus time plots of Figures 7-3, 7-4, and 7-5 and Appendix P display an occasional sampling episode in which contaminant concentrations increase from the previous episode. For example, see Mix 7A days 30 and 40, Mix 7B day 60, and Mix 8 day 30. The increased concentrations are generally evident in all measured compounds, and in average (of 12 samples per pile) as well as peak values. Concentrations are noted to return to the same general decreasing trend at subsequent sampling episodes. The observation that the increase occurs in average values indicates that it is a pile-wide phenomenon rather than in isolated samples.

Figure 7-3 TNT Degradation

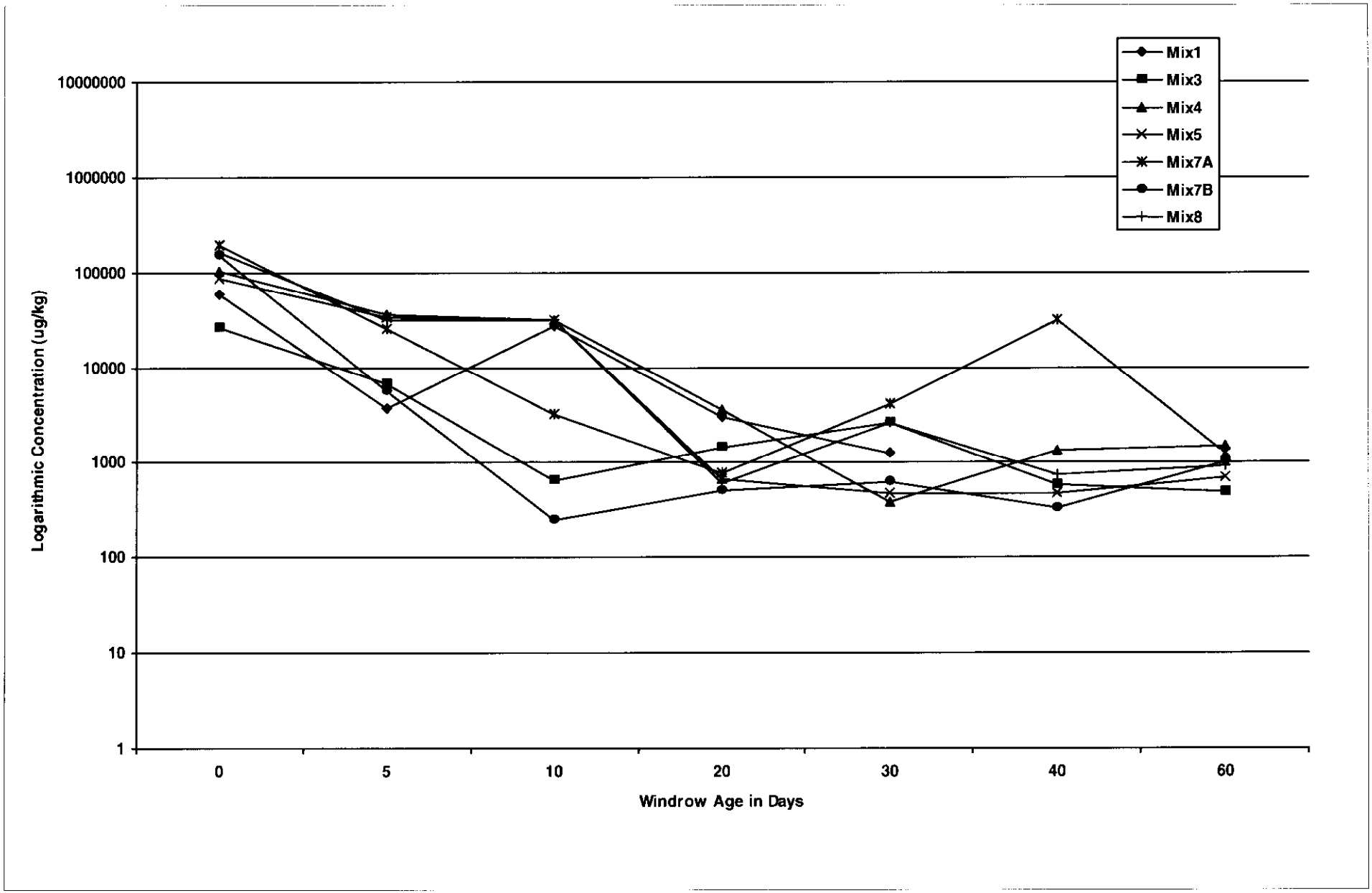


Figure 7-4 RDX Degradation

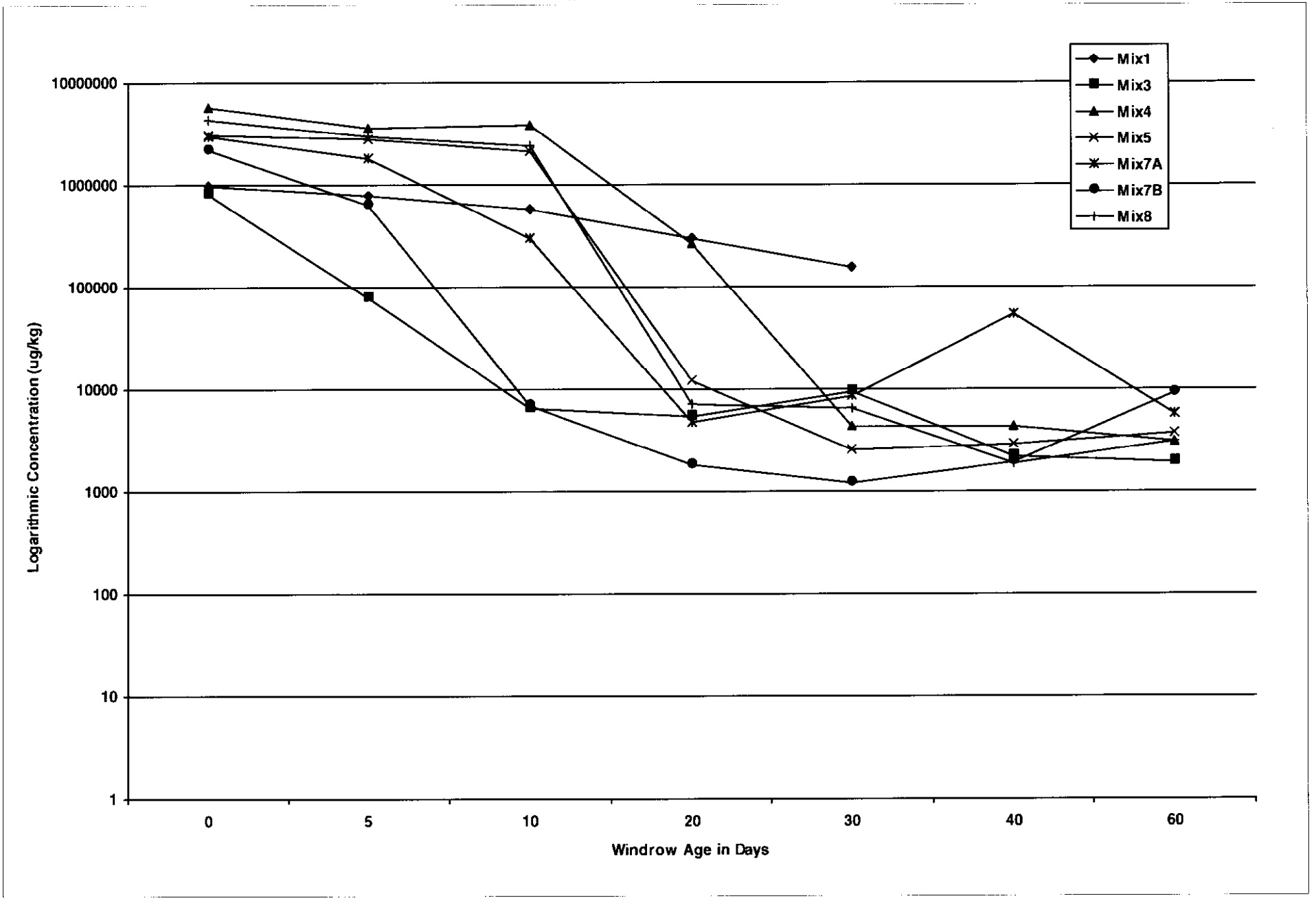
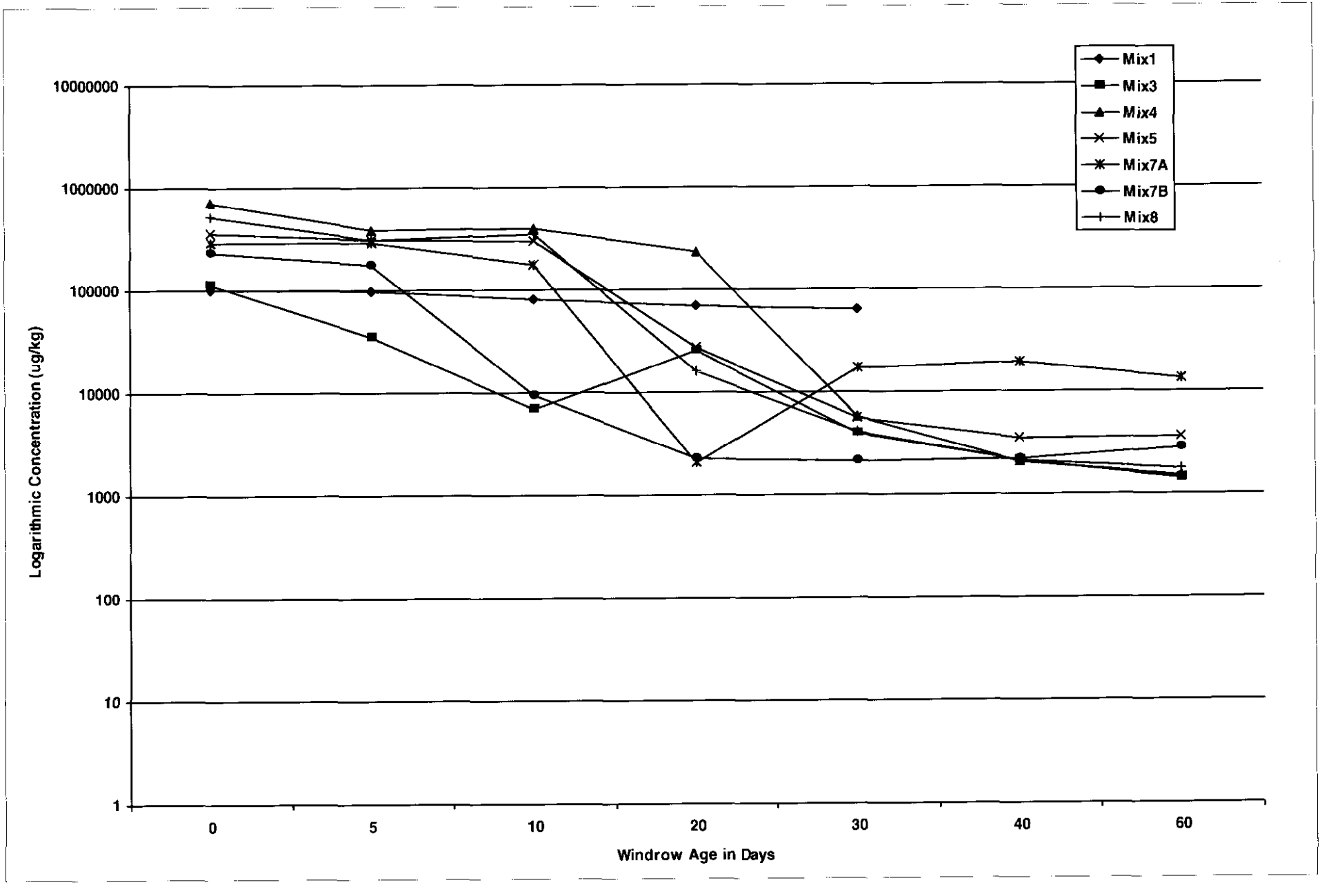


Figure 7-5 HMX Degradation



This variation is probably the result of the windrow turning procedure. The lower few inches of each pile is not normally turned by the Scarab windrow turner to avoid tearing into the concrete floor of the Soils Bioremediation Facility. Consequently there is a thin bottom layer of compost that is not incorporated into the active, managed pile. Occasionally, the Scarab may have dug into this unturned zone, bringing untreated compost containing higher contaminant levels into the rest of the pile. The data must be evaluated with this variation in mind. For example, day 30 results for all piles cannot necessarily be directly compared.

All mixes reached remedial goals within 30 days (with the exception of Mix 1). There were notable differences between some mixes. Windrow 7B showed the most rapid initial degradation (in the first 5 to 10 days). Windrow 7A also showed rapid initial degradation, and was only incrementally slower than 7B. Windrow 3 also showed rapid initial degradation, but that may in part result from lower initial contaminant concentrations.

7.1.9.1 Mix 1

Mix 1 was halted at 30 days due to poor performance. Remedial goals were exceeded for RDX and 2-ADNT and 4-ADNT at 30 days. Contaminant reduction at 20 days was 95 percent for TNT, 67 percent for RDX, and 26 percent for HMX.

7.1.9.2 Mix 3

Both the TNT and RDX remedial goals were reached by day 10. The initial explosives concentrations of Mix 3 were significantly lower than all other mixes except mix 1, with concentrations as low as approximately 1/10 that of the more contaminated mixes. However, the high percentage reduction of contaminants indicates that Mix 3 is an effective degrader. Day 20 data appeared anomalous as explained in Section 7.1.8 above. Contaminant reduction at 10 days was 96 percent for TNT, 99 percent for RDX, and 94 percent for HMX.

7.1.9.3 Mix 4

The TNT remedial goal was reached by day 10 and the RDX remedial goal was reached by day 30. Contaminant reduction at 20 days was 97 percent for TNT, 95 percent for RDX, and 68 percent for HMX.

7.1.9.4 Mix 5

Both the TNT and RDX remedial goals were reached by day 20. Contaminant reduction at 20 days was 98 percent for TNT, 99 percent for RDX, and 92 percent for HMX.

7.1.9.5 Mix 7A

The TNT remedial goal was reached by day 5 and the RDX remedial goal was reached by day 20. Contaminant reduction at 20 days was 99 percent for TNT, RDX, and HMX.

7.1.9.6 Mix 7B

The TNT remedial goal was reached by day 5 and the RDX remedial goal was reached by day 10. Contaminant reduction at 20 days was 99 percent for TNT, RDX, and HMX.

7.1.9.7 Mix 8

The TNT remedial goal was reached by day 10 and the RDX remedial goal was reached by day 30. Contaminant reduction at 20 days was 99 percent for TNT and RDX, and 97 percent for HMX.

7.2 COMPARISON TO TEST OBJECTIVES

As stated in Section 2.1, the overall objective is to determine which compost mix provides the optimum environment for microorganism growth and degradation of explosives in contaminated soil. Based upon the test results presented above, it is clear that although all mixes met the preliminary remedial goals. Mix 7B develops a favorable temperature profile more rapidly and degrades explosives more rapidly than the other mixes. It is significant that Mix 7A, which differs from 7B only in the relative proportions of chicken manure and straw, performed nearly as well. This is discussed further in Section 10, Summary and Recommendations.

7.3 DATA QUALITY CONTROL SUMMARY

Data quality for analytical data were evaluated through assessment of PARCCs. Analytical quality assurance objectives were established to ensure the quality of the analytical data produced by the contract laboratory.

Precision is the degree to which the measurement is reproducible. This was determined by comparison of sample duplicates, LCS/LCSD, or designated sample MS/MSD. Precision was calculated as the RPD between these duplicates according to the procedures.

Accuracy was expressed as the percent recovery of a compound from a sample spiked with known concentrations of target compounds for each analytical method. Determining the accuracy of a measurement requires a knowledge of the true or accepted value for the parameter being measured and the value of the parameter for the unspiked sample.

The representativeness of the data is the degree to which data represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Data were considered representative if the sampling was in accordance with the sampling programs outlined in the *Quality Assurance Project Plan for Pilot Scale Operations at the Biofacility* (MK, 1997d). Field duplicate samples and rinse blanks were collected and analyzed to assess field representativeness. Trip blanks also were included with each sample shipment and were analyzed for volatile organics to evaluate potential cross-contamination during transport and storage, which may impact data representativeness.

Completeness is a measure of the amount of valid data obtained from an analytical data set compared with the amount that would be expected to be obtained under normal sampling and analytical conditions. Completeness is based on only those samples collected and submitted for laboratory analysis; 90 percent was established for this project.

Comparability expresses the confidence with which one data set can be compared to another. Samples from the same media (i.e., soil, water) were considered comparable if the procedures for collecting and analyzing the samples are complied with and consistent.

Comparability was assured through the use of established and approved analytical methods and protocols. The laboratory's QC program was designed to establish consistency in the performance of the analytical process. The program includes traceability of measurements to standardized reference materials to establish comparability with other laboratory results, and internal controls to verify consistency of the contract laboratory's performance.

Laboratory QC samples were analyzed to evaluate the PARCC parameters. The laboratory samples included, where appropriate, method blanks, laboratory MS/MSDs, sample duplicates, etc. Analyses of the laboratory QC samples were run concurrently with the analytical batch to which the samples were assigned. As an additional QC check for method SW8330, surrogates were are added to each sample (including QC samples) and analyzed in an analytical batch.

The laboratory method blanks were carried through each step of the analytical method to examine the potential for cross-contamination. A method blank consists of organic-free deionized water or sterile soil (or equivalent). All laboratory method blanks were acceptable, based upon the project data quality objectives. Total cadmium was detected in one method blank at 0.40 mg/kg, chromium was detected in one TCLP blank at 6.74 µg/L, and mercury was detected in two TCLP blanks at 2.97 µg/L and 0.24 µg/L. Positive blank results may indicate possible false positive results in associated samples in which results are less than five times the levels found in the blanks. One TCLP blank exhibited a negative result (-0.20 µg/L) for mercury and one TCLP blank exhibited a negative result for lead (-4.78 µg/L). Negative blank results may indicate possible false negative results in associated samples.

The laboratory-designated matrix spikes are samples spiked with known concentrations of target analytes. These samples were taken through the entire analytical procedure and the recovery of the analytes calculated. The laboratory matrix spike was used to evaluate the accuracy of the method for different matrices. The two spiked aliquots (MS/MSD) were processed separately and the results compared to evaluate the effects of the matrix on the precision of the method. Results are expressed as the RPD between the percent recovery for duplicate spiked samples analyzed.

Precision was acceptable for most of the analytical batches. A number of MS/MSD pairs exhibited elevated RPD's for 3NT, 4-NT, HMX, RDX, TNT, and Tetryl. These elevated RPD's are likely attributed to the sample matrix and relative spiking concentrations to the concentration in the corresponding samples. The LCS/LCSD pairs exhibited acceptable RPD's except Tetryl in a few batches

Accuracy was acceptable for most sample analytical batches based on the data quality requirements. MS/MSD percent recoveries showed some variation. Variations in MS/MSD accuracy were likely due to sample matrix and the relative spiking levels as compared to the concentrations found in the corresponding samples.

Laboratory duplicates are a second measured aliquot taken by the laboratory which is taken through the entire analytical procedure. The analytical results are used to evaluate the precision of the method for a specific matrix. Two duplicate pairs exhibited elevated RPDs for total lead and one duplicate pair exhibited an elevated RPD for TCLP chromium.

Surrogates were added to each environmental sample and QC sample in analytical batches for method SW8330. Surrogates are known concentrations of target analytes spiked into each QC sample and environmental samples which are taken through the entire analytical procedure and the recovery of the analytes calculated. The surrogate spikes were used to evaluate the accuracy of the method for different matrices. Results of surrogate analysis are expressed in percent recovery and used to evaluate the accuracy of method. Seven samples (including and LCS and LCSD) exhibited elevated percent recoveries for the surrogate 3,4-DNT, indicating a possible high bias in associated detected analytes. Nine samples (including two matrix spikes) exhibited low percent recoveries for the surrogate 3,4-DNT, indicating a possible low bias in associated samples.

Reporting limits were based on method detection limits for inorganics and method quantitation limits for organics. The method detection limit is defined as minimum concentration of a substance that can be identified, measured, and reported with a 99 percent confidence level that the analyte concentration is greater than zero. The method quantitation limit is defined as equivalent to a fixed multiple of the method

detection limit or lowest standard as outlined in SW846. It should be recognized that detection and quantitation limits are sample matrix dependent and were elevated as a result of matrix interferences and/or dilution factors. Overall assessment is that the data obtained has met the data quality objectives for the program. Data not meeting aceptable criteria have been flagged appropriately.

8.0
COST AND TIME REQUIREMENTS

Table 8-1 presents cost estimates for the amendment mixes used in the contaminated soil tests. The best performing mixes, 7A and 7B, are also the least expensive.

Total cost estimates for full-scale treatment are not included here because the final operational procedures and schedule have not yet been finalized. However, cost estimates including all labor, equipment, and materials have been developed for several different operational scenarios. Costs will vary significantly depending on windrow volumes, cycle time, and soil loading. In general, based on a total of 110,000 cubic yards treated over approximately 10 years, total costs are anticipated to be on the order of $4,000,000-$5,000,000 annually.

TABLE 8-1
MIX COST AND AVAILABILITY

Mix	Dollars per ton*	Availability
1	$12.66	Readily available, with the possible exception of POTW sludge
3	$16.60	Usually available
4	$24.49	Usually available
5	$22.36	Usually available
7A	$7.17	Readily available
7B	$8.94	Readily available
8	$17.53	Readily available

* All costs are based on delivered rates and known rate increases at the time of this report.

9.0
SAFETY AND INDUSTRIAL HYGIENE SAMPLING AND MONITORING SUMMARY

During pilot-scale operations there were no accidents or incidents and no Occupational Safety and Health Administration (OSHA) recordables. There were two minor first aid cases. Where applicable, all entries on the Site Safety and Health Plan (SSHP) Weekly Inspection Reports were rated satisfactory for the duration of the project as completed by the safety and health supervisor. The project was staffed with a full-time safety and health supervisor.

Human health risks associated with bioremediation by aerobic windrow composting of soils contaminated with nitroaromatic and nitroamine explosive residues have not been significantly investigated and characterized in the industry. Only three facilities in the United States that have used or are using this technology have been identified. Time-integrated industrial hygiene (IH) air sampling was conducted to evaluate biological and chemical agents during contaminated soil excavation, screening, and composting operations. IH monitoring was used to evaluate total dust, heat stress, and noise exposures.

A copy of the summary report for IH monitoring and sampling is included Appendix Q of this report. The following paragraphs summarize the IH monitoring activities and sampling results.

Bioaerosol samples were obtained inside the compost building and duplicated outside for background levels. Samples were collected using an Andersen 2-Stage Impactor based on guidelines found in the American Industrial Hygiene Association (AIHA) *Field Guide for the Determination of Biological Contaminants in Environmental Samples*. Six sample sets were obtained for bacteria using Standard Methods Agar (SMA) and six for fungi (molds and yeast) using acidified Potato Dextrose Agar (PDA). The SMA is a non-selective, general-purpose agar suitable for both bacteria and fungi (molds and yeast). The acidified PDA is selective agar for fungi (molds and yeast) using pH to inhibit bacteria growth. Analysis for total plate count was completed using a Quebec colony counter. Bacterial pathogen isolations were performed on the SMA plates for 22 species.

The results of the data analysis indicate that the total concentration of microbes on the SMA plates inside the compost building, expressed in units of colony forming units per cubic meter of air (cfu/m^3), was significantly greater than the total concentration outside the compost building. The outside total concentration median value was calculated as 120 cfu/m^3, and the inside concentration was calculated as 1,185 cfu/m^3.

The opposite result occurred on the acidified PDA plates. The total concentration on these plates inside the compost building was less than the total concentration outside the compost building. The outside total concentration median value was calculated as 1,090 cfu/m^3; the inside concentration was calculated as 785 cfu/m^3. The inside concentration median value was approximately 38 percent less than the outside. The reason for this occurrence is not fully understood at this time. However, it is speculated that, because of the large quantity of manure used in the compost pile, the bacterial species present in the structure may have been competing with the fungi. This would have resulted in a decrease in the total number of viable airborne fungi colonies that could be cultured on the acidified PDA plates.

No bacteria of any significance was detected on the SMA plates. All bacterial pathogen isolation results were negative. No *Aspergillus* species were detected on the PDA plates. The predominant species detected on all sample plates were *Penicillium*, *Alternaria*, and *Cladosporium*. These species are all molds normally found in the atmosphere and are classified as normally mild or non-pathogenic fungi. The bioaerosol concentrations obtained were well below suggested recommended occupational exposure limits of 10,000 cfu/m^3 in total and 500 cfu/m^3 for each specific group of organisms or species of a potentially pathogenic nature.

Split-shift personal (≈ 4-hour duration) and area air samples for explosives were obtained at the excavation site and inside of the compost building. The air samples were collected on XAD-2 OSHA Versatile Sampler (OVS) sampling tubes based on a modified OSHA Method 44 and analyzed using high-pressure liquid chromatography (HPLC), based on EPA Method 8330. Each sampling tube was analyzed for 14 different analytes. A total of nine personal and nine area samples were obtained. All samples had results for all analytes less than the detection limit of 0.05 milligrams per cubic meter (mg/m^3) and therefore significantly below any required or recommended occupational exposure limits. The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value Time Weighted Average (TLV-TWA) for 2,4,6-TNT is 0.5 mg/m^3, the Permissible Exposure Limit (PEL) is 1.5 mg/m^3. The lowest exposure limit for the 14 analytes is 0.15 mg/m^3, representing DNT. Based on the sampling results, there was no indication that the thermophilic heat of reaction associated with the compost piles (45 to 65°C with an average of 55°C) caused any of the explosive contaminants, including the major transformation products of TNT, to vaporize and pose an additional occupational health hazard inside of the compost building. The sampling results for TNT and RDX were low, and similar to those obtained during the Umatilla project.

Split-shift personal and area air samples for metals were obtained at the excavation site and inside of the composting building. The air samples were collected on an 0.8-micrometer (µm) cellulose ester membrane (MCE) filter, with support pad, with a 3-piece 37-mm clear styrene acrylonitrile (SAN) cassette based on OSHA Method ID-125 and analyzed using Graphite Furnace based on National Institute of Occupational Safety and Health (NIOSH) Method 7300. Each sampling cassette was analyzed for 21 elements. Two personal and two area samples were obtained. All metal sample concentrations were reported as below the detection limit, with the exception of one area sample from the excavation site that had a reported an aluminum concentration of 0.019 mg/m^3. The OSHA PEL for aluminum metal as a dust is 15 mg/m^3, and the detection limit for aluminum was 0.014 mg/m^3. Therefore, all concentrations were significantly below any required or recommended occupational exposure limit.

Area samples for organics were obtained inside of the compost building. The air samples were collected on solid sorbent tubes, coconut shell charcoal, 100 mg/50 mg and analyzed based on the following NIOSH Methods:

(1) NIOSH 1500 for hydrocarbons

(2) NIOSH 1501 for aromatic hydrocarbons

(3) NIOSH 1003 for halogenated hydrocarbons

The number of samples totaled six, two for each NIOSH Method. On the same day, six control samples were obtained outside of the building adjacent to the exclusion zone perimeter on north side. All NIOSH 1500 analysis results were below the detection limit for all analytes in all samples, including the field sample blanks and, therefore, were significantly below any recommended or required occupational exposure limits. This was the same result reported for the NIOSH 1501 and 1003 analyses.

During soil excavation and screening, personnel wore Modified Level D personal protective equipment (PPE), with the addition of a 3M 8710 dust/mist maintenance-free disposable respirator (disposable dust mask). The 3M respirator is NIOSH approved (TC-21C-132) for dusts and mists (including coal, flour, and free silica) having a TWA of not less than 0.05 mg/m^3. Clothing and protective gear included dedicated coveralls, 16-inch polyvinyl chloride boots, standard Tyvek®, safety glasses, and double nitrile gloves.

There was no visible dust generated during excavation and screening. The fact that the ground was moist from the previous day's rain may have contributed to the absence of visible dust. A direct-reading dust/aerosol monitor was used to monitor total dust at three locations around the screener. The results

were 0.3 mg/m^3 at the discharge, 0.28 mg/m^3 at the reject conveyer, and 0.28 mg/m^3 at the operators station.

During composting operations, personnel wore the same level of PPE used during excavation and screening. Employees were provided with work coveralls that were changed daily. Employees were also required to shower at the end of each shift using the shower facilities at the personnel decontamination facility at the work site. The PPE selection and hygiene procedures were consistent with those recommended in the literature for operational compost facilities.

Full-face air purifying respirators (APRs) with high-efficiency particulate air (HEPA) and ammonia cartridges were necessary for the first 3 to 5 days when working around compost piles that contained chicken and turkey manure at greater than 15 percent by volume, because of the ammonia off-gassing (described below). During composting operations, when the windrows were turned, the inside total dust levels averaged below 1.0 mg/m^3 using a direct-reading instrument. The maximum total dust reading was 1.2 mg/m^3. This can be attributed to the 40 to 60 percent moisture content of the compost piles. These results are similar to those obtained at the Umatilla project. At the Bangor Submarine Base, noticeable ammonia odors were experienced, but the concentrations measured were below occupational exposure limits. Dust concentrations were measured and were well below any occupational exposure limits.

On September 8, 1997, amendments were mixed inside of the compost building prior to the addition of contaminated soil. Concentrations of approximately 10 mg/m^3 were measured during two 2-minute time intervals using a direct-reading instrument. The OSHA PEL for particulates not otherwise regulated (PNOR) is 15 mg/m^3 for total dust. The ACGIH TLV-TWA for particulates not otherwise classified (PNOC) is 10 mg/m^3 for the inhalable fraction. Based on the results of the instantaneous measurements of dust concentrations and task durations, if time-integrated total dust samples were taken for full-shift or split-shift, the most likely result would be concentrations below the PEL and TLV-TWA.

During amendment handling and mixing of compost piles, it was observed that excessive ammonia (NH_3) was being generated by the chicken and turkey manure. Measurements of ammonia concentrations using colorimetric indicator tubes indicated localized ammonia concentrations as high as 150 ppm. The PEL is 50 ppm, and the ACGIH TLV-TWA is 25 ppm. Respiratory protection was upgraded to half-mask APR with NH_3/HEPA cartridges. However, the ammonia gas was causing excessive tearing of the eyes. The respirator protection was subsequently upgraded to full-face APR with NH_3/HEPA cartridges. After 3 to 5 days, ammonia levels dropped below the PEL, then slowly dropped to 1 to 10 ppm and were nondetect by the end of the compost cycle (30 days). This pattern was similar in both the clean soil and contaminated soil testing.

Acetic acid was detected in the potato waste amendment pile using colorimetric indicator tubes. The concentration measured approximately 5 ppm during digging of the pile and once after turning the pile. The OSHA PEL is 50 ppm, and the ACGIH TLV-TWA is 10 ppm.

During the clean soil testing, colorimetric indicator tubes were used to spot check for other constituents. Carbon dioxide concentrations were equivalent to normal atmospheric levels. No detectable levels of formaldehyde, benzene, acetone, petroleum distillates, toluene, dichloromethane, nitrogen dioxide, nitrous fumes, hydrogen sulfide, carbon monoxide, or vinyl chloride were measured.

On July 9, 1997, during clean soil testing, the Industrial Scientific multi-gas instrument was used to measure concentrations of combustible vapor, oxygen, hydrogen sulfide, and carbon monoxide around each compost pile in Building 3. Oxygen measured 20.8 percent by volume. The instrument read nondetect for percent LEL, carbon monoxide, and hydrogen sulfide. At the same time and location, a PID was used to measure total volatile organic hydrocarbon. The concentrations ranged from 10 ppm to 14 ppm.

In comparing to the Umatilla project, no hydrogen sulfide was detected, the same as NSWC Crane. Umatilla experienced two excursions above the TLV for carbon monoxide, but this was the result of the use of gasoline-powered equipment inside of the structure. At Umatilla, the buildings were enclosed and equipped with mechanical ventilation providing approximately six air changes per hour. At NSWC Crane, the buildings are open at the ends and have no ventilation systems. Umatilla experienced no combustible gas alarms and no nitrogen dioxide alarms. The average reading for ammonia at Umatilla was 5 to 10 ppm and usually listed at 8 ppm. At NSWC Crane, the ammonia levels experienced were much higher during the first few days of composting, as described above.

Initial physiological monitoring for heat stress at the end of June and early July 1997 indicated a week to 10 days was necessary for worker acclimatization using PPE. Certain personnel responded differently to the same heat loading. Prior to PPE downgrades, significant heat stress was indicated by worker pulse rates and ear canal temperatures along with heat disorder physiological symptoms. After PPE downgrades and acclimatization, minimal heat stress was indicated. In addition to PPE downgrades, the use of ice vests became mandatory when ambient temperature was above 90° F or when an excessive work load was anticipated.

Basic sound-level monitoring was performed during all work activities. In general, all equipment during operation required personnel in the vicinity to use hearing protection devices, based on sound levels exceeding 85 dBA within 15 foot radius of equipment. Operators of "cab enclosed" equipment did not require hearing protection. All measured sound levels were below 85 dBA at distances greater than 15 feet, with the exception of near the windrow turning machine (Scarab). Noise dosimetry for the Scarab operator indicated a measured TWA of 73.2 dBA and 64.5 dBA. For the environmental technician, the TWA was 72.7 dBA.

On October 14, 1997, nine wipe samples were obtained for explosive residue analysis. All sample results for all analytes were reported as less than 1.0 microgram (µg) per wipe, which indicated that surfaces were clean. The surfaces sampled included the shower trailer (three locations), lunchroom, laboratory (four locations), and health and safety office.

10.0
CONCLUSIONS AND RECOMMENDATIONS

Mix 7B provides the best environment for the remediation of explosives-contaminated soil of all mixes that were pilot tested. Mix 7A, which differs from 7B only in that it contains 3.5 percent chicken manure and 71.5 percent straw, instead of 15 percent chicken manure and 60 percent straw, met all preliminary remedial goals and performed nearly as well as 7B. The amendment cost for 7A is $1.77 per cubic yard (or 20 percent) less than 7B. Operations costs are expected to be equal for the two mixes.

All pilot tests were performed with 25 percent contaminated soil and 75 percent amendments. The observations presented here indicate that bioremediation by composting is a robust process, and is relatively insensitive to small changes in amendment recipes. The comparison between Mixes 7A and 7B illustrates this. There were no observations or indications that the process is not capable of handling greater soil loads. This could potentially greatly reduce the time and costs for full-scale remediation. Consider, for example, a total of 110,000 cubic yards of contaminated soil, treated by three windrows of 500 cubic yards each and operating simultaneously in 30-day cycles. At 25 percent soil loading, this will require 10.25 years. At 30 percent soil loading, 8.5 years are required, which is a savings of 1.75 years, or 17 percent. Operational costs are expected to be on the order of 10 times the amendment costs. Therefore, savings in operational costs have greater potential for overall cost benefits than modifications to the mix.

Mix 7B is recommended for full-scale treatment. Increasing soil loading to 30 percent with the second full-scale treatment cycle is also recommended, subject to evaluation and approval of the 20-day data from the first cycle. Further increases in soil loading should be considered following evaluating 3 to 6 months of treatment at 30 percent soil loading. Although there are also potential cost savings from using Mix 7A, greater savings are possible by increasing soil loading. Mix 7B is recommended because its better performance suggests that it is more capable of handling increased soil loading.

11.0
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APPENDIX A
FIELD CLARIFICATION REQUESTS (FCRs)

APPENDIX A
TABLE OF CONTENTS

DESCRIPTION	NO. PAGES
FIELD CLARIFICATION REQUESTS (FCRs)	20 pages

ORIGINAL

NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324-	**FCR No.:** 4324-0009-FCR-PS001
Pilot Scale Operational Plan		Page 1 of 1

Reference Documents: Pilot Scale Operational Plan, Rev. 5 dated June 6, 1997

Problem / Change Description:

Approval is requested for the following changes:

1). Operational Plan Text
   a. Replace Table of Contents for correction of page numbers. approved EPA added mod date
   b. Section 10.0; Replace Table 10-1 which adds a wheeled tractor for transporting samples and sampling/monitoring equipment within the Biofacility. Modified denial of permanent use of equipment temp basis only on loan from Navy Transportation
2.)Appendix C;
   a. Replace Cover page and Table of Contents to include the list of NSWC Crane MFA utility and foundation drawings. recommend have PES cust. instr.
   b. Insert the following drawings which incorporates the revised trailer and amendment locations: G100, 4324-0009-01-A, B, and C, P-100, P-101, P-102, and P-103.
3). Appendix D;
   a. Add Table of Contents for SOPs
   b. Replace Figures 4-1 and 4-2 in SOP 4.0 which has been updated for current densities of straw, alfalfa, and turkey manure.
   c. Replace page 1 of 1 in SOP 12.0 which revises section 2.1 to exclude bacteria enumeration of PAHs, VOAs, specific hydrocarbons and oil degraders. approved w/mod. language
4). Appendix F; Replace cover page and Table of Contents which corrects page numbers.
5). Appendix G; Replace "Windrow Process Data- Daily Log" with attached for ease of field technician usage. (rejected)
6). Appendix H; Replace Cover page and Table of Contents which corrects page numbers.

Initiated by	Signature:	Organization: Morrison Knudsen	Date: 06/26/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature:	Date: 6/27/97	Approval by ROICC/NTR or RPM	Signature:	Date 7/7/97
Approval by MK PjM	Signature:	Date: 6/27/97	Additional Reviews: By/Date Christine D. Freeman 7/9/97 Approved 1a, 2a, b, 3a, b, c w/mod, 4, & 6. Denial of permanent use of 1b. Suggested change given approved rejected daily process log 7/24/97 #5		
Approval by MK QC	Signature:	Date: 6/27/97			
Approval by MK REG SPT.	Signature:	Date: 6/27/97			

Regulator Approval/Notification Recommended:
Yes ☒ No ☐

8/14/97

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NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324- NA	**FCR No.:** 4324-0009-FCR-PS002
Pilot Scale Operational Plan. Site Safety and Health Plan		Page 1 of 1

Reference Documents: Pilot Scale Operational Plan Appendix A; Site Safety and Health Plan, Rev. 5 dated June 6, 1997

Problem / Change Description:

Based on initial clean soil testing operations and results from the industrial hygeine and safety monitoring, the following changes are requested to the Pilot Scale Site Safety and Health Plan:

Attached marked pages A-5, A-6, A-9, A-11, A-12, A-13, A-18, A-19, A-20, A-22, A-27, A-28, A-29, A-36, A-37, A-38, A-39, A-40, A-41, A-42, A-43, A-44, A-45, A-46, A-51, A-52, A-54, A-67, A-70, A-71, A-77, A-82, Attachment A pages 2 of 9, 3 of 9, 4 of 9, 5 of 9, and 7 of 9. All lines affected are marked with an X in the margin.

Initiated by	Signature: Don Mitchell	Organization: Morrison Knudsen	Date: 06/26/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature: Don Mitchell	Date: 7/9/97	**Approval by ROICC/NTR or RPM**	Signature: Burl Thompson	Date: 7/10/97
Approval by MK PjM	Signature: D Beall	Date: 7/10/97	Additional Reviews: By/Date RICHARD SPURGEON SSHO 7/9/97 R. L. Spurgeon Christine D. Freeman 7/10/97		
Approval by MK QC	Signature: Steven Cory	Date: 7/10/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 7/10/97			

Regulator Approval/Notification Recommended:

Yes ☒ No ☐ approved w/ mods as described on pages A-37, A-47, A-54 Carol Mitchell 8/14/97

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ORIGINAL

NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324- NA	**FCR No.:** 4324-0009-FCR-PS003
Pilot Scale Operational Plan		Page 1 of 1

Reference Documents: Pilot Scale Operational Plan, Rev. 5 dated June 6, 1997

Problem / Change Description:

Based on initial results of clean soil testing and operational experience the following changes to the Pilot Scale Operational Plan are requested:

Attached marked pages:

1). Pilot Scale Operational Plan test; 1-7, 5-3, 6-1, 6-2, 6-7, 6-8, 6-11, 6-12, 6-13, 6-14, 6-15, 6-18 (Figure 6-4), 7-2, 7-3, 7-4, 8-1, 8-2, 8-5, 8-7, 8-9, 9-1, 9-2, 11-1, 14-1, 14-2, 15-1, 15-2, and 15-3. approved w/ mods. cws

2). Appendix D
SOP 1.0; 6, 7, 8, 9, 10, 11, 12, 13, and 14 of 14. approved w/ mods cws
SOP 2.0; 4, 5, and 8 of 8. approved w/ mods cws
SOP 4.0; 2, 3, and 4 of 4. approved cws
SOP 8.0; 1, 3, and 4 of 4. approved w/ mods cws

3). Appendix G; Added "Laboratory Moisture Data Form" sheets 1 & 2. approved cws

Initiated by	Signature: Don Mitchell	Organization: Morrison Knudsen	Date: 07/18/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature: Don Mitchell	Date: 7/18/97	Approval by ROICC/NTR or RPM	Signature: [illegible]	Date 7/22/97
Approval by MK PjM	Signature: D Beall	Date: 7/22/97	Additional Reviews: By/Date Christine D. Freeman NSWC Crane EPD 8/20/97		
Approval by MK QC	Signature: Steven Cory	Date: 7/20/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 7/20/97			

Regulator Approval/Notification Recommended: Yes ☒ No ☐ Approved w/ mods CWS 8/14/97

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ORIGINAL

NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324- NA	**FCR No.:** 4324-0009-FCR-PS004
Pilot Scale Operational Plan, Site Safety and Health Plan		Page 1 of 1

Reference Documents: Pilot Scale Operational Plan Appendix A; Site Safety and Health Plan, Rev. 5 dated June 6, 1997 and the Pilot Scale Operational Plan Appendix D, SOPs

Problem / Change Description:

Based on initial clean soil testing operations and results from the industrial hygeine and safety monitoring, the following changes are requested to the Pilot Scale Site Safety and Health Plan and Field SOPs:

Attached marked pages: A-11, A-12, A-27, A-29, A-30, A-31, A-32, A-72, A-77, pages 2 and 3 of 4 in Attachment A, and pages 4, 5, and 8 of 9 in Attachment A. SOP 4.0 page 2 of 6, SOP 8.0 page 2 of 4, and SOP 10.0 pages 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14 of 19.
All lines affected are marked with an X in the margin.

Initiated by	Signature:	Organization: Morrison Knudsen	Date: 07/28/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature:	Date: 7/28/97	**Approval by ROICC/NTR or RPM**	Signature:	Date 8/22/97
Approval by MK PjM	Signature: D Beail	Date: 7/29/97	Additional Reviews: By/Date R. J. [illegible] SSHO 7/29/97		
Approval by MK QC	Signature: Steven Coy	Date: 7/28/97	Christine D. Freeman NSWC Crane EPD 8/25/97		
Approval by MK REG SPT.	Signature: Steven Coy	Date: 7/28/97			

Regulator Approval/Notification Recommended:

Yes ☐ No ☐ Approval [illegible] 8/14/97

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ORIGINAL

NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324-	**FCR No.:** 4324-0009-FCR-PS005
Pilot Scale Operational Plan		Page 1 of 1

Reference Documents: Pilot Scale Operational Plan, Rev. 5 dated June 6, 1997

Problem / Change Description:

Approval is requested for the following changes:

1). SOP 6.0, Transport And Loading Soil Into Windrows
Marked pages 2 and 3 of 6. Changes include the option of stockpiling contaminated soil in a building at the Bioremediation Facility.

2). SOP 2.0, Sample Collection For Off-site Laboratory Analysis
Marked pages 1, 3, 4, 5, 6, 7, and 8 of 8. Changes include the addition of the Wiley Mill and sample splitter.

3). SOP 4.0, Amendment Proportioning And Mixing;; add the following statement to Section 5.0;
"The Amendment mixtures will normally be generated within the same work day that the soil addition is performed, however, the amendment mixtures may be generated no more than two days in advance of the soil addition." akcu 15 8/7/97

Initiated by	Signature:	Organization: Morrison Knudsen	Date: 07/28/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature:	Date: 7/28/97	**Approval by ROICC/NTR or RPM**	Signature:	Date 8/22/97
Approval by MK PjM	Signature: D Ball	Date: 7/29/97	Additional Reviews: By/Date Christine D. Freeman NSWC Crane, EPD 8/25/97 Some items previously modified for SOP 2 that FCR stands.		
Approval by MK QC	Signature: Steven Cory	Date: 7/28/97			
Approval by MK REG SPT.	Signature: Steven Cory 7/2	Date: 7/28/97			

Regulator Approval/Notification Recommended:
Yes ☐ No ☐ Approved 8/12/97

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ORIGINAL

NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324-	**FCR No.:** 4324-0009-FCR-PS006
Pilot Scale Operational Plan		Page 1 of 1

Reference Documents: Pilot Scale Operational Plan, Rev. 5 dated June 6, 1997, Appendix F and Pilot Scale QAPP, Rev 5, dated June 6, 1997

Problem / Change Description:

Approval is requested for the following changes:

1.) Appendix F, Supplement to QAPP
Marked pages F-6, F-7, F-9, F-11, and F-13

2). Pilot Scale QAPP
Marked pages Section 1, page 15 of 34; Section 4, pages 1, 5, 6, 8, 11, 23, 24, 27, and 32 of 34; Section 6, page 1 of 4; Section 7, page 1 of 4, Section 13, Page 1 of 3; and Appendix A, pages 2 and 3 of Table A-1.

Initiated by	Signature: Don Mitchell	Organization: Morrison Knudsen	Date: 07/30/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature: Don Mitchell	Date: 7/30/97	**Approval by ROICC/NTR or RPM**	Signature: [illegible]	Date 8/22/97
Approval by MK PjM	Signature: D Ball	Date: 7/30/97	Additional Reviews: By/Date Christine D. Freeman 8/25/97 NSWC Crane Env. Prot. Dept.		
Approval by MK QC	Signature: Steven Coy	Date: 7/30/97			
Approval by MK REG SPT.	Signature: Steven Coy	Date: 7/30/97			

Regulator Approval/Notification Recommended:
Yes ☐ No ☐ Approved w/ mod [illegible] 8/19/97

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ORIGINAL

NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324- NA	**FCR No.:** 4324-0009-FCR-PS007
Pilot Scale Operational Plan, Site Safety and Health Plan		Page 1 of 1

Reference Documents: Pilot Scale Operational Plan Appendix A; Site Safety and Health Plan, Rev. 5 dated June 6, 1997

Problem / Change Description:

Approval is requested for the following changes:

1). Delete "Draft Hazard Analysis Report for Soils Bioremediation Process Equipment" dated May 16, 1997 and replace with Final report dated July 7, 1997.

2). Add letter # 4324-563 from Dave Beall of MK to Ms. Chris Freeman of NSWC EPD dated July 17, 1997; Explosives Hazard Analysis Report : Recommendations.

3). Add "Hazard Review Of Wiley Mill" dated May 1990, by T. A. Groce of Hercules Incorporated.

Initiated by	Signature:	Organization: Morrison Knudsen	Date: 07/30/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature:	Date: 7/30/97	**Approval by ROICC/NTR or RPM**	Signature:	Date 8/22/97
Approval by MK PjM	Signature: D Beall	Date: 7/30/97	Additional Reviews: By/Date Christine D. Freeman NSWC Crane, EPD 8/25/97		
Approval by MK QC	Signature: Steven Cory	Date: 7/30/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 7/30/97			

Regulator Approval/Notification Recommended:

Yes ☐ No ☐ Approved Carol [illegible] 8/17/97

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ORIGINAL

NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324- NA	**FCR No.:** 4324-0009-FCR-PS008
Pilot Scale Operational Plan, Site Safety and Health Plan		Page 1 of 1

Reference Documents: Pilot Scale Operational Plan Rev. 5 dated June 6, 1997, Appendix D; SOPs

Problem / Change Description:

Based on initial clean soil testing operations. the following changes are requested to the Field SOPs:

SOP 3.0 pages 4, 5, and 6 of 6
SOP 5.0 pages 1, 2, and 4 of 4
SOP 7.0 pages 2, 4, and 5,of 5.

All lines affected are marked with an X in the margin.

Initiated by	Signature:	Organization: Morrison Knudsen	Date: 07/31/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature:	Date: 7/31/97	**Approval by ROICC/NTR or RPM**	Signature:	Date 8/21/97
Approval by MK PjM	Signature:	Date: 7/31/97	Additional Reviews: By/Date Christine D. Freeman 8/21/97 NSWC Crane EPD		
Approval by MK QC	Signature: Steven Cory	Date: 7/31/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 7/31/97			

Regulator Approval/Notification Recommended:

Yes ☐ No ☐ Approved except for discharge Carol Wittenbach 8/17/97

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ORIGINAL

NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324- NA	**FCR No.:** 4324-0009-FCR-PS009
Pilot Scale Operational Plan, Site Safety and Health Plan		Page 1 of 1

Reference Documents: Pilot Scale Operational Plan Rev. 5 dated June 6, 1997 and Pilot Scale QAPP Rev. 4 dated June 6, 1997.

Problem / Change Description:

Based on initial clean soil testing operations, the following changes are requested:

1). Pilot Scale QAPP: Reduce the quantity of sample jars required for laboratory analysis by combining certain samples. Modify Section 4, page 7 of 34 per attached marked up page.

2). Pilot Scale Operational Plan Appendix F; Revise per atteched marked up pages F-8 & F-9. Revisions clarify duplicate frequency descrepancy (5% vs 1 per 24)

All lines affected are marked with an X in the margin.

Initiated by	Signature: Don Miller	Organization: Morrison Knudsen	Date: 08/11/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature: Don Miller	Date: 8/11/97	**Approval by ROICC/NTR or RPM**	Signature: Bob Rubert	Date 8/21/97
Approval by MK PjM	Signature: D Ball	Date: 8/12/97	Additional Reviews: By/Date Christine D Freeman NSWC Crane EPD 8/21/97		
Approval by MK QC	Signature: Steven Cory	Date: 8/13/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 8/13/97			

Regulator Approval/Notification Recommended:

☑ No ☐ Approval w/ mod denial of decon issue Carol Witt Smith 8/19/97

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ORIGINAL

NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324- NA	**FCR No.:** 4324-0009-FCR-PS010
Pilot Scale Operational Plan, Site Safety and Health Plan		Page 1 of 1

Reference Documents: Pilot Scale Operational Plan Rev. 5 dated June 6, 1997, Appendix E.

Problem / Change Description:

Based on initial clean soil testing operations, the following changes are requested:

1). Pilot Scale Operational Plan Appendix E, Soil Excavation Plan; Modify Figure E-1 per attached.

Reduce the size of exclusion zone due to less quantity of soil required than originally anticipated. Relocate soil screener, contamiantion reduction zone, and truck loading area for improved operations.

Initiated by	Signature:	Organization: Morrison Knudsen	Date: 08/11/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature:	Date: 8/11/97	**Approval by ROICC/NTR or RPM**	Signature:	Date 8/21/97
Approval by MK PjM	Signature: D Beall	Date: 8/13/97	Additional Reviews: By/Date Christine D. Freeman NSWC Crane EPD 8/21/97		
Approval by MK QC	Signature: Steven Coy	Date: 8/13/97			
Approval by MK REG SPT.	Signature: Steven Coy	Date: 8/13/97			

Regulator Approval/Notification Recommended:

Yes ☑ No ☐ Approved Paul 8/19/97

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NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324- NA	**FCR No.:** 4324-0009-FCR-PS011
Pilot Scale Operational Plan, Site Safety and Health Plan		Page 1 of 1

Reference Documents: Pilot Scale Operational Plan Rev. 5 dated June 6, 1997, Appendix G.

Problem / Change Description:

Based on initial clean soil testing operations, the following changes are requested:

1). Pilot Scale Operational Plan Appendix G,Operational Forms, QC Checklists, and Logs; Revise QC Checklists SP-01, EX-02, BF-01, RB-01, WM-01, and DE-01 per attached marked pages.

These chances are being requested for deletion of items not applicable to pilot scale operations, editorial changes, and deletion of duplicate items.

Initiated by	Signature:	Organization: Morrison Knudsen	Date: 08/13/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature:	Date: 8/15/97	**Approval by ROICC/NTR or RPM**	Signature:	Date 9/5/97
Approval by MK PJM	Signature: D Ball	Date: 8/14/97	Additional Reviews: By/Date Christine D. Freeman 8/25/97 NSWC Crane EPD		
Approval by MK QC	Signature: Steven Cory	Date: 8/14/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 8/14/97			

Regulator Approval/Notification Recommended:

Yes ☒ No ☐

typos approved most issues clarified 8/19/97

need to make file changes yet.

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ORIGINAL

NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324- NA	**FCR No.:** 4324-0009-FCR-PS012
Pilot Scale Operational Plan, Site Safety and Health Plan		Page 1 of 1

Reference Documents: Pilot Scale Operational Plan Appendix A; Site Safety and Health Plan, Rev. 5 dated June 6, 1997

Problem / Change Description:

Based on initial clean soil testing operations and results from the industrial hygeine and safety monitoring, the following changes are requested to the Pilot Scale Site Safety and Health Plan :

Attached marked pages: A-47, A-48, A-49, A-50, A-57, A-58, and A-67. These reflect changes in the Emergency Response telephone extension number.
All lines affected are marked with an X in the margin.

Initiated by	Signature: Don Miller	Organization: Morrison Knudsen	Date: 08/20/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature: Don Miller	Date: 8/20/97	**Approval by ROICC/NTR or RPM**	Signature: [illegible]	Date 9/5/97
Approval by MK PjM	Signature: For D.R. Bell [illegible]	Date: 8/22/97	Additional Reviews: By/Date Christine D. Freeman NSWC Crane, EPD 8/25/97 need to make file changes		
Approval by MK QC	Signature: Steven Cory	Date: 8/22/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 8/22/97			

Regulator Approval/Notification Recommended:

Yes ☐ No ☒

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NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324-049	**FCR No.:** 4324-0009-FCR-PS013
Pilot Scale Operational Plan		Page 1 of 1

Reference Documents: ***Pilot Operational Plan, Rev. 5 dated June 6, 1997***

Problem / Change Description:

Revise section 7.3.2 of OPS Plan to add an option for disposal of Mine Fill "A" water. Add the following information:

> .....in poly tanks and sampled for disposal. The decon waste water at Mine Fill "A", Bldg #153 area may be disposed of by draining through the existing potentially contaminated water run off sump, which is located closest to the building. No sampling will be required when this method is implemented. The method of disposal.....

NOTE: This sump drains to an existing holding tank via underground pipe. The building supervisor approved e use of the sump, since it has been designed to handle potentially contaminated water for the facility. The holding tank water is periodically transferred to a transport truck and processed through Mine Fill "A" treatment facility.

Initiated by	Signature:	Organization: Morrison Knudsen	Date: 08/22/97

Resolution: Proceed as recommended

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature: For Don Miller	Date: 8/22/97	~~**Approval**~~ **by ROICC/NTR or RPM**	Signature: See Below	Date 9/5/97
Approval by MK PjM	Signature: For D.R. Beall	Date: 8/22/97	Additional Reviews: By/Date Christine D. Freeman 8/25/97 NSWC Crane EPD Denied		
Approval by MK QC	Signature: Steven Cory	Date: 8/22/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 8/22/97			

Regulator Approval/Notification Recommended:

Yes ☐ No ☐

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NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	**Subcontract No.:** 4324- NA	**FCR No.:** 4324-0009-FCR-PS014
Pilot Scale Operational Plan, Site Safety and Health Plan		Page 1 of 4

Reference Documents: Pilot Scale Operational Plan Appendix D, Rev. 6 dated August 14, 1997

Problem / Change Description:

Based on initial clean soil testing operations and results from the industrial hygiene and safety monitoring, the following changes are requested to the Pilot Scale Operational Plan , Appendix D SOP 10.0:

Attached marked up pages of SOP 10.0, Time Integrated Industrial Hygiene Air Sampling. All lines affected are marked with an X in the margin.

Also insert the following paragraph as Section 3.0.

3.0 PREREQUISITES

Prior to calibration of sampling pumps, the temperature, barometric pressure, and relative humidity data will be obtained from the Bloomington Airport Tower and recorded on Attachment 1. The phone number for the Tower is 812-825-7421. The following conversion formulae are applicable:

Degree Celsius (°C) = 5/9(°F - 32)
Degrees Kelvin (°K) = °C + 273
millimeters mercury (mmHg) = inches Hg x 25.40

See sheets 2, 3, and 4.

Initiated by	Signature:	Organization: Morrison Knudsen	Date: 10/13/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature:	Date: 10/14/97	**Approval by ROICC/NTR or RPM**	Signature:	Date: 4/9/98
Approval by MK PjM	Signature:	Date: 10/14/97	Additional Reviews: By/Date Christine D. Freeman 10/29/97 (see comments)		
Approval by MK QC	Signature:	Date: 10/14/97			
Approval by MK REG SPT.	Signature:	Date: 10/14/97			

If section 3 does not exist all #'s should be modified.
What is Section 3.0 in SOP 10.0 now?

Regulator Approval/Notification Recommended:

Yes ☑ No ☐

Approved w/ mod 12/1/97

Why aren't instruments calculated to crane conditions recorded at Demo or ABG, which are more local? If available use facility data first then Bloomington.

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TOTAL P.02

NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC	COPY

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	Subcontract No.: 4324- NA	FCR No.: 4324-0009-FCR-PS015 Rev. 1
Pilot Scale QAPP		Page 1 of 1

Reference Documents: Pilot Scale Biofacility Operations QAPP, Rev. 5 dated August 14, 1997, Appendix F SOP 8330

Problem / Change Description:

Based Subcontract Laboratory SOP updates, the following changes are requested:

Attached letter dated July 11, 1997 From Southwest Laboratory and the following SOP's:

SWL-OL-200	Nitroaromatics and Nitramines
SWL-IN-415	BOD in Water
SWL-IN-403	COD
SWL-IN-503	TKN
SWL-IN-205	ICP Digestive
SWL-IN-209	Metals Analysis
SWL-IN-207	Mercury Digestive and Analysis
S[illegible]N-311	TOC in Soil/Sediment
S[illegible]N-310	TOC in Water

Initiated by	Signature:	Organization: Morrison Knudsen	Date: 09/19/97

Resolution:

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature:	Date: 9/23/97	Approval by ROICC/NTR or RPM	Signature:	Date
Approval by MK PJM	Signature: for DR BEALL	Date: 9/23/97	Additional Reviews: By/Date		
Approval by MK QC	Signature: Steven Cory	Date: 9/23/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 9/23/97			

Regulator Approval/Notification Recommended:
Yes ☐ No ☐

ORIGINAL

NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	Subcontract No.: 4324-049	FCR No.: 4324-0009-FCR-PS016
Pilot Scale Operational Plan		Page 1 of 1

Reference Documents: Pilot Operational Plan, Rev. 6 dated August 14, 1997; Appendix D, SOP 3.0 and Appendix F, QAPP Supplement

Problem / Change Description:

1. Add the following paragraph to Section 3.3 of OPS Plan Appendix D, SOP 3.0 to clarify frequency of sample equipment decontamination:

   Non-disposable equipment used for obtaining samples for off-site laboratory analysis, such as explosives and metals, shall be decontaminated per the following procedure between each windrow grid sampling. Non-disposable equipment used for obtaining samples for on-site laboratory analysis, such as pH and moisture, shall be decontaminated per the following procedure after each windrow, and as necessary when clogging occurs. Hand augers will be decontaminated between each windrow grid.

2. Pilot Scale Ops Plan, Appendix F, QAPP Supplement
   a. Delete last sentence of Section 2.0, paragraph 2.1, and
   b. Add the following as a second paragraph to Section 3.0, paragraph 3.2.1:

   A second duplicate reading for temperature shall be taken if the initial reading and the first duplicate reading differ by more than 5°C. A second duplicate reading for oxygen shall be taken if the initial reading or first duplicate reading is less than 10% and the readings differ by 4 or more percent oxygen. The second duplicate readings shall be recorded in the comments section of the Windrow Process Data - Daily Log.

Initiated by	Signature:	Organization: Morrison Knudsen Corporation	Date: 09/23/97

Resolution: Proceed as recommended

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature:	Date: 9/24/97	Approval by ROICC/NTR or RPM	Signature:	Date 9/25/97
Approval by MK PjM	Signature: for DR REIU	Date: 9/24/97	Additional Reviews: By/Date Christine D. Greenman 9/25/97		
Approval by MK QC	Signature: Steven Cory	Date: 9/24/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 9/24/97	the changes in the FRC must go into the Pilot & Full scale Plans		

Regulator Approval/Notification Recommended:
Yes ☒ No ☐ Approved 12/1/97

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NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	Subcontract No.: N/A	FCR No.: 4324-0009-FCR-PS017
Pilot Scale Operational Plan		Page 1 of 1

Reference Documents: Pilot Operational Plan, Rev. 6 dated August 14, 1997; Appendix E

Problem / Change Description:

Add the attached Soil Excavation Plan dated September 25, 1997, to the Pilot Scale Operations. This change is required in order to initiate soil excavation, screening, and stockpiling soil in building 1 proir to Full Scale Operational Plan approval which will provide soil for operating full scale operations from February through April of 1998.

Initiated by	Signature:	Organization: Morrison Knudsen Corporation	Date: 09/25/97

Resolution: Proceed as recommended

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature:	Date: 9/25/97	Approval by ROICC/NTR or RPM	Signature:	Date 9/25/97
Approval by MK PjM	Signature:	Date: 9/25/97	Additional Reviews: By/Date Christine D. Freeman approved w/ comments		11/14/97
Approval by MK QC	Signature: Steven Cory	Date: 9/25/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 9/25/97			

Regulator Approval/Notification Recommended:
Yes ☒ No ☐ approved w/ modifications 11/14/97

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NAVFAC Southern Division/ Morrison Knudsen Corporation	District II RAC

FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	Subcontract No.: N/A	FCR No.: 4324-0009-FCR-PS018
Pilot Scale Operational Plan		Page 1 of 1

Reference Documents: Pilot Operational Plan, Rev. 6 dated August 14, 1997; Appendix D , SOP 2.0 and SOP 3.0

Problem / Change Description:

1. Add the following paragraphs to Section 5.2 of SOP 2.0, Sample Collection For Off-site Laboratory Analysis

   ROCK DECONTAMINATION RINSE WATER

   1. After performing the decontamination process as described in SOP 3.0, randomly select one rock per 0.5 cubic yards with a length and width no less than 4 inches and a thickness no less than 2 inches. Place the rock in a clean/decontaminated stainless steel bowl or poly container.
   2. Pour slightly more than 2 liters of distilled or microfiltered water over the rock as a final rinse. Hold the rock over the container and adjust its position to assure rinsing of all surfaces. Remove the rock and return it to the decontaminated rock storage pile.
   3. Collect the final rinse water in two one-liter amber glass jars for off-site laboratory analysis. Follow the sample labeling, tagging and identification, chain of custody, and shipping and handling procedures described in Section 4.0 of the approved Pilot Scale QAPP. Document all sampling activities in the field logbook.

2. Add the following paragraphs to the end of Section 3.2 of SOP 3.0, Decontamination of Facilities, Equipment, and Personnel

   Rock Decontamination

   1. Lay the affected rocks in a single layer in the lined and bermed decontamination area or rinse bin.
   2. Thoroughly rinse each rock using a high pressure low volume spray. Wash all visible signs of explosives residue from the rocks (a minimum of 5 minutes per cubic yard of rocks).
   3. Turn each rock over and repeat step 2.
   4. Return the rocks to a bin and rinse thoroughly again. rinse 3 times (draining water each time collect sample from last rinse) When drained, cover and store the decontaminated rocks in a lined and bermed area until final disposition has been obtained.
   5. Collect final rinse samples for off-site laboratory analysis per SOP 2.0.

3. Change SOP 3.0 Section 3.2 title to read: Equipment and Rock Decontamination At The Excavation Site

Initiated by	Signature: Don Miller	Organization: Morrison Knudsen Corporation	Date: 10/10/97

Resolution: Proceed as recommended

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature: Don Miller	Date: 10/10/97	Approval by ROICC/NTR or RPM	Signature:	Date
Approval by MK PjM	Signature: D Beall	Date: 10/14/97	Additional Reviews: By/Date Christine D. Freeman - Denied		
Approval by MK QC	Signature: Steven Cory	Date: 10/14/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 10/14/97			

Regulator Approval/Notification Recommended:
Yes ☐ No ☐

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FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	Subcontract No.: N/A	FCR No.: 4324-0009-FCR-PS019
Pilot Scale Operational Plan		Page 1 of 1

Reference Documents: Pilot Operational Plan, Rev. 6 dated August 14, 1997; Appendix D , SOP 2.0 and SOP 3.0

Problem / Change Description:

1. Add the following paragraphs to Section 5.2 of SOP 2.0, Sample Collection For Off-site Laboratory Analysis

ROCK RINSE WATER SAMPLING

Rock rinse water is required to be sampled and anlayzed to determine effectivness of washing and rinsing procedures prior to disposition of the rocks.

Sample Collection

1. After performing the decontamination process as described in SOP 3.0 of the Pilot Scale Operational Plan, Appendix D, elevate the bin containing the decontaminated rocks high enough to place a rinse sample collection container underneath.
2. Place the new or decontaminated rinse water collection container under the elevated rock bin and pour slightly more than 2 liters of distilled or microfiltered water over the rocks as a final rinse.
3. Transfer the final rinse water into two one-liter amber glass jars for off-site laboratory analysis. Follow the sample labeling, tagging and identification, chain of custody, and shipping and handling procedures described in Section 5.0 of the approved Pilot Scale QAPP. Document all sampling activities in the logbook.
4. Cover and store the decontaminated rocks in a lined and bermed area until final disposition has been obtained.

2. Add the following paragraphs to the end of Section 3.2 of SOP 3.0, Decontamination of Facilities, Equipment, and Personnel

Rock Decontamination

1. Lay the affected rocks in a single layer in the lined and bermed decontamination area.
2. Thoroughly rinse each rock using a high pressure low volume spray. Wash all visible signs of explosives residue from the rocks (a minimum of 5 minutes per cubic yard of rocks).
3. Turn each rock over and repeat step 2. Allow to drain.
4. Return the rocks to a clean storage bin, elevate the bin and rinse thoroughly again. Allow to drain.
5. Rinse the rocks a second cycle in the bin. Allow to drain.
6. Collect final rinse samples for off-site laboratory analysis per SOP 2.0 in the approved Pilot Scale Operational Plan. Appendix D.
7. When drained, cover and store the decontaminated rocks in a lined and bermed area until final disposition has been obtained.

3. Change SOP 3.0 Section 3.2 title to read: Equipment and Rock Decontamination At The Excavation Site

Initiated by	Signature: Don Mitchell	Organization: Morrison Knudsen Corporation	Date: 11/19/97

Resolution: Proceed as recommended

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature: Don Mitchell	Date: 10/19/97	Approval by ROICC/NTR or RPM	Signature:	Date
Approval by MK PjM	Signature: [illegible]	Date: 12/2/97	Additional Reviews: By/Date		
Approval by MK QC	Signature: Steven Cory	Date: 11/20/97			
Approval by MK REG SPT.	Signature: Steven Cory	Date: 11/20/97			

Regulator Approval/Notification Recommended:
Yes ☐ No ☐

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FIELD CLARIFICATION REQUEST (FCR)

Delivery Order No.: 4324-0009	Subcontract No.: N/A	FCR No.: 4324-0009-FCR-PS020
Pilot Scale Operational Plan		Page 1 of 3

Reference Documents: Pilot Operational Plan, for Soils Bioremediation Facility Section 9.3 and 9.4
QAPP for Pilot Scale Operations at the Biofacility Section 4.1 and Table 4.1

Problem / Change Description:

The documents referenced above require pre and post excavation soil sampling grids to be 20 foot by 20 foot dimensions. This small of grid is not feasible at all locations.

Initiated by	Signature: D Beall	Organization: Morrison Knudsen Corporation	Date: 12/22/97

Resolution:

Revise referenced documents to include larger dimensioned grids where feasible (i.e., 20' x 40', 40' x 100', 20' x 60') and as agreed to by NSWC EPD. Facility maps for Mine Fill "A", Buildings 152 and 157 have incorporated the grid dimensions agreed to by the NSWC EPD and are attached. These maps will be incorporated into the Full Scale Operational Plan, but will be used with this FCR in the interim, pending FS Ops Plan approval. Maps for future areas (i.e., Mine Fill "B", Rockeye, and ABG) will be incorporated as amendments to the FS Ops Plan at a later date.

If this FCR affects a subcontract, indicate CID number: N/A

Approval by MK PE	Signature: D Beall For	Date: 12/23/97	Approval by ROICC/NTR or RPM	Signature:	Date 1/21/98
Approval by MK PjM	Signature: D Beall	Date: 12/23/97	Additional Reviews: By/Date Christine D. Freeman 12/30/97		
Approval by MK QC	Signature: R. J. Springer	Date: 12/23/97			
Approval by MK REG SPT.	Signature: D Beall For	Date: 12/23/97			

Regulator Approval/Notification Recommended:
Yes ☒ No ☐ Approved 1/7/98

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APPENDIX B
CLEAN SOIL RECORD OF RECIPE

APPENDIX B
TABLE OF CONTENTS

DESCRIPTION	NO. PAGES
CLEAN SOIL RECORD OF RECIPE	7 pages

RECORD OF RECIPE

RECIPE # 2 (Bldg 3)

PERFORMED BY: R. Dayhoff

DATE: 6/27/97

INSPECTED BY: T. Dogal

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH ~~2~~ 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		Supplier
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	
Turkey Manure											
Chicken Manure	7	10150	7.9	11410	7.2	10470	6.55	9510	21.65	31390	Wabash Valley Produce/Dayhoff Farms
Cow Manure											
POTW Sludge											
Vegetable Waste											
Alfalfa											
Straw											
Wood Chips	8	4240	8.2	4340	7.9	4180	8.2	4340	24.3	12860	Kaho Brothers
Sawdust											
Soil	15	32600	-	-	-	-	-	-	15	32600	NSWC Crane
Total				15750		14650		13850	60.95	76850	

Comments:

RECORD OF RECIPE

RECIPE # 4 (Bldg 3) **PERFORMED BY:** R. Dayhoff

DATE: 6/27/97 **INSPECTED BY:** T. Dogal

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH ~~2~~ 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		Supplier
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	
Turkey Manure											
Chicken Manure	65	943	1.0	1450	.62	890	.93	1360	2.5	3700	Wabash Valley Produce/Dayhoff Farms
Cow Manure	4.5	6413	4.4	6240	4.6	6500	4.4	6400	13.4	19140	Lueken Dairy/ Dayhoff Farms
POTW Sludge											
Vegetable Waste	2.15	3225	2.5	3800	2.2	3370	2.1	3100	6.8	10270	Frito Potato Co./ Kambach Feeds
Alfalfa	3.85	520	4.45	600	3.4	460	3.7	500	11.55	1560	Dayhoff Farms
Straw											
Wood Chips											
Sawdust	3.85	1579	4.0	1660	3.9	1580	4.14	1700	12.04	4940	Kaho Brothers
Soil	15	32600	-	-	-	-	-	-	15	32600	NSWC Crane
Total				13750		12800		13060	61.29	72210	

Comments:

RECORD OF RECIPE

RECIPE # 7b (Bldg 3)

PERFORMED BY: R. Dayhoff

DATE: 6/28/97

INSPECTED BY: T. Dogal

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH ~~2~~ 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		Supplier
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	
Turkey Manure											
Chicken Manure	9	13050	3.2	4430	3.0	3360	3.0	3260	9.2	11050	Wabash Valley Produce/Dayhoff Farms
Cow Manure											
POTW Sludge											
Vegetable Waste											
Alfalfa											
Straw •	36	2916	[1] 5.8	1750	6.3	1340	6.4	1360	18.5[2]	4450	Dayhoff Farms
Wood Chips											
Sawdust											
Soil	15	32600	-	-	-	-	-	-	15	32600	NSWC Crane
Total			90	6180	9.3	4700	9.4	4620	42.7	48100	

Comments: [1] Before cm added 1.2 bales [2] Volume based on compressed state of straw bale. • 238 lbs/cy vs. 81 lbs/cy

RECORD OF RECIPE

RECIPE # 7c (Bldg 3)

PERFORMED BY: R. Dayhoff

DATE: 6/28/97

INSPECTED BY: T. Dogal

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH ~~2~~ 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		Supplier
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	
Turkey Manure											
Chicken Manure	6	8200	1.8	2300	2.2	3360	2.5	4370	6.5	10030	Wabash Valley Produce/Dayhoff Farms
Cow Manure											
POTW Sludge											
Vegetable Waste	6	9000	20	3430	2.5	4420	2.3	4460	6.8	12310	Frito Lay Potato/ Kambach Feeds
Alfalfa											
Straw	33	2673	4.8	1020	4.9	1120	4.9	1150	14.6[1]	3390	Dayhoff Farms
Wood Chips											
Sawdust											
Soil	15	32600	-	-	-	-	-	-	15	32600	NSWC Crane
Total			18.6	6750	9.6	8900	9.7	9980	42.9	58230	

Comments: [1] Volume based on compressed state of straw bale.

RECORD OF RECIPE

RECIPE # 3 (Bldg 2)

PERFORMED BY: R. Dayhoff

DATE: 6/28/97

INSPECTED BY: T. Dogal

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH ~~2~~ 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		Supplier
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	
Turkey Manure	15	11745	5.3	6080	5.6	8180	5.2	5750	16.1	20010	D. Benham Purdue Farms/ Dayhoff Farms
Chicken Manure											
Cow Manure											
POTW Sludge											
Vegetable Waste											
Alfalfa	15	2025	4.7	1070	4.7	1100	4.8	1200	14.2	3370	Dayhoff Farms
Straw											
Wood Chips	15	7950	5.0	2750	5.0	3020	5.0	3050	15	8820	Kaho Brothers
Sawdust											
Soil	15	32600	-	-	-	-	-	-	15	32600	NSWC Crane
Total			14	9900	15	12300		10000	60.3	64800	

Comments:

RECORD OF RECIPE

RECIPE # 5 (Bldg 2)

PERFORMED BY: C. Kixmiller

DATE: 6/29/97

INSPECTED BY: T. Dogal

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH ~~2~~ 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		Supplier
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	
Turkey Manure	15.45	12097	5.25	4600	5.5	6160	5.5	4800	16.25	15560	D. Benham Purdue Farms/ Dayhoff Farms
Chicken Manure											
Cow Manure											
POTW Sludge											
Vegetable Waste	6.45	9675	2.15	1390	2.75	2360	2	2220	6.90	5970	Frito Potato Co./ Kambach Feeds
Alfalfa	11.55	1559	4.0	650	3.85	540	4.0	660	11.85	1850	Dayhoff Farms
Straw											
Wood Chips											
Sawdust	11.55	4736	4.0	1630	3.75	1440	3.75	1430	11.5	4500	Kaho Brothers
Soil	15	32600	-	-	-	-	-	-	15	32600	NSWC Crane
Total			15.2	8270	15.85	10500	15.25	9110	61.5	60480	

Comments: Added amendments based on overall dimensions of windrow. Added 3 cyds Turkey manure; 3.5 cyd/700 lb alfalfa; 3 cyd sawdust 6/30/97

RECORD OF RECIPE

RECIPE # 6 (Bldg 2) **PERFORMED BY:** C. Kixmiller

DATE: 6/29/97 **INSPECTED BY:** T. Dogal

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH ~~2~~ 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		Supplier
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	
Turkey Manure	15	11745	5.50	7300	5.25	7120	5.0	5360	15.75	19780	D. Benham Purdue Farms/ Dayhoff Farms
Chicken Manure											
Cow Manure											
POTW Sludge											
Vegetable Waste	9	13500	3.75	4240	3.25	4060	4.25	5850	11.25	14750	Frito Potato Co./ Kambach Feeds
Alfalfa	9	1215	3.50	630	3.25	580	3	400	9.75	1610	Dayhoff Farms
Straw											
Wood Chips	6	3180	3	1200	2.75	500	2.25	1140	8.0	2840	
Sawdust	6	2460	2.50	870	3.50	1540	3.75	950	8.75	3360	Kaho Brothers
Soil	15	32600	-	-	-	-	-	-	15	32600	NSWC Crane
Total			18.25	14240	18	13800	17.25	13700	68.5	42340	

Comments:

APPENDIX C
CLEAN SOIL TEMPERATURE

APPENDIX C
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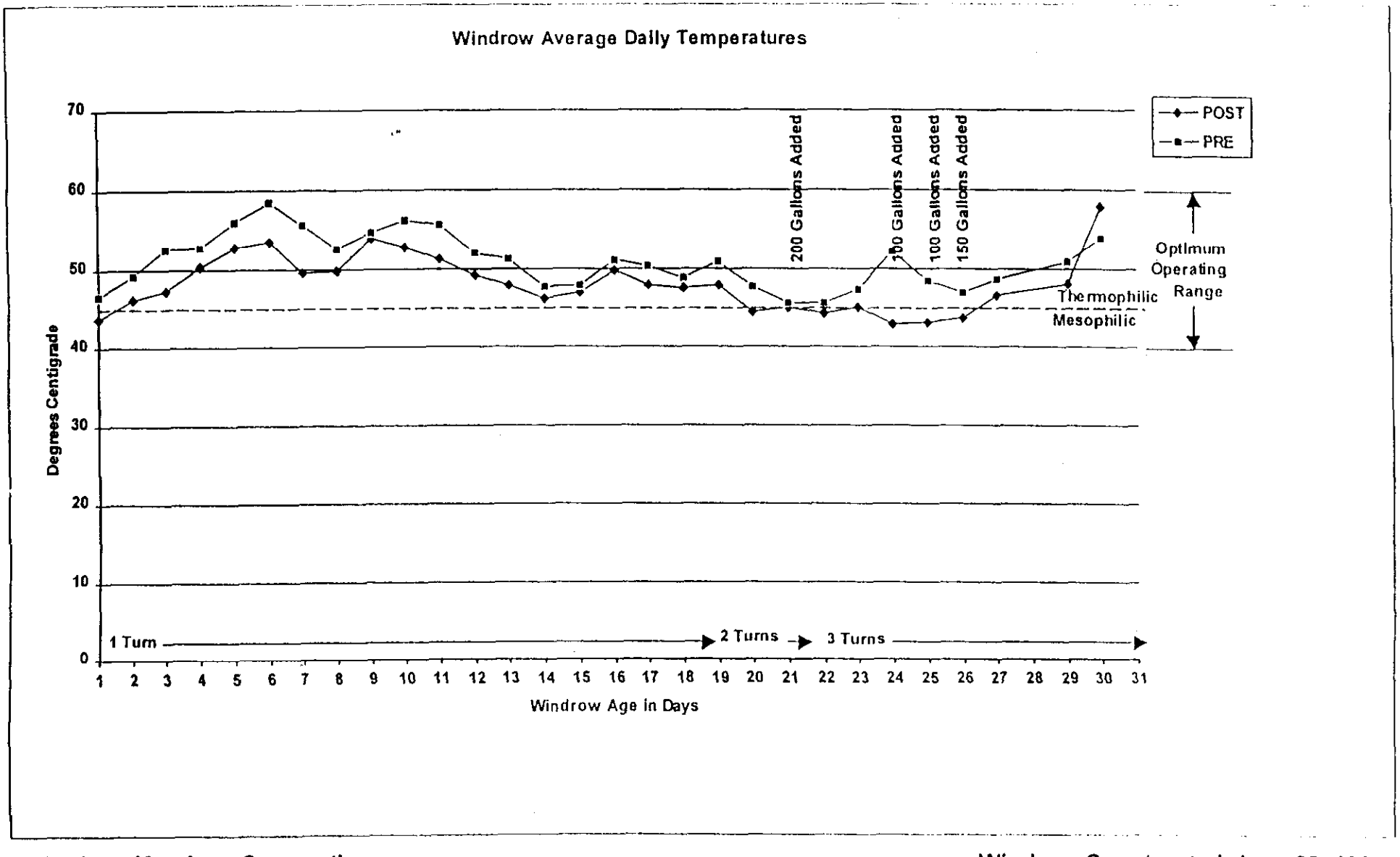
NWSC Crane BioFacility Pilot ale Demonstration

Compost Recipe Mix2



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

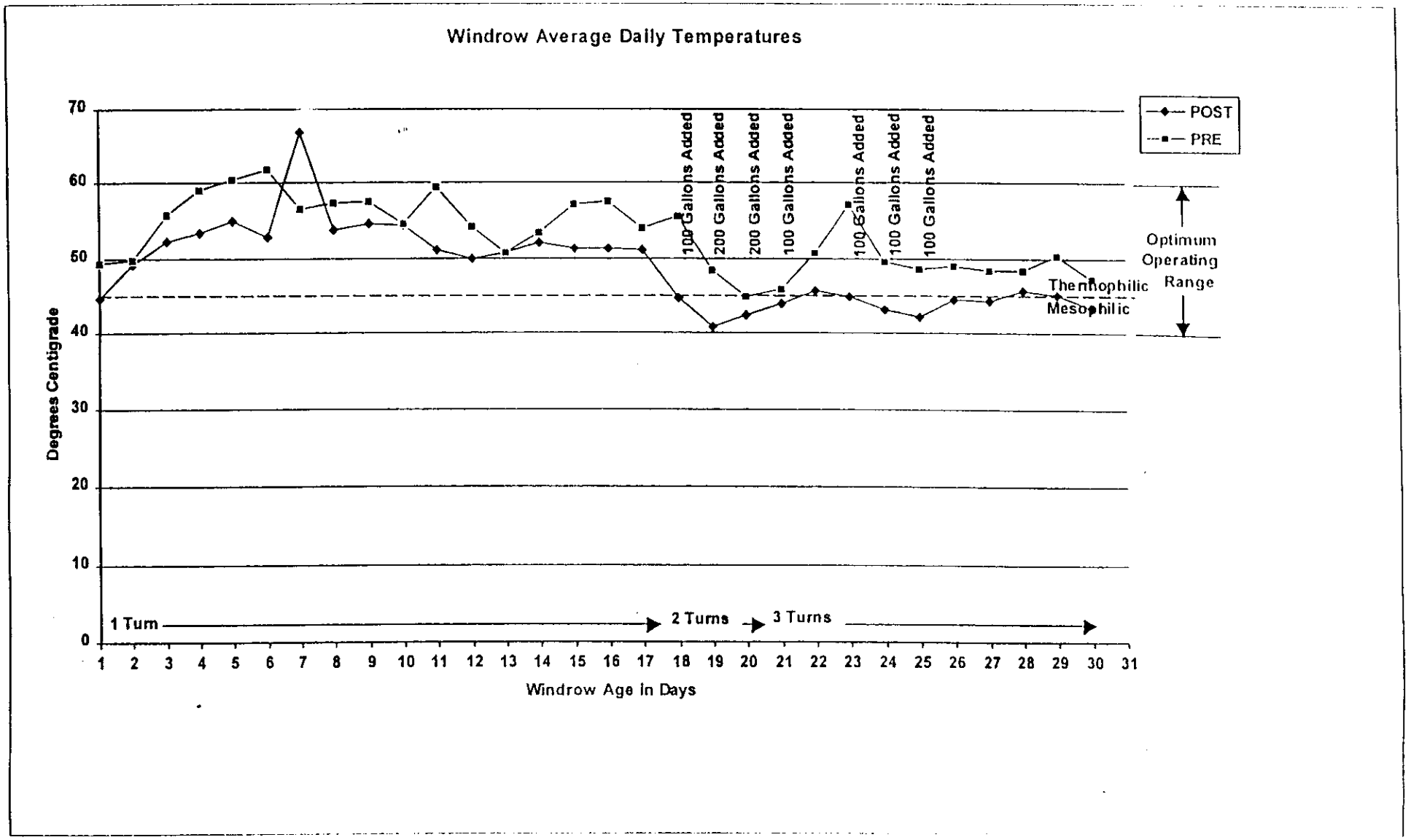
Average Daily Windrow Temperature Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (Deg C)	POST-Turn (Deg C)
MIX2	6/28/97	6/29/97	1	46.67	43.79
		6/30/97	2	49.29	46.33
		7/1/97	3	52.71	47.38
		7/2/97	4	52.96	50.46
		7/3/97	5	56.08	52.92
		7/4/97	6	58.50	53.63
		7/5/97	7	55.67	49.75
		7/6/97	8	52.75	49.88
		7/7/97	9	54.79	53.96
		7/8/97	10	56.22	52.79
		7/9/97	11	55.79	51.38
		7/10/97	12	52.04	49.38
		7/11/97	13	51.38	47.96
		7/12/97	14	47.83	46.38
		7/13/97	15	47.96	47.08
		7/14/97	16	51.17	49.96
		7/15/97	17	50.50	48.04
		7/16/97	18	49.00	47.54
		7/17/97	19	51.04	47.96
		7/18/97	20	47.88	44.63
		7/19/97	21	45.79	45.13
		7/20/97	22	45.79	44.50
		7/21/97	23	47.42	45.08
		7/22/97	24	52.33	43.04
		7/23/97	25	48.63	43.21
		7/24/97	26	47.08	43.79
		7/25/97	27	48.67	46.63
		7/27/97	29	50.92	48.17
		7/28/97	30	54.00	57.92

All average temperatures are in degrees centigrade

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 3



Morrison Knudsen Corporation

Windrow Constructed June 29, 1997

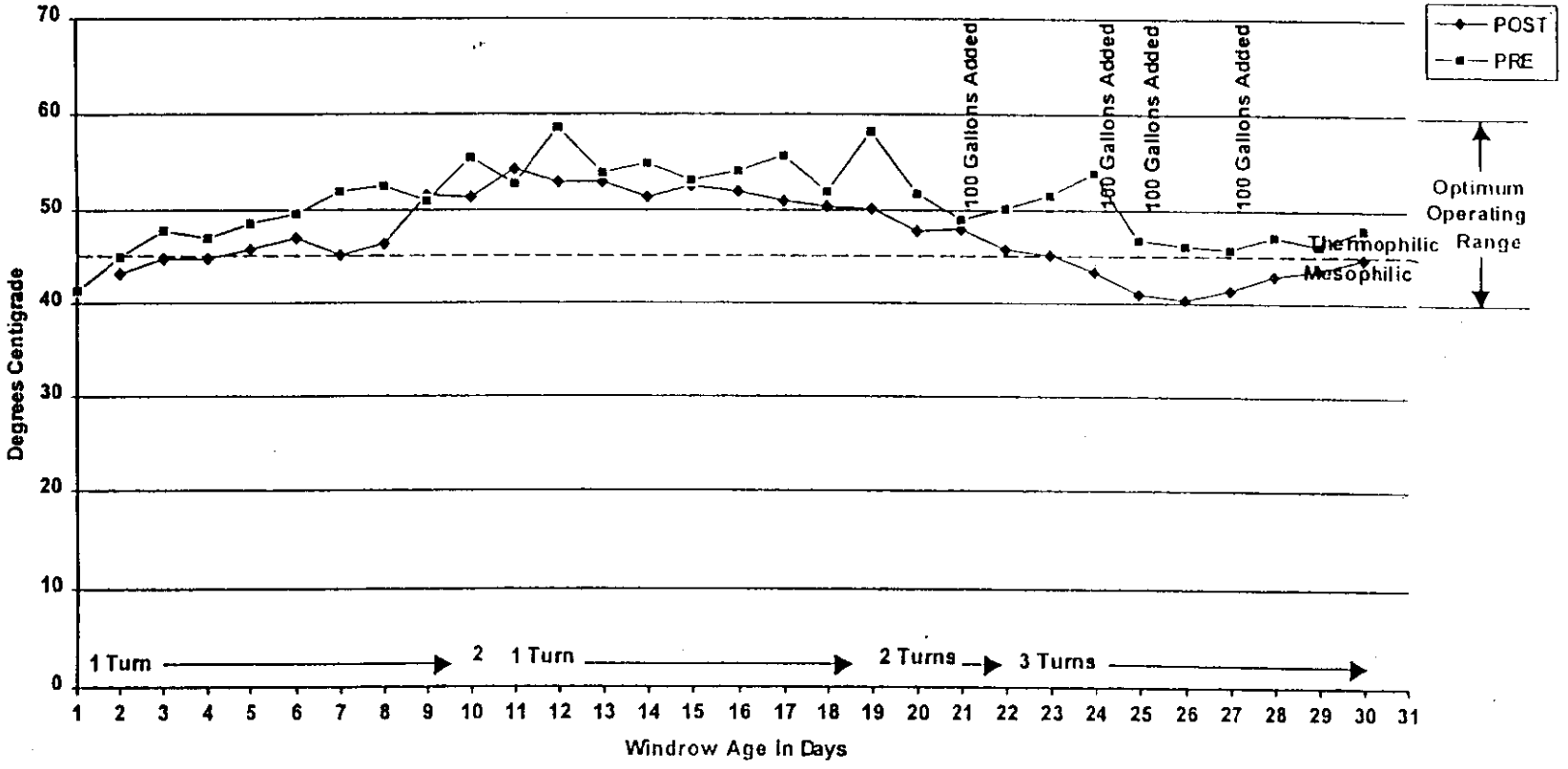
Average Daily Windrow Temperature Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (Deg C)	POST-Turn (Deg C)
MIX3	6/29/97	6/30/97	1	49.33	44.63
		7/1/97	2	49.79	49.13
		7/2/97	3	55.79	52.38
		7/3/97	4	59.04	53.50
		7/4/97	5	60.46	54.96
		7/5/97	6	61.88	52.92
		7/6/97	7	56.63	66.96
		7/7/97	8	57.33	53.96
		7/8/97	9	57.50	54.54
		7/9/97	10	54.63	54.38
		7/10/97	11	59.58	51.04
		7/11/97	12	54.21	50.04
		7/12/97	13	50.83	50.79
		7/13/97	14	53.46	52.04
		7/14/97	15	57.17	51.29
		7/15/97	16	57.54	51.29
		7/16/97	17	54.00	51.21
		7/17/97	18	55.71	44.67
		7/18/97	19	48.33	40.79
		7/19/97	20	45.00	42.42
		7/20/97	21	45.83	43.88
		7/21/97	22	50.75	45.71
		7/22/97	23	57.21	44.88
		7/23/97	24	49.63	43.21
		7/24/97	25	48.54	42.21
		7/25/97	26	49.00	44.58
		7/26/97	27	48.46	44.42
		7/27/97	28	48.46	45.63
		7/28/97	29	50.46	45.08
		7/29/97	30	47.29	43.29

All average temperatures are in degrees centigrade

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix4



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

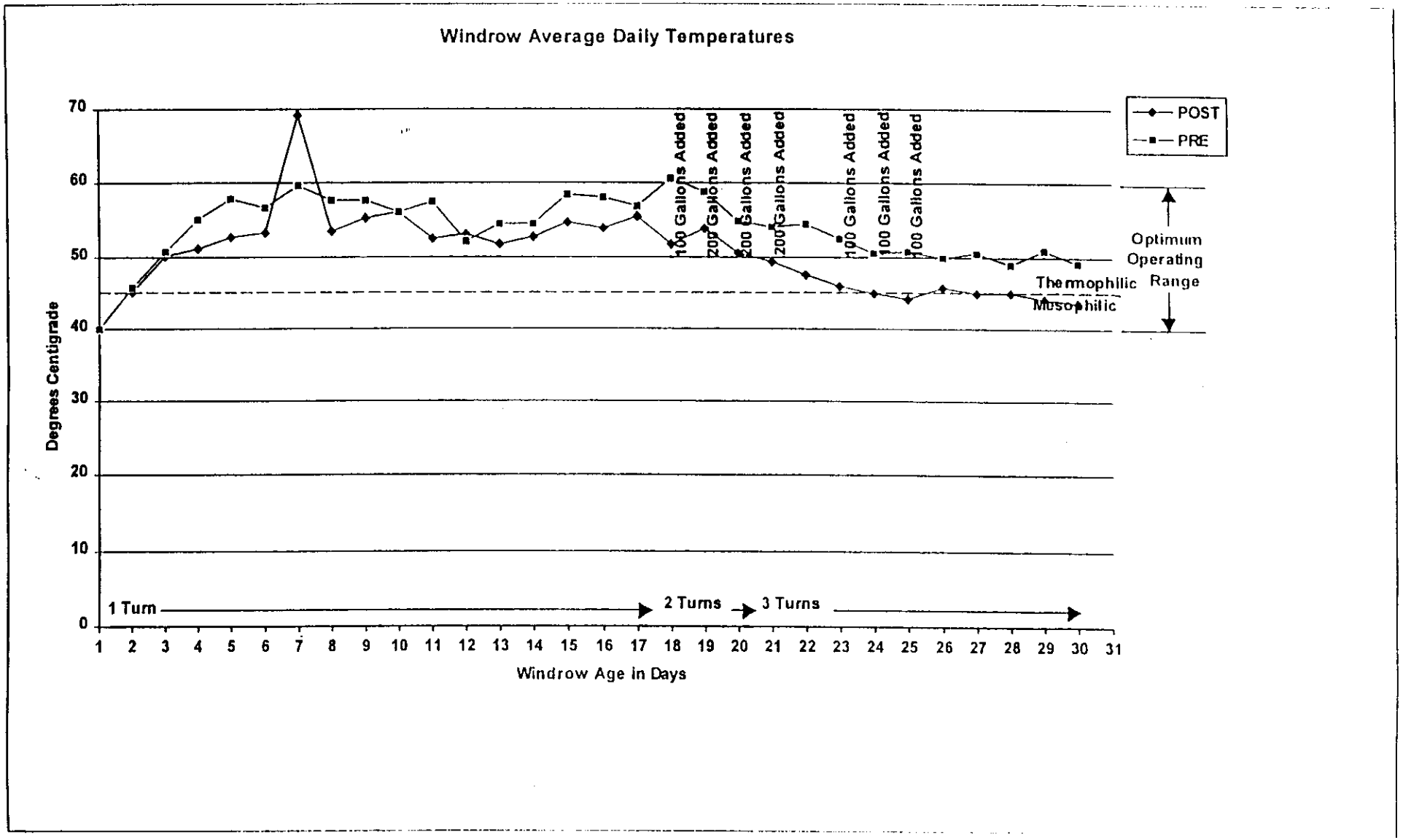
Average Daily Windrow Temperature Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (Deg C)*	*POST-Turn (Deg C)*
MIX4	6/28/97	6/29/97	1	41.33	
		6/30/97	2	45.00	43.08
		7/1/97	3	47.75	44.79
		7/2/97	4	46.88	44.83
		7/3/97	5	48.46	45.75
		7/4/97	6	49.46	46.83
		7/5/97	7	51.83	45.17
		7/6/97	8	52.42	46.25
		7/7/97	9	50.96	51.50
		7/8/97	10	55.54	51.38
		7/9/97	11	52.67	54.38
		7/10/97	12	58.75	52.92
		7/11/97	13	53.96	52.96
		7/12/97	14	54.83	51.29
		7/13/97	15	53.08	52.42
		7/14/97	16	54.13	52.00
		7/15/97	17	55.58	50.88
		7/16/97	18	51.88	50.38
		7/17/97	19	58.33	50.04
		7/18/97	20	51.67	47.71
		7/19/97	21	48.83	47.92
		7/20/97	22	50.13	45.71
		7/21/97	23	51.46	45.17
		7/22/97	24	53.88	43.29
		7/23/97	25	46.71	40.96
		7/24/97	26	46.21	40.42
		7/25/97	27	45.83	41.46
		7/26/97	28	47.17	43.04
		7/27/97	29	46.21	43.46
		7/28/97	30	47.92	44.71

All average temperatures are in degrees centigrade

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 5



Morrison Knudsen Corporation

Windrow Constructed June 29, 1997

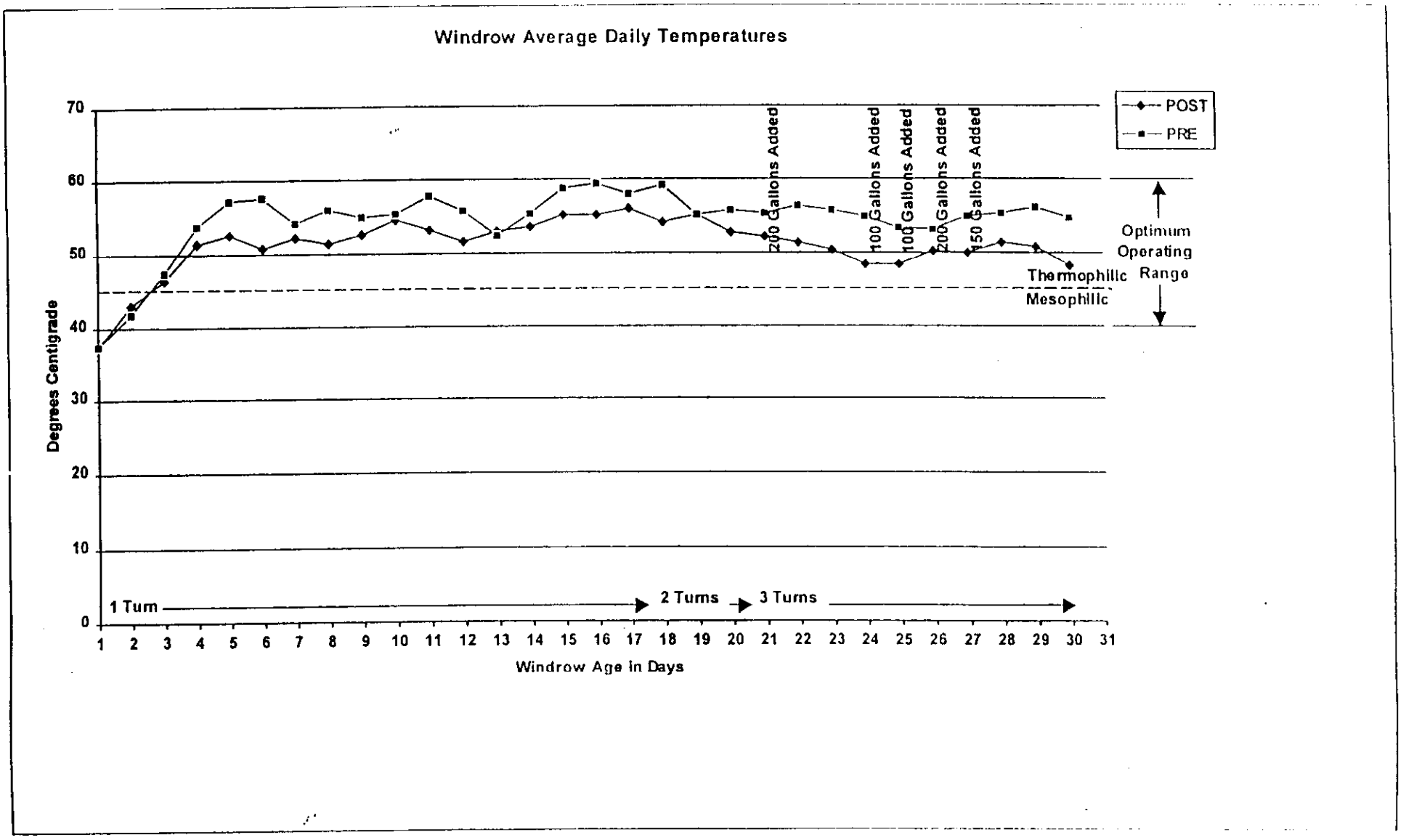
Average Daily Windrow Temperature Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (Deg C)*	*POST-Turn (Deg C)*
MIX5	6/29/97	6/30/97	1	40.00	
		7/1/97	2	45.79	45.17
		7/2/97	3	50.75	50.04
		7/3/97	4	55.08	51.17
		7/4/97	5	57.88	52.79
		7/5/97	6	56.63	53.21
		7/6/97	7	59.63	69.13
		7/7/97	8	57.71	53.42
		7/8/97	9	57.67	55.33
		7/9/97	10	56.17	56.08
		7/10/97	11	57.38	52.58
		7/11/97	12	52.08	53.04
		7/12/97	13	54.46	51.71
		7/13/97	14	54.54	52.79
		7/14/97	15	58.50	54.75
		7/15/97	16	58.17	53.83
		7/16/97	17	56.83	55.54
		7/17/97	18	60.58	51.79
		7/18/97	19	58.96	53.83
		7/19/97	20	54.79	50.58
		7/20/97	21	54.13	49.38
		7/21/97	22	54.42	47.63
		7/22/97	23	52.42	45.88
		7/23/97	24	50.42	45.00
		7/24/97	25	50.67	44.21
		7/25/97	26	49.83	45.67
		7/26/97	27	50.50	45.04
		7/27/97	28	48.96	45.00
		7/28/97	29	50.92	44.13
		7/29/97	30	49.04	43.50

All average temperatures are in degrees centigrade

NWSC Crane BioFacility Pilot ale Demonstration

Compost Recipe Mix 6



Morrison Knudsen Corporation

Windrow Constructed June 29, 1997

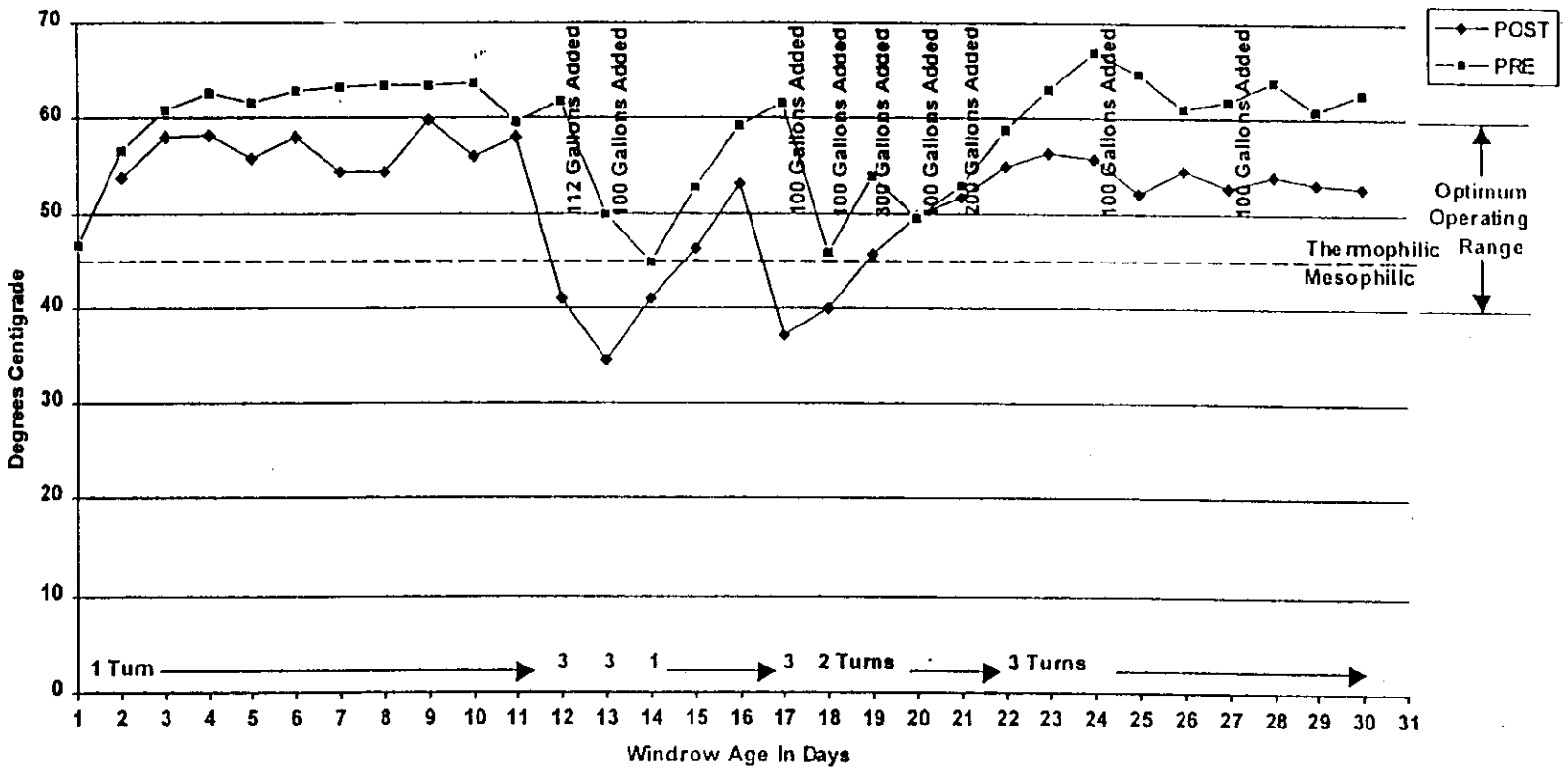
Average Daily Windrow Temperature Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (Deg C)*	*POST-Turn (Deg C)*
MIX6	6/29/97	6/30/97	1	37.25	37.21
		7/1/97	2	41.67	43.00
		7/2/97	3	47.33	46.29
		7/3/97	4	53.71	51.38
		7/4/97	5	57.25	52.58
		7/5/97	6	57.50	50.67
		7/6/97	7	54.21	52.17
		7/7/97	8	56.00	51.38
		7/8/97	9	54.88	52.63
		7/9/97	10	55.38	54.46
		7/10/97	11	57.79	53.08
		7/11/97	12	55.79	51.46
		7/12/97	13	52.33	52.96
		7/13/97	14	55.46	53.54
		7/14/97	15	58.75	55.13
		7/15/97	16	59.42	55.17
		7/16/97	17	57.92	55.96
		7/17/97	18	59.21	54.17
		7/18/97	19	55.21	55.21
		7/19/97	20	55.83	52.79
		7/20/97	21	55.33	52.13
		7/21/97	22	56.38	51.25
		7/22/97	23	55.79	50.38
		7/23/97	24	54.96	48.33
		7/24/97	25	53.38	48.29
		7/25/97	26	53.13	50.08
		7/26/97	27	55.04	49.92
		7/27/97	28	55.38	51.29
		7/28/97	29	56.17	50.75
		7/29/97	30	54.79	48.17

All average temperatures are in degrees centigrade

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix7B



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

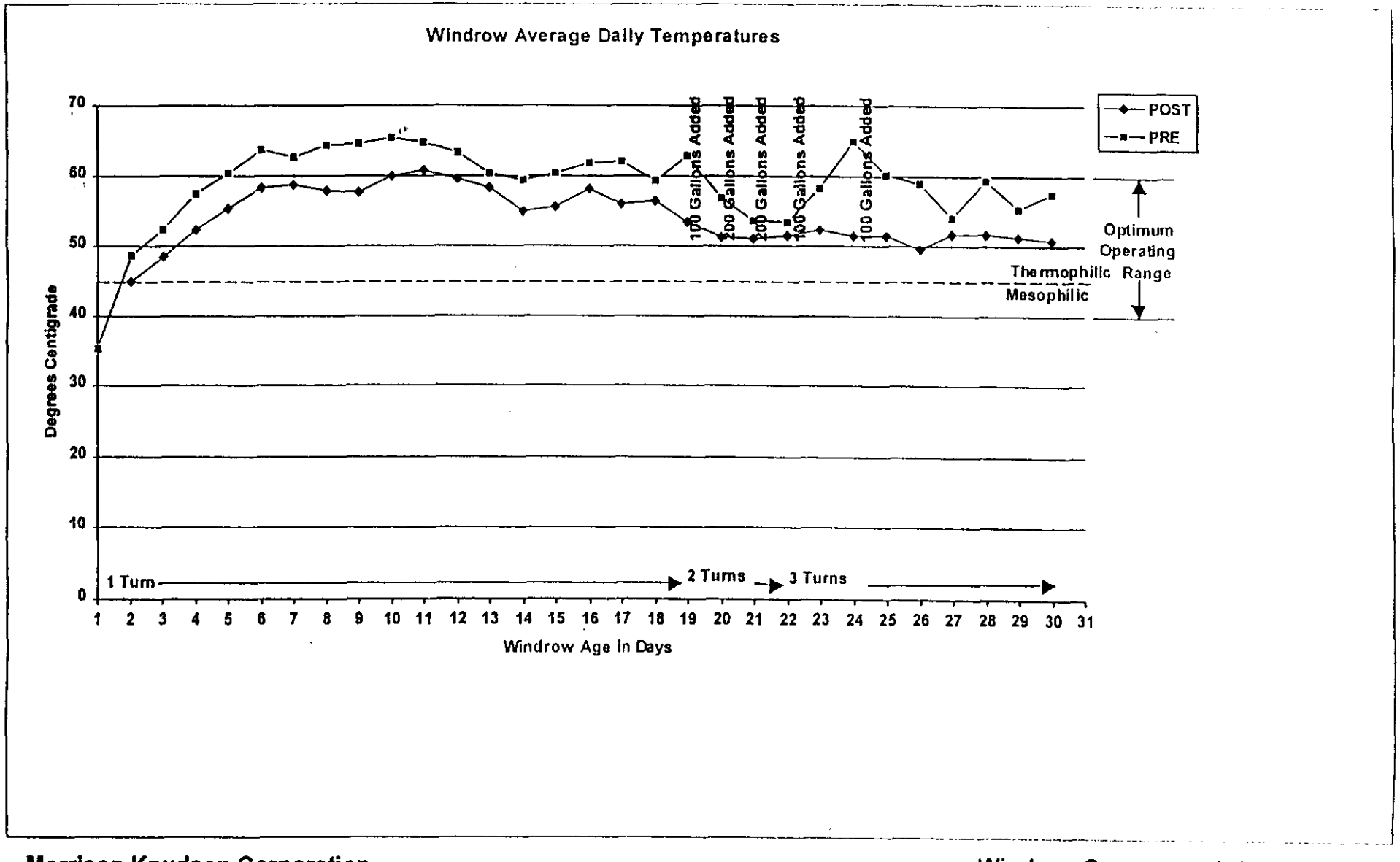
Average Daily Windrow Temperature Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (Deg C)*	*POST-Turn (Deg C)*
MIX7B	6/28/97	6/29/97	1	46.71	
		6/30/97	2	56.58	53.79
		7/1/97	3	60.96	58.08
		7/2/97	4	62.71	58.32
		7/3/97	5	61.63	55.88
		7/4/97	6	62.83	57.96
		7/5/97	7	63.21	54.33
		7/6/97	8	63.46	54.29
		7/7/97	9	63.58	59.83
		7/8/97	10	63.75	56.04
		7/9/97	11	59.63	58.00
		7/10/97	12	61.83	40.91
		7/11/97	13	49.96	34.50
		7/12/97	14	44.88	40.96
		7/13/97	15	52.78	46.36
		7/14/97	16	59.28	53.06
		7/15/97	17	61.65	37.21
		7/16/97	18	45.83	39.92
		7/17/97	19	53.92	45.71
		7/18/97	20	49.42	49.79
		7/19/97	21	53.00	51.79
		7/20/97	22	58.83	55.08
		7/21/97	23	63.13	56.50
		7/22/97	24	66.92	55.79
		7/23/97	25	64.67	52.13
		7/24/97	26	61.00	54.63
		7/25/97	27	61.92	52.78
		7/26/97	28	63.88	53.96
		7/27/97	29	60.92	53.17
		7/28/97	30	62.63	52.79

All average temperatures are in degrees centigrade

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix7C



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

Average Daily Windrow Temperature Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (Deg C)*	*POST-Turn (Deg C)*
MIX7C	6/28/97	6/29/97	1	35.33	
		6/30/97	2	48.71	45.04
		7/1/97	3	52.33	48.54
		7/2/97	4	57.38	52.33
		7/3/97	5	60.42	55.33
		7/4/97	6	63.71	58.33
		7/5/97	7	62.71	58.63
		7/6/97	8	64.25	57.88
		7/7/97	9	64.63	57.54
		7/8/97	10	65.42	60.00
		7/9/97	11	64.83	60.71
		7/10/97	12	63.33	59.50
		7/11/97	13	60.42	58.25
		7/12/97	14	59.38	54.83
		7/13/97	15	60.29	55.58
		7/14/97	16	61.79	57.96
		7/15/97	17	61.96	55.92
		7/16/97	18	59.21	56.33
		7/17/97	19	62.83	53.33
		7/18/97	20	56.71	51.33
		7/19/97	21	53.71	51.08
		7/20/97	22	53.38	51.46
		7/21/97	23	58.33	52.38
		7/22/97	24	65.04	51.46
		7/23/97	25	60.21	51.54
		7/24/97	26	58.92	49.58
		7/25/97	27	54.04	51.79
		7/26/97	28	59.21	51.79
		7/27/97	29	55.25	51.38
		7/28/97	30	57.46	50.83

All average temperatures are in degrees centigrade

APPENDIX D
CLEAN SOIL MOISTURE

APPENDIX D
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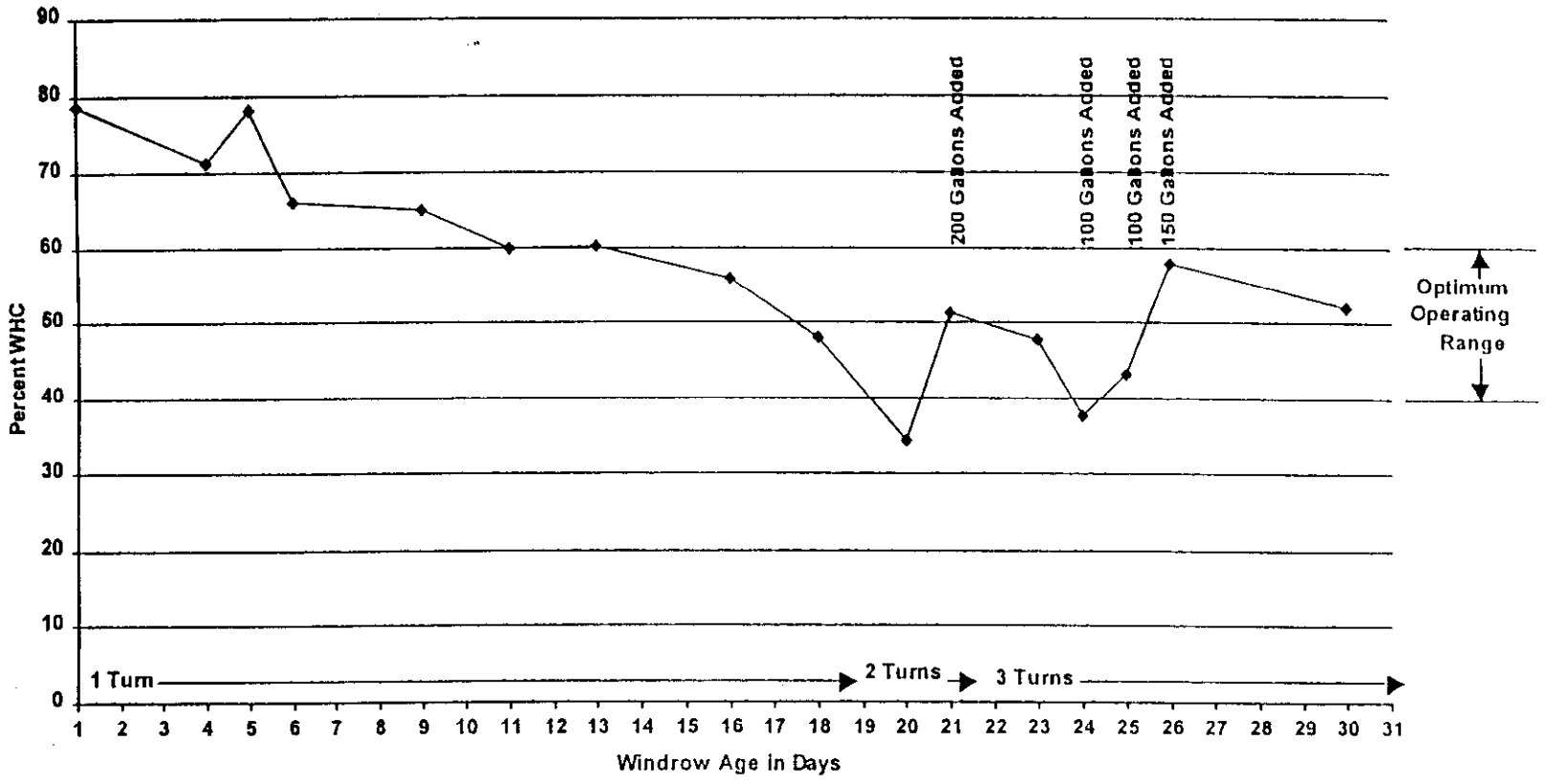
DESCRIPTION	NO. PAGES
CLEAN SOIL MOISTURE	14 pages

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 2



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

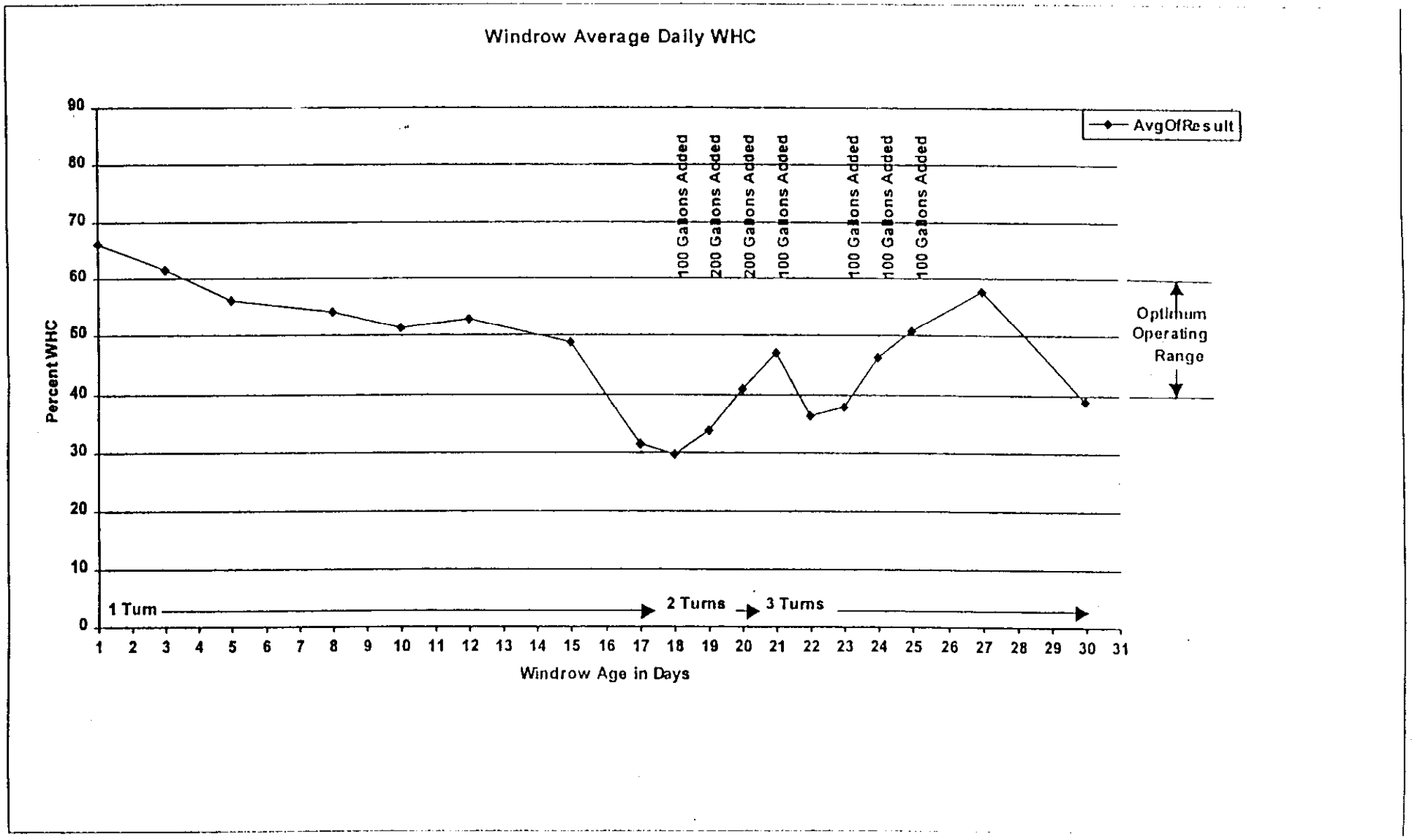
Average Daily Windrow WHC Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (%)	POST-Turn (%)
MIX2	6/28/97	6/29/97	1	78.75	
		7/2/97	4	71.33	
		7/3/97	5	78.00	
		7/4/97	6	66.00	
		7/7/97	9	65.00	
		7/9/97	11	60.00	
		7/11/97	13	60.25	
		7/14/97	16	55.75	
		7/16/97	18	48.00	
		7/18/97	20	34.33	
		7/19/97	21	51.27	
		7/21/97	23	47.90	
		7/22/97	24		37.70
		7/23/97	25		43.18
		7/24/97	26		57.78
		7/28/97	30	52.17	

All average MWHC values are expressed in percent

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix3



Morrison Knudsen Corporation

Windrow Constructed June 29, 1997

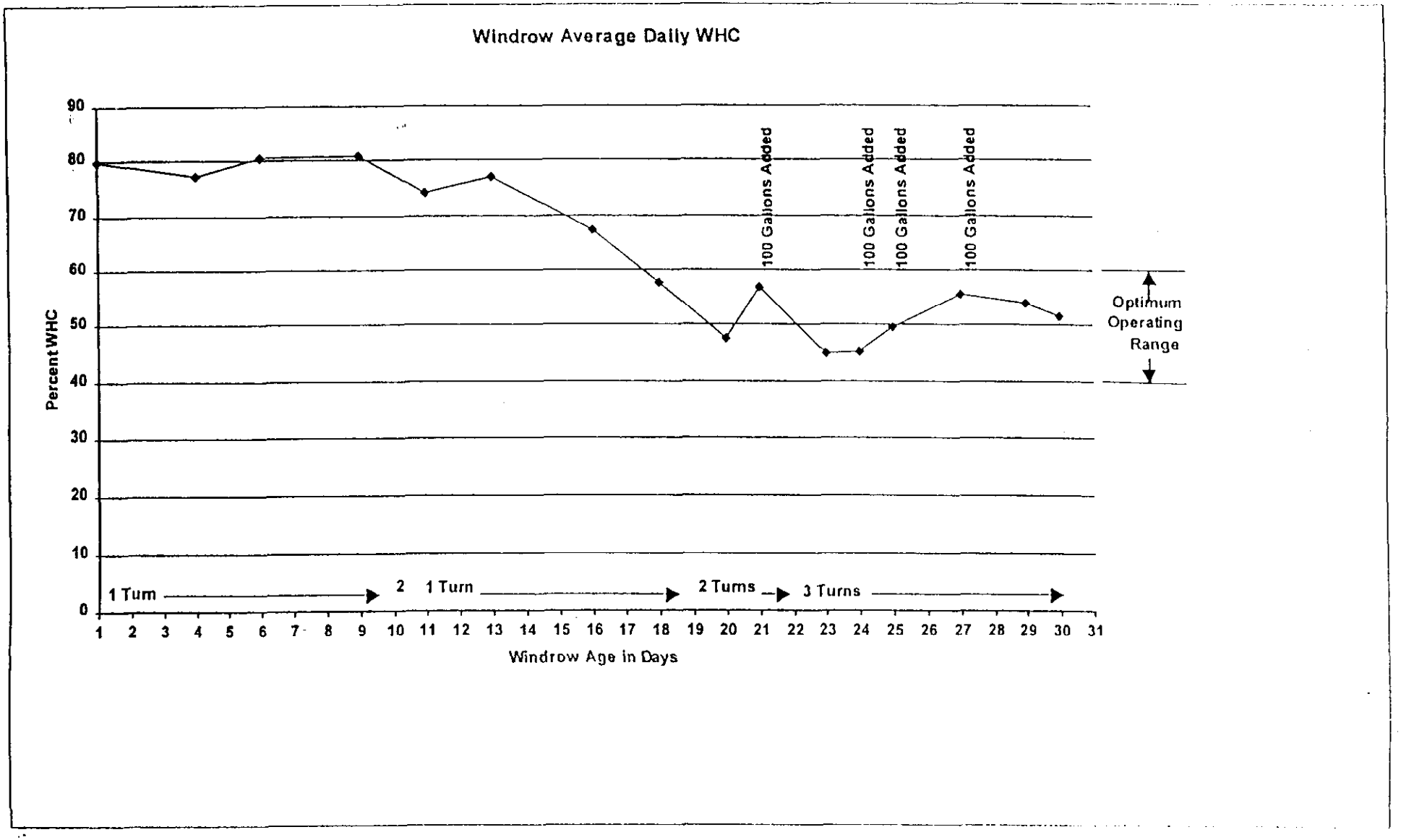
Average Daily Windrow WHC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX3	6/29/97	6/30/97	1	66.25	
		7/2/97	3	61.50	
		7/4/97	5	56.25	
		7/7/97	8	54.25	
		7/9/97	10	51.50	
		7/11/97	12	53.00	
		7/14/97	15	48.75	
		7/16/97	17	31.50	
		7/17/97	18	29.60	
		7/18/97	19	33.75	
		7/19/97	20	40.98	
		7/20/97	21	47.15	
		7/21/97	22	36.20	
		7/22/97	23		37.83
		7/23/97	24		46.27
		7/24/97	25		50.80
		7/26/97	27	57.85	
		7/29/97	30	38.90	

All average MWHC values are expressed in percent

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix4



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

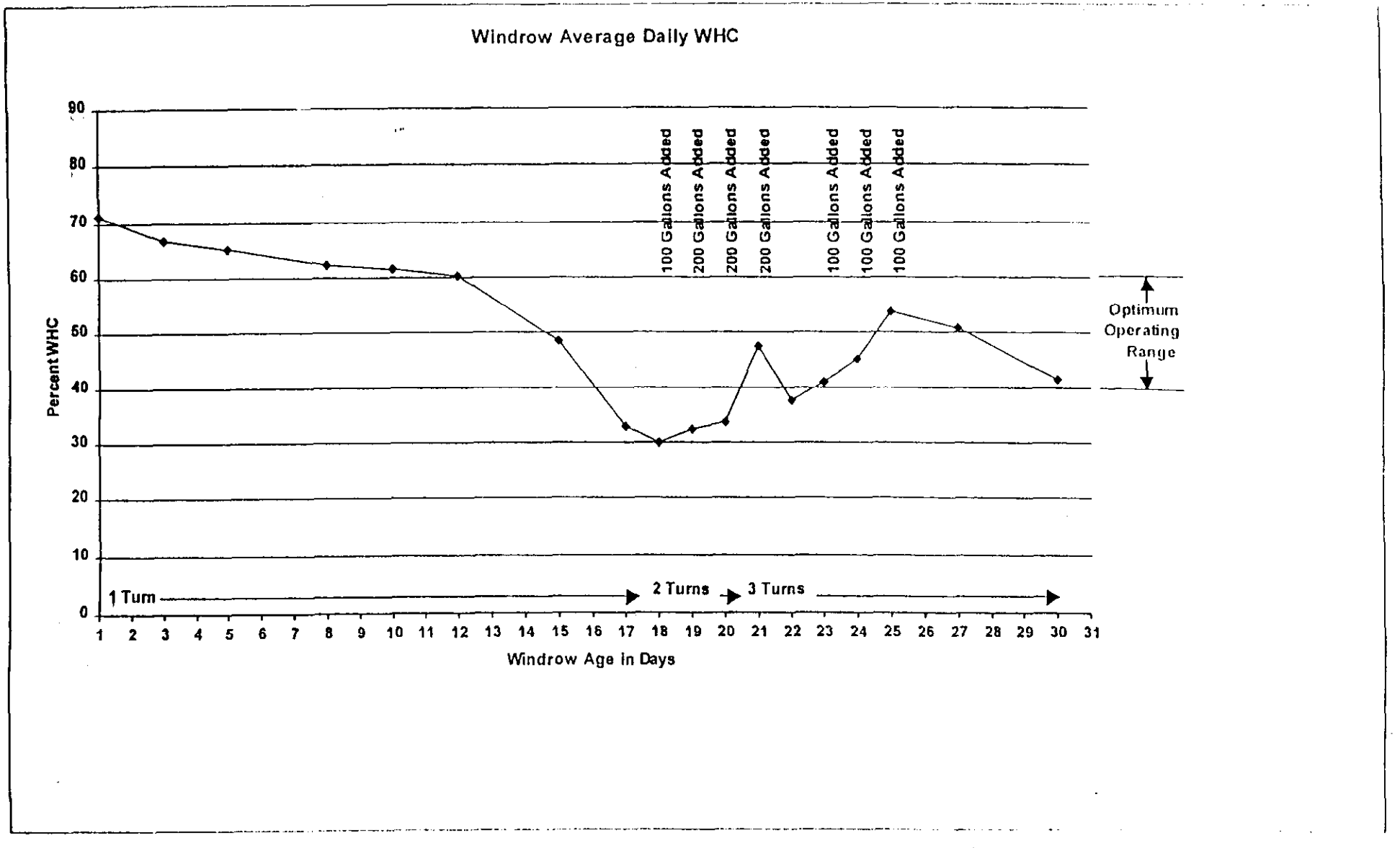
Average Daily Windrow WHC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX4	6/28/97	6/29/97	1	79.75	
		7/2/97	4	77.25	
		7/4/97	6	80.50	
		7/7/97	9	81.00	
		7/9/97	11	74.00	
		7/11/97	13	77.00	
		7/14/97	16	67.25	
		7/16/97	18	57.75	
		7/18/97	20	47.40	
		7/19/97	21	56.88	
		7/21/97	23	44.95	
		7/22/97	24		45.15
		7/23/97	25		49.65
		7/25/97	27		55.65
		7/27/97	29	54.13	
		7/28/97	30	51.63	

All average MWHC values are expressed in percent

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 5



Morrison Knudsen Corporation

Windrow Constructed June 29, 1997

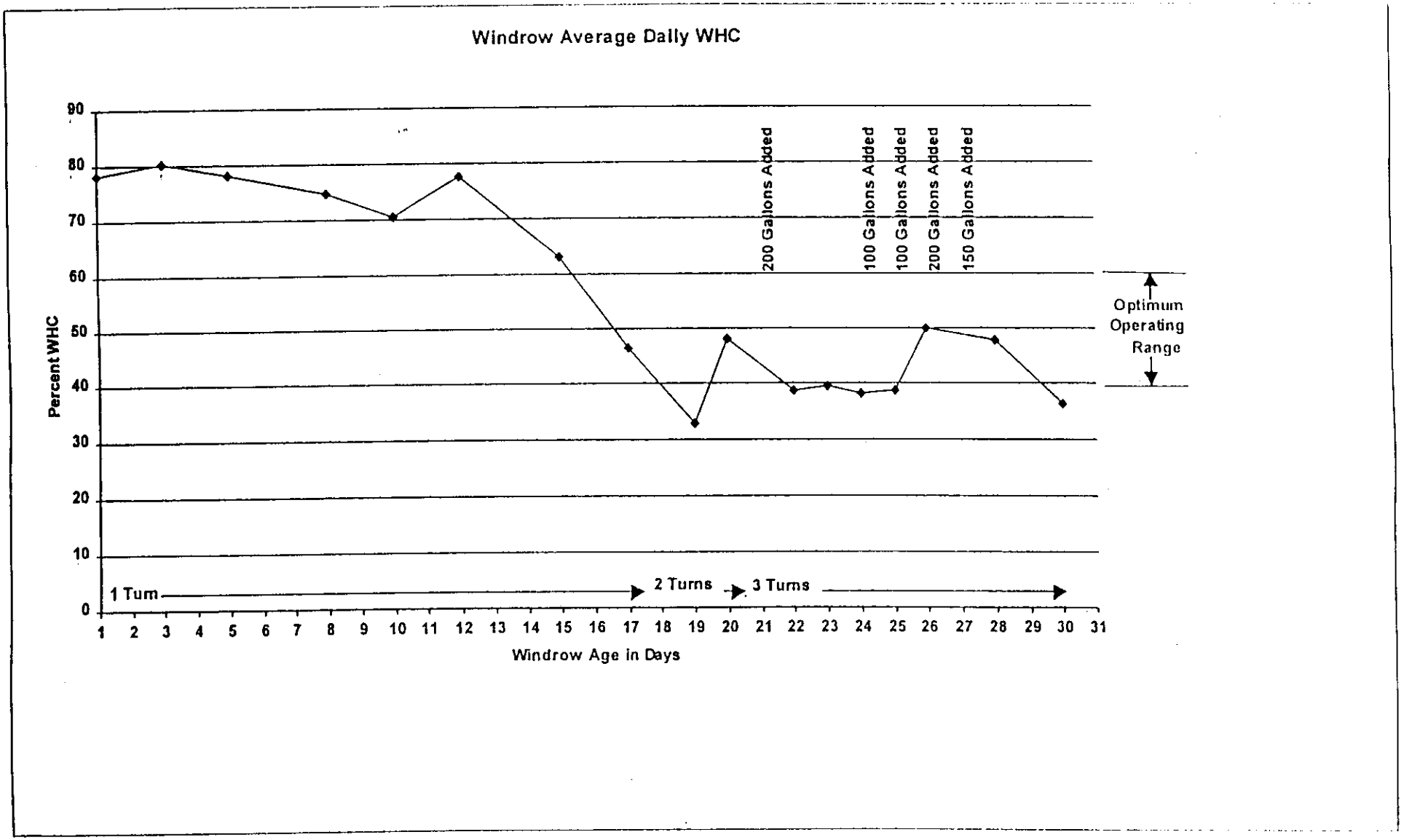
Average Daily Windrow WHC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX5	6/29/97	6/30/97	1	71.25	
		7/2/97	3	66.75	
		7/4/97	5	65.25	
		7/7/97	8	62.25	
		7/9/97	10	61.50	
		7/11/97	12	60.25	
		7/14/97	15	48.50	
		7/16/97	17	32.75	
		7/17/97	18	30.10	
		7/18/97	19	32.27	
		7/19/97	20	33.67	
		7/20/97	21	47.50	
		7/21/97	22	37.63	
		7/22/97	23		41.00
		7/23/97	24		45.15
		7/24/97	25		53.73
		7/26/97	27	51.00	
		7/29/97	30	41.60	

All average MWHC values are expressed in percent

NWSC Crane BioFacility Pilot S ..e Demonstration

Compost Recipe Mix 6



Morrison Knudsen Corporation

Windrow Constructed June 29, 1997

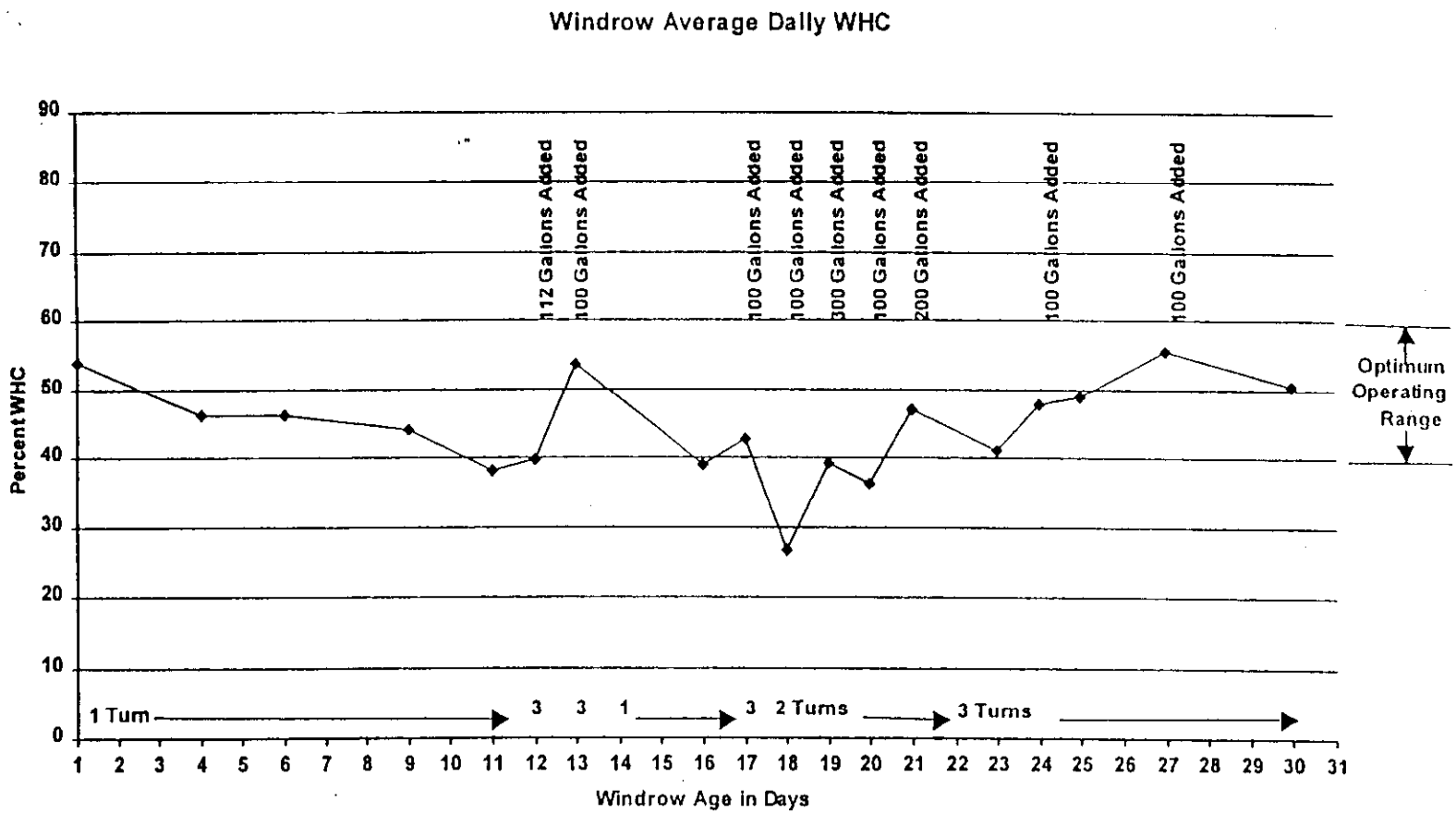
Average Daily Windrow WHC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX6	6/29/97	6/30/97	1	78.25	
		7/2/97	3	80.25	
		7/4/97	5	78.25	
		7/7/97	8	74.75	
		7/9/97	10	70.50	
		7/11/97	12	77.50	
		7/14/97	15	63.00	
		7/16/97	17	46.50	
		7/18/97	19	32.95	
		7/19/97	20	47.97	
		7/21/97	22	38.77	
		7/22/97	23		39.55
		7/23/97	24		38.35
		7/24/97	25		38.92
		7/25/97	26		49.88
		7/27/97	28	47.70	
		7/29/97	30	36.50	

All average MWHC values are expressed in percent

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix7B



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

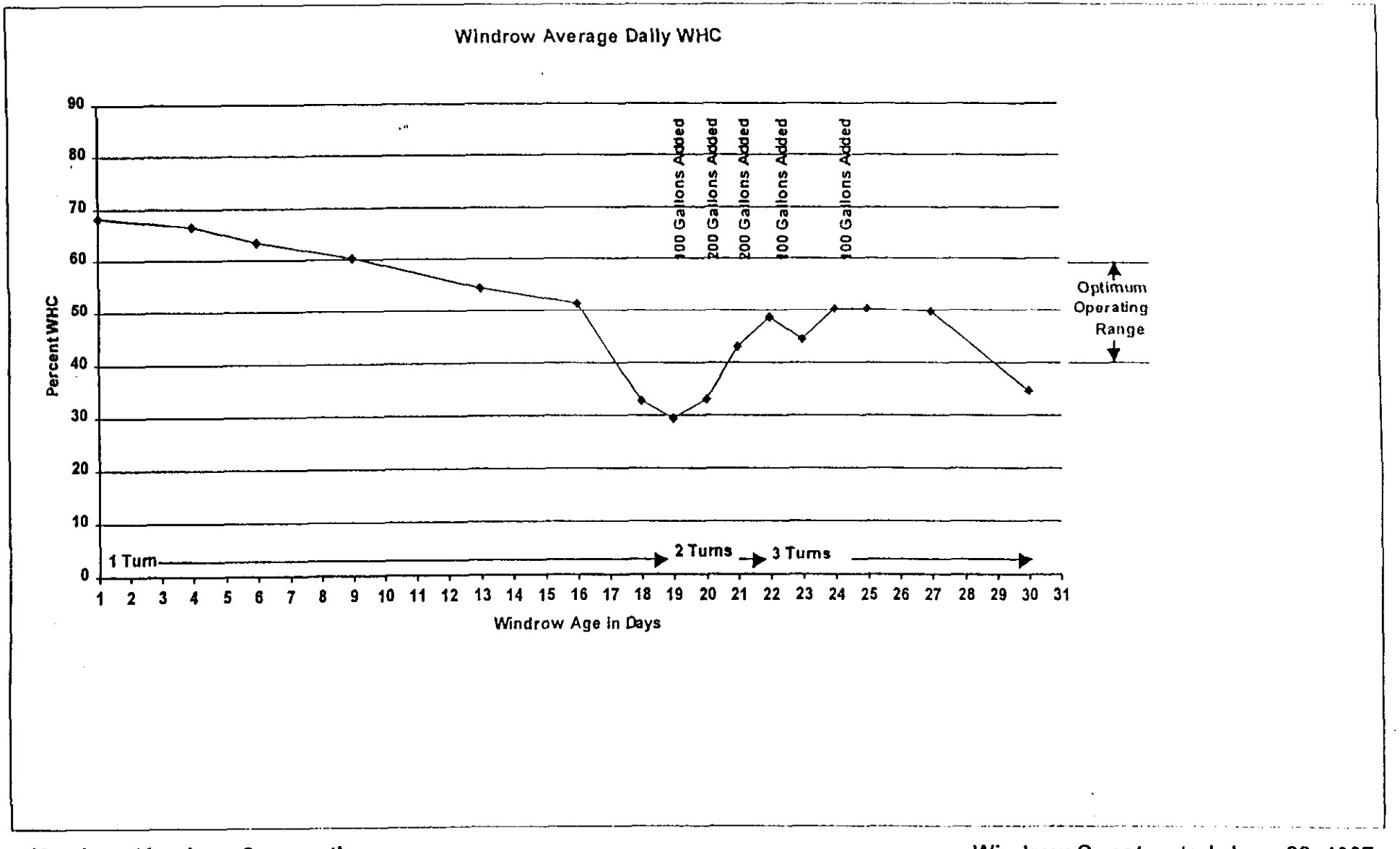
Average Daily Windrow WHC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX7B	6/28/97	6/29/97	1	54.00	
		7/2/97	4	46.25	
		7/4/97	6	46.25	
		7/7/97	9	44.00	
		7/9/97	11	38.25	
		7/10/97	12		39.75
		7/11/97	13	53.75	
		7/14/97	16	39.00	
		7/15/97	17	42.75	
		7/16/97	18	26.75	
		7/17/97	19	39.25	
		7/18/97	20	36.42	
		7/19/97	21	46.93	
		7/21/97	23	41.00	
		7/22/97	24		47.83
		7/23/97	25		48.85
		7/25/97	27		55.45
		7/28/97	30	50.55	

All average MWHC values are expressed in percent

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix7C



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

Average Daily Windrow WHC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX7C	6/28/97	6/29/97	1	68.25	
		7/2/97	4	66.50	
		7/4/97	6	63.50	
		7/7/97	9	60.25	
		7/11/97	13	54.50	
		7/14/97	16	51.50	
		7/16/97	18	32.75	
		7/17/97	19	29.33	
		7/18/97	20	33.10	
		7/19/97	21	42.95	
		7/20/97	22	48.53	
		7/21/97	23	44.35	
		7/22/97	24		50.45
		7/23/97	25		50.23
		7/25/97	27	49.73	
		7/28/97	30	34.73	

All average MWHC values are expressed in percent

APPENDIX E
CLEAN SOIL OXYGEN

APPENDIX E
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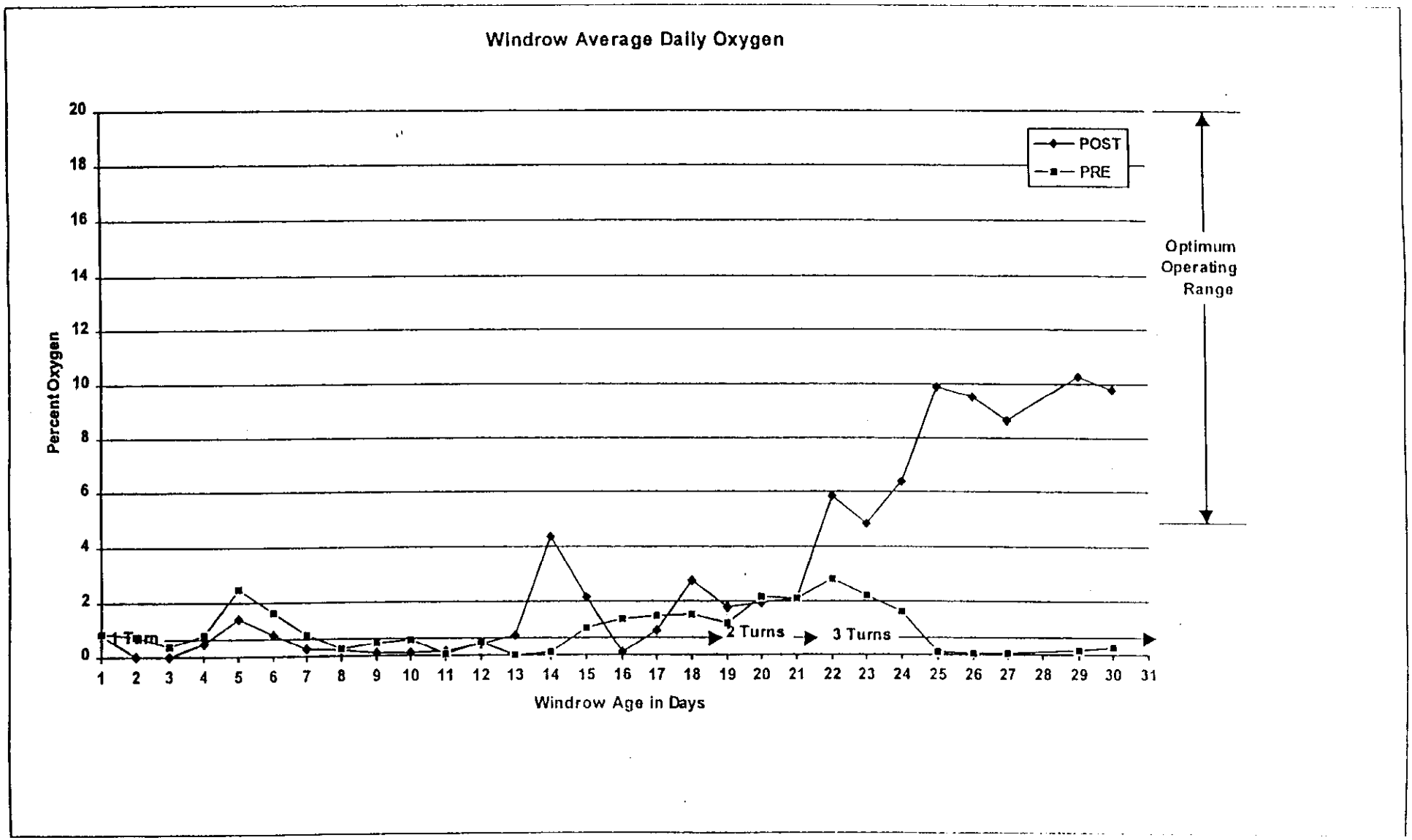
Clean Soil Oxygen	14 pages

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 2



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

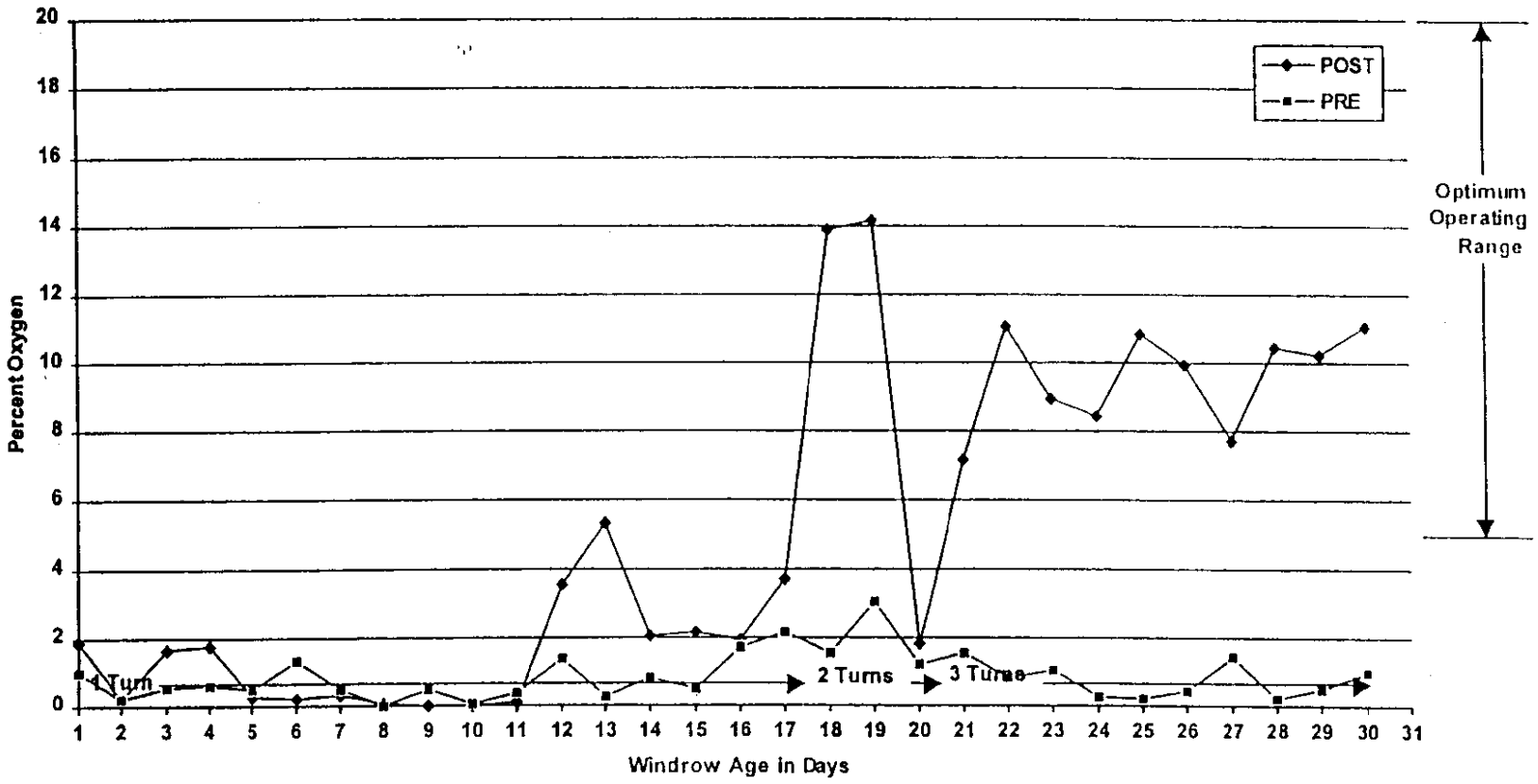
Average Daily Windrow Oxygen Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX2	6/28/97	6/29/97	1	0.88	0.79
		6/30/97	2	0.75	0.00
		7/1/97	3	0.38	0.00
		7/2/97	4	0.83	0.46
		7/3/97	5	2.50	1.42
		7/4/97	6	1.63	0.79
		7/5/97	7	0.83	0.25
		7/6/97	8	0.29	0.21
		7/7/97	9	0.50	0.08
		7/8/97	10	0.61	0.08
		7/9/97	11	0.04	0.17
		7/10/97	12	0.46	0.42
		7/11/97	13	0.00	0.75
		7/12/97	14	0.13	4.38
		7/13/97	15	1.00	2.17
		7/14/97	16	1.33	0.13
		7/15/97	17	1.46	0.92
		7/16/97	18	1.50	2.75
		7/17/97	19	1.21	1.79
		7/18/97	20	2.13	1.92
		7/19/97	21	2.08	2.08
		7/20/97	22	2.79	5.88
		7/21/97	23	2.21	4.83
		7/22/97	24	1.63	6.38
		7/23/97	25	0.08	9.88
		7/24/97	26	0.04	9.54
		7/25/97	27	0.04	8.67
		7/27/97	29	0.17	10.29
		7/28/97	30	0.25	9.79

All average Oxygen values are expressed as a percent

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 3



Morrison Knudsen Corporation

Windrow Constructed June 29, 1997

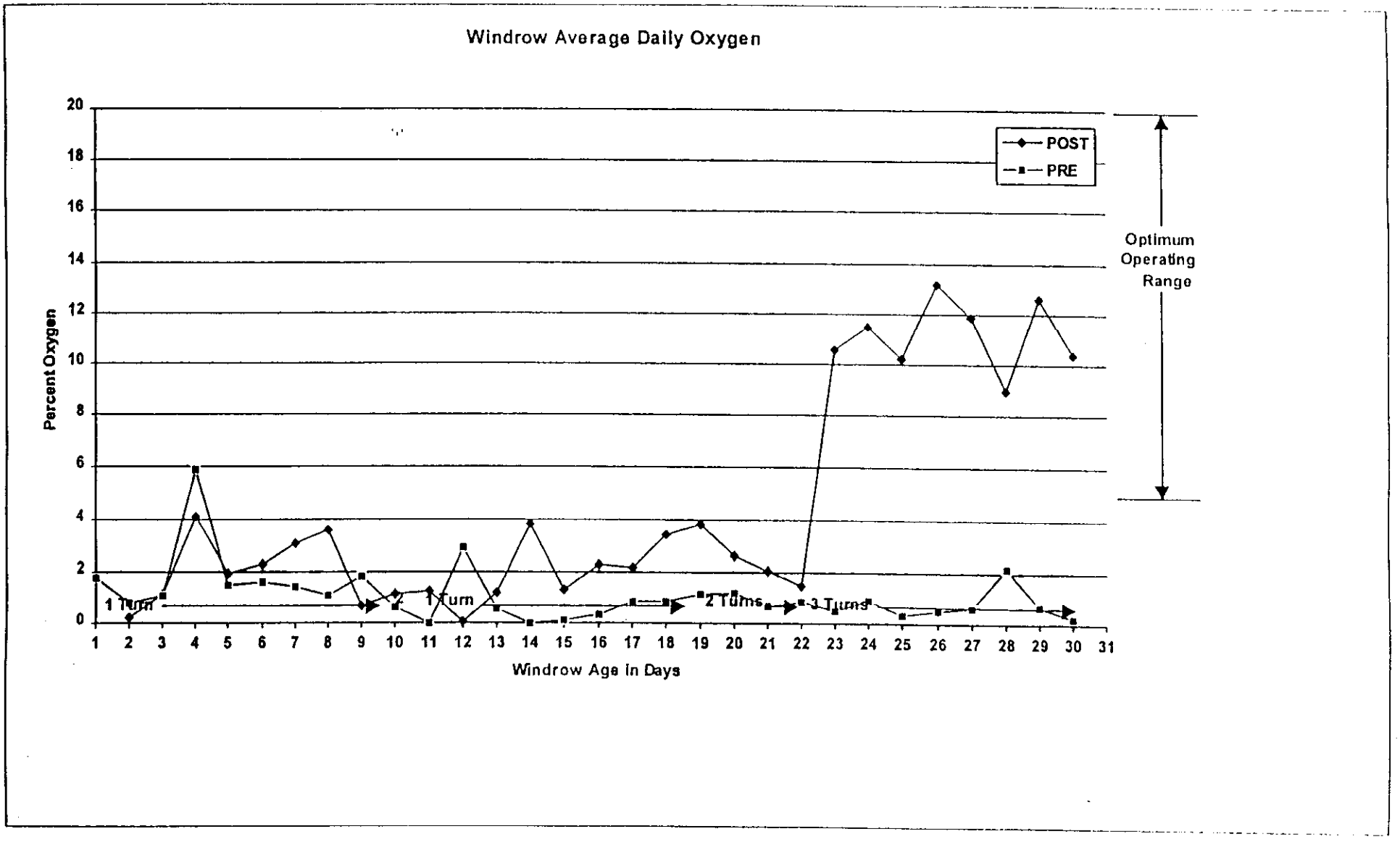
Average Daily Windrow Oxygen Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX3	6/29/97	6/30/97	1	1.00	1.88
		7/1/97	2	0.21	0.21
		7/2/97	3	0.54	1.67
		7/3/97	4	0.63	1.79
		7/4/97	5	0.50	0.29
		7/5/97	6	1.33	0.21
		7/6/97	7	0.50	0.33
		7/7/97	8	0.00	0.04
		7/8/97	9	0.50	0.00
		7/9/97	10	0.08	0.00
		7/10/97	11	0.38	0.13
		7/11/97	12	1.38	3.54
		7/12/97	13	0.29	5.33
		7/13/97	14	0.83	2.04
		7/14/97	15	0.50	2.17
		7/15/97	16	1.71	1.96
		7/16/97	17	2.17	3.75
		7/17/97	18	1.54	13.88
		7/18/97	19	3.08	14.17
		7/19/97	20	1.25	1.83
		7/20/97	21	1.54	7.17
		7/21/97	22	0.83	11.04
		7/22/97	23	1.08	8.96
		7/23/97	24	0.29	8.42
		7/24/97	25	0.21	10.83
		7/25/97	26	0.42	9.92
		7/26/97	27	1.42	7.75
		7/27/97	28	0.25	10.42
		7/28/97	29	0.50	10.25
		7/29/97	30	1.00	11.08

All average Oxygen values are expressed as a percent

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix4



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

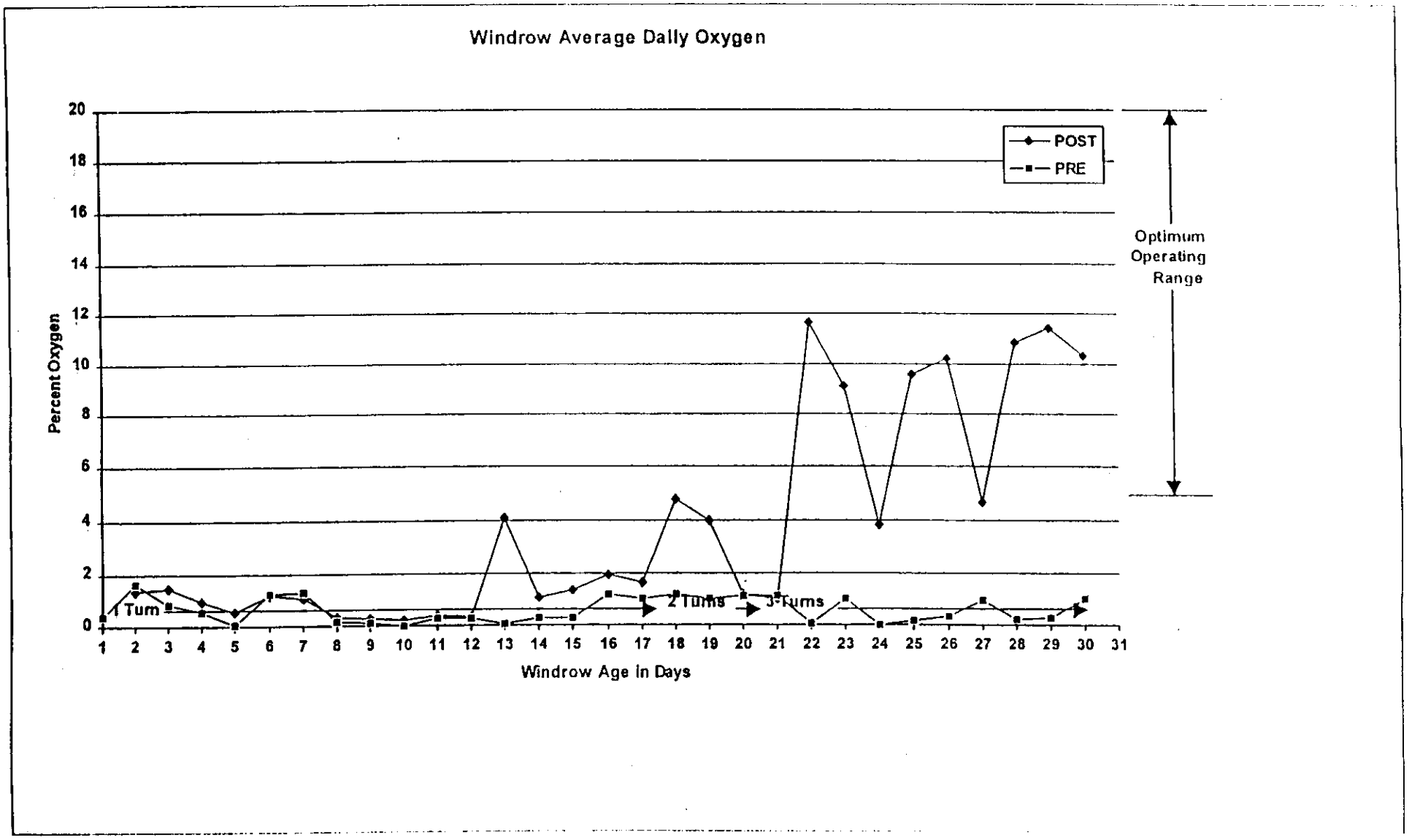
Average Daily Windrow Oxygen Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX4	6/28/97	6/29/97	1	1.75	
		6/30/97	2	0.79	0.21
		7/1/97	3	1.08	1.13
		7/2/97	4	5.92	4.08
		7/3/97	5	1.46	1.92
		7/4/97	6	1.58	2.29
		7/5/97	7	1.42	3.08
		7/6/97	8	1.08	3.58
		7/7/97	9	1.83	0.71
		7/8/97	10	0.63	1.13
		7/9/97	11	0.00	1.25
		7/10/97	12	2.88	0.08
		7/11/97	13	0.58	1.21
		7/12/97	14	0.00	3.83
		7/13/97	15	0.13	1.29
		7/14/97	16	0.33	2.25
		7/15/97	17	0.83	2.17
		7/16/97	18	0.83	3.42
		7/17/97	19	1.13	3.79
		7/18/97	20	1.17	2.63
		7/19/97	21	0.71	2.04
		7/20/97	22	0.88	1.46
		7/21/97	23	0.50	10.54
		7/22/97	24	0.92	11.46
		7/23/97	25	0.33	10.25
		7/24/97	26	0.50	13.21
		7/25/97	27	0.63	11.88
		7/26/97	28	2.17	9.00
		7/27/97	29	0.67	12.63
		7/28/97	30	0.25	10.38

All average Oxygen values are expressed as a percent

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 5



Morrison Knudsen Corporation

Windrow Constructed June 29, 1997

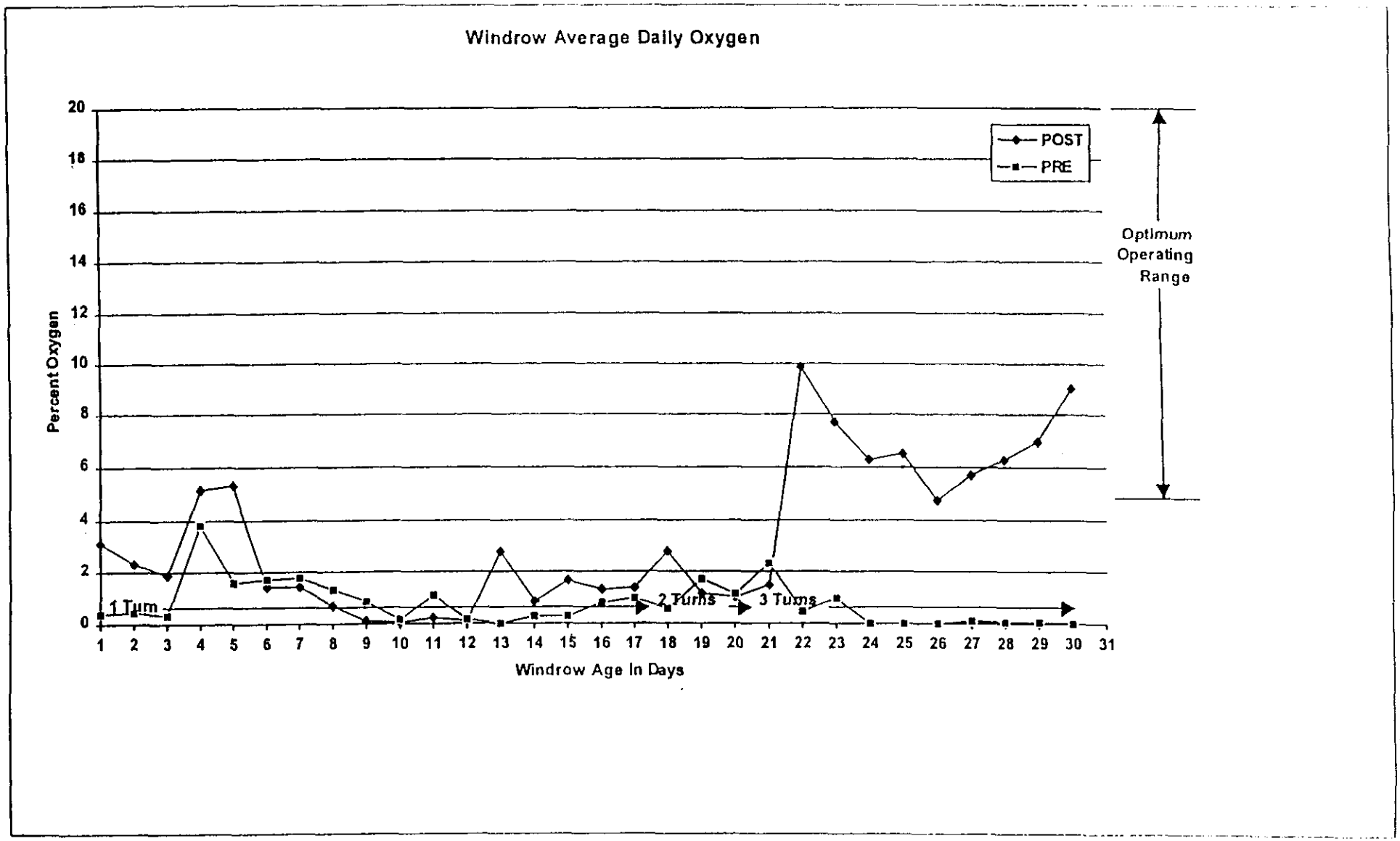
Average Daily Windrow Oxygen Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX5	6/29/97	6/30/97	1	0.38	
		7/1/97	2	1.65	1.38
		7/2/97	3	0.88	1.46
		7/3/97	4	0.54	0.96
		7/4/97	5	0.04	0.54
		7/5/97	6	1.25	1.17
		7/6/97	7	1.33	1.08
		7/7/97	8	0.17	0.33
		7/8/97	9	0.13	0.29
		7/9/97	10	0.00	0.21
		7/10/97	11	0.29	0.42
		7/11/97	12	0.29	0.33
		7/12/97	13	0.04	4.08
		7/13/97	14	0.29	1.08
		7/14/97	15	0.29	1.38
		7/15/97	16	1.17	1.96
		7/16/97	17	1.00	1.67
		7/17/97	18	1.21	4.75
		7/18/97	19	1.00	3.96
		7/19/97	20	1.13	1.17
		7/20/97	21	1.13	1.04
		7/21/97	22	0.08	11.67
		7/22/97	23	1.00	9.13
		7/23/97	24	0.00	3.79
		7/24/97	25	0.17	9.63
		7/25/97	26	0.33	10.25
		7/26/97	27	0.96	4.67
		7/27/97	28	0.21	10.88
		7/28/97	29	0.29	11.42
		7/29/97	30	1.04	10.33

All average Oxygen values are expressed as a percent

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix6



Morrison Knudsen Corporation

Windrow Constructed June 29, 1997

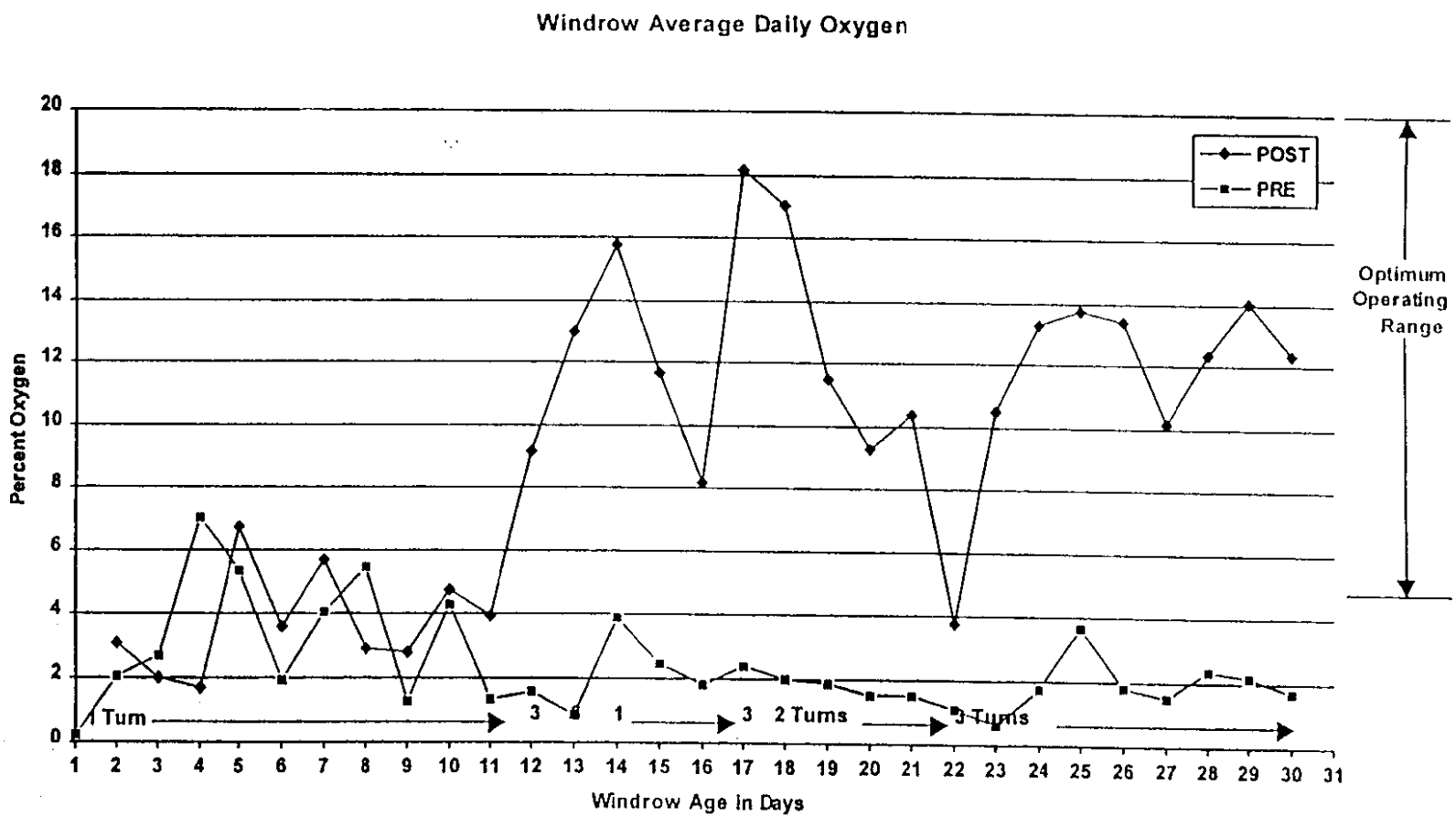
Average Daily Windrow Oxygen Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX6	6/29/97	6/30/97	1	0.38	3.17
		7/1/97	2	0.46	2.33
		7/2/97	3	0.33	1.88
		7/3/97	4	3.83	5.17
		7/4/97	5	1.58	5.33
		7/5/97	6	1.70	1.46
		7/6/97	7	1.79	1.42
		7/7/97	8	1.29	0.71
		7/8/97	9	0.83	0.13
		7/9/97	10	0.17	0.04
		7/10/97	11	1.08	0.25
		7/11/97	12	0.17	0.13
		7/12/97	13	0.00	2.83
		7/13/97	14	0.29	0.88
		7/14/97	15	0.29	1.67
		7/15/97	16	0.79	1.33
		7/16/97	17	0.96	1.38
		7/17/97	18	0.58	2.79
		7/18/97	19	1.71	1.17
		7/19/97	20	1.13	1.04
		7/20/97	21	2.38	1.50
		7/21/97	22	0.46	9.88
		7/22/97	23	1.00	7.71
		7/23/97	24	0.00	6.29
		7/24/97	25	0.00	6.54
		7/25/97	26	0.00	4.75
		7/26/97	27	0.13	5.75
		7/27/97	28	0.08	6.29
		7/28/97	29	0.08	7.00
		7/29/97	30	0.00	9.04

All average Oxygen values are expressed as a percent

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix7B



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

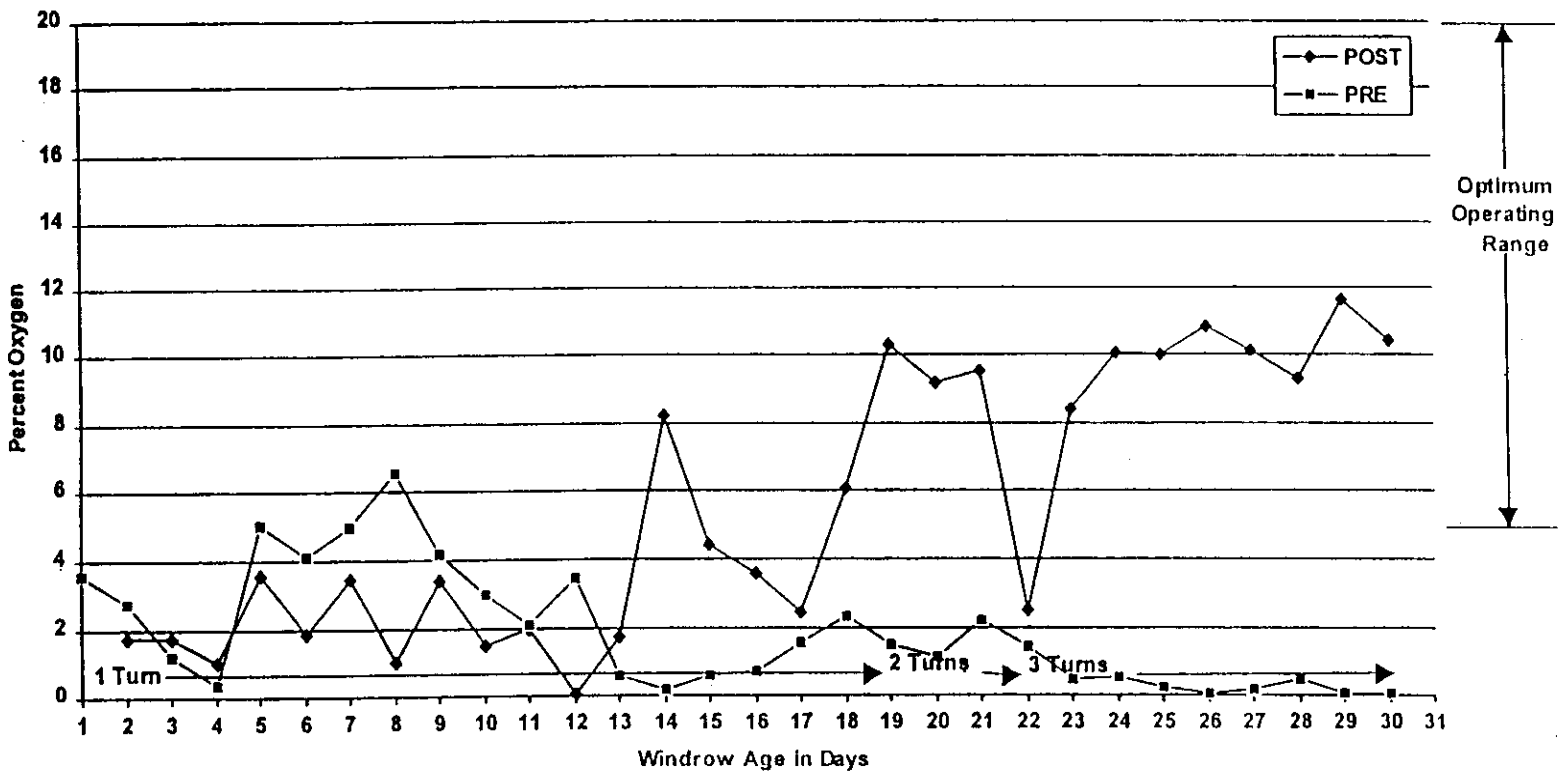
Average Daily Windrow Oxygen Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX7B	6/28/97	6/29/97	1	0.21	
		6/30/97	2	2.04	3.08
		7/1/97	3	2.67	1.96
		7/2/97	4	7.00	1.68
		7/3/97	5	5.33	6.71
		7/4/97	6	1.92	3.58
		7/5/97	7	4.08	5.67
		7/6/97	8	5.46	2.88
		7/7/97	9	1.29	2.79
		7/8/97	10	4.29	4.75
		7/9/97	11	1.33	3.92
		7/10/97	12	1.54	9.17
		7/11/97	13	0.88	13.00
		7/12/97	14	3.88	15.75
		7/13/97	15	2.44	11.64
		7/14/97	16	1.80	8.20
		7/15/97	17	2.35	18.16
		7/16/97	18	1.96	17.04
		7/17/97	19	1.83	11.46
		7/18/97	20	1.50	9.29
		7/19/97	21	1.50	10.38
		7/20/97	22	1.13	3.79
		7/21/97	23	0.63	10.50
		7/22/97	24	1.75	13.29
		7/23/97	25	3.63	13.75
		7/24/97	26	1.79	13.42
		7/25/97	27	1.50	10.17
		7/26/97	28	2.29	12.38
		7/27/97	29	2.17	14.04
		7/28/97	30	1.67	12.33

All average Oxygen values are expressed as a percent

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix7C



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

Average Daily Windrow Oxygen Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (%)	POST-Turn (%)
MIX7C	6/28/97	6/29/97	1	3.63	
		6/30/97	2	2.75	1.75
		7/1/97	3	1.21	1.75
		7/2/97	4	0.33	1.00
		7/3/97	5	5.04	3.63
		7/4/97	6	4.17	1.88
		7/5/97	7	4.96	3.46
		7/6/97	8	6.54	1.04
		7/7/97	9	4.21	3.42
		7/8/97	10	3.00	1.50
		7/9/97	11	2.13	2.00
		7/10/97	12	3.50	0.08
		7/11/97	13	0.58	1.75
		7/12/97	14	0.17	8.25
		7/13/97	15	0.63	4.42
		7/14/97	16	0.71	3.63
		7/15/97	17	1.54	2.46
		7/16/97	18	2.33	6.04
		7/17/97	19	1.50	10.33
		7/18/97	20	1.17	9.17
		7/19/97	21	2.25	9.54
		7/20/97	22	1.42	2.54
		7/21/97	23	0.46	8.42
		7/22/97	24	0.54	10.08
		7/23/97	25	0.25	10.04
		7/24/97	26	0.04	10.88
		7/25/97	27	0.17	10.17
		7/26/97	28	0.50	9.29
		7/27/97	29	0.04	11.67
		7/28/97	30	0.08	10.48

All average Oxygen values are expressed as a percent

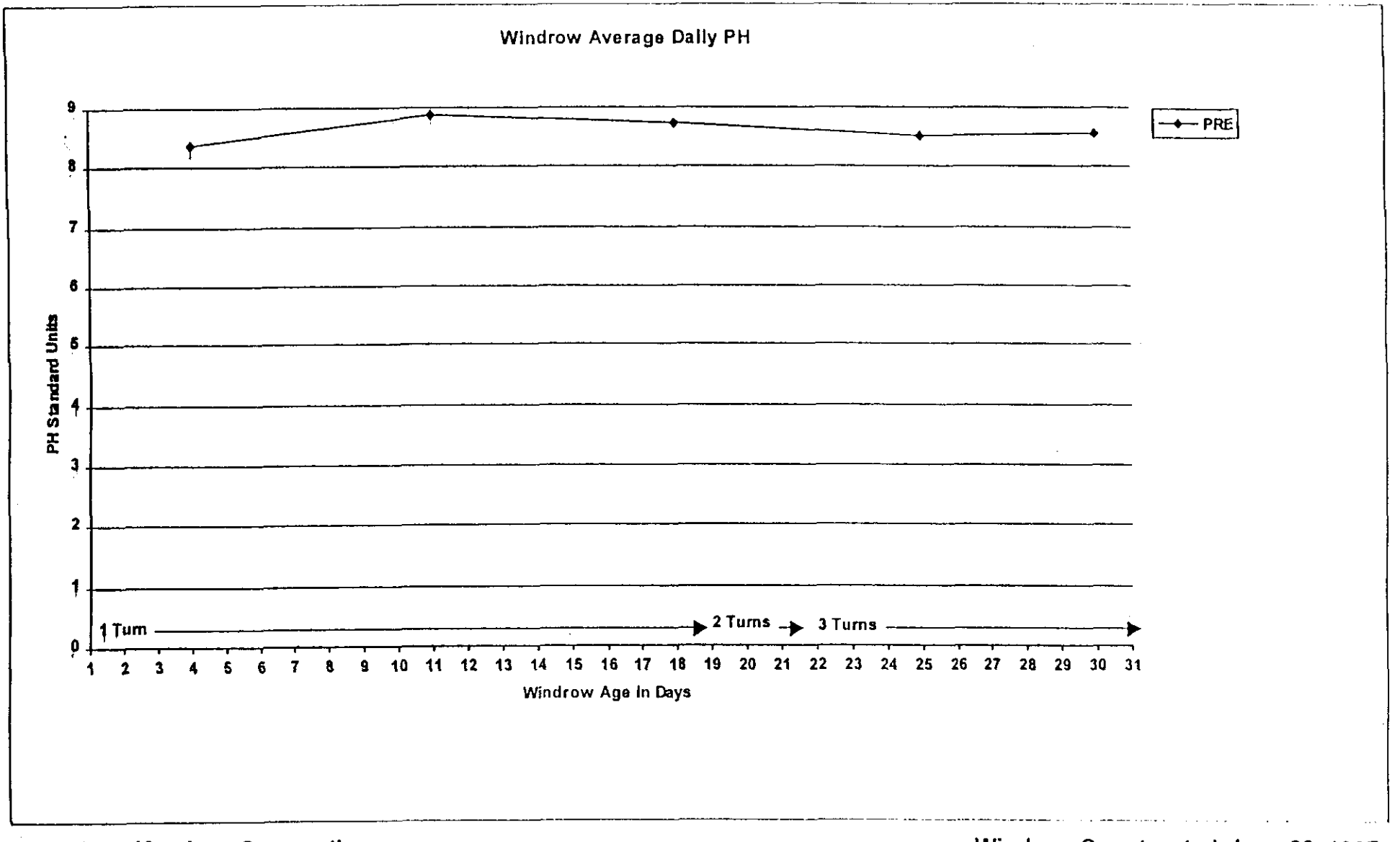
APPENDIX F
CLEAN SOIL pH

APPENDIX F
TABLE OF CONTENTS

DESCRIPTION	NO. PAGES
CLEAN SOIL pH	14 pages

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 2



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

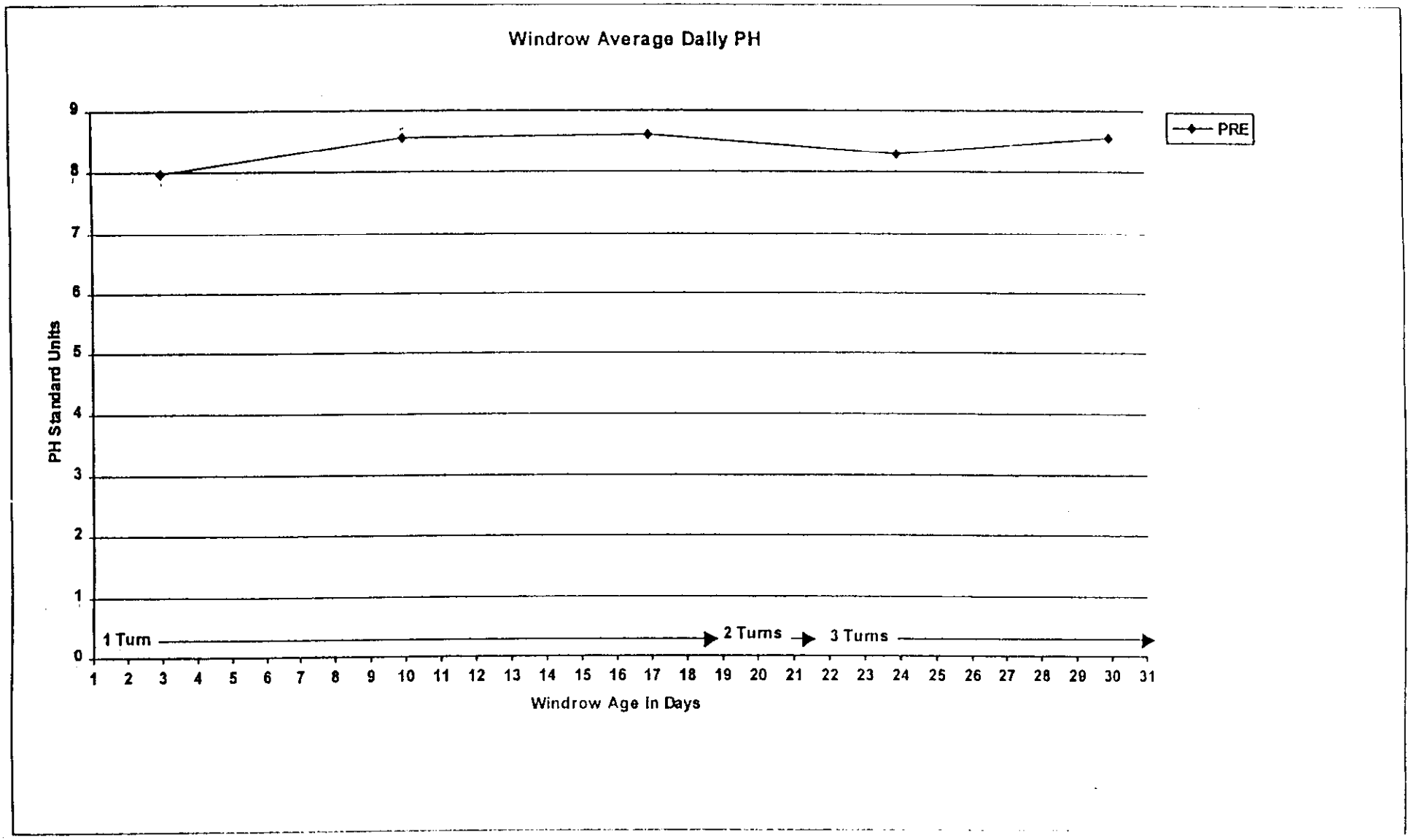
Average Daily Windrow PH Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (STD Units)*
MIX2	6/28/97	7/2/97	4	8.38
		7/9/97	11	8.88
		7/16/97	18	8.73
		7/23/97	25	8.52
		7/28/97	30	8.57

All average PH values are expressed in standard units

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 3



Morrison Knudsen Corporation

Windrow Constructed June 29, 1997

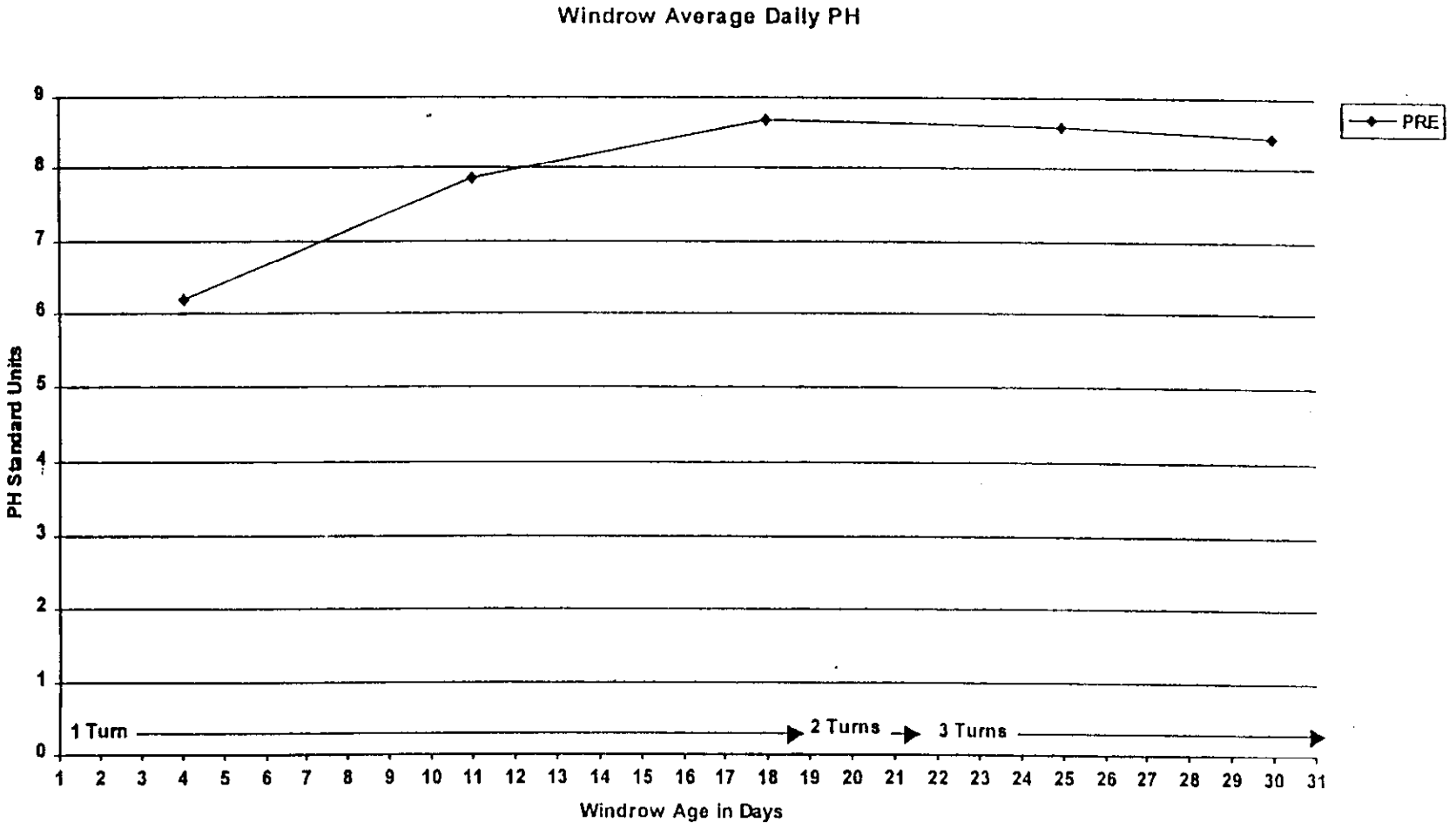
Average Daily Windrow PH Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (STD Units)*
MIX3	6/29/97	7/2/97	3	7.99
		7/9/97	10	8.57
		7/16/97	17	8.61
		7/23/97	24	8.30
		7/29/97	30	8.58

All average PH values are expressed in standard units

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix4



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

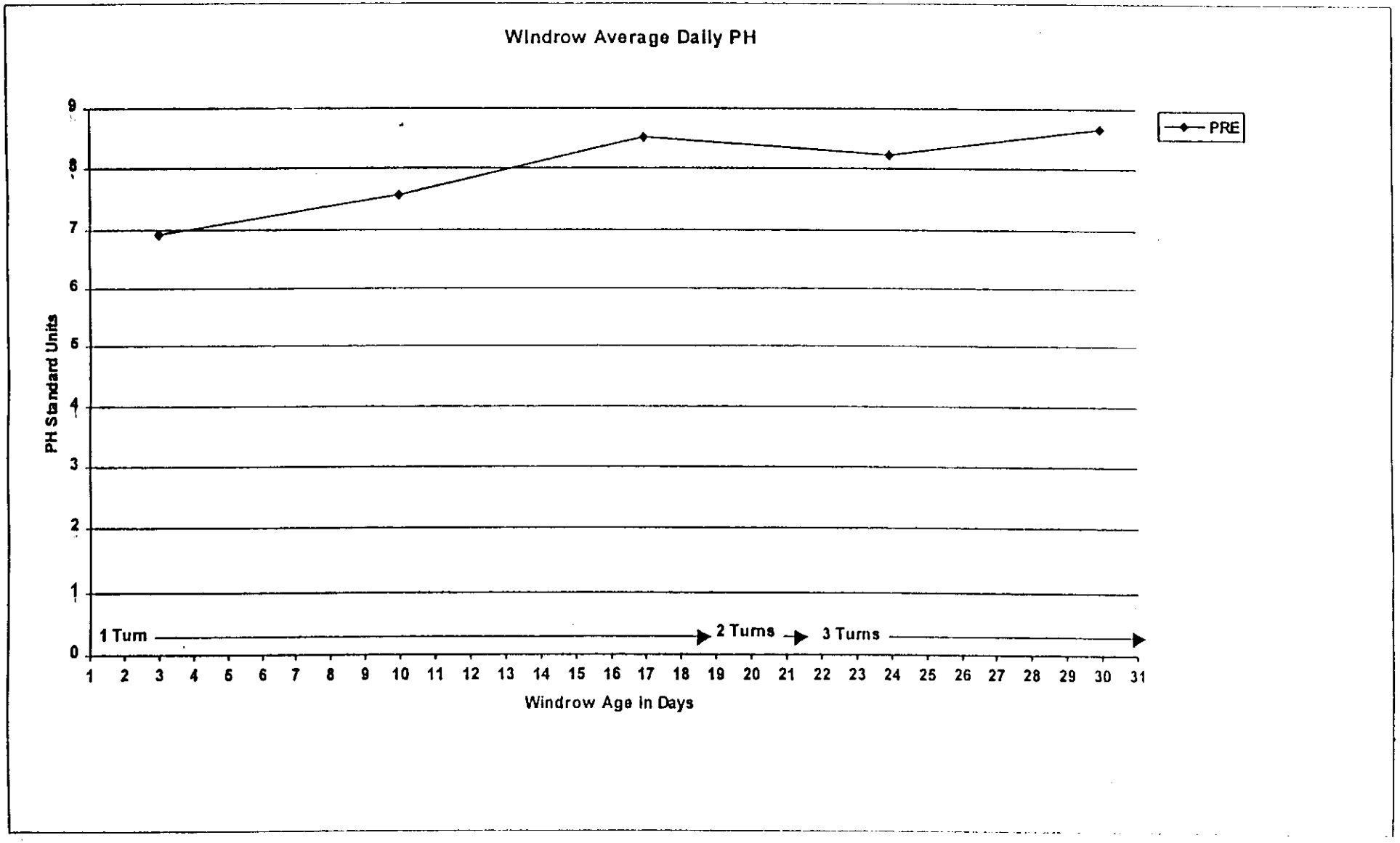
Average Daily Windrow PH Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (STD Units)*
MIX4	6/28/97	7/2/97	4	6.18
		7/9/97	11	7.88
		7/16/97	18	8.69
		7/23/97	25	8.60
		7/28/97	30	8.45

All average PH values are expressed in standard units

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 5



Morrison Knudsen Corporation

Windrow Constructed June 29, 1997

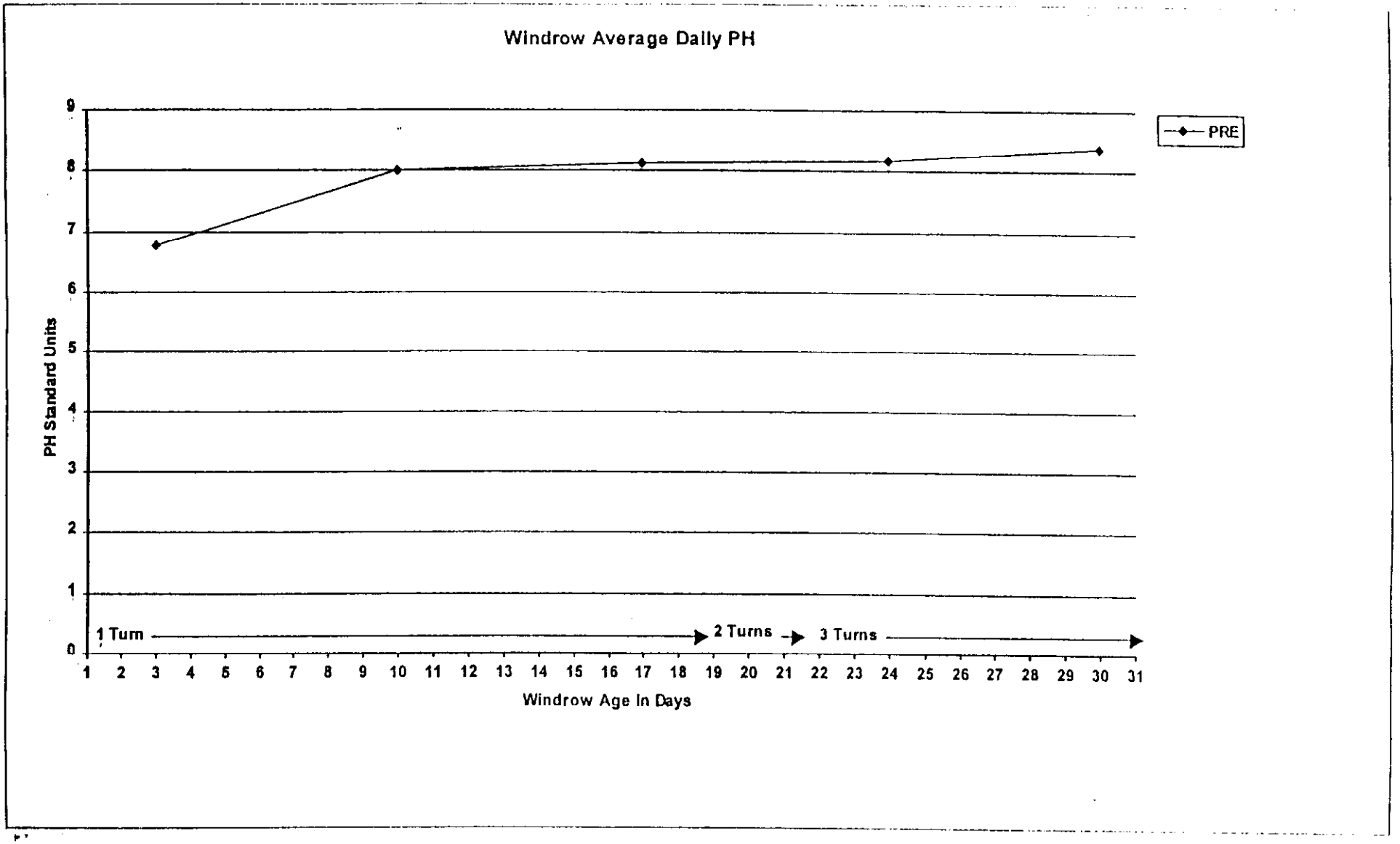
Average Daily Windrow PH Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (STD Units)*
MIX5	6/29/97	7/2/97	3	6.92
		7/9/97	10	7.58
		7/16/97	17	8.52
		7/23/97	24	8.23
		7/29/97	30	8.65

All average PH values are expressed in standard units

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix6



Morrison Knudsen Corporation

Windrow Constructed June 29, 1997

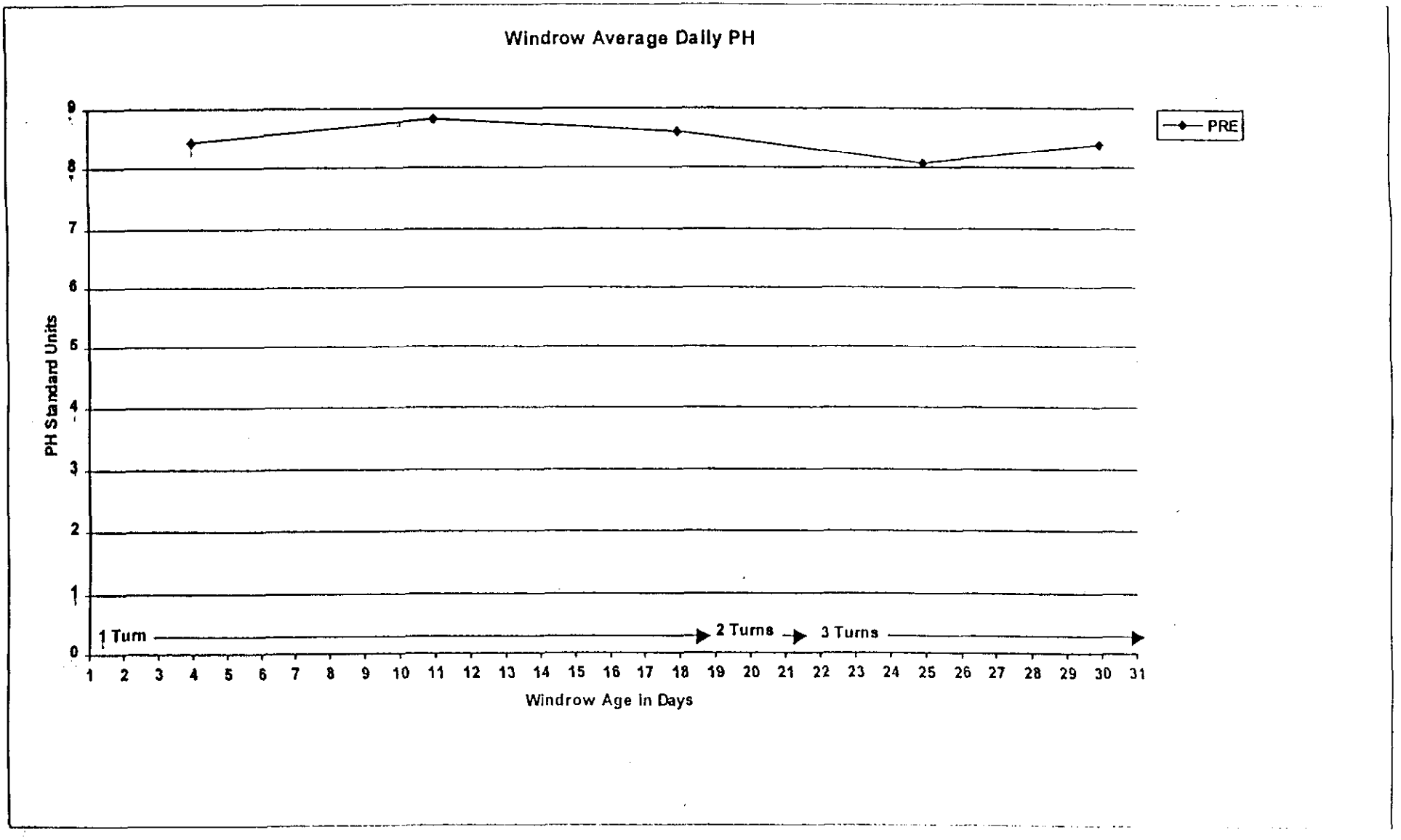
Average Daily Windrow PH Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (STD Units)*
MIX6	6/29/97	7/2/97	3	6.78
		7/9/97	10	8.00
		7/16/97	17	8.14
		7/23/97	24	8.19
		7/29/97	30	8.40

All average PH values are expressed in standard units

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix7B



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

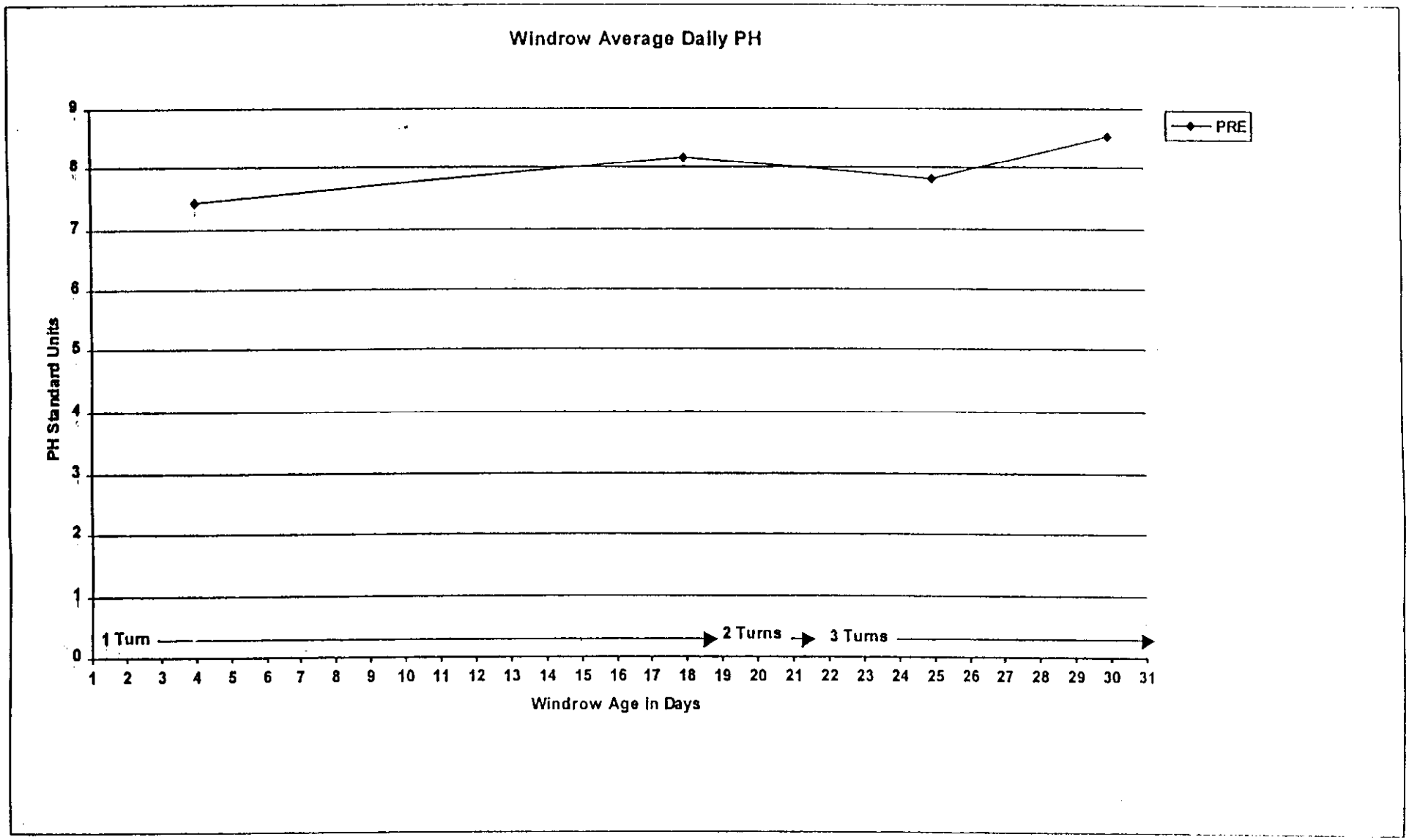
Average Daily Windrow PH Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (STD Units)*
MIX7B	6/28/97	7/2/97	4	8.44
		7/9/97	11	8.83
		7/16/97	18	8.61
		7/23/97	25	8.07
		7/28/97	30	8.40

All average PH values are expressed in standard units

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix7C



Morrison Knudsen Corporation

Windrow Constructed June 28, 1997

Average Daily Windrow PH Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (STD Units)*
MIX7C	6/28/97	7/2/97	4	7.43
		7/16/97	18	8.19
		7/23/97	25	7.82
		7/28/97	30	8.55

All average PH values are expressed in standard units

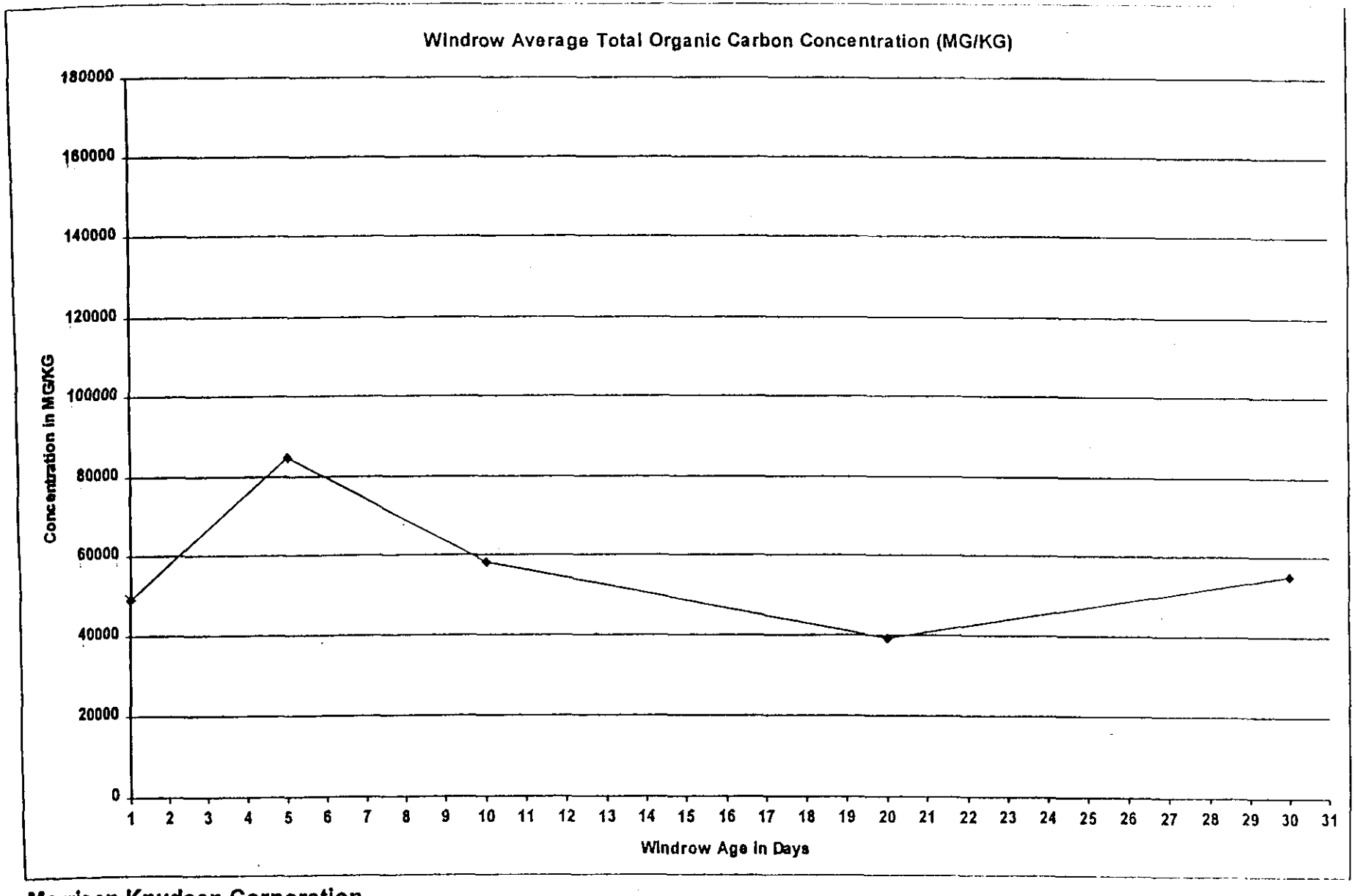
APPENDIX G
CLEAN SOIL C:N

APPENDIX G
TABLE OF CONTENTS

DESCRIPTION	NO. PAGES
CLEAN SOIL C:N	28 pages

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 2



Morrison Knudsen Corporation

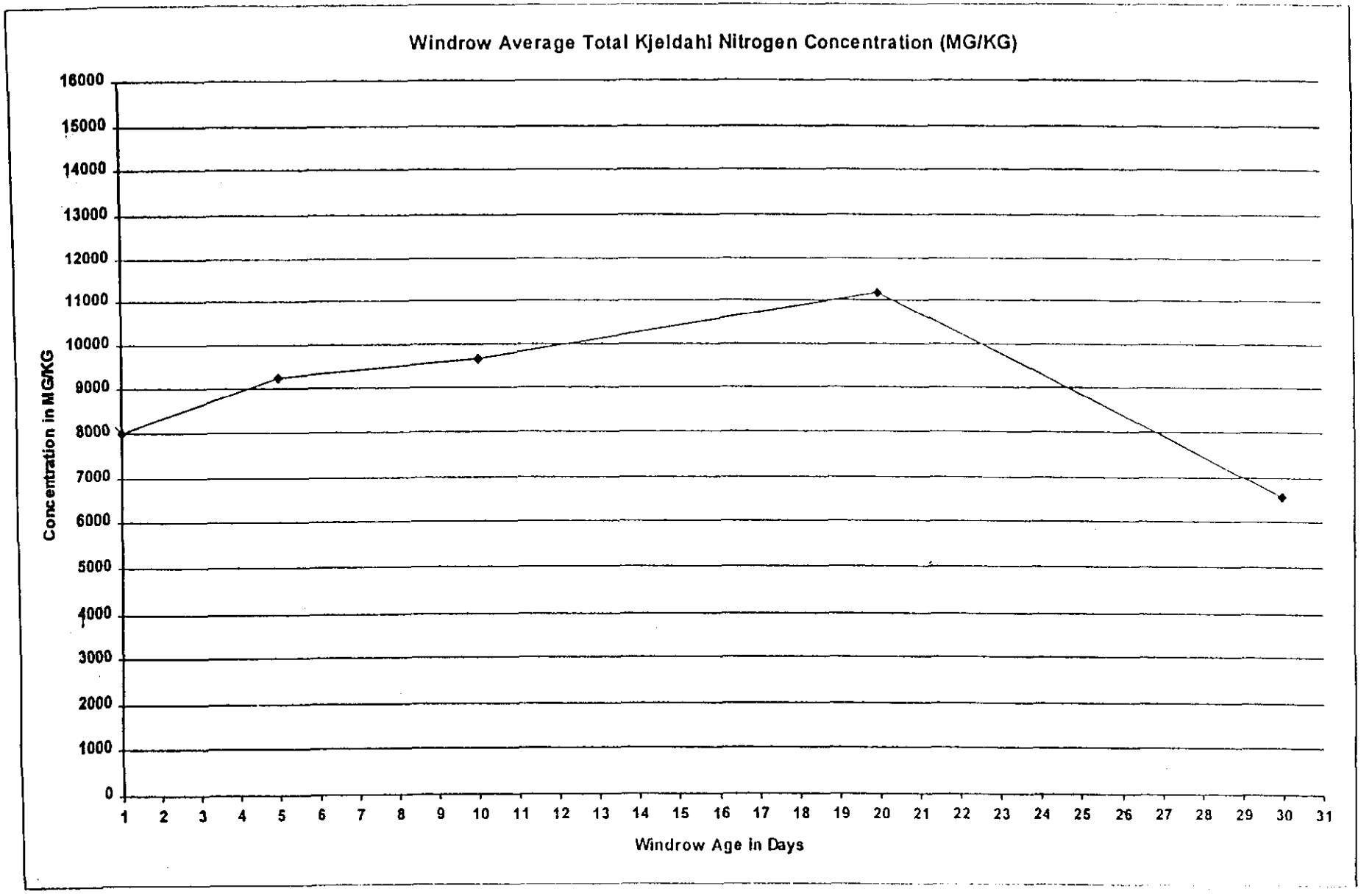
Average Daily Windrow TOC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX2	6/28/97	6/28/97	0	59167
		6/29/97	1	49300
		7/3/97	5	84760
		7/8/97	10	58367
		7/18/97	20	39242
		7/28/97	30	55292

All average TOC values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 2



Morrison Knudsen Corporation

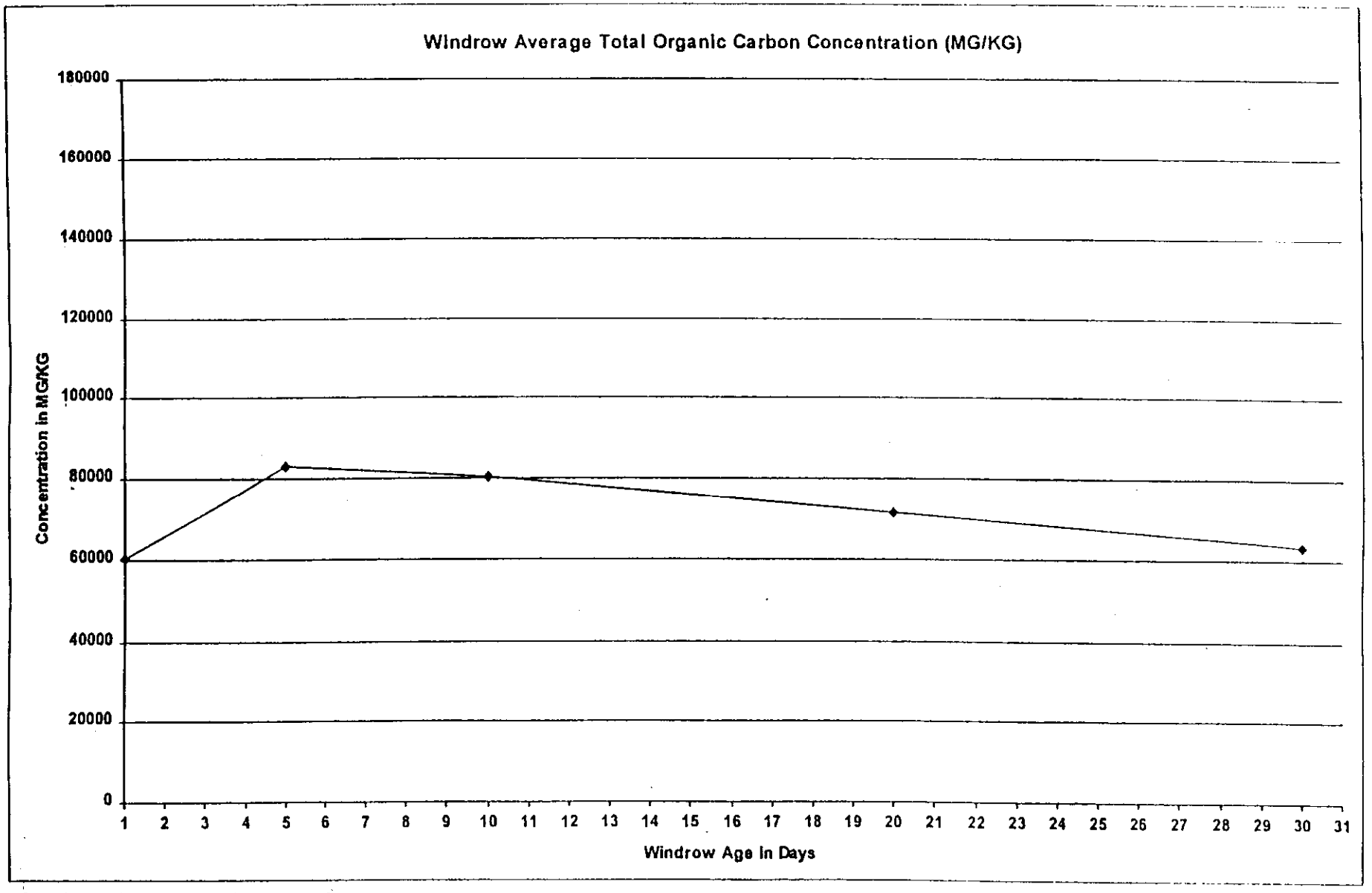
Average Daily Windrow TKN Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX2	6/28/97	6/28/97	0	9060
		6/29/97	1	8012
		7/3/97	5	9233
		7/8/97	10	9639
		7/18/97	20	11182
		7/28/97	30	6558

All average TKN values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 3



Morrison Knudsen Corporation

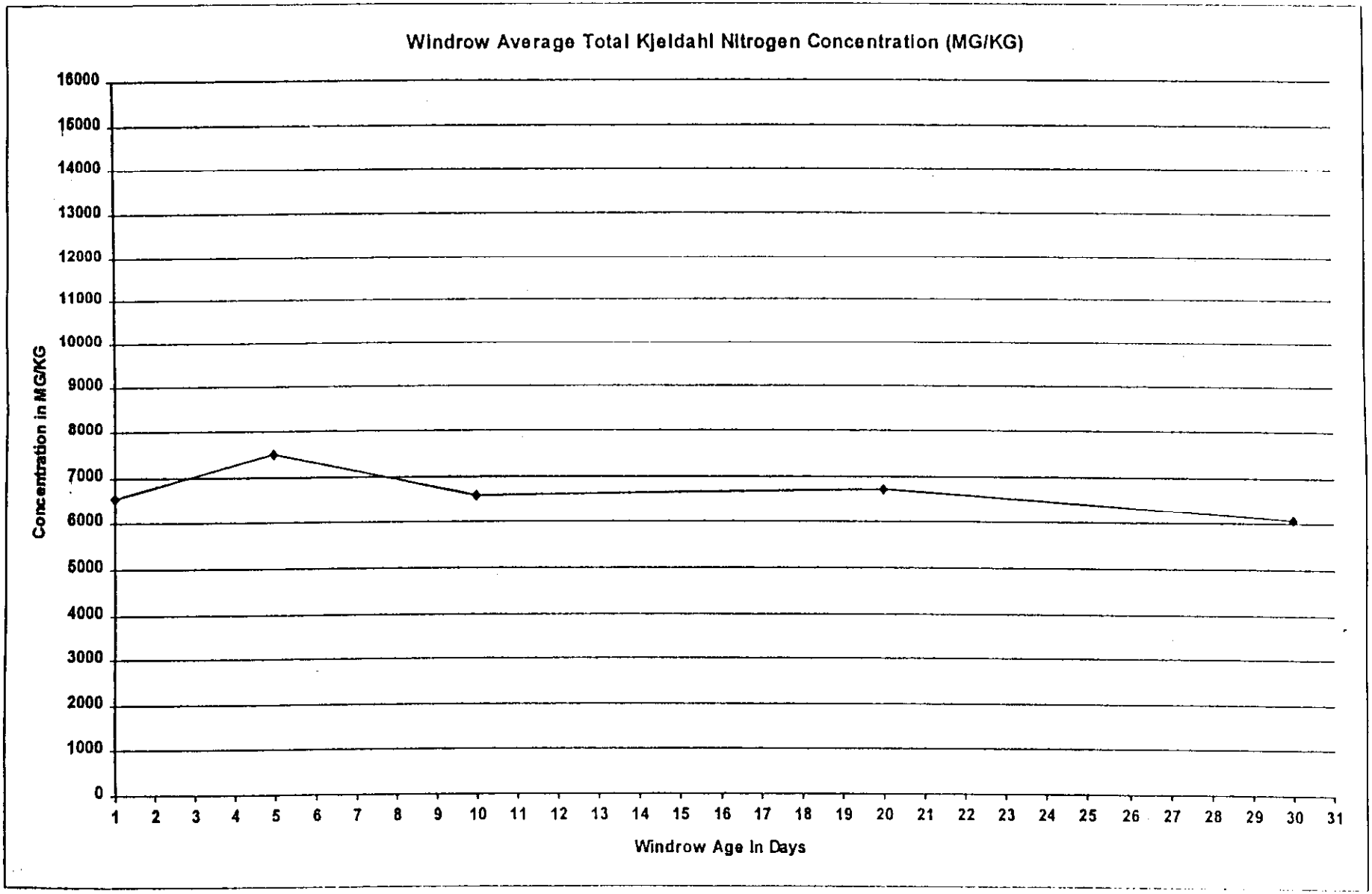
Average Daily Windrow TOC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX3	6/29/97	6/30/97	1	60366
		7/4/97	5	82942
		7/9/97	10	80450
		7/19/97	20	71567
		7/29/97	30	63333

All average TOC values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 3



Morrison Knudsen Corporation

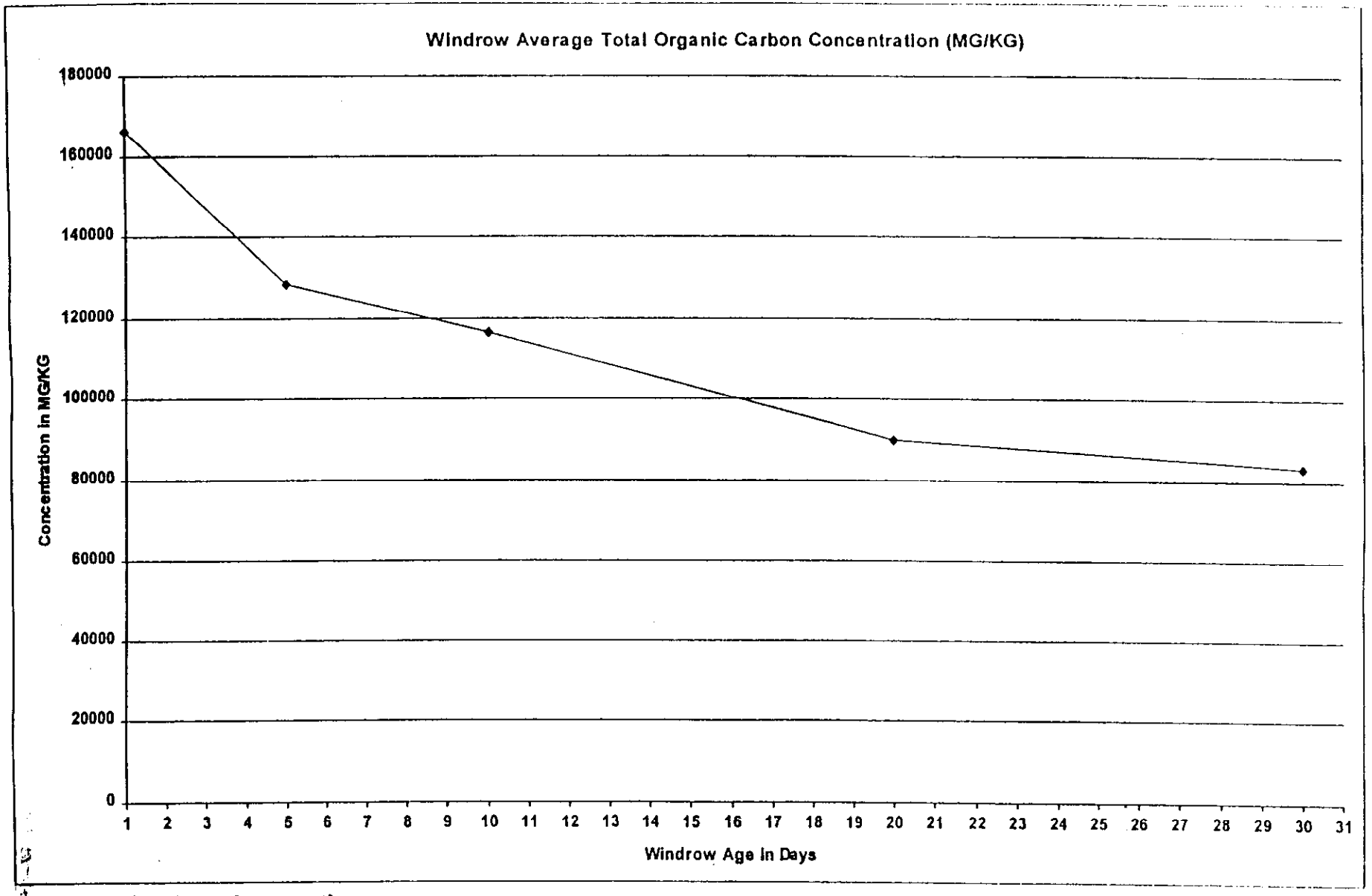
Average Daily Windrow TKN Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX3	6/29/97	6/30/97	1	6532
		7/4/97	5	7497
		7/9/97	10	6584
		7/19/97	20	6729
		7/29/97	30	6090

All average TKN values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 4



Morrison Knudsen Corporation

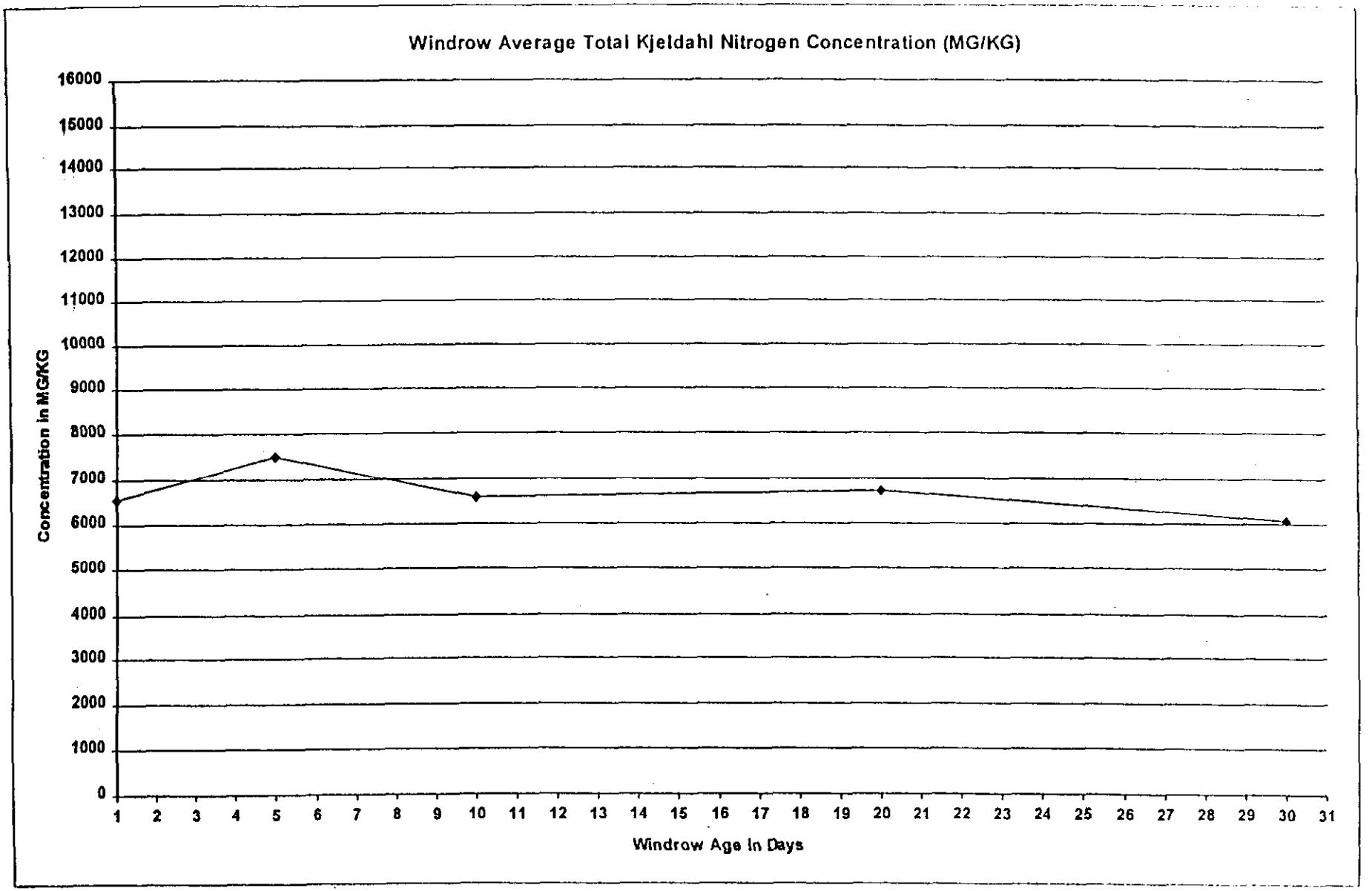
Average Daily Windrow TOC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX4	6/28/97	6/29/97	1	166117
		7/3/97	5	128617
		7/8/97	10	116625
		7/18/97	20	89950
		7/28/97	30	83325

All average TOC values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 4



Morrison Knudsen Corporation

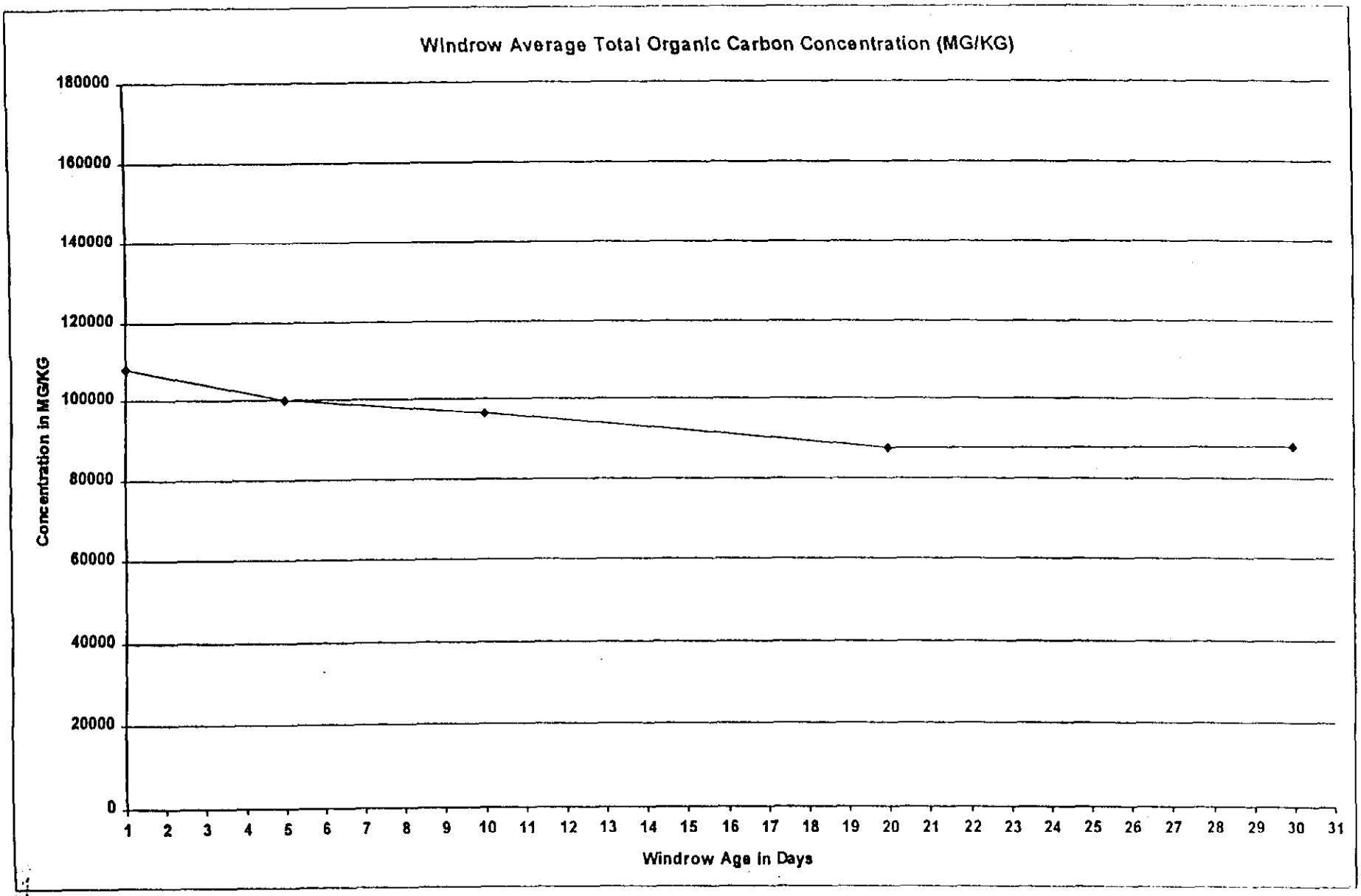
Average Daily Windrow TKN Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX4	6/28/97	6/29/97	1	5952
		7/3/97	5	8505
		7/8/97	10	7955
		7/18/97	20	6901
		7/28/97	30	5093

All average TKN values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilot ale Demonstration

Compost Recipe Mix 5



Morrison Knudsen Corporation

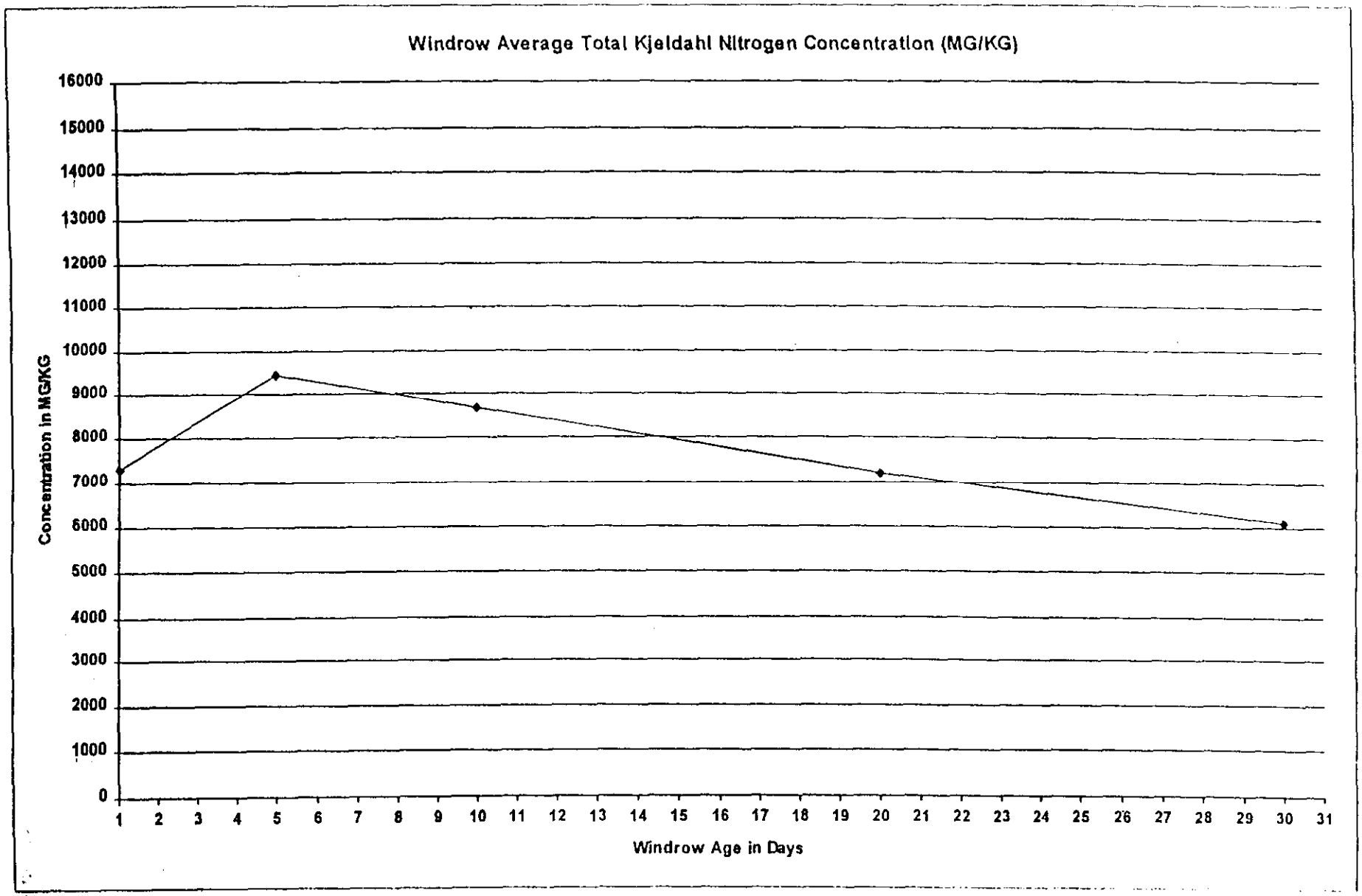
Average Daily Windrow TOC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX5	6/29/97	6/30/97	1	107908
		7/4/97	5	100125
		7/9/97	10	96358
		7/19/97	20	87225
		7/29/97	30	87908

All average TOC values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 5



Morrison Knudsen Corporation

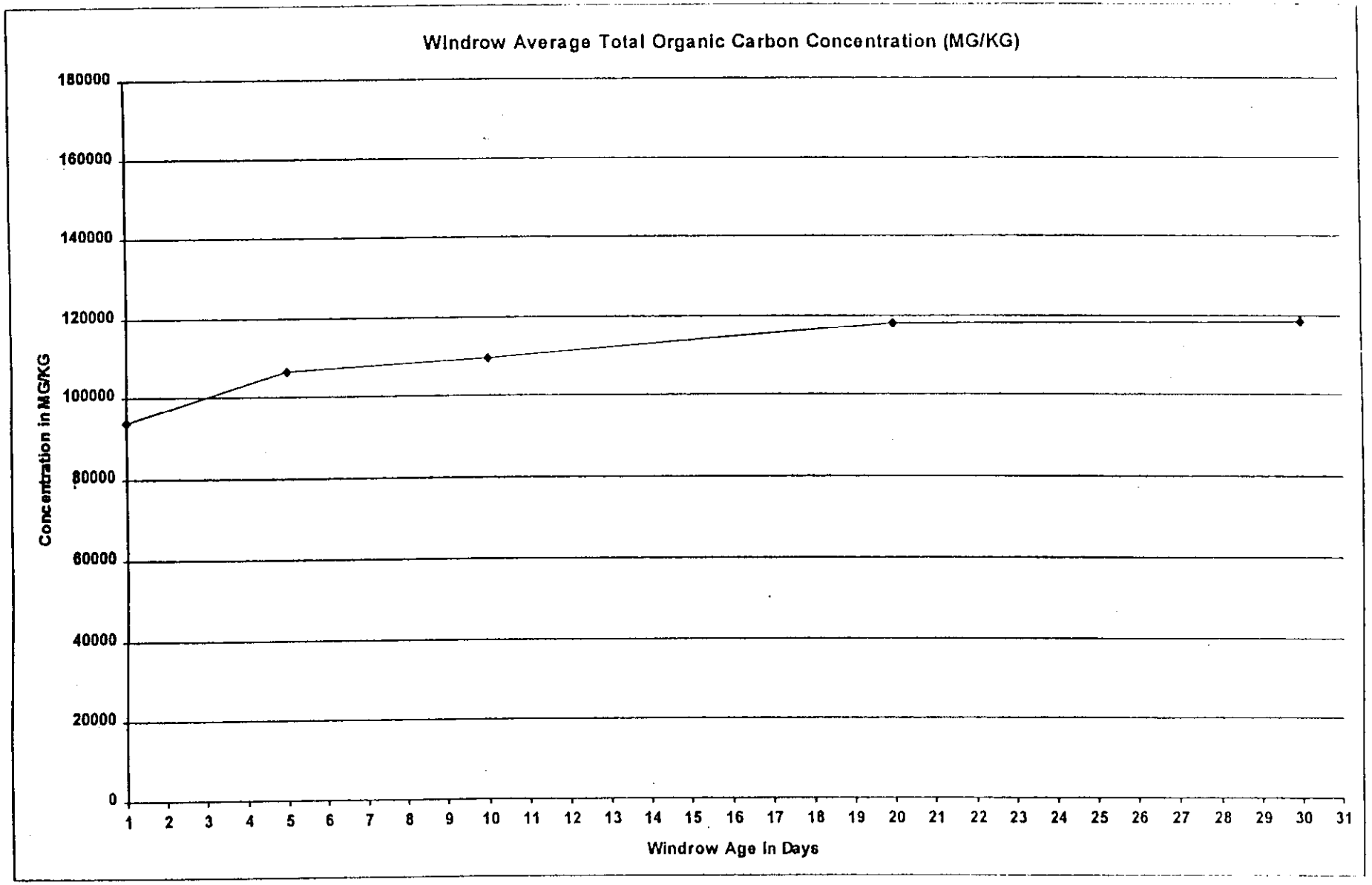
Average Daily Windrow TKN Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX5	6/29/97	6/30/97	1	7300
		7/4/97	5	9467
		7/9/97	10	8692
		7/19/97	20	7203
		7/29/97	30	6105

All average TKN values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 6



Morrison Knudsen Corporation

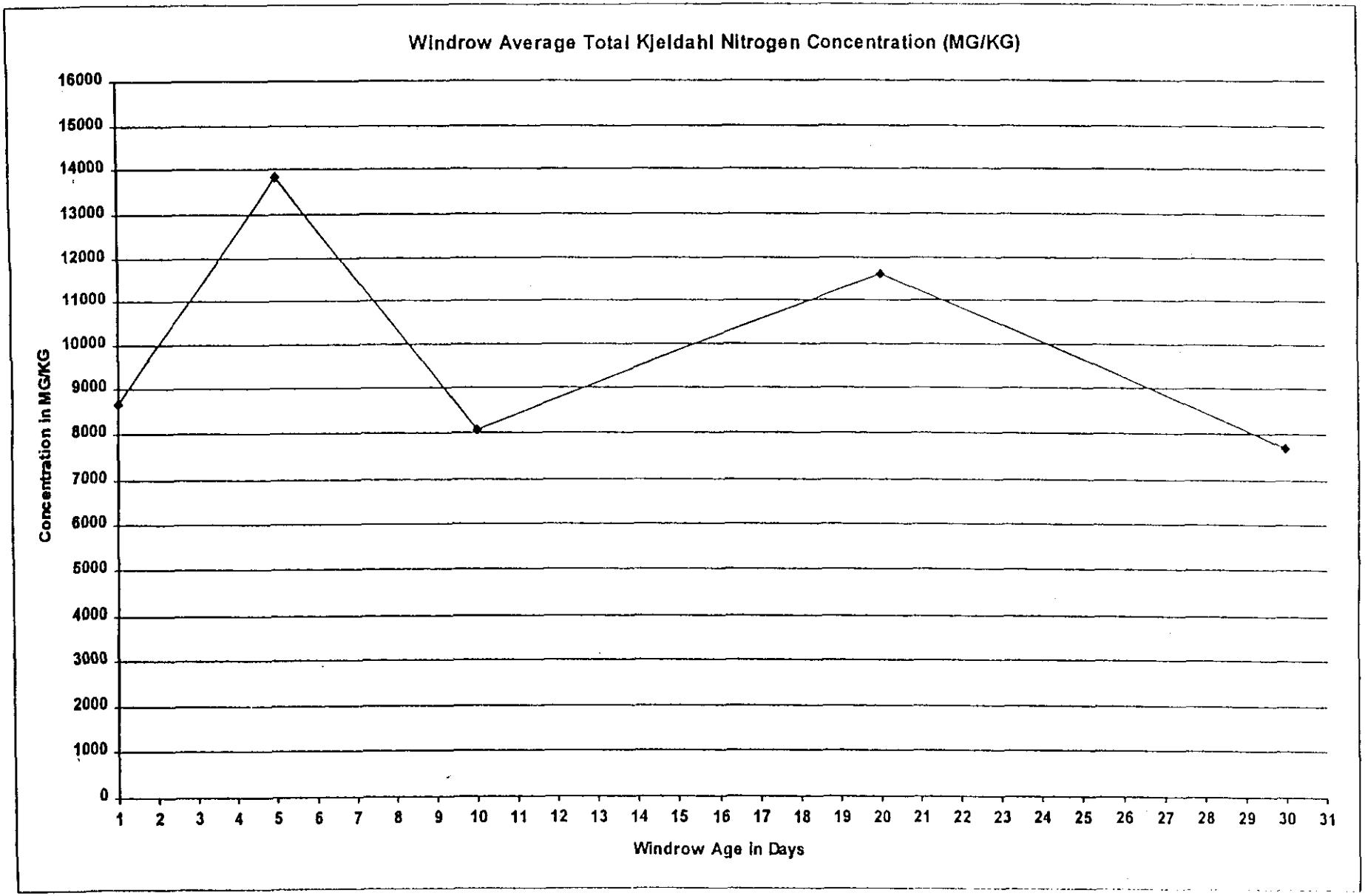
Average Daily Windrow TOC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX6	6/29/97	6/30/97	1	93725
		7/4/97	5	106600
		7/9/97	10	109308
		7/19/97	20	117929
		7/29/97	30	118471

All average TOC values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilc. ɔcale Demonstration

Compost Recipe Mix 6



Morrison Knudsen Corporation

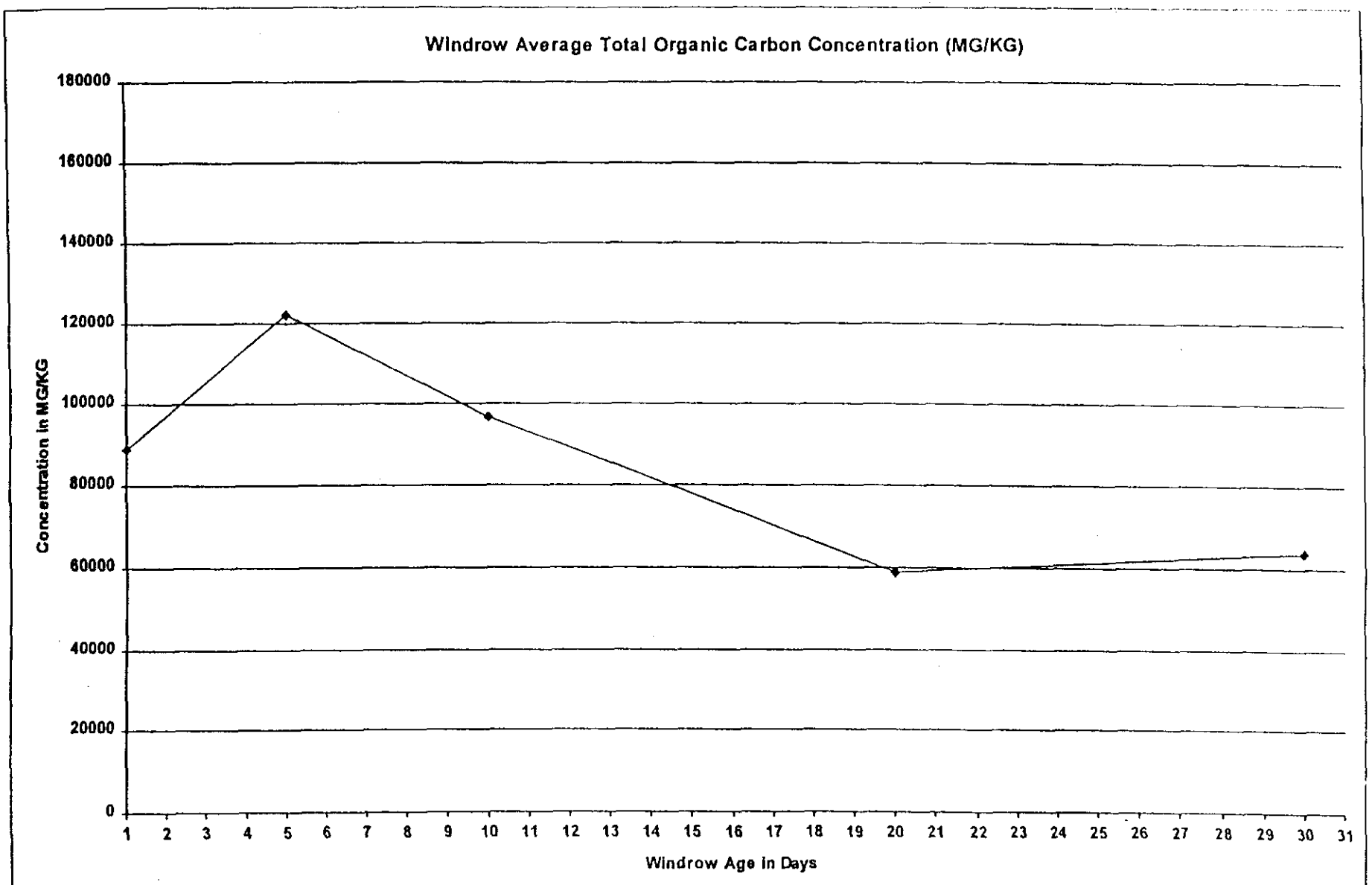
Average Daily Windrow TKN Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX6	6/29/97	6/30/97	1	8687
		7/4/97	5	13841
		7/9/97	10	8078
		7/19/97	20	11609
		7/29/97	30	7693

All average TKN values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 7B



Morrison Knudsen Corporation

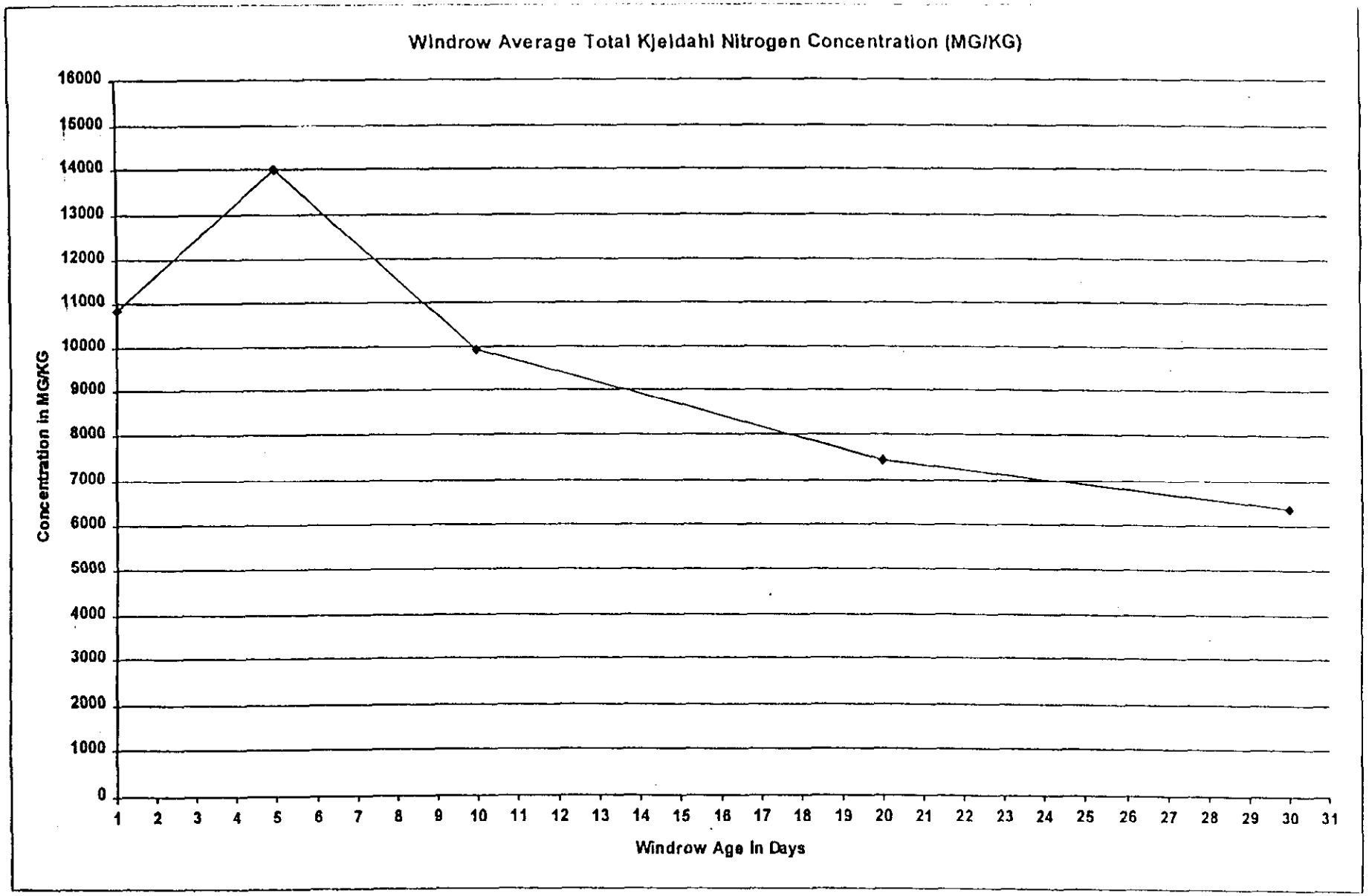
Average Daily Windrow TOC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX7B	6/28/97	6/29/97	1	88717
		7/3/97	5	122167
		7/8/97	10	96833
		7/18/97	20	59133
		7/28/97	30	63933

All average TOC values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 7B



Morrison Knudsen Corporation

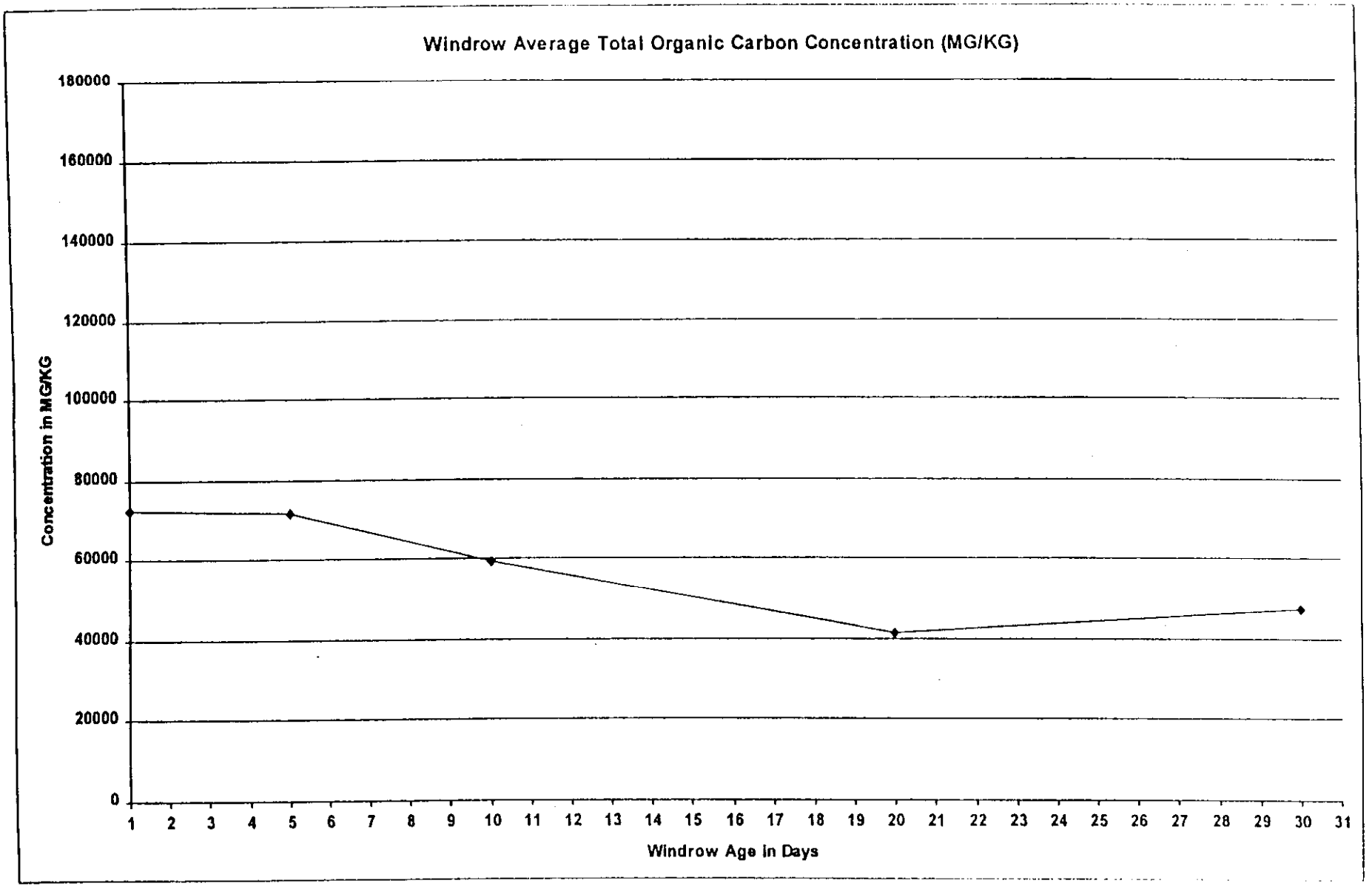
Average Daily Windrow TKN Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX7B	6/28/97	6/29/97	1	10850
		7/3/97	5	13993
		7/8/97	10	9937
		7/18/97	20	7436
		7/28/97	30	6393

All average TKN values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 7C



Morrison Knudsen Corporation

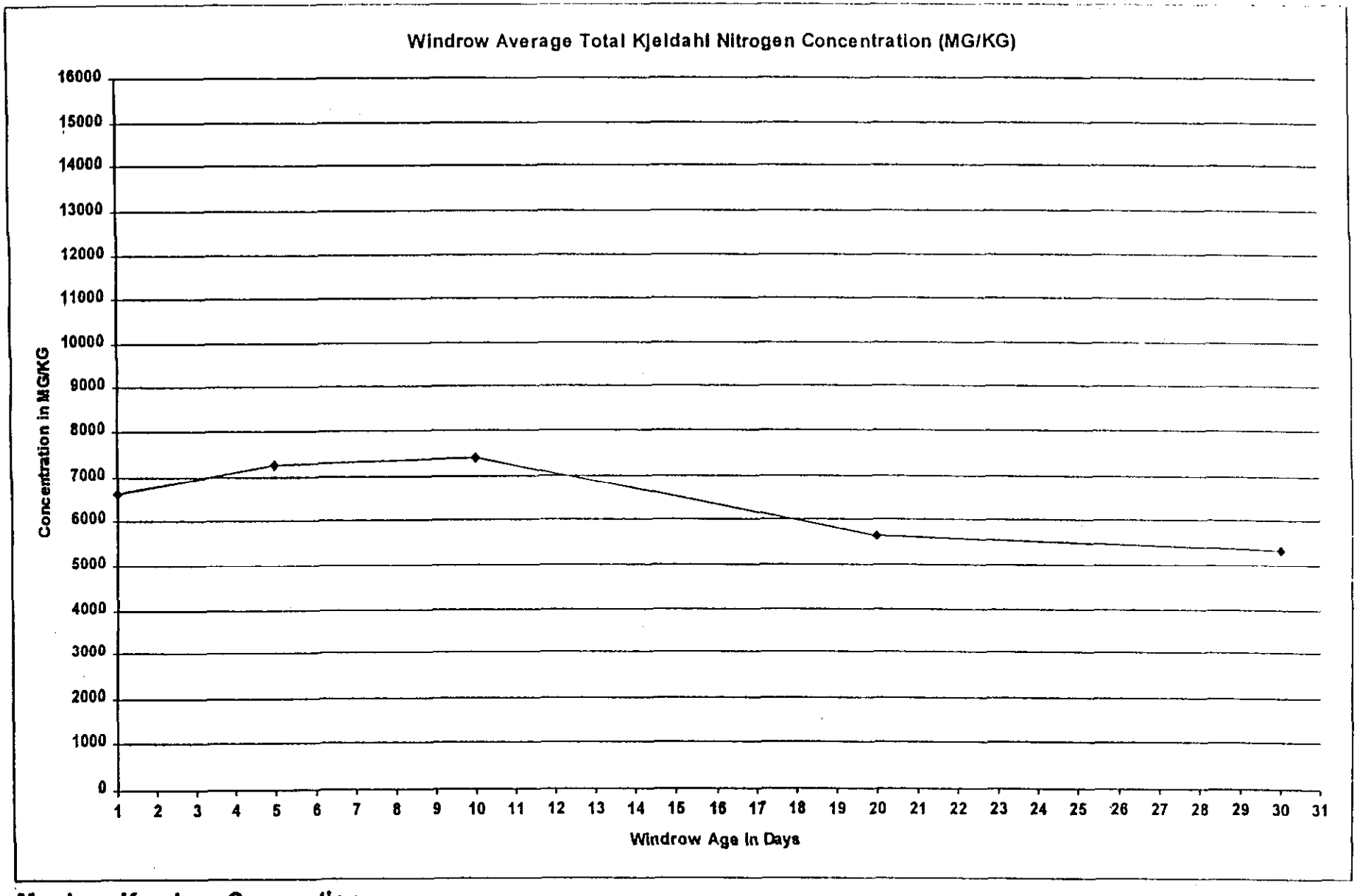
Average Daily Windrow TOC Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX7C	6/28/97	6/29/97	1	72542
		7/3/97	5	71675
		7/8/97	10	59267
		7/18/97	20	41275
		7/28/97	30	47500

All average TOC values are expressed in milligrams per kilogram

NWSC Crane BioFacility Pilot Scale Demonstration

Compost Recipe Mix 7C



Morrison Knudsen Corporation

Average Daily Windrow TKN Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Concentration (MG/KG)*
MIX7C	6/28/97	6/29/97	1	6611
		7/3/97	5	7244
		7/8/97	10	7406
		7/18/97	20	5628
		7/28/97	30	5349

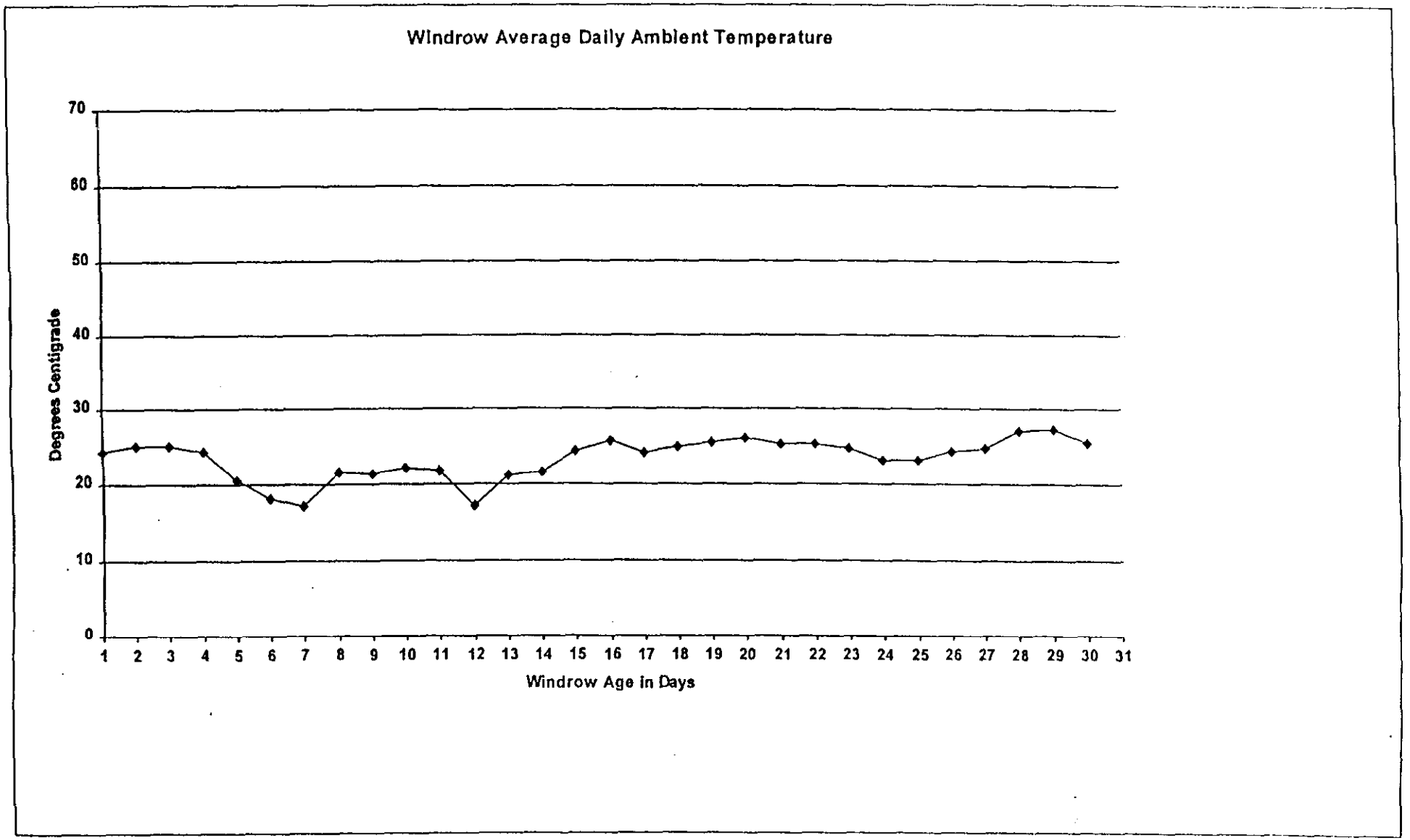
All average TKN values are expressed in milligrams per kilogram

APPENDIX H
CLEAN SOIL AMBIENT TEMPERATURE AND HUMIDITY

APPENDIX H
TABLE OF CONTENTS

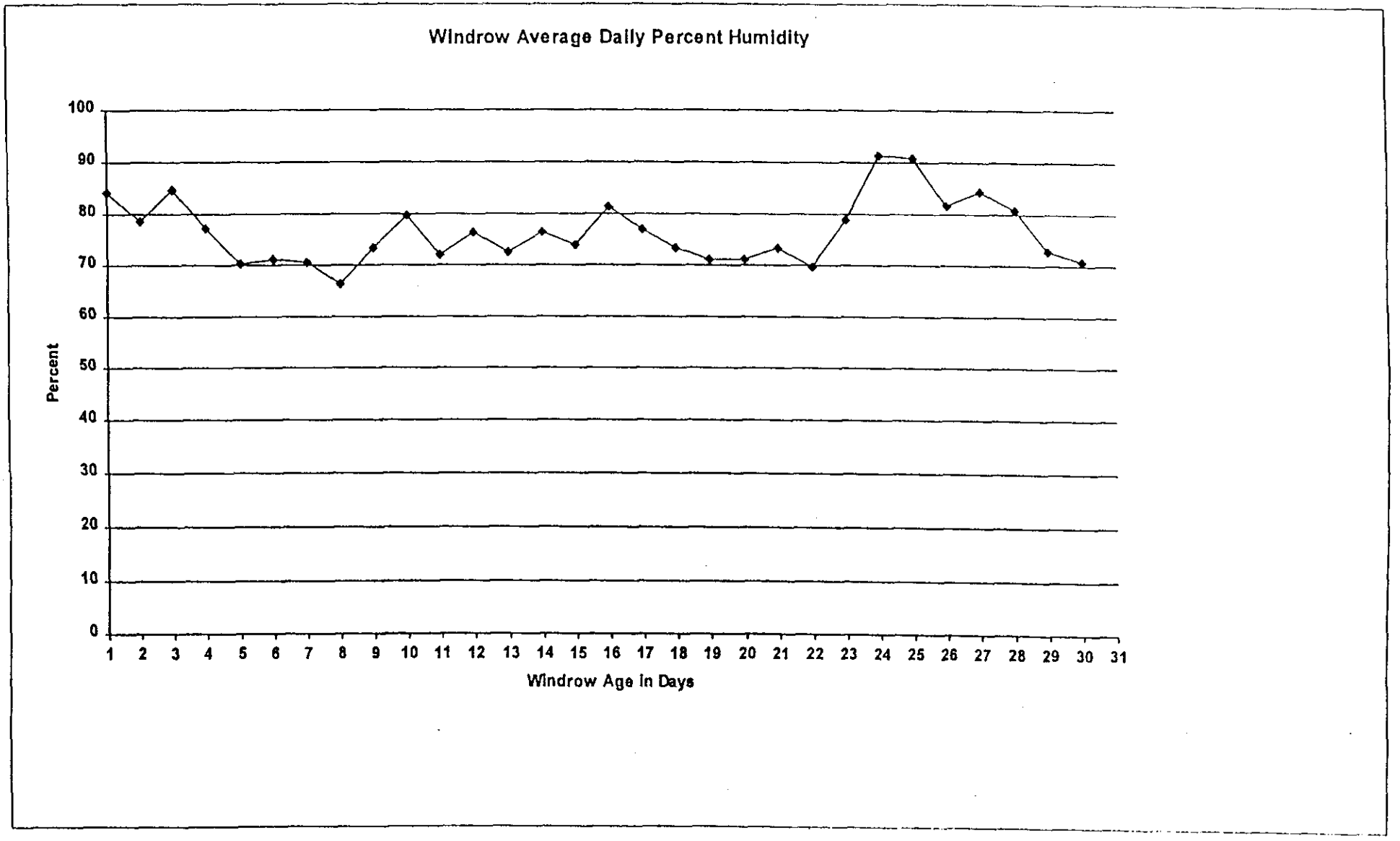
DESCRIPTION	NO. PAGES
CLEAN SOIL AMBIENT TEMPERATURE AND HUMIDITY	2 pages

NWSC Crane BioFacility Pilc. Scale Demonstration



Morrison Knudsen Corporation

NWSC Crane BioFacility Pilot Scale Demonstration



Morrison Knudsen Corporation

APPENDIX I
CONTAMINATED SOIL RECORD OF RECIPE

APPENDIX I
TABLE OF CONTENTS

DESCRIPTION	NO. PAGES
CONTAMINATED SOIL RECORD OF RECIPE	7 pages

RECORD OF RECIPE

RECIPE # 1 (Batch 2)

DATE: 10/9/97

PERFORMED BY: Rick Dayhoff

INSPECTED BY: [illegible]

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH 2 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		SUPPLIER
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	
Turkey Manure											
Chicken Manure											
Cow Manure											
POTW Sludge	15	25275	—	—	—	—	—	—	15	25275	NAVY SEWAGE TREATMENT PLANT
Vegetable Waste											
Alfalfa	15	4215	4.6	900	4.7	920	4.8	920	14.1	2790	DAYHOFF FARMS
Straw											
Wood Chips	7.5	3975	2.5	1860	2.5	1880	2.5	1800	7.5	5530	KAHO BROS.
Sawdust	7.5	3025	2.5	1800	2.5	1850	2.4	1730	7.4	5380	KAHO BROS.
Soil	15	32600	—	—	—	—	—	—	15	32600	NSWC-CRANE
Total	60	69140							59	71575	

Comments: WATER ADDED 150 gal ~~150 gal~~ ~~150 gal~~

RECORD OF RECIPE

RECIPE # 3 (Bldg 2) **PERFORMED BY:** R.Dayhoff

DATE: 9/19/97 **INSPECTED BY:** T. Dogal

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH 2 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		Supplier
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	
Turkey Manure	15	11745	5	4800	5.1	5150	5.2	5400	15.3	15350	D. Benham-Purdue Farms Dayhoff Farms
Chicken Manure											
Cow Manure											
POTW Sludge											
Vegetable Waste											
Alfalfa	15	4215	4.9	1400	5.2	1500	5.3	1600	15.4	4500	Dayhoff Farms
Straw											
Wood Chips	15	7950	5	2000	5	2350	5.2	2800	15.2	7150	Kaho Brothers
Sawdust											
Soil	15	32600			-	-	-	-	15	32600	NSWC Crane
Total									60.9	59600	

Comments: Water 800 lbs.. Water 900 lbs. 1100 lbs.

RECORD OF RECIPE

RECIPE # 4 (Bldg 3)

PERFORMED BY: R. Dayhoff

DATE: 9/18/97

INSPECTED BY: T. Dogal

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH ~~2~~ 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		Supplier
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	
Turkey Manure											
Chicken Manure	1.95	2828	.70	2200	.8	2500	.6	1500	2.1	6200	Wabash Valley Produce/Dayhoff Farms
Cow Manure	13.5	19238	4.40	4200	4.2	4010	4.1	3750	12.7	11960	Lueken Dairy/ Dayhoff Farms
POTW Sludge											
Vegetable Waste	6.45	9675	2.60	4300	2.25	4000	1.9	2700	6.75	11000	Frito Lay Co/ Kambach Feeds
Alfalfa	11.55	3246	3.9	1350	3.7	1210	3.3	980	10.9	3540	Dayhoff Farms
Straw											
Wood Chips											
Sawdust	11.55	4736	4.0	1700	3.7	1590	3.6	1400	11.3	4690	Kaho Brothers
Soil	15	32600	-	-	-	-	-	-	15	32600	NSWC Crane
Total	60	72323	15.6	13750	14.65	13310	13.5	10330	58.75	69990	NSWC Crane

Comments:

RECORD OF RECIPE

RECIPE # 5 (Bldg 2) **PERFORMED BY: R. Dayhoff**

DATE: 9109197 **INSPECTED BY: T. Doaal**

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH 2 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		Supplier
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	
Turkey Manure	15.45	12097	5.2	5550	5.4	5750	4.8	4500	15.4	15800	D. Benham Purdue Farms/ Dayhoff Farms
Chicken Manure											
Cow Manure											
POTW Sludge											
Vegetable waste	6.45	9675	2.0	4630	2.5	5500	2.7	5900	7.2	16030	Frito Lay Co/ Kambach Feeds
Alfalfa	11.55	3246	3.5	650	3.9	750	3.8	720	11.2	2120	Dayhoff Farms
straw											
Woqd Chips											
Sawdust	11.55	4736	3.9	2270	3.8	2150	3.6	1950	11.3	6370	Kaho Brothers
Soil	15	32600	-	-	-	-	-	-	15	32600	NSWC Crane
Total									60.1	72920	NSWC Crane

Comments:

RECORD OF RECIPE

RECIPE # 7a (Bldg 3)

PERFORMED BY: R. Dayhoff

DATE: 9/08/97

INSPECTED BY: T. Dogal

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		BATCH 4 ACTUAL QUANTITY	
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds
Turkey Manure												
Chicken Manure [1]	2.1	3045	.55	1400	.55	1500	.45	1250	1.95	5300	.45	1150
Cow Manure												
POTW Sludge												
Vegetable Waste												
Alfalfa												
Straw [2]	42.9	7593	10	1600	10.5	1800	11	1900	43.5	7350	12	2050
Wood Chips												
Sawdust												
Soil	15	32600	-	-	-	-	-	-	15	32600		
Total	60	43238	10.55	3000	11.05	3300	11.45	3150	60.45	42250	12.40	3200

Comments: *Suppliers:* 1. Wabash Valley Produce/Dayhoff Farms 2. Dayhoff Farms

Water Batch #1: 187 g-1500#, #2: 237 g-1900#, #3: 250g-2000#, #4: 250g-2000#

BLDG # 2

RECORD OF RECIPE

RECIPE # 7b

DATE: 9/1/97

PERFORMED BY: [illegible]

INSPECTED BY: [illegible]

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH 2 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		BATCH #4	BATC
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds		Cu
Turkey Manure												
Chicken Manure (1)	9	13050	2.3	4800	2.2	4450	2.3	4650	9.4	18950	5050	2.
Cow Manure												
POTW Sludge												
Vegetable Waste												
Alfalfa												
Straw (2)	36	6372	9	1800	9	1700	9	1700	36.1	7200	2000	c
Wood Chips			- 1									
Sawdust												
Soil	15	32600	—		—	—	—	—	15	32600		
Total									60.5	58750		

Comments: 4000# water

SUPPLIERS (1) WABASH VALLEY PRODUCE
DAYHOFF FARMS

(2) DAYHOFF FARMS

RECORD OF RECIPE

RECIPE # 8 (Bldg 3) **PERFORMED BY: R. Dayhoff**

DATE: 9108197 **INSPECTED BY: T. Doaal**

AMENDMENT	DESIGN QUANTITY		BATCH 1 ACTUAL QUANTITY		BATCH 2 ACTUAL QUANTITY		BATCH 2 3 ACTUAL QUANTITY		TOTAL ACTUAL QUANTITY		Supplier
	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	cubic yards	pounds	
Turkey Manure											
Chicken Manure	4.2	6090	1.5	2400	1.5	2200	1.5	2400	4.5	7000	Wabash Valley Produce/Dayhoff Farms
Cow Manure	6	8550	21	3000	1.6	2300	3.0	4500	6.9	9800	Lueken Dairy/ Dayhoff Farms
POTW Sludge											
Vegetable Waste	6	9000	2.0	3000	2.2	3600	2.3	3600	6.5	10400	Frito Lay Co/ Kambach Feeds
Alfalfa											
Straw	28.8	5098	10.0	1700	9.5	1600	9.5	1800	29	5100	Dayhoff Farms
Wood Chips											
Sawdust											
Soil	15	32600	-	•					15	32600	NSWC Crane
Total	50	61336	15.6	10100	1.50	9700	16.3	12500	61.9	64900	

Comments: Batch #1: 70 gal. 560 #waler added Batch #2: 100 gal • 800# water added

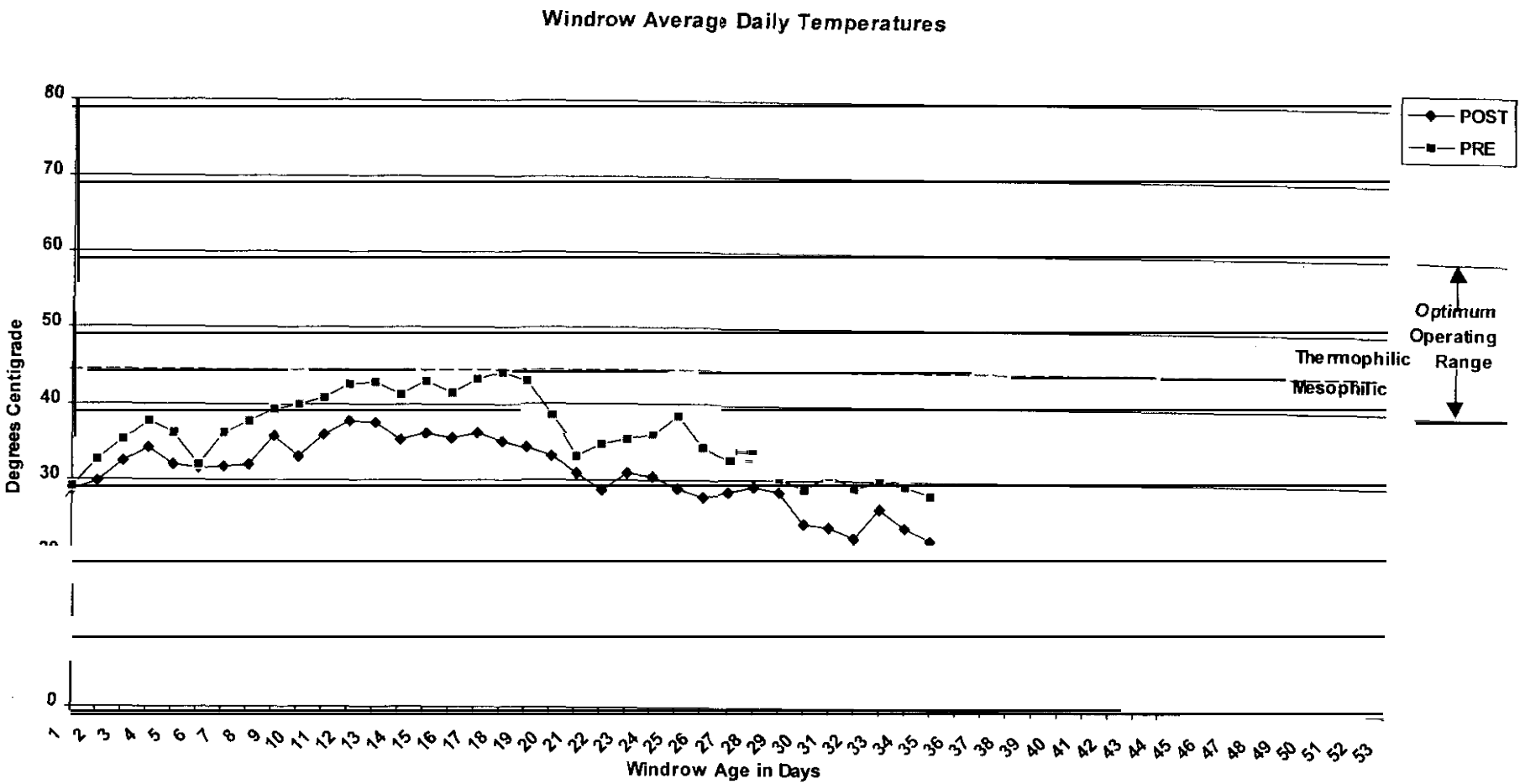
APPENDIX J
CONTAMINATED SOIL TEMPERATURE

APPENDIX J
TABLE OF CONTENTS

DESCRIPTION	NO. PAGES
CONTAMINATED SOIL TEMPERATURE	14 pages

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Compost Recipe Mix 1 Constructed October 9, 1997



Morrison Knudsen Corporation

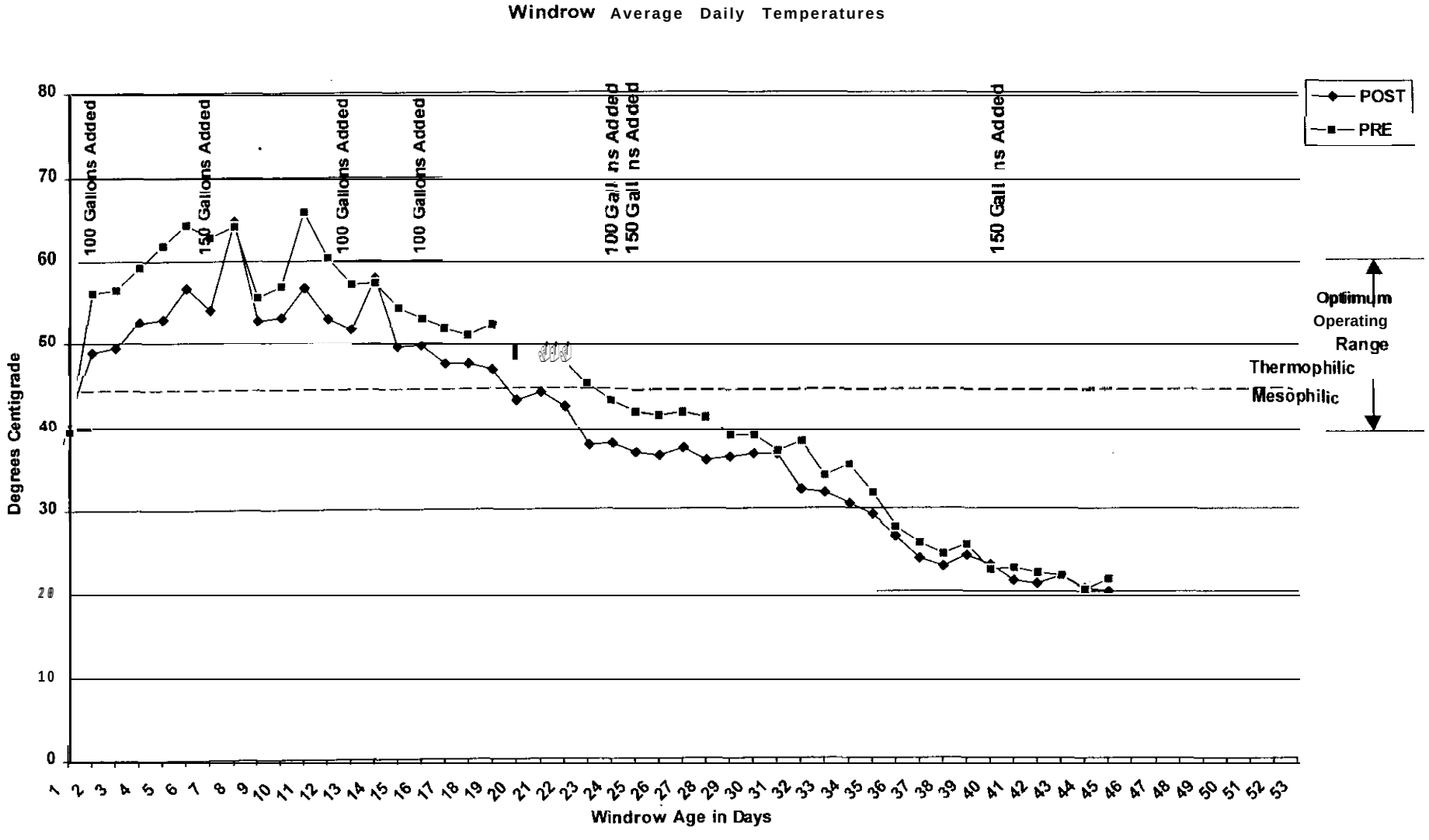
Average Daily Windrow Temperature Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (Deg C)	POST-Turn (Deg C)
MIX1	1019197	1019197	0		24.13
		10/10/97	1	29.00	28.54
		10/11/97	2	32.63	29.79
		10/12/97	3	35.13	32.25
		10/13/97	4	37.58	34.08
		10114197	5	36.04	32.00
		10/15/97	6	31.96	31.50
		10116197	7	36.08	31.71
		10/17/97	8	37.67	31.83
		10/18/97	9	39.29	35.71
		10/19197	10	39.79	33.04
		10/20/97	11	40.75	35.83
		10/21/97	12	42.58	37.75
		10/22/97	13	42.67	37.42
		10123197	14	41.17	35.29
		10/24/97	15	42.92	36.04
		10125197	16	41.46	35.38
		10126197	17	43.17	36.17
		10127197	18	44.04	34.96
		10/28/97	19	42.96	34.13
		10/29/97	20	38.42	33.13
		10/30/97	21	33.13	30.79
		10/31/97	22	34.67	28.58
		11/1/97	23	35.25	30.71
		11/2/97	24	35.79	30.33
		11/3/97	25	38.33	28.88
		11/4/97	26	34.13	27.79
		11/5/97	27	32.50	28.33
		11/6/97	28	33.58	28.96
		11/7/97	29	30.17	28.38
		11/8/97	30	26.79	24.33
		11/9/97	31	30.64	23.88
		11110197	32	29.00	22.54
		11/11/97	33	29.88	26.42
		11/12/97	34	29.25	23.92
		11113197	35	28.21	22.46

AN average temperatures are in degrees centigrade
February 10, 1998

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Compost Recipe Mix 3 Constructed September 9, 1997



Morrison Knudsen Corporation

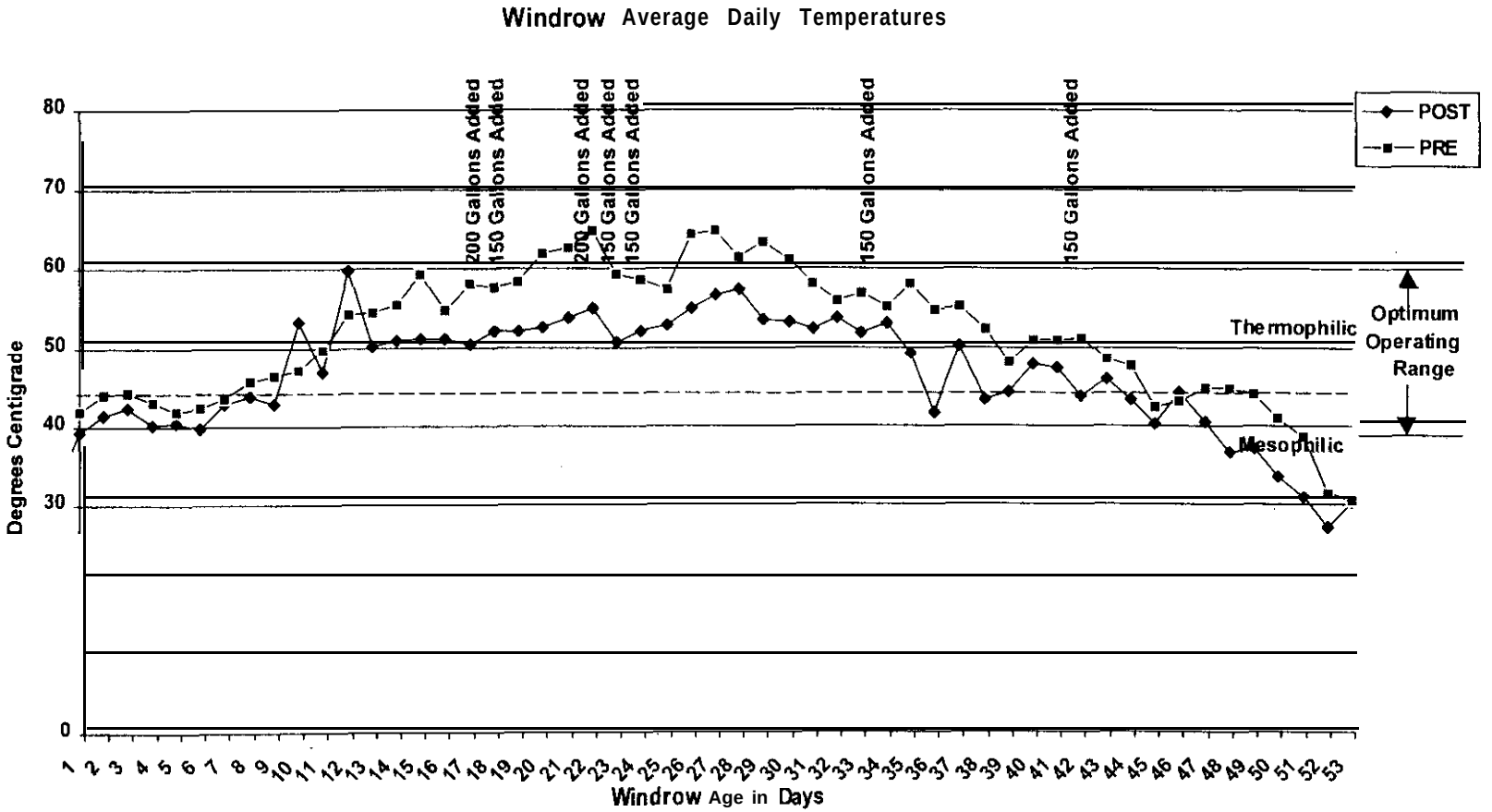
Average Daily Windrow Temperature Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (Deg C)	POST-Turn (Deg C)
MIX3	9/9/97	9/9/97	0		31.04
		9/10/97	1	39.50	40.79
		9/11/97	2	56.29	40.92
		9/12/97	3	56.58	49.42
		9/13/97	4	59.29	52.67
		9/14/97	5	61.88	53.08
		9/15/97	6	64.33	56.91
		9/16/97	7	62.96	54.29
		9/17/97	8	64.25	64.75
		9/18/97	9	55.79	52.83
		9/19/97	10	57.13	53.25
		9/20/97	11	65.79	56.79
		9/21/97	12	60.46	53.08
		9/22/97	13	57.25	51.75
		9/23/97	14	57.33	57.96
		9/24/97	15	54.38	49.54
		9/25/97	16	53.04	49.67
		9/26/97	17	51.88	47.42
		9/27/97	18	51.25	47.50
		9/28/97	19	52.38	46.75
		9/29/97	20	49.33	43.04
		9/30/97	21	48.13	44.04
		10/1/97	22	47.83	42.33
		10/2/97	23	45.21	37.63
		10/3/97	24	43.17	37.92
		10/4/97	25	41.75	36.79
		10/5/97	26	41.42	36.42
		10/6/97	27	41.83	37.29
		10/7/97	28	41.17	35.83
		10/8/97	29	38.75	36.13
		10/9/97	30	38.79	36.58
		10/10/97	31	36.83	36.46
		10/11/97	32	37.96	32.21
		10/12/97	33	33.96	31.79
		10/13/97	34	35.25	30.50
		10/14/97	35	31.79	29.08
		10/15/97	36	27.58	26.46
		10/16/97	37	25.79	24.00
		10/17/97	38	24.46	22.96
		10/18/97	39	25.58	24.38
		10/19/97	40	22.54	23.13
		10/20/97	41	22.83	21.33
		10/21/97	42	22.17	20.96
		10/22/97	43	21.88	21.92
		10/23/97	44	20.17	20.38
		10/24/97	45	21.50	20.04

AN average temperatures are in degrees centigrade
February 10, 1998

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Compost Recipe Mix 4 Constructed September 8, 1997



Morrison Knudsen Corporation

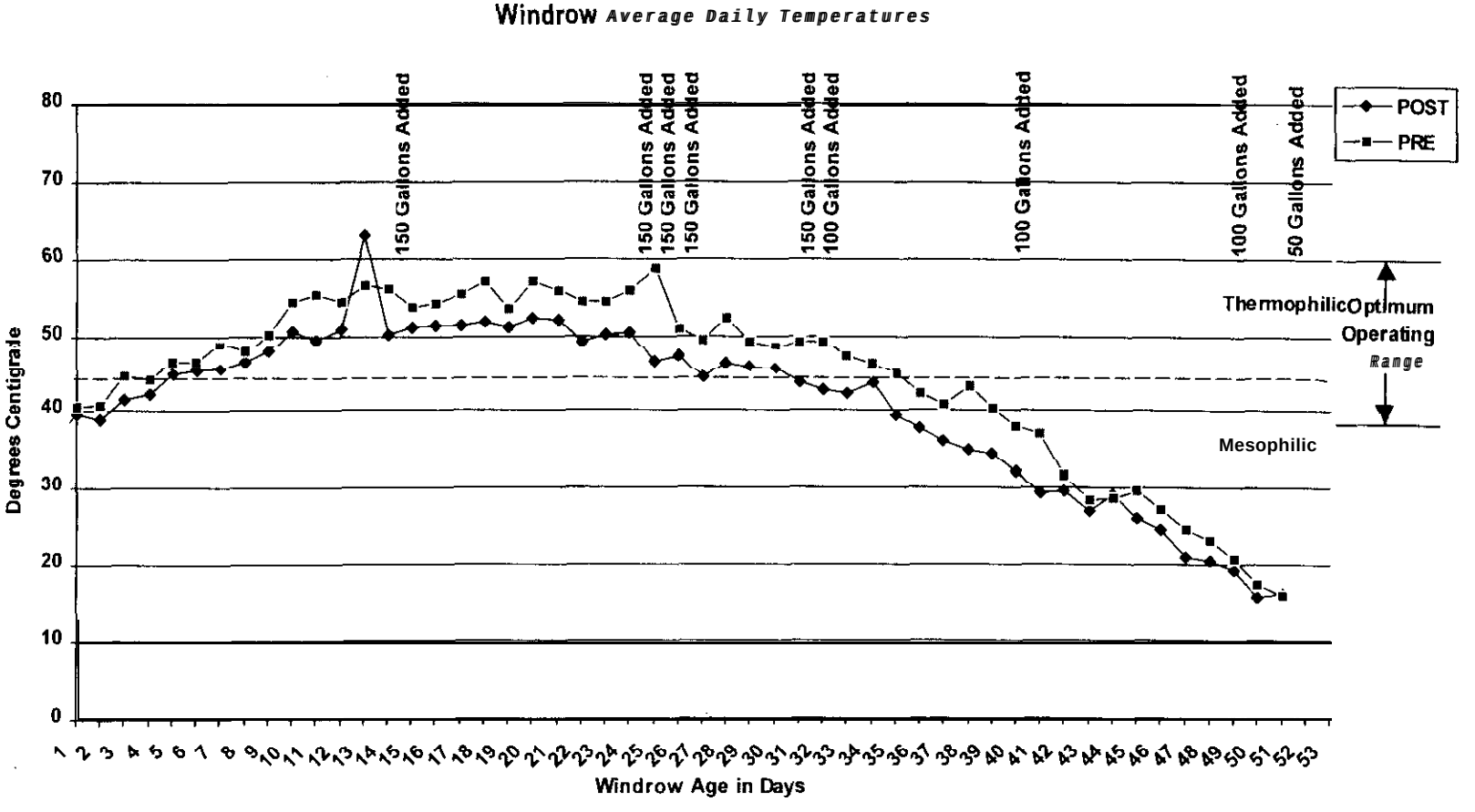
Average Daily Windrow Temperature Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (Deg C)	POST-Turn (Deg CL
MIX4	9/8/97	918197	0		32.36
		9/9/97	1	41.92	39.29
		9/10/97	2	44.00	41.38
		9/11/97	3	4429	42.50
		9/12/97	4	43.17	40.25
		9/13/97	5	41.96	40.36
		9/14/97	6	42.30	39.83
		9/15/97	7	43.46	42.79
		9/16/97	8	45.70	43.92
		9/17/97	9	46.33	42.66
		9/18/97	10	47.25	53.38
		9/19/97	11	49.71	46.96
		9/20/97	12	54.21	59.67
		9/21/97	13	54.50	50.13
		9/22/97	14	55.56	50.92
		9/23/97	15	59.25	51.21
		9124197	16	54.86	51.21
		9/25/97	17	56.21	50.38
		9/26/97	18	57.63	52.21
		9/27/97	19	58.33	52.04
		9/28/97	20	61.63	52.71
		9/29/97	21	62.67	53.75
		9/30/97	22	64.75	55.08
		10/1/97	23	59.29	50.63
		10/2/97	24	56.63	52.25
		1013197	25	57.50	52.75
		1014197	26	64.21	55.04
		10/5/97	27	64.83	56.71
		10/6/97	28	61.38	57.50
		1017197	29	63.25	53.58
		10/8/97	30	61.17	53.36
		10/9/97	31	58.17	52.33
		10/10/97	32	55.92	53.83
		10/11/97	33	57.00	51.60
		10/12/97	34	55.21	53.13
		10/13/97	35	58.04	49.25
		10/14/97	36	54.79	41.71
		10/15/97	37	55.13	50.29
		10/1197	36	52.46	43.33
		10/17/97	39	46.08	44.38
		10/18/97	40	50.92	47.79
		10/19/97	41	50.92	47.50
		10/20/97	42	51.08	43.79
		10/21/97	43	48.46	45.92
		10/22/97	44	47.67	43.29
		10/23/97	45	42.42	40.33
		10/24/97	46	43.00	44.29
		10/25/97	47	44.63	40.46
		10/26/97	46	44.67	36.58
		10/27/97	49	44.04	37.06
		10/28/97	50	40.96	33.50
		10129197	51	38.54	30.96
		10/30/97	52	31.38	27.17
		10/31/97	53	30.46	30.17

All average temperatures are in degrees centigrade
February 10, 1998

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Compost Recipe Mix 5 Constructed September 10, 1997



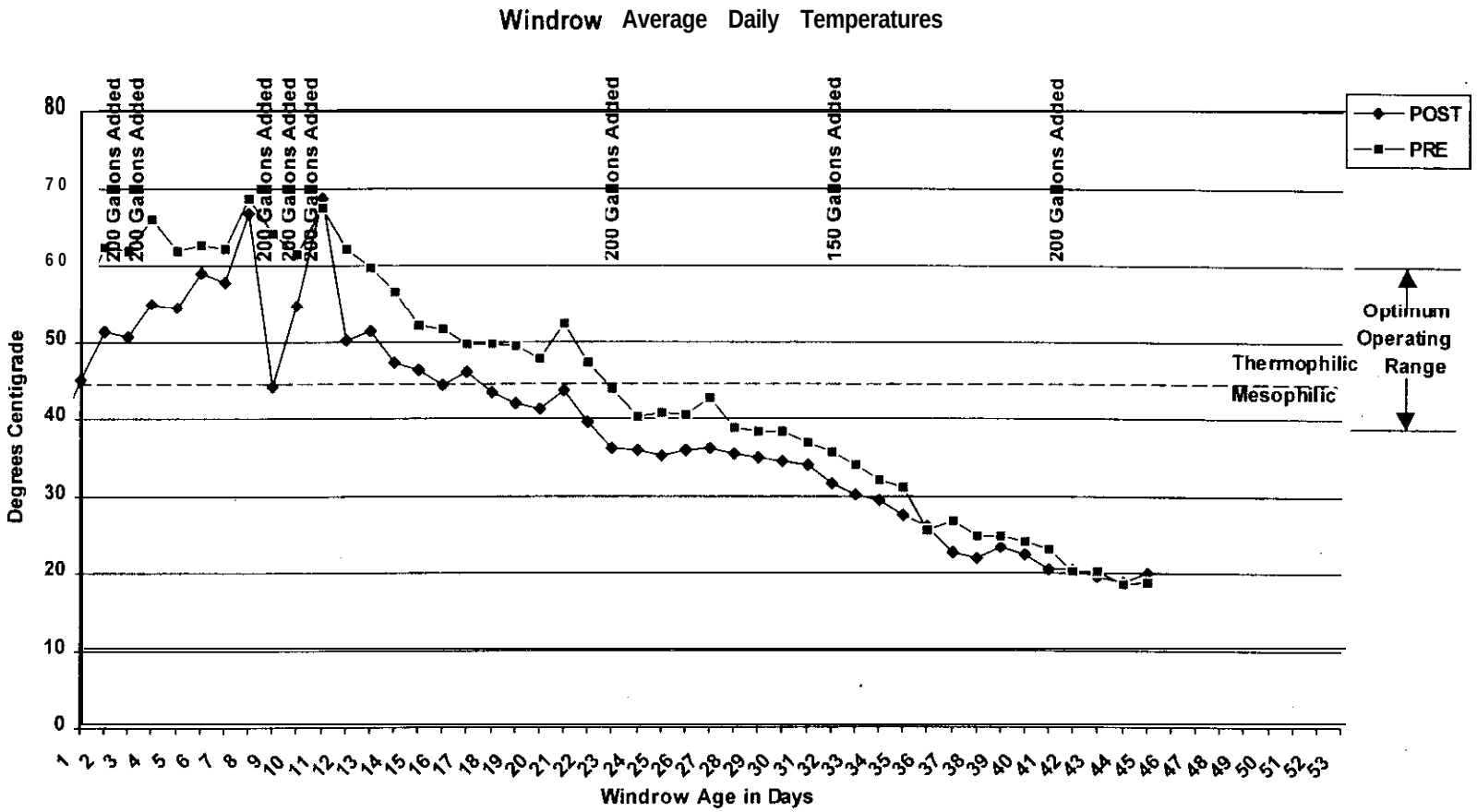
Average Daily Windrow Temperature Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (Deg C)	POST-Turn (Deg C)
MIX5	9110197	9/10/97	0		36.13
		9/11/97	1	40.56	39.54
		9/12/97	2	40.67	36.66
		9/13/97	3	44.56	41.54
		9/14/97	4	44.00	42.17
		9/15/97	5	46.50	44.71
		9/16/97	6	46.33	45.21
		9117197	7	40.63	45.54
		9/18/97	6	47.96	46.42
		9/19/97	9	50.13	47.63
		9/20/97	10	54.56	50.79
		9/21/97	11	55.36	49.54
		9/22/97	12	54.46	50.68
		9/23/97	13	56.71	63.06
		9/24/97	14	56.13	50.29
		9/25/97	15	53.79	51.21
		9/26/97	16	54.17	51.50
		9/27/97	17	55.50	51.38
		9/28/97	16	57.06	51.79
		9/29/97	19	53.54	51.17
		9/30/97	20	57.04	52.33
		10/1/97	21	55.66	52.17
		10/2/97	22	54.42	49.36
		1013197	23	54.58	50.25
		10/4/97	24	55.96	50.42
		10/5/97	25	56.63	46.42
		10/6/97	26	50.96	47.21
		10/7/97	27	49.63	44.25
		1016197	26	52.36	46.29
		1019197	29	49.36	45.79
		10110197	30	46.63	45.54
		10/11/97	31	49.38	43.63
		10/12/97	32	49.33	42.56
		10/13/97	33	47.06	42.06
		10/14/97	34	46.29	43.46
		10/15/97	35	44.66	39.33
		10il6/97	36	42.13	37.71
		10H7/97	37	40.71	35.96
		10/18/97	36	43.00	34.66
		10/19/97	39	40.33	34.17
		10/20/97	40	37.66	32.17
		10121197	41	37.00	29.33
		10122197	42	31.71	29.54
		10123197	43	26.29	26.96
		10124197	44	26.63	29.06
		10/25/97	45	29.46	25.68
		10126197	46	27.21	24.63
		10127197	47	24.50	21.00
		10/28/97	46	23.06	20.56
		10129197	49	20.79	19.25
		10130197	50	17.42	15.67
		10/31/97	51	15.92	16.21

AN average temperatures are in degrees centigrade
February 10, 1998

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Compost Recipe Mix 7A Constructed September 9, 1997



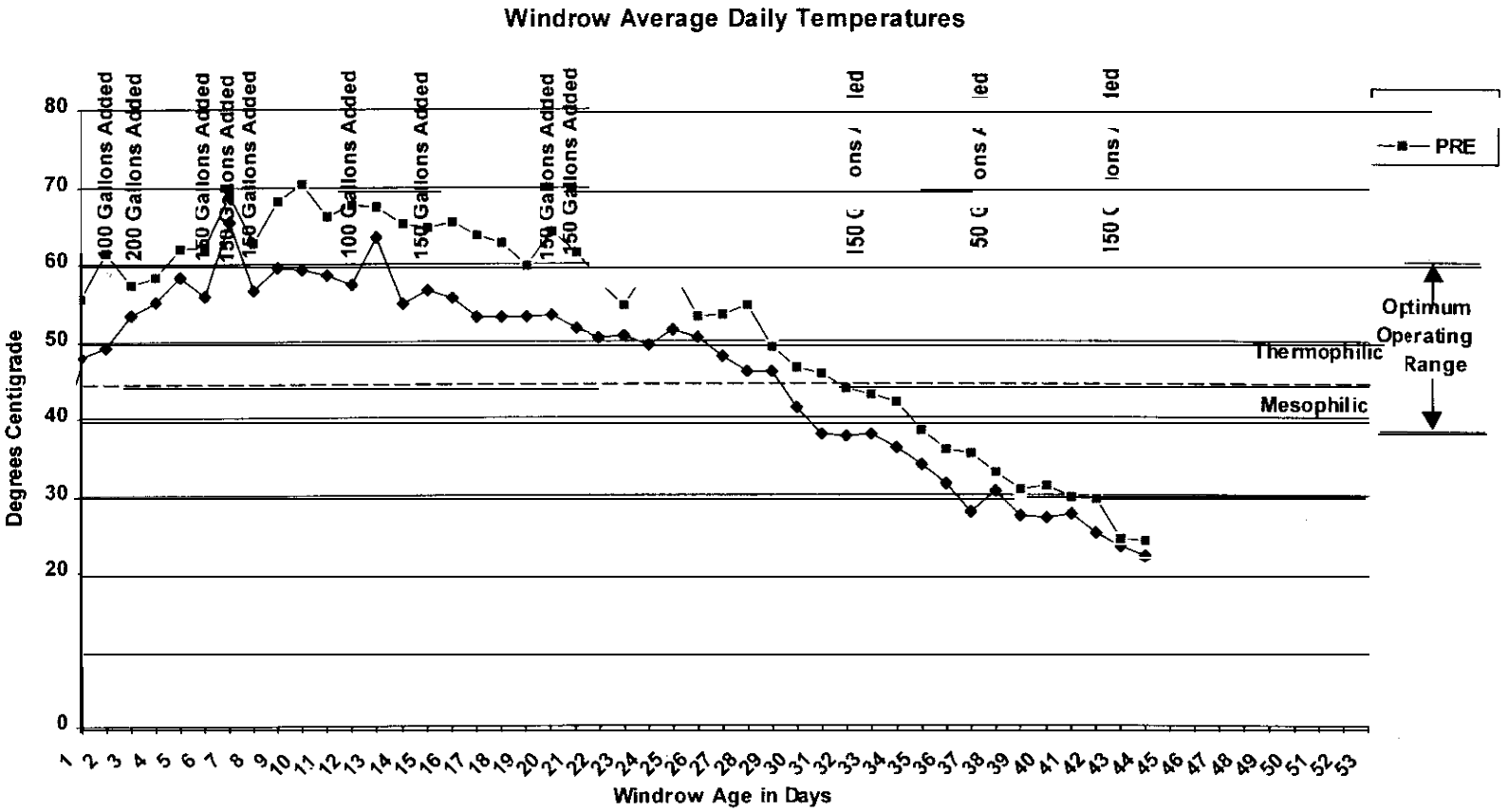
Average Daily Windrow Temperature Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (Deg C)	POST-Turn (Deg C)
MIX7A	9/9/97	9/9/97	0		37.79
		9/10/97	1	56.00	45.13
		9/11/97	2	62.33	51.21
		9112197	3	61.92	50.67
		9/13197	4	66.04	54.96
		9/14/97	5	62.00	54.54
		9/15/97	6	62.71	59.04
		9/16/97	7	62.13	57.63
		9/17/97	8	68.58	66.67
		9/18/97	9	64.17	44.08
		9/19/97	10	61.54	54.79
		9/20/97	11	67.50	66.67
		9/21/97	12	62.21	50.13
		9/22/97	13	59.79	51.39
		9/23/97	14	56.63	47.13
		9/24/97	15	52.00	46.25
		9/25/97	16	51.63	44.29
		9/26/97	17	49.71	46.00
		9127197	18	49.58	43.38
		9/28/97	19	49.29	42.00
		9/29/97	20	47.63	41.21
		9/30/97	21	52.25	43.50
		10/1/97	22	47.21	39.63
		10/2/97	23	43.63	36.08
		10/3/97	24	40.21	35.68
		10/4/97	25	40.67	35.21
		10/5/97	26	40.46	35.63
		1016197	27	42.54	36.04
		10/7/97	28	38.71	35.54
		1018197	29	30.42	35.00
		1019197	30	38.42	34.50
		10/10/97	31	36.79	33.96
		10/11/97	32	35.71	31.67
		10/12197	33	33.96	30.21
		10/13/97	34	32.00	29.46
		10/14197	35	31.00	27.50
		10/15/97	36	25.56	26.04
		10# 6/97	37	26.71	22.67
		10117197	36	24.66	21.68
		10/18/97	39	24.71	23.46
		10/19/97	40	24.04	22.29
		10120197	41	23.25	20.50
		10121197	42	20.33	20.50
		10/22/97	43	20.25	19.63
		10123197	44	16.67	16.75
		10124197	45	18.75	20.00

AN average temperatures are in degrees centigrade
February 10, 1998

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Compost Recipe Mix 7B Constructed September 10, 1997



Morrison Knudsen Corporation

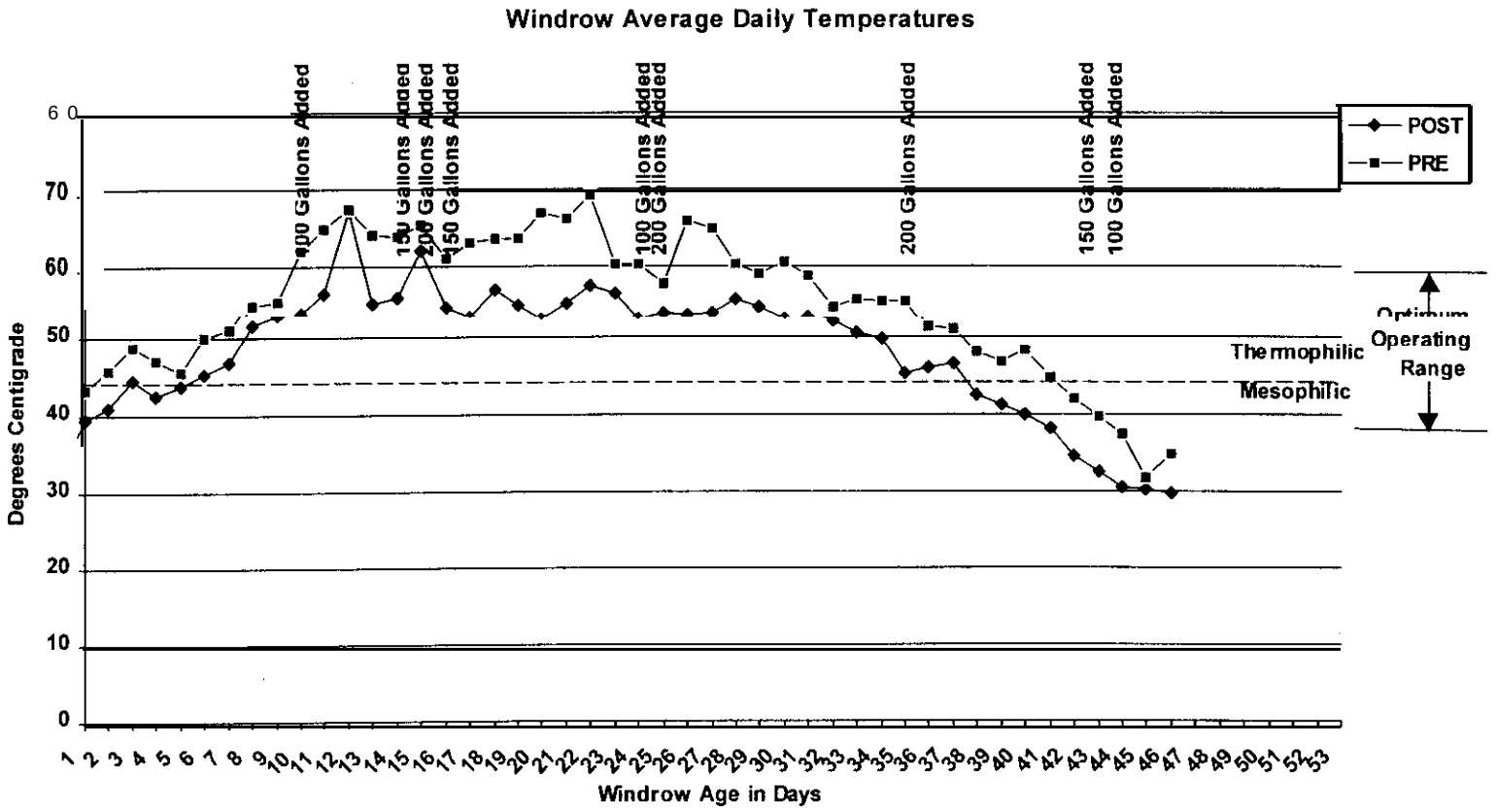
Average Daily Windrow Temperature Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (Deg C)	POST-Turn (Deg C)
MIX76	9110197	9/10/97	0		37.35
		9111/97	1	55.67	47.92
		9/12/97	2	61.38	49.21
		9/13/97	3	57.25	53.42
		9/14/97	4	50.17	55.13
		9/15/97	5	61.96	56.21
		9/16/97	6	62.25	55.76
		9117197	7	68.79	65.50
		9/18/97	8	62.71	56.63
		9/19/97	9	66.21	59.54
		9120197	10	70.33	59.33
		9/21/97	11	66.25	56.54
		9/22/97	12	67.67	57.17
		9/23/97	13	67.36	63.46
		9124197	14	65.13	54.92
		9/25/97	15	64.75	56.56
		9/26/97	16	65.54	55.63
		9/27/97	17	63.63	53.04
		9128197	18	62.63	53.17
		9/29/97	19	59.63	53.21
		9/30/97	20	64.08	53.36
		10/1/97	21	61.54	51.56
		10/2/97	22	57.58	50.29
		1013197	23	54.46	50.54
		1014197	24	59.46	49.29
		10/5/97	25	59.04	51.46
		10/6/97	26	53.21	50.46
		1017197	27	53.42	47.96
		1018197	26	54.46	46.04
		10/9/97	29	49.21	46.00
		10/10197	30	46.46	41.33
		10111197	31	45.75	37.67
		10/12/97	32	43.56	37.58
		10113197	33	43.00	37.75
		10/14/97	34	41.92	36.00
		10115197	35	38.17	33.71
		10116197	36	35.75	31.29
		10/17/97	37	35.25	27.75
		10/18/97	36	32.63	30.46
		10/19/97	39	30.50	27.17
		10/20/97	40	31.17	26.92
		10/21/97	41	29.63	27.33
		10122197	42	29.33	25.04
		10/23/97	43	24.29	23.17
		10/24/97	44	24.00	22.06

All average temperatures are in degrees centigrade
February 10, 1998

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix8 Constructed September 8, 1997



Morrison Knudsen Corporation

Average Daily Windrow Temperature Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (Deg C)	POST-Turn (Deg C)
MIX8	9/8/97	9/8/97	0		33.25
		919197	1	43.17	39.46
		9/10/97	2	45.63	40.96
		9/11/97	3	46.66	44.50
		9/12/97	4	47.00	42.36
		9/13/97	5	45.42	43.63
		9/14/97	6	50.04	45.33
		9/15/97	7	51.17	46.66
		9/16197	8	55.04	51.54
		9117197	9	55.56	52.66
		9/18/97	10	62.06	53.92
		9/19/97	11	64.63	56.56
		9120197	12	67.50	67.33
		9/21/97	13	64.04	55.21
		9/22/97	14	63.96	55.66
		9/23/97	15	65.46	62.13
		9/24/97	16	61.04	54.71
		9/25/97	17	63.08	53.54
		9126197	18	63.67	56.92
		9/27/97	19	63.56	54.91
		9126197	20	66.66	53.06
		9/29/97	21	66.25	55.17
		9/30/97	22	69.21	57.50
		10/1/97	23	60.33	56.36
		1012197	24	60.29	53.17
		10/3/97	25	57.71	53.63
		10/4/97	26	65.63	53.71
		10/5/97	27	64.91	53.63
		1016197	26	60.29	55.63
		10/7/97	29	59.17	54.71
		10/8/97	30	60.56	53.21
		10/9/97	31	58.71	53.36
		10/10/97	32	54.63	52.13
		10/11/97	33	55.67	50.54
		10/12/97	34	55.54	49.96
		10113197	35	55.46	45.13
		10114197	36	51.42	45.92
		10/15/97	37	51.13	46.42
		10116197	36	47.96	42.46
		10/17/97	39	46.71	41.04
		10/18/97	40	46.25	39.66
		10#9197	41	44.71	38.13
		10/20/97	42	42.04	34.50
		10/21/97	43	39.67	32.36
		10122197	44	37.33	30.36
		10/23/97	45	31.56	30.04
		10124197	46	34.71	29.71

AN overage temperatures are in degrees centigrade
February 10, 1998

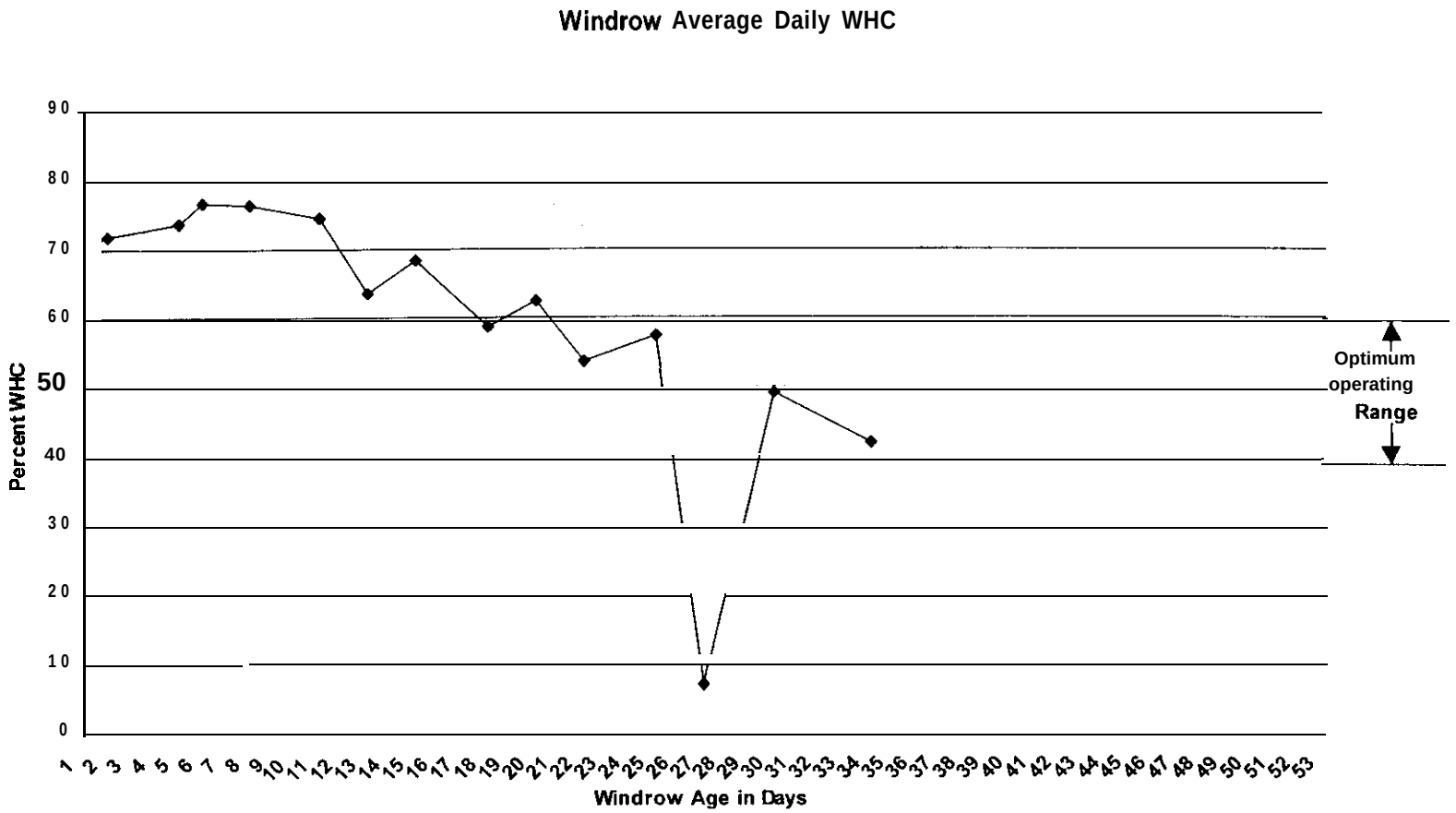
APPENDIX K
CONTAMINATED SOIL MOISTURE

APPENDIX K
TABLE OF CONTENTS

DESCRIPTION	NO. PAGES
CONTAMINATED SOIL MOISTURE	14 pages

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Compost Recipe Mix 1 Constructed October 9, 1997



Morrison Knudsen Corporation

Average Daily Windrow WHC Summary Report

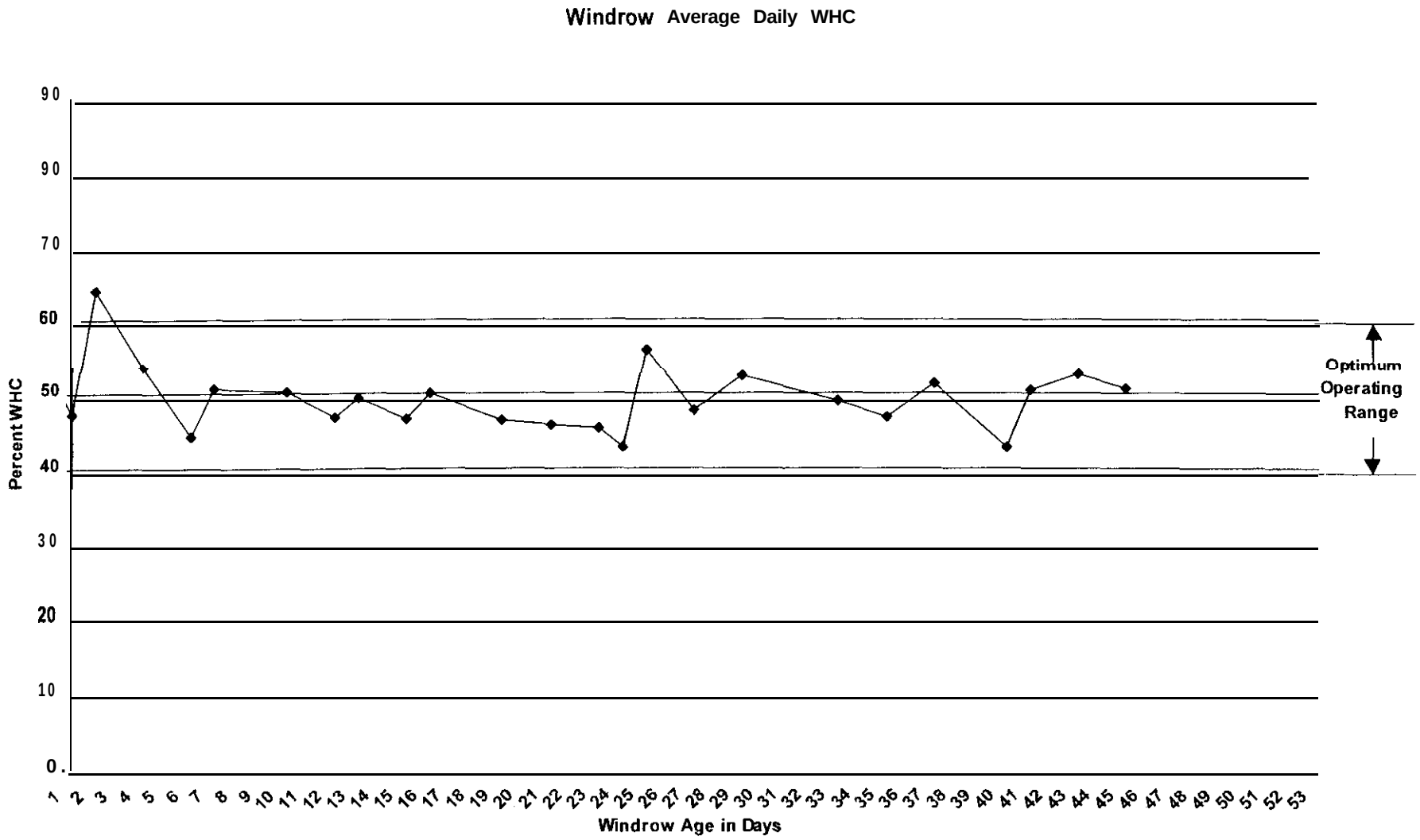
Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX1	10/9/97	1019197	0	68.80	
		10/11/97	2	71.70	
		10/14/97	5		73.65
		10/15/97	6		76.55
		10117197	8	76.40	
		10120197	11		74.55
		10/22/97	13	63.35	
		10124197	15	68.40	
		10/27/97	16	56.65	
		10129197	20	62.38	
		10/31/97	22	53.67	
		11/3/97	25	57.35	
		11/5/97	27	7.03	
		11/8/97	30		49.15
		11/12/97	34	41.67	

AN average MWHC values are expressed in percent

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Compost Recipe Mix 3 Constructed September 9, 1997



Morrison Knudsen Corporation

Average Daily Windrow WHC Summary Report

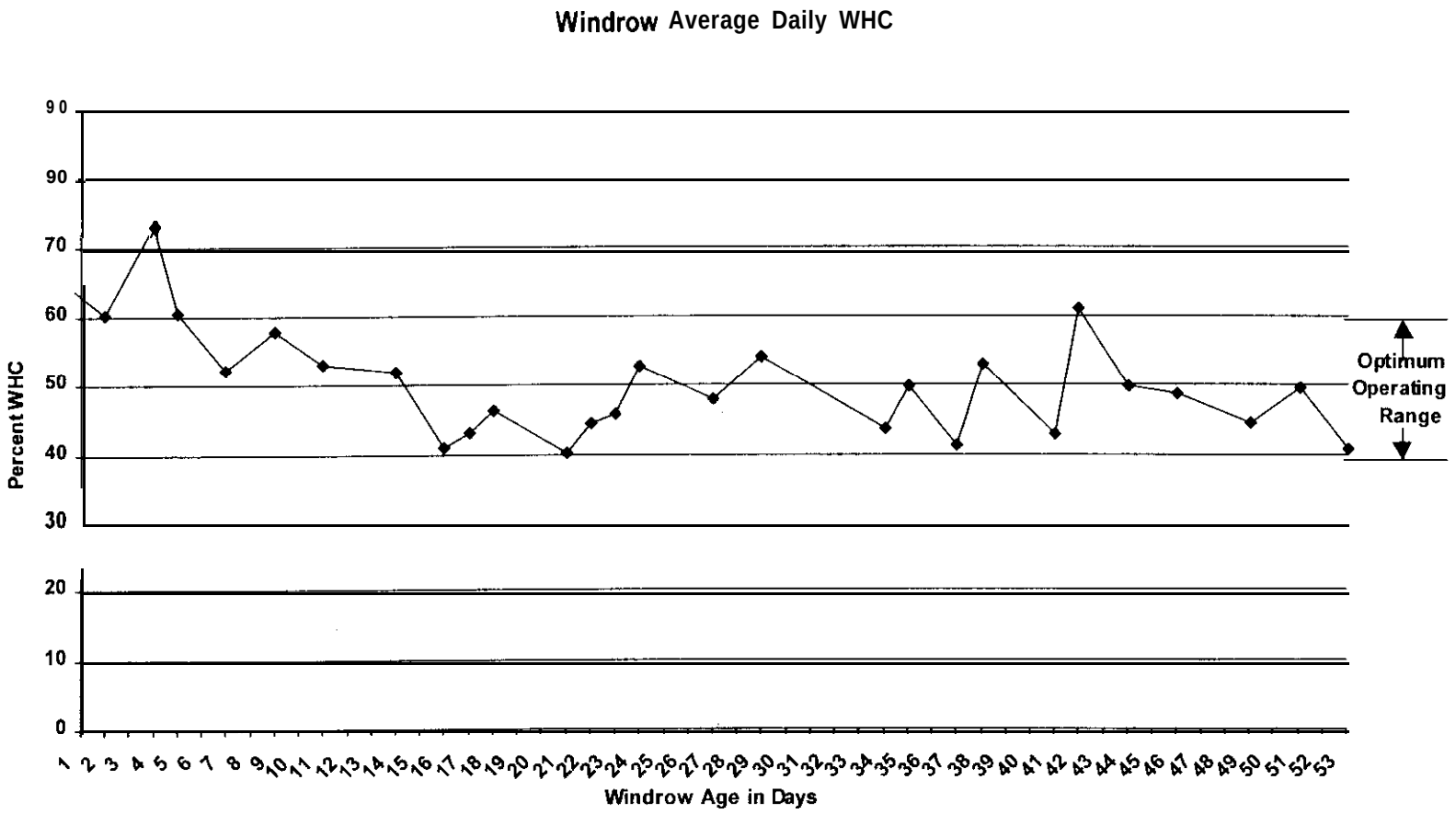
Windrow Number	*Construction Dote*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX3	9/9/97	9/9/97	0		53.53
		9/10/97	1		47.25
		9/11/97	2		63.88
		9/13/97	4	53 75	
		9/15/97	6	44.27	
		9/16/97	7		50.73
		9/19/97	10	50.33	
		9/21/97	12	46.90	
		9/22/97	13		49.35
		9/24/97	15	46.70	
		9/25/97	16		50.10
		9/28/97	19	46.40	
		9/30/97	21	46.70	41.90
		10/2/97	23	45.30	
		10/3/97	24		42.73
		10/4/97	25		55.95
		10/6/97	27	47.75	
		10/8/97	29	52.42	
		10/12/97	33	49.03	
		10/14/97	35	46.73	
		10/16/97	37	51.30	
		10/19/97	40		42.68
		10/20/97	41		50.42
		10/22/97	43	52.63	
		10/24/97	45	50.63	

All average MWHC values are expressed in percent

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Compost Recipe Mix 4 Constructed September 8, 1997



Morrison Knudsen Corporation

Average Daily Windrow WHC Summary Report

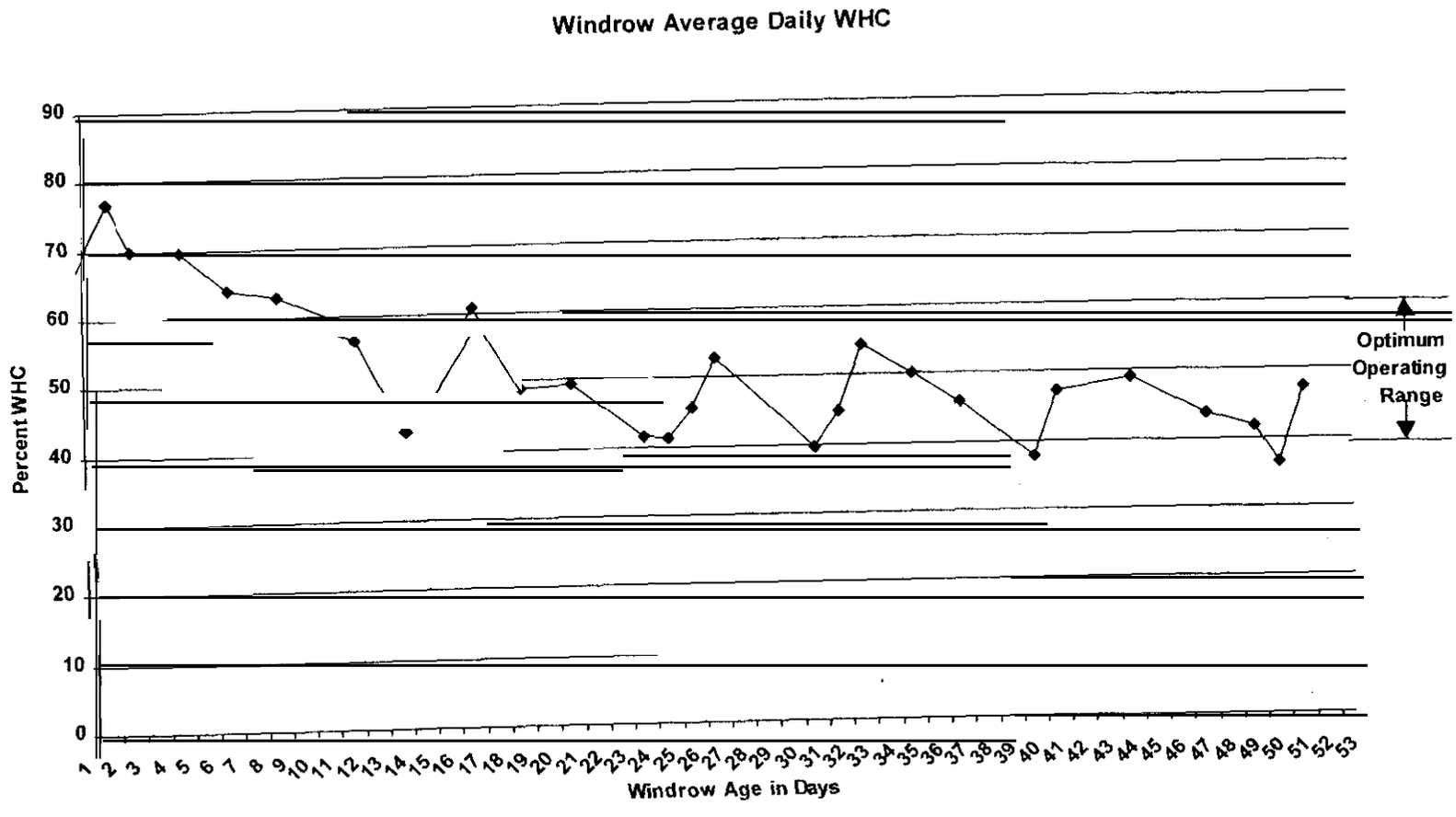
Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (%)	POST-Turn (%)
MIX4	9/8/97	9/8/97	0		65.65
		9/10/97	2		60.30
		9/12/97	4	73.05	
		9/13/97	5		60.63
		9/15/97	7	52.13	
		9/17/97	9	57.78	
		9/19/97	11	52.92	
		9/22/97	14	52.00	
		9/24/97	16	40.95	
		9/25/97	17		43.18
		9/26/97	18		46.23
		9/29/97	21	40.05	
		9/30/97	22		44.35
		10/1/97	23		45.80
		10/2/97	24		52.85
		10/5/97	27	47.98	
		10/7/97	29	54.23	
		10/12/97	34	43.63	
		10/13/97	35		49.90
		10/15/97	37	41.23	
		10/16/97	38		53.15
		10/19/97	41	42.75	
		10/20/97	42		61.15
		10/22/97	44	49.73	
		10/24/97	46	48.77	
		10/27/97	49	44.48	
		10/29/97	51	49.66	
		10/31/97	53	40.73	

AN average MWHC values are expressed in percent

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demons

Compost Recipe Mix 5 Constructed September 10, 1997



Morrison Knudsen Corporation

Average Daily Windrow WHC Summary Report

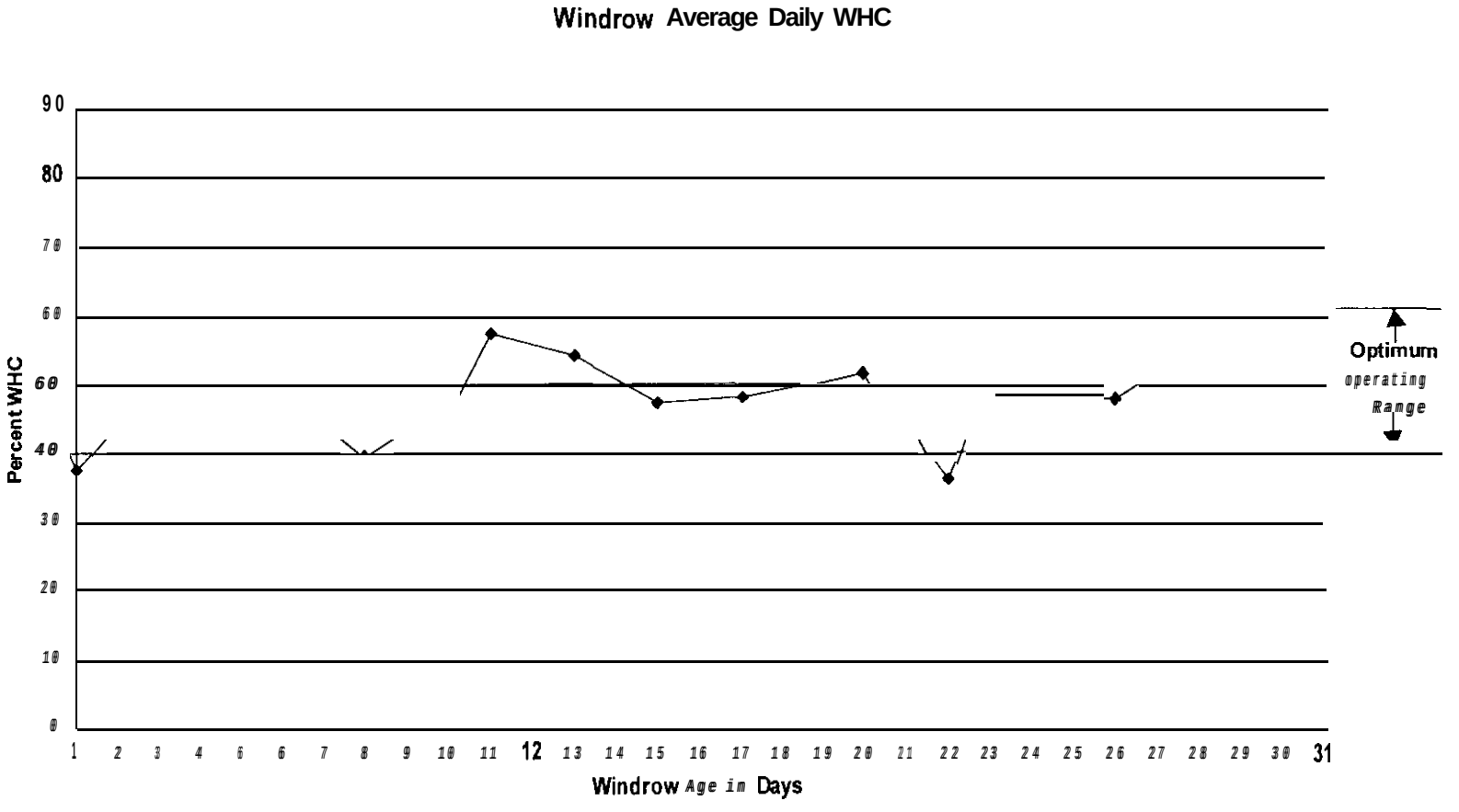
Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (%)	POST-Turn (%)
MIX5	9110197	9110197	0		61.80
		9/12/97	2	77.00	
		9113197	3	69.92	
		9/15/97	5	69.73	
		9117197	7	64.05	
		9119197	9	63.05	
		9/22/97	12	58.70	
		9/24/97	14	45.15	
		9/25/97	15		40.53
		9127197	17	60.83	
		9/29/97	19	46.65	
		10/1/97	21	49.27	
		10/4/97	24	41.48	
		10/5/97	25		41.18
		10/6/97	26		45.53
		10/7/97	27		52.63
		10/11/97	31	39.53	
		10/12/97	32	44.75	
		10113197	33		54.48
		10/15197	35	50.13	
		10/17/97	37	45.90	
		10/20/97	40		37.75
		10121197	41		47.08
		10124197	44	48.90	
		10/27/97	47	43.70	
		10/29/97	49	41.73	
		10130197	50		36.55
		10131197	51		47.42

AN average MWHC values are expressed in percent

February IO, 1998

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Compost Recipe Mix 7A Constructed September 9, 1997



Morrison Knudsen Corporation

Average Daily Windrow WHC Summary Report

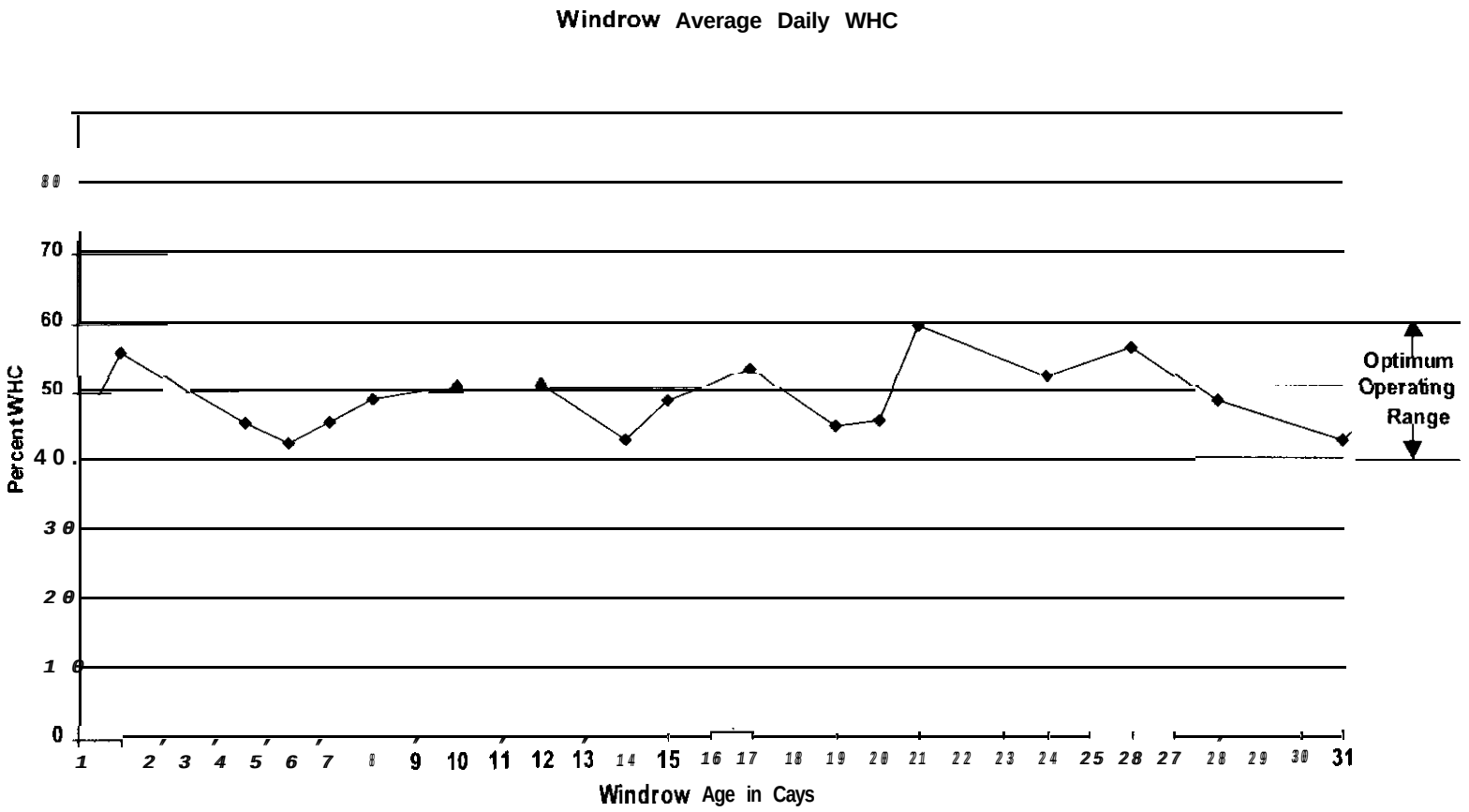
Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (%)	POST-Turn (%)
MIX7A	9/9/97	9/9/97	0		50.28
		9110197	1		37.73
		9/11/97	2		43.52
		9/12/97	3		52.88
		9/15/97	6	47.20	
		9117197	8	39.70	
		9118197	9		42.65
		9/19/97	10		45.58
		9/20/97	11		57.15
		9/22/97	13	54.08	
		9124197	15	47.27	
		9126197	17	48.10	
		9/29/97	20	51.58	
		10/1/97	22	36.15	
		1012197	23		48.82
		1015197	26	47.75	
		10/7/97	28	54.58	
		10/11/97	32	39.88	
		10112197	33	46.50	
		10/14/97	35	46.48	
		10/16/97	37	48.20	
		10/19/97	40		35.82
		10120197	41		66.67
		10122197	43	50.86	
		10/24/97	45	54.73	

AN average MWHC values are expressed in percent

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Compost Recipe Mix 7B Constructed September 10, 1997



Morrison Knudsen Corporation

Average Daily Windrow WHC Summary Report

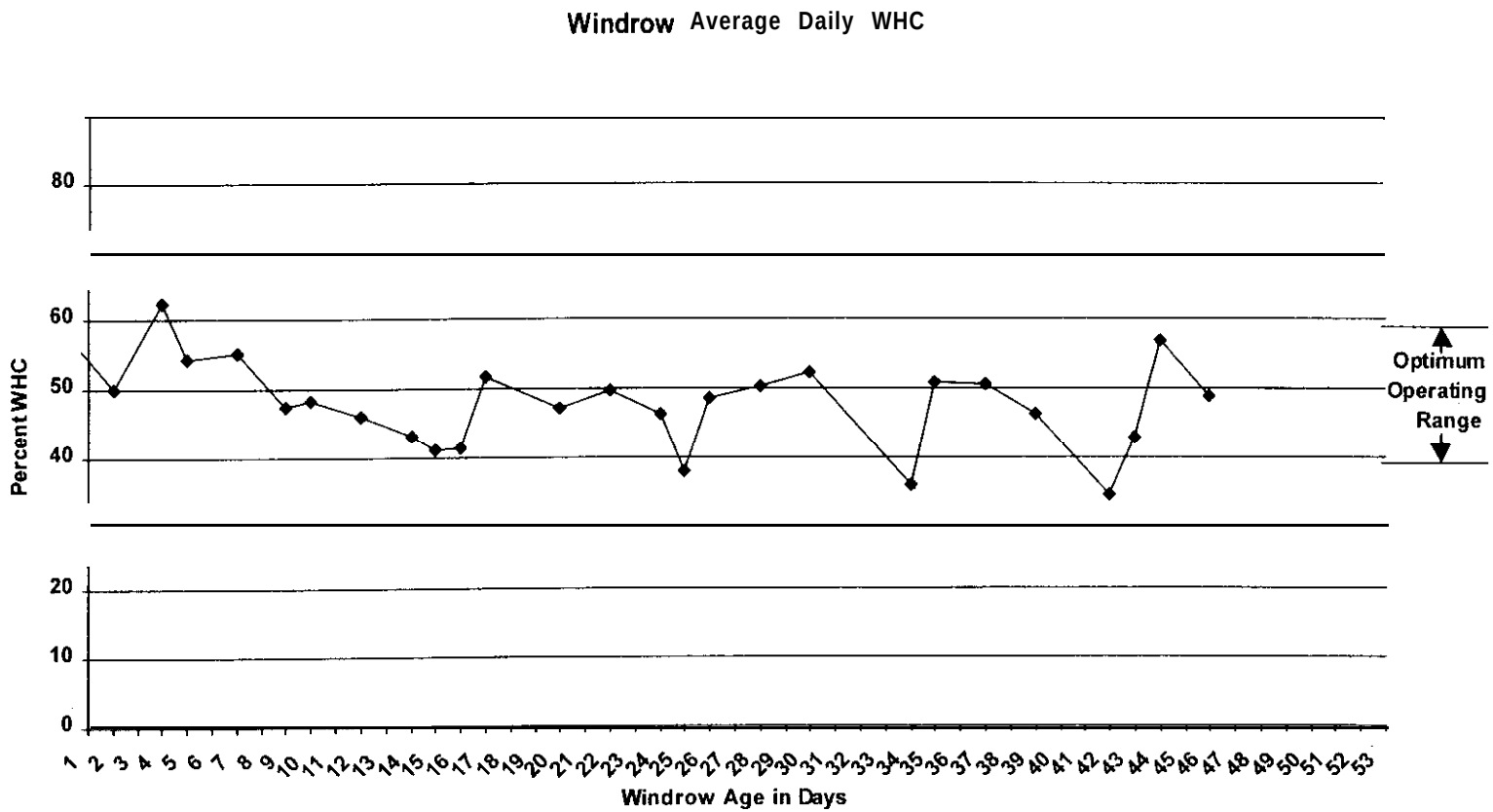
Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (%)	POST-Turn (%)
MIX7B	9110197	9110197	0		42.53
		9/11/97			44.35
		9/12/97	2		56.05
		9/15/97	5	45.35	
		9/16/97	6		42.53
		9/17/97	7	4543	
		9/18/97	8		48.65
		9/20/97	10		50.60
		9/21/97	11	47.23	
		9122197	12		50.60
		9124197	14	42.50	
		9125197	15		48.03
		9127197	17	52.75	
		9/29/97	19	44.30	
		9/30/97	20		45.18
		10/1/97	21		58.58
		10/4/97	24	51.55	
		1016197	26	55.78	
		1018197	28	47.80	
		10/11/97	31	42.35	
		10112197	32	47.52	
		10/14/97	34	52.35	
		10/16/97	36	41.90	
		10/17/97	37		46.50
		10120197	40		45.22
		10/22/97	42	38.30	
		10/23/97	43		66.73

AN average MWHC values are expressed in percent

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Compost Recipe Mix 8 Constructed September 8, 1997



Morrison Knudsen Corporation

Average Daily- Windrow WHC Summary Report

Windrow Number	Construction Dote	Date Monitored	Age (Days)	PRE-Turn (%)	POST-Turn (%)
MIX8	9/8/97	9/8/97	0		68.77
		9/10/97	2		50.00
		9/12/97	4	62.38	
		9113197	5		54.23
		9/15/97	7	55.08	
		9117197	9	47.55	
		9/18/97	10		48.38
		9/20/97	12		45.92
		9/22/97	14	43.05	
		9/23/97	15	41.23	
		9124197	16		41.48
		9/25/97	17		51.75
		9128197	20		47.05
		9130197	22	49.68	
		10/2/97	24		46.30
		10/3/97	25		37.95
		1014197	26		48.70
		10/6/97	28	50.45	
		to/a/97	30	52.33	
		10112197	34	35.88	
		10/13197	35		50.90
		10/15/97	37	50.70	
		10/17/97	39	46.18	
		10120197	42	34.48	
		10121197	43		42.88
		10/22/97	44		57.07
		10124197	46	48.75	

All average MWHC values are expressed in percent

February 10, 1998

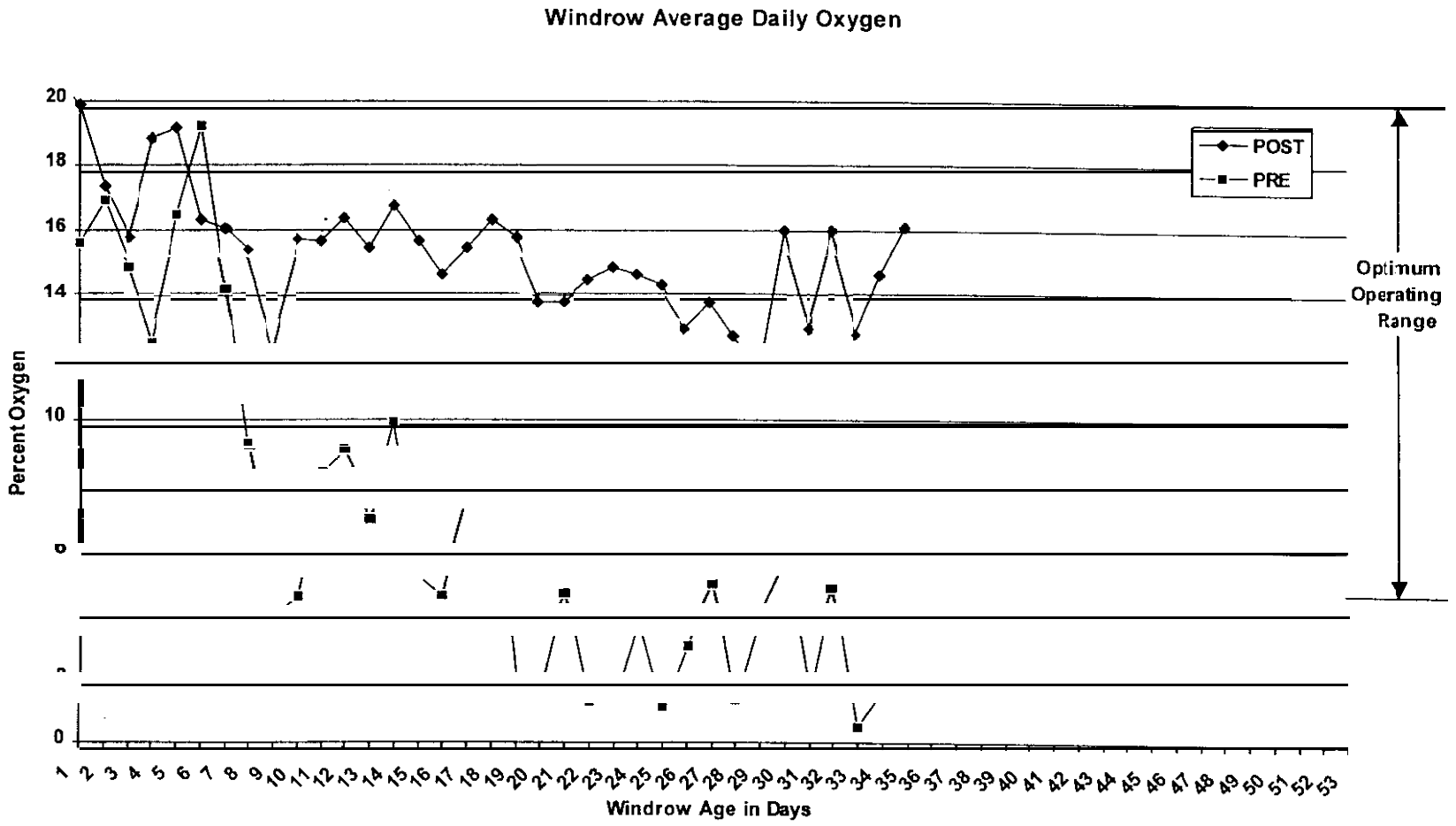
APPENDIX L
CONTAMINATED SOIL OXYGEN

APPENDIX L
TABLE OF CONTENTS

DESCRIPTION			NO. PAGES	
CONTAMINATED	SOIL	OXYGEN	21	pages

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 1 Constructed October 9, 1997



Morrison Knudsen Corporation

Average Daily Windrow Oxygen Summary Report

Windrow Number	Construction Date	Dote Monitored	Age (Days)	PRI-Turn (%)	POST-Turn (%)
MIX1	1019197	1019197	0		20.67
		10110197	1	15.58	19.92
		10/11/97	2	16.92	17.33
		10/12197	3	14.91	15.75
		10113197	4	12.46	18.83
		10/14/97	5	16.50	19.17
		10/15/97	6	19.25	16.29
		10/16/97	7	14.21	16.04
		10/17/97	a	9.29	15.38
		10/1a/97	9	3.92	12.13
		10/19/97	10	4.63	15.71
		10/20/97	11	8.50	16.63
		10/21/97	12	9.17	16.38
		10/22/97	13	7.00	15.42
		10/23/97	14	9.96	16.75
		10124197	15	5.21	15.67
		10125197	16	4.58	14.63
		10126197	17	7.96	15.42
		10127197	18	a.46	16.33
		10128197	19	1.96	15.75
		10/29/97	20	1.71	13.79
		10130197	21	4.67	13.75
		10/31/97	22	1.25	14.42
		11/1/97	23	1.42	14.83
		11/2/97	24	3.67	14.58
		11/3/97	25	1.08	14.29
		11/4/97	26	3.04	12.88
		11/5/97	27	4.96	13.71
		11/6/97	28	1.33	12.67
		1117197	29	3.83	11.46
		11/8/97	30	5.79	16.00
		11/9/97	31	1.67	12.88

All average Oxygen values are expressed as a percent

February IO, 1998

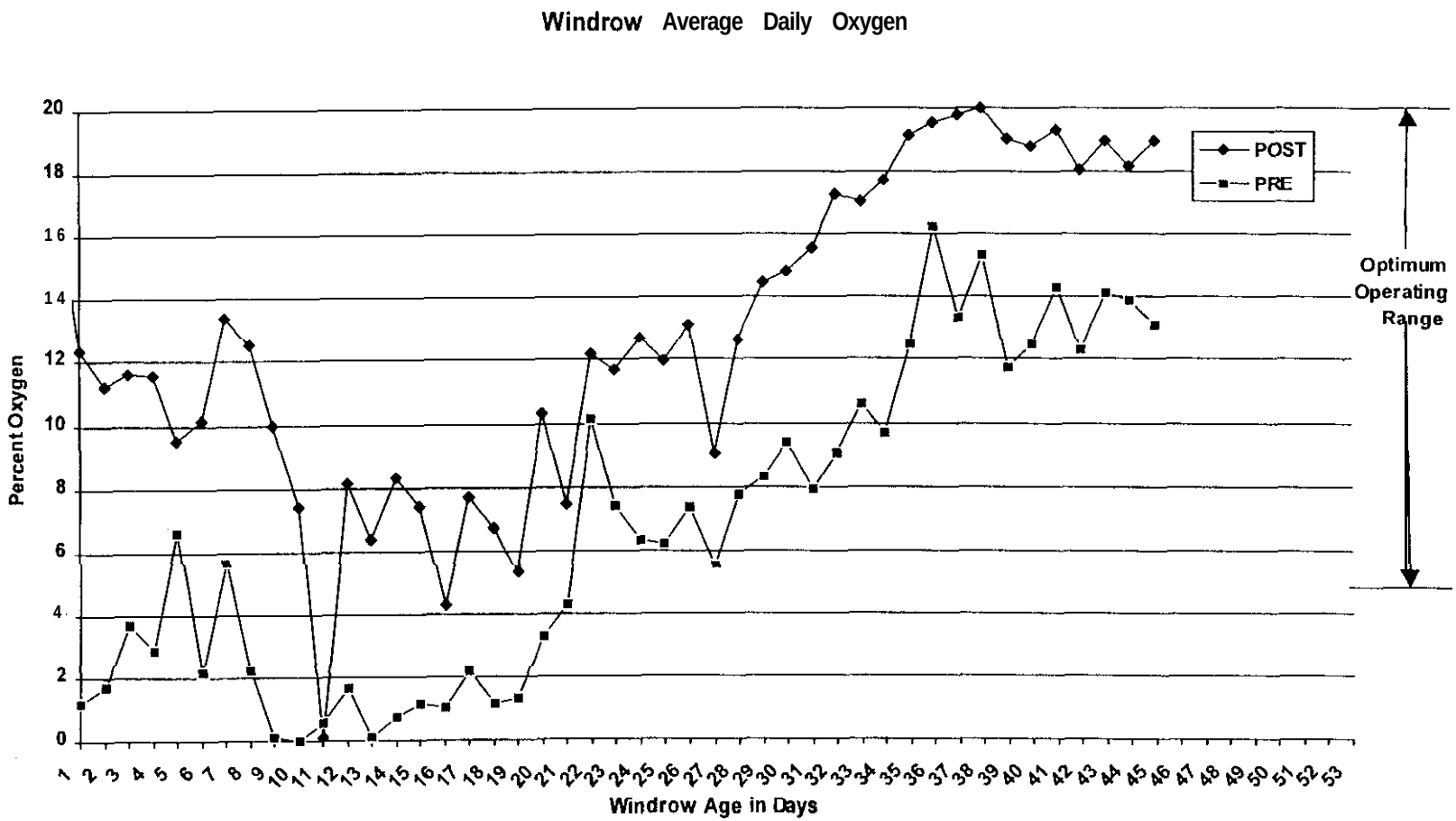
Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX1	1019197	11/10197	32	4.83	16.00
		11/11/97	33	0.50	12.75
		11/12/97	34	1.63	14.58
		11/13/97	35	1.58	16.08

All average Oxygen values are expressed as a percent

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 3 Constructed September 9, 1997



Morrison Knudsen Corporation

Average Daily Windrow Oxygen Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (%)	POST-Turn (%)
MIX3	919197	9/9/97	0		17.79
		9/10/97	1	1.21	12.38
		9/11/97	2	1.71	11.25
		9/12/97	3	3.71	11.63
		9/13/97	4	2.92	11.54
		9/14/97	5	6.56	9.50
		9/15/97	6	2.17	10.17
		9/16/97	7	5.67	13.38
		9/17/97	8	2.25	12.54
		9118/97	9	0.13	10.00
		9/19/97	10	0.00	7.42
		9120197	11	0.54	0.13
		9/21/97	12	1.63	8.17
		9/22/97	13	0.13	6.36
		9/23/97	14	0.75	8.29
		912497	15	1.13	7.42
		9/25/97	16	1.00	4.25
		9126197	17	2.17	7.67
		9127197	18	1.13	6.75
		9128197	19	1.33	5.29
		9/29/97	20	3.33	10.29
		9130197	21	4.25	7.46
		10/1/97	22	10.13	12.21
		10/2/97	23	7.42	11.67
		10/3/97	24	6.33	12.71
		10/4/97	25	6.21	11.96
		1015197	26	7.38	13.13
		10/6/97	27	5.50	9.04
		10/7/97	28	7.75	12.67
		10/8/97	29	6.29	14.50
		10/9/97	30	9.38	14.79
		10110197	31	7.92	15.56

All average Oxygen values are expressed as a percent

February IO, 1998

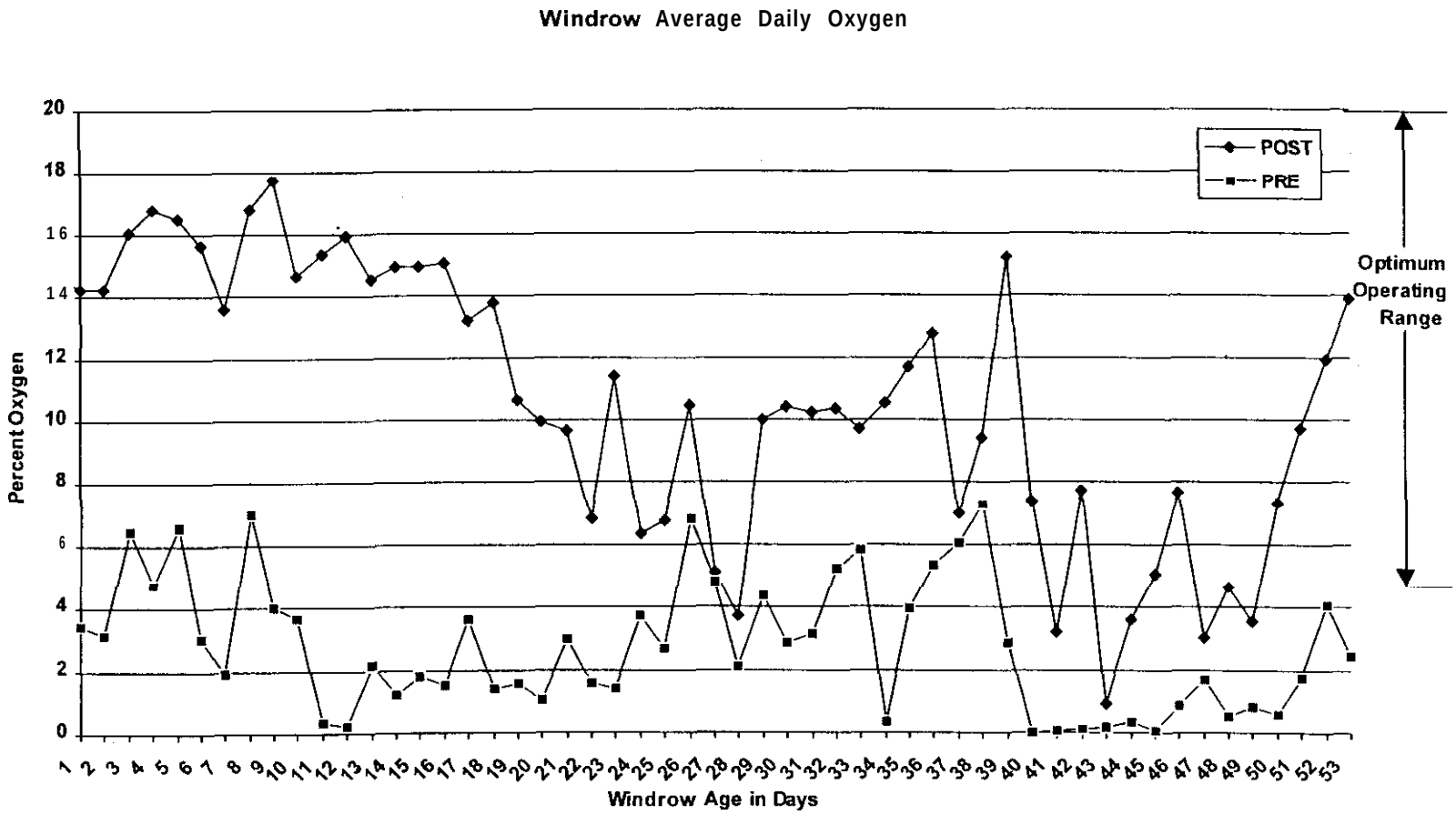
Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (%)	POST-Turn (%)
MIX3	9/9/97	10/11/97	32	9.04	17.29
		10/12/97	33	10.58	17.04
		10/13/97	34	9.67	17.71
		10/14/97	35	12.46	19.17
		10/15/97	36	16.25	19.54
		10/16/97	37	13.33	19.79
		10/17/97	38	15.33	20.00
		10/18/97	39	11.75	19.04
		10/19/97	40	12.46	16.79
		10/20/97	41	14.29	19.29
		10/21/97	42	12.29	16.06
		10122197	43	14.13	19.00
		10/23/97	44	13.86	16.17
		10124197	45	13.08	18.96

AN average Oxygen values are expressed as a percent

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 4 Constructed September 8, 1997



Average Daily Windrow Oxygen Summary Report

Windrow Number	*Construction Date*	*Dare Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX4	9/8/97	9/8/97	0		14.67
		9/9/97	1	3.42	14.25
		9/10/97	2	3.17	14.25
		9111197	3	6.46	16.04
		9/12/97	4	4.79	16.79
		9/13/97	5	6.56	16.50
		9/14/97	6	3.00	15.67
		9/15197	7	1.92	13.56
		9/16/97	8	7.00	16.79
		9/17/97	9	4.00	17.7,
		9/18/97	I0	3.67	14.63
		9/19/97	11	0.36	15.36
		9/20/97	12	0.25	15.92
		9121197	13	2.13	14.64
		9/22/97	14	1.25	14.96
		9/23/97	15	1.79	14.96
		9/24/97	16	1.50	15.06
		9125197	17	3.63	13.21
		9/26/97	18	1.38	13.79
		9/27/97	19	1.56	I0.63
		9128197	20	1.04	9.92
		9/29/97	21	2.96	9.67
		9/30/97	22	1.54	6.79
		10/1/97	23	1.42	11.42
		10/2/97	24	3.71	6.33
		10/3/97	25	2.67	6.75
		10/4/97	26	6.79	10.46
		10/5/97	27	4.83	5.13
		10/6/97	26	2.06	3.75
		10/7/97	29	4.36	10.00
		1016197	30	2.63	10.42
		10/9/97	31	3.17	10.25

All average Oxygen values are expressed as a percent

February IO, 1998

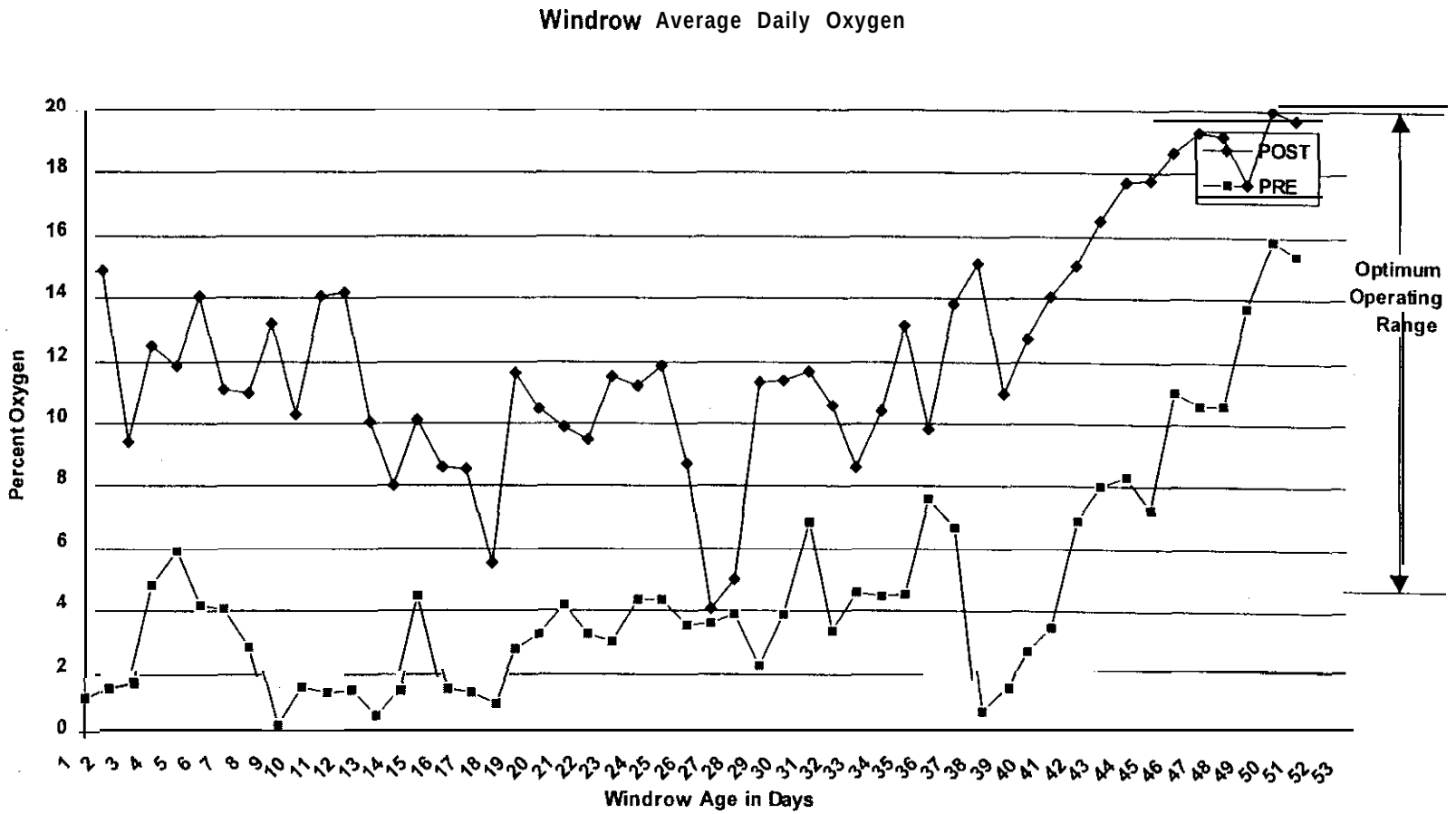
Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE- Turn (%)*	*POST- Turn (%)*
	9/8/97	10/10/97	32	5.25	10.38
		10/11/97	33	5.63	9.71
		10/12/97	34	0.38	10.54
		10/13/97	35	3.96	11.71
		10/14/97	36	6.36	12.79
		10/15/97	37	6.04	7.00
		10/16/97	38	7.29	9.42
		10/17/97	39	2.63	15.21
		10/18/97	40	0.00	7.36
		10/19/97	41	0.06	3.21
		10/20/97	42	0.13	7.76
		10/21/97	43	0.17	0.92
		10/22/97	44	0.33	3.56
		10/23/97	45	0 08	5.08
		10/24/97	46	0.68	7.67
		10/25/97	47	1.67	3.04
		10/26/97	48	0.50	4.63
		10/27/97	49	0.79	3.54
		10/28/97	50	0.56	7.33
		10/29/97	51	1.75	9.71
		10/30/97	52	4.06	11.92
		10/31/97	53	2.42	13.68

AN average Oxygen values are expressed as a percent

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 5 Constructed September 10, 1997



Morrison Knudsen Corporation

Average Daily Windrow Oxygen Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (%)	POST-Turn (%)
MIX5	9/10/97	9110197	0		15.79
		9/11/97	1	1.06	14.75
		9112197	2	1.36	14.68
		9113197	3	1.56	9.42
		9114197	4	4.63	12.50
		9/15/97	5	5.92	11.63
		9/16/97	6	4.17	14.04
		9/17/97	7	4.06	11.13
		9/18/97	8	2.00	11.00
		9/19/97	9	0.25	13.21
		9/20/97	10	1.42	10.29
		9/21/97	11	1.21	14.04
		9/22/97	12	1.29	14.21
		9/23/97	13	0.50	10.06
		9/24/97	14	1.29	6.00
		9/25/97	15	4.50	10.13
		9/26/97	16	1.29	6.56
		9/27/97	17	1.17	0.54
		9/28/97	16	0.79	5.50
		9129197	19	2.79	11.63
		9130197	20	3.25	10.46
		10/1/97	21	4.17	9.66
		10/2/97	22	3.25	9.46
		10/3/97	23	3.00	11.50
		1014197	24	4.33	11.25
		1015197	25	4.33	11.63
		10/6/97	26	3.54	6.75
		10/7/97	27	3.63	4.04
		10/8/97	26	3.92	5.00
		10/9/97	29	2.25	11.33
		10110197	30	3.92	11.42
		10/11/97	31	6.63	it.71

All average Oxygen values are expressed as a percent

February 10, 1998

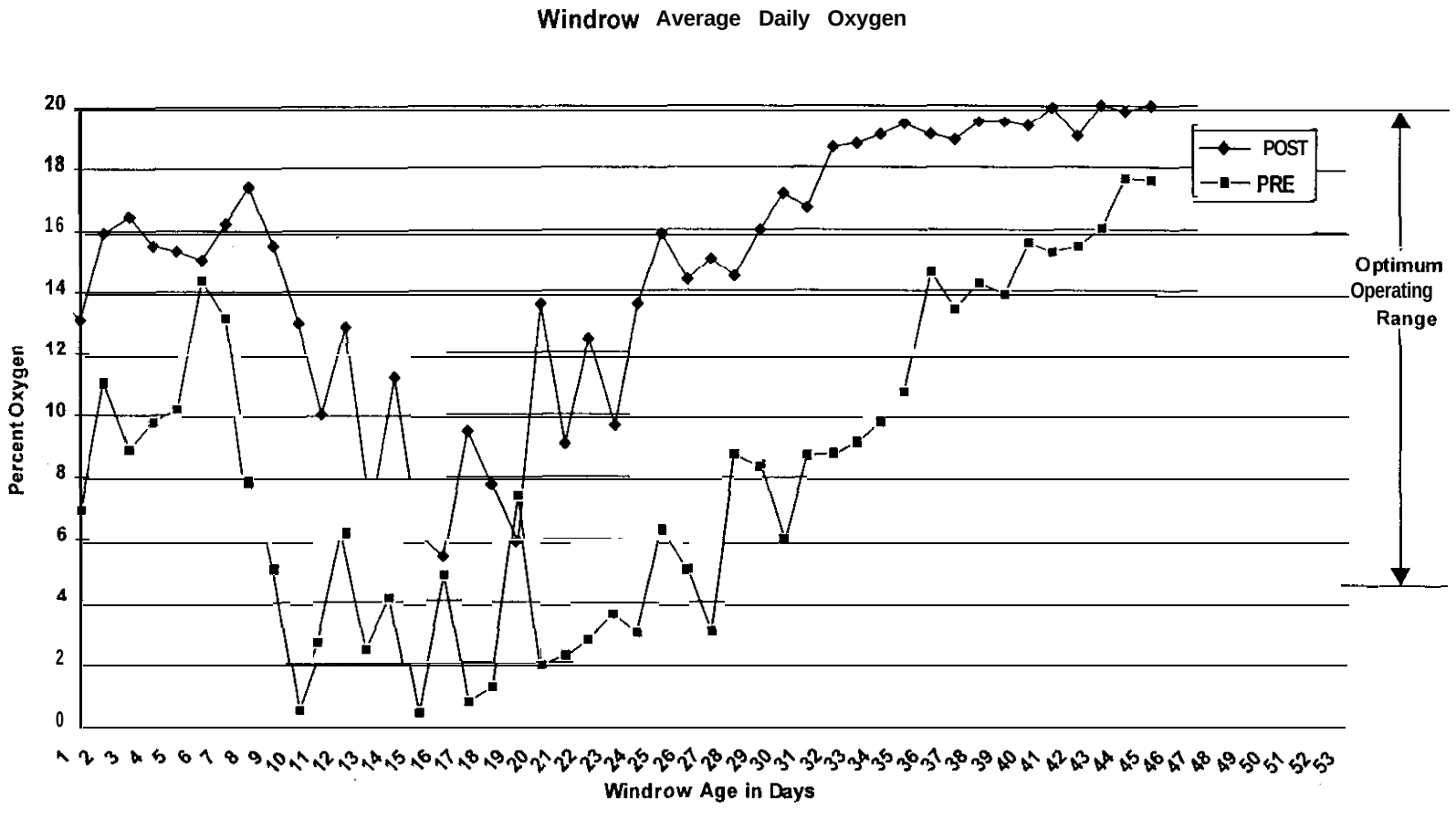
Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX5	9/10/97	10/12/97	32	3.36	10.58
		10/13/97	33	4.56	8.63
		10/14/97	34	4.46	10.42
		10/15/97	35	4.54	13.13
		10/16/97	36	7.63	9.63
		10/17/97	37	6.67	13.63
		10/18/97	38	0.42	15.13
		10/19/97	39	1.21	11.00
		10/20/97	40	2.75	12.75
		10/21/97	41	3.50	14.04
		10/22/97	42	6.92	15.04
		10/23/97	43	6.04	16.50
		10/24/97	44	6.29	17.71
		10/25/97	45	7.29	17.79
		10/26/97	46	11.04	16.67
		10/27/97	47	10.58	19.29
		10/28/97	48	10.58	19.21
		10/29/97	49	13.75	17.67
		10/30/97	50	15.68	20.00
		10/31/97	51	15.42	19.71

AN average Oxygen values are expressed as a percent

February 10, 1998

NSWC Crane BioFacility Pilot ScaleContamination Soil Demonstration

Compost Recipe Mix 7A Constructed September 9, 1997



Morrison Knudsen Corporation

Average Daily Windrow Oxygen Summary Report

Vindrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX7A	9/9/97	9/9/97	0		13.66
		9/10/97	1	6.92	13.13
		9/11/97	2	11.08	15.96
		9/12/97	3	8.66	16.46
		9/13/97	4	9.79	15.54
		9/14/97	5	10.17	15.33
		9/15/97	6	14.33	15.04
		9/16/97	7	13.17	16.25
		9/17/97	8	7.66	17.42
		9/18/97	9	5.13	15.54
		9/19/97	10	0.54	13.00
		9/20/97	11	2.71	10.08
		9/21/97	12	6.25	12.68
		9/22/97	13	2.46	6.66
		9/23/97	14	4.13	11.21
		9/24/97	15	0.42	6.17
		9/25/97	16	4.63	5.46
		9/26/97	17	0.75	9.46
		9/27/97	18	1.21	7.79
		9/28/97	19	7.42	5.92
		9/29/97	20	1.96	13.56
		9/30/97	21	2.25	9.04
		10/1/97	22	2.63	12.50
		10/2/97	23	3.67	9.63
		10/3/97	24	3.08	13.66
		10/4/97	25	6.33	15.66
		10/5/97	26	5.04	14.36
		10/6/97	27	3.08	15.04
		10/7/97	28	8.79	14.50
		10/8/97	29	8.42	16.00
		10/9/97	30	6.06	17.17
		10/10/97	31	6.79	16.71

All average Oxygen values are expressed as a percent

February 10, 1998

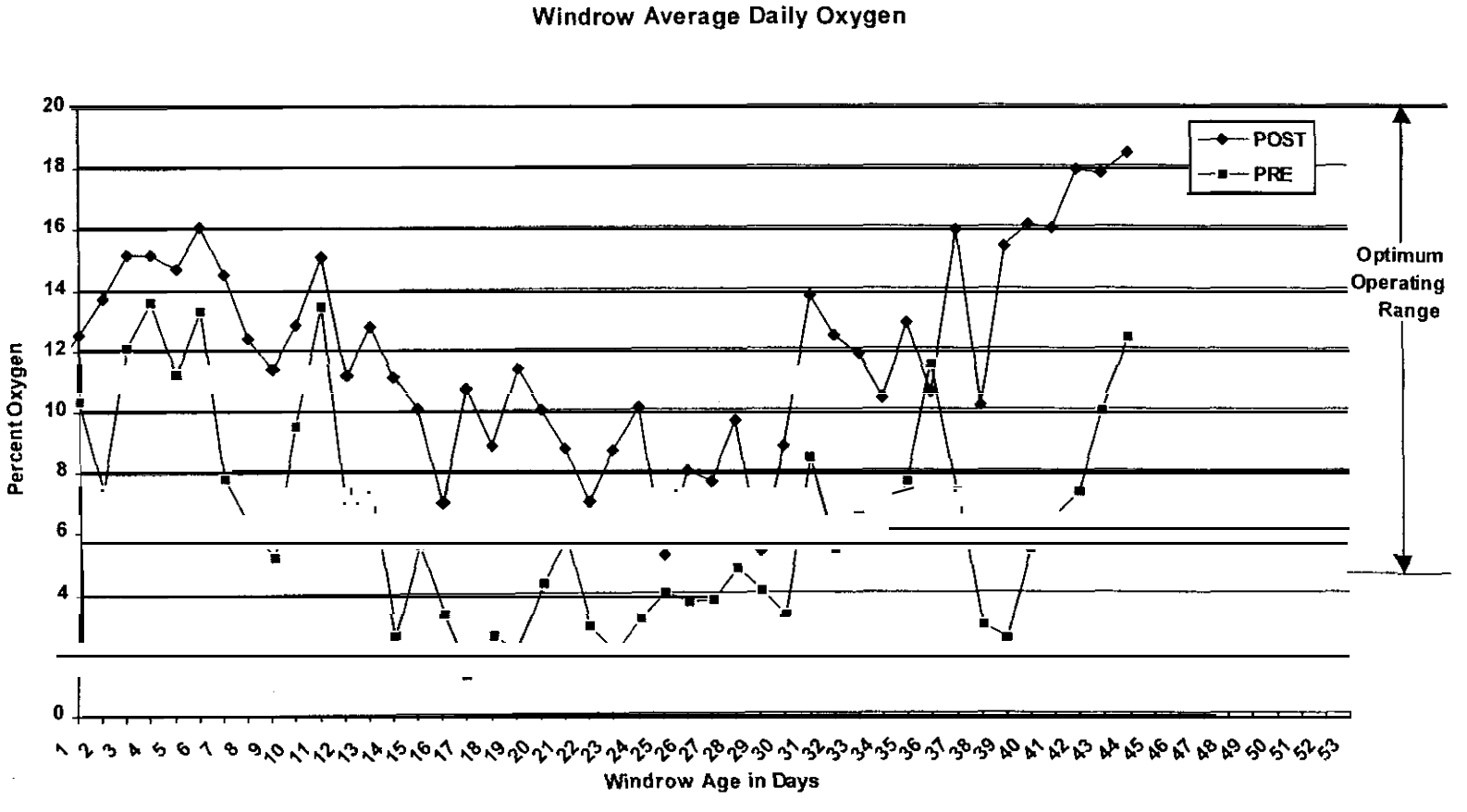
Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX7A	919197	10/11197	32	8.83	18.63
		10112197	33	9.17	18.75
		10/13197	34	9.63	19.04
		10/14/97	35	10.75	19.42
		10115197	36	14.58	19.04
		10/16197	37	13.42	18.86
		10/17/97	38	14.25	19.46
		10/18/97	39	13.88	19.46
		10119197	40	15.58	19.33
		10/20/97	41	15.29	19.92
		10/21/97	42	15.50	19.00
		10/22/97	43	16.04	20.00
		10123197	44	17.67	19.63
		10124197	45	17.58	20.00

All average Oxygen values are expressed as a percent

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 7B Constructed September 10, 1997



Morrison Knudsen Corporation

Average Daily Windrow Oxygen Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX7B	9110197	9/10/97	0		11.43
		9/11/97	1	10.38	12.54
		9/12/97	2	7.46	13.71
		9/13/97	3	12.08	15.21
		9/14/97	4	13.63	15.17
		9/15/97	5	11.21	14.71
		9/16/97	6	13.29	16.08
		9/17/97	7	7.83	14.54
		9/18/97	8	6.21	12.42
		9/19/97	9	5.21	11.38
		9/20/97	10	9.54	12.83
		9/21/97	11	13.46	15.08
		9/22/97	12	7.00	11.13
		9/23/97	13	7.38	12.75
		9/24/97	14	2.58	11.08
		9/25/97	15	5.54	10.08
		9126197	16	3.33	6.96
		9127197	17	1.25	10.71
		9/28/97	18	2.58	8.88
		9/29/97	19	2.04	11.33
		9/30/97	20	4.25	10.00
		1011197	21	5.75	8.71
		10/2/97	22	2.88	7.00
		1013197	23	2.04	8.67
		1014197	24	3.13	10.04
		10/5/97	25	4.00	5.21
		10/6/97	26	3.67	8.00
		10/7/97	27	3.71	7.67
		10/8/97	28	4.75	9.63
		10/9/97	29	4.04	5.29
		10110197	30	3.25	8.79
		10/11/97	31	8.46	13.75

All average Oxygen values are expressed as a percent

February 10.1998

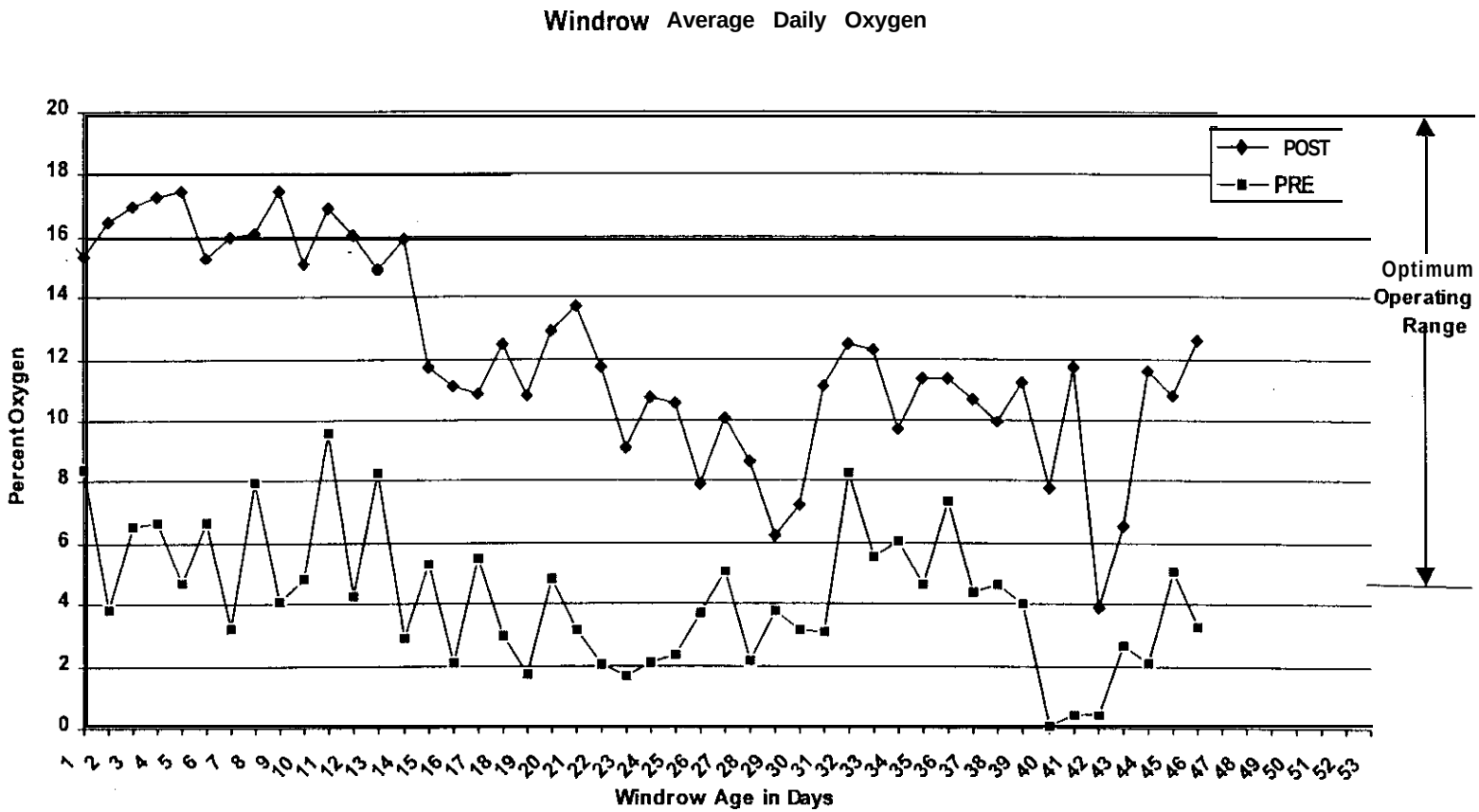
Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX7B	9/10/97	10/12/97	32	5.33	12.42
		10/13/97	33	6.42	11.79
		10/14/97	34	5.63	10.33
		10/15/97	35	7.67	12.63
		10/16/97	36	11.46	10.54
		10/17/97	37	7.29	15.88
		10H 8/97	38	2.88	10.13
		10119197	39	2.46	15.33
		10120197	40	5.33	16.08
		10/21/97	41	6.33	15.96
		10/22/97	42	7.21	17.66
		10/23/97	43	9.96	17.75
		10/24/97	44	12.36	16.42

All average Oxygen values are expressed as a percent

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 8 Constructed September 8, 1997



Average Daily Windrow Oxygen Summa y Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX8	9/8/97	9/8/97	0		16.38
		919197	1	a.42	15.38
		9/10/97	2	3.83	16.50
		9/11/97	3	6.54	16.96
		9/12/97	4	6.67	17.29
		9/13/97	5	4.67	17.50
		9/14/97	6	6.67	15.33
		9/15/97	7	3.21	16.00
		9/16/97	a	7.96	16.13
		9/17/97	9	4.08	17.46
		9/18/97	10	4.79	15.13
		9/19/97	11	9.58	16.92
		9/20/97	12	4.25	16.04
		9/21/97	13	8.25	14.92
		9/22/97	14	2.88	15.92
		9123197	15	5.33	11.75
		9/24/97	16	2.13	11.13
		9/25/97	17	5.50	10.86
		9/26/97	18	2.96	12.50
		9127197	19	1.71	10.83
		9/28/97	20	4.83	12.92
		9/29/97	21	3.13	13.71
		9/30/97	22	2.04	11.71
		10/1/97	23	1.67	9.06
		10/2/97	24	2.08	10.75
		10/3/97	25	2.38	I0.54
		10/4/97	26	3.71	7.92
		1015197	27	5.05	10.04
		10/6/97	28	2.17	8.67
		10/7/97	29	3.79	6.25
		10/8/97	30	3.17	7.25
		10/9/97	31	3.08	11.13

All average Oxygen values are expressed as a percent

February 10, 1998

Windrow Number	*Construction Date*	*Date Monitored*	*Ape (Days)*	*PRE-Turn (%)*	*POST-Turn (%)*
MIX8	9/8/97	10/10/97	32	8.29	12.46
		10/11/97	33	5.58	12.29
		10/12/97	34	6.04	9.67
		10/13/97	35	4.63	11.38
		10/14/97	36	7.38	11.33
		10/15/97	37	4.38	10.67
		10/16/97	38	4.63	9.96
		10117197	39	4.04	11.25
		1Oil 8/97	40	0.04	7.75
		10119197	41	0.46	11.71
		10/20/97	42	0.46	3.88
		10/21/97	43	2.67	6.54
		10/22/97	44	2.13	11.63
		10123197	45	5.08	10.83
		10/24/97	46	3.25	12.58

AN average Oxygen values are expressed as a percent

February 10, 1998

APPENDIX M
CONTAMINATED SOIL pH

APPENDIX M
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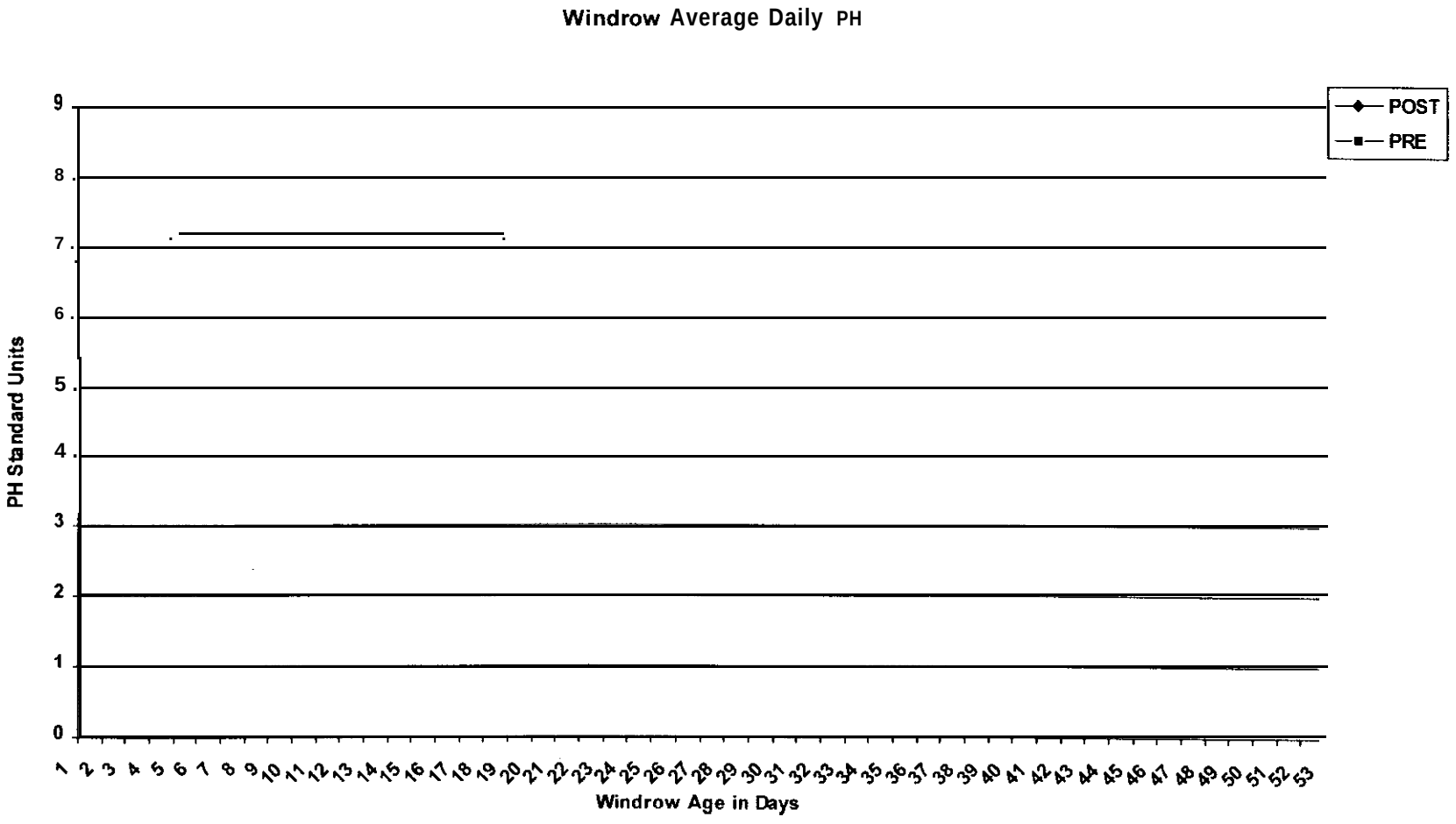
DESCRIPTION	NO. PAGES
CONTAMINATED SOIL pH	14 pages

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 1 Constructed October 9, 1997



Morrison Knudsen Corporation

Average Daily Windrow PH Summary Report

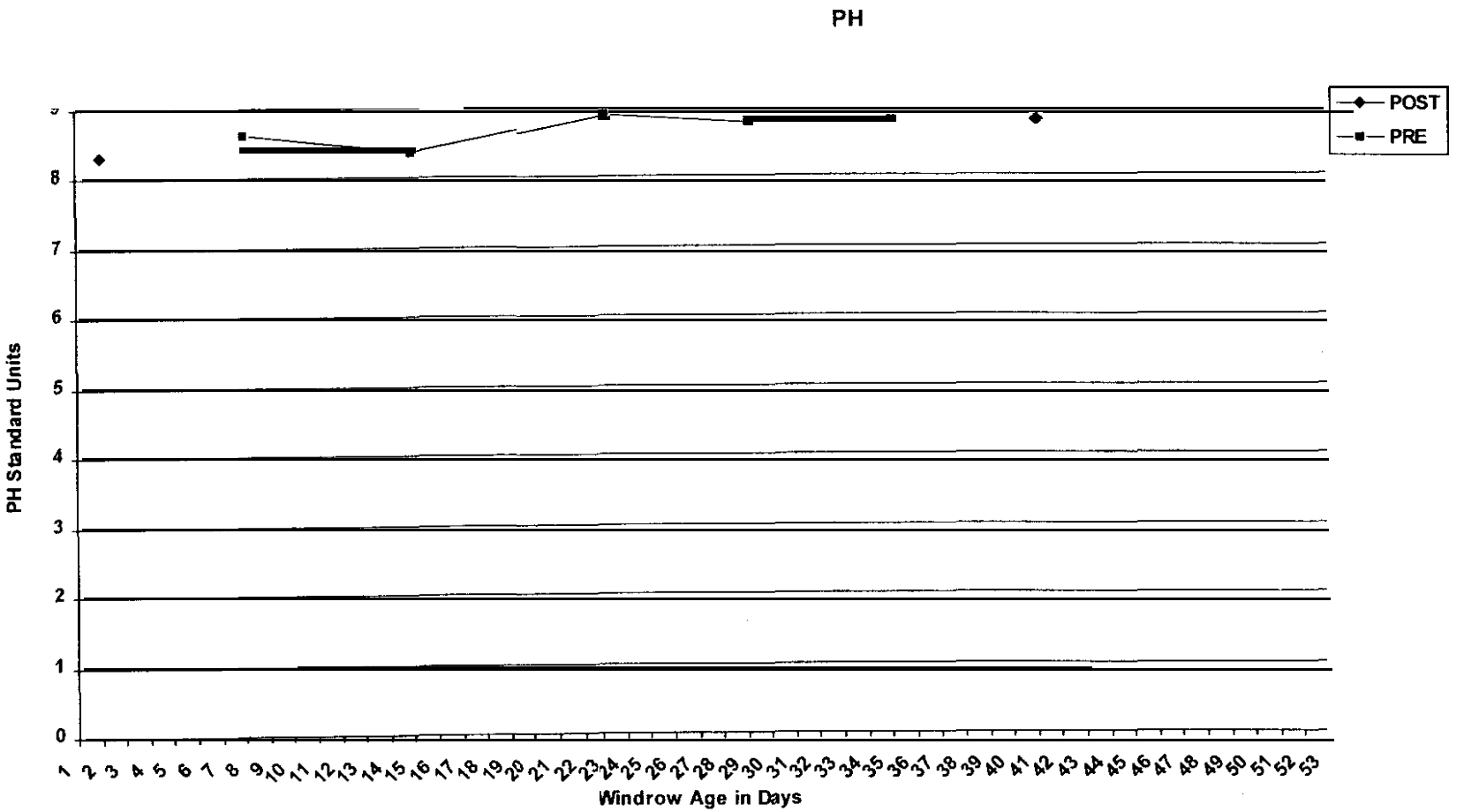
Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (STD Units)*
MIX1	10/9/97	10/10/97	1	6.84
		10/14/97	5	
		10/20/97	11	
		10/28/97	19	

AN average PH values are expressed in standard units

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 3 Constructed September 9, 1997



Morrison Knudsen Corporation

Average Daily Windrow PH Summary Report

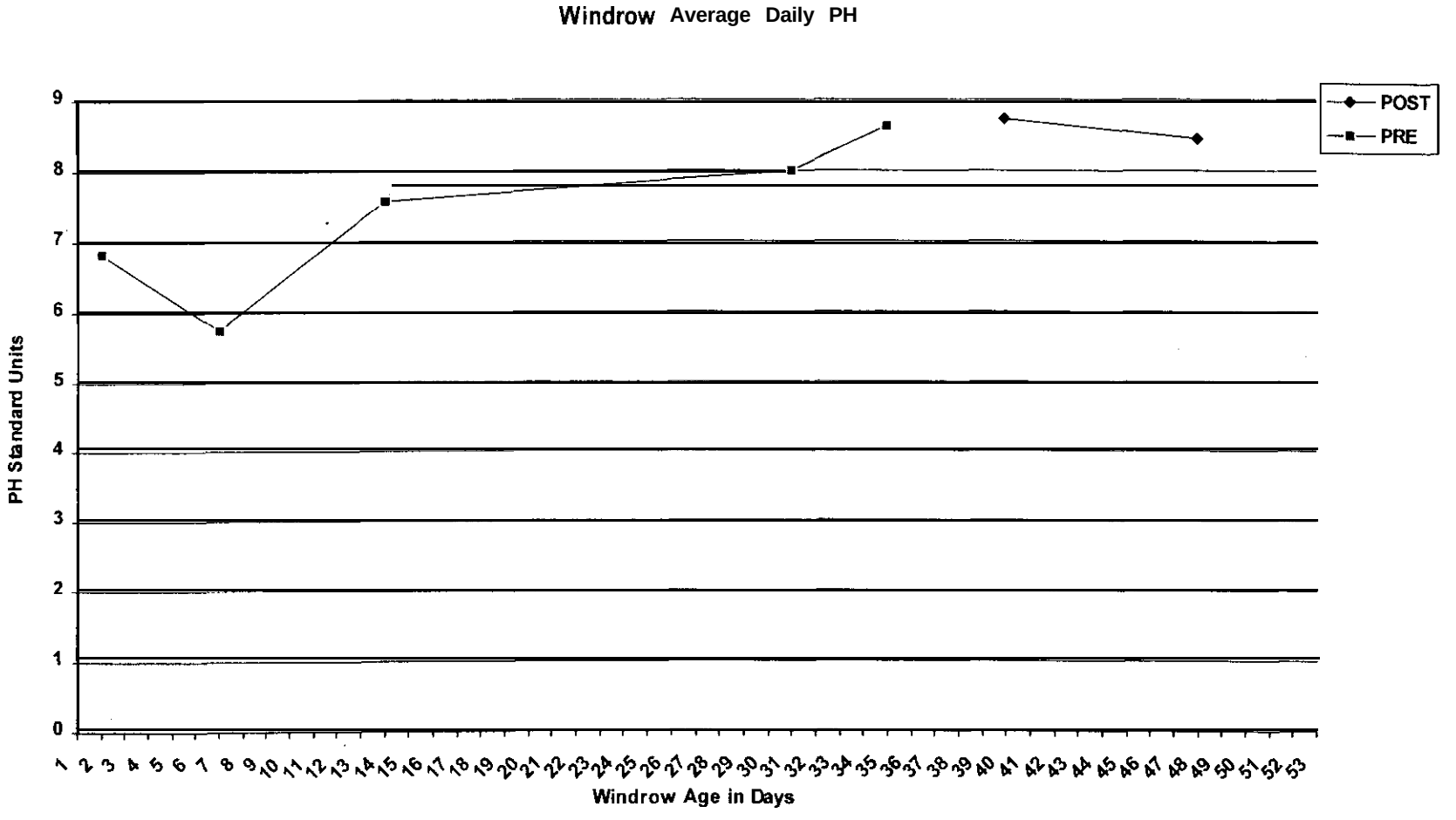
Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE- Turn (STD Units)*
MIX3	9/9/97	9/11/97	2	
		9/17/97	8	8.63
		9/24/97	15	8.38
		10/2/97	23	8.93
		10/8/97	29	8.80
		10/14/97	35	8.83
		10/20/97	41	

AN average PH values are expressed in standard units

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 5 Constructed September 10, 1997



Morrison Knudsen Corporation

Average Daily Windrow PH Summary Report

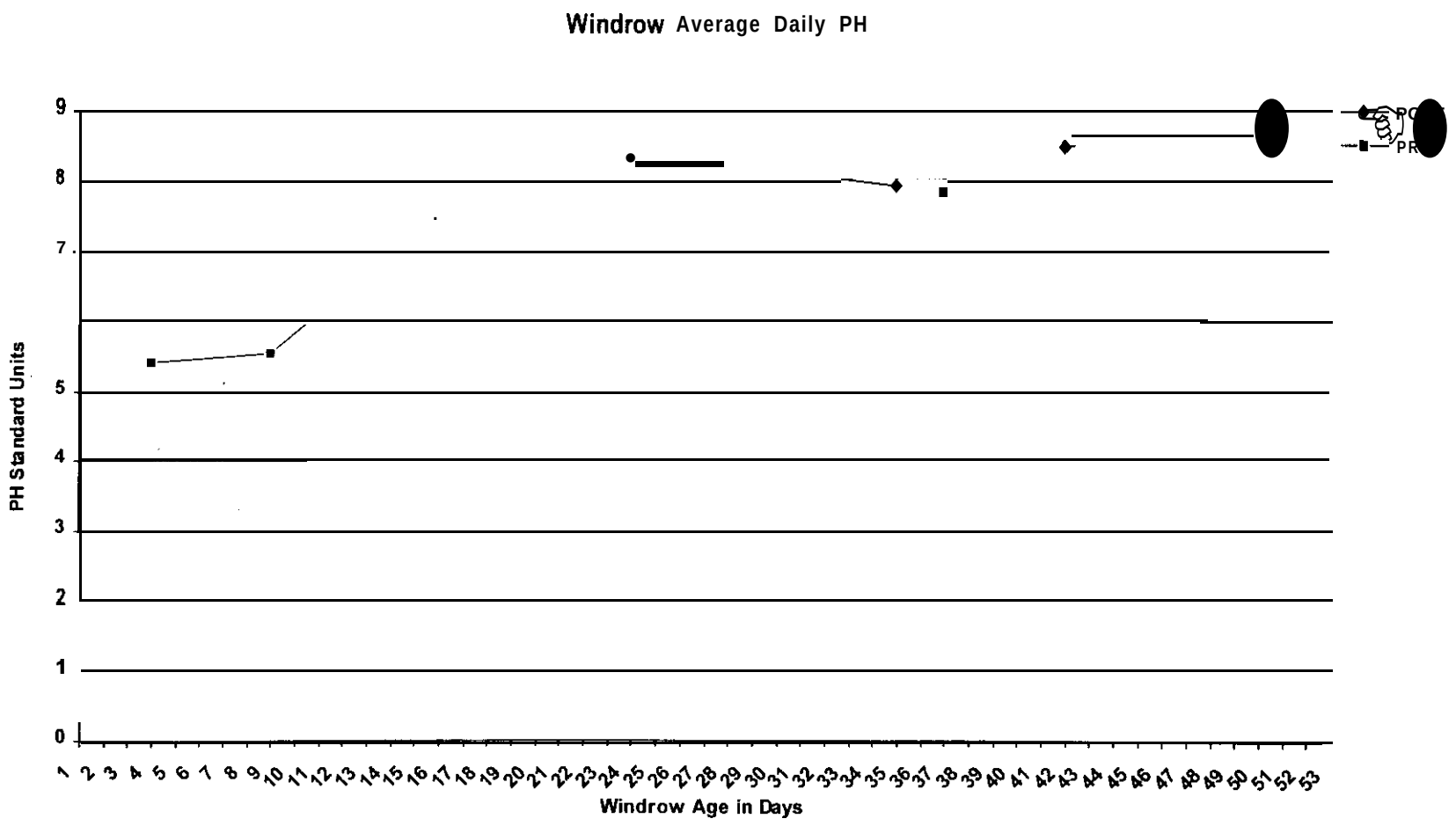
Windrow Number	Construction Date	Dote Monitored	Age (Days)	PRE-Turn (STD Units)
MiX4	9/8/97	9112197	4	5.43
		9/17/97	9	5.55
		9/24/97	16	7.50
		10/2/97	24	
		10/13/97	35	
		10/15/97	37	7.83
		10/20/97	42	
		10/28/97	50	

All average PH values are expressed in standard units

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 4 Constructed September 8, 1997



Morrison Knudsen Corporation

Average Daily Windrow PH Summary Report

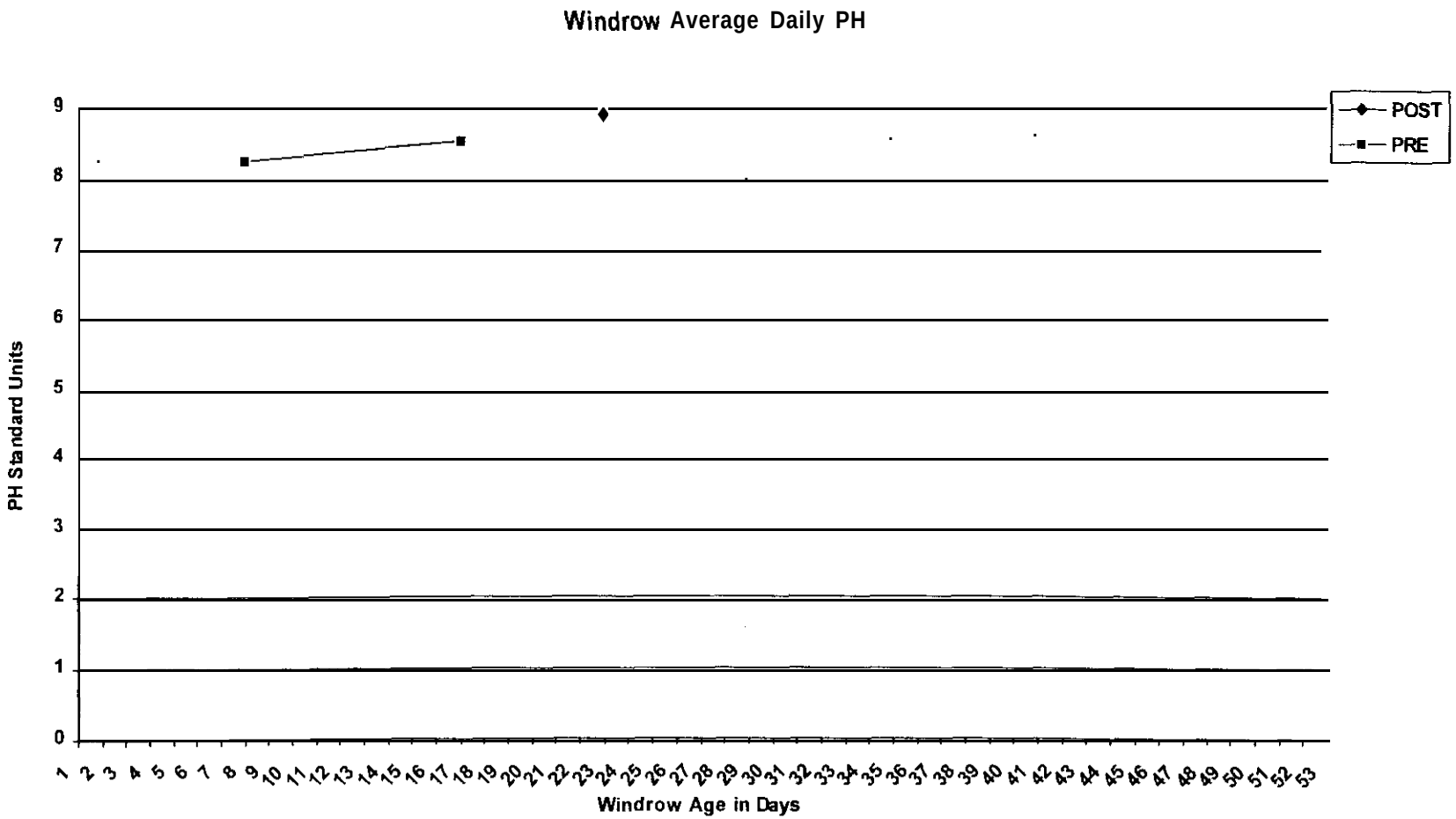
Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (STD Units)
MIX5	9/10/97	9112197	2	6.83
		9117197	7	5.75
		9124197	14	7.58
		10111197	31	8.00
		10/15/97	35	8.63
		10/20/97	40	
		10/28/97	48	

All average PH values are expressed in standard units

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 7A Constructed September 9, 1997



Morrison Knudsen Corporation

Average Daily Windrow PH Summary Report

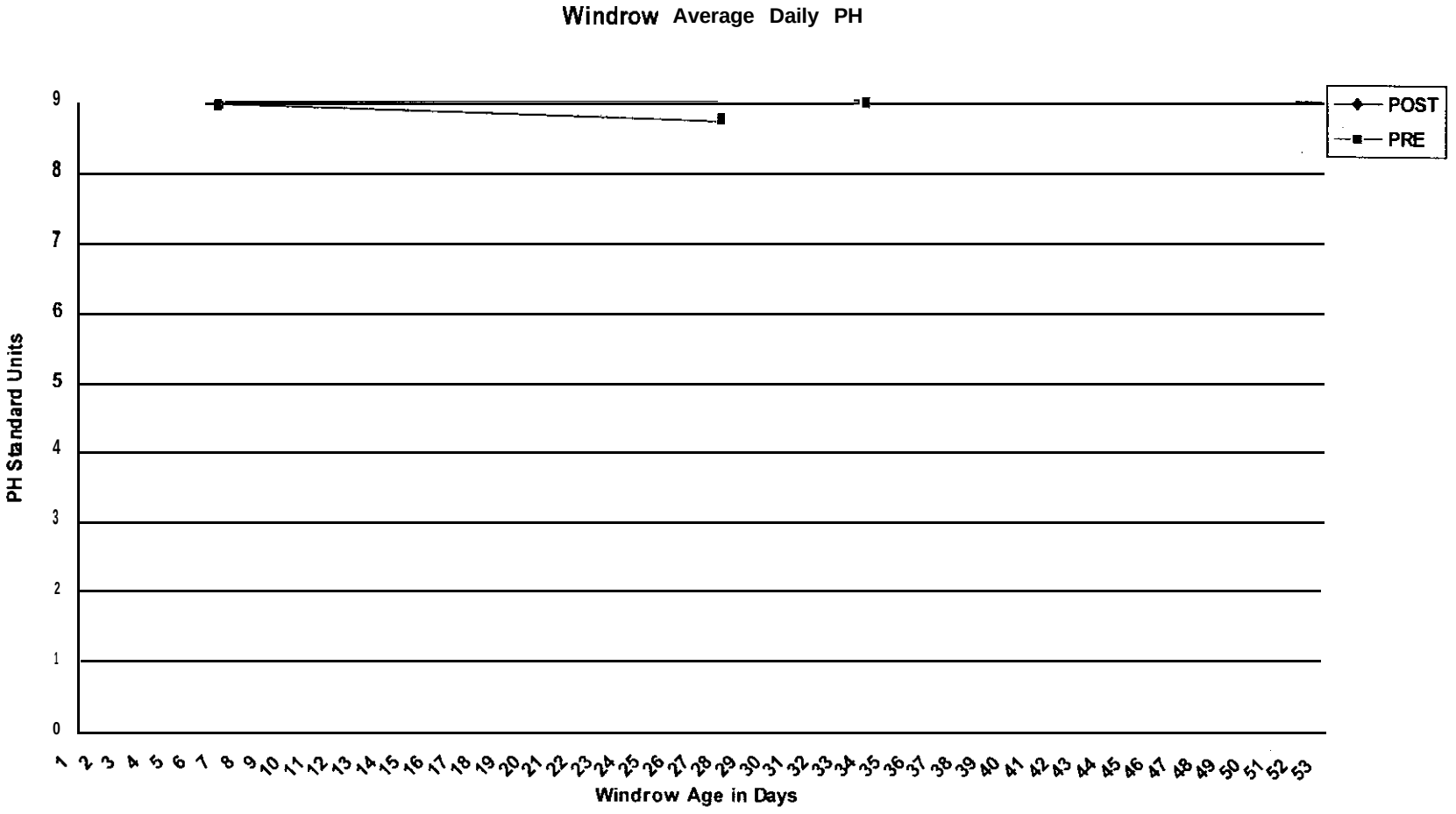
Windrow Number	*Construction Dote*	*Date Monitored*	*Age (Days)*	*PRE- Turn (STD Units)*
MIX7A	9/9/97	9/11/97	2	
		9/17/97	8	8.25
		9/26/97	17	8.50
		10/2/97	23	
		10/8/97	29	8.00
		10/14/97	35	8.58
		10/20/97	41	

AN average PH values are expressed in standard units

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 7B Constructed September 10, 1997



Morrison Knudsen Corporation

Average Daily Windrow PH Summary Report

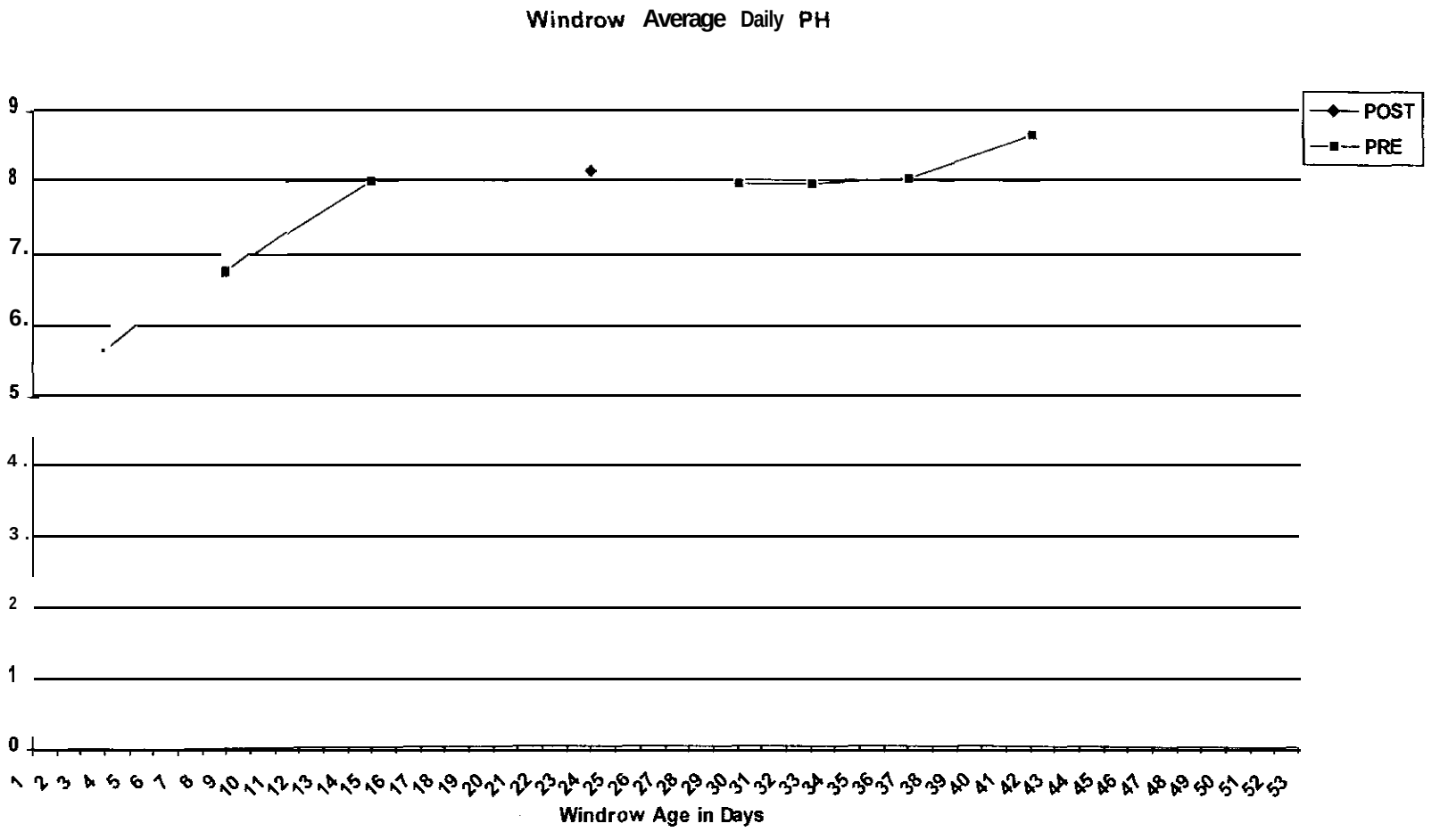
Windrow Number	Construction Date	Date Monitored	Age (Days)	PRE-Turn (STD Units)
MIX7B	9110197	9/11/97	1	
		9/17/97	7	8.97
		10/8/97	28	a.75
		10114197	34	a.97
		10/20/97	40	

All average PH values me expressed in standard units

February 10, 1998

NSWC Crane BioFacility Pilot Scale Contamination Soil Demonstration

Compost Recipe Mix 8 Constructed September 8, 1997



Morrison Knudsen Corporation

Average Daily Windrow PH Summary Report

Vindrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*PRE-Turn (STD Units)*
MIX8	9/8/97	9/12/97	4	5.68
		9/17/97	9	6.75
		9/23/97	15	8.00
		10/2/97	24	
		10/8/97	30	7.95
		10/11/97	33	7.95
		10/15/97	37	8.03
		10/20/97	42	8.63

All average PH values are expressed in standard units

February 10, 1998

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CONTAMINATED SOIL C:N

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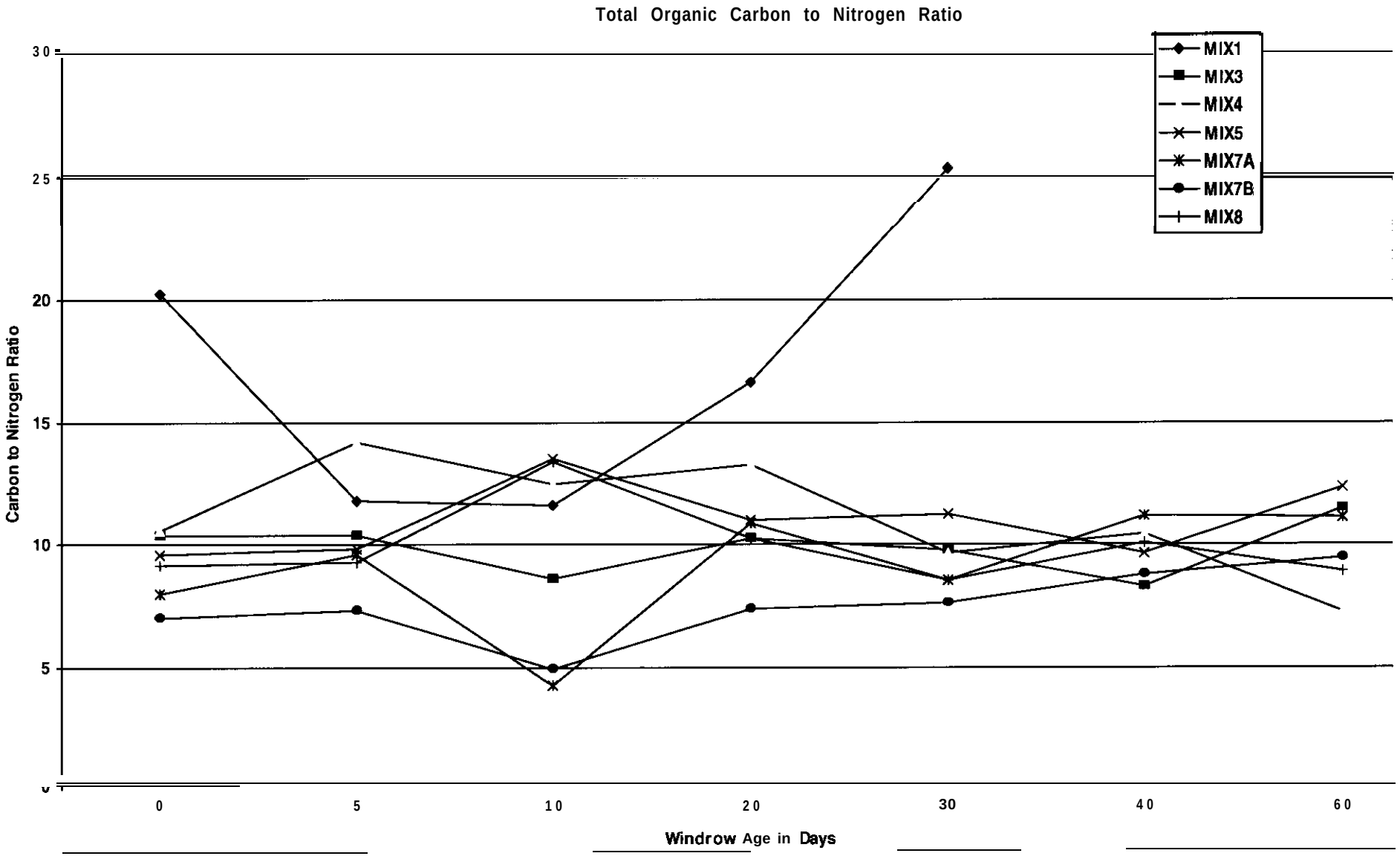
NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Average Total Organic Carbon to Kjeldahl Nitrogen Concentration Percent Ratio



APPENDIX 0
CONTAMINATED SOIL AMBIENT TEMPERATURE AND HUMIDITY

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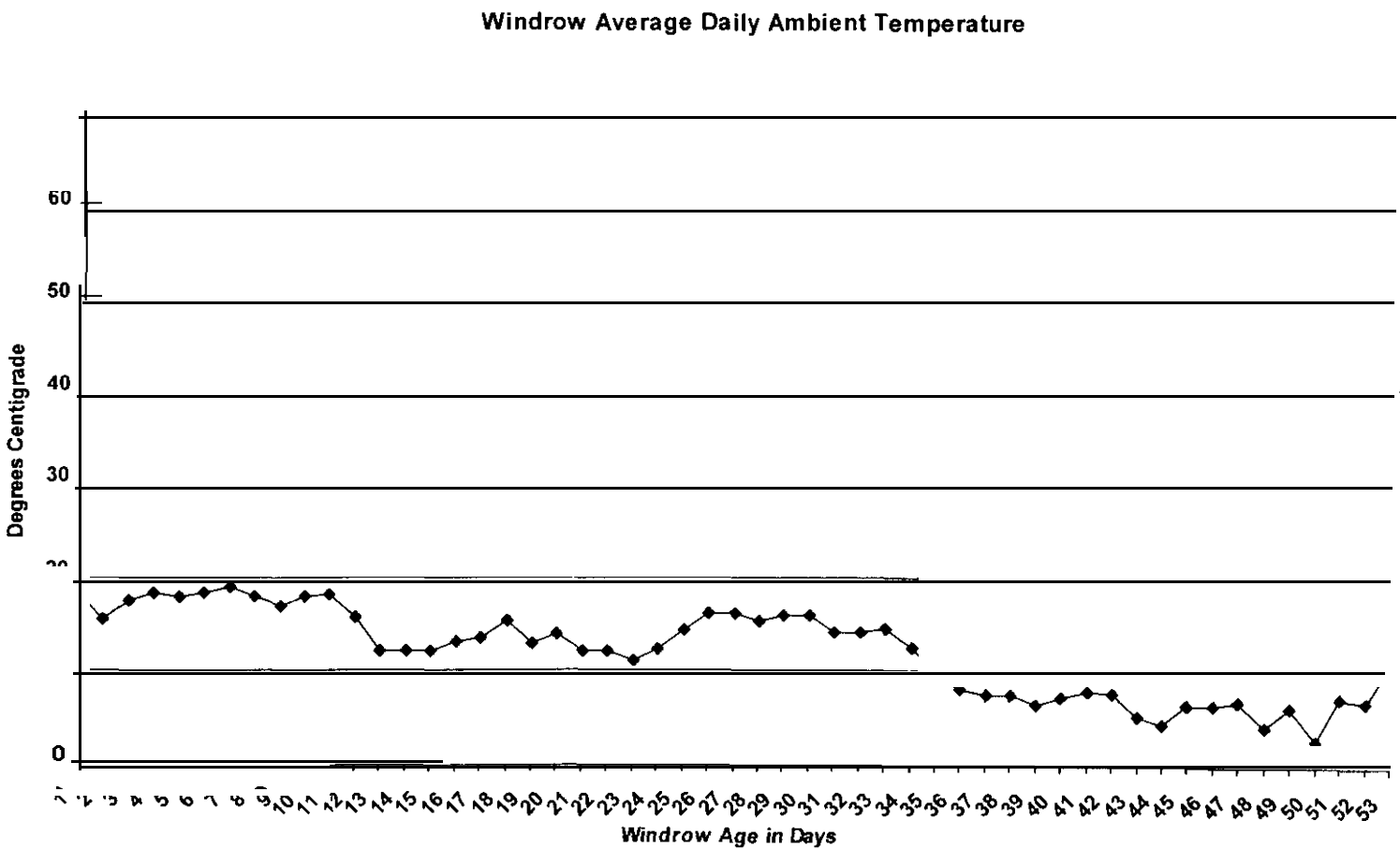
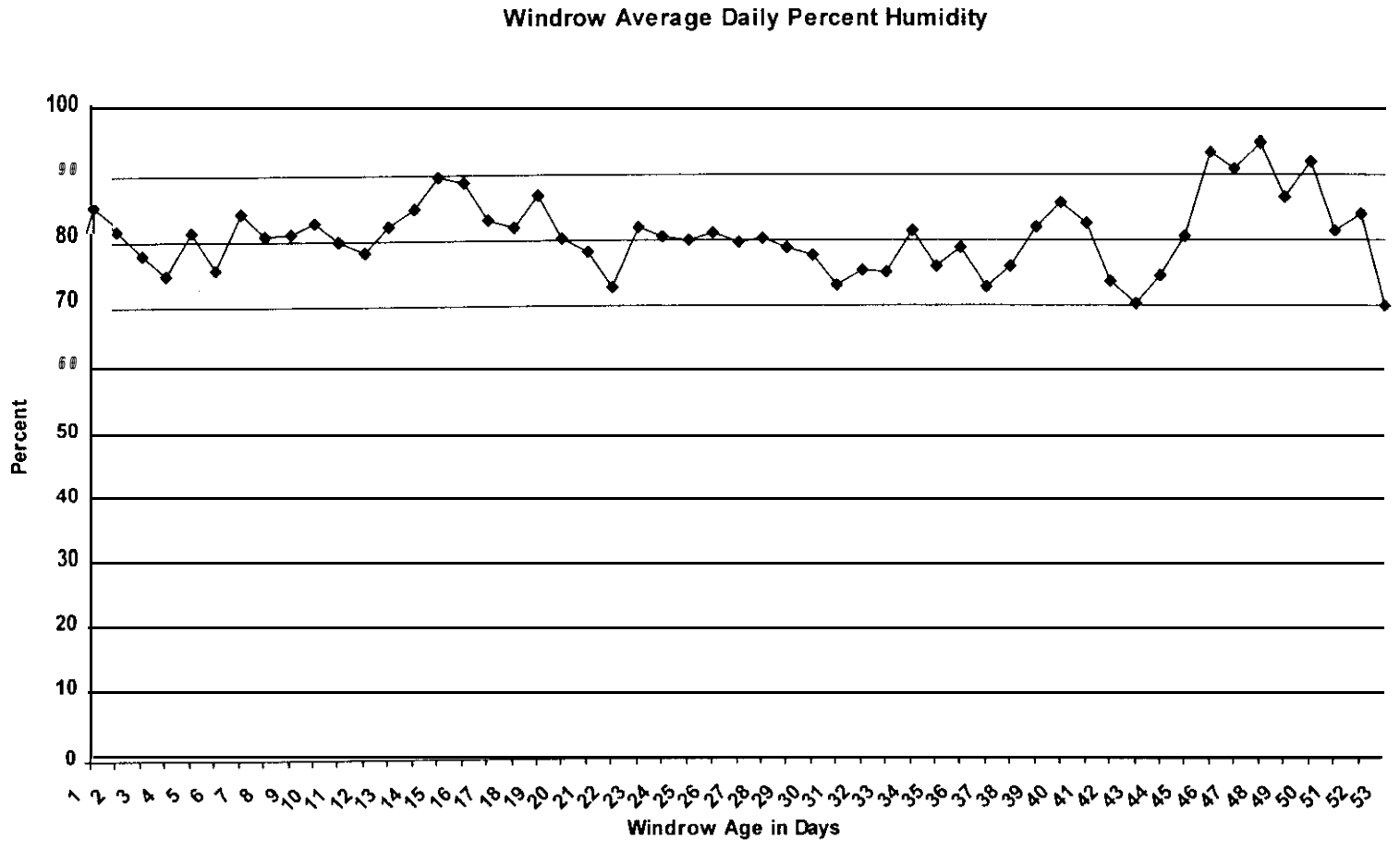
DESCRIPTION	NO. PAGES
CONTAMINATED SOIL AMBIENT TEMPERATURE AND HUMIDITY	2 pages

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration



Morrison Knudsen Corporation

NSWC Crane BioFacility Pilot Scale Demonstration



Morrison Knudsen Corporation

APPENDIX P
CONTAMINATED SOIL EXPLOSIVES DEGRADATION

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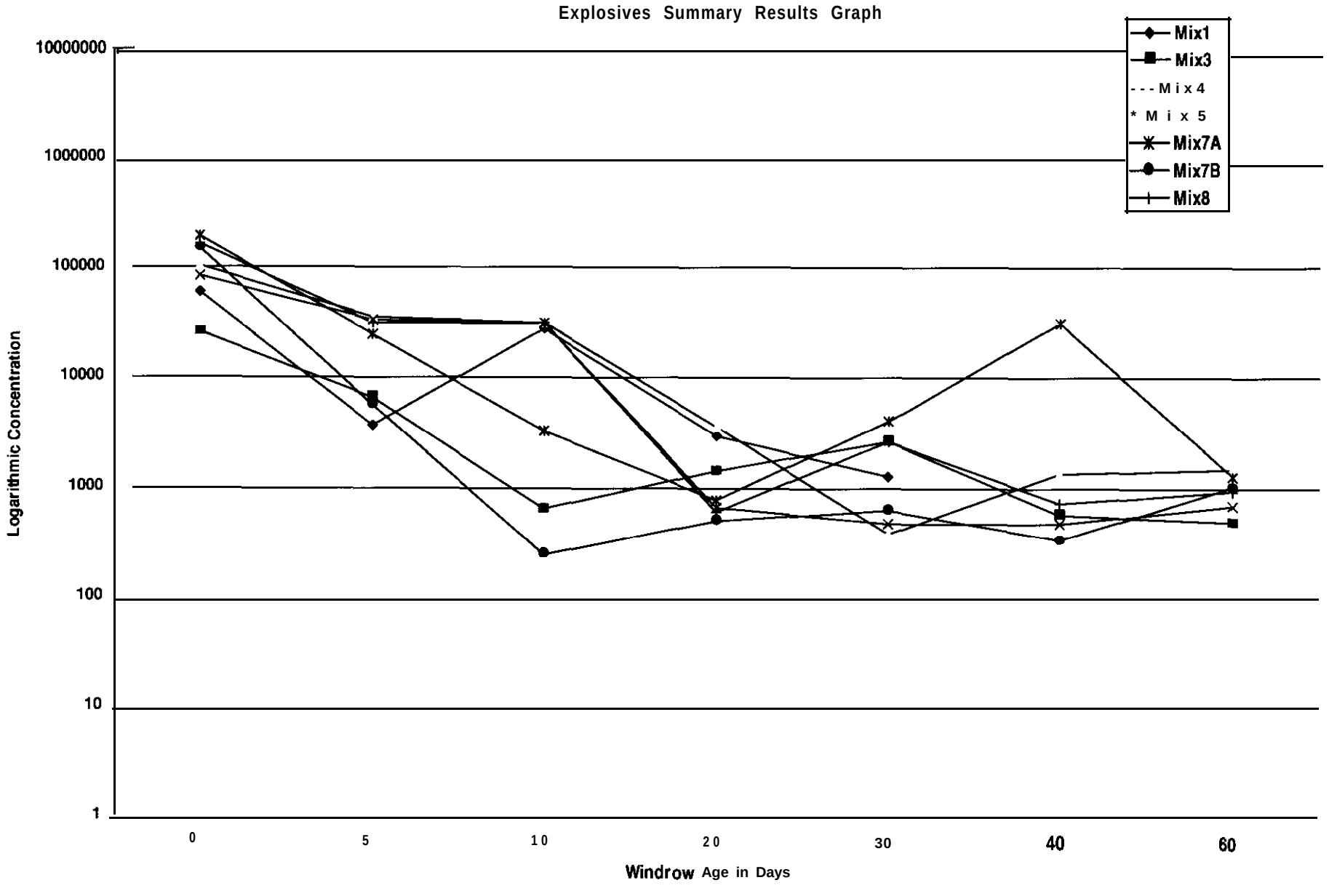
CONTAMINATED SOIL EXPLOSIVES DEGRADATION	9 pages

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Average 2,4,6-TNT Concentrations (UG/KG)



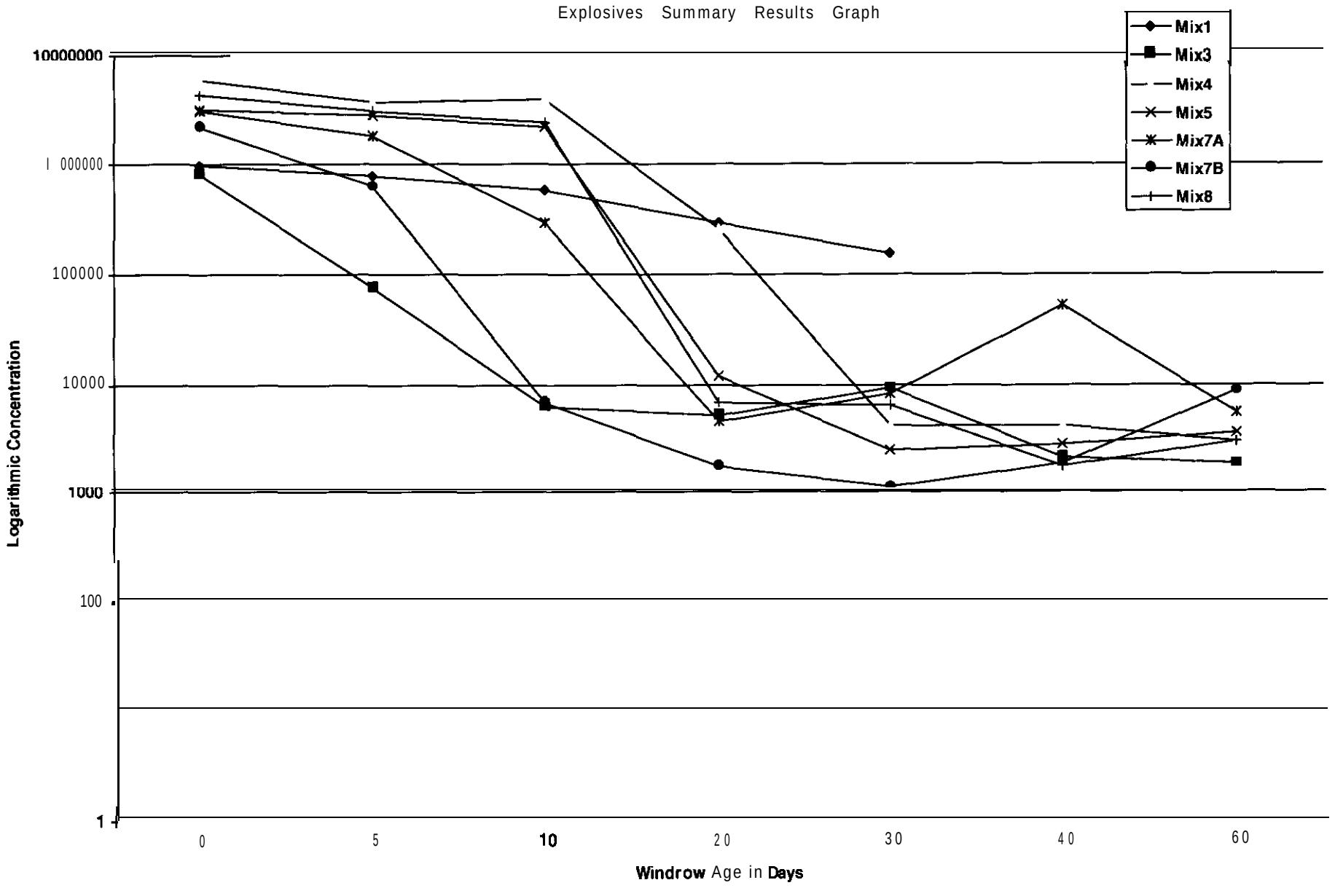
Average Daily Windrow 2,4,6-TNT Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	Avg. Conc. (UG/KG)
MIX1	1019197	10/9/97	0	59123
MIX1	10/9/97	10/14/97	5	3642
MIX1	1019197	10/19/97	10	27464
MIX1	10/9/97	10/29/97	20	2974
MIX1	10/9/97	11/8/97	30	1250
MIX3	9/9/97	9/9/97	0	26191
MIX3	9/9/97	9/14/97	5	6656
MIX3	919197	9/19/97	10	650
MIX3	9/9/97	9/29/97	20	1445
MIX3	919197	10/9/97	30	2634
MIX3	9/9/97	10/19/97	40	575
MIX3	9/9/97	11/8/97	60	491
MIX4	9/8/97	9/8/97	0	103692
MIX4	9/8/97	9/13/97	5	35436
MIX4	916197	9/18/97	10	31200
MIX4	916197	9/28/97	20	3619
MIX4	9/8/97	10/8/97	30	364
MIX4	9/8/97	10/18/97	40	1342
MIX4	9/8/97	11/7/97	60	1473
MIX5	9/10/97	9/10/97	0	84646
MIX5	9110197	9/15/97	5	33692
MIX5	9/10/97	9/20/97	10	31200
MIX5	9110/97	9/30/97	20	670
MIX5	9/10/97	10/10/97	30	473
MIX5	9/10/97	10/20/97	40	469
MIX5	9/10/97	11/9/97	60	662

Windrow Number	Construction Date	Date Monitored	Age (Days)	Avg. Conc. (UG/KG)
MIX7A	9/9/97	919197	0	190536
MIX7A	9/9/97	9/14/97	5	24934
MIX7A	9/9/97	9119197	10	3226
MIX7A	919197	9129197	20	777
MIX7A	9/9/97	10/9/97	30	4070
MIX7A	9/9/97	10/19/97	40	31769
MIX7A	919197	11/8/97	60	1246
MIX7B	9/1 0197	9110197	0	148514
MIX78	9/1 0197	9115197	5	5716
MIX7B	9110197	9120197	10	250
MIX7B	9110197	9/30/97	20	497
MIX7B	9110197	1 0/1 0197	30	622
MIX7B	9/10/97	10/20/97	40	337
MIX7B	9110197	11/9/97	60	1012
MIX8	9/8/97	9/8/97	0	164169
MIX8	9/8/97	9/1 3197	5	31752
MIX8	916197	9/18/97	10	31200
MIX8	9/8/97	9/28/97	20	602
MIX8	9/8/97	1016197	30	2594
MIX8	9/8/97	10/18/97	40	735
MIX8	9/8/97	11/7/97	60	927

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Average RDX Concentrations (UG/KG)



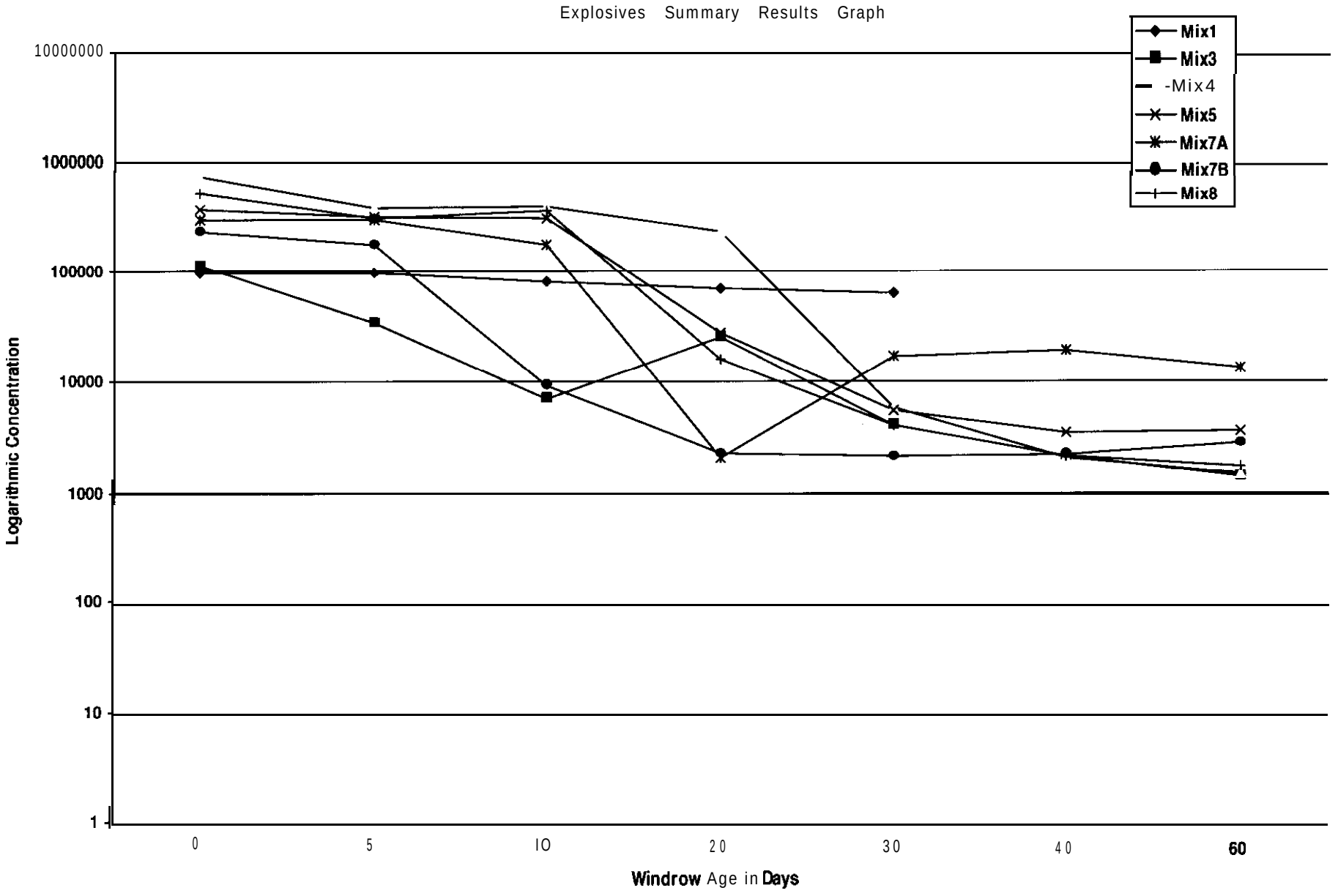
Average Daily Windrow RDX Summary Report

Windrow Number	*Construction Date*	*Date Monitored*	*Age (Days)*	*Avg. Conc. (UG/KG)*
MIX1	1019197	10/9/97	0	971231
MIX1	10/9/97	10/14/97	5	78.8571
MIX1	10/9/97	10/19/97	10	571357
MIX1	1019197	10/29/97	20	297533
MIX 1	10/9/97	11/8/97	30	153154
MIX3	9/9/97	9/9/97	0	806077
MIX3	9/9/97	9/14/97	5	77008
MIX3	919197	9/19/97	10	6385
MIX3	9/9/97	9/29/97	20	5334
MIX3	9/9/97	10/9/97	30	9395
MIX3	9/9/97	10119197	40	2205
MIX3	9/9/97	11/8/97	60	1910
MIX4	918197	9/8/97	0	5725365
MIX4	9/8/97	9/13197	5	3615385
MIX4	9/8/97	9/18/97	10	3853646
MIX4	9/8/97	9/28/97	20	262857
MIX4	9/8/97	10/8/97	30	4312
MIX4	9/8/97	10/18/97	40	4321
MIX4	9/8/97	11/7/97	60	3082
MIX5	9110197	9/10/97	0	3093077
MIX5	9/10/97	9/15/97	5	2756923
MIX5	9/10/97	9/20/97	10	2141786
MIX5	9/10/97	9/30/97	20	12008
MIX5	9/10/97	10/10/97	30	2526
MIX5	9/10/97	10/20/97	40	2857
MIX5	9/10/97	11/9/97	60	3655

Windrow Number	Construction Date	Date Monitored	Age (Days)	Avg. Conc. (UG/KG)
MIX7A	9/9/97	9/9/97	0	3001769
MIX7A	9/9/97	9/14/97	5	1762714
MIX7A	9/9/97	9/19/97	10	294154
MIX7A	9/9/97	9/29/97	20	4670
MIX7A	919197	10/9/97	30	8431
MIX7A	9/9/97	10/19/97	40	53679
MIX7A	9/9/97	11/8/97	60	5650
MIX7B	9/10/97	9/10/97	0	2175214
MIX7B	9/10/97	9/15197	5	627615
MIX7B	9110197	9/20/97	10	6991
MIX7B	9/1 0197	9/30/97	20	1831
MIX7B	9110197	10110197	30	1189
MIX78	9/10/97	10/20/97	40	1945
MIX7B	9110197	11/9/97	60	9046
MIX8	9/8/97	9/8/97	0	4266923
MIX8	9/8/97	9/13/97	5	2996154
MIX8	9/8/97	9/18/97	10	2372306
MIX8	918197	9/28/97	20	7025
MIX8	9/8/97	10/8/97	30	6564
MIX8	9/8/97	10/18/97	40	1837
MIX8	9/8/97	11/7/97	60	3053

NSWC Crane BioFacility Pilot Scale Contaminated Soil Demonstration

Average HMX Concentrations (UG/KG)



Average Daily Windrow HMX Summary Report

Windrow Number	Construction Date	Date Monitored	Age (Days)	Avg. Conc. (UG/KG)
MIX1	10/9/97	10/9/97	0	99254
MIX1	1 O/S/S7	10/14/97	5	96571
MIX,	10/9/97	10/19/97	10	61466
MIX1	10/9/97	10/29/97	20	69793
MIX1	10/9/97	11/8/97	30	62969
MIX3	9/9/97	9/9/97	0	114738
MIX3	9/9/97	9/14/97	5	34746
MIX3	9/9/97	9/19/97	10	6961
MIX3	9/9/97	9129197	20	25169
MIX3	9/9/97	10/9/97	30	3966
MIX3	9/9/97	10/19/97	40	2120
MIX3	9/9/97	11/8/97	60	1400
MIX4	9/8/97	9/8/97	0	716077
MIX4	9/8/97	9/13/97	5	360231
MIX4	9/8/97	9/18/97	10	369365
MIX4	9/8/97	9/28/97	20	230643
MIX4	9/8/97	10/8/97	30	5760
MIX4	9/8/97	10/18/97	40	2047
MIX4	9/8/97	11/7/97	60	1478
MIX5	9/10197	9/10197	0	363077
MIX5	9/10197	9/15/97	5	309646
MIX5	9/10197	9/20/97	10	299766
MIX5	9110197	9/30/97	20	27477
MIX5	9/10/97	10110197	30	5510
MIX5	9/10197	10/20/97	40	3492
MIX5	9/10/97	11/9/97	60	3572
MIX7A	9/9/97	9/9/97	0	291923

Windrow Number	Construction Date	Dote Monitored	Age (Days)	Avg. Conc. (UG/KG)
MIX7A	919197	9/14/97	5	291929
MIX7A	9/9/97	9/19/97	10	172769
MIX7A	9/9/97	9/29/97	20	2066
MIX7A	919197	10/9/97	30	17085
MIX7A	9/9/97	10/19/97	40	19150
MIX7A	919197	11/8/97	60	13362
MIX7B	9/10/97	9/10/97	0	229829
MIX7B	9/10/97	9/15/97	5	174306
MIX78	9/10/97	9/20/97	IO	9351
MIX7B	9/10/97	9/30/97	20	2236
MIX7B	9/19197	10/10/97	30	2112
MIX78	9110197	10/20/97	40	2200
MIX76	9/10/97	1119197	60	2800
MIX8	9/8/97	9/8/97	0	514615
MIX8	9/8/97	9/13/97	5	304615
MIX8	9/8/97	9/18/97	IO	351306
MIX8	9/8/97	9128197	20	15977
MIX8	9/8/97	10/8/97	30	4007
MIX8	918197	10/18/97	40	2143
MIX8	9/8/97	11/7/97	60	1737

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1.0
INTRODUCTION

Time-integrated industrial hygiene (IH) bioaerosol sampling was completed on September 12, 1997 to establish background levels of airborne bacteria and fungi (molds and yeast). A duplicate bioaerosol sampling campaign was obtained on the same day inside of the Compost Building 3 during contaminated soil composting and the results compared to background concentrations to determine if a higher concentration of bacteria and fungi (molds and yeast) exists inside of structure during active composting, and if so, the potential employee health concerns.

Time-integrated IH air sampling for total metals and for explosive aerosols/vapors was completed during contaminated soil excavation and screening. Samples were obtained at NSWC Crane Mine Fill A excavation site on August 22, 1997 and August 26, 1997. Sampling for the same analytes was also completed on September 22, 1997 inside of Compost Building 3. Time-integrated IH air sampling for hydrocarbons was completed on September 24, 1997 inside of Compost Building 2.

IH monitoring using direct reading instrumentation was completed at various times during pilot scale for physical and chemical agents. They included the following:

A. Total Dust using portable Laser Dust Monitor.
B. *Chemical Agents using colorimetric indicator tubes, combustible gas meter, and* photo-ionization detector (PID).
C. Heat Stress based on worker pulse rates and ear canel temperature readings.
D. Sound Level Surveys.

Equipment, sampling media and analytical services for time integrated IH air sampling were provided by Lyle Environmental Management, Inc. under Purchase Order (PO) 2F6-4324-2783. Field monitoring and sampling was conducted by MK personnel.

1.1 PURPOSE AND OBJECTIVES

Bioaerosols

The purpose of the bioaerosol sampling campaign was to evaluate bioaerosol air concentrations inside of Compost Building 3 using Andersen Two-Stage Impactors obtaining both respirable and non-respirable sized samples. The results were compared both qualitatively and quantitatively to background bioaerosol air samples. Background samples were obtained from an ambient outdoor location upwind from the perimeter of the Compost Building.

More specifically, the objective of this sampling was to assess whether airborne bioaerosol concentrations of total bacteria including pathogenic species such as *E.coli*, along with fungi (molds and yeast) including *Aspergillus* species such as *Aspergillus fumigatus*, inside of the Compost Building 3 are less than or equal to the airborne bioaerosol concentrations for the same constituents in the ambient outdoor air outside and upwind of the perimeter of the Building. The results were compared to any recommended occupational exposure limits to further characterize the potential human health exposure risks from bioaerosols during active composting operations.

The results were also used to validate the adequacy of engineering, administrative, and personal protective equipment (PPE) controls established in the Pilot Scale Operational Plan and to determine if any upgrading or downgrading is necessary or acceptable for continued production operations.

Explosive Aerosol/Vapors, Metals and Organics

The purpose of the sampling was to further characterize the potential human health exposure risks associated with explosive aerosol/vapors and metals during soil excavation and screening and composting of contaminated soil. The results of this IH sampling campaign were used to validate the adequacy of the engineering, administrative, and personal protective equipment (PPE) controls established in the SSHP and to determine if any upgrading or downgrading is necessary or acceptable for continued production operations. Hydrocarbon area sampling was conducted for the purpose of determining what, if any, hydrocarbon constituents may be present inside of a Compost Building during active composting.

The objective was to evaluate total explosive aerosol and vapor concentrations and total metal dust concentrations at the excavation site and inside of Compost Building 3 using personal and area time integrated IH air sampling. More specifically, the sampling campaign was conducted to verify that the time weighted air concentration of TNT and RDX is below the permissible exposure limit (PEL) of 1.5 mg/m^3 established by the Occupational Safety and Health Administration (OSHA, 1996). For TNT, the Threshold Limit Value - Time Weighted Average (TLV-TWA) is 0.5 mg/m^3 set by the American Conference of Governmental Industrial Hygienists (ACGIH, 1996). The ACGIH TLV-TWA for RDX is the same as the OSHA PEL. For metals and hydrocarbons, the time weighted concentrations for each analyte was compared to the OSHA PELs and ACGIH TLV-TWA to verify they are below acceptable limits.

In this report, aerosol refers to a assembly of liquid or solid particles suspended in a gaseous medium long enough to enable observation and measurement. Generally, the sizes of aerosols particles are in the 0.001-100 micrometer (μm) range. Dust particles are a subset of aerosols. They are defined as solid particles formed by the crushing or other mechanical breakage of a parent material. These particles generally have irregular shapes and are larger then about 0.5 (μm). Vapor refers to the volatile form of substances that are normally in the solid or liquid state at room temperature and pressure. The nitroaromatic and nitroamine compounds in soil and the metals may become airborne as an aerosol during excavation and the soil screening process.

During composting when windrows are turned to facilitate perturbation processes, workers could be exposed to these chemicals and possibly their transformation products in the form of aerosol suspensions and by direct contact. The possibility also exists that the thermophilic heat of reaction in compost piles, estimated to be in the range of 45 to 65 °C (Celsius), could contribute enough heat to cause TNT and some of its transformation products to volatilize and exist in a vapor state inside of the structure as well. This may also be true for some of the transformation products of RDX and HMX.

Total Dust Air Monitoring

A direct reading instrument was used to measure total dust concentrations during selected tasks which have the potential for creating airborne nuisance dust. The objective was to verify dust levels were being maintained below an action level of 10 mg/m^3 in the immediate work zone and below 1.0 mg/m^3 at work site perimeters.

Other Chemical Agents

Direct reading instrumentation including colorimetric indicator tubes were used to measure organic and inorganic gases and vapors. The objective was to test for known or potential off-gases associated with composting operations, and if found, insure proper controls were in place to protect worker safety and health.

Heat Stress

Periodic monitoring of worker pulse rate and ear canal temperatures was completed. Ear canal temperatures were obtained using a Thermoscan instrument and pulse rates were obtained manually. The purpose was to assess potential heat stress conditions and to establish initial work/rest regimes when workers were wearing impervious protective clothing during their acclimatization period.

Noise

A baseline sound level survey was obtained on all operational equipment to determine if the action level of 85 dBA is exceeded both inside "cab enclosed" equipment and in the near vicinity of equipment where operators may be positioned during operation. The results of the surveys were used to establish requirements for hearing protection devices (HPD). Time weighted noise dose was determined for the Scarab operator and one Environmental Technician using a noise dosimeter. Two samples were split shift and one was full shift.

Wipe Samples

Wipe samples for explosive residues were obtained from the decontamination area (shower trailer), laboratory, lunch room and health and safety office.

1.2 DEFINITION OF TERMS

The following definitions are included for understanding the bioaerosol sampling results.

Colony Forming Unit (cfu)- one or more cells that grow to form a single visible colony.

cfu/m^3 -number of colony forming units expressed per meter cubed of air. Represents the concentration of bioaerosols in air.

Sample Median - measure of central tendency, the value that divides the data into halves. The median is generally used when an underlying population distribution shape is not assumed, and is the measure of central tendency used in nonparametric statistics. It is often used with data that has a highly skewed distribution, i.e. there exists a sizeable portion of the data with either extremely high values, or extremely low values relative to the rest of the data.

2.0
MATERIALS

2.1 BIOAEROSOL SAMPLING

A Staplex, Model VM-5 high volume sampling pump was used. A Gilibrator-2 Bubble Generator was used to obtain calibration data on the pump. The sampling train included a Two-Stage Andersen Impactor calibrated using a plastic evacuation chamber approximately 4 liter (L) in volume with calibration specific petri dishes. One hundred percent ethanol in the form of Everclear® grain alcohol was used in the field to disinfect the Impactor. Miscellaneous consumables included sterile disposable gloves, freezer bags, spray bottle, aluminum pans, and towelettes. An electronic timer was used to time each sampling run.

Samples were collected by impaction on pre-selected growth media plates (petri dishes) using the high volume sampling pump with Two-Stage Andersen Impactor. The growth media was Standard Method Agar (SMA) for bacteria and acidified Potato Dextrose Agar (PDA) for fungi (molds and yeast). The Andersen Two-Stage uses plastic petri dishes containing 20 mL of the appropriate growth media prepared by the analytical laboratory. The SMA is non-selective and is a general purpose agar which can be used both for bacteria and fungi (molds and yeast). The PDA is selective agar for fungi (molds and yeast), especially *Aspergillus* species.

Both the SMA and PDA are supplied to the analytical laboratory by Becton Dickinson and Company. The approximate formula for SMA per L purified water is: 5.0 g pancreatic digest of casein; 2.5 g yeast extract; 1.0 g dextrose; and 15.0 g agar. The approximate formula for PDA per L purified water is: 4.0 g potato, infusion from (solids); 20.0 g dextrose; and 15.0 g agar. The calibration specific petri dishes are extra sampling petri dishes filled with either SMA or PDA. They were used only for determining the pre- and post-sampling flow rates of the sampling pump.

2.2 EXPLOSIVE AEROSOL/VAPORS SAMPLING

Air Samples were obtained using Gillian and SKC multi-flow sampling pumps. The pumps were flow calibrated using a Gilibrator electronic bubble meter. Air samples were collected on a sorbent and filter tube, specifically, a 270/140 XAD-2 and glass fiber filter, OSHA Versatile Sampler (OVS) Tube. For personal samples, an OSHA Versatile Sampler (OVS) Tube Holder from SKC Corporation was used to hold the OVS Tube in place, fastened to the worker, and connected to the sampling train.

2.3 METALS SAMPLING

Air Samples were obtained using Gillian and SKC multi-flow sampling pumps. The pumps were flow calibrated using a Gilibrator electronic bubble meter. Air samples were collected on 0.8 µm cellulose ester membrane (MCE) filter with support pad with 3-piece 37 mm clear styrene acrylonitrile (SAN) cassette. For all samples, a cassette holder from SKC Corporation was used to hold the cassette in place and connected to the sampling train.

2.4 ORGANICS SAMPLING

Air Samples were obtained using Gillian and SKC multi-flow sampling pumps. The pumps were flow calibrated using a Gilibrator electronic bubble meter. Air samples were collected on solid sorbent tubes, coconut shell charcoal, 100 mg/50 mg. For all samples, a tube holder from SKC Corporation was used to hold the sorbent tube in place and connected to the sampling train.

2.5 TOTAL DUST AIR MONITORING

Air monitoring for total dust was completed using a Sensidyne Laser Dust Monitor, Model LD-1.

2.6 OTHER CHEMICAL AGENT AIR MONITORING

An MSA Kwik-Draw handpump, Serial Number 7228 was used for air monitoring using colorimetric indicator tubes. Colorimetric indicator tubes were also MSA supplied and included the following tubes: 1) ammonia, 2) carbon dioxide, 3) hydrogen sulfide, 4) formaldehyde, 5) nitrogen dioxide, 5) acetone, 6) petroleum compounds, 7) toluene, 8) dichloromethane, and 9) alcohol / methanol / propanol.

A PhotoVac MicroTip, Model MP-1000 photo ionization detector (PID) was used for general area monitoring for total organics inside of Compost Building 3.

A Industrial Scientific Model TMX-412 multi-gas meter was used for general area monitoring inside of Compost Building 3. The instrument is equipped with sensors for combustible gas as a percentage of Lower Explosive Limit (LEL), percent by volume oxygen, concentration of hydrogen sulfide in parts per million (ppm), and concentration of carbon monoxide in ppm.

2.7 HEAT STRESS MONITORING

Personnel ear canal temperatures were obtained using a Thermoscan instrument.

2.8 NOISE MONITORING

Sound levels were measured using a Ametek MK-2 Series Audio Dosimeter.

2.9 EXPLOSIVE RESIDUES WIPE SAMPLES

Wipe samples for explosive residues were obtained on glass fiber filters pre-wetted with the solvent acrylonitrile.

2.10 CALIBRATION LOGS

A copy of the sampling pump calibration data forms for items included in paragraphs 2.1 through 2.4 is included in Appendix A to this report.

3.0
METHODS

3.1 BIOAEROSOL SAMPLING

During active composting, twelve area samples were obtained inside of the composting structure and twelve area samples outside of the structure. The samples were obtained approximately three days into the composting process. Samples inside of the structure were taken during turning and immediately after the windrows are turned.

One sample set consists of six samples for each of the following:

1. Bacteria - 1 respirable and 1 nonrespirable culture plate.
2. Fungi (Molds and Yeast) - 1 respirable and 1 nonrespirable culture plate.

Therefore one sample set inside of the structure for bacteria required 12 culture plates and one sample set for Fungi (Molds and Yeast) inside of the structure required 12 culture plates for a total of 24 culture plates. After primary incubation of the bacteria plates at the laboratory, single consistent colonies were then inoculated onto selective and differential agars for bacterial pathogen isolation. Bacterial isolations were performed by streaking for isolation, using morphologically distinct colonies, onto SMA from the inoculated plates.

The outside samples totaled 24 the same as the inside samples. In addition, eight field sample blanks were obtained in the field. Details on the sampling procedure are found in SOP 10.0.

3.1.1 Locations Sampled

The bioaerosol samples were area samples obtained both inside of Compost Building 3 and outside of the perimeter of this building. The inside samples were obtained approximately 3 meters (m) inside of Compost Building 3 from the east end. This was also in the downwind direction approximately 9 m from the center of the nearest compost pile. The space between the two laboratory trailers was used for the outside sampling location. This location was approximately 100 m away in the northerly direction and upwind (west) from the east end of Compost Building 3. The wind direction during two days of sampling was from the west/southwest so the location was satisfactory as the outdoor location representing background for collection of bioaerosol samples.

3.1.2 Sample Analysis

At the laboratory, as soon as possible and before 24 hr, the sample plates were placed right-side-up for fungi and upside down for bacteria in an incubator set at an appropriate temperature for incubation. For bacteria, the incubation temperature was 35 ± 1 °C for 48 hours ± 2 hr. For fungi (molds and yeast), the incubation temperature was 22.5 ± 2.5 °C for 120-168 hours.

Analysis for bacteria (total plate count) was completed by laboratory using a Quebec colony counter, dark-field, with suitable light source and grid plate in accordance with the Food and Drug Administration (FDA) Bacteriological Analytical Manual. Subsequent bacterial pathogen isolations were performed by streaking for isolation, using morphologically distinct representative colonies, onto SMA from the inoculated plates. Plates were incubated and single consistent colonies were then inoculated onto selective and differential agars to culture for the following species of bacteria: *Pseudomonas aeruginosa*; *Pseudomonas fluorescens*; *Pseudomonas putida*; *Pseudomonas cepacia* (approximately 50% of strains); *Pseudomonas pseudoalcagenes* (approximately 50% of strains); *Pseudomonas species VE-2* (approximately 50% of strains); *Staphylococcus aureus*; *Staphylococcus epidermis*; *Escherichia coli (E.coli)*; *Salmonella typhi*;

Salmonella enteritidis; *Salmonella choleraesuis*; *Citrobacter freundii*; *Citrobacter diversus*; *Citrobacter amalonnaticus*; *Enterobacter cloacae*; *Enterobacter aerogenes*; *Enterobacter agglomerans*; *Enterbacter gergoviae*; *Proteus vulgaris*; and *Morganella morganii*.

Analysis for fungi (molds and yeast) was completed by laboratory using a Quebec colony counter, dark-field, with suitable light source and grid plate in accordance with Lyle Laboratories SOP for Yeast and Mold Count, Document Number 369-72 (SOP, 1996) based on procedures for determining plate count developed by the Association of Official Analytical Chemists (AOAC), and by the American Public Health Association (APHA).

The concentration of microorganisms was determined based on the number of colonies counted divided by the volume of air sampled. The concentration is expressed in units of colony forming units per cubic meter of air (cfu/m^3) as calculated in the following equation:

$$\text{Bioaerosol concentration (cfu/m}^3\text{)} = \frac{\text{Number of colonies counted}}{\text{Vol. of air sampled in m}^3}$$

The laboratory reported quantitative laboratory analysis results for each sample in total count (cfu) and cfu/m^3. The laboratory also reported qualitative laboratory analysis results for each sample by identifying the type of microorganism isolated. *Aspergillus* species and bacterial pathogenic species including *E.coli* were reported as non-detect (value of <1) or negative respectively.

3.1.3 Statistical Analysis

The sample median, minimum, and maximum value were calculated for the non-respirable fraction, the respirable sized fraction and the total concentration (non-respirable + respirable fraction) for each set of plates. SPSS statistical software for MS Windows Release 6.1 was used for descriptive statistical analysis including preparation of box plots comparing airborne levels of total fungi and total bacteria outside verses inside of the compost building. In addition, the SPSS software was used to conduct two-tailed Mann-Whitney U - Wilcoxon Rank W Tests for comparing inside and outside total concentrations at a p Value of 0.05 level of significance (95% Confidence). The Mann-Whitney U - Wilcoxon Rank W Test is a nonparametric statistical test used to compare the locations of two independent populations with continuous (or at least ordinal) distributions as described in (Eudey et al.,1995 and Daniel, 1991).

3.1.4 Field Monitoring Data Forms

A copy of the Field Monitoring Data Forms is included in Attachment B to this report.

3.1.5 Chain-of-custody Record Forms

A copy of the Chain-of-Custody Record Forms is included in Attachment C to this report.

3.2 EXPLOSIVE AEROSOL/VAPORS, METALS, AND ORGANICS SAMPLING

The following paragraphs describes applicable methods used for each of the three constituents.

3.2.1 Explosive Aerosol/vapors

Samples was based on the OSHA Method 44 (OSHA, 1983) and analyzed at the laboratory per a modified Environmental Protection Agency (EPA) Method 8330 (USEPA, 1994). Both personal and area samples were split-shift samples collected at a flow rate of 1.0 liters per minute (L/min) for a duration of approximately four hours. The samples were shipped on ice to the laboratory for analysis. Two field sample blanks were obtained on each day of sampling.

Analysis at the laboratory was completed using a Hewlet Packard 1040A UV-VIS Diode Array High Pressure Liquid Chromatography (HPLC) detector system providing a scan for specific analytes and isomers including HMX; RDX; 1,3,5-TNB; 1,3-DNB; Tetryl; Nitrobenzene; 2,4,6-TNT; 4-A-2,6-TNT; 2-A-4,6-DNT; 2,4-DNT; 2,6-DNT; 2-Nitrotoluene; 3-Nitrotoluene; and 4-Nitrotoluene. The laboratory followed their standard operating procedure (SOP, 1995) with a modification involving analysis of the fiber filter contained in the XAD-2 tube separately from the XAD-2 adsorption media.

3.2.2 Metals

Samples collection was based on the OSHA Method ID-125 (OSHA, 1991) and analyzed at the laboratory per National Institute of Occupational Safety and Health (NIOSH) Method 7300 (NIOSH, 1994b). Both personal and area samples were split-shift samples collected at a flow rate of 3.0 L/min for a duration of approximately four hours. One field sample blank was obtained on each day of sampling.

Analysis at the laboratory was completed using GBC Graphite Furnace 906G and GF3000. Specific analytes included the following: aluminum, antimony, arsenic, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, selenium, silicon, silver, tin, vanadium, and zinc.

3.2.3 Organics

Samples were collected and analyzed based on the following NIOSH Methods: (1) NIOSH 1500 for hydrocarbons; (2) NIOSH 1501 for aromatic hydrocarbons; and (3) NIOSH 1003 for halogenated hydrocarbons. Areas samples were collected at a flow rate of approximately 0.20 L/min for 20, 150 and 300 minutes. Analysis at the laboratory was completed using Gas Chromatography Flame Ionization Detector (GC-FID) and Mass Spectrometry (MS).

3.2.4 Subjects And Locations Sampled

On August 22, 1997, samples were obtained during the morning shift at Mine Fill A while mechanical excavation was being performed on berm areas surrounding Building 153. Screening of soil was also in progress along with hand-digging around utilities located in the work area. Attachment D to this report contains a markup of the soils excavation plan map showing the general work layout and location of area samplers.

The following summarizes the sampling subjects and locations:

- one explosives personal sample from backhoe operator;
- one explosives personal sample from screener operator;

- one explosives personal sample from laborer;
- one explosive area sample at Contamination Reduction Zone (CRZ)/Exclusion zone line within 2 feet of excavation;
- one explosive area sample on downwind side of screener within 6 foot of reject conveyor;
- one explosive area sample on downwind side of excavation at work structure;
- *one metals personal sample from backhoe operator;*
- one metals area sample at CRZ/Exclusion Zone line within two feet of excavation.

Two field sample blanks for explosives and one for metals were also obtained. During the afternoon shift on August 26, 1997, the same personal and area locations were sampled. The same number of sample field blanks were obtained.

On September 22, 1997, samples were obtained during the morning shift inside of Compost Building 3. For explosives, three personal samples of split-shift were obtained, one from the windrow machine operator, one from the Bobcat operator, and one from the Environmental Technician. Three area samples were also obtained. They were split-shift duration, obtained inside of Compost Building 3 on the downwind end near the compost piles, but far enough so as not be hit by the windrow turner machine and any of the compost thrown from its mixing flails. In addition, one split-shift personal sample for metals was obtained from the Environmental Technician and one split-shift area sample for metals was also obtained. Two field sample blanks for explosives and one for metals were obtained.

On September 24, 1997, area samples were obtained for hydrocarbons inside of Compost Building 2. The samples total six, two for each NIOSH Method. On the same day, six control samples were obtained outside of the building adjacent to the exclusion zone perimeter on north side. A total of three sample field blanks were obtained, one for each NIOSH Method.

3.2.5 Field Monitoring Data Forms

A copy of the Field Monitoring Data Forms is included in Attachment B to this report.

3.2.6 Chain-of-custody Record Forms

A copy of the Chain-of-Custody Record Forms is included in Attachment C to this report.

3.3 TOTAL DUST MONITORING

Total dust monitoring was conducted at the excavation site on 6/25/97. It included direct readings around the screener and the excavation site perimeter. On 6/27/97 direct readings were obtained during amendment mixing and amendment batch dumping. On 7/9/97 direct readings were obtained in Compost Building 3 during compost pile mixing using the Scarab windrow pile turner and during operation of the skid steer while clean-up around compost piles was completed. On 9/8/97 direct readings were obtained during amendment mixing inside of the Compost Buildings. All data was recorded on Total Dust Industrial Hygiene Sample Summary sheets. A copy of these sheets is included in Attachment E.

3.4 OTHER CHEMICAL AGENT MONITORING

Chemical monitoring using colorimetric indicator tubes was conducted inside the compost buildings during both clean soil and contaminated soil composting. Air samples were obtained during the first and second week of composting. Ammonia was the gas sampled for the most and included building interior samples, chicken and turkey manure pile samples, and Scarab cab interior. All samples were obtained in accordance with manufacturers instructions. All data was recorded on Detector Tube Industrial Hygiene Sample Summary sheets. A copy of these sheets is included in Attachment F.

A one day sampling event was conducted on 7/9/97 inside of Compost Building 3 using the Industrial Scientific TMX-412 multi-gas meter and the PhotoVac MicroTip PID. Data was recorded on a Gas/Vapor/Fume/Mist Industrial Hygiene Sample Summary sheets. A copy of these sheets is included in Attachment G.

3.5 HEAT STRESS MONITORING

Heat stress monitoring in the form of temperature and pulse rate monitoring was conducted on 6/26/97, 6/27/97, and 7/2/97. Pulse rates were obtained by timing beats at the radial pulse. Temperatures were in obtained in the ear canal using a Thermoscan instrument. Data was recorded on Heat Stress Industrial Hygiene Sample Summary sheets. A copy of these sheets is included in Attachment H.

3.6 NOISE MONITORING

Sound level surveys on operational equipments was completed on 6/10/97 and 6/25/97. Sound levels were measured in dB(A) using the noise dosimeter in survey mode only. Sound levels inside the cabs of cab enclosed equipments were measured at engine speeds typical of operation. On the outside of equipments, surveys were obtained in the near vicinity of equipments or where personnel are required to be positioned to operate the unit. Time weighted average noise dose was obtained from the Scarab operator on 10/6/97 and 10/8/97 and from an Environmental Technician on 10/7/97. The noise dose was measured using the noise dosimeter. Data was recorded on Sound Level Survey sheets, Noise Dosimetry Sample Field Sheet(s), and Noise Dosimetry Industrial Hygiene Sample Summary sheets. A copy of these sheets is included in Attachment I.

3.7 EXPLOSIVE RESIDUES WIPE SAMPLES

Wipe samples were obtained using a 10 centimeter (cm) by 10 cm template to mark-off sample areas. Glass fiber filters were pre-wetted with acrylonitrile solvent to the point of saturation. The marked area was wiped and the wipe placed inside of sampling container for shipment to laboratory for analysis. Nine samples were obtained. Areas sampled included the shower trailer (dirty room); shower trailer (shower room); shower trailer (clean room); lunchroom; laboratory floor; laboratory counter; laboratory oven; laboratory grinder room; and health and safety office.

4.0
RESULTS

4.1 BIOAEROSOL SAMPLING RESULTS

The following paragraphs presents the bioaerosol sampling results.

4.1.1 Results Summary

No bacteria of any significance was detected in any of the sample bacteria culture plates for both outside and indoor locations. All bacterial pathogen isolation was negative for the following species: *Pseudomonas aeruginosa*; *Pseudomonas fluorescens*; *Pseudomonas putida*; *Pseudomonas cepacia* (approximately 50% of strains); *Pseudomonas pseudoalcagenes* (approximately 50% of strains); *Pseudomonas species VE-2* (approximately 50% of strains); *Staphylococcus aureus*; *Staphylococcus epidermis*; *Escherichia coli (E.coli)*; *Salmonella typhi*; *Salmonella enteritidis*; *Salmonella choleraesuis*; *Citrobacter freundii*; *Citrobacter diversus*; *Citrobacter amalonnaticus*; *Enterobacter cloacae*; *Enterobacter aerogenes*; *Enterobacter agglomerans*; *Enterbacter gergoviae*; *Proteus vulgaris*; and *Morganella morganii*.

Results of the sample analysis from the fungi (molds and yeast) culture plates indicate no *Aspergillus* species were detected for both indoor and outside locations. The predominant species detected on all sample plates, both bacteria sample plates and fungi (molds and yeast) sample plates were *Penicillium*, *Alternaria*, and *Cladosporium*. These species are molds normally found in atmosphere. *Rhizopus*, another mold, was detected on a small number of the culture plates. All of these molds are classified as normally mild or non-pathogenic fungi. The following paragraphs describe the bioaerosol summary results for the September 12, 1997 sampling campaign in more detail. A copy of the laboratory microbial analysis reports are included in Appendix J.

4.1.2 Bacteria Plate Analysis Summary

Results of the Laboratory analysis on the bacteria sample plates are summarized on Table 1 and Table 2. Table 1 contains the outside sample results and Table 2 the inside sample results. The tables include columns to distinguish the results of analysis for the non-respirable fraction and the respirable fraction. For each fraction the following are listed:

- the sample number;
- the total cfu count;
- the concentration in cfu/m^3;
- results of bacterial pathogen (bact path) subculture analysis.

Under the Total Concentration column, the non-respirable and the respirable concentrations for each corresponding sample set are summed. Lastly, the sample median is calculated for the non-respirable fraction, the respirable fraction, and the total concentration. When comparing the total concentration median values for the outside samples and inside samples, the outside concentration was calculated as 120 cfu/m^3 and the inside concentration as 1185 cfu/m^3. **The inside concentration median was approximately 10 times greater then the outside.** Using the outside sample median of 120 cfu/m^3 and comparing it to the six total bacteria concentration sample results from the inside sampling run using a Sign Test as described in (Daniel, 1991), all values except for one are greater than 120 cfu/m^3 indicating that the total airborne microbial loading was greater inside of the structure. Figure 1 is a box plot showing the amount of variability in the data sets representing the total concentration in cfu/m^3 from the inside and outside locations. The bacteria plates were filled with SMA, a non-selective general purpose growth agar suitable for bacteria and fungi. The results indicate molds were the predominant species detected on this growth agar with some percentage being bacteria.

TABLE 1 BIOAEROSOLS, OUTSIDE BACTERIA PLATE RESULTS SUMMARY

Outside Bacteria Plate Results, Sample Run Date 9/12/97								
Non-Respirable Fraction				Respirable Fraction				Total Concentration
Sample #	Total Ct. cfu	cfu/m^3	Bact. Path.	Sample #	Total Ct. cfu	cfu/m^3	Bact. Path.	Non-Respirable + Respirable Fractions in cfu/m^3
BOTBNR O01A	20	130	neg	BOTBRE V02A	4	30	neg	160
BOTBNR V03A	6	40	neg	BOTBRE O04A	12	80	neg	120
BOTBNR V05A	7	50	neg	BOTBRE V06A	9	60	neg	110
BOTBNR O07A	11	70	neg	BOTBRE O08A	11	70	neg	140
BOTBNR O09A	10	60	neg	BOTBRE V10A	10	60	neg	120
BOTBNR V11A	4	30	neg	BOTBRE O12A	10	60	neg	90
BOTBNR O13B Blank	<1	NA	NA					NA
BOTBNR O14B Blank	<1	NA	NA					NA
Sample Median		55				60		120

Notes: Ct. - Count, NA - not applicable, Neg - negative result. Note: field blanks are not included in sample median calculations.

TABLE 2 BIOAEROSOLS, INSIDE BACTERIA PLATE RESULTS SUMMARY

Inside Bacteria Plate Results, Sample Run Date 9/12/97								
Non-Respirable Fraction				Respirable Fraction				Total Concentration
Sample #	Total Ct. cfu	cfu/m^3	Bact. Path.	Sample #	Total Ct. cfu	cfu/m^3	Bact. Path.	Non-Respirable + Respirable Fractions in cfu/m^3
BINBNRO 15A	103	690	neg	BINBREV 16A	95	630	neg	1320
BINBNRV 17A	144	960	neg	BINBREO 18A	127	850	neg	1810
BINBNRV 19A	136	910	neg	BINBREV 20A	77	510	neg	1420
BINBNRO 21A	10	70	neg	BINBREO 22A	6	40	neg	110
BINBNRO 23A	20	130	neg	BINBREV 24A	43	290	neg	420
BINBNRV 25A	98	650	neg	BINBREO 26A	60	400	neg	1050
BINBNRO 27B Blank	1	NA	NA					NA
BINBNRO 28B Blank	1	NA	NA					NA
Sample Median		670				455		1185

Notes: Ct. - Count, NA - not applicable, NA - negative. Note 1: field blanks are not included in sample median calculation.

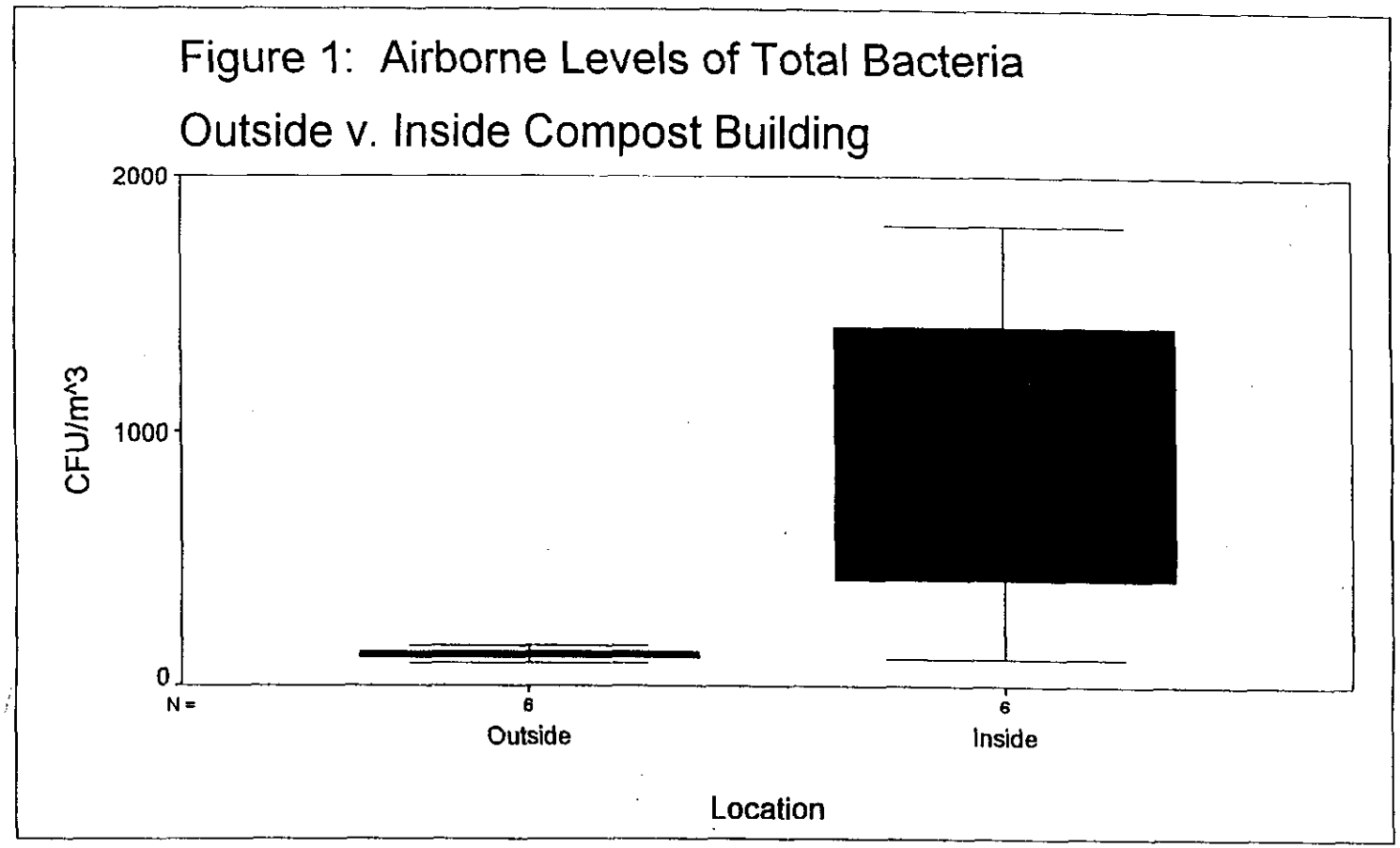
Figure 1: Airborne Levels of Total Bacteria
Outside v. Inside Compost Building
2000
1000
0
CFU/m^3
N =
6
6
Outside
Inside
Location

4.1.3 Bioaerosol, Outside Bacteria Plate Results Summary

The sample medians for the concentration of non-respirable and respirable fractions are approximately equal with values of 55 cfu/m^3 and 60 cfu/m^3 respectively. The median for the total concentration was calculated as 120 cfu/m^3. Sample field blanks exhibited no appreciable growth.

4.1.4 Bioaerosol, Inside Bacteria Plate Results Summary

The sample medians for the concentration of non-respirable and respirable fractions were 670 cfu/m^3 and 455 cfu/m^3 respectively. The median for the total concentration was calculated as 1185 cfu/m^3. Sample field blanks exhibited no appreciable growth.

4.1.5 Fungi (Molds And Yeast) Plate Analysis Summary

Results of the Laboratory analysis on the Fungi (Molds and Yeasts) samples are summarized on Table 3 and Table 4. Table 3 contains the outside sample results and Table 4 the inside sample results.

The tables include columns to distinguish the results of analysis for the non-respirable fraction and the respirable fraction. For each fraction the following are listed:

- the sample number;
- the total cfu count;
- the concentration in cfu/m^3;
- results of qualitative analysis for the *Aspergillus* species on all sample plates.

Under Total Concentration column, the non-respirable and the respirable concentrations for each sample set are summed. Lastly, the sample median is calculated for the non-respirable fraction, the respirable fraction, and the total concentration.

When comparing the total concentration median values for the outside samples and inside samples, the outside concentration was calculated as 1090 cfu/m^3 and the inside concentration as 785 cfu/m^3. **The inside concentration median was approximately 38% less than the outside.** Using the outside sample median of 1090 cfu/m^3 and comparing it to the six total fungi concentration sample results for the inside run using a Sign Test as described in (Daniel, 1991), all six values are less than 1090 cfu/m^3 indicating that the total microbial loading of fungi (molds and yeast) was less inside of the structure. Figure 2 is a box plot showing the amount of variability in the data sets representing the total concentration in cfu/m^3 from the inside and outside locations.

The fungi (molds and yeast) plates were filled with acidified PDA, a selective growth agar suitable for fungi (molds and yeast) especially *Aspergillus* species. The results indicate molds were the predominant species detected on this growth agar, the same as the SMA growth agar used for bacteria.

TABLE 3 BIOAEROSOLS, OUTSIDE FUNGI (MOLDS AND YEAST) PLATE RESULTS SUMMARY

Outside Fungi (Molds and Yeast) Plate Results, Sample Run Date 9/12/97								
Non-Respirable Fraction				Respirable Fraction				Total Concentration
Sample #	Total Ct. cfu	cfu/m^3	Aspergillus sp.	Sample #	Total Ct. cfu	cfu/m^3	Aspergillus sp.	Non-Respirable + Respirable Fractions in cfu/m^3
BOTFNR O01A	64	410	<1	BOTFRE O02A	111	720	<1	1130
BOTFNR O03A	127	820	<1	BOTFRE O04A	131	850	<1	1670
BOTFNR O05A	93	600	<1	BOTFRE0 06A	113	730	<1	1330
BOTFNR O07A	56	360	<1	BOTFRE O08A	99	640	<1	1000
BOTFNR O09A	59	380	<1	BOTFRE O10A	103	670	<1	1050
BOTFNR O11A	44	280	<1	BOTFRE O12A	91	590	<1	870
BOTFNR O13B Blank	<1	NA	NA					NA
BOTFNR O14B Blank	2	NA	<1					NA
Sample Median		395				695		1090

Notes: Ct. - Count, NA - not applicable, <1 under *Aspergillus sp.* column means no *Aspergillus* species were detected. Note 1: field blanks are not included in the sample median calculation.

TABLE 4 BIOAEROSOLS, INSIDE FUNGI (MOLDS AND YEAST) PLATE RESULTS SUMMARY

Inside Fungi (Molds and Yeast) Plate Results, Sample Run Date 9/12/97								
Non-Respirable Fraction				Respirable Fraction				Total Concentration
Sample #	Total Ct. cfu	cfu/m^3	*Aspergillus sp.*	Sample #	Total Ct. cfu	cfu/m^3	*Aspergillus sp.*	Non-Respirable + Respirable Fractions in cfu/m^3
BINFNRO 15A	55	370	<1	BOTFRE O16A	96	640	<1	1010
BINFNRO 17A	60	400	<1	BOTFRE O18A	84	560	<1	960
BINFNRO 19A	46	310	<1	BOTFRE0 20A	78	520	<1	830
BINFNRO 21A	27	180	<1	BOTFRE O22A	68	450	<1	630
BINFNRO 23A	42	280	<1	BOTFRE O24A	69	460	<1	740
BINFNRO 25A	26	460	<1	BOTFRE O26A	34	230	<1	690
BINFNRO 27B Blank	<1	NA	NA					NA
BINFNRO 28B Blank	<1	NA	NA					NA
Sample Median		340				490		785

Notes: Ct. - Count, NA - not applicable, <1 under *Aspergillus sp.* column means no *Aspergillus* species were detected. Note 1: field blanks not included in the sample median calculation.

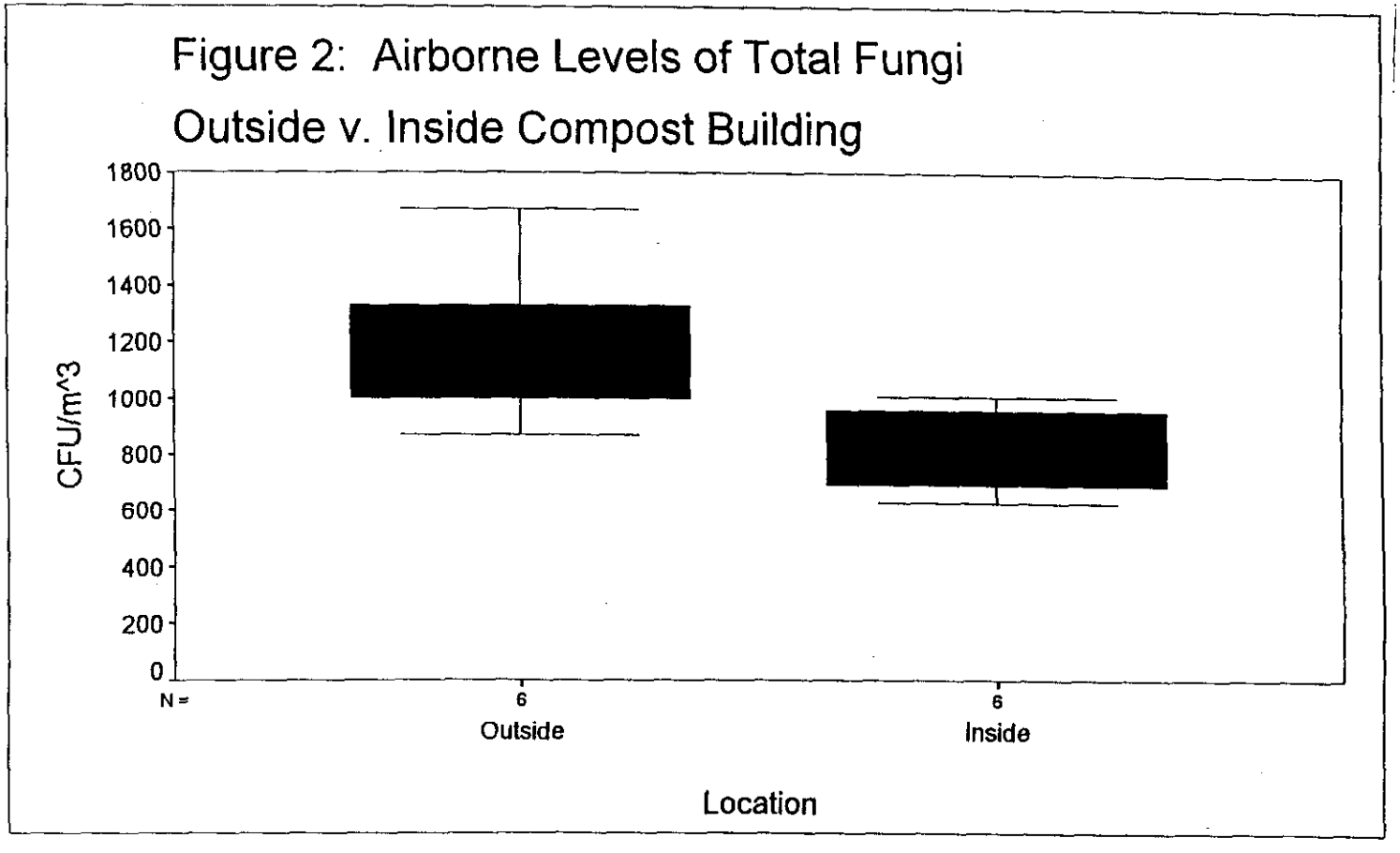
Figure 2: Airborne Levels of Total Fungi
Outside v. Inside Compost Building
CFU/m^3
1800
1600
1400
1200
1000
800
600
400
200
0
N =
6
6
Outside
Inside
Location

4.1.6 Bioaerosol, Outside Fungi(molds And Yeast) Results Summary

The sample medians for the concentration of non-respirable and respirable fractions were 395 cfu/m^3 and 695 cfu/m^3 respectively. The median for the total concentration was calculated as 1090 cfu/m^3. Sample field blanks exhibited no appreciable growth.

4.1.7 Bioaerosol, Inside Fungi(molds And Yeast) Results Summary

The sample medians for the concentration of non-respirable and respirable fractions were 340 cfu/m^3 and 490 cfu/m^3 respectively. The median for the total concentration was calculated as 785 cfu/m^3. Sample field blanks exhibited no appreciable growth.

4.1.8 Statistical Analysis of Bacteria And Fungi(molds And Yeast) Analysis Results

The Mann - Whitney U - Wilcoxon Rank Sum W Test was used to compare the total concentration from the bacteria culture plates outside of Compost Building 3 (N=6) to the total concentration inside of Compost Building 3 (N=6) at a level of significance of $p = 0.05$. The outside concentration was less than the inside statistically at $p = 0.026$.

The Mann - Whitney U - Wilcoxon Rank Sum W Test was used to compare the total concentration from the fungi (molds and yeast) culture plates outside of Compost Building 3 (N=6) to the total concentration inside of Compost Building 3 (N=6) at a level of significance of $p = 0.05$. The outside concentration was greater than the inside concentration statistically at $p = 0.015$.

4.1.9 *Discussion*

The American Conference of Governmental Industrial Hygienists (ACGIH) Bioaerosols Committee report there are no numerical guidelines or Threshold Limit Values (TLVs) that allow ready interpretation of bioaerosol data (ACGIH, 1995). ACGIH (1995) states there are no TLVs for concentrations of total culturable or countable organisms and particles (e.g., "bacteria" or "fungi"); specific culturable or countable organisms and particles (e.g., *Aspergillus fumigatus*); infectious agents (e.g., *Legionella pneumophila*); or assayable biological-source contaminants (e.g., endotoxin or volatile organic compounds).

Heida et al. (1995) refer to a Dutch study group who recently reported that bacterial or fungal concentrations above 10,000 cfu/m^3 in total or above 500 cfu/m^3 for each specific group of organisms or species of a potentially pathogenic nature should be considered a threat to the worker's health. Above this level, preventive action should be undertaken at all times. For gram-negative bacteria, a TLV of 1,000 cfu/m^3 has been proposed, since a number of species of this group are able to release pathogenic endotoxin, which may cause an additional health hazard.

Millner (1995) reports Rylander suggested at the 1993 Bioaerosols Associated with Composting Facilities Workshop in Beltsville, Maryland that a level of up to 1,000 gram-negative bacteria/m^3 should be considered as safe until additional information is available. The complete report on this Workshop is found in Millner et al. (1994).

For this study, the highest sample median for total concentration was reported inside the facility using the SMA growth agar. This value was 1,185 cfu/m^3 which is significantly lower than the 10,000 cfu/m^3 recommended in the Heida et al. (1995) study. The primary species detected in this study were *Penicillium*, *Alternaria*, and *Cladosporium*, all molds normally found in the atmosphere and considered normally mild and not pathogenic, so the 500 cfu/m^3 discussed in Heida et al. (1995) is not applied. No gram-negative bacteria of any significance were detected in any of the culture plates so the TLV of 1,000 cfu/m^3 mentioned in both Heida et al. (1995) and Millner (1995) is not applied. Outside, representing background, the sample median for total concentration using the SMA growth agar was 120 cfu/m^3.

The fungi (molds and yeast) culture plates used acidified PDA growth agar. It is interesting to note that the sample median for total concentration using the PDA was higher at the outdoor location, which represented background, as compared to the indoor location. The outdoor location was 1,090 cfu/m^3 and the inside location measured 785 cfu/m^3. It is speculated that the bacterial species present inside of the structure because of the large quantity of fresh manures used in the compost piles may have been competing with the fungi (molds and yeast) causing a decrease in the total number of viable airborne fungi colonies that could be cultured on the acidified Potato Dextrose Agar (PDA) plates. It is also possible that the thermophilic heat of reaction in the compost piles (45 to 65 °C, average of 55 °C), may have killed-off and contributed to the decrease in the number of airborne viable fungi (Golueke (1991)). The acidified PDA is selective agar for fungi (molds and yeast) and was selected especially for culturing *Aspergillus* species.

The following summaries are provided on the predominant species detected on the culture plants for this study. Data was obtained from the University of Minnesota fungal glossary located at Internet address http://www.dehs.umn.edu/fungus/myco.html. *Alternaria* species is a very common allergen with an IgE mediated response. It is often found in carpets, textiles, and on horizontal surfaces in building interiors. It is often found on window frames. Outdoors it may be isolated from samples of soils, seeds and plants. It is commonly found in outdoor samples. The large spore size 20-200 μm in length and 7-18 μm in sizes, suggest that the spores from this fungi will deposit in the nose, mouth and upper respiratory tract. It may be related to bakers asthma and has been associated with hypersensitivity pneumonitis.

Cladosporium species are the most commonly identified outdoor fungus. The numbers are often high in the summer months and reduced during the winter. It is a common allergen. It is found on dead plants, woody plants, food, straw, soil, paint and textiles. It may cause mycosis, which is the growth of a fungus on or in the body by the mechanism of infection. It is a common cause of extrinsic asthma (immediate - type hypersensitivity: type 1). Acute symptoms include edema and bronchiospasms, chronic cases may develop pulmonary emphysema.

Penicillium species are commonly found in soil, food, cellulose and grains. It is also found in paint and compost piles. It may cause hypersensitivity pneumonitis, allergic alveolitis in susceptible individuals. It is reported to be allergenic (skin). Some species can produce mycotoxins. It is a common cause of extrinsic asthma (immediate - type hypersensitivity: type 1). Acute symptoms include edema and bronchiospasms, chronic cases may develop pulmonary emphysema.

Rhizopus species were detected on a limited number of plates. This fungus is reported to be allergenic and may cause mucorosis in immune compromised individuals. The sites of infection are the lung, nasal sinus, brain, eye and skin. Infection may have multiple sites. It is often linked to occupational allergy.

During composting operations, personnel wore Modified Level D PPE with the addition of a 3M 8710 Dust/Mist maintenance-free disposable respirator (disposable dust mask). The 3M respirator is NIOSH approved (TC-21C-132) for dusts and mists having a TWA not less than 0.05 mg/m^3, including coal, flour, and free silica. Clothing and protective gear included dedicated coveralls, 16 inch polyvinyl chloride boots, standard Tyvek®, safety glasses, and double nitrile gloves. It should be noted that full-face air purifying respirators with high efficiency particulate air (HEPA) and ammonia cartridges were necessary for the first three - five days when working around the compost piles containing chicken manure greater than 15% by volume because of the ammonia off-gassing. During composting operations, when the windrows were turned, the inside total dust levels averaged below 1.0 mg/m^3. The maximum total dust reading was 1.2 mg/m^3. This can be attributed to the 40-60% moisture content of the compost piles. These results were similar to what was obtained at the Umatilla project.

The use of Modified Level D PPE with approved disposable dust masks is considered as providing an adequate level of employee protection against direct contact and any potential airborne biological hazards. In addition, employees are provided with work coveralls that are changed on a daily basis. Employees are

also required to shower at the end-of-shift using the shower facilities contained within a personnel decontamination facility at the work site. The PPE selection and hygiene procedures were consistent with what was recommended by Rynk et al. (1992), Heida et al. (1995), Epstein (1992), and Richard (1995).

Implication of Study

This study supports the findings that the total airborne microbial loading inside of a composting facility using windrow composting technology is likely to be higher than the loading outside of the facility in the ambient air representing background conditions. This study also supports the finding that in a well managed compost operation, pathogenic bacterial and fungi species are killed-off and only rarely encountered, or are present in relatively small numbers.

Comparison with Current Literature

This study supports the conclusions reached by Golueke (1991) that pathogenic fungi either are only rarely encountered, or are present in relatively small numbers during composting. Two of the predominant species detected, *Penicillium* and *Cladosporium*, were also detected at composting facilities during studies conducted by Heida et al. (1995) and Olmsted (1995). Total concentrations obtained in this study were much lower than those reported by Heida et al. (1995), Olmsted (1995), Lundholm and Rylander (1980), and Clark et al. (1983b) but were similar to those obtained by Spencer (1994).

Other studies present results of bioaerosol sampling campaigns that have detected *Aspergillus fumigatus* at composting plants. The results in this study had no detectable *Aspergillus* species which includes *Aspergillus fumigatus*. This is consistent with Golueke (1991) who reports that concentrations of *Aspergillus fumigatus* become significantly high only when woodchips or sawdust are used as the bulking agents in compost piles. Both of these bulking agents were used in the compost piles at NSWC Crane, but there volume contribution were minimal in each of the composting piles.

Limitations

Limitations on this study include the number of bioaerosol samples obtained. Inside of the compost building, 6 samples sets were obtained for bacteria (total of 12 plates) and 6 sample sets for fungi (molds and yeast) (total of 12 culture plates). The same number were obtained outside of the building representing background. The second limitation is the fact the data comes from pilot scale operations involving a minimal amount of contaminated soil. During follow-on production composting operations, the compost buildings are sized to hold approximately ten times the amount of material treated during pilot scale.

Recommendations for Future Studies

Additional bioaerosol sampling during production composting will confirm the results of this study and determine how much of an increase in bioaerosol loading will occur based on the increased amount of material treated. The results can again be compared to other studies for total loading and species detected. It will be pertinent to discuss with the analytical laboratory the addition of an antifungal antibiotic such as cycloheximide to the SMA media to inhibit growth of fungi since fungal growth might interfere with some bacterial growth and limit identification and enumeration of species.

4.2 EXPLOSIVE AEROSOL/VAPORS, METALS, AND ORGANIC VAPOR SAMPLING RESULTS

All explosive aerosol/vapor sample concentrations for all analytes were reported by the laboratory as <0.05 milligrams per cubic meter (mg/m^3) of air sampled. The 0.05 mg/m^3 represents a conservative detection limit that was based on the lowest total flow sample submitted.

For explosives, one sample representing the laboratory matrix spike had recoveries that were acceptable (± 25%) except for tetryl. Analysis for tetryl showed a poorly resolved shoulder on another peak which may account for the possible variation in quantification resulting in a high recovery. The second laboratory matrix spike for explosives had acceptable recoveries (± 25%). The laboratory matrix spike represents the analyte recovery from a spiked blank tube taken from the same lot as the tubes for the field samples.

All metal sample concentrations were reported as below the detection limit except for one area sample from the excavation site which had a reported concentration for aluminum at 0.019 mg/m^3. The OSHA PEL for aluminum metal as a dust is 15 mg/m^3. The detection limit for aluminum was 0.014 mg/m^3. All recoveries were acceptable for the laboratory matrix spike except for one sample where silver was inadvertently omitted.

All NIOSH 1500 analysis results were below the detection limit for all analytes in all samples including the field sample blank. This was also the same result reported for the NIOSH 1501 and 1003 analysis. A copy of the laboratory analytical reports is included in Attachment J to this report.

4.2.1 Discussion

For explosives, to determine compliance with the OSHA PEL, the NIOSH sampling strategy is used to determine if the 95% one-sided upper confidence limit (UCL) is less than 1 (unity) (indicating no possibility of overexposure) for TNT and RDX measured air concentrations © in mg/m^3 based on the following formula:

$$UCL\ (95\%) \approx C/PEL + SAE$$

The value for C used in the above equation was 0.05 mg/m^3, the lower limit of detection. The OSHA PEL is 1.5 mg/m^3 for TNT and RDX. The sampling and analytical error (SAE) as a decimal was set at 0.15. The calculated value for UCL (95%) is significantly less then 1. If the ACGIH TLV-TWA of 0.5 mg/m^3 for TNT is used in place of 1.5 mg/m^3, the UCL (95%) is still significantly below 1. For the remaining compounds analyzed per the 8330 Method, the same result applies, the UCL (95%) is less then 1. Table 4 provides a listing of each analyte, the OSHA PEL or NIOSH Recommended Exposure Limit (REL), the ACGIH TLV-TWA (as reported in the following: OSHA, 1996, ACGIH, 1995-1996, and NIOSH, 1994b) and the analytical result of the analysis.

TABLE 5 EXPLOSIVES ANALYTE SUMMARY TABLE

Analyte	OSHA PEL	ACGIH TLV-TWA	Analytical Result
HMX	none listed	none listed	< 0.05 mg/m^3
RDX	1.5 mg/m^3	1.5 mg/m^3	< 0.05 mg/m^3
1,3,5-Trinitrobenzene	none listed	none listed	< 0.05 mg/m^3
1,3-Dinitrobenzene	1.0 mg/m^3	1.0 mg/m^3	< 0.05 mg/m^3
Tetryl	1.5 mg/m^3	1.5 mg/m^3	< 0.05 mg/m^3
Nitrobenzene	5.0 mg/m^3	5.0 mg/m^3	< 0.05 mg/m^3
2,4,6-Trinitrotoluene (TNT)	1.5 mg/m^3	0.5 mg/m^3	< 0.05 mg/m^3
4-Amino-2,6-Dinitrotoluene	none listed	none listed	< 0.05 mg/m^3
2-Amino-4,6-Dinitrotoluene	none listed	none listed	< 0.05 mg/m^3
2,4-Dintrotoluene	none listed, use 1.5 mg/m^3 for Dintrotoluene	none listed, use 0.15 mg/m^3 for Dintrotoluene	< 0.05 mg/m^3
2,6-Dinitrotoluene	none listed, use 1.5 mg/m^3 for Dintrotoluene	none listed, use 0.15 mg/m^3 for Dintrotoluene	< 0.05 mg/m^3
2-Nitrotoluene	NIOSH REL of 11 mg/m^3	11 mg/m^3	< 0.05 mg/m^3
3-Nitrotoluene	NIOSH REL of 11 mg/m^3	11 mg/m^3	< 0.05 mg/m^3
4-Nitrotoluene	NIOSH REL of 11 mg/m^3	11 mg/m^3	< 0.05 mg/m^3

The sampling results for TNT and RDX were low, these results were similar to those obtained during the Umatilla project. In addition, the explosives analytical method used at Umatilla project had a lower limit of quantification for TNT and RDX. There is no indication that the thermophilic heat of reaction associated with the compost piles (45 to 65 °C, average of 55 °C) caused any of the explosive contaminants including the major transformation products of TNT to vaporize and pose an additional occupational health hazard inside of the compost building.

For metals, the same NIOSH UCL (95%) calculation is used for each of the analytes and the result is less than 1. The sampling and analytical error (SAE) as a decimal was set at 0.15. Table 5 provides a listing of each analyte, the OSHA PEL or NIOSH REL, the ACGIH TLV-TWA (as reported in OSHA, 1996, ACGIH, 1995-1996, and NIOSH, 1994b) and the analytical result of the analysis. The results are expected to be less than any exposure limits.

For organics, both inside and outside sample results were below the lower limit of detection and significantly less than any occupational exposure limits. Tables 6,7,8 list each analyte, the OSHA PEL or NIOSH REL, the ACGIH TLV-TWA (as reported in OSHA, 1996, ACGIH, 1995-1996, and NIOSH, 1994b). and the analytical result for each of the three NIOSH Methods.

During soil excavation and screening and composting operations, personnel wore Modified Level D PPE with the addition of a 3M 8710 Dust/Mist maintenance-free disposable respirator (disposable dust mask). The 3M respirator is NIOSH approved (TC-21C-132) for dusts and mists having a TWA not less than 0.05 mg/m^3, including coal, flour, and free silica. Clothing and protective gear included dedicated coveralls, 16 inch polyvinyl chloride boots, standard Tyvek®, safety glasses, and double nitrile gloves. One note, only single nitrile gloves were worn inside the composting building.

There was no visible dust generated during excavation and screening. The fact that the ground was moist from previous days rain may have contributed to this. A direct reading dust/aerosol monitor was used to monitor total dust at three locations around the Screener. The results were 0.3 mg/m^3 at the discharge, 0.28 mg/m^3 at the reject conveyer, and 0.28 mg/m^3 at the operators station. These values were less than the 1.0 mg/m^3 action level for the work site perimeter total dust as established in the SSHP document. The instrument used was a Sensidyne Laser Dust Monitor, Model LD-1.

During composting operations, when the windrows were turned, the inside total dust levels averaged below 1.0 mg/m^3 also. The maximum total dust reading was 1.2 mg/m^3. This can be attributed to the 40-60% moisture content of the compost piles.

TABLE 6 METALS ANALYTE SUMMARY TABLE

Analyte	OSHA PEL	ACGIH TLV-TWA	Analytical Result
Aluminum	15 mg/m^3 total dust	10 mg/m^3	< 0.014 mg/m^3, the highest area sample was reported as 0.019 mg/m^3 during excavation
Antimony	0.5 mg/m^3	0.5 mg/m^3	<0.001 mg/m^3
Arsenic	0.01 mg/m^3	0.01 mg/m^3	< 0.001 mg/m^3
Beryllium	0.002 mg/m^3	0.002 mg/m^3	< 0.001 mg/m^3
Cadmium	0.005 mg/m^3	0.01 mg/m^3 total dust	< 0.000030 mg/m^3
Calcium	15 mg/m^3 total dust	2 mg/m^3	< 0.07 mg/m^3
Chromium	1 mg/m^3	0.5 mg/m^3	<0.04 mg/m^3
Cobalt	0.1 mg/m^3	0.02 mg/m^3	<0.001 mg/m^3
Copper	1 mg/m^3	1 mg/m^3	< 0.07 mg/m^3
Iron	10 mg/m^3	5 mg/m^3	< 0.20 mg/m^3
Lead	0.05 mg/m^3	0.05 mg/m^3	<0.001 mg/m^3
Magnesium	15 mg/m^3 total particulate	10 mg/m^3	<0.40 mg/m^3
Manganese	NIOSH REL of 1 mg/m^3 OSHA Ceiling of 5 mg/m^3	0.2 mg/m^3	<0.07 mg/m^3
Molybdenum	15 mg/m^3	10 mg/m^3	<0.001 mg/m^3
Nickel	1 mg/m^3	1 mg/m^3	<0.20 mg/m^3
Selenium	0.2 mg/m^3	0.2 mg/m^3	<0.001 mg/m^3
Silicon	15 mg/m^3 total dust	10 mg/m^3	<0.07 mg/m^3
Silver	0.01 mg/m^3	0.1 mg/m^3	<0.001 mg/m^3
Tin	2 mg/m^3	2 mg/m^3	<0.00059 mg/m^3
Vanadium	Ceiling of 0.1 mg/m^3 for total fume	0.05 mg/m^3	<0.001 mg/m^3
Zinc	15 mg/m^3 total dust	10 mg/m^3	<0.04 mg/m^3

TABLE 7 NIOSH 1500 ANALYTE SUMMARY TABLE

Analyte	OSHA PEL	ACGIH TLV-TWA	Analytical Result
Benzene	1 ppm	10 ppm	<0.66 ppm
Cyclohexane	300 ppm	300 ppm	<0.54 ppm
Cyclohexene	300 ppm	300 ppm	< 0.57 ppm
n-Heptane	500 ppm	400 ppm	< 0.40 ppm
n-Hexane	500 ppm	50 ppm	< 0.45 ppm
Methylcyclohexane	500 ppm	400 ppm	< 0.46 ppm
n-Octane	500 ppm	300 ppm	<0.36 ppm
n-Pentane	1,000 ppm	600 ppm	<0.51 ppm
Toluene	200 ppm	50	< 0.55 ppm

Note: ppm - parts per million

TABLE 8 NIOSH 1501 ANALYTE SUMMARY TABLE

Analyte	OSHA PEL	ACGIH TLV-TWA	Analytical Result
Benzene	1 ppm	10 ppm	<0.097 ppm
p-tert-Butyltoluene	10 ppm	1 ppm	<0.050 ppm
Cumene	50 ppm	50 ppm	< 0.062 ppm
Ethylbenzene	100 ppm	100 ppm	< 0.070 ppm
a-Methylstyrene	100 ppm	50 ppm	< 0.066 ppm
Napthalene	10 ppm	10 ppm	< 0.0068 ppm
Styrene	100 ppm	50 ppm	<0.075 ppm
Toluene	200 ppm	50 ppm	<0.081 ppm
2-Methylstyrene	100 ppm	NA	<0.066 ppm
4-Methylstyrene	100 ppm	NA	<0.066 ppm
Xylene	100 ppm	100 ppm	< 0.070 ppm

Note: ppm - parts per million
NA - Not Applicable

TABLE 9 NIOSH 1003 ANALYTE SUMMARY TABLE

Analyte	OSHA PEL	ACGIH TLV-TWA	Analytical Result
Benzyl chloride	1 ppm	1 ppm	<0.034 ppm
Bromoform	0.5 ppm	0.5 ppm	<0.044 ppm
Carbon tetrachloride	10 ppm	5 ppm	< 0.040 ppm
Chlorobenzene	75 ppm	10 ppm	< 0.038 ppm
Chlorobromomethane	200 ppm	200 ppm	< 0.058 ppm
Chloroform	50 ppm	10 ppm	< 0.048 ppm
o-Dichlorobenzene	50 ppm	25 ppm	<0.034 ppm
p-Dichlorobenzene	75 ppm	10 ppm	<0.0028 ppm
1,1-Dichloroethane	100 ppm	100 ppm	<0.046 ppm
cis-1,2-Dichloroethylene	200 ppm	200 ppm	<0.051 ppm
trans-1,2-Dichloroethylene	200 ppm	200 ppm	<0.050 ppm
Ethylene dichloride	50 ppm	10 ppm	<0.049 ppm
Hexachloroethane	1 ppm	1 ppm	<0.0016 ppm
1,1,1-Trichloroethane	350 ppm	350 ppm	<0.039 ppm
Tetrachloroethylene	100 ppm	25 ppm	<0.038 ppm
1,1,2-Trichloroethane	10 ppm	10 ppm	<0.042 ppm
1,2,3-Trichloropropane	50 ppm	10 ppm	< 0.036 ppm

Note: ppm - parts per million

4.3 TOTAL DUST MONITORING

The maximum dust concentration measured during screening was approximately 1 mg/m^3. The maximum dust concentration measured during composting when the windrows are turned was 1.2 mg/m^3. On 9/8/97, amendments were mixed inside of the Compost Building prior to the addition of contaminated soil. Concentrations of approximately 10 mg/m^3 were measured during two 2 minute time intervals. The OSHA PEL for particulates not otherwise regulated (PNOR) is 15 mg/m^3 for total dust. The ACGIH TLV-TWA for particulates not otherwise classified (PNOC) is 10 mg/m^3 for the inhalable fraction. Based on the results of the instantaneous measurements of dust concentrations and task durations, if time integrated total dust samples were taken for full-shift or split-shift, the most likely result would be concentrations below the PEL and TLV-TWA.

4.4 OTHER CHEMICAL AGENT MONITORING

During amendment handling and mixing of compost piles, it was observed that excessive ammonia (NH_3) was being generated by the chicken and turkey manure. Measurements of ammonia concentrations using colorimetric indicator tubes indicated localized ammonia concentrations as high as 150 ppm. The PEL is 50 ppm and the ACGIH TLV-TWA is 25 ppm. Respiratory protection was upgraded to half-mask air purifying respirator (APR) with NH_3/HEPA cartridges, however, the ammonia gas was causing excessive tearing of the eyes. The respirator protection was upgraded to full-face APR with NH_3/HEPA cartridges. After 3 to 5 days, ammonia levels dropped below the PEL and then slowly dropped to 1-10 ppm and non-detect by the end of the compost cycle (30 days). This pattern was similar in both the clean soil and contaminated soil phases.

Acetic acid was detected in the potato waste amendment pile using colorimetric indicator tubes. The concentration measured approximately 5 ppm during digging of the pile and once after turning the pile. The OSHA PEL is 50 ppm and the ACGIH TLV-TWA is 10 ppm.

During the clean soil phase colorimetric indicator tubes were used to spot check for other constituents. Carbon dioxide concentrations were equivalent to normal atmospheric levels. No detectable levels of formaldehyde, benzene, acetone, petroleum distillates, toluene, dichloromethane, nitrogen dioxide, nitrous fumes, hydrogen sulfide, carbon monoxide, and vinyl chloride were measured.

On 7/9/97 during the clean soil phase, the Industrial Scientific multi-gas instrument was used to measure concentrations of combustible vapor, oxygen, hydrogen sulfide, and carbon monoxide around each compost pile in Building 3. Oxygen measured 20.8 % by volume. The instrument read non-detect for % LEL, carbon monoxide and hydrogen sulfide. At the same time and location, a PID was used to measure total volatile organic hydrocarbon. The concentrations ranged from 10 ppm to 14 ppm.

At the Umatilla project, no hydrogen sulfide was detected. Umatilla experienced two excursions above the TLV for carbon monoxide, but this was the result of gasoline powered equipment use inside of the structure. At Umatilla, the buildings were enclosed and equipped with mechanical ventilation providing approximately 6 air changes per hour. At Crane, the buildings are open at the ends and have no ventilation systems. Umatilla experienced no combustible gas alarms and no nitrogen dioxide alarms. The average readings for ammonia at Umatilla was 5-10 ppm and listed usually at 8 ppm. At Crane, ammonia levels experienced were much higher during the first few days of composting as described above.

4.5 HEAT STRESS MONITORING

Initial physiological monitoring for heat stress at the end of June and early July 1997 indicated a week to ten days was necessary for worker acclimatization using PPE. Certain personnel responded differently to the same heat loading. Prior to PPE downgrades, significant heat stress was indicated by worker pulse rates and ear canal temperatures along with heat disorder physiological symptoms. After PPE

downgrades and acclimatization, minimal heat stress was indicated. In addition to PPE downgrades, ice vest use became mandatory when ambient temperature is above 90° F or when excessive work load is anticipated.

4.6 NOISE MONITORING

Basic sound level monitoring was performed during all work activities. In general, all equipment during operation requires personnel in near vicinity to use hearing protection devices based on sound levels exceeding 85 dBA within 15 foot radius of equipment. Operators of all "cab enclosed" equipment do not require hearing protection. All measured sound levels were below 85 dBA except for near the Scarab windrow turning machine. Noise dosimetry for the Scarab operator indicates a measured time weighted average of 73.2 dBA and 64.5 dBA. For the Environmental Technician, it was 72.7 dBA.

4.7 EXPLOSIVE RESIDUES WIPE SAMPLES

All samples results for all analytes were reported as < 1.0 µg per wipe and are considered not contaminated. The analytes were the same as reported in Table 6 for explosive aerosols/vapors. The laboratory analytical method was the same as that for explosive/aerosol/vapors. All recoveries for the matrix spike were reported by the laboratory as satisfactory. Attachment K contains a copy of the laboratory analytical report.

5.0
CONCLUSIONS

For bioaerosols, the results of the IH sampling campaign indicate that the total concentration median value on the SMA plates inside the compost building was significantly greater than the total concentration outside. The outside total concentration median value was calculated as 120 cfu/m^3 and the inside concentration as 1,185 cfu/m^3. The SMA is a non-selective and a general purpose agar suitable for both bacteria and fungi (molds and yeast).

The opposite result occurred on the acidified PDA plates whereas the total concentration median value on the acidified PDA plates inside the compost building was less than the total concentration outside. The outside total concentration median value was calculated as 1,090 cfu/m^3 and the inside concentration as 785 cfu/m^3. The inside concentration median value was approximately 38% less than the outside. The reason for this occurrence is not fully understood at this time. The acidified PDA is selective agar for fungi (molds and yeast) using pH to inhibit bacteria growth.

No bacteria of any significance was detected on any of the SMA plates. All bacterial pathogen isolation results were negative. No *Aspergillus* species were detected on the fungi (molds and yeast) plates.

The predominant species detected on all sample plates were *Penicillium*, *Alternaria*, and *Cladosporium*. These species are all molds normally found in the atmosphere and are classified as normally mild or non-pathogenic fungi. The bioaerosol concentrations obtained were well below suggested recommended occupational exposure limits of 10,000 cfu/m^3 in total and 500 cfu/m^3 for each specific group of organisms or species of a potentially pathogenic nature.

The results of the IH sampling campaign during contaminated soil excavation and screening and composting indicate no potential of over-exposure to airborne explosive aerosol/vapors or metal dusts with at least a 95% confidence factor. No airborne organic vapors of any significance was detected in any of the samples analyzed. All wipe samples for explosive residues were negative indicating no contamination in wiped areas.

During soil excavation and screening, the decision to downgrade the respiratory protection requirements from air purifying respirators to approved disposable dust masks was satisfactory. The Site Safety and Health Plan (SSHP) originally specified a half-mask air purifying respirator (with indirect venting safety goggles) or full-face air purifying respirator, both with high efficiency particulate air (HEPA) cartridges. The SSHP permitted modification to the level of PPE based on air monitoring and sampling results.

Future soil excavation and screening will be completed in Modified Level D with approved disposable dust masks. Random area monitoring will be completed at the perimeter of the contamination reduction zone (CRZ) to verify dust levels are below 10 mg/m^3 total dust. If dust levels exceed this value, the soil will be dampened prior to or during screening.

It is anticipated that future production composting operations will be completed in Modified Level D with approved disposable dust masks also. The level of respiratory protection will be upgraded if ammonia levels are high during the initial start of the compost process.

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ATTACHMENT A

CALIBRATION DATA FORMS

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Inside Cal

Attachment 1. Calibration Data Form: Low, High, and Multi-Flow Sampling Pumps

Name and Location of Calibration: NSWC Crane Bioremediation Facility Inside Sampling Run

Calibration Conducted By: Frank J. Petrik Date Calibration Conducted: 9/12/97 1100 hrs

Calibration Instrument (Type/Manufacturer/Model): Calibrator-2, Bubble Generator, P/N D8000285 SN 21619-14

Air Sampling Pump (Type/Manufacturer/Model): Staplex VM-5 Serial 5415

Collection Medium In Line: Anderson 2-Stage (Cal Plates) Calibrator Volume: 2-30L/MIN

Air Temperature: 24.5 °C Air Pressure: 805 mm Hg Relative Humidity: 42 %

Pump No.	Pre-Sampling Calibration Flow Rate (Q_{pre})					Post-Sampling Calibration Flow Rate (Q_{post})					Avg. Flow Rate	Std. Flow Rate
	Q (L/min)				Q_{pre}	Q (L/min)				Q_{post}	Q_{avg}	Q_{std}
	Q_1	Q_2	Q_3	AVG	L/min	Q_1	Q_2	Q_3	AVG	L/min	L/min	L/min
5415	28.34	28.34	28.34	28.34	28.34	28.19	28.27	28.27	28.24	28.24	28.29	30.01

Calibration Notes:

Outside Cal

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 1. Calibration Data Form: Low, High, and Multi-Flow Sampling Pumps

Name and Location of Calibration: NSWC Crane Bioremediation Facility Outside Sampling Run

Calibration Conducted By: Frank J Petrick Date Calibration Conducted: 9/12/97

Calibration Instrument (Type/Manufacturer/Model): Gilibrator-2, Bubble Generator, P/N D800285 SN 21619-14

Air Sampling Pump (Type/Manufacturer/Model): Staplex VM-5 Serial 5415

Collection Medium In Line: Andersen 2-Stage (Cal Plate) Calibrator Volume: 2-30 L/MIN

Air Temperature: 15.5 °C Air Pressure: 801.1 mm Hg Relative Humidity: 74 %

Pump No.	Pre-Sampling Calibration Flow Rate (Q_{pre})					Post-Sampling Calibration Flow Rate (Q_{post})					Avg. Flow Rate	Std. Flow Rate
	Q (L/min)				Q_{pre}	Q (L/min)				Q_{post}	Q_{avg}	Q_{std}
	Q_1	Q_2	Q_3	AVG	L/min	Q_1	Q_2	Q_3	AVG	L/min	L/min	L/min
5415	28.72	28.72	27.76	28.4	28.4	28.34	28.38	28.38	28.36	28.36	28.38	30.9

Calibration Notes:
Pre & Post are within 10 %

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 1. Calibration Data Form: Low, High, and Multi-Flow Sampling Pumps

Name and Location of Calibration: BIO REMEDIATION FACILITY NSWC CRANE

Calibration Conducted By: R. SPURGEON Date Calibration Conducted: 8/22/97

Calibration Instrument (Type/Manufacturer/Model): GILIBRATOR ELECTRONIC BUBBLE 8517

Air Sampling Pump (Type/Manufacturer/Model): GILLIAN MULTI FLOW HFS-513 SKC 224 PCXR4

Collection Medium In Line: XAD-2 OVS TUBE Calibrator Volume: 4 L/MIN

Air Temperature: 21 °C Air Pressure: 801 mm Hg Relative Humidity: 65 %

Pump No.	Pre-Sampling Calibration Flow Rate (Q_{pre})					Post-Sampling Calibration Flow Rate (Q_{post})					Avg. Flow Rate		
	Q (units)				Q_{pre}	Q (units)				Q_{post}	Q_{avg}		
	Q_1	Q_2	Q_3	Q_{avg}	/min	Q_1	Q_2	Q_3	Q_{avg}	/min	/min	Q std	
548538	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.05	1.12	EXP MFA 001A
148660	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.07	EXP MFA 002A
148661	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.07	EXP MFA 003A
548995	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.07	EXP MFA 001P
548527	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.07	EXP MFA 002P
548553	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.07	EXP MFA 003 P

Calibration Notes:

$$Q_{AVE} = \frac{Q_{PRE} + Q_{POST}}{2} = \frac{\quad}{2} =$$

$$\% \text{ ERROR} = \left| \frac{Q_{pre} - Q_{post}}{Q_{pre}} \right| \times 100$$

+/- 10%

$$Q_{STD} = Q_{AVE} \times \frac{298\,°K}{294\,°K} \times \frac{801 \text{ mm Hg}}{760 \text{ mm Hg}} =$$

$$\% \text{ ERROR} = \left| \frac{1.0 - \quad}{1.0} \right| \times 100$$

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 1. Calibration Data Form: Low, High, and Multi-Flow Sampling Pumps

Name and Location of Calibration: BIO REMEDIATION FACILITY NSWC CRANE

Calibration Conducted By: R. SPURGEON Date Calibration Conducted: 8/22/97 0700

Calibration Instrument (Type/Manufacturer/Model): GILIBRATOR ELECTRONIC BUBBLE 8517

Air Sampling Pump (Type/Manufacturer/Model): GILLIAN MULTI FLOW - HFS-513

Collection Medium In Line: MCE FILTER Calibrator Volume: 4 L/MIN

Air Temperature: 21 °C Air Pressure: 801 mm Hg Relative Humidity: 65 %

Pump No.	Pre-Sampling Calibration Flow Rate (Q_{pre})					Post-Sampling Calibration Flow Rate (Q_{post})					Avg. Flow Rate	
	Q (units)				Q_{pre}	Q (units)				Q_{post}	Q_{ave}	Q_{STD}
	Q_1	Q_2	Q_3	Q_{avg}	min	Q_1	Q_2	Q_3	Q_{avg}	min	min	
14859	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.95	MET MFA 001A 3.15
14863	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.95	MET MFA 001 P 3.15

Calibration Notes:

$$Q_{ave} = \frac{Q_{pre} + Q_{post}}{2} = \frac{3.0 + 2.9}{2} = 2.95$$

$$\% \text{ ERROR} = \left| \frac{Q_{pre} - Q_{post}}{Q_{pre}} \right| \times 100$$

+/- 10%

$$Q_{STD} = Q_{ave} \times \frac{298°K}{294°K} \times \frac{801 \text{ mm Hg}}{760 \text{ mm Hg}} =$$

$$\% \text{ ERROR} = \left| \frac{3.0 - 2.9}{3.0} \right| \times 100 \doteq 3\%$$

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 1. Calibration Data Form: Low, High, and Multi-Flow Sampling Pumps

Name and Location of Calibration: BIO - REMEDIATION FACILITY NSWC CLANE

Calibration Conducted By: R. SPURGEON Date Calibration Conducted: 8/26/97

Calibration Instrument (Type/Manufacturer/Model): GILIBRATOR ELECTRONIC BUBBLE B517

Air Sampling Pump (Type/Manufacturer/Model): GILLIAN MULTI-FLOW HFS-513 SKC 224 PCXRH

Collection Medium In Line: XAD-2 OUS TUBE Calibrator Volume: 4 L/MIN

Air Temperature: 31 °C Air Pressure: 803 mm Hg Relative Humidity: 46 %

Pump No	Pre-Sampling Calibration Flow Rate (Q_{pre})					Post-Sampling Calibration Flow Rate (Q_{post})					Avg. Flow Rate		
	Q (units)				Q_{pre}	Q (units)				Q_{post}	Q_{avg}		
	Q_1	Q_2	Q_3	Q_{avg}	min	Q_1	Q_2	Q_3	Q_{avg}	min	min	Q_{STD}	
548995	1.0	1.0	1.0	1.0	1.0	.98	1.0	1.0	.99	.99	1.0	1.0	FESTUS
548538	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	WOOD ST
548553	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	SCREE
548527	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	KEN
148161	1.0	1.0	1.0	1.0	1.0	.98	.99	.99	.99	.99	1.0	1.0	CE/EI
148160	1.0	1.0	1.0	1.0	1.0	.95	.94	.94	.94	.94	.97	1.0	RIC

Calibration Notes:

$Q_{AVE} = \frac{Q_{pre} + Q_{post}}{2} = \frac{\quad}{2} =$

$Q_{STD} = Q_{AVE} \times \frac{298\,°K}{304\,°K} \times \frac{803\,mm\,Hg}{760\,mm\,Hg} =$

$\% \text{ ERROR} = \left| \frac{Q_{pre} - Q_{post}}{Q_{pre}} \right| \times 100$

+/- 10%

$\% \text{ ERROR} = \left| \frac{1.0 - \quad}{1.0} \right| \times 100$

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 1. Calibration Data Form: Low, High, and Multi-Flow Sampling Pumps

Name and Location of Calibration: BIO-REMEDIATION FACILITY NSWC CRANE

Calibration Conducted By: R. SPURGEON Date Calibration Conducted: 8/26/97

Calibration Instrument (Type/Manufacturer/Model): GILIBRATOR ELECTRONIC BUBBLE B517

Air Sampling Pump (Type/Manufacturer/Model): WILLIAN MULTI-FLOW HFS-513

Collection Medium In Line: MCE FILTER Calibrator Volume: 4 L/MIN

Air Temperature: 31 °C Air Pressure: 803 mm Hg Relative Humidity: 46 %

Pump No	Pre-Sampling Calibration Flow Rate (Q_{pre})					Post-Sampling Calibration Flow Rate (Q_{post})					Avg. Flow Rate	
	Q (units)				Q_{pre}	Q (units)				Q_{post}	Q_{avg}	
	Q_1	Q_2	Q_3	Q_{avg}	min	Q_1	Q_2	Q_3	Q_{avg}	/min	.min	QSTD
14859	3.0	3.0	3.0	3.0	3.0	2.6	2.6	2.6	2.6	2.6	2.8	2.9 FRETUS
14863	3.0	3.0	3.0	3.0	3.0	2.7	2.7	2.7	2.7	2.7	2.9	3.0 CRE/EXT

Calibration Notes:

$$Q_{AVE} = \frac{Q_{pre} + Q_{post}}{2}$$

$$\% \text{ ERROR} = \left| \frac{Q_{pre} - Q_{post}}{Q_{pre}} \right| \times 100$$

$$Q_{STD} = Q_{AVE} \times \frac{298\,°K}{304\,°K} \times \frac{803\,mm\,Hg}{760\,mm\,Hg}$$

% ERROR +/- 10%

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

EXPLOSIVES

TOTAL P.07

Attachment 1. Calibration Data Form: Low, High, and Multi-Flow Sampling Pumps

Name and Location of Calibration: BIO-REMEDIATION FACILITY NSWC CRANE

Calibration Conducted By: R. SPURGEON Date Calibration Conducted: 4/22/97

Calibration Instrument (Type/Manufacturer/Model): CALIBRATOR ELECTRONIC AVABLE 8517

Air Sampling Pump (Type/Manufacturer/Model): SKC 224 PCXR4 GILIAN MULTI-FLOW HFS-513

Collection Medium In Line: XAD-2 OVB TUBE Calibrator Volume: 4 L/min

Air Temperature: 21 °C Air Pressure: 772 mm Hg Relative Humidity: 43% %

Pump No.	Pre-Sampling Calibration Flow Rate (Q_{pre})					Post-Sampling Calibration Flow Rate (Q_{post})					Avg. Flow Rate	Std. Flow Rate
	Q (L/min)				Q_{pre}	Q (L/min)				Q_{post}	Q_{avg}	Q_{std}
	Q_1	Q_2	Q_3	AVG	L/min	Q_1	Q_2	Q_3	AVG	L/min	L/min	L/min
14860	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
548993	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
548538	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
548927	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
14862	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Calibration Notes:

$Q_{AVG} = \frac{Q_{pre} + Q_{post}}{2} = \frac{\quad}{2} =$

$Q_{STD} = Q_{AVG} \times \frac{298°K}{294°K} \times \frac{772 \text{ mmHg}}{760 \text{ mmHg}}$

$\% \text{ ERROR} = \left| \frac{Q_{pre} - Q_{post}}{Q_{pre}} \right| \times 100$

+/- 10%

$\% \text{ ERROR} = \left| \frac{1.0 -}{1.0} \right| \times 100$

P TALW

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 1. Calibration Data Form: Low, High, and Multi-Flow Sampling Pumps

Name and Location of Calibration: BIO-REMEDIATION FACILITY NSWC CRANE

Calibration Conducted By: R. SPURGEON Date Calibration Conducted: 9/22/97

Calibration Instrument (Type/Manufacturer/Model): GILIBRATOR ELECTRONIC BUBBLE B517

Air Sampling Pump (Type/Manufacturer/Model): GILLIAN MULTI-FLOW HFS-513

Collection Medium In Line: MCE FILTER Calibrator Volume: 4 L/MIN

Air Temperature: 21 °C Air Pressure: 772 mm Hg Relative Humidity: 43 %

Pump No.	Pre-Sampling Calibration Flow Rate (Q_{pre})					Post-Sampling Calibration Flow Rate (Q_{post})					Avg. Flow Rate	Std. Flow Rate
	Q (L/min)				Q_{pre}	Q (L/min)				Q_{post}	Q_{avg}	Q_{std}
	Q_1	Q_2	Q_3	AVG	L/min	Q_1	Q_2	Q_3	AVG	L/min	L/min	L/min
14863	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.09
14887	3.0	3.0	3.0	3.0	3.0	3.1	3.1	3.1	3.1	3.1	3.05	3.14

Calibration Notes:

$$Q_{AVE} = \frac{Q_{pre} + Q_{post}}{2}$$

$$Q_{STD} = Q_{AVE} \times \frac{298°K}{294°K} \times \frac{\cancel{805}\ 772\ mm\ Hg}{760\ mm\ Hg}$$

$$\% \text{ ERROR} = \left| \frac{Q_{pre} - Q_{post}}{Q_{pre}} \right| \times 100$$

% ERROR +/- 10%

MORRISON KNUDSEN CORPORATION ORGANICS
NAVFAC SOUTHERN DIVISION

Attachment 1. Calibration Data Form: Low, High, and Multi-Flow Sampling Pumps

Name and Location of Calibration: BIO-REMEDIATION FACILITY NSWC CRANE

Calibration Conducted By: R. SPURLEIN Date Calibration Conducted: 9/24/97

Calibration Instrument (Type/Manufacturer/Model): GILIBRATOR ELECTRONIC BUBBLE 8517

Air Sampling Pump (Type/Manufacturer/Model): GILLIAN MULTI-FLOW HFS-513
SKC 224-PCXR4

Collection Medium In Line: CHARCOAL TUBE Calibrator Volume: 4 LPM

Air Temperature: 21 °C Air Pressure: 777 mm Hg Relative Humidity: 50% %

Pump No.	Pre-Sampling Calibration Flow Rate (Q_{pre})					Post-Sampling Calibration Flow Rate (Q_{post})					Avg. Flow Rate	Std. Flow Rate
	Q (L/min)				Q_{pre}	Q (L/min)				Q_{post}	Q_{avg}	Q_{std}
	Q_1	Q_2	Q_3	AVG	L/min	Q_1	Q_2	Q_3	AVG	L/min	L/min	L/min
14859	0.20	0.20	0.20	0.20	0.20	0.17 ~~1.7~~	0.18 ~~1.8~~	0.17	.17	.17	.19	.20
148602	0.20	0.20	0.20	0.20	0.20	0.16	0.16	0.17	.16	.16	.18	.19
148603	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.21
548971 ~~14857~~	0.20	0.20	0.20	0.20	0.20	0.19	0.19	0.20	0.19	0.19	0.20	0.21
548527	0.20	0.20	0.20	0.20	0.20	0.19	0.19	0.20	0.19	0.19	0.20	0.21
548995	0.20	0.20	0.20	0.20	0.20	0.18	0.22	0.18	0.19	0.19	0.20	0.21
548553	0.20	0.20	0.20	0.20	0.20	0.19	0.19	0.19	0.19	0.19	0.20	0.21

Calibration Notes:

$$Q_{AVG} = \frac{Q_{pre} + Q_{post}}{2}$$

$$Q_{STD} = Q_{AVG} \times \frac{298\,°K}{294\,°K} \times \frac{777\,mmHg}{760\,mmHg}$$

$$\% \text{ ERROR} = \left| \frac{Q_{pre} - Q_{post}}{Q_{pre}} \right| \times 100$$

+/- 10%

A 9

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

ORGANICS

TOTAL P.08

Attachment 1. Calibration Data Form: Low, High, and Multi-Flow Sampling Pumps

Name and Location of Calibration: BIO - REMEDIATION FACILITY NSWC CRANE

Calibration Conducted By: R. SPURGEON Date Calibration Conducted: 9/24/97

Calibration Instrument (Type/Manufacturer/Model): GILIBRATOR ELECTRONIC BUBBLE 8517

Air Sampling Pump (Type/Manufacturer/Model): GILLIAN MULTI-FLOW HFS-513
SKC 224-PCXAX

Collection Medium In Line: CHARCOAL TUBE Calibrator Volume: 4 LPM

Air Temperature: 21 °C Air Pressure: 777 mm Hg Relative Humidity: 50 %

Pump No.	Pre-Sampling Calibration Flow Rate (Q_{pre})					Post-Sampling Calibration Flow Rate (Q_{post})					Avg. Flow Rate	Std. Flow Rate
	Q (L/min)				Q_{pre}	Q (L/min)				Q_{post}	Q_{avg}	Q_{std}
	Q_1	Q_2	Q_3	AVG	L/min	Q_1	Q_2	Q_3	AVG	L/min	L/min	L/min
548538	0.20 ~~0.19~~	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.21
548995	0.20	0.20	0.20	0.20	0.20	0.18	0.22	0.18	0.19	0.19	0.20	0.21

Calibration Notes:

$$Q_{AVE} = \frac{Q_{pre} + Q_{post}}{2}$$

$$\% \text{ ERROR} = \left| \frac{Q_{pre} - Q_{post}}{Q_{pre}} \right| \times 100$$

$$Q_{STD} = Q_{AVE} \times \frac{298\,^{\circ}K}{294\,^{\circ}K} \times \frac{777\,mmHg}{760\,mmHg}$$

+/- 10%

ATTACHMENT B

FIELD MONITORING DATA FORMS

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: NSWC Crane Bio Facility Contaminant Sampled: Fungi (molds & yeast) Inside

Monitoring Conducted By and Date: FJ Potak 9/12/97 Collection Media: PDA

Monitoring Instrument (Type/Manufacturer/Model): Anderson 2-Stage Impactor SN 1227

Air Temperature: ____ °C Air Pressure: ____ mm Hg Relative Humidity: ____ %

	Identification of Personnel or Area	Field Sample ID No.	Pump No.	Q_{pre} L/min	Q_{post} L/min	Q_{avg} L/min	Q_{std} L/min	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol) (L)
1	Area (A)	BINFNRO 15A	5415				30.01	5 MIN	0 MIN	5 MIN	150.05
2	A	BINFREO 16A									
3	A	BINFNRO 17A									
4	A	BINFREO 18A									
5	A	BINFNRO 19A									
6	A	BINFREO 20A									
7	A	BINFNRO 21A									
8	A	BINFREO 22A									
9	A	BINFNRO 23A									
10	A	BINFREO 24A									

Field Notes:

Volume Sampled (L) = 30.01 $\frac{L}{MIN}$ x 5 MIN = 150.05 L

B1

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: _____ Contaminant Sampled: Fungi/molds/yeast Inside

Monitoring Conducted By and Date: _____ Collection Media: _____

Monitoring Instrument (Type/Manufacturer/Model): _____

Air Temperature: _____ °C Air Pressure: _____ mm Hg Relative Humidity: _____ %

	Identification of Personnel or Area	Field Sample ID No.	Pump No.	Q_{pre} L/min	Q_{post} L/min	Q_{avg} L/min	Q_{std} L/min	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol)
11	A	BNF NRO 25A	5415				30.01	5 MIN	0 MIN	5 MIN	150.05
12	A	BNF REO 26 A	5415				30.01	5 MIN	0 MIN	5 MIN	150.05
13	A	BNF NRO 27B	N/A								N/A
14	A	BNF NRO 28B	N/A								N/A

Field Notes:

Page 2 of 2

B-2

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: NSWC Crane Bio Facility Contaminant Sampled: Bacteria Inside

Monitoring Conducted By and Date: F.J. Petsick 9/10/97 Collection Media: SMA

Monitoring Instrument (Type/Manufacturer/Model): Anderson 2-Stage Impactors SN 1227

Air Temperature: ____ °C Air Pressure: ____ mm Hg Relative Humidity: ____ %

	Identification of Personnel or Area	Field Sample ID No.	Pump No.	Q_{pre} L/min	Q_{post} L/min	Q_{avg} L/min	Q_{std} L/min	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol) (L)
1	AREA (A)	BINB NRO 15A	5415				30.01	5 MIN	0 MIN	5 MIN	150.05
2	A	BINB REV 16A									
3	A	BINB NRV 17A									
4	A	BINB REO 18A									
5	A	BINB NRO 19A									
6	A	BINB REV 20A									
7	A	BINB NRV 21A									
8	A	BINB REO 22A									
9	A	BINB NRO 23A									
10	A	BINB REV 24A									

Field Notes:

Volume Sampled (L) = 30.01 L/MIN x 5 MIN = 150.05 L

B-3

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: _____ Contaminant Sampled: Bacteria Inside

Monitoring Conducted By and Date: _____ Collection Media: _____

Monitoring Instrument (Type/Manufacturer/Model): _____

Air Temperature: _____ °C Air Pressure: _____ mm Hg Relative Humidity: _____ %

	Identification of Personnel or Area	Field Sample ID No.	Pump No.	Q_{pre} L/min	Q_{post} L/min	Q_{avg} L/min	Q_{std} L/min	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol)
11	A	BINB NRV 25A	5415				30.01	5 MIN	0 MIN	5 MIN	150.05
12	A	BINB REO 26A	5415				30.01	5 MIN	0 MIN	5 MIN	150.05
13	A	BINB NRO 27B	N/A								N/A
14	A	BINB NRO 28B	N/A								N/A

Field Notes:

B-4

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: NSWC Crane Bio Facility Contaminant Sampled: Bacteria Outside

Monitoring Conducted By and Date: FJ Petsik 9/12/97 Collection Media: SMA

Monitoring Instrument (Type/Manufacturer/Model): Andersen 2-Stage Impactor SN 1207

Air Temperature: °C Air Pressure: mm Hg Relative Humidity: %

	Identification of Personnel or Area	Field Sample ID No.	Pump No.	Q_{pre} L/min	Q_{post} L/min	Q_{avg} L/min	Q_{std} L/min	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol) (L)
1	Area (A)	BOTBNRO #1A	54/15				30.9	5 MIN	0 MIN	5 MIN	154.5
2	A	BOTB REV #2A									
3	A	BOTBNRV #3A									
4	A	BOTB REO #4A									
5	A	BOTB NRO #5A									
6	A	BOTB REV #6A									
7	A	BOTBNRV #7A									
8	A	BOTB REO #8A									
9	A	BOTB NRO #9A									
10	A	BOTB REV 10A									

Field Notes:

Volume Sampled $30.9 \frac{L}{MIN} \times 5\ MIN = 154.5\ L$

154.5 L is the corrected flow, see calibration sheet

B-5

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: _____ Contaminant Sampled: Bacteria Outside

Monitoring Conducted By and Date: _____ Collection Media: _____

Monitoring Instrument (Type/Manufacturer/Model): _____

Air Temperature: _____ °C Air Pressure: _____ mm Hg Relative Humidity: _____ %

	Identification of Personnel or Area	Field Sample ID No.	Pump No.	Q_{pre} L/min	Q_{post} L/min	Q_{avg} L/min	Q_{std} L/min	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol)
11	A	BOTB NRU 11A	5415				30.9				154.5
12	A	BOTB REO 12A	5415				30.9				154.5
13	A	BOTB NRO 13B	NA								NA
14	A	BOTB NRO 14B	NA								NA

Field Notes:

B-6

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: NSWC Crane Bio Facility Contaminant Sampled: Fungi (outside) Mold & Yeast

Monitoring Conducted By and Date: FJ Petsik 9/12/97 Collection Media: PDA

Monitoring Instrument (Type/Manufacturer/Model): Andersen 2-Stage Impactor SN 1227

Air Temperature: ____ °C Air Pressure: ____ mm Hg Relative Humidity: ____ %

	Identification of Personnel or Area	Field Sample ID No.	Pump No.	Q_{pre} L/min	Q_{post} L/min	Q_{avg} L/min	Q_{std} L/min	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol) (L)
1	Area (A)	BOTFNRO 01 A	5415				30.9	5 min	0 min	5 min	154.5
2	A	BOTFREO 02 A									
3	A	BOTFNRO 03 A									
4	A	BOTFREO 04 A									
5	A	BOTFNRO 05 A									
6	A	BOTFREO 06 A									
7	A	BOTFNRO 07 A									
8	A	BOTFREO 08 A									
9	A	BOTFNRO 09 A									
10	A	BOTFREO 10 A									

Field Notes:

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: _____ Contaminant Sampled: Fungi (OUTSIDE)

Monitoring Conducted By and Date: _____ Collection Media: _____

Monitoring Instrument (Type/Manufacturer/Model): _____

Air Temperature: _____ °C Air Pressure: _____ mm Hg Relative Humidity: _____ %

	Identification of Personnel or Area	Field Sample ID No.	Pump No.	Q_{pre} L/min	Q_{post} L/min	Q_{avg} L/min	Q_{std} L/min	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol)
11	A	BOTFNRO 11A	5415				30.9	5 MIN	0 MIN	5 MIN	154.5
12	A	BOTF REO 12A	5415				30.9	5 MIN	0 MIN	5 MIN	154.5
13	A	BOTF NRO 13B	N/A								N/A
14	A	BOTF NRO 14B	N/A								N/A

Field Notes:

B-8

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: MINE FILL A Contaminant Sampled: EXPLOSIVES

Monitoring Conducted By and Date: R. SPURGEON 8/22/97 Collection Media: XAD-2 OVS

Monitoring Instrument (Type/Manufacturer/Model): GILLIAN MULTI FLOW HFS-513 SKC 224-PCX R4

Air Temperature: 21 °C Air Pressure: 802 mm Hg Relative Humidity: 65 %

Identification of Personnel or Area	Field Sample ID No.	Pump No.	Pre-Sample Calibration Flow Rate	Post-Sample Calibration Flow Rate	~~Average~~ STD Flow Rate (Q)	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol)
A	EXPMFA 001A	548538	1.0	1.1	~~1.04~~ 1.12	0755	1158	243	~~255~~ 272
A	EXP MFA 002A	14860	1.0	1.0	1.07	0758	1156	238	255
A	EXP MFA 003A	14861	1.0	1.0	1.07	0800	1155	235	251
P	EXP MFA 001P	548995	1.0	1.0	1.07	0750	1157	247	264
P	EXP MFA 002P	548527	1.0	1.0	1.07	0752	1200	248	265
P	EXP MFA 003P	548553	1.0	1.0	1.07	0754	1159	245	262
BLANK	EXP MFA 001F	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BLANK	EXP MFA 002F	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Field Notes:
VOLUME SAMPLED = Q_{STD} (L/MIN) X TOTAL SAMPLE TIME (MIN) =

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: MINE FILL A Contaminant Sampled: METALS

Monitoring Conducted By and Date: P. SPURGEON 8/22/97 Collection Media: MCE FILTER

Monitoring Instrument (Type/Manufacturer/Model): GILLIAN MULTI-FLOW HFS-513

Air Temperature: 21 °C Air Pressure: 801 mm Hg Relative Humidity: 65 %

Identification of Personnel or Area	Field Sample ID No.	Pump No.	Pre-Sample Calibration Flow Rate	Post-Sample Calibration Flow Rate	Average Flow Rate (Q)	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol)	
P	MET MFA 001 P	14863	3.0	2.9	2.95	0803	1157	234	690 L	J. HALAN
A	MET MFA 001 A	14859	3.0	2.9	2.95	0804	1158	234	690 L	LOCATION 1
BLANK	MET MFA 001 F	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	BLANK

Field Notes:

VOLUME SAMPLED (L) = Q STD (L/MIN) X TOTAL SAMPLE TIME (MIN)

B-10

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: MINE FILL A Contaminant Sampled: EXPLOSIVES

Monitoring Conducted By and Date: R. SPURGEON 8/26/97 Collection Media: XAD-2 OVS

Monitoring Instrument (Type/Manufacturer/Model): GILLIAN MULTI-FLOW HFS-513 SKC 224-PCXR4

Air Temperature: 31 °C Air Pressure: 803 mm Hg Relative Humidity: 46 %

Identification of Personnel or Area	Field Sample ID No.	Pump No.	Pre-Sample Calibration Flow Rate	Post-Sample Calibration Flow Rate	Average Flow Rate (Q)	Sample Start Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol)	
✓ A	EXPMFA004A	548538	1.0	1.0	1.0	1206	1610	244	244	WOOD STRUCT
✓ A	EXPMFA 005 A	148161	1.0	.99	1.0	1220	1611	231	231	CRE/ERCLUS
✓ A	EXP MFA 006 A	548553	1.0	1.0	1.0	1204	1612	248	248	SCREENE
✓ P	EXP MFA 004 P	548995	1.0	.99	1.0	1205	1615	250	250	J. HAGAN
✓ P	EXP MFA 005 P	548527	1.0	1.0	1.0	1204	1615	251	251	K. PHLUB
✓ P	EXP MFA006 P	148160	1.0	.94	.97	1205	1615	250	250	R. DAYHOF
✓ BLANK	EXP MFA 003 F	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
✓ BLANK	EXP MFA004F	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Field Notes:
VOL. SAMPLED = Q STD (L/MIN) X TOTAL TIME SAMPLED (MIN)

MORRISON KNUDSEN CORPORATION
NAVFAC SOUTHERN DIVISION

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: MINE FILL A Contaminant Sampled: METALS

Monitoring Conducted By and Date: R. SAURGEON 8/26/97 Collection Media: MCE FILTER

Monitoring Instrument (Type/Manufacturer/Model): GILLIAN MULTI-FLOW HFS-513

Air Temperature: 31 °C Air Pressure: 803 mm Hg Relative Humidity: 46 %

Identification of Personnel or Area	Field Sample ID No.	Pump No.	Pre-Sample Calibration Flow Rate	Post-Sample Calibration Flow Rate	Average Flow Rate (Q)	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol)	
P	METMFA 002 P	14859	3.0	2.6	2.8	1205	1600	249	711	FESTUS
A	METMFA 002 A	14863	3.0	2.7	2.9	1205	1612	247	741	EEE/EMU
BLANK	METMFA 002 F	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Field Notes:
VOLUME SAMPLED = QSTD (L/MIN) X TOTAL SAMPLE TIME (MIN)

NAVFAC SOUTHERN DIVISION

EXPLOSIVES

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: BIO-FACILITY (BLDG -#3) Contaminant Sampled: EXPLOSIVES

Monitoring Conducted By and Date: R. SPURGEON 9/22/97 Collection Media: XAD-2 OVS TUBE

Monitoring Instrument (Type/Manufacturer/Model): GILLIAN MULTI-FLOW HFS-513 SKC 224 PCXR4

Air Temperature: 21 C Air Pressure: 772 mmHg Relative Humidity: 43 %

Identification of Personnel or Area	Field Sample ID No.	Pump No.	Q_{pre} L/min	Q_{post} L/min	Q_{avg} L/min	Q_{std} L/min	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol)	
P	EXP 010 001 P	548995	1.0	1.0	1.0	1.0	0730	1146	256	256	T. HAGAN
P	EXP 010 002 P	548553	1.0	1.0	1.0	1.0	0730	1103	213	213	K. PHILLIPS
A	EXP 010 001 A	548538	1.0	1.0	1.0	1.0	0730	1105	215	215	BLDG #3
A	EXP 010 002 A	14862	1.0	1.0	1.0	1.0	0730	1105	215	215	BLDG #3
A	EXP 010 003 A	14860	1.0	1.0	1.0	1.0	0730	1105	215	215	BLDG #3
P	EXP 010 003 P	548527	1.0	1.0	1.0	1.0	0730	1116	226	226	R. DAYHOFF
BLANK	EXP 010 001 F	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
BLANK	EXP 010 002 F	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Field Notes:

VOLUME SAMPLED = Q_{std} (L/MIN) X TOTAL SAMPLE TIME (MIN)

NAVFAC SOUTHERN DIVISION

M. ALS

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: BIO - FACILITY (BLDG #3) Contaminant Sampled: METALS

Monitoring Conducted By and Date: R. SPURLEON 9/22/97 Collection Media: MCE FILTER

Monitoring Instrument (Type/Manufacturer/Model): GILLIAN MULTI-FLOW HFS-513

Air Temperature: 21 C Air Pressure: 772 mmHg Relative Humidity: 43 %

Identification of Personnel or Area	Field Sample ID No.	Pump No.	Q_{pre} L/min	Q_{post} L/min	Q_{avg} L/min	Q_{std} L/min	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol)
P	MET BIO 001 P	14863	3.0	3.0	3.0	3.09	0730	1130	240	742
A	MET BIO 001 A	14859	3.0	3.1	3.05	3.14	0730	1105	215	675
BLANK	MET BIO 001 F	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

M. MADDOX
BLDG #3

Field Notes:
VOLUME SAMPLED = Q_{STD} (L/MIN) X TOTAL SAMPLE TIME (MIN)

OF INICS

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: BIO-FACILITY (BLDG #2) Contaminant Sampled: ORGANICS

Monitoring Conducted By and Date: R. SPURGEON 9/24/97 Collection Media: CHARCOAL TUBE

Monitoring Instrument (Type/Manufacturer/Model): GILLIAN MULTI-FLOW HFS-513
SKC 224-PCXR4

Air Temperature: 21 C Air Pressure: 777 mmHg Relative Humidity: 50 %

Identification of Personnel or Area	Field Sample ID No.	Pump No.	Q_{pre} L/min	Q_{post} L/min	Q_{avg} L/min	Q_{std} L/min	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol)
A	08IN 1500 001A	148163	0.20	0.20	0.20	0.21	1445	1505	20	4.2
A	08IN/500 002A	548971 ~~148597~~	0.20	0.19	0.20	0.21	1445	1505	20	4.2
A	08IN 1501 001A	548538	0.20	0.20	0.20	0.21	1345	1615	150	31.5
A	08IN 1501 002A	548995	0.20	0.19	0.20	0.21	1345	1615	150	31.5
A	08IN 1003 001A	548553	0.20	0.19	0.20	0.21	1300	1600	300	63.0
A	08IN 1003 002A	548527	0.20	0.19	0.20 ~~0.20~~	0.21	1300	1600	300	63.0
A	08OT 1500001A	148163	0.20	0.20	0.20	0.21	1305	1325	20	4.2
A	08OT 1500002C	548971 ~~148597~~	0.20	0.19	0.20	0.21	1325	1345	20	4.2
A	08OT 1501001C	14859	0.20	0.17 ~~0.18~~	0.19 ~~0.18~~	0.20 ~~0.19~~	1305	1535	150	30.0
A	08OT 1501002C	148162	0.20	0.16	0.18	0.19	1305	1535	150	28.5

Field Notes:

VOL. SAMPLED = Q_{STD} (L/MIN) X TOTAL TIME SAMPLED (MIN)

Attachment 2. Field Monitoring Data Form: Integrated Monitoring for Particulates, Gases, Vapors, or Bioaerosols

Facility Name and Location: BIO-FACILITY (BLDG #2) Contaminant Sampled: ORGANICS

Monitoring Conducted By and Date: R. SPURGEON 9/24/97 Collection Media: CHARCOAL TUBE

Monitoring Instrument (Type/Manufacturer/Model): GILLIAN MULTI-FLOW HFS-513
SKC 224-PCXR4

Air Temperature: 21 °C Air Pressure: 777 mmHg Relative Humidity: 50 %

Identification of Personnel or Area	Field Sample ID No.	Pump No.	Q_{pre} L/min	Q_{post} L/min	Q_{avg} L/min	Q_{std} L/min	Sample Start-Time	Sample Stop Time	Total Sample Time (T)	Volume Sampled (Vol)
A	08OT 1003 001C	548553	0.20	0.19	0.20	0.21	0721	1221	300	63.0
A	08OT 1003 002C	548527	0.20	0.19	0.20	0.21	0730	1230	300	63.0
FIELD BLANK	08OT 1500 001F	N/A								
FIELD BLANK	08OT 1501 001F	N/A								
FIELD BLANK	08OT 1003 001F	N/A								

Field Notes:

VOL. SAMPLED = Q_{STD} (L/MIN) X TOTAL TIME SAMPLED (MIN)

ATTACHMENT C

CHAIN-OF-CUSTODY RECORD FORMS

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES DIVISION

CHAIN OF CUSTODY RECORD

1500 West 3rd Street
Cleveland, Ohio 44113-1406
(216) 523-5600

Project No.: 43011-0009
Project Name: NSWC Crane Bio Facility
Samplers: (Signature) Fred Petrak
Sampler: (Print) F J Petrak

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Split Samples Yes	Split Samples No	Fecal Coliform/Strep	Remarks
Bio	Outside		✓	BOTFNRO 01A			✓	Look for
			✓	BOTFRED 02A			✓	Aspergillus species
			✓	BOTFNRO 03A			✓	Note: A fumigatus
			✓	BOTFRED 04A			✓	
			✓	BOTFNRO 05A			✓	
			✓	BOTFRED 06A			✓	
			✓	BOTFNRO 07A			✓	
			✓	BOTFRED 08A			✓	
			✓	BOTFNRO 09A			✓	
			✓	BOTFRED 10A			✓	
			✓	BOTFNRO 11A			✓	
			✓	BOTFRED 12A			✓	
			✓	BOTFNRO 13B			✓	
			✓	BOTFNRO 14B			✓	

Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
FJ Petrak	9/13/93 1105	[illegible]			

MKES127/89 (Cleveland) #0656/93

Custody Seal # N/A

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES DIVISION

CHAIN OF CUSTODY RECORD

1500 West 3rd Street
Cleveland, Ohio 44113-1406
(216) 523-5600

Project No.: 4324-0009
Project Name: NSWC Carver Bio Facility
Samplers: (Signature) Frank Pol
Sampler: (Print) Frank J Polak

Split Samples

Analysis Required: BACTERIA

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Yes	No	BACTERIA	Remarks
Bio	Outside 07641	9/13/97	✓	BOTBNRO 1A			✓	
	07642		✓	BOTBREV 2A			✓	Subcultur Ecoli
	07643		✓	BOTBNRV 3A			✓	Subcultur Ecoli
	07644		✓	BOTBREV 4A			✓	
	07645		✓	BOTBNRO 5A			✓	
	07646		✓	BOTBREV 6A			✓	Subcultur Ecoli
	07647		✓	BOTBNRV 7A			✓	Subcultur Ecoli
	07648		✓	BOTBREV 8A			✓	
	07649		✓	BOTBNRO 9A			✓	
	07650		✓	BOTBREV 10A			✓	Subcultur Ecoli
	07651		✓	BOTBNRV 11A			✓	Subcultur Ecoli
	07652		✓	BOTBREV 12A			✓	
	07653		✓	BOTBNRO 13B			✓	
	07654		✓	BOTBNRO 14B			✓	

Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
Frank Pol / MKE	9/13/97 1105	Frank Pol / MKE			
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:

MKES127/89 (Cleve

#9656/93

Custody Seal # N/A

C-2

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES DIVISION

CHAIN OF CUSTODY RECORD

1500 West 3rd Street
Cleveland, Ohio 44113-1406
(216) 523-5600

Project No.: 1324-0001
Project Name: [illegible] Bin Facility
Samplers: (Signature) [illegible]
Sampler: (Print) FJ Pelak

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Split Samples Yes	Split Samples No	Bacteria	Remarks
BIO	Area		✓	BINBNRV15A			✓	
	—		✓	BINBNRV16A			✓	Submit Ecoli
	"		✓	BINBNRV17A			✓	Submit Ecoli
			✓	BINBNRV18A			✓	
			✓	BINBNRV19A			✓	
			✓	BINBNRV20A			✓	Submit Ecoli
			✓	BINBNRV21A			✓	Submit Ecoli
			✓	BINBNRV22A			✓	
			✓	BINBNRV23A			✓	
			✓	BINBNRV24A			✓	Submit Ecoli
			✓	BINBNRV25A			✓	Submit Ecoli
			✓	BINBNRV26A			✓	
			✓	BINBNRV27B			✓	
			✓	BINBNRV28B			✓	

Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
FJ Pelak	9/13/97 1105	[illegible]			

MKES127/88 (Cleveland)

#9656/93

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES DIVISION

CHAIN OF CUSTODY RECORD

1500 West 3rd Street
Cleveland, Ohio 44113-1406
(216) 523-5600

Project No.: 13 11-0069
Project Name: USAF Grand Bin Facility
Samplers: (Signature) [illegible]
Sampler: (Print) Frank J Petrek

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Split Samples Yes	Split Samples No	Fungi, molds & yeast	Remarks
Bio	Area (A)		✓	BINFNRO 15A			✓	Aspergillus spores
			✓	BINFREO 16A			✓	look like
			✓	BINFNRO 17A			✓	A fumigatus
			✓	BINFREO 18A			✓	
			✓	BINFNRO 19A			✓	
			✓	BINFREO 20A			✓	
			✓	BINFNRO 21A			✓	
			✓	BINFREO 22A			✓	
			✓	BINFNRO 23A			✓	
			✓	BINFREO 24A			✓	
			✓	BINFNRO 25A			✓	
			✓	BINFREO 26A			✓	
			✓	BINFNRO 27B			✓	
			✓	BINFNRO 28B			✓	

Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
F J Petrek	8/18/97 1105	[illegible]			
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:

MKES127/88 (Cleveland)

#9656/93

C-4

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES DIVISION

CHAIN OF CUSTODY RECORD

1500 West 3rd Street
Cleveland, Ohio 44113-1406
(216) 523-5600

Project No.: 4324 0009
Project Name: NSWC CRANE (MINE FILLA)
Samplers: (Signature) R. J. Spurgeon
Sampler: (Print) RICHARD SPURGEON

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Split Samples Yes	Split Samples No	Analysis Required: 8330	Remarks
EXP	PERSONAL	8/22/97	1158	EXPMFA001P		✓	X	EXPLOSIVES (TOTAL)
EXP	PERSONAL	8/22/97	1154	EXPMFA002P		✓	X	
EXP	PERSONAL	8/22/97	1155	EXPMFA003P		✓	X	
EXP	AREA	8/22/97	1157	EXPMFA001A		✓	X	
EXP	AREA	8/22/97	1200	EXPMFA002A		✓	X	
EXP	AREA	8/22/97	1159	EXPMFA003A		✓	X	
EXP	FIELD BLANK	8/22/97	1403	EXPMFA001F		✓	X	
EXP	FIELD BLANK	8/22/97	1407	EXPMFA002F		✓	X	

Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
MK	8/22/97 1515				
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:

MKCS137.68 (Cleveland)

C-5

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES DIVISION

CHAIN OF CUSTODY RECORD

1500 West 3rd Street
Cleveland, Ohio 44113-1406
(216) 523-5600

Project No.: 4324 - 0009
Project Name: NSWC CRANE (MINE FILL A)
Samplers: (Signature) R. J. [illegible]
Sampler: (Print) RICHARD SPURLEON

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Split Samples Yes	Split Samples No	NIOSH 7300	Remarks
METALS	PERSONAL	8/22/97	1157	METMFA001P		✓	✓	METALS
METALS	AREA	8/22/97	1158	METMFA001A		✓	✓	↓
METALS	FIELD BLANK	8/22/97	1330	METMFA001F		✓	✓	↓

Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
[illegible] / MKC	8/27/97 1515				
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:

CUSTODY SEAL # 5927

C-6

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES DIVISION

CHAIN OF CUSTODY RECORD

1500 West 3rd Street
Cleveland, Ohio 44113-1406
(216) 523-5600

Project No.: 4324-0009
Project Name: NSWC CRANE (MINE FILL A)
Samplers: (Signature) R.S. [illegible]
Sampler: (Print) RICHARD SPURGEON

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Split Samples Yes	Split Samples No	8330	NUSH 7300	Remarks
EXP	AREA	8/26/97	1610	EXPMFA004A		✓	X	X	EXPLOSIVES (TOTAL)
EXP	AREA	8/26/97	1611	EXPMFA005A		✓	X		
EXP	AREA	8/26/97	1612	EXPMFA006A		✓	X		
EXP	PERSONAL	8/26/97	1615	EXPMFA004P		✓	X		
EXP	PERSONAL	8/26/97	1615	EXPMFA005P		✓	X		
EXP	PERSONAL	8/26/97	1615	EXPMFA006P		✓	X		
EXP	FIELD BLANK	8/26/97	1800	EXPMFA003F		✓	X		
EXP	FIELD BLANK	8/26/97	1800	EXPMFA004F		✓	X		
MET	PERSONAL	8/26/97	1600	METMFA002P		✓		X	METALS
MET	AREA	8/26/97	1612	METMFA002A		✓		X	
MET	FIELD BLANK	8/26/97	1800	METMFA002F		✓		X	

Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
[illegible] MK	8/27/97 1515				
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:

MKES 127-99 (Cleveland)

CUSTODY # 5930

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES DIVISION

CHAIN OF CUSTODY RECORD

1500 West 3rd Street
Cleveland, Ohio 44113-1406
(216) 623-5600

Project No.: 4324-0009
Project Name: NSWC CRANE (BIO - FACILITY)
Samplers: (Signature) R. J. Spurgeon
Sampler: (Print) RICHARD SPURGEON

Analysis Required: 8330, NIOSH 7300

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Split Samples Yes	Split Samples No	8330	NIOSH 7300	Remarks
EXP	AREA	9/22/97	1105	EXPB10001A		✓	X		EXPLOSIVES (TOTAL)
EXP	AREA	9/22/97	1105	EXPB10002A		✓	X		↓
EXP	AREA	9/22/97	1105	EXPB10003A		✓	X		↓
EXP	PERSONAL	9/22/97	1146	EXPB10001P		✓	X		↓
EXP	PERSONAL	9/22/97	1103	EXPB10002P		✓	X		↓
EXP	PERSONAL	9/22/97	1116	EXPB10003P		✓	X		↓
EXP	FIELD BLANK	9/22/97	1330	EXPB10001F		✓	X		↓
EXP	FIELD BLANK	9/22/97	1330	EXPB10002F		✓	X		↓
MET	AREA	9/22/97	1105	METB10001A		✓		X	METALS
MET	PERSONAL	9/22/97	1130	METB10001P		✓		X	↓
MET	FIELD BLANK	9/22/97	1330	METB10001F		✓		X	↓

Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:	Relinquished By: (Signature) / Company:	Date/Time	Received By: (Signature) / Company:
R. J. Spurgeon MK	9/22/97 1445				

CUSTODY SEAL # 5537

MORRIS KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES DIVISION

CHAIN OF CUSTODY RECORD

1500 West 3rd Street
Cleveland, Ohio 44113-1406
(216) 523-5800

Project No.: 4324 - 0009
Project Name: NSWC CRANE (MINE FILL A)
Samplers: (Signature) R. J. [illegible]
Sampler: (Print) RICHARD SPURGEON

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Split Samples Yes	Split Samples No	NIOSH 1500	NIOSH 1501	NIOSH 1003	Remarks
ORGANIC	AREA	9/24/97	1505	OBIN1500001A		✓	X			ORGANICS
			1505	OBIN1500002A		✓	X			
			1615	OBIN1501001A		✓		X		
			1615	OBIN1501002A		✓		X		
			1600	OBIN1003001A		✓			X	
			1600	OBIN1003002A		✓			X	
	CONTROL		1325	OBOT1500001C		✓	X			
	CONTROL		1345	OBOT1500002C		✓	X			
	CONTROL		1535	OBOT1501001C		✓		X		
	CONTROL		1535	OBOT1501002C		✓		X		
	CONTROL		1221	OBOT1003001C		✓			X	
	CONTROL		1230	OBOT1003002C		✓			X	
	FIELD BLANK		1630	OBOT1500001F			X			
	FIELD BLANK		1630	OBOT1501001F				X		
	FIELD BLANK		1630	OBOT1003001F					X	

Analysis Required

Relinquished By: (Signature)	Date/Time	Received By: (Signature)	Relinquished By: (Signature)	Date/Time	Received By: (Signature)
Company: MK	11/25/97 0900	Company:	Company:		Company:
Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:
Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:
Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:

MKE8937/95 (Cleveland)

F1556/93

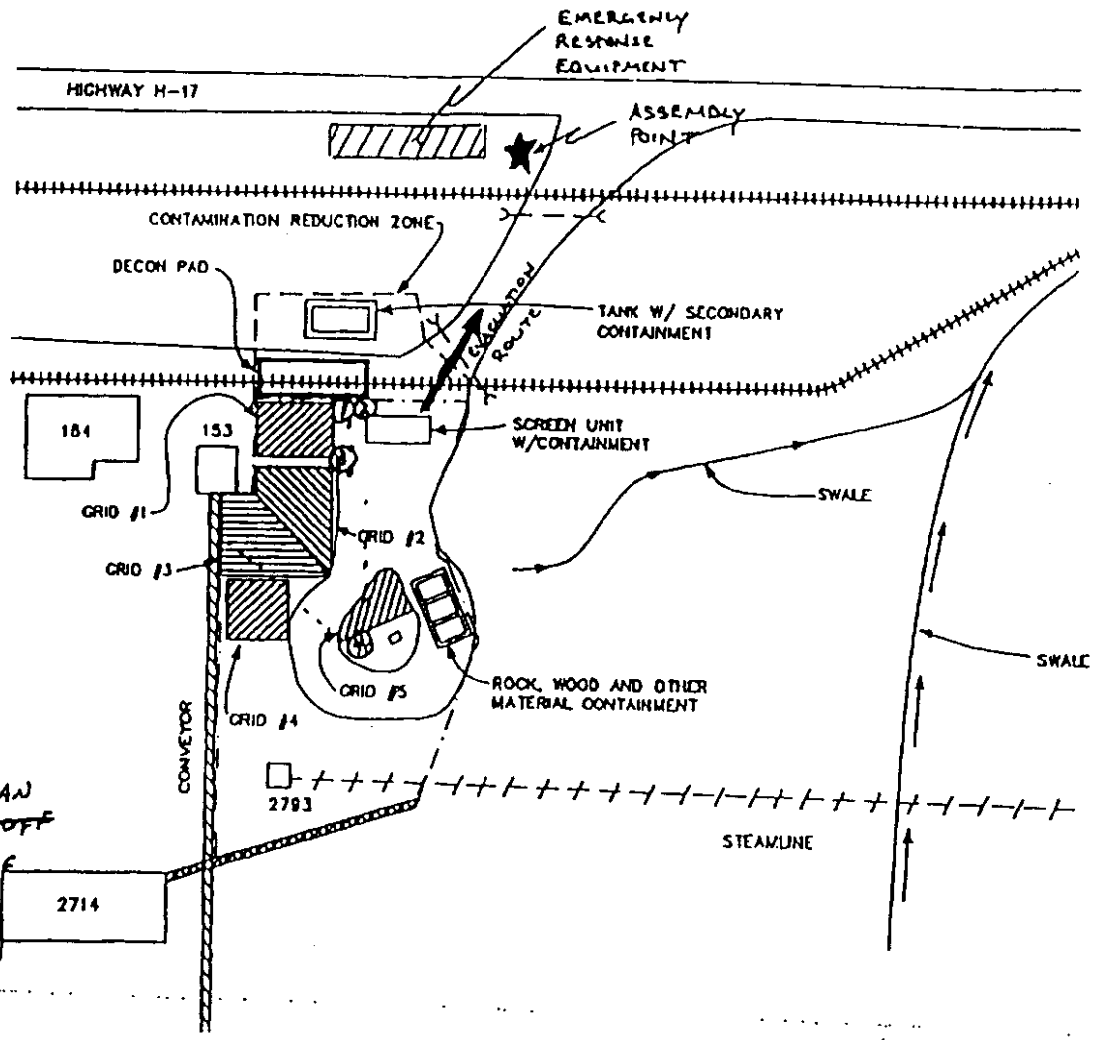
ATTACHMENT D

MARKUP OF SOILS EXCAVATION PLAN MAP- MINE FILL A

PHONE # 854-1333

NO. MK-4

812 639 1177



NOT TO SCALE

LEGEND

- BUILDING
- CONVEYOR
- STEAMLINE
- RAILROAD
- EXCLUSION ZONE LIMIT
- STRAW BALE SILT FENCE
- CONTAMINATION REDUCTION ZONE LIMIT

① MET MFA 001 A
② EXP MFA 001 A
③ EXP MFA 002 A
④ EXP MFA 003 A

PERSONAL

T MFA 001 P - JAMES HAGAN ~~RICK DAYHOFF~~
P MFA 002 P - RICK DAYHOFF
P MFA 003 P - KEN PHILLIPS
P MFA 001 P - JAMES HAGAN

PILOT SCALE
OPERATIONAL PLAN
NSWC CRANE
CRANE, IN

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES

FIGURE E-1
SOIL EXCAVATION PLAN
MINE FILL A, BLDG 153

DWG DATE: 8/11/97 | DWG NAME: GRIDLOC1

1-1

ATTACHMENT E

TOTAL DUST INDUSTRIAL HYGIENE SAMPLE SUMMARY SHEETS

-MO ON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT VI

TOTAL DUST INDUSTRIAL HYGIENE SAMPLE SUMMARY

MATERIAL OF INTEREST (MOI) IN DUST: INHALABLE PARTICULATES Page 1 of 1

IDENTIFICATION | SAMPLE TYPE | Exposure Limit: OSHA PEL: DUST 15 MOI PNOC

Prepared By: R. SPURGEON | Personal: ____ | ACGIH TLV: DUST 10 MOI PNOC

Date Prepared: 6/25/97 | Area: ✓ | Location: BUFACILITY | Scheduled Hours Per Shift ____

Date / Sample #	Name or Area / Soc. Sec. #	Job Class / Equipment	Resp Type / % Use	Pump Type / ID #	Time On	Time Off	Samp Time (min)	Flow (lpm)	Vol (m³)	Filter Wt. Dust mg	Filter Wt. MOI mg	MOI %	Concentration Dust mg/m³	Concentration MOI mg/m³	Shift TWA Dust mg/m³	Shift TWA MOI mg/m³	% PEL or % TLV Dust mg/m³	% PEL or % TLV MOI mg/m³
6/25/97	EXCAVATION SITE SCREENER	—	HA w/ OV/HEPA	LA-1	0951	—	1	3.4	3.4 m³	—	—	—	.39	.39	—	—	4%	4%
TO-001	—	SCREENER	100%	1221065														
6/25/97	EXCAVATION SITE SCREENER	—	" "	" "	0955	—	1	3.4	3.4 L	—	—	—	.96	.96	—	—	10%	10%
TO-002	—	SCREENER	" "	" "														
6/25/97	EXCAVATION SITE PERIMETER	—	" "	" "	1003	—	1	3.4	3.4 L	—	—	—	.36	.36	—	—	4%	4%
TO-003	—	SCREENER	" "	" "														

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT VI

TOTAL DUST INDUSTRIAL HYGIENE SAMPLE SUMMARY

MATERIAL OF INTEREST (MOI) IN DUST: INHALABLE PARTICULATE Page 1 of 1

IDENTIFICATION — SAMPLE TYPE — Exposure Limit: OSHA PEL: DUST 15 MOI PNOC

Prepared By: R. SPURGEON — Personal: ____ — ACGIH TLV: DUST 10 MOI PNOC

Date Prepared: 6/27/97 — Area: ✓ — Location: BIO-FACILITY — Scheduled Hours Per Shift ____

Date / Sample #	Name or Area / Soc. Sec. #	Job Class / Equipment	Resp Type / % Use	Pump Type / ID #	Time On	Time Off	Samp Time (min)	Flow (lpm)	Vol (m³)	Filter Wt. Dust mg	Filter Wt. MOI mg	MOI %	Concentration Dust mg/m³	Concentration MOI mg/m³	Shift TWA Dust mg/m³	Shift TWA MOI mg/m³	% PEL or % TLV Dust mg/m³	% PEL or % TLV MOI mg/m³
6/27/97 TD-001	AMENDMENT PILE / —	— / MANURE MIXING	FF 4 NIOSH/MSHA LD-1 / 100%	1231865	1010	—	1	3.4	3.4	~~27~~	~~27~~	~~3%~~	.27	.27	—	—	3%	3%
6/27/97 TD-002	AMENDMENT PILE / —	— / SAWDUST MIXING	" " / " "	" " / " "	1015	—	1	3.4	3.4	—	—	—	.31	.31	—	—	3%	3%
6/27/97 TD-003	AMENDMENT PILE / —	— / 6A	" " / " "	" " / " "	1020	—	1	3.4	3.4	—	—	—	.29	.29	—	—	3%	3%
6/27/97 TD-004	BUILDING #3 / —	— / DUMPING BATCH	" " / " "	" " / " "	1040	—	1	3.4	3.4	—	—	—	.37	.37	—	—	4%	4%

MO ON KNUDSEN CORPORATION
ENGINE J. CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT V

RESPIRABLE DUST INDUSTRIAL HYGIENE SAMPLE SUMMARY

MATERIAL OF INTEREST (MOI) IN DUST: DUST (RESPIRABLE) Page 1 of 1

IDENTIFICATION

Prepared By: R. SPURGEON

Date Prepared: 7/9/97

SAMPLE TYPE

Personal: ____

Area: ✓

Exposure Limit:

OSHA PEL: DUST 15 MOI PNOC TO
5 PNOC RESPIRABLE

ACGIH TLV: DUST 3 MOI PNOC RESP
10 PNOC INHALABLE

Location: BIO FACILITY

Scheduled Hours Per Shift ____

Date / Sample #	Name or Area / Soc. Sec. #	Job Class / Equipment	Resp Type / % Use	Pump Type / ID #	Time On	Time Off	Samp Time (min)	Flow (lpm)	Vol (m³)	Filter Wt. Dust mg	Filter Wt. MOI mg	MOI %	Concentration Dust mg/m³	Concentration MOI mg/m³	Shift TWA Dust mg/m³	Shift TWA MOI mg/m³	% PEL or % TLV Dust mg/m³	% PEL or % TLV MOI mg/m³
7/9/97	BIO FACILITY BLDG #3	—	DUST MASK	DUST MONITOR														
TD-001	—	SCARAB	100%	LD-1	1400	—	—	—	—	—	—	—	.94	.94	—	—	19%	19%
7/9/97	BLDG #2 BIO FACILITY	—	" "	" "														
TD-002	—	SKIDSTEER	" "	" "	1420	—	—	—	—	—	—	—	.72	.72	—	—	14%	14%
7/9/97	BLDG #3 BIO FACILITY	—	" "	" "														
TD-003	—	SCARAB	" "	" "	1400	—	—	—	—	—	—	—	.84	.84	—	—	17%	17%
7/9/97	BIO - FACILITY BLDG #3	—	" "	" "														
TD-004	—	SCARAB	" "	" "	1400	—	—	—	—	—	—	—	1.2	1.2	—	—	24%	24%

E-3

·MC ON KNUDSEN CORPORATION
ENGINE...G, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT VI

TOTAL DUST INDUSTRIAL HYGIENE SAMPLE SUMMARY

MATERIAL OF INTEREST (MOI) IN DUST: PARTICULATE (PNOC) Page 1 of 1

IDENTIFICATION

Prepared By: R. SPURGEON.

Date Prepared: 9/8/97

SAMPLE TYPE

Personal:

Area:

Exposure Limit: OSHA PEL: DUST 10 (NON RESP.) MOI

ACGIH TLV: DUST 3 (RESPIRABLE) MOI

Location: BIO - FACILITY

Scheduled Hours Per Shift 10

Date / Sample #	Name or Area / Soc. Sec. #	Job Class / Equipment	Resp Type / % Use	Pump Type / ID #	Time On	Time Off	Samp Time (min)	Flow (lpm)	Vol (m³)	Filter Wt. Dust mg	Filter Wt. MOI mg	MOI %	Concentration Dust mg/m³	Concentration MOI mg/m³	Shift TWA Dust mg/m³	Shift TWA MOI mg/m³	% PEL or % TLV Dust mg/m³	% PEL or % TLV MOI mg/m³
9/8/97	BIO - FACILITY	AMENDMENT	DUST MASK	LDM														
PNOC - 001	—	MIXING	100%	LD-1	0830	—	1	—	—	—	—	—	.32	—	—	—	3%	—
9/8/97	BIO - FACILITY	AMENDMENT	"	"														
PNOC - 002	—	MIXING	"	"	0832	—	1	—	—	—	—	—	10.32	—	—	—	10.3%	—
9/8/97	BIO - FACILITY	AMENDMENT	"	"														
PNOC - 003	—	MIXING	"	"	0835	—	1	—	—	—	—	—	8.93	—	—	—	89%	—
9/8/97	BIO - FACILITY	AMENDMENT	"	"														
PNOC - 004	—	MIXING	"	"	1510	—	1	—	—	—	—	—	.31	—	—	—	3%	—
9/8/97	BIO - FACILITY	AMENDMENT	"	"														
PNOC - 005	—	MIXING	"	"	1513	—	1	—	—	—	—	—	.32	—	—	—	3%	—

ATTACHMENT F

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY SHEETS

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR: NH_3

IDENTIFICATION: EXPOSURE LIMIT: SAMPLE TYPE: Page 1 of 1

Prepared By: R. SPURGEON Date: 6/11/97 Basis: ACGIH TLV 25 OSHA PEL 50 Area ____

DETECTOR TUBE: Location: BUILDING #3 Personal ____

Brand: MSA Type: NH_3 2-500 ppm Survey ✓

Batch #: NE 053 Expiration Date: 5/99 Sequential ____ Scheduled Hours per Shift: ____

Pump Type: MSA KWIK-DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
0900	CHICKEN MANURE PILE	—	N/A								
NH_3 - 001	—	BUILDING #3	N/A	74	68%	29.8	10	8	8	32%	
0910	CHICKEN MANURE PILE	—	N/A								
NH_3 - 002	—	BUILDING #3	N/A	74	68%	29.8	10	16	16	64%	
0920	CHICKEN MANURE PILE	—	N/A								
NH_3 - 003	—	BUILDING #3	N/A	74	68%	29.8	10	50	50	200%	

PILE DAY 1

F-1

MOR ON KNUDSEN CORPORATION
ENGINEERS, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR: NH_3
IDENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

Prepared By: R. SPURLEON Date: 6/12/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area ____

DETECTOR TUBE:

Location: BUILDING #3

Personal ____

Brand: MSA Type: NH_3 2-500 ppm

Survey ✓

Batch #: NE 053 Expiration Date: 5/99

Sequential ____ Scheduled Hours per Shift: ____

Pump Type: MSA KWIK-DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1230	CHICKEN MANURE PILE	—	N/A								
NH_3-004	—	BLDG #3	N/A	79	60%	29.7	2	80	80	320%	
1240	SCRAPE CAB	—	N/A								
NH_3-005	—	BLDG #3	N/A	79	60%	29.7	10	8	8	32%	

PILE DAY 2

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ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR: NH_3
IDENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

Prepared By: R. SPURGEON Date: 6/27/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area

DETECTOR TUBE:

Location: BIO-FACILITY

Personal

Brand: MSA Type: NH_3 2-500ppm

Survey ✓

Batch #: NH - 053 Expiration Date: 5/99

Sequential

Scheduled Hours per Shift:

Pump Type: MSA KWIK DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1010	CHICKEN MANURE OPENING	—	FF w/ NH_3/HEPA								
NH_3 - 006	—	AMENDMENT PILE	100%	85	58%	29.92	2	120	120	480%	
1020	CHICKEN MANURE DIGGING	—	" "								
NH_3 - 007	—	AMENDMENT PILE	" "	85	58%	29.92	2	150	150	600%	
1040	1ST PILE FORMED BATCH #1	—	" "								MIX #2
NH_3 - 008	—	AMENDMENT PILE	" "	85	58%	29.92	10	1	1	4%	35%
1110	1ST PILE FORMED BATCH #2	—	" "								MIX #2
NH_3 - 009	—	AMENDMENT PILE	" "	85	58%	29.92	2	150	150	600%	85%

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MOR ON KNUDSEN CORPORATION
ENGINE. CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR: NH_3

IDENTIFICATION: EXPOSURE LIMIT: SAMPLE TYPE: Page 1 of 1

Prepared By: R. SPURGEON Date: 6/29/97 Basis: ACGIH TLV 25 OSHA PEL 50 Area ____

DETECTOR TUBE: Location: BIO FACILITY Personal ____

Brand: MSA Type: NH_3 2-50 ppm Survey ✓

Batch #: NE-053 Expiration Date: 5/99 Sequential ____ Scheduled Hours per Shift: ____

Pump Type: MSA KWIK-DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube [ ]	Corrected [ ]	%PEL & %TLV	Comments
											DAY 1
0840	CHICKEN BATCH MIX 78 15%	—	FF w/ NH_3 HEPA								AFTER TURNING
NH_3-010	—	BLDG #3	100%	81	85	29.8	10	1	1	4 ~~04~~	
0844	CHICKEN BATCH MIX 7C 18%	—	" "								AFTER TURNING
NH_3-011	—	BLDG #3	" "	81	85	29.8	10	20	20	80	
0848	CHICKEN BATCH MIX 2 35%	—	" "								NOT TURNED
NH_3-012	—	BLDG #3	" "	81	85	29.8	2	100	100	400	
0852	CHICKEN BATCH MIX 4 3%	—	" "								AFTER TURNING
NH_3-013	—	BLDG #3	" "	81	85	29.8	10	2	2	8	

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MOR ON KNUDSEN CORPORATION
ENGINE... CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: CO_2
DENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

repared By: R. SPURGEON Date: 6/30/97 Basis: ACGIH TLV ~~25~~ 5000 OSHA PEL ~~50~~ 5000

Area

ETECTOR TUBE:

Location: BIO. FACILITY

Personal

rand: MSA Type: CO_2 100 – 3000 ppm

Survey ✓

atch #: PE - 005 Expiration Date: 5/99

Sequential

Scheduled Hours per Shift:

ump Type: ~~Kwik~~ MSA - DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1035	CHICKEN MANURE PILE	—	FIE w/ NH_3 /HCN								AFTER TURNING
CO_2 - 001	—	MIX #2	100%	74	94	29.8	10	600	600	12%	
1040	CHICKEN MANURE PILE	—	" "	"	"	"					AFTER TURNING
CO_2 - 002	—	MIX #4	" "				10	400	400	8%	
1020	CHICKEN MANURE	—	" "	"	"	"					AFTER TURNING
CO_2 - 003	—	MIX 7C	" "				10	500	500	10%	
1011	CHICKE MANURE PILE	—	" "	"	"	"					AFTER TURNING
CO_2 - 004	—	MIX 7B	" "				10	400	400	8%	

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MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR: NH_3
IDENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

Prepared By: R. SPURGEON Date: 6/30/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area

DETECTOR TUBE:

Location: BIO-FACILITY

Personal

Brand: MSA Type: NH_3 2-500 ppm

Survey ✓

Batch #: NE-053 MSA Expiration Date: 5/99

Sequential

Scheduled Hours per Shift:

Pump Type: QUICK DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	Sampling Conditions: R.H.	Sampling Conditions: Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Concentration: Corrected ( )	Concentration: %PEL or %TLV	Comments
1035	CHICKEN MANURE PILE 35%	—	FF w/ NH_3/ HEPA								AFTER TURNING
NH_3 010	—	MIX 2	100%	74	94	29.8	10	50	50	200%	
1040	CHICKEN MANURE PILE 3%	—	" "	" "	" "	" "					AFTER TURNING
NH_3 011	—	MIX 4	" "				10	<2	<2	<8%	
1020	CHICKEN MANURE PILE 10%	—	" "	" "	" "	" "	10				AFTER TURNING
NH_3 012	—	MIX 7C	" "				10	4	4	16%	
1011	CHICKEN MANURE PILE 15%	—	" "	" "	" "	" "					AFTER TURNING
NH_3 013	—	MIX 7B	" "				10	15	15	60%	

MORGAN KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR: NH_3
IDENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

Prepared By: R. SPURGEON Date: 6/30/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area

DETECTOR TUBE:

Location:

Personal

Brand: ~~MAS~~ MSA Type: NH_3 2-500ppm

Survey ✓

Batch #: NE-053 Expiration Date: 5/99

Sequential

Scheduled Hours per Shift:

Pump Type: KWIK DRAW MSA Serial #: 7228

Time	Name or Area	Job Class	Resp Type	Sampling Conditions			Pump Strokes	Concentration			Comments
Sample #	Soc. Sec. #	Location	% Use	Temperature	R.H.	Atm. Pres.		Tube ( )	Corrected ( )	%PEL or %TLV	
0920	TURKEY MANURE PILE 25%	—	FF w/ NH_3/HEPA								AFTER TURNING
NH_3-014	—	MIX #3	~~FF w/ NH_3/HEPA~~ 100%	74	94	29.80	10	4	4	16	
0942	TURKEY MANURE PILE 25%	—	" "	" "	" "	" "					AFTER TURNING
NH_3-015	—	MIX #5	" "				10	4	4	16	
0955	TURKEY MANURE PILE 25%	—	" "	" "	" "	" "					AFTER TURNING
NH_3-016	—	MIX #2	" "				10	4	4	16	

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR IDENTIFICATION: NH_3

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 2

Prepared By: R. SPURGEON Date: 7/1/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area ____

DETECTOR TUBE:

Location: BIO FACILITY

Personal ____

Brand: MSA Type: NH_3 2-500ppm

Survey ✓

Batch #: NE-053 MSA Expiration Date: 5/99

Sequential ____ Scheduled Hours per Shift: ____

Pump Type: KWIK-DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1007	CHICKEN PILE 35%	→	FF w/ NH_3/HEPA								AFTER TURNING
NH_3-017	—	MIX #2	" "	79	74	29.8	10	25	25	100%	
1011	CHICKEN PILE 3%	→	" "	"	"	"					AFTER TURNING
NH_3-018	—	MIX #4	" "				10	2	2	8%	
1015	CHICKEN PILE 15%	—	" "	"	"	"					AFTER TURNING
NH_3-019	—	MIX #7B	" "				10	15	15	60%	
1021	CHICKEN PILE 10%	—	" "	"	"	"					AFTER TURNING
NH_3-020	—	MIX #7C	" "				10	2	2	8%	

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ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: NH_3
ENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 2 of 2

epared By: R. SPURGEON Date: 7/1/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area

ETECTOR TUBE:

Location: BIO - FACILITY

Personal

and: MSA Type: NH_3 2-500 ppm

Survey ✓

atch #: NE-053 MSA Expiration Date: 5/99

Sequential

Scheduled Hours per Shift:

mp Type: KWIK-DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube [ ]	Corrected [ ]	%PEL or %TLV	Comments
1025	TURKEY PILE 15%	—	FF W/ NH_3/HEPA								AFTER TURNING
NH_3-021	—	MIX #3	100%	79	74	29.8	10	12	12	48%	
1027	TURKEY PILE 15%	—	" "	"	"	"					AFTER TURNING
NH_3-022	—	MIX #5	" "				10	8	8	32%	
1030	TURKEY PILE 15%	—	" "	"	"	"					AFTER TURNING
NH_3-023	—	MIX #6	" "				10	4	4	16%	

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ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: CO_2 / NO_2 / H_2S / HCHO
DENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

repared By: R. SPURGEON Date: 7/1/97 Basis: ACGIH TLV___ OSHA PEL ↓ Area___

HCHO .75 ppm
CO_2 - 5000 ppm

ETECTOR TUBE:

Location: 810 FACILITY

Personal___

NO_2 - 5 ppm
H_2S - 20 ppm

Survey ✓

CO_2 100 - 3000 ppm
NO_2 .5 - 50 ppm
H_2S 1 - 200 ppm
HCHO .1 - 10 ppm

rand: MSA Type:

CO_2 - PE015
NO_2 - PR052
H_2S - WE047
HCHO - OE007

atch #: Expiration Date: 5/99

Sequential___ Scheduled Hours per Shift: ___

ump Type: MSA KWIK Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1007	CHICKEN PILE 35%	—	FF w/ NH_3 / HCHO								AFTER
CO_2 - 005	—	MIX #2	100%	79	74	29.80	10	300	300	< 6%	TURNING
1007	CHICKEN PILE 35%	—	"	"	"	"				< 10%	AFTER
NO_2 - 001	—	MIX #2	"				5	< .5	< .5	~~< 5%~~	TURNING
1007	CHICKEN PILE 35%	—	"	"	"	"					AFTER
~~NO~~ H_2S - 001	—	MIX #2	"				10	< 1	< 1	< 5%	TURNING
1007	CHICKEN PILE 35%	—	"	"	"	"					AFTER
HCHO - 001	—	MIX #2	"				20	< .1	< .1	< 13%	TURNING

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR: NH_3

IDENTIFICATION: EXPOSURE LIMIT: SAMPLE TYPE: Page 1 of 2

Prepared By: R. SPURGEON Date: 7/4/97 Basis: ACGIH TLV 25 OSHA PEL 50 Area ____

DETECTOR TUBE: Location: BIO-FACILITY Personal ____

Brand: MSA Type: NH_3 2-500 Survey ✓

Batch #: NE-053 MSA Expiration Date: 5/99 Sequential ____ Scheduled Hours per Shift: ____

Pump Type: KWIK-O-LAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1015	TURKEY PILE #3	—	DUST MASK								AFTER TURNING
NH_3 - 017	—	BLDG #2	100%	68	55	29.80	10	3	3	12%	
1020	TURKEY PILE #5	—	" "								" "
NH_3 - 018	—	BLDG #2	" "	68	55	29.80	10	2	2	8%	
1030	TURKY PILE #6	—	" "								" "
NH_3 - 019	—	BLDG #2	" "	68	55	29.80	10	1	1	4%	
1255	CHICKEN PILE #7	—	" "								" "
NH_3 - 020	—	BLDG #3	" "	72	55	29.80	2	20	20	80%	

MORGAN KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR IDENTIFICATION: NH_3

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 2 of 2

Prepared By: R. SPURGEON Date: 7/4/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area ____

DETECTOR TUBE:

Location: B10-FACILITY

Personal ____

Brand: MSA Type: NH_3 2-500ppm

Survey ✓

Batch #: NE-053 Expiration Date: 5/99

Sequential ____ Scheduled Hours per Shift: ____

Pump Type: MSA QUIK-DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1315	CHICKEN PICE #4	—	DUST MASK								AFTER TURNING
NH_3-021	—	BLOG #3	100%	72	55	29.80	10	<2	<2	0	
1322	CHICKEN PICE #7B	—	" "								
NH_3-022	—	BLOG #3	" "	72	55	29.80	10	2	2	8%	
1330	CHICKEN PICE #7C	—	" "								
NH_3-023	—	BLOG #3	" "	72	55	29.80	10	5	5	20%	

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR: NH_3
IDENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

Prepared By: R. SPURGEON Date: 7/9/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area

DETECTOR TUBE:

Location: BIO FACILITY

Personal

Brand: MSA Type: NH_3 2-500 ppm

Survey ✓

Batch #: WE-047 Expiration Date: 4/99

Sequential

Scheduled Hours per Shift:

Pump Type: MSA KWIK DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1400	MIX #4 CHICKEN MANURE	—	DUST MASKS								AFTER
NH_3-024	—	BLDG #3	100%	84	66%	29.90	10	8	8	16%	TURNING
1407	MIX #2 CHICKEN MANURE	—	" "								AFTER
NH_3-025	—	BLDG #3	" "	84	66%	29.90	10	40	40	80%	TURNING

* ↑ IN NH_3 IS DUE TO PILES BECOMING INACTIVE (NOT TURNED ENOUGH INSUFFICIENT O_2

PILE TURNING INCREASED FROM ONCE PER DAY TO 4 X PER DAY.

MORRISON KNUDSEN CORPORATION
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ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: VARIOUS (SEE BELOW)

IDENTIFICATION: EXPOSURE LIMIT: SAMPLE TYPE: Page 1 of 3

Prepared By: R. SPURLEON Date: 7/10/97 Basis: ACGIH TLV___ OSHA PEL___ Area___

DETECTOR TUBE: Location: BIO - FACILITY Personal___

Brand: MSA Type: C_6H_6 → 1-25 ppm Survey ✓

Batch #: * Expiration Date: 5/99 Sequential___ Scheduled Hours per Shift: ___

Pump Type: MSA KWIK-DRAW Serial #: 7228

NH3 → 2-500 ppm
ACETON → 100 ppm
CO_2 → 100-3000 ppm
ALCOHOL/METHANOL/PROPANOL → 25-5000 ppm
NO_2 → .5-50 ppm
H_2S → 1-200 ppm
CO → 5-1000 ppm
NITROAROMATICS → .5-50 ppm
TOLUENE → 5-1000 ppm
PETROLEUM DIST → 1-14 mg/L
FORMALDEHYDE → .1-10 ppm
DICHLORMETHANE → 50-1000
VC 1-70 ppm

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1000	BIO FACILITY MIX #4	—	DUST MASK								
VC-1	—	BLDG #3	100%	64.2	86%	30.01	10	ND	ND	N/A	
1000	" "	—	" "	" "	" "	" "					
NITRO-1	—	" "	" "				5	ND	ND	N/A	
1000	" "	—	" "	" "	" "	" "					
TOL-1	—	" "	" "				5	ND	ND	N/A	
1000	" "	—	" "	" "	" "	" "					
ACETONE-1	—	" "	" "				10	ND	ND	N/A	
1000	" "	" "	" "	" "	" "	" "					
METHANOL-1							10	ND	ND	N/A	

CO_2 → PE 015 5/99
CO → XA 072 5/99
NH_3 → WE 047 4/99
NITROS → PE-044 5/99
H_2S → WE-067 5/99
TOL → XF-137 5/98
VC → YF 025 5/98
NO_2 → PE 052 5/99
BENZENE → VF 002 5/98

MORGAN KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR: VARIOUS
IDENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 2 of 3

Prepared By: R. SPURLEON Date: 7/10/97 Basis: ACGIH TLV___ OSHA PEL___

Area___

DETECTOR TUBE:

Location: BIO-FACILITY

Personal___

Brand: MSA Type: SEE BELOW

Survey ✓

Batch #:___ Expiration Date: 5/99

Sequential___ Scheduled Hours per Shift: ___

Pump Type: MSA KWIK DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube [ ]	Corrected [ ]	%PEL or %TLV	Comments
1000	BIO-FACILITY MIX #4	—	DUST MASK								
CO_2-1	—	BLDG #3	100%	64.2	86%	30.01	10	600	600	12%	
1000	BIO FACILITY MIX #4	—	" "	" "	" "	" "					
NH_3-1	—	BLDG #3	" "				10	25	25	100%	
1000	BIO FACILITY MIX #4	—	" "	" "	" "	" "					
PET. DIST.-1	—	BLDG #3	" "				1	ND	ND	N/A	
1000	BIO-FACILITY MIX #4	—	" "	" "	" "	" "					
FORMALDEHYDE-1	—	BLDG #3	" "				10	ND	ND	N/A	
1000 ALCOHOL-1	BIO FACILITY MIX #4	BLDG #3	" "	" "	" "	" "	10	ND	ND	N/A	

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ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: VARIOUS
DENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

repared By: R. SPURGEON Date: 7/10/97 Basis: ACGIH TLV___ OSHA PEL___

Area___

ETECTOR TUBE:

Location: BIO - FACILITY

Personal___

rand: MSA Type: SEE BELOW

Survey ✓

atch #: MSA Expiration Date: 5/99

Sequential___ Scheduled Hours per Shift: ___

ump Type: KWIK DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube [ ]	Corrected [ ]	%PEL or %TLV	Comments
1000	BIO - FACILITY MIX #4	—	DUST MASK								
NO_2 - 1	—	BLDG #3	100%	64.2	86%	30.01	5	ND	ND	N/A	
1000	BIO FACILITY MIX #4	—	" "	" "	" "	" "					
H_2S - 1	—	BLDG #3	" "				10	ND	ND	N/A	
1000	BIO - FACILITY MIX #4	—	" "	" "	" "	" "					
C_6H_6 - 1	—	BLDG #3	" "				15	ND	ND	N/A	
1000	BIO - FACILITY MIX #4	—	" "	" "	" "	" "					
DICHLOROMETHANE	—	BLDG #3	" "				10	ND	ND	N/A	
1000 CO - 1	BIO FACILITY MIX #4	BLDG #3	" "	" "	" "	" "	10	ND	ND	N/A	

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MORRISON KNUDSEN CORPORATION
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ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR: NH_3

IDENTIFICATION: EXPOSURE LIMIT: SAMPLE TYPE: Page 1 of 1

Prepared By: R. SPURGEON Date: 9/8/97 Basis: ACGIH TLV 25 OSHA PEL 50 Area

DETECTOR TUBE: Location: BIO. FACILITY Personal

Brand: MSA Type: NH_3 2-500 ppm Survey ✓

Batch #: NE-053 Expiration Date: 7/99 Sequential Scheduled Hours per Shift:

Pump Type: MSA EWIK DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	B.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
0815	CHICKEN MANURE AMENDMENT PILE	—	F.F. APR W/ MSA NH_3								
NH_3-026	—	BIO FACILITY	100%	73	74%	31.48	2	75	71	14% ~~1.4%~~	AFTER UNCOVERING
0826	CHICKEN MANURE AMENDMENT PILE	—	" "								
NH_3-027	—	BIO-FACILITY	" "	73	74%	31.48	10	2	2	4%	10 MIN AFTER UNCOVERING
0830	CHICKEN MANURE AMENDMENT PILE	—	" "								
NH_3-028 ~~030~~	—	BIO-FACILITY	" "	73	74%	31.48	2	150	143	286%	DURING DIGGING
0831	CHICKEN MANURE AMENDMENT PILE	—	" "								
NH_3-029 ~~031~~	—	BIO-FACILITY	" "	73	74%	31.48	10	18	17	34%	≈ 15' FROM DIGGING DOWNWIND

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR IDENTIFICATION: NH_3

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

Prepared By: R. SPURGEON Date: 9/8/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area ____

DETECTOR TUBE:

Location: BIO - FACILITY

Personal ____

Brand: MSA Type: NH_3 ~~0-20~~ 2-500 ppm

Survey ✓

Batch #: NE-053 MSA Expiration Date: 7/99

Sequential ____ Scheduled Hours per Shift: ____

Pump Type: QUICK DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1332	BIO - FACILITY	—	FF APR w/ HCl/NH_3								DAY "0" PRIOR TO
NH_3-030	—	MIX #4	100%	87	46	31.48	10	<2	<2	N/A	SOIL ADDI
1335	BIO-FACILITY	—	"								DAY "0" PRIOR TO
NH_3-031	—	MIX #8	"	87	46	31.48	2	75	71	142%	SOIL APPLIC
1337	—	—	"								DAY "0" PRIOR TO
NH_3-032	BIO-FACILITY	MIX 7A	"	87	46	31.48	10	<2	<2	N/A	SOIL ADDI

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ENGINE... CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: ACETIC ACID
ENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

epared By: R. SPURGEON Date: 9/8/77 Basis: ACGIH TLV ~~25~~ 10 OSHA PEL ~~50~~ 10 Area

ETECTOR TUBE:

Location: BIO-FACILITY

Personal

and: ~~MSA~~ DRAGER Type: ~~NH3 2-500 ppm~~ ACETIC ACID 5-80 ppm

Survey ✓

tch #: ~~NE-0534~~ CF-0181 Expiration Date: ~~7/99~~ 8/99

Sequential

Scheduled Hours per Shift:

mp Type: ~~KWIK-DRAW~~ ~~MSA~~ DRAGER Serial #: ~~7228~~ ARET - F015

Time	Name or Area	Job Class	Resp Type	Sampling Conditions			Pump Strokes	Concentration			Comments
Sample #	Soc. Sec. #	Location	% Use	Temperature	R.H.	Atm. Pres.		Tube	Corrected	%PEL or %TLV	
0827	POTATO WASTE AMENDMENT PILE	—	F-F APR W/ HEPA/NH3								AFTER UNCOVERING
CETIC ACID-001	—	BIO-FACILITY	100%	73	74%	31.48	5	<5	<5	N/A	
0828	POTATO WASTE AMENDMENT PILE	—	" "								DURING FILLING
CETIC ACID-002	—	BIO-FACILITY	" "	73	74%	31.48	5	5	5	50%	

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MORTON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: NH_3
ENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 2

epared By: R. SPURGEON Date: 9/9/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area

ETECTOR TUBE:

Location: BIO FACILITY

Personal

and: MSA Type: 2-500 ppm

Survey ✓

atch #: NE-053 Expiration Date: 7/99

Sequential

Scheduled Hours per Shift:

ump Type: MSA KWIK DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube	Corrected	%PEL or %TLV	Comments
0740	BIO-FACILITY	—	FF APR ITEM/NH3								
NH_3-033	—	MIX 7A	100	71	89%	31.33	10	<2	<2	N/A	
1040	BIO-FACILITY	—	" "								
NH_3-034	—	MIX 8	" "	71	89	31.33	10	<2	<2	N/A	
1315	BIO-FACILITY	—	" "								
NH_3-035	—	MIX #4	" "	71	89	31.33	10	<2	<2	N/A	
1320	BIO-FACILITY	—	" "								
NH_3-036	—	MIX	" "	71	89	31.33	2	90	86	172%	

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ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: NH_3
ENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 2 of 2

epared By: R. SPURGEON Date: 9/9/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area

ETECTOR TUBE:

Location: BIO-FACILITY

Personal

and: MSA Type: 2 - 500 ppm

Survey ✓

itch #: NE-053 Expiration Date: 7/99

Sequential

Scheduled Hours per Shift:

mp Type: MSA KWIKDRAW Serial #: 7228

Time	Name or Area	Job Class	Resp Type	Sampling Conditions			Pump Strokes	Concentration			Comments
Sample #	Soc. Sec. #	Location	% Use	Temperature	R.H.	Atm. Pres.		Tube ( )	Corrected ( )	%PEL or %TLV	
~~NH_3 0~~ 1325	BIO-FACILITY	—	FF APR HEPA/NH3		89	31.33					
NH_3 -037	—	TURKEY MANURE PICK	100	71	~~31.33~~	~~8~~	2	70	67	134%	
1324	BIO-FACILITY		" "								
NH_3 - 038	—	TURKEY MANURE WHILE DIGGING	" "	71	89	31.33	2	140	134	268%	

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ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: NH_3
ENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

epared By: R. SPURGEON Date: 9/10/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area

ETECTOR TUBE:

Location: BIO - FACILITY

Personal

and: MSA Type: 2 - 500 ppm

Survey ✓

atch #: NE-053 Expiration Date: 7/99

Sequential

Scheduled Hours per Shift:

ump Type: MSA KWIK DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Correction ( )	%PEL or %TLV	Comments
1020	BIO - FACILITY	~~CHICKEN TOKETIN~~	DUST MASK								AFTER TURNING
NH_3 - 039	—	MANURE #4	100%	71	63	31.39	10	<2	<2	N/A	
1022	BIO - FACILITY	—	DUST MASK	"	"	"					AFTER TURNING
NH_3 - ~~038~~ 040	—	PILE 7A	100%				10	2	2	N/A	
1025	BIO - FACILITY	—	"	"	"	"					AFTER TURNING
NH_3 - ~~039~~ 041	—	PILE #8	"				10	<2	<2	N/A	
1040	BIO - FACILITY	—	"	"	"	"					AFTER MAKING
NH_3 - ~~040~~ 042	—	7B	"				2	70	67	134%	

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MOR ON KNUDSEN CORPORATION
ENGINE... CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: NH_3
ENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

epared By: R. SPURGEON Date: 9/11/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area

ETECTOR TUBE:

Location: BIO - FACILITY

Personal

and: MSA Type: 2 - 500ppM

Survey ✓

atch #: NE - 053 Expiration Date: 7/99

Sequential

Scheduled Hours per Shift:

mp Type: KWIK DRAW (MSA) Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1515 NH_3 - 054A	BIO-FACILITY	—	FF APR (HEPA/NH_3)								AFTER TURNING
NH_3 - 054	—	PILE #5	100%	24.5°C	37	31.51	10	12	11	22%	
1517	BIO-FACILITY	—	"	"	"	"	10				"
NH_3 - 055	—	PILE 7A	"				2	37	35	70%	
1521	BIO-FACILITY	—	"	"	"	"					"
NH_3 - 056	—	PILE #3	"				10	<2	<2	N/A	

SAMPLE # 43 - 53 SKIPPED.

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MORGAN KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

GAS/VAPOR: NH_3
IDENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

Prepared By: R. SPURGEON Date: 9/15/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area ____

DETECTOR TUBE:

Location: BIO-FACILITY

Personal ____

Brand: MSA Type: 2-500 ppm

Survey ✓

Batch #: NE-053 Expiration Date: 7/99

Sequential ____

Scheduled Hours per Shift: ____

Pump Type: MSA KWIK DRAW Serial #: 722B

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1315	BLDG #2	—	FF APR w/HEPA/NH_3								AFTER
NH_3-060	—	PILE #3	100%	87	37%	29.35	10	30	31	62%	TURNING
1317	BLDG #3	—	DUST MASK								"
NH_3-061	—	PILE #4	100%	87	37%	29.35	10	<2	<2	N/A	
1321	BLDG #3	—	"								"
NH_3-062	—	PILE #7A	"	87	37%	29.35	10	<2	<2	N/A	
1327	BLDG #3	—	"								"
NH_3-063	—	PILE #8	"	87	37%	29.35	10	<2	<2	N/A	

SAMPLE # NH_3-057 → NH_3-059 SKIPPED.

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ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: NH_3
ENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

epared By: R. SPURGEON Date: 9/16/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area

ETECTOR TUBE:

Location: BIO - FACILITY

Personal

and: MSA Type: 2 - 500 ppm

Survey ✓

tch #: NE-053 Expiration Date: 7/99

Sequential

Scheduled Hours per Shift:

mp Type: MSA KWIK DRAW Serial #: 7228

Time	Name of Area	Job Class	Resp Type	Sampling Conditions			Pump Strokes	Concentration			Comments
Sample #	Soc. Sec. #	Location	% Use	Temperature	R.H.	Atm. Pres.		Tube ( )	Corrected ( )	%PEL or %TLV	
1032	BLDG #2	—	FE APR w/ NH_3 / ASMA								AFTER TURNING & WATER ADDITI
NH_3-064	—	MIX #7B	100%	88	40%	29.52	10	42	43	86%	
1037	BLDG #2	—	"								AFTER TURNING & WATER ADDITI
NH_3-065	—	MIX #3	"	88	40%	29.52	10	70	71	142%	

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MOR ON KNUDSEN CORPORATION
ENGINE... CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: ACETIC ACID
ENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE: Page 1 of 1

epared By: R. SPURGEON Date: 9/17/97 Basis: ACGIH TLV 10 OSHA PEL 10

Area

TECTOR TUBE:

Location: BIO - FACILITY

Personal

and: DRAGER Type: ACETIC ACID 5-80ppm

Survey ✓

tch #: LF-0181 Expiration Date: 8/99

Sequential

Scheduled Hours per Shift:

mp Type: DRAGER Serial #: ARFJ-F015

Time	Name or Area	Job Class	Resp Type	Sampling Conditions			Pump Strokes	Concentration			Comments
Sample #	Soc. Sec. #	Location	% Use	Temperature	R.H.	Atm. Pres.		Tube ( )	Corrected ( )	%PEL or %TLV	
1240	BLDG #2	—	FFAPR w/ HEPA/NH3								AFTER
ETIC ACID-003	—	MIX #5	100%	75	46%	29.18	5	5	5	50%	TURNING
1245	BLDG #2	—	"	"	"	"					"
ETIC ACID-004	—	MIX #3	"				5	<5	<5	N/A	

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MOR ON KNUDSEN CORPORATION
ENGINE... CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: NH3
ENTIFICATION:

EXPOSURE LIMIT:

SAMPLE TYPE:

Page 1 of 1

epared By: R. SPURGEON Date: 9/17/97 Basis: ACGIH TLV 25 OSHA PEL 50

Area

ETECTOR TUBE:

Location: 610 - FACILITY

Personal

and: MSA Type: 2-500ppm

Survey ✓

atch #: NE-053 MSA Expiration Date: 7/99

Sequential

Scheduled Hours per Shift:

mp Type: KWIK DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1232	BLDG #2	—	FE APR/MEP								AFTER TURNING
NH3-066	—	MIX #3	100%	75	46	29.18	2	90	92	184%	
1234	BLDG #2	—	"	"	"	"					"
NH3-067	—	MIX #78	"				10	18	18	36%	
1237	BLDG #2	—	"	"	"	"					"
NH3-068	—	MIX #5	"				10	<2	<2	N/A	

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MOR ON KNUDSEN CORPORATION
ENGINL. CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: NH_3
ENTIFICATION: EXPOSURE LIMIT: SAMPLE TYPE: Page 1 of 1

epared By: R. SPURGEON Date: 9/18/97 Basis: ACGIH TLV 25 OSHA PEL 50 Area -

TECTOR TUBE: Location: BIO - FACILITY Personal ____

and: MSA Type: 2-500 ppm Survey ✓

tch #: NE 053 Expiration Date: 7/99 Sequential ____ Scheduled Hours per Shift: ____

mp Type: MSA KWIK DRAW Serial #: 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
1503	BLDG #2	—	FF APR w/HEPA/NH3								AFTER TUNNEL
NH_3-069	—	MIX 78	100%	86	29%	29.52	10	12	12	24%	
~~1508~~ 1513	BLDG #2	—	"	"	"	"					
NH_3-070	—	MIX 3	"				10	60	61	122%	

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MORGAN KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT X

DETECTOR TUBE INDUSTRIAL HYGIENE SAMPLE SUMMARY

AS/VAPOR: NH_3

IDENTIFICATION: EXPOSURE LIMIT: SAMPLE TYPE: Page 1 of 1

Prepared By: R. SPURGEON Date: 9/17/97 Basis: ACGIH TLV 25 OSHA PEL 50 Area ____

DETECTOR TUBE: Location: BIO-FACILITY Personal ____

Brand: MSA Type: 2-500 ppm Survey ✓

Batch #: NE-053 Expiration Date: 7/99 Sequential ____ Scheduled Hours per Shift: ____

Pump Type: MSA KWIK DRAW Serial #: ~~224~~ 7228

Time / Sample #	Name or Area / Soc. Sec. #	Job Class / Location	Resp Type / % Use	Sampling Conditions: Temperature	R.H.	Atm. Pres.	Pump Strokes	Concentration: Tube ( )	Corrected ( )	%PEL or %TLV	Comments
0940	BLDG #2	—	FF A/R w/ HEPA/NH_3								AFTER TURNING
NH_3-071	—	MIX #3	.01%	83	51	29.21	10	22	23	46%	
0942	BLDG #2	—	"		"						AFTER TURNING
NH_3-072	—	MIX #7B	"				10	12	12	24%	

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ATTACHMENT G

GAS/VAPOR/FUME/MIST INDUSTRIAL HYGIENE SAMPLE SUMMARY SHEETS

MORRISON KNUDSEN CORPORATION

GAS/VAPOR/FUME/MIST INDUSTRIAL HYGIENE SAMPLE SUMMARY

FILTER DEVICE

Brand: INDUSTRIAL SCIENTIFIC Type: JMX - 412 Batch # SEE $O_2/H_2S/CO/LEL$ Expiration Date: 5/7/98

IDENTIFICATION

Prepared by: R. SPURGEON

Date Prepared: 7/9/97

SAMPLE INFE

Personal: _____ Location: _____

Area: ✓ Scheduled Hours Per Shift:-

DATE / SAMPLE #	NAME OR AREA / SOC. SEC. #	JOB CLASS / LOCATION	RESP TYPE / % USE	PUMP TYPE / PID #	SAMPLE TIME ON	SAMPLE TIME OFF	SAMPLE TIME (MIN)	FLOW (lpm)	VOL (m.)	LAB RESULTS	CONCENTRATION $O_2/H_2S/CO/LEL$		SHIFT TWA	EXPOSURE LIMIT PEL/TLV	% PEL or % TLV	MOI
7/9/97	BIO FACILITY BLDG #3	—	DUST MASK	JMX 412	1400						20.8/0/0/0					
MG-001	—	MIX #2	100%	185	—	—	—	—	—	—			—	—	—	—
7/9/97	BIO FACILITY BLDG #3	—	" "	" "												
MG-002	—	MIX #4	" "	" "	1400	—	—	—	—	—	20.8/0/0/0		—	—	—	—
7/9/97	BIO FACILITY BLDG #3	—	" "	" "												
MG-003	—	MIX 7D	" "	" "	1400	—	—	—	—	—	20.8/0/0/0		—	—	—	—
7/9/97	BIO FACILITY BLDG #3	—	" "	" "									—			
MG-004	—	MIX 7C	" "	" "	1400	—	—	—	—	—	20.8/0/0/0			—	—	—

MORRISON KNUDSEN CORPORATION

GAS/VAPOR/FUME/MIST INDUSTRIAL HYGIENE SAMPLE SUMMARY

FILTER DEVICE

Brand: MICROTIP Type: MP-1000 (PID) Batch # N/A Expiration Date: 5/9/98

IDENTIFICATION

Prepared by: R. SPURGEON

Date Prepared: 7/9/97

SAMPLE TYPE

Personal: _____ Location: BIO FACILITY

Area: ✓ Scheduled Hours Per Shift:-

DATE / SAMPLE #	NAME OR AREA / SOC. SEC. #	JOB CLASS / LOCATION	RESP TYPE / % USE	PUMP TYPE / ID #	TIME ON	TIME OFF	SAMP TIME (MIN)	FLOW (lpm)	VOL (m)	LAB RESULTS	CONCENTRATION		8 HR SHIFT TWA	EXPOSURE LIMIT PEL/TLV	% PEL or TLV	MONITOR
7/9/97	BIO FACILITY BLDG #3	—	DUST MASK	PID	1400											
PID-001	—	MIX #4	100%	20%	—	—	-	-	-	-		10.8 ppm	—	N/A	N/A	VOC
7/9/97	BIO-FACILITY BLDG #3	—	" "	" "												
PID-002	—	MIX #2	" "	" "	1400	—	—	—	—	—		13 ppm	—	N/A	N/A	VOC
7/9/97	BIO-FACILITY BLDG #3	—	" "	" "												
PID-003	—	MIX 7B	" "	" "	1407	—	—	—	—	—		14 ppm	—	N/A	N/A	VOC
7/9/97	BIO-FACILITY BLDG #3	—	" "	" "												
PID-004	—	MIX 7C	" "	" "	1407	—	—	—	—	—		13 ppm	—	N/A	N/A	VOC

(2)

ATTACHMENT H

HEAT STRESS INDUSTRIAL HYGIENE SAMPLE SUMMARY SHEETS

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION
& ENVIRONMENTAL GROUP

ATTACHMENT XI

HEAT STRESS INDUSTRIAL HYGIENE SAMPLE SUMMARY

ocation: 810 FACILITY EXCAV.
nstrument Type: THERMO SCAN
attery Check: Y ✓ N ____

Prepared by: R. SPURGEON

Page 1 of 1

PPE: DEDICATED / TYVEK / INNER & OUTER NITRILE / 1/2 MASK RESP. / GOGGLES

Date	Name	Location/Job	Baseline		Sample #1		Sample #2		Sample #3		Sample #4		Apparent Temp	Work/Rest Cycle	
			Resting Pulse	Resting Temp	Working Pulse	Working Temp	Working Pulse	Working Temp	Working Pulse	Working Temp	Working Pulse	Working Temp			
2/26/97	K. PHILLIPS	CLUMP PILE LABORER	86	98.7	20	99.7	88	98.7	—	—	—	—	105	45/15	
2/26/97	R. DAYHOFF	" "	88	98.7	20	99.7	104	99.0	120	98.7	104	99.8			
2/26/97	C. KIX-MILLER	TRUCK OPER	92	98.2	84	97.7	—	—	—	—	—	—			(1)
2/26/97	J. DAYHOFF	DECON	92	98.5	96	97.7	—	—	—	—	—	—			(2)
2/26/97	C. BITTMAN	966 OPER	88	97.7	92	97.6	100	97.7	—	—	—	—			
2/26/97	J. HAGAN	BACKHOE OPER	92	97.2	112	97.4	—	—	—	—	—	—			

(1) PPE: DEDICATED ONLY

(2) PPE: DEDICATED / RAINSUIT / FACESHIELD / INNER NITRILE / OUTER HEAVY NITRILE

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION & ENVIRONMENTAL GROUP

ATTACHMENT XI

HEAT STRESS INDUSTRIAL HYGIENE SAMPLE SUMMARY

Location: 310 FACILITY Prepared by: A. SPURGEON Page 1 of 1

Apparent Temperature: 85°F Weather Conditions: SUNNY LIGHT BREEZE

Date	Name	Location/Job	Baseline		Sample #1		Sample #2		Sample #3		PPE	Work/Rest Cycle
			Resting Pulse	Resting Temp	Working Pulse	Working Temp	Working Pulse	Working Temp	Working Pulse	Working Temp		
6/27	J. KIRMILLER	TRUCK OPER	84	98.2	68	98.2					DEDICATED	45/15
—	D. NORRIS	—	64	97.3	—	—					—	—
6/27	K. PHILLIPS	LUMP PILE LABORER	86	98.7	80	98.3					DEDICATED	45/15
6/27	L. BITTNAR	966 OPER	88	97.7	92	98.3					DEDICATED	45/15
6/27	R. DAVIDOFF	TRACTOR OPER	88	98.7	80	97.9					DEDICATED	45/15
—	S. [illegible]	—	80	97.1	—	—					—	—
—	J. DAVIDOFF	—	72	98.5	—	—					—	—
—	J. HALAN	—	92	97.2	—	—					—	—
—	J. PAUAL	—	70	97.3	—	—					—	—
—	R. [illegible]	—	56	97.5	—	—					—	—
—	M. [illegible]	—	68	97.3	—	—					—	—

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION & ENVIRONMENTAL GROUP

ATTACHMENT XI

HEAT STRESS INDUSTRIAL HYGIENE SAMPLE SUMMARY

Location: BIO - FACILITY

Prepared by: R. S PURGEON

Page 1 of 1

Apparent Temperature: 82

Weather Conditions: SUNNY HOT →

Date	Name	Location/Job	Baseline		Sample #1		Sample #2		Sample #3		PPE	Work/Rest Cycle
			Resting Pulse	Resting Temp	Working Pulse	Working Temp	Working Pulse	Working Temp	Working Pulse	Working Temp		
7/2	C. KIXMILLER	ASSIST SAMPLING PILE	84	98.2	PUT ON 146	BREAK —	DURING 108	BREAK 98.8	AFTER 88	BREAK 98.3	DEDICATED/TYVEK/DUST MASK INNER & OUTER GLOVES	30/30
7/2	D. NORRIS	SAMPLING PILE	64	97.3	PUT ON 136	BREAK —	AFTER 88	BREAK —			" "	30/30
—	K. PHILLIPS	—	86	98.7	—	—	—	—	—	—	—	—
—	G. BITTMAN	—	88	97.7	—	—	—	—	—	—	—	—
7/2	R. DAYHOFF	MISC LABOR	88	98.7	88	98.3	—	—	—	—	DEDICATED ONLY	45/15
7/2	S. GORY	OVERSITE	80	97.1	100	98.1	—	—	—	—	DEDICATED/TYVEK/DUST MASK INNER & OUTER GLOVES	30/30
7/2	J. DAYHOFF	ASSIST SAMPLING PILE	72	98.5	PUT ON 108	BREAK 98.3	DURING 100	BREAK —	AFTER 86	BREAK —	" "	30/30
—	J. HALAM	—	92	97.2	—	—	—	—	—	—	—	—
—	T. DOGAL	—	76	97.3	—	—	—	—	—	—	—	—
—	P. CHEVALIER	—	56	97.5	—	—	—	—	—	—	—	—
7/2	M. COCHRAN	SAMPLING PILE	68	97.3	PUT ON 152	BREAK —	DURING 88	BREAK 98.9	AFTER 88	BREAK 98.3	" "	30/30

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ATTACHMENT I

SOUND LEVEL SURVEY AND DOSIMETRY INDUSTRIAL HYGIENE SAMPLE SHEETS

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT I
PAGE 1 OF 2
SOUND LEVEL SURVEY

Location: BUILDING #3 Date: 6/10/97

Prepared By: R. SPURGEON

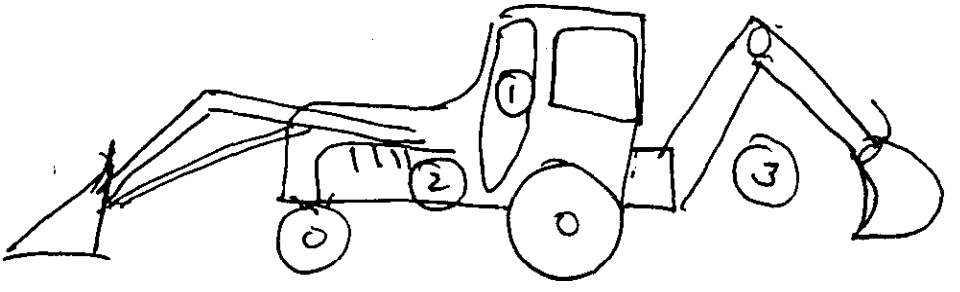
Sound Level Mater: MK-2 Serial #: 20129

Calibrator: AC-1 Serial #: 04437

Calibration: Initiall 94.3/114.3/123.7 final 94.3/114.3/123.7

Test No.	Description Location/Equipment	Distance	dB(A)	Healing Protection Required Y	N	Comments
1	BACKHOE INSIDE	CAB	80.4		✓	
2	BACKHOE OUTSIDE	6'	94.5	✓		
3	BACKHOE OUTSIDE	6'	97.2	✓		

Drawing of equipment or work layout
Reference Numbers refer to the Test Number above



MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT I
PAGE 1 OF 2
SOUND LEVEL SURVEY

Location: BUILDING #2 Date: 6 10 97

Prepared By: . S PURGEON

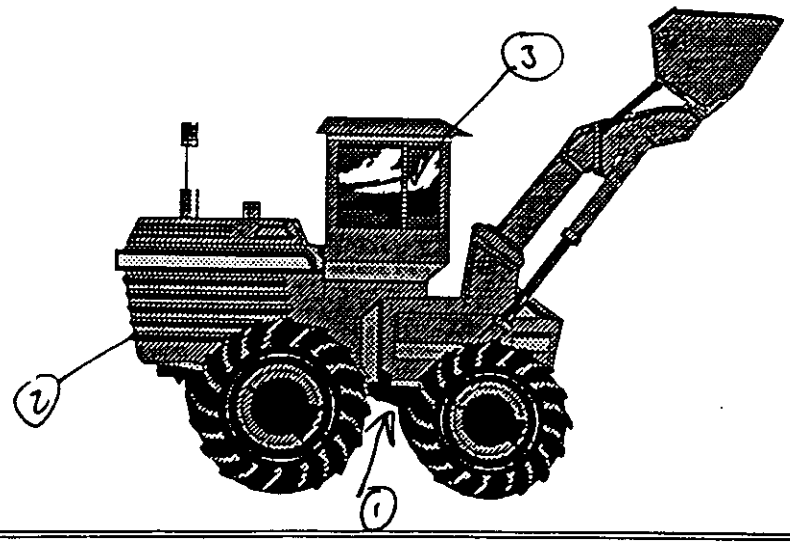
Sound Level Meter: MK-2 Serial #: 20129

Calibrator: AC-1 Serial #: 04437

Calibration: Initial 94.3, 114.3, 123.7 Final 94.3, 114.3, 123.7

Test No.	Description Location/Equipment	Distance	dB(A)	Hearing Protection Required Y	N	Comments
1	966 INSIDE	CAB	83.7		✓	
2	966 OUTSIDE	6'	97.3	✓		
3	966 OUTSIDE	6'	100.3	✓		

Drawing of equipment or work layout
Reference Numbers refer to the Test Number above



MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

Al-i-ACHMENT I
PAGE 1 OF 2
SOUND LEVEL SURVEY

Location: BUILDING # 3 Date: 6 10 97

Prepared By: R. SPURGEON

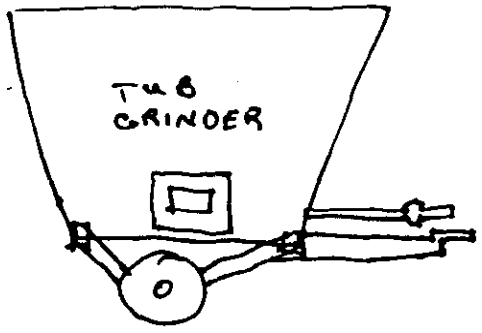
Sound Level Meter: MK - 2 Serial #: 20124

Calibrator: AC - 1 Serial #: 0 4 4 3 7

Calibration: Initial 94.3 114.3 1 23.7 Final 94.3/114.3/123.7

Test No.	Description Location/Equipment	Distance	dB(A)	Hearing Protection Required Y	N	Comments
1	TUB GRINDER FRONT	6'	89.3	✓		
2	TUB GRINDER SIDE	6'	83.7		✓	

Drawing of equipment or work layout
Reference Numbers refer to the Test Number above



MORRISON KNUDSEN CORPORATION,
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

AII-ACHMENT I
PAGE 1 OF 2
SOUND LEVEL SURVEY

ocation: BUILDING #2 Date: 6/10/97

'repared By: R. SPURGEON

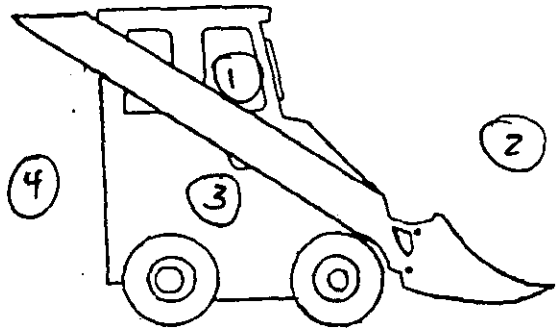
Sound Level Meter: MK-2 Serial #: 0129

Calibrator: AC-1 Serial #: 04437

Calibration: Initial 94.3/114.3/123.7 Final 94.3/114.3/123.7

Test No.	Description Location/Equipment	Distance	dB(A)	Hearing Protection Required Y	N	Comments
1	BOBCAT CAB	—	92.1	✓		
2	BOBCAT FRONT	4'	91.3	✓		
3	BOBCAT SIDE	4'	92.7	✓		
4	BOBCAT REAR	4'	96.5	✓		

Drawing of equipment or work layout
Reference Numbers refer to the Test Number above



MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT I
PAGE 1 OF 2
SOUND LEVEL SURVEY

Location: BUILDING # Date: 6/10/97

Prepared By: SPURGEON

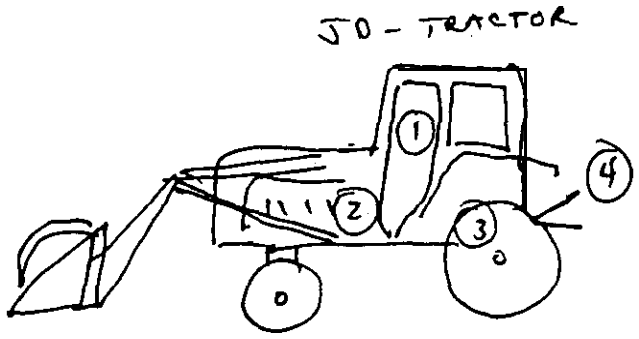
Sound Level Meter: ~~AC-1~~ MK-2 Serial #: 20129

Calibrator: AC-1 Serial #: 04437

Calibration: Initial 94.3 / 114.3 / 123.7 Final 94.3 / 114.3 / 123.7

Test No.	Description Location/Equipment	Distance	dB(A)	Hearing Protection Required Y	N	Comments
1	J.D. INSIDE	CAB	79.6		✓	
2	J.D. OUTSIDE	6'	93.3	✓		
3	J.D. OUTSIDE	6'	97.6	✓		
4	J.D. OUTSIDE	6'	94.8	✓		

Drawing of equipment of work layout
Reference Numbers refer to the Test Number above



MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT I
PAGE 1 OF 2
SOUND LEVEL SURVEY

Location: BUILDING #3 Date: 6/10/97

Prepared By: R. SPURGEON

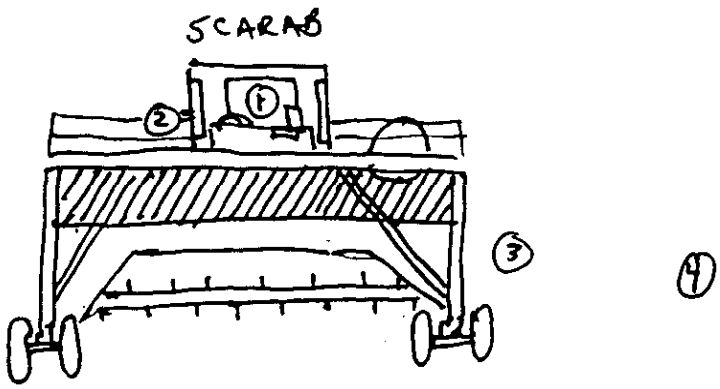
Sound Level Meter: MK-2 Serial #: 20129

Calibrator: AC-1 Serial #: 04437

Calibration: Initial 94.3/114.3/123.7 Final 94.3/114.3/123.7

Test No.	Description Location/Equipment	Distance	dB(A)	Hearing Protection Required Y	N	Comments
1	SCARAB CAB	CAB	87.7	✓		
2	SCARAB PLATFORM	PLATFORM	100.8	✓		
3	SCARAB 10-20'	10-20'	98.8	✓		
4	SCARAB 50'	50'	93.7	✓		

Drawing of equipment or work layout
Reference Numbers refer to the Test Number above



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ATTACHMENT I
PAGE 1 OF 2
SOUND LEVEL SURVEY

.ocation: BIO - FACILITY Date: 6/25/97

'repared By: R. SPURGEON

Sound Level Meter: MK-2 Serial #: 20129

Calibrator: AC-1 Serial #: 04437

Calibration: Initial 94.0/113.9/123.7 Final 94.0/113.9/123.6

Test No.	Description Location/Equipment	Distance	dB(A)	Hearing Protection Required Y	N	Comments
1	6A DURING SCREENING	VARIOUS	79		✓	
2	SCREENER	< 10'	98.7	✓		
3	SCREENER @ OPERATOR STATION	< 3'	99.4			
4	SCREENER	10-15'	82.5-90.2	✓		

Drawing of equipment or work layout
Reference Numbers refer to the Test Number above

MORRISON KNUDSEN CORPORATION
ENGINEERING, C O - AND ENVIRONMENTAL GROUP

ATTACHMENT II

NOISE DOSIMETRY SAMPLE FIELD SHEET

Sample I.D.: Date: 10/8/97

Sample I.D. #: CRANE - 003

Name, Person Sampled: RICK DAYHOFF SS#: 313 - 44 - 6752

Job: SCARAB OPERATOR Work Location: BIO - FACILITY

Dosimeter • Model: MK - 2 Serial #: 201 2 9 Dosimeter Threshold: 80 dB(A)

Calibration: Initial 94/114.3/123.7 Final: 94/114.3/123.7

Calibrator: AC - 1 Serial #: 0443 7 (5/13/96) Battery Check: ✓

Dosimeter Information • Time On: 0720 Time Off: 1600 Run Time: 8 HRS 20 MIN

Avg: 73.2 Dose%: 26.9 % Max: 110.0 dBA O.L.: N/A

Over 115 dB(A)? Yes ___ No ✓

Workplace Conditions:

Operations: Normal ✓ Abnormal ___ Explain TURNING PILES

Hearing Protection • Type: TASCO TRI - FIT % of Time Worn: 100 %

Weather Conditions:

Approximate Temperature: °F 70

Sky: Precipitation ___ Cloudy ✓ Partly Cloudy ___ Clear ___

Wind: Calm ___ Light ✓ Medium ___ High ___

Work Description/Comments:

Scheduled Hours per Shift: 8

Sampled By: R. J. [signature]

ATTACHMENT III

NOISE DOSIMETRY INDUSTRIAL HYGIENE SAMPLE SUMMARY

IDENTIFICATION

Location: BIO-FACILITY

Prepared By: R. SPURGEON

Date Prepared: 10/8/97

GENERAL INFORMATION

Calibrator: AC-1

Exposure Limit: 85

OSHA-PEL 90 ACGIH-TLV 90

Page 1 of 1

Scheduled Hours Per Shift 8

Date / Sample #	Name or Area / Soc. Sec. #	Job Description: Classification	Job Description: Location	Hearing Protection: Type	Hearing Protection: % Use	Dosimeter: Model	Dosimeter: Serial #	Dosimeter: Thr	Run Time Hr:Min:Sec	Over Limit Min:Sec	Max Level	% Dose	Avg dB(A)	Full Shift % Dose
10/8/97 CRANE 003	R. DAYHOFF 313-44-6752	SEALAB OPERATOR	BIO-FACILITY	TRASCO TRI FIT	100%	MK-2	20129	80	8:20	N/A	110.0	26.9	73.2	26.9

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MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

A-I-I-ACHMENT II

NOISE DOSIMETRY SAMPLE FIELD SHEET

Samole I.D.: Date: 10/6/97

Sample I.D. #: CRANE - 001

Name, Person Sampled: RICK DAYHOFF SS#: 313-44-6752

Job: OPERATOR SCARAB) Work Location: BIO-FACILITY

Dosimeter - Model: MK-2 Serial #: 20129 Dosimeter Threshold: 80 dB(A)

Calibration: Initial 94/114.3/123.7 Final: 94/114.3/123.7

Calibrator: AC-1 Serial #: 04437 (5/13/86) Battery Check: OK

Dosimeter Information - Time On: 0730 Time Off: 1209 Run Time: 4HR 39 MIN

Avg: 64.5 dB D & e % : . & Max: 102.5 dB O.L.: N/A

< 80 dB

Over 115 dB(A)? Yes ___ No ✓

---

orkplace Conditions:

Operations: Normal ✓ Abnormal __ Explain OPERATOR OF SCARAB TURNING PILES

Hearing Protection - Type: TASCO TRI-FIT % of Time Worn: 100%

Weather Conditions:

Approximate Temperature: 82 °F

Sky: Precipitation _____ Cloudy _____ Partly Cloudy ✓ Clear _____

Wind: Calm _____ Light ✓ Medium _____ High _____

Work Description/Comments: _____

Scheduled Hours per Shift: 8

---

ampled By: [signature]

ATTACHMENT III

NOISE DOSIMETRY INDUSTRIAL HYGIENE SAMPLE SUMMARY

IDENTIFICATION

Location: BIO-FACILITY

Prepared By: R. SPURGEON

Date Preoared: 10/7/97

GENERAL INFORMATION

Calibrator: AC-1

Exposure Limit: 90 dBA

OSHA-PEL 90 ACGIH-TLV 90

Page 1 of 1

Scheduled Hours Per Shift 8

Date / Sample #	Name or Area / Soc. Sec. #	Job Description: Classification	Job Description: Location	Hearing Protection: Type	Hearing Protection: % Use	Dosimeter: Model	Dosimeter: Serial #	Dosimeter: Thr	Run Time Hr:Min:Sec	Over Limit Min:Sec	Max Level	% Dose	Avg dB(A)	Full Shift % Dose
10/7/97	M. MADDOX	ENV.		TASCO TRI									60.1	
CRANE-002	344-60-9829	TECH	BIO-FACILITY	FIT	100%	MK-2	20129	80	3:53	N/A	48.6	9.1%	7x10	72.7%

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MORRISON KNUDSEN CORPORATION .
ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL GROUP

ATTACHMENT II

NOISE DOSIMETRY SAMPLE FIELD SHEET

Sample I.D.: Date: 1 0 7 9 7

Sample I.D. #: CRANE - 002

Name, Person Sampled: MIKE MADDOX SS#: 344-60-9829

Job: ENV. TECH. Work Location: BIO - FACILITY

Dosimeter - Model: MK - 2 Serial #: 20129 Dosimeter Threshold: 80 dB(A)

Calibration: Initial 93.7 114 124.3 Final: 93.7 114 124.3

Calibrator: AC-1 Serial #: 04437 Battery Check: 0 K

Dosimeter Information - Time On: 0 5 0 0 Time Off: 1153 Run Time: 3 HR 53 MIN

Avg: 72.7 dBA Dose%: 9.1% Max: 98.6 dBA O.L.: N/A

Over 115 dB(A)? Yes __ No ✓

Workplace Conditions:

Operations: Normal ✓ Abnormal __ Explain SAMPLING PILES

Hearing Protection - Type: TASCO TRI-FIT % of Time Worn: 100%

Weather Conditions:

Approximate Temperature: 70 °F

Sky: Precipitation _____ Cloudy ✓ Partly Cloudy _____ Clear _____

Wind: Calm ✓ Light _____ Medium _____ High _____

Work Description/Comments: _____

Scheduled Hours per Shift: 8

Sampled By: R. L. [illegible]

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ATTACHMENT III

NOISE **DOSIMETRY** INDUSTRIAL HYGIENE SAMPLE SUMMARY

IDENTIFICATION

Location: BIO-FACILITY

Prepared By: R. SPURGEON

Date Prepared: 10/7/97

GENERAL INFORMATION

Calibrator: AC - 1

Exposure Limit: 90 dBA

OSHA-PEL 90 ACGIH-TLV 90

Page 1 of 1

Scheduled Hours Per Shift 8

Date / Sample #	Name or Area / Soc. Sec. #	Job Description: Classification	Job Description: Location	Hearing Protection: Type	Hearing Protection: % Use	Dosimeter: Model	Dosimeter: Serial #	Dosimeter: Thr	Run Time Hr:Min:Sec	Over Limit Min:Sec	Max Level	% Dose	Avg dB(A)	Full Shift % Dose
10/7/97	M. MADDOX	ENV.		TASCO TRI									60.1	
CRANE-002	344-60-9829	TECH	BIO-FACILITY	FIT	100%	MK-2	20129	80	:53	N/A	48.6	9.1%	[illegible]	72.7%

I-13

ATTACHMENT J

LYLE ENVIRONMENTAL MANAGEMENT LABORATORY REPORTS

Date of Report: October 6, 1997

LABORATORY REPORT

Report to: Morrison Knudsen Corporation
1500 West 3rd Street
Cleveland, OH 44113-1406

Analysis for: Frank Petrik
Phone: (216) 523-5600
Fax: (216) 523-5035
Sample Numbers: 07627-84
Sample ID: Plates

Laboratory Record:
Received: September 13, 1997
Analyzed: Sept. 14-Oct 3., 1997
Reported: October 6, 1997

PO Number: NA

MICROBIOLOGICAL ANALYSIS

Sample Number	Lyle Number	Bacterial Pathogen Isolation	Yeast and Mold Isolation	Standard Plate Count, CFU	Yeast and Mold, CFU/ml	Standard Plate Count, CFU/m²	Yeast and Mold, CFU/m²	Total Aspergillus	Aspergillus Species
BINBNRO15A	07627	negative	NA	103	NA	690.0	NA	<1	NA
BINBREV16A	07628	negative	NA	95	NA	630.0	NA	<1	NA
BINBNRV17A	07629	negative	NA	144	NA	960.0	NA	<1	NA
BINBREO18A	07630	negative	NA	127	NA	850.0	NA	<1	NA
BINBNRO19A	07631	negative	NA	136	NA	910.0	NA	<1	NA
BINBREV20A	07632	negative	NA	77	NA	510.0	NA	<1	NA
BINBNRV21A	07633	negative	NA	10	NA	70.0	NA	<1	NA
BINBREO22A	07634	negative	NA	6	NA	40.0	NA	<1	NA
BINBNRO23A	07635	negative	NA	20	NA	130.0	NA	<1	NA
BINBREV24A	07636	negative	NA	43	NA	290.0	NA	<1	NA
BINBNRV25A	07637	negative	NA	98	NA	650.0	NA	<1	NA
BINBREO26A	07638	negative	NA	60	NA	400.0	NA	<1	NA
BINBNRO27B	07639	negative	NA	1	NA	NA	NA	<1	NA
BINBNRO28B	07640	negative	NA	1	NA	NA	NA	<1	NA
BOTBNRO01A	07641	negative	NA	20	NA	130.0	NA	<1	NA
BOTBREV02A	07642	negative	NA	4	NA	30.0	NA	<1	NA
BOTBNRV03A	07643	negative	NA	6	NA	40.0	NA	<1	NA
BOTBREO04A	07644	negative	NA	12	NA	80.0	NA	<1	NA
BOTBNRO05A	07645	negative	NA	7	NA	50.0	NA	<1	NA
BOTBREV06A	07646	negative	NA	9	NA	60.0	NA	<1	NA
BOTBNRV07A	07647	negative	NA	11	NA	70.0	NA	<1	NA
BOTBREO08A	07648	negative	NA	11	NA	70.0	NA	<1	NA

J-1

CFN:7627-84 mkn (3.5" Micro 7)
LYLE LABORATORIES
1507 CHAMBERS ROAD COLUMBUS OH 43212-1539 614/488-1022

A CERTIFIED LABORATORY: AIHA Accredited #9307; Ohio EPA Lisc. #878;
Ohio EPA Certified #4150; NIOSH PAT Program Participant #0707

Sample Number	Lyte Number	Bacterial Pathogen Isolation	Yeast and Mold Isolation	Standard Plate Count, CFU	Yeast and Mold, CFU	Standard Plate Count, CFU/g	Yeast and Mold, CFU/g	E.coli	Aspergillus
BOTBNRO09A	07649	negative	NA	10	NA	60.0	NA	<1	NA
BOTBREV10A	07650	negative	NA	10	NA	60.0	NA	<1	NA
BOTBNRV11A	07651	negative	NA	4	NA	30.0	NA	<1	NA
BOTBREO12A	07652	negative	NA	10	NA	60.0	NA	<1	NA
BOTBNRO13B	07653	negative	NA	<1	NA	NA	NA	NA	NA
BOTBNRO14B	07654	negative	NA	<1	NA	NA	NA	NA	NA
BINFNRO15A	07655	NA	positive*	NA	55	NA	370.0	NA	<1
BINFREO16A	07656	NA	positive*	NA	96	NA	640.0	NA	<1
BINFNRO17A	07657	NA	positive*	NA	60	NA	400.0	NA	<1
BINFREO18A	07658	NA	positive*	NA	84	NA	560.0	NA	<1
BINFNRO19A	07659	NA	positive*	NA	46	NA	310.0	NA	<1
BINFREO20A	07660	NA	positive*	NA	78	NA	520.0	NA	<1
BINFNRO21A	07661	NA	positive*	NA	27	NA	180.0	NA	<1
BINFREO22A	07662	NA	positive*	NA	68	NA	450.0	NA	<1
BINFNRO23A	07663	NA	positive*	NA	42	NA	280.0	NA	<1
BINFREO24A	07664	NA	positive*	NA	69	NA	460.0	NA	<1
BINFNRO25A	07665	NA	positive*	NA	26	NA	170.0	NA	<1
BINFREO26A	07666	NA	positive*	NA	34	NA	230.0	NA	<1
BINFNRO27B	07667	NA	negative	NA	<1	NA	NA	NA	NA
BINFNRO28B	07668	NA	negative	NA	<1	NA	NA	NA	NA
BOTFNRO01A	07669	NA	positive*	NA	64	NA	410.0	NA	<1
BOTFREO02A	07670	NA	positive*	NA	111	NA	720.0	NA	<1
BOTFNRO03A	07671	NA	positive*	NA	127	NA	820.0	NA	<1
BOTFREO04A	07672	NA	positive*	NA	131	NA	850.0	NA	<1
BOTFNRO05A	07673	NA	positive*	NA	93	NA	600.0	NA	<1
BOTFREO06A	07674	NA	positive*	NA	113	NA	730.0	NA	<1
BOTFNRO07A	07675	NA	positive*	NA	56	NA	360.0	NA	<1
BOTFREO08A	07676	NA	positive*	NA	99	NA	640.0	NA	<1
BOTFNRO09A	07677	NA	positive*	NA	59	NA	380.0	NA	<1
BOTFREO10A	07678	NA	positive*	NA	103	NA	670.0	NA	<1
BOTFNRO11A	07679	NA	positive*	NA	44	NA	280.0	NA	<1
BOTFREO12A	07680	NA	positive*	NA	91	NA	590.0	NA	<1
BOTFNRO13B	07681	NA	negative	NA	<1	NA	NA	NA	NA

Sample Number	Lyle Number	Bacterial Pathogen Isolation	Yeast and Mold Isolation	Standard Plate Count, CFU	Yeast and Mold, CFU	Standard Plate Count, CFU	Yeast and Mold, CFU	[illegible]	[illegible]
BOTFNRO14B	*07682*	*NA*	*negative*	NA	2	NA	NA	<1	<1
Travel Blanks									
TRAVEL BLANK	*07683*	*negative*	*negative*	NA	<1	NA	NA	NA	NA
TRAVEL BLANK	*07684*	*negative*	*negative*	<1	NA	NA	NA	NA	NA

NA= Not applicable

Positive* indicates the isolation was consistent with one or more of the following yeasts or molds. 1.) Alternaria sp., 2.) Penicillium sp., 3.) Cladosporium sp.. 4.) Rhizopus sp.

Lyle Laboratory Analyst
Hendrik Oulanoff

Lyle Laboratory Analyst
Pamela Jacobs

Date of Report: October 7, 1997

LABORATORY REPORT

Report to; Morrison Knudson Corp.
1500 West 3rd Street
Cleveland, OH 43113-1406

Analysis for: Frank Petrik
Phone: (216) 523-5035
Fax: (216) 523-5201
SampleNumbers: 07966-73
Laboratory Record:
Received: Sept. 23, 1997
Analyzed: Sept.30-Oct. 2.1997
Reported: October 7. 1997

Industrial Hygiene Analysis
Airborne Explosives

Compound	EXPBIO001A Lyle ID# 07966 mg/m³	EXPBIO002A Lyle ID# 07967 mg/m³	EXPBIO003A Lyle ID# 07968 mg/m³
HMX	<0.05	<0.05	<0.05
RDX	<0.05	<0.05	<0.05
1.3,5-Trinitrobenzene	<0.05	<0.05	<0.05
1,3-Dinitrobenzene	<0.05	<0.05	<0.05
Tetryl	<0.05	<0.05	<0.05
Nitrobenzene	<0.05	<0.05	<0.05
2,4,6-Trinitrotoluene	<0.05	<0.05	<0.05
4-Amino-2,6-dinitrotoluene	<0.05	<0.05	<0.05
2-Amino-4,6-dinitrotoluene	<0.05	<0.05	<0.05
2,4-Dinitrotoluene	<0.05	<0.05	<0.05
2,6-Dinitrotoluene	<0.05	<0.05	<0.05
2-Nitrotoluene	<0.05	<0.05	<0.05
3-Nitrotoluene	<0.05	<0.05	<0.05
4-Nitrotoluene	<0.05	<0.05	<0.05

J-4

LYLE LABORATORIES
1507 CHAMBERS ROAD COLUMBUS OH 43212-1539 614/488-1022

A CERTIFIED LABORATORY: AIHA Accredited #9307; Ohio EPA Lic. #878
Ohio EPA Certified #4150; NIOSH PAT Program Participant #9307

Compound	EXPB10001P Lyle ID# 07969 mg/m³	EXPB10002P Lyle ID# 07970 mg/m³	EXPB10003P Lyle ID# 07971 mg/m³
HMX	<0.05	<0.05	<0.05
RDX	<0.05	<0.05	<0.05
1,3,5-Trinitrobenzene	<0.05	<0.05	<0.05
1,3-Dinitrobenzene	<0.05	<0.05	<0.05
Tetryl	<0.05	<0.05	<0.05
Nitrobenzene	<0.05	<0.05	<0.05
2,4,6-Trinitrotoluene	<0.05	<0.05	<0.05
4-Amino-2,6-dinitrotoluene	<0.05	<0.05	<0.05
2-Amino-4,6-dinitrotoluene	<0.05	<0.05	<0.05
2,4-Dinitrotoluene	<0.05	<0.05	<0.05
2,6-Dinitrotoluene	<0.05	<0.05	<0.05
2-Nitrotoluene	<0.05	<0.05	<0.05
3-Nitrotoluene	<0.05	<0.05	<0.05
4-Nitrotoluene	<0.05	<0.05	<0.05

J-5

Compound	EXPB10001F Lyle ID# 07972 mg/m³	EXPB10001F Lyle ID# 07973 mg/m³	Matrix Spike % Recovery (average)*
HMX	<0.05	<0.05	74.2
RDX	<0.05	<0.05	43.7
1,3,5-Trinitrobenzene	<0.05	<0.05	87.0
1,3-Dinitrobenzene	<0.05	<0.05	80.7
Tetryl	<0.05	<0.05	25.7
Nitrobenzene	<0.05	<0.05	120
2,4,6-Trinitrotoluene	<0.05	<0.05	95.8**
4-Amino-2,6-dinitrotoluene	<0.05	<0.05	95.8**
2-Amino-4,6-dinitrotoluene	<0.05	<0.05	93.7
2,4-Dinitrotoluene	<0.05	<0.05	90.2**
2,6-Dinitrotoluene	<0.05	<0.05	90.2**
2-Nitrotoluene	<0.05	<0.05	66.9
3-Nitrotoluene	<0.05	<0.05	52.3
4-Nitrotoluene	<0.05	<0.05	91.7

* compounds were spiked near the detection limit, all recoveries were acceptable. Result is average of two spikes, front section of filter.

- * = coelute, recovery is for both compounds

Quantitation Method: *Test Methods for Evaluation Solid Wastes,* EPA SW846, Rev. 0, *September* 1994 Method 8330.

Lyle SOP: Explosive Residue Analysis on OVS-2 (XAD-2) Adsoption tube. Revision 1

Jennifer Petherolf
Lyle Laboratory Analyst

Jeffrey A. Buggs
Laboratory Manager

J-6

To: Frank J. Petrik
Senior Safety Supervisor
Morrison Knudson Corporation
Phone: 216-523-5035
Fax: 216-523-5201

From: Jeffrey A. Suggs
Laboratory Manager
Lyle Environmental Management, Inc.
Phone: 614-488-1022
Fax: 614-488-I 198

Date: September 16, 1997

Subject: Response to "Questions on Explosives . .." Received Fax 9/10/97

Please find the answers or clarifications to your questions below:

1. All results were reported as <0.05 mg/m³. This represents a conservative detection limit based on the lowest total flow sample submitted. Since the detection limit is artificially high, the same value was chosen for all compounds.

2. The column listing the matrix spike recovery % represents the recovery from a blank tube from the same lot as the tubes for the samples. All recoveries are acceptable (±25%) except Tetryl. Tetryl is a poorly resolved shoulder on another peak which may account for the possible variation in quantification resulting in a high recovery.

3. Project Specific Desorption Efficiencies (DE) have not yet been determined. Based on your letter, we are aware that Morrison Knudson is very concious of full documentation for analytical reports. Therefore we are now running a five level DE curve in triplicate, this curve should satisfy EPA and OSHA Portocols. DE's are scheduled to be run the week of 9/19/97. It has been our experience that DE's are typically in the range of 90-100% for most compounds. Had any compounds been detected, DE's would have been determined on an as needed basis prior to reporting results. The conservative detection limits used (see answer #I above) allow for a very conservative DE of 50% .

J-7

LYLE LABORATORIES
1507 CHAMBERS ROAD COLUMBUS OH 43212-1539 614/488-1022

A CERTIFIED LABORATORY: AIHA Accredited #9307; Ohio EPA Lisc. #8
Ohio EPA Certified #4150; NIOSH PAT Program

4. The corrected formula for calculation including terms for the pre-filter is as follows:

$$C(mg/m^3) = \frac{[W_p + W_f + W_b - (B_p + B_f + B_r)]X10^3}{V_L}$$

Where:

C = concentration of analyte in air, in mg/m^3
W_p = mass of analyte in sample prefilter, in mg
W_p = mass of analyte in sample front, in mg
W_b = mass of analyte in sample back, in mg
B_p = mass of analyte in blank prefilter, in mg
B_p = mass of analyte in blank front, in mg
B_b = mass of analyte in blank back, in mg
V_L = volume of air sampled, in L

The pre-filters were run separately, so that if any analytes had been found, the "particulate" value could be separated from the "vapor" value.

5. Since the sampling and analytical error (SAE) is not available, use the value 0.15.

Jeffrey A. Suggs
Laboratory Manager

J-8

Date of Report: September 22, 1997

LABORATORY REPORT

Report to: Morrison Knudson Corp.
1500 West 3rd Street
Cleveland, OH 43113-1406

Analysis for: Richard Spurgeon
Phone: (216) 523-5600
Fax: (216) 523-5547

industrial Hygiene Analysis
Desorption Efficiencies for
Airborne Explosives

Compound	Average Desorption Efficiency
HMX	99.07%
RDX	97.45%
1,3,5-Trinitrobenzene	97.86%
1,3-Dinitrobenzene	97.59%
Tetryl	85.79%
Nitrobenzene	95.27%
2,4,6-Trinitrotoluene	98.64%
4-Amino-2,6-dinitrotoluene	98.64%
2-Amino-4,6-diiitrotoluene	98.28%
2,4-Dinitrotoluene	96.66%
2,6-Dinitrotoluene	96.66%
2-Nitrotoluene	95.51%
3-Nitrotoluene	95.72%
4-Nitrotoluene	96.30%

J-9

LYLE LABORATORIES
,507 CHAMBERS ROAD COLUMBUS OH 43212-1539 614/488-1022

A CERTIFIED LABORATORY: AIHA Accredited #9307; Ohio EPA Lisc. #87
Ohio EPA Certified #4150; NIOSH PAT Program Participant #9307

Quantitation Method: *Test Methods for Evaluation Solid Wastes*, EPA SW846, Rev. 0, September 1994 Method 8330.

Lyle SOP: Explosive Residue Analysis on OVS-2 (XAD-2) Adsoption tube Revision 1

Note: Average desorption efficiencies are based on triplicate runs of five different concentrations. (Fifteen analyses total)

Jennifer Fetherolf
Lyle Laboratory Analyst

Jeffrey A. Suggs
Laboratory Manager

J-10

Date of Report October 2 1, 1997

LABORATORY REPORT

Report to: Morrison Knudson Corp.
1500 West 3rd Street
Cleveland, Ohio 43 113

Analysis for: Frank Petrik
Phone: (216) 523-5035
Fax: (2 523-5261)
Sample **Numbers:** 07183-5
Sample ID: Air Filters
Laboratory Record:
Received: August 25, 1997
Analyzed: October 15, 1997
Reported: October 21, 1997

INORGANIC CHEMISTRY ANALYSIS

Air Filter (mg/m³) **Project # 4324-0009 NSWC Crane (Mine** Fill A)

Element	METMFA002P Lyle ID # 07183	METMFA002A Lyle ID # 07184	BMETMFA002F Lyle ID # 07185	n k
Aluminum	<0.014	<0.014	<0.014	co.014
Antimonv	<0.001	<0.001	<0.001	<0.001
Arsenic	co.00 1	<0.001	<0.001	co.00 1
Beryllium	<0.001	co.00 1	<0.001	<0.001
Cadmium	<0.000028	<0.000028	<0.000028	<0.000028
Calcium	<0.07	co.07	<0.07	<0.07
Chromium	<0.04	co.04	<0.04	<0.04
Cobalt	<0.001	<0.001	<0.001	<0.001
Copper	<0.07	co.07	<0.07	<0.07
Iron	<0.20	co.20	<0.20	<0.20
Lead	<0.001	<0.001	<0.001	<0.001
Magnesium	<0.40	co.40	<0.40	<0.40

A:\07183-85.MKC[3.5", Chem—84] J-11

LYLE LABORATORIES
1507 CHAMBERS ROAD COLUMBUS OH 4X12-1539 614/488-1022
FAX 614/488-1198

A CERTIFIED LABORATORY: AIHA Accredited #9307; Ohio EPA Lic. #87
Ohio EPA Certified #4150; NIOSH PAT Program Participant #9307
PROFESSIONAL MEMBERSHIP IN: ASM, AIHA, ACS, AASRC, AAAS

Element	METMFA002P Lyle ID # 07183	METMFA002A Lyle ID # 07184	METMFA002F Lyle ID # 07185	Blank
Manganese	<0.07	<0.07	<0.07	<0.07
Molybdenum	<0.001	<0.001	<0.001	<0.001
Nickel	<0.20	<0.20	<0.20	<0.20
Selenium	<0.001	<0.001	<0.001	<0.001
Silicon	co.07	<0.07	<0.07	co.07
Silver	<0.001	<0.001	co.00 1	<0.001
Tin	<0.00056	<0.00056	<0.00056	<0.00056
Vanadium	<0.001	<0.001	<0.001	<0.001
Zinc	<0.04	<0.04	<0.04	<0.04

NIOSH 7300
GBC 906G Flame AA
GBC GF3000 Graphite Furnace
GBC 906G Graphite Furnace AA
GBC PAL3000 Auto Sampler

Blank = Air filter sample prepared using the same digestion procedures used in sample preparation.
Blank Spike= Air filter sample spiked with a known metals concentration added that is prepared using the digestion procedures used in Sample preparation.

Elizabeth Adkins

Lyle Laboratory Analyst
Elizabeth Adkins

Lyle Laboratory Manager
Jeffrey A. Suggs

A:\07183-85.MKC[3.5", Chcm-84)

J-12

Date **of Report** October 21, 1997

LABORATORY REPORT

Report to: Morrison Knudson Corp.
1500 West 3rd Street
Cleveland, Ohio 43 113

Analysis for: Frank Petrik
Phone: (216) 523-5035
Fax: (216) 523-5201
Sample Numbers: 07090-2
Sample ID: Air Filters
Laboratory Record:
Received: August 25, 1997
Analyzed: October 15, 1997
Reported: October 2 1, 1997

INORGANIC CHEMISTRY ANALYSIS

Air Filter (mg/m³) **Project # 4324-0009 NSWC Crane (I** ine Fill A)

				Quality Control	
Element	METMFAOO I P Lyle ID # 07090	METMFA001A Lyle ID # 07091	METMFA001F Lyle ID # 07092	Blank	% Rec
Aluminum	<0.014	0.019	<0.014	<0.014	170*
Antimony	<0.001	<0.001	<0.001	<0.001	66
Arsenic	<0.001	<0.001	<0.001	<0.001	86
Beryllium	<0.001	<0.001	<0.001	<0.001	99
Cadmium	<0.000029	<0.000029	<0.000029	<0.000029	82
Calcium	co.07	<0.07	<0.07	<0.07	90
Chromium	<0.04	<0.04	<0.04	<0.04	90
Cobalt	<0.001	<0.001	<0.001	<0.001	90
Copper	<0.07	<0.07	<0.07	<0.07	92
Iron	<0.20	<0.20	<0.20	<0.20	126
Lead	<0.001	<0.001	<0.001	<0.001	107

A:\07090-2.MKC[3.5", Chem--84] J-13

LYLE LABORATORIES
1507 CHAMBERS ROAD COLUMBUS OH 43212-1539 614/488-1022
FAX 614/488-1198

A CERTIFIED LABORATORY: AIHA Accredited #9307; Ohio EPA Lisc. #87
Ohio EPA Certified #4150; NIOSH PAT Program Participant #9307
PROFESSIONAL MEMBERSHIP IN: ASM, AIHA, ACS, AASRC, AAAS

				Quality Contr	
Element	METMFAOO 1 P Lyle ID # 07090	METMFAOO 1 A Lyle ID # 07091	METMFAOO 1 F Lyle ID # 07092	Blank	% Rec
Magnesium	<0.40	<0.40	<0.40	<0.40	117
Manganese	<0.07	<0.07	<0.07	<0.07	70
Molybdenum	<0.001	<0.001	<0.001	<0.001	99
Nickel	<0.20	<0.20	<0.20	<0.20	118
Selenium	<0.001	co.00 1	<0.001	co.00 1	116
Silicon	co.07	co.07	co.07	co.07	102
Silver	<0.001	<0.001	<0.001	<0.001	N/A**
Tin	<0.00058	<0.00058	<0.00058	<0.00058	78
Vanadium	<0.001	<0.001	<0.001	co.00 1	8 3
Zinc	<0.04	<0.04	<0.04	<0.04	111

NIOSH 7300
GBC 906G Flame AA . GBC 906G Graphite Furnace AA
GBC GF3000 Graphite Furnace GBC PAL3000 Auto Sampler

Blank = Air titter sample prepared using the same digestion procedures used in sample preparation.
Blank Spike= Air filter sample spiked with a known metals concentration added that is prepared using the same digestion procedures used in Sample preparation.
* Aluminum blank spiked at the detection limit..
** Spike recoveries for silver inadvertantly omitted

Elizabeth Adkins
Lyle Laboratory Analyst
Elizabeth Adkins

Lyle Laboratory Manager
Jeffrey A. Suggs

A:\07090-2.MKC[3.5", Chem--84]

Date of Report October 29, 1997

LABORATORY REPORT

Report to: Morrison Knudson Corp.
1500 West 3rd Street
Cleveland, Ohio 43113

Analysis for: Frank Petrik
Phone: (216) 523-5035
Fax (216) 3-5201
Sample Numbers: 7974-6
Sample ID: Air Filters
Laboratory Record:
Received: September 30, 1997
Analyzed: Sept. 30-Oct. 22, 1997
Reported: October 29, 1997

INORGANIC CHEMISTRY ANALYSIS

Air Filter (mg/m³) **Project # 4324-0009 NSWC Crane** (Mine Fill A)

Element	METB10001A Lyle ID # 7974	METB10001P Lyle ID # 7975	METB10001F Lyle ID # 7976	Blank
Aluminum	0.0094	0.0070	0.0022	<0.00027
Antimony	<0.00030	<0.00027	<0.00030	<0.00030
Arsenic	0.00042	0.00026	<0.00022	<0.00022
Beryllium	<0.000037	<0.000034	<0.000037	<0.000037
Cadmium	<0.000030	<0.000030	<0.000030	<0.000030
Calcium	<0.074	<0.067	<0.074	<0.074
Chromium	<0.037	<0.034	<0.037	<0.037
Cobalt	<0.19	<0.17	<0.19	<0.19
Copper	<0.074	<0.067	<0.074	<0.074
Iron	<0.19	<0.17	<0.19	<0.19
Lead	<0.00022	<0.00022	<0.00022	<0.00022
Magnesium	<0.37	<0.34	<0.37	<0.37

A:\07090.MAR[3.5", Chem--83] J-15

LYLE LABORATORIES
1507 CHAMBERS ROAD COLUMBUS OH 43212-1539 614/488-1022
FAX 614/488-1198

A CERTIFIED LABORATORY: AIHA Accredited #9307; Ohio EPA Lisc. #878
Ohio EPA Certified #4150; NIOSH PAT Program Participant #9307
PROFESSIONAL MEMBERSHIP IN: ASM, AIHA, ACS, AASRC, AAAS

Element	METB10001A Lvle ID # 7974	METB10001P Lvle ID # 7975	METB10001F Lyle ID # 7976	Blank
Manganese	co.074	<0.067	co.074	co.074
Molybdenum	<0.00044	0.00094	<0.00044	<0.00044
Nickel	co.037	co.034	co.037	co.037
Selenium	<0.0010	<0.00094	~0.0010	<0.0010
Silicon	0.012	0.0088	0.0044	<0.0015
Silver	0.000065	0.000042	0.000050	<0.000037
Thallium	<0.0010	<0.00094	<0.0010	<0.0010
Tin	<0.00059	<0.00054	<0.00059	<0.00059
Vanadium	<0.0010	<0.00094	<0.0010	<0.0010
Zinc	<0.015	<0.013	<no15	<0.015

NIOSH 7300
GBC Flame 906G AA GBC Graphite Furnace 906G AA
GBC GF3000 Graphite Furnace GBC PAL3000 Auto Sampler

Blank = Air filter sample prepared using the same digestion procedures used in sample preparation.
Blank Spike= Air filter sample spiked with a known metals concentration added that is prepared using the same digestion procedures used in Sample preparation.

Elizabeth Adkins
Lyle Laboratory Analyst
Elizabeth Adkins

Lyle Laboratory Manager
Jeffrey A. Suggs

Date of Report: October 21, 1997

LABORATORY REPORT

Report to: Morrison Knudsen
1500 W. 3rd St.
Cleveland OH 44113

Analysis for: Frank Petrik
Phone: (216) 523-5035
Fax: (2 16) 523-520 1
Sample **Numbers:see** below
Sample Type: Charcoal tubes
Laboratory Record:
Received: Sept. 24, 1997
Analyzed: October 15, 1997,
Reported: October 21, 1997

ORGANIC CHEMISTRY ANALYSIS

Sample Identification	Lyle ID#
OBIN 1500 001A	08084
OBIN 1500 002A	08085
OBIN 1501 001A	08086
OBIN 1501 002A	08087
OBIN 1003 001A	08088
OBIN 1003 002A	08089
OBOT 1500 001C	08090
OBOT 1500 002C	08091
OBOT 1501 001C	08092
OBOT 1501 002C	08093
OBOT 1003 001C	08094
OBOT 1003 002C	08095
OBOT 1500 001F	08096
OBOT 1501 001F	08097
OBOT 1003 001F	08098

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LYLE LABORATORIES
1507 CHAMBERS ROAD COLUMBUS OH 43212-1539 614/488-1022
FAX 614/488-1198

A CERTIFIED LABORATORY: AIHA Accredited #9307; Ohio EPA Lisc. #8
Ohio EPA Certified #4150; NIOSH PAT Program Participant #9307
PROFESSIONAL MEMBERSHIP IN: ASM, AIHA, ACS, AASRC, AAAS

Niosh 1500 Compounds (ppm in air)				
Compound Name	**08084**	**08085**	**08090**	**08091**
Benzene	<0.66	<0.66	<0.66	<0.66
Cyclohexane	<0.54	<0.54	<0.54	<0.54
Cyclohexene	<0.57	<0.57	<0.57	<0.57
n-Heptane	<0.40	<0.40	<0.40	<0.40
n-Hexane	<0.45	<0.45	<0.45	<0.45
Methylcyclohexane	<0.46	<0.46	<0.46	<0.46
n-Octane	<0.36	<0.36	<0.36	<0.36
n-Pentane	<0.51	<0.51	<0.51	<0.51
Toluene	<0.55	<0.55	<0.55	<0.55

Compound Name	**08096**	**OSHA Exposure limits (ppm)**
Benzene	<0.66	10
Cyclohexane	<0.54	300
Cyclohexene	<0.57	300
n-Heptane	<0.40	500
n-Hexane	<0.45	500
Methylcyclohexane	<0.46	500
n-Octane	<0.36	500
n-Pentane	<0.51	1000
Toluene	<0.55	200

Niosh 1501 Compounds (ppm in air)				
Compound Name	***08086***	***08087***	***08092***	***08093***
Benzene	<0.087	<0.087	<0.092	<0.097
p-tert-Butyltoluene	***<0.045***	***<0.045***	***<0.047***	<0.050

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Compound Name	08086	08087	08092	08093
Cumene	<0.056	<0.056	<0.059	<0.062
Ethylbenzene	<0.063	<0.063	<0.067	<0.070
a-Methylstyrene	<0.060	<0.060	<0.063	<0.066
Napthalene	<0.0061	<0.0061	<0.0064	<0.0068
Styrene	<0.068	<0.068	<0.071	<0.075
Toluene	<0.073	<0.073	<0.077	<0.081
2-Methylstyrene	<0.060	<0.060	<0.063	<0.066
4-Methylstyrene	<0.060	<0.060	<0.063	<0.066
Xylene	<0.063	<0.063	<0.066	<0.070

Compound Name	08097	OSHA Exposure limits (ppm)
Benzene	<0.097	1
p-tert-Butyltoluene	<0.050	10
Cumene	<0.062	50
Ethylbenzene	<0.070	100
a-Methylstyrene	<0.066	100
Naphthalene	<0.0068	10
Styrene	<0.075	100
Toluene	<0.081	200
2-Methylstyrene	<0.066	100
4-Methylstyrene	<0.066	100
Xylene	<0.070	100

Niosh 1003 Compounds (ppm in air)				
Compound Name	08088	08089	08094	080%
Benzyl chloride	co.034	co.034	co.034	co.034
Bromoform	co.044	co.044	co.044	<0.044
Carbon tetrachloride	<0.040	<0.040	<0.040	<0.040

Chlorobenzene	<0.038	<0.038	<0.038	<0.038
Chlorobromomethane	<0.058	<0.058	<0.058	<0.058
Chloroform	<0.048	<0.048	<0.048	<0.048
o-Dichlorobenzene	<0.034	<0.034	<0.034	<0.034
p-Dichlorobenzene	<0.0028	<0.0028	<0.0028	<0.0028
1,1-Dichloroethane	<0.046	<0.046	<0.046	<0.046
cis-1,2-Dichloroethylene	<0.051	<0.051	<0.051	<0.051
trans-1,2-Dichloroethylene	<0.050	<0.050	<0.050	<0.050
Ethylene dichloride	<0.049	<0.049	<0.049	<0.049
Hexachloroethane	<0.0016	<0.0016	<0.0016	<0.0016
1,1,1-Trichloroethane	<0.039	<0.039	<0.039	<0.039
Tetrachloroethylene	<0.038	<0.038	<0.038	<0.038
1,1,2-Trichloroethane	<0.042	<0.042	<0.042	<0.042
1,2,3-Trichloropropane	<0.036	<0.036	<0.036	<0.036

Compound Name	**08098**	**OSHA Exposure limits (ppm)**
Benzyl chloride	<0.034	1
Bromoform	<0.044	0.5
Carbon tetrachloride	<0.040	10
Chlorobenzene	<0.038	75
Chlorobromomethane	<0.058	200
Chloroform	<0.048	50
o-Dichlorobenzene	<0.034	50
p-Dichlorobenzene	<0.0028	75
1,1-Dichloroethane	<0.046	100
cis-1,2-Dichloroethylene	<0.051	200
trans-1,2-Dichloroethylene	<0.050	200
Ethylene dichloride	<0.049	50
Hexachloroethane	<0.0016	1

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Compound Name	08098	OSHA Exposure limits (ppm)
1,1,1-Trichloroethane	<0.039	350
Tetrachloroethylene	<0.038	100
1,1,2-Trichloroethane	<0.042	10
1,2,3-Trichloropropane	<0.036	50

Note: Results are based on the concentration of the low standard relative to the volume of air sampled

Methods: Hydrocarbons, BP 36-126, NIOSH 1500; Hydrocarbons, Aromatic, NIOSH 1501; Hydrocabons, Halogenated, NIOSH 1003. NIOSH Manual of Analytical Methods, Fourth Ed., 8/15/94.

Jennifer Fetherolf
Lyle Laboratory Analyst

Jeffrey A. Sugs
Laboratory Manager

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ATTACHMENT K

WIPE SAMPLE RESULTS FOR EXPLOSIVES

Date of Report: November 4. 1997

LABORATORY REPORT

Report to: Morrison Knudson Corp.
1500 West 3rd Street
Cleveland, OH 43 113- 1406

Analysis for: Frank Perrik
Phone: (216) 523-5035
Fax: (216) 523-5201
SampleNumbers:08617-25
Laboratory Record:
Received: October 16, 1997
Analyzed: Oct. 17-Nov.3, 1997
Report&November 4, 1997

Project Number: 4324-0009

Industrial Hygiene Analysis
Explosives

Compound	EXPBIO001W Lyle ID# 08617 ug/wipe	EXPBIO002W Lyle ID# 08618 ug/wipe	EXPBIO003W Lyle ID# 08619 ug/wipe
HMX	<1.0	<1.0	<1.0
RDX	<1.0	<1.0	<1.0
1,3,5-Trinitrobenzene	<1.0	<1.0	<1.0
1,3-Dinitrobenzene	<1.0	<1.0	<1.0
Tetryl	<1.0	<1.0	<1.0
Nitrobenzene	<1.0	<1.0	<1.0
2,4,6-Trinitrotoluene	<1.0	<1.0	<1.0
4-Amino-2,6-dinitrotoluene	<1.0	<1.0	<1.0
2-Amino-4,6-diiuotoluene	<1.0	<1.0	<1.0
2,4-Dinitrotoluene	<1.0	<1.0	<1.0
2,6-Dinitrotoluene	<1.0	<1.0	<1.0
2-Nitrotoluene	<1.0	<1.0	<1.0
3-Nitrotoluene	<1.0	<1.0	<1.0
4-Nitrotoluene	<1.0	<1.0	<1.0

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A CERTIFIED LABORATORY: AIHA Accredited #9307: Ohio EPA Lisc. #87
Ohio EPA Certified #4150: NIOSH PAT Program Participant #9307
PROFESSIONAL MEMBERSHIP IN: ASM. AIHA. ACS. AASRC. AAAS

Compound	EXPBIO004W Lyle ID# 08620 ug/wipe	EXPBIO005W Lyle ID# 08621 ug/wipe	EXPBIO007W Lyle ID# 08622 ug/wipe
HMX	<1.0	<1.0	<1.0
RDX	<1.0	<1.0	<1.0
1,3,5-Trinitrobenzene	<1.0	<1.0	<1.0
1,3-Dinitrobenzene	<1.0	<1.0	<1.0
Tetryl	<1.0	<1.0	<1.0
Nitrobenzene	<1.0	<1.0	<1.0
2,4,6-Trinitrotoluene	<1.0	<1.0	<1.0
4-Amino-2,6-dinitrotoluene	<1.0	<1.0	<1.0
2-Amino-4,6-dinitrotoluene	<1.0	<1.0	<1.0
2,4-Dinitrotoluene	<1.0	41.0	<1.0
2,6-Dinitrotoluene	<1.0	<1.0	Cl.0
2-Nitrotoluene	<1.0	< 1.0	Cl.0
3-Nitrotoluene	<1.0	< 1.0	<1.0
4-Nitrotoluene	<1.0	<1.0	<1.0

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Compound	EXPBEXPBIO007W Lyle ID# 08617-25 ug/wipe	EXPBEXPBIO008W Lyle ID# 08624 ug/wipe	EXPBEXPBIO009W Lyle ID# 08625 ug/wipe	Matrix Spike % Recovery
HMX	< 1.0	c 1.0	< 1.0	188
RDX	< 1.0	< 1.0	< 1.0	268
1,3,5-Trinitrobenzene	< 1.0	< 1.0	< 1.0	143
1,3-Dinitrobenzene	< 1.0	< 1.0	< 1.0	142
Tetryl	< 1.0	< 1.0	< 1.0	154
Nitrobenzene	< 1.0	< 1.0	< 1.0	135
2,4,6-Trinitrotoluene	< 1.0	< 1.0	< 1.0	[illegible]
4-Amino-2,6-dinitrotoluene	< 1.0	< 1.0	< 1.0	155**
2-Amino-4,6-dinitrotoluene	< 1.0	< 1.0	< 1.0	155**
2,4-Dinitrotoluene	< 1.0	< 1.0	< 1.0	135
2,6-Dinitrotoluene	< 1.0	< 1.0	< 1.0	162 155**
2-Nitrotoluene	< 1.0	< 1.0	< 1.0	155**
3-Nitrotoluene	< 1.0	< 1.0	< 1.0	135
4-Nitrotoluene	< 1.0	< 1.0	< 1.0	162
				421

Note: Matrix spike recovery performed on Whatman 125mm filter papers. Spike level was at detection limit. Above recoveries are acceptable at the detection limit.

All samples confirmed on second column due to interference.

*, ** = coelute, recovery is for both compounds

Quantitation Method: *Test Methods for Evaluation Solid Wastes,* EPA SW846, Rev. 0, September 1994 Method 8330.

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