

Draft Final Report on
Volume I: Task 3. An Evaluation of
Engineering Options to Prevent
Migration of Contaminants at
the DOE-Niagara Falls Storage Site

March 3, 1981
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DRAFT FINAL REPORT

on

VOLUME I: TASK 3. AN EVALUATION OF
ENGINEERING OPTIONS TO PREVENT
MIGRATION OF CONTAMINANTS AT
THE DOE-NIAGARA FALLS STORAGE SITE

prepared for

U.S. DEPARTMENT OF ENERGY
REMEDIAL ACTION PROGRAM

March 3, 1981

by

A. A. Lawrence

prepared by

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Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

Under Subcontract for
National Lead Company of Ohio
Serial No. 4069

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1.0 INTRODUCTION

The DOE-Niagara Falls Storage Site, NFSS, has been managed by the National Lead Company of Ohio, NLO, for the AEC, ERDA, and DOE for a number of years. The site has several buildings containing stored Afrimet residues, an open storage area which has only a cover of soil for protection, and several areas which are contaminated from previous storage or dumping of contaminated materials. Through the years these residues and other contaminated materials have leaked or have been leached through the soil and transported into the extensive on-site and off-site drainage systems, principally the Central Drainage Ditch (CDD) and the West Drainage Ditch (WDD). The drainage system has been contaminated by radionuclides and heavy metals.

2.0 DESCRIPTION OF PROJECT

This project entails the evaluation of engineering options to prevent off-site migration and recontamination of the drainage ditches.

The principal drainage ditch of concern in this project is designated the Central Drainage Ditch (CDD). It runs from south to north near the western boundary of the site. Most of the on-site drainage enters the CDD before it passes through the north boundary fence. There is, however, another off-site ditch designated the West Drainage Ditch (WDD) which runs parallel to the CDD, about 150 ft west of the west boundary fence. The WDD does intersect the CDD off-site and north of the site boundary. The WDD does show contamination (^{137}Cs) in the surface silt for about 5600 ft.

The principal lines of the drainage system which will be modified are shown in Figure 2-1.

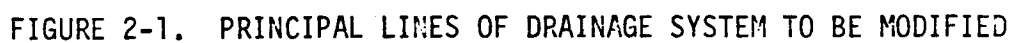
3.0 PROJECT PURPOSE AND JUSTIFICATION

3.1 Purpose

The purpose of this project is to evaluate various options for the prevention of further migration of contaminants from the DOE-Niagara Falls Storage Site (DOE-NFSS) by migration in the ditchways.

3.2 Justification

This project is justified by the necessity to prevent the recontamination of off-site waterways.



4.0 SYSTEM DEFINITION AND BASELINE REQUIREMENTS

4.1 Functional Requirements

The functional requirements for the modified drainage system are to prevent future migration of contaminants to the off-site ditches, provide a means of detecting the onset of future contaminant migration, and provide a means of containing a normal rainfall.

4.2 Performance Requirements

The performance of the modified drainage system should meet the following criteria for reliability, availability, and maintainability.

1. The modified system should require only a daily check by a watchman to verify that it is in operating condition.
2. Availability of the system should be close to 100 percent in all seasons of the year. The records of rainfall for the area indicate approximately equal rainfall in every month of the year. Appendix C contains precipitation data from the U.S. Weather Bureau for three locations around the DOE-NFSS. An average of the data for these stations is used in the evaluation of this project.
3. Maintainability should be such that normal functions of the system can be maintained by a minimal staff. Annual or semi-annual cleaning of the system should suffice. If sophisticated treatment systems involving filters, valves, and other equipment are necessary, a standby crew will be required for operation. Periodic inspections involving start-up of mechanical or systems will be necessary to insure their operability.

4.3 Effluent Criteria

The effluents shall meet the current EPA, NRC, and DOE standards for water beyond the site boundaries of the DOE-NFSS. Additionally, water-borne particulate effluents should be minimized to prevent recontamination of sediments to ^{226}Ra levels >5 pCi/g. The principal contaminants at present are in particulate form which should be recoverable by the use of screens.

4.4 Critical Elements

The critical elements in the evaluation of options for modifying the drainage ditches include:

- the ability of the drainage system to contain a heavier-than-normal rainfall or snowmelt,
- the operation of a contamination detection system, and
- the availability of a water storage reservoir.

4.5 Constraints

The principal constraints on the modification of the drainage system are:

- the virtually level topography of the site which provides minimal opportunities for a flood water retention basin (There are no natural valleys which can be dammed.),
- the necessity for continuous monitoring of the effluent to detect contaminants, and
- the legalities involved in diverting portions of the watershed, both on-site and off-site, to other ditches and creeks.

5.0 CONCEPT AND OPTIONS

5.1 Identification of Options

The principal options to be considered in the modification of the on-site drainage system are:

1. clean the present drainage ditches and then modify them by the construction of settling basins and weirs,
2. as a possible addition to the above--construct a water treatment system through which all water will be processed to remove contaminants before passing off-site (This will involve possible diversion to a large storage area.),
3. divert as much of the surface water that feeds into the system as possible (This can be accomplished by draining the southwestern and southeastern portions on the site and off-site area which drain onto the site in the southwest drainage ditch and/or Twelvemile Creek.), or
4. do nothing until the R-10 residues and other sources of contamination are placed in safe storage.

5.1.1 Discussion of Site and Options

These options are predicated upon normal water flow through the drainage system, a near stagnant condition. In those periods of heavy rainfall and spring thaws, it is anticipated that the nearly level condition of the site will result in significantly higher levels of run-off water with only a small increase in the flow rate. Such conditions will, of course, exceed the capacity and intent of the system of weirs, basins, and filters. The expectation is that the greatly increased quantities of water will satisfactorily dilute the contaminants below the acceptable levels or that the use of a pumped storage system will provide adequate storage volume beyond the capacity of the existing

drainage system. The stored water will be processed as necessary to remove contaminants and then released.

The U.S. Weather Bureau records show that the average annual rainfall for the three area weather stations--Lewiston, Lockport, and Wilson--is 32 inches. Of this, snowfall contributes 5.5 inches.

An analysis indicates that a 1-inch rainfall on the approximately 650 acres comprising the watershed area will generate 17,650,000 gals of water. Assuming 75 percent of this as immediate runoff, the other 25 percent being absorbed by the ground, there are 13,240,000 gals to be sampled, collected, pumped, stored, and treated, if necessary, before off-site release. Under normal flow conditions, that is other than during rainfall or severe snow thawing conditions, the observed amount of water passing off-site can be readily treated for contaminants. During heavy runoff conditions, it is likely that the dilution of contaminants will be so great that they will be below the presently established acceptable levels. In such a case, the stored water will be released at a controlled rate into the Central Drainage Ditch near the north boundary of the site. If the level of contamination of the stored water should prove to be in excess of established levels of acceptability, then processing steps will be required to remove or reduce the contaminants to an acceptable level. Options will include dilution at the point of discharge; use of evaporators, a slow and very expensive process; and chemical or ion exchange processes which would result in large quantities of sludges requiring disposal. The environmental aspects of each option will have to be considered.

The storage capacity of the existing, on-site drainage system is estimated to be between 4 and 5 million gals, primarily in the Central Drainage Ditch. This estimate is based on calculations using the U.S. Engineer Office drawings from the drainage system as built. Diversion of the West Drainage Ditch by a connector to the Central Drainage Ditch would add about 2 million gals capacity for a total of 6 to 7 million gals, about one-half of the required capacity for a 1-inch rainfall.

The necessary storage capacity is available in the above grade storage basin situated west of Lutts Road and Buildings 408, 410, etc. The estimated usable volume of the basin is 35,000,000 gals, sufficient for the runoff from a 2-inch rainfall.

The watershed area with the principal waterways is shown in Figure 5-1.

5.1.2 High Water

Any consideration of holding on-site runoff water in the ditches poses several problems. The first problem being that of the possibility of spreading contaminated material over a large area by simply damming the drainage ditches. The available information indicates that the water level in the ditches does not usually exceed 3-4 ft. The site elevations vary so little that in the event of an unusual (e.g., once in 100 yrs) rainfall virtually the entire site would be inundated. Rainfall frequency information for the Lewiston, NY, area is tabulated in Appendix A. A large area in the southern portion of the site was excavated to a depth of 1 ft in 1972 to provide fill dirt. This and other low-lying areas are connected to the Central Drainage Ditch by one or more feeder ditches which would serve to flood them if the central ditch is backed up.

However, if one is willing to incur the costs, large water volumes can be treated. A cost analysis of a pumping station, dam, and treatment plant is presented in Appendix B. Current considerations are to construct two or more settling basins on the Central Drainage Ditch. These basins as envisioned will adequately handle the normal season runoff flow. The pool behind each weir will be about 50 x 30 ft in area with a nominal depth of 2 ft below the crest of the weir. Baffles in mid-stream will cause the stream flow to reverse itself, slowing as it does and allowing for efficient sedimentation. The addition of chemicals to the water could precipitate even more materials and underwater weirs will further aid in the settling of sediments before they reach the exit weir.

5.1.3 Options for Passive Systems

Four options for the improvement of the NFSS drainage system are presented here. Three of the options can be considered as passive systems in that they involve the construction of settling basins and

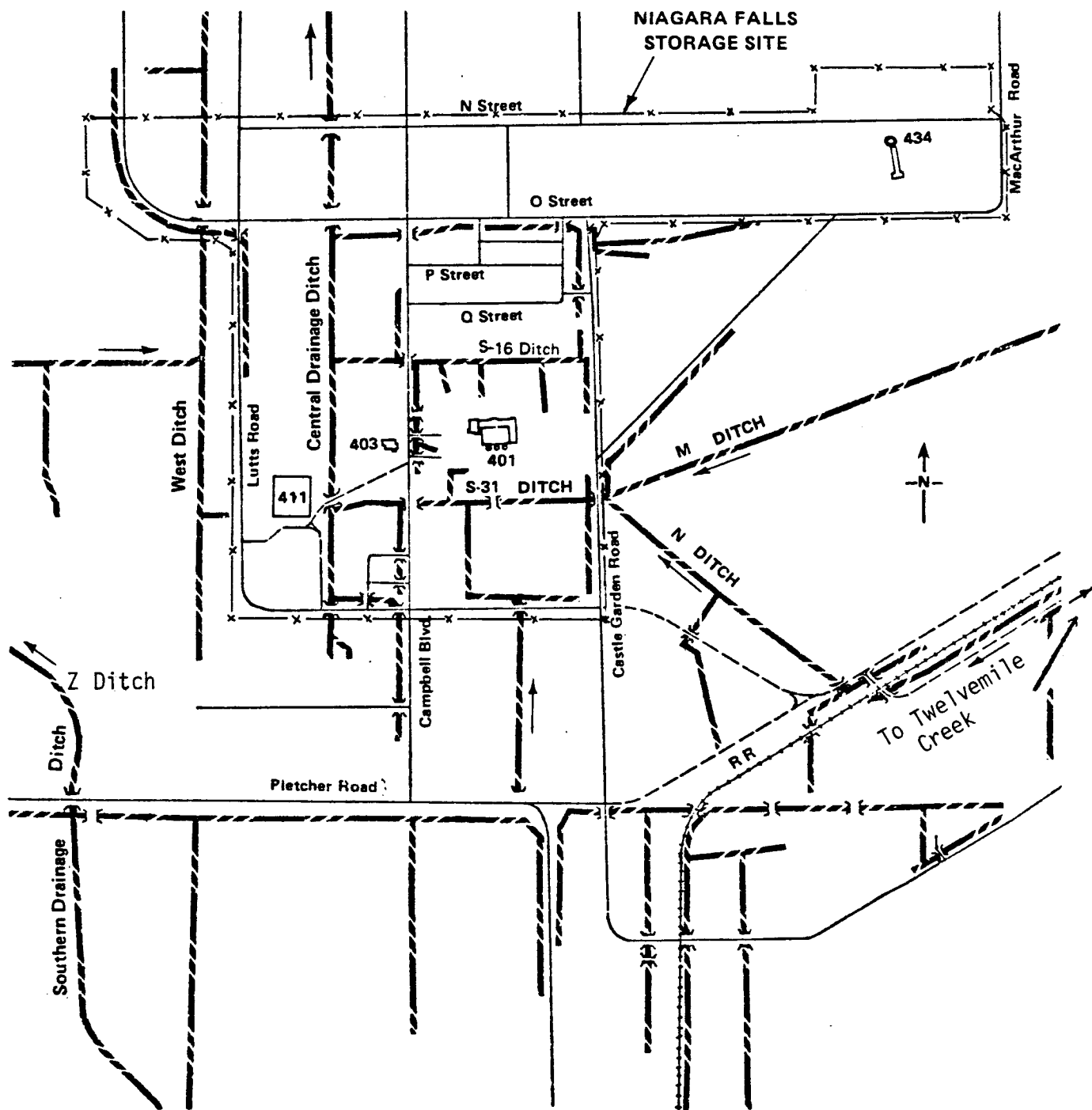


FIGURE 5-1. NIAGARA FALLS STORAGE SITE WATERSHED AREA AND DRAINAGE DITCHES

weirs to encourage the settling of particulate matter at one or more strategic points in the drainage system. A fourth option is an active system in that it incorporates a pumping station for the diversion of water during periods of heavy rainfall, or thaws, to a holding reservoir for later sampling and treatment if necessary. This active system can be used in addition to any one of the passive options. Additionally, a secondary option, which in itself would not satisfy the purpose of this project, is discussed as an add-on to the four principal options. Figure 5-2 shows the location of the settling basins and weirs for the passive systems as well as the location of the pumping station and treatment plant and pipeline to the reservoir for the active system.

Option 1

- Construct settling basins and weirs on the Central Drainage Ditch and the West Drainage Ditch on a line just south of "N" Street. This will facilitate sampling of water just before it goes through the north boundary fence.
- The settling basin will be approximately 30 ft wide by 50 ft long at elevation 305±. A weir and a diversion pier at the downstream end of the basin will induce settling of sediments. A layer of bentonite will be placed on the bottom of the settling basin to provide a surface from which settled or precipitated residues may be scraped. Periodic sampling downstream from the weir will be used to determine if contaminants are continuing to move downstream. Periodic samples of the bottom sediments in the basin will determine what contaminants are present and the necessity for dredging the sediment from the basin.
- A filter system to collect particulates will be installed at the north boundary weirs. It will be necessary to provide an upstream grid or screen to collect debris and prevent it from damaging or clogging the particulate filter. This screening system will be necessary for all of the options calling for a settling basin and weir.

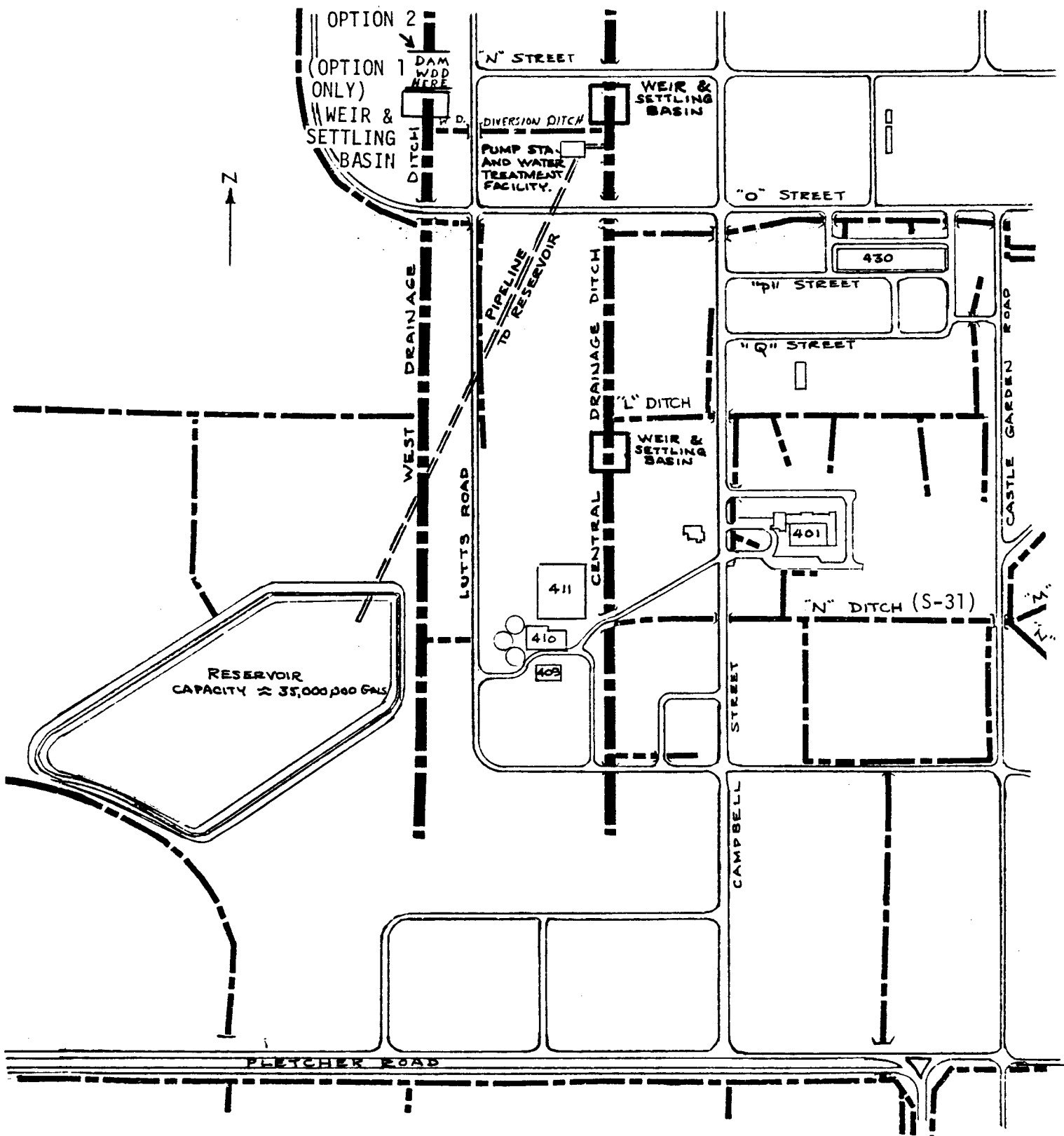


FIGURE 5-2. LOCATION OF SETTLING BASINS, WEIRS, AND PUMPING STATION

Option 2

- Construct a settling basin and a weir on the Central Drainage Ditch just south of "N" Street.
- Dam the West Drainage Ditch at the north boundary fence line. The dam will be constructed of clay dumped and compacted in the ditch after the bottom has been dredged to remove sediment and contaminants.
- Dig a connecting ditch from the West Drainage Ditch eastward to the Central Drainage Ditch at a point approximately 50 ft south of and parallel to "N" Street.

Option 3

- Same as Option 2 with the addition of a settling basin and weir on the Central Drainage Ditch at a point immediately south (upstream) of the intersection of the "L" Ditch.
- Dig two new drainage ditches encompassing the site occupied by Buildings 400, 410, 411, 412, 413, 414, and 415 and the residue piles adjacent to Buildings 411 and 409. The two ditches intersect the Central Drainage Ditch. The northern ditch extends westerly to Lutts Road and thence southerly to the access road leading between Buildings 409 and 412. The southern ditch extends westerly to Lutts Road and thence northerly to the access road leading between Buildings 409 and 412.

Description of Settling Basins

The pool behind each weir will be about 50 ft long by 30 ft wide with a nominal depth of 2 ft below the crest of the weir. The gradient of the ditch is very low so that the crests of the weirs and the downstream water level will be close to the same elevation. Baffles in mid-stream will be designed to cause the stream flow to reverse thereby slowing as it does and allowing suspended sediments to settle. The addition of

chemicals to the water could further enhance the precipitation of materials. A system of subsurface weirs will also aid in the settling of sediments before they reach the exit weir. The "N" Street basin will furnish a second opportunity to capture any sediments that pass the upstream basin. A conceptual sketch of a typical basin and weir is shown in Figure 5-3(a,b,c). Details of the basin design will be determined as a result of studies of local rainfall and flow rates.

The design of the settling basin weir will be determined by the environmental requirements for intercepting particulate matter and the degree to which the on-site sources of contamination are removed.

An essentially complete removal of the R-10 residues, spoils piles, and contaminated areas such as the naval dump and the slurry pond should reduce any future contamination to a level which can be controlled by a simple weir backed by a settling basin as shown in Figure 5-3(a), with one or more diversion dams to induce settling of particulates during normal flow conditions. It is assumed that the amount of water generated by a significant rainfall (e.g., 0.5 inch or greater) would result in off-site discharges having concentrations substantially below acceptable levels.

As an alternate to the simple weir, filter screens such as shown in Figure 5-3(b) can be installed in the weir to collect the particulate matter that moves downstream. Such a screen will require periodic inspection, cleaning and replacement if damaged. The screen can be equipped with a sensing device that will signal when the congestion of particulates has effectively blocked the flow of water. Additionally, it will be necessary to install a screen upstream of the filter to capture floating and submerged debris carried along during period of high water. Such a screen can be equipped with a catwalk from which the accumulated debris can be collected and removed.

Another option, shown in Figure 5-3(c), would entail the construction of a dam with a culvert and gate valve to control the flow of water. This option would be considered for use if it is necessary to pump the on-site stream flow to a holding reservoir prior to treatment of any contamination. The gate valve would close off the culvert allowing the drainage system to fill with water collected on-site from rainfall or melting snow. Such a

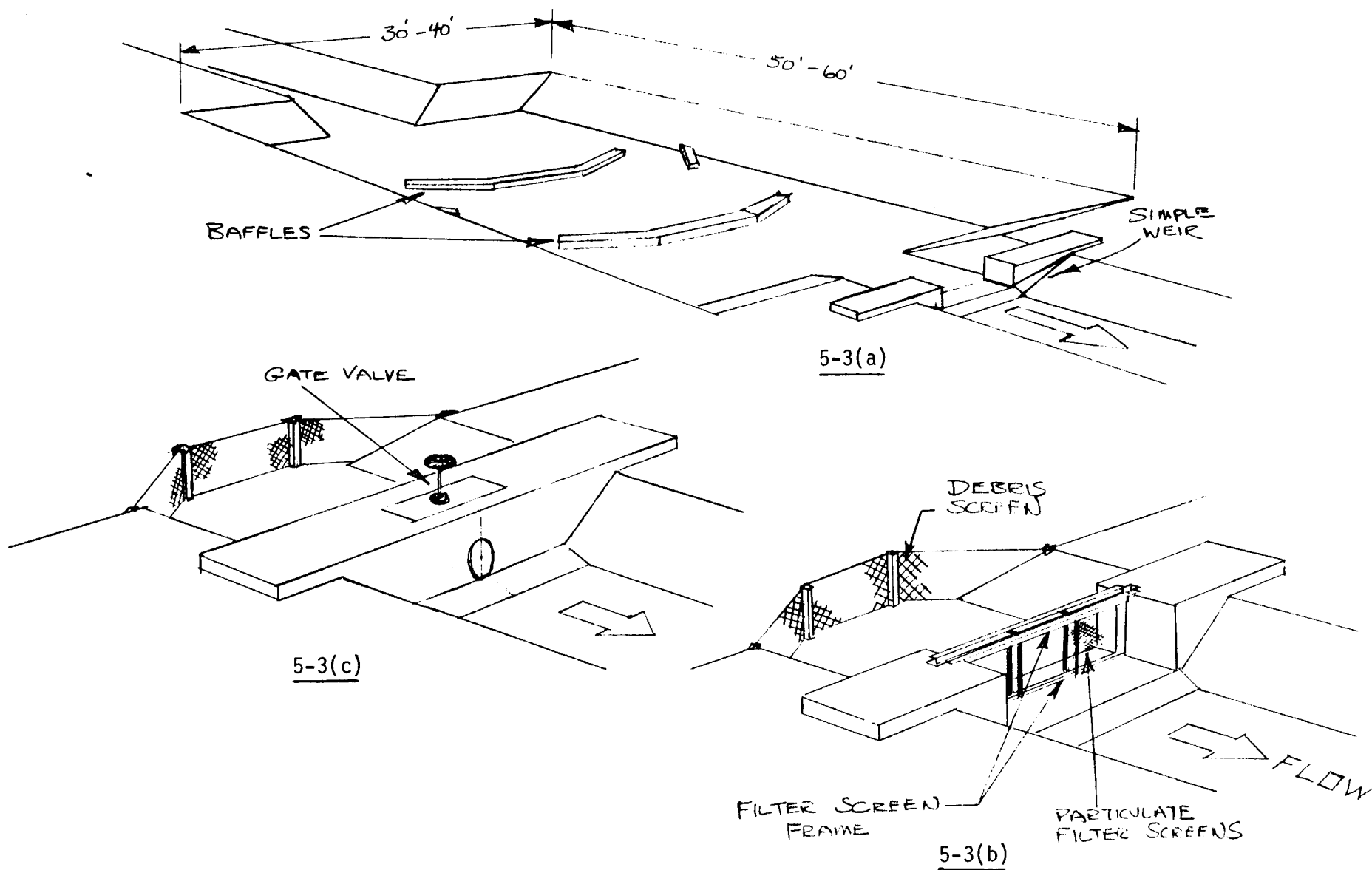


FIGURE 5-3. CONCEPTUAL SKETCH OF TYPICAL BASIN AND WEIR

system can be manually or remotely operated. A manual system would require hands-on closing of the valve and a startup of the pump to divert the water to a storage area. This necessitates permanent on-site attendants 24 hrs a day or a reliable, quick-response crew to enter the site whenever significant rainfall or snow thawing is expected.

The system can be automated to provide remote activation of valve and pump operations upon command from a sensor detecting a rise in water level or from a command station.

Sampling stations will be established immediately downstream from each weir for periodic sampling of the stream.

5.1.4 Option for Active System

Option 4

- Option 4 would provide an "active" system for the treatment of all water and contaminants passing off the site. It would be an add-on to any one of the previous options and therefore the most expensive.
- Types of equipment and processes which would be a part of an active system include:
 - large holding tanks or pond, approximately 35,000,000 gallons
 - a pumping station to transfer water to holding tanks or ponds
 - an ion exchanger
 - precipitators, solvent extraction
 - a chemical treatment facility, ion exchange
 - an evaporator to collect residues, approximately 10-20 gpm.

Figure 5-4 presents a conceptual layout for such a water treatment system.

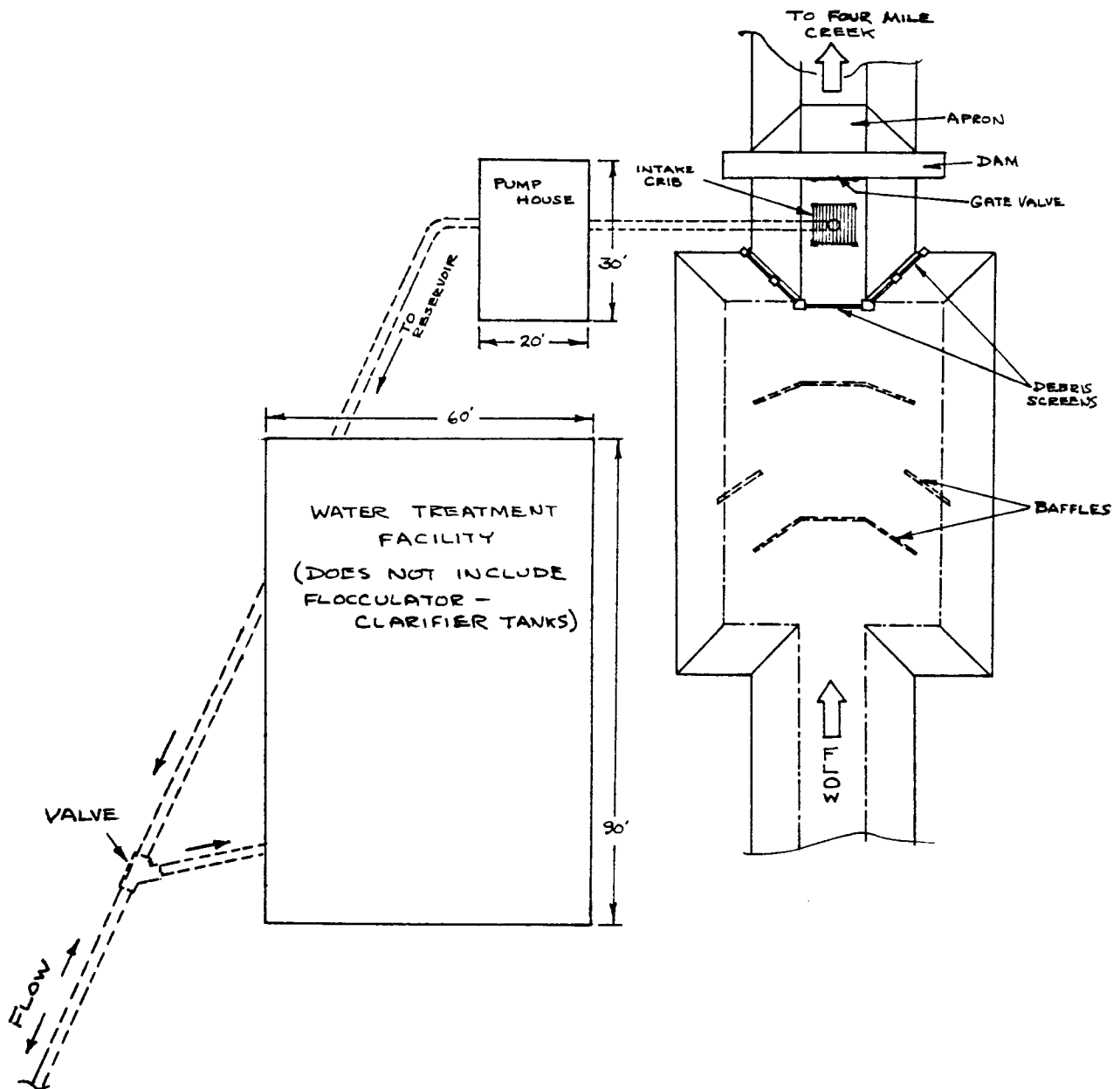


FIGURE 5-4. CONCEPTUAL LAYOUT OF SETTLING BASIN, PUMP HOUSE AND WATER TREATMENT FACILITY

Low Head Dam

The cost of a low head dam has been estimated based upon containing the runoff from a 1 inch precipitation event which has about 1/3 inch of water infiltrating into the soils. Therefore, the runoff amounts to approximately 12 million gallons per day. The low head dam will be constructed of reinforced concrete and will be 20 feet wide and 10 feet high. It will have a flow-through chamber for passing normal flow. This dam will provide the pool for a pump station to pickup the water.

Intake Structure and Pumping Station

Constructed adjacent to and as a part of the low head dam will be an intake structure and a pumping station. This structure will be approximately 30 feet long, 20 feet wide, and 10 feet high. Three electric pumps, each 4.0 million gallons per day, will pick up the water for conveyance to a diked storage area for treatment. The design total dynamic head is 40 feet. The pump and motors would be weatherproofed and sit on top of the concrete structure. Pump enclosures would add \$15,000 for the metal building required.

Water Main

A 24-inch ductile iron pipe has been designed to convey the water from the pumping station to the diked storage lagoon. The design distance used was 2,000 feet. Water could be diverted from this main to the treatment facilities.

Waste Treatment Plant

The proposed waste treatment plant will be capable of treating 1.2 million gallons per day of wastewater by utilizing the process of high pH chemical precipitation-flocculation, recarbonation, filtration, and cation exchange.

Raw wastewater would be pumped to a flash mixing unit where reactant chemicals such as iron (III) sulfate, lime, trisodium phosphate, and nonionic

or anionic polyelectrolyte are intimately mixed with the wastewater stream. The chemically treated stream then gravitates to combined flocculator-clarifiers to allow gravity settling of the larger floc particles. A small fraction of the sludge produced is normally recycled to the flash mixers to aid in the floc formation.

The clarifier effluents are then combined and recarbonated before filtration with graded anthracite to remove any fine particles carried over from the clarifier units. The filtrate passes through two hydrogen form cation exchange columns and then gravitates to a treated waste holding tank. If the treated water meets acceptable effluent concentrations, the effluent is discharged through an outfall sewer; if not, the stream is retreated.

Sludge would be drawn from the bottom of the flocculator-clarifier and dewatered by a recessed plate and frame filter press. Filtrate from the sludge press is returned to the flash mixer. The spent ion-exchange regenerant is chemically treated and the sludge is pumped to storage. The regenerant sludge is eventually mixed with cement in a drum tumbler unit and containerized for burial.

Bulk storage facilities, slakers, volumetric feeders, and positive displacement feed pumps will be provided for chemical storage and handling. The bulk storage facilities will provide a 30-day supply of chemicals.

A 5400 sq ft metal building will be provided to house all treatment units with the exception of the flocculator-clarifier tanks.

The cost estimates for a low head dam, pump station, pipeline, and wastewater treatment facilities necessary to reduce the concentrations of heavy metals and reduce low-level radioactivity in the runoff are shown in Appendix B. Also included are an itemized cost estimate and the total annual cost.

5.1.5 Restricting Flow of Water onto the Site

A secondary option which can be considered in conjunction with any of the options is to investigate the potential for diverting all off-site streams, ditches, and water flow from the site. Some flow apparently begins south of Pletcher Road entering the site through ditches east of Campbell Avenue and also at the west end of the former railroad yard in

the southeast quadrant. There appears to be ample possibility for damming those ditches and diverting the flow into the "Z" Ditch south of Pletcher Road and thence to Fourmile Creek or in an easterly direction into Twelvemile Creek.

The contours of the area are such that there should be no difficulty in establishing a suitable gradient in the connecting ditches. Exercise of this option would entail the preparation of an environmental impact statement to justify the action. Consideration would have to be given to legal concerns for rights-of-way as well as water rights.

Reducing the watershed area serviced by the CDD by approximately 50 percent would reduce the estimated runoff from a 1-inch rainfall to 6,120,000 gals. The basic storage capacity of CDD and WDD would be unchanged and, therefore, would be capable of holding the runoff. As noted in Appendix C, the region can expect a rainfall of 4.7 in. in a 24-hr duration in a 100-yr period. Clearly, additional storage capacity would be required in such an event. Note that in such an event, it would be necessary to build a dike around the entire perimeter of the site to prevent any runoff.

5.2 Evaluation of the Options

The three "passive" options differ primarily in the location and/or number of settling basins and weirs. Option 1 will require monitoring of the effluent at two locations as it passes off-site. The cost would be comparable to Option 2. Option 2 collects the effluent from both the West and Central Drainage ditches at one location. This joining of the ditches will increase the total flow off-site; however, the connecting ditch increases the storage capability in the event of a heavy rainfall. Option 3 offers the advantage of two settling basins on the CDD, the upstream location being situated close to the probable sources of contamination. Additionally, the addition of drainage ditches surrounding the R-10 and spoils pile as well as the buildings in which the Afrimets are stored will collect any future runoff from those areas until they are cleaned up.

In all of the "passive" options, the cleaning of the ditches will serve to remove pockets of materials identified in the radiological survey as well as contaminated sediments which would otherwise continue to migrate off-site. The construction of settling basins, weirs, and filter screens will induce the settling of solubles and sediments and the collection of particulates. Removing the vegetation will also hasten the flow of water from the site.

The "active" system with its pumping station, storage reservoir, and complete water treatment plant would provide the ultimate in decontamination. This system would provide ample assurance that the water leaving the site meets the present state and federal water criteria. It would also be expensive; and once the site has been cleared of stored materials, it would most likely be unnecessary.

The secondary option of diverting up to 50 percent of the watershed to the southwest drainage ditch and/or Twelvemile Creek should be considered as an effective means of reducing the flow through the Central Drainage Ditch, thereby decreasing the likelihood of contamination migration. It will also decrease the quantity of water requiring processing should it be necessary to construct a water treatment plant for contamination control. The principal reservations about diversion are the legal ramifications which might ensue as a result of diverting water from a site considered to be a source of radiological contamination.

Additionally, the question of water rights may be raised. The latter would not appear to be a particularly significant deterrent in this case since the flow through the CDD is primarily through unused areas north of the site. The final option mentioned in Section 5.1 of not cleaning the on-site ditches until the R-10 residues, spoils pile, and any other potential sources of ditchway contamination are removed has merit only in that the existing vegetation inhibits the flow of water off-site. The vegetation and existing pools provide an inducement to sedimentation as well as serving to collect particulates. Such an option could be best served by the construction of low head dams at the north boundary which would be equipped with particulate screens. This would be the least cost option. It appears viable only for the short-term.

5.3 Identification of the Recommended Concept

The recommended concept is one involving the removal of vegetation, contaminants, and contaminated sediments from the Central Drainage Ditch and those tributary ditches which have been identified in Battelle Report No. BCL-2074 (December 1980 Draft Final) as having radiological contamination above permissible limits. The removed materials should be placed in an interim-storage facility, on-site, until such time as the DOE shall determine their ultimate disposition. A system of settling basins, particulate screens, and weirs should be constructed to aid in the detention of future contaminant migrations. The West Drainage Ditch should be dammed at the north boundary of the site and a diversion ditch dug to connect the CDD to permit monitoring at one location. The option of diverting the southern watershed to the southwest drainage ditch and/or Twelvemile Creek should be pursued as a means of relieving the load on the CDD.

So long as the R-10 residues, spoils pile, and any other sources of contamination remain in their present locations, there remains a potential source of ditch-way contamination. If these sources are completely removed, the recommended concept should prove effective. In the event that they are not removed or placed in safe storage, it may be necessary to construct a water treatment system as discussed in Option 4.

6.0 UNCERTAINTIES

The principal uncertainties associated with the project are:

- the adequacy of the weirs, thus potentially necessitating costly water treatment facilities,
- the legalities concerning the option of diverting watershed drainage systems in the southern areas which now drain onto the site, and
- the potential for spills during the removal of the R-10's and the spoils pile as well as the stored residues.

7.0 PRELIMINARY ASSESSMENTS

7.1 Safety and Health

The drainage system modification options do not appear to pose any major safety problems. A health physics program will be required for contractor personnel engaged in the removal, transportation, and storage of ditch residues. Additionally, a continuing monitoring program during the construction of the drainage system modifications will be required. A health physics (HP) program prepared for the removal, transportation, and storage on-site of off-site drainage ditch residues is attached as Appendix A.

7.2 Quality Assurance

A complete quality assurance (QA) program which is in compliance with both NRC and DOE requirements must be used for this project.

7.3 Environmental Considerations for All Options

The environmental impact of any of the drainage system options under consideration is essentially the same. The cleaning of vegetation and silt from the drainage ditches will help to eliminate stagnant pools of water which now provide breeding places for mosquitoes as well as improve the flow of water. The removal of brush and debris along the embankments will allow easier access for periodic inspection of the ditches and the site. A system of vegetation removal should be instituted to keep the ditches clean. A recommendation would be to grade the top of the embankments along the Central Drainage Ditch and the portion of the West Drainage Ditch which is on-site as well as the connector ditch, if that option is selected, sufficiently to permit regular mowing of the vegetation as is done along the roadways. Maintaining a clear embankment as far as Balmer Road might also be considered for an extended period of perhaps 5 yrs or as long as monitoring of the ditches is necessary.

The gradient of the ditches is so low that rapid runoff does not appear to be a problem. Scouring of the bottom obviously has not occurred as evidenced by the dense and continuous vegetation. The flow rate has been reported to be in the 2-3 ft/min range which is insufficient to cause any significant damage. The settling basins with their flow-impeding baffles will serve to slow the flow as it leaves the site.

The environmental impact of the chemicals which might be added to enhance precipitation of contaminants will require consideration. It is likely that the chemicals will be added in excess of requirements to precipitate all of the contaminants, thereby resulting in a surplus of unreacted material in the water. Consideration of chemical treatment is discussed on pp. 17-18. Another factor to be considered in the requirement and design of any facility is the rate of precipitation relative to the water flow rate. Under normal circumstances, this would not appear to be a problem; but during periods of heavy rainfall or spring thaws, the quantity of water as runoff could be excessive.

Included in the concern for the cleanup operations of each option are the radiological aspects of each option. The total occupational dose commitment must be considered in the review of each option.

Environmental aspects of these options must be considered. The terrain is so nearly level that seemingly minor variations in the topography can have far flung effects for the entire site. Any general excavation is an open invitation to the formation of a pond or swamp complete with swamp vegetation, mosquitoes and frogs. Therefore, any excavation must be undertaken with an eye to its effects on not only the neighboring terrain, but also on its effects on the far end of the site.

8.0 METHOD OF ACCOMPLISHMENT

The project can be accomplished using conventional construction methods. Emphasis must be placed on the health physics aspects in the areas where the radiological survey indicates that precautionary measures must be taken.

9.0 SUMMARY COST ESTIMATE

The cost estimates for the drainage system modifications are attached as Appendix B.

10.0 DESIGN STANDARDS

Standard construction and good workmanship practices must be used and a quality assurance program must be implemented to assure objectives.

11.0 REFERENCE DATA

Reference data for annual precipitation and intensity are presented as Appendix C.

12.0 APPENDICES

Appendix A--Health Physics Program
Appendix B--Summary of Cost Estimates
Appendix C--U.S. Weather Bureau Data

APPENDIX A

HEALTH PHYSICS PROGRAM

APPENDIX A

HEALTH PHYSICS PROGRAM

Health Physics Program Associated with the Removal, Transportation, and 1-Yr Storage On-Site of Off-Site Drainage Ditch Residues

Health Physics Program--Personnel

A comprehensive health physics program for contractor personnel engaged in removal, transportation, and storage of off-site drainage ditch residues shall be required. Although radiation exposures will be quite minimal monitoring program will be necessary for substantiation/documentation purposes.

In addition a radiation safety training program specifically related to the minimal radiological health impact of the operations shall be conducted. Emphasis shall be placed on the minimal radiological concerns and comparisons should be made with typical everyday activities.

A program of monitoring personnel for external radioactive material contamination shall also be conducted. Appropriate decontamination techniques shall be employed whenever contamination is found.

Health Physics Program--Environmental Removal of Off-Site Ditch Residues

During removal of ditch residues, an environmental monitoring program will be necessary to substantiate impact of the removal operations.

Air Monitoring/Sampling

An air monitoring sampling program at the ditch excavation site will be required. The program shall include initial, interim, and post-operational radiological assessments. Particulates as well as gaseous airborne components shall be measured where appropriate. The selection of sampling locations shall be predetermined before startup operations.

Meteorological conditions shall be observed and documented during sampling. It will be most important to coordinate air sampling events with particular operations in order to accurately assess the environmental impact.

Monitoring of External Radiation Levels at the Excavation Site

A program of monitoring external gamma radiation levels around the disturbed area of the off-site ditches shall be performed to assess the effects of excavation operations. The program shall include initial, interim, and post-operational measurements.

Water Sampling

A water sampling program shall be conducted at runoff locations for waterborne radionuclides. The program will include initial, interim, and post-operational measurements. Sampling shall be performed at pre-selected locations where runoff will be known or suspected to occur.

Transportation of Ditch Residues

Air Monitoring/Sampling

An air monitoring/sampling program shall be conducted for the residues transportation route. The program shall include initial, interim, and post-operational radiological assessments. Particulates as well as gaseous airborne components shall be collected where appropriate. The selection of sampling locations shall be predetermined before startup operations. Meteorological conditions shall be documented during the program.

Monitoring of External Radiation Levels Along the Transport Route

External gamma radiation levels along the transport route shall be monitored. Initial, interim, and post-operational measurements shall be conducted.

Contamination Survey of Transport
Route Roadway Surfaces

All roadway and immediately contiguous surfaces shall be surveyed for possible spillage or loss of residues during transportation. Surfaces shall be instrumentally surveyed. Any spillage observed will be sampled and removed to acceptable levels.

Observations

The selection of any of the options presented for cleaning the ditches, construction of short- or intermediate-term storage facilities, packaging or bulk storage of contaminated materials, and improvements for the future detection and containment of contaminants on the DOE-Niagara Falls Storage Site should take into consideration the scheduling of the disposal of the sources of those contaminants. Prior elimination of the sources (e.g., R-10 residues) followed by adequate cleanup of the drainage system will largely eliminate the more costly options for monitoring, filtering, and continued contaminant disposal.

APPENDIX B

SUMMARY OF COSTS
RELATED TO PHASE I, TASK 3

APPENDIX B

SUMMARY OF COSTS
RELATED TO PHASE I, TASK 3

Cost figures are presented here for various options associated with the cleanup of the DOE-NFSS ditches, both off-site and on-site, as well as for short- and intermediate-term storage areas and for an optional water treatment plant.

Costs of Cleaning Off-Site Ditches

Costs are presented for the excavation of soil and vegetation from the off-site ditches and also for the hauling and short-term storage of these materials. Table B-1 presents the costs for the Central Drainage Ditch based on a presumed necessity for cleaning the entire length from the north site boundary to the intersection of Fourmille Creek. Figures are shown for cleaning to depths of 2 and 4 ft. The use of unit costs will permit the extrapolation of costs to other depths as determined by the final soil sample analysis. The table has also been divided into three sections based on the width of the ditch bottom. Construction drawings were not available for the West Drainage Ditch; and so, on the basis of similarity to the Central Drainage Ditch, the excavation, hauling, and storage costs for soil and vegetation were based on a ratio of the lengths of the two ditches ($5,300/15,000 = 0.35$).

Table B-2 presents the costs of hauling and storage of soils and vegetation from the Central Drainage Ditch. The costs for the Central and West Drainage ditches' cleanup are presented in Table B-3.

Costs of Cleaning On-Site Ditches

The costs for cleaning, hauling, and storing the excavated materials from the on-site ditches are based on the same estimated unit costs used for the off-site ditches. There may be some slight savings

TABLE B-1. COSTS OF EXCAVATING CENTRAL DRAINAGE DITCH OFF-SITE

	STATION (100 FT)	WIDTH(FT)	DEPTH OF CUT(FT)	VOLUME(YDS)	UNIT COST, \$1/YD	COSTS (\$1000)
EXCAVATION	0 + 00 — 36 + 60	20	2	5,420	12.20	\$ 66.2
	36 + 60 — 55 + 60	20	2	2,815	12.20	34.3
	55 + 60 — 61 + 60	20	4	1,780	12.20	21.7
	61 + 60 — 110 + 00	20	2	7,170	12.20	87.5
	110 + 00 — 132 + 00	14	2	2,280	12.20	27.8
	132 + 00 — 150 + 00	12	2	1,600	12.20	19.5
TOTALS	0 + 00 — 150 + 00			21,065		\$257.0

TABLE B-2. COSTS OF HAULING AND STORAGE OF SOIL AND VEGETATION FROM CENTRAL DRAINAGE DITCH

	VOLUME(YDS)	UNIT COST, \$1/YD	COST (\$1000)
Hauling-Soil	21,065	4.16	\$ 87.6
Storage-Soil	21,065	0.84	17.7
Hauling-Vegetation (25% of Soil Volume)	5,270	4.16	21.9
Storage-Vegetation	5,270	0.84	4.4
			TOTAL \$131.6

TABLE B-3. COSTS OF C.D.D. AND W.D.D. CLEANUP

	Two-Foot Cut
Central Drainage Ditch Excavation	\$257,000
Hauling and Storage	131,600
West Drainage Ditch Excavation (.35 x CDD costs)	90,000
Hauling and Storage (.35 x CDD costs)	<u>46,000</u>
TOTAL	\$524,600

in the operation because it will be conducted on-site and because of the short hauls required. Estimated costs are shown in Table B-4.

TABLE B-4. ESTIMATED COSTS OF EXCAVATING, HAULING, AND STORAGE OF SOIL AND VEGETATION FROM ON-SITE DITCHES

	Unit Cost (\$)	Quantity (YD ³)	Cost (\$1000)
Excavation	12.20	4,022	\$49.1
Hauling	4.16		16.7
Storage Site	0.84		<u>3.4</u>
TOTAL			\$69.2

Short-Term Storage Area Costs

The costs for preparing a short-term storage area as described in Options 1 through 3 are presented in Table B-5. For costing purposes, an area 80 by 320 ft was used. The costs can be applied to both the roadway Options 1 and 2 or to the open area of Option 3. Transportation costs

for the fill dirt to be used as berms are not included. If a burrow pit on-site is available, the costs will be only those of digging and moving it to the storage site.

TABLE B-5. COSTS FOR SHORT-TERM STORAGE AREAS

300 yd ³ fill	\$ 1,700
Clear 80' x 320' area and form 3' wall with fill	2,100
18 rolls polyethylene 40' x 100' @ \$14 per roll	3,600
500 yd ³ gravel	4,400
Laborer - 100 hrs @ \$18 per hr	1,800
Total	<u>\$13,600</u>

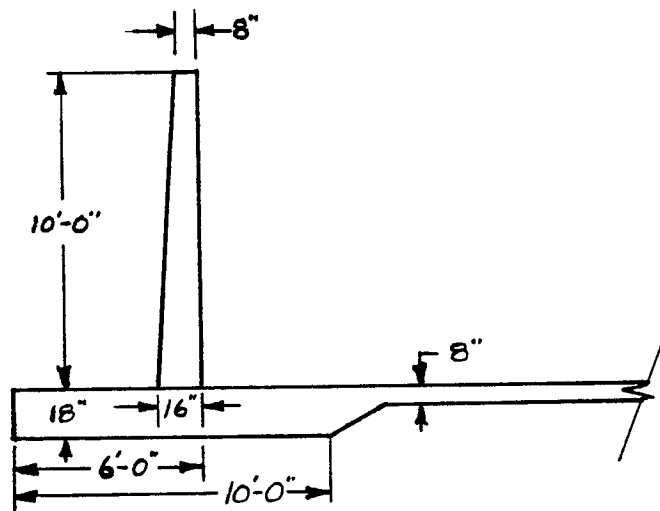
Totals include indirect costs and contingencies, ~40 percent.

A maximum of eleven 80 x 320 ft storage areas will be needed to store 6,500 yds³ of vegetation and 26,000 yds³ of soil from the off-site ditches.

$$11 \times \$13,600 = \$149,600$$

Intermediate-Term Storage Facility Costs

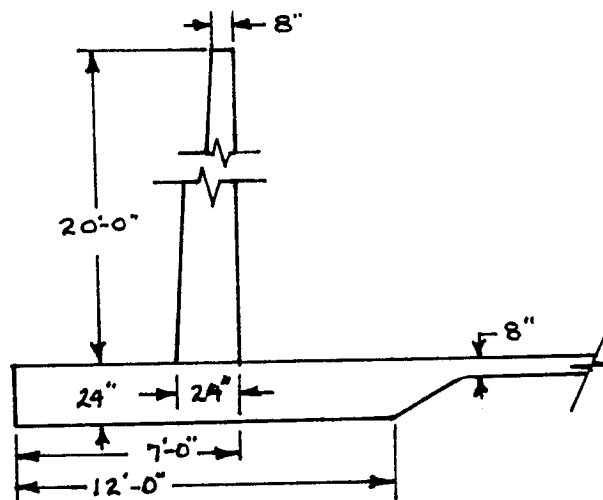
Preliminary cost estimates have been prepared for two basic designs for intermediate-term (5 to 25 yrs) storage facilities (Figures B-1 and B-2). These facilities are intended for the bulk storage of spoils piles, soil excavated from ditches, and other contaminated areas, e.g., Navy dump site. With modification, they could be used for the storage of packaged materials. Both designs have an 80'-0" x 400'-0" floor area. The walls to floor juncture will be sealed with an asphaltic or similar material to minimize leakage through the joint in either direction.



Design B-1a

1. Excavation	\$ 19,000
2. Slab underwall	75,200
3. Remaining 8" slab	84,900
4. 10'-0" wall	120,600
5. Finish wall	7,900
6. Waterstop and caulk	22,600
Total	<u>\$330,200</u>

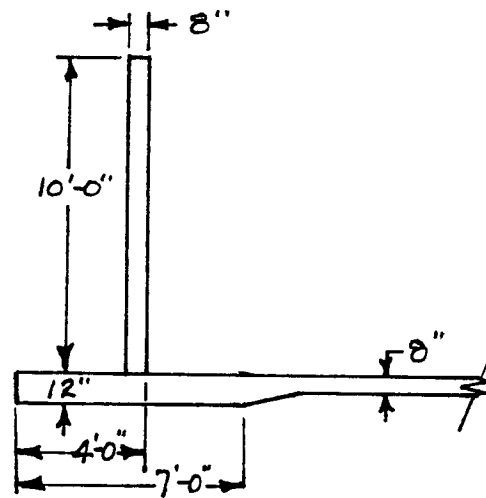
Costs include design contingency and inflation factor to May, 1981.



Design B-1b

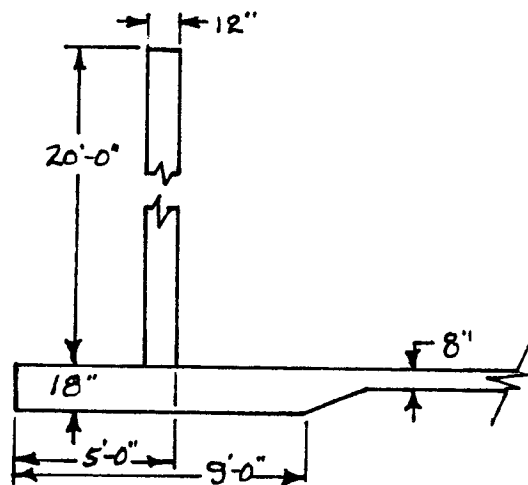
1. Excavation	\$ 19,000
2. Slab underwall	113,700
3. Remaining 8" slab	84,900
4. 20'-0" wall	279,200
5. Finish wall	18,400
6. Waterstops and caulk	26,700
Total	<u>\$541,900</u>

FIGURE B-1. DESIGN I INTERMEDIATE STORAGE FACILITY



Design B-IIa

1. Excavation	\$ 19,000
2. Slab underwall	41,100
3. Remaining 8" slab	84,900
4. 10'-0" wall	93,600
5. Finish wall	7,900
6. Waterstop and caulk	22,600
Total	<u>\$269,100</u>



Design B-IIb

1. Excavation	\$ 19,100
2. Slab underwall	69,900
3. Remaining 8" slab	84,900
4. 20'-0" wall	227,200
5. Finish wall	18,400
6. Waterstop and caulk	26,700
Total	<u>\$446,200</u>

FIGURE B-2. DESIGN II INTERMEDIATE STORAGE FACILITY

Costs for Passive Systems

The estimated costs for constructing a settling basin and weir are presented in Table B-6.

TABLE B-6. COST OF SETTLING BASIN

Excavation	\$ 3,300
Concrete work (weir and baffles)	7,000
Bentonite base	25,400
Miscellaneous grading	<u>700</u>
Total	\$36,400

These costs include contingency and design factors and inflation to May, 1981.

The costs for each of the passive system options are summarized in Table B-7. The costs of digging the ditches surrounding the Building 410 complex are predicated upon the R-10 spoils pile remaining as is. The costs associated with the installation of the filter screen system are not included here because N.L.O. has already installed such a system at NFSS.

TABLE B-7. COST SUMMARY FOR PASSIVE SYSTEM OPTIONS

Option 1. Basins and weirs on the W.D. and C.D.D.	73K	
		<u>73K</u>
Option 2. Excavate connector ditch from W.D. to C.D.D.	32.5K	
Basins and weir on C.D.D.	36.4K	
Dam W.A.D. with connector materials	<u>1.0K</u>	
		69.9K
Option 3. Two basins and weirs on C.D.D.	73K	
Drainage ditches around 410 complex	<u>25K</u>	
		98K

Costs for Active SystemTABLE B-8. PRELIMINARY ESTIMATES OF COST BASED
UPON JANUARY 1, 1981 PRICES*

	Cost Estimate
Miscellaneous Items	
Low Head Dam and Apron	\$ 60,000
12 Million Gallons per day Intake Structure and Pumping Station	480,000
Electrical (power available within 1,000 feet)	60,000
2,000 Feet of 24-inch Ductile Iron Pipe	150,000
Treatment Facilities	
Site Work	190,000
Process Piping	175,000
Treatment Building	205,000
Treatment Equipment	1,210,000
Electrical and Instrumentation	<u>220,000</u>
Total Construction Cost	\$2,750,000
Engineering	250,000
Project Contingency	<u>140,000</u>
Total Project Cost	\$3,140,000

* All cost estimates include a 10 percent design contingency and a 10 percent bid margin.

Annual operation and maintenance costs for the waste treatment facility are listed in Table B-9 assuming a labor rate of \$15.00 per hour, power at \$.04 per kilowatt-hour, lime at \$48.33 per ton, polyelectrolyte at \$.10 per pound, iron (III) sulfate at \$84.25 per ton, and trisodium phosphate at \$17.75 per 100 weight. Plant equipment is amortized for 20 years at 10 percent interest.

TABLE B-9. ANNUAL OPERATION AND MAINTENANCE COSTS

Item	Cost
Labor	\$130,000
Chemical	178,000
Power	10,000
Maintenance	<u>17,000</u>
Total Annual O&M Cost	\$335,000
Amortized Project Cost	<u>369,000</u>
Total Annual Cost	<u>\$704,000</u>

APPENDIX C

WEATHER INFORMATION
LEWISTON, NEW YORK, REGION

APPENDIX C

WEATHER INFORMATION
LEWISTON, NEW YORK, REGION

Precipitation records for three United States weather stations surrounding the U.S. DOE-NFSS are presented here.

TABLE C-1. RAIN AND SNOWFALL,
LEWISTON, NY, AREA

Station	Rain and Snowfall, Lewiston Area ^(a)			
	Average Annual Precipitation	Maximum in 1 Year of Record	Average Annual Snowfall	Maximum Snowfall of Record
Lewiston	29.44	36.44	50.8 ^(b)	75.7
Lockport	36.56	38.11	NR ^(c)	NR
Wilson	<u>25.13</u>	<u>31.66</u>	NR	NR
AVERAGE	31.71	35.40		

(a) Source: Climatology of the United States. Decennial Census of the United States Climate, U.S. Department of Commerce, Washington, D.C.

(b) Included as part of rainfall.

(c) NR = No record.

The rainfall frequency is presented for durations from 30 min to 24 hrs and periods from 1 to 100 yrs.

TABLE C-2. RAINFALL FREQUENCY, NIAGARA REGION(a)

Period (yrs)	Rainfall (in.)	Period (yrs)	Rainfall (in.)
<u>30 MINUTES</u>		<u>1 HR</u>	
1	0.7	1	0.9
2	0.8	2	1.0
5	1.1	5	1.4
10	1.3	10	1.6
25	1.5	25	1.9
50	1.7	50	2.1
100	1.75	100	2.2
<u>2 HRS</u>		<u>3 HRS</u>	
1	1.0	1	1.2
2	1.1	2	1.3
5	1.5	5	1.6
10	1.8	10	2.0
25	2.0	25	2.35
50	2.5	50	2.7
100	2.7	100	3.0
<u>6 HRS</u>		<u>12 HRS</u>	
1	1.4	1	1.6
2	1.55	2	2.0
5	2.0	5	2.6
10	2.5	10	3.0
25	2.8	25	3.5
50	3.1	50	3.6
100	3.5	100	4.0
<u>24 HRS</u>			
1	2.0		
2	2.2		
5	3.0		
10	3.5		
25	4.0		
50	4.5		
100	4.7		

(a) Source: Rainfall Frequency Atlas of the United States. Tech. Paper No. 40, Weather Bureau, U.S. Department of Commerce, Washington, D.C.

DRAFT FINAL REPORT

on

VOLUME II: TASK 3. AN ENGINEERING
EVALUATION OF THE WASTE
IMPOUNDMENT OPTIONS AT THE DOE-
NIAGARA FALLS STORAGE SITE

prepared for

U.S. DEPARTMENT OF ENERGY
REMEDIAL ACTION PROGRAM

March 4, 1981

by

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prepared by

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505 King Avenue
Columbus, Ohio 43201

Under Subcontract for
NATIONAL LEAD COMPANY OF OHIO
Serial No. 4069

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1.0 INTRODUCTION

The DOE-Niagara Falls Storage Site, NFSS, has been managed by the National Lead Company of Ohio, NLO, for the AEC, ERDA, and DOE for a number of years. The site has several buildings containing stored Afrimet residues, an open storage area which has only a cover of soil for protection, and several areas which are contaminated from previous storage or dumping of contaminated materials. Through the years these residues and other contaminated materials have leaked or have been leached through the soil and transported into the extensive on-site and off-site drainage systems, principally the Central Drainage Ditch (CDD) and the West Drainage Ditch (WDD). The drainage system has been contaminated by radionuclides and heavy metals.

In 1972, the Central Drainage Ditch and a short section of Six-mile Creek were decontaminated and the removal material dumped in an on-site spoils pile. Since that time, migration of radionuclides has

recontaminated both the Central Drainage Ditch and the West Drainage Ditch. Additionally, heavy metals have been detected in these ditches as well as under the spoils pile.

2.0 DESCRIPTION OF PROJECT

The project entails the evaluation of sites and engineered waste impoundment facilities for the R-10 spoils pile and contaminated material from the ditchways.

3.0 PROJECT PURPOSE AND JUSTIFICATION

3.1 Purpose

The purpose of this project is to evaluate options for suitable storage facilities for the overburden covering the R-10 residues and the contaminated materials removed from the off-site ditches.

3.2 Justification

This project is justified by the necessity to remove a potential health hazard from the off-site ditches and to store the overburden covering the R-10's.

4.0 SYSTEM DEFINITION AND BASELINE REQUIREMENTS

4.1 Functional Requirements

The primary functional requirements are intermediate-term containment of the spoils and ditch materials and radon suppression.

Intermediate-term is defined as 20 to 25 years. Other functional requirements are surveillability and accessibility.

4.2 Performance Requirements

The principal reliability requirement for this project is that the containment facility be designed to withstand the seasonal changes and weather of the site. It must be capable of protecting the stored materials from rain, snow, wind and inadvertent intrusion.

The facility must also provide means to monitor the condition of the stored materials by reading instruments or measuring any effluent that may drain from wet storage. The design must be such that conventional loading and unloading equipment can be used without resorting to unusual or inconvenient measures.

The facility should be designed so as to require a minimum of maintenance.

4.3 Critical Elements

There do not appear to be any critical elements which would hamper the design and development of suitable facilities for storage of the ditch materials and the R-10 spoils. The test borings on the site indicate that the bearing qualities are generally uniform throughout the areas under consideration for storage pads. The selection of those options which do not include an engineered substructure would impose a critical item in the matter of the strength and durability of the ground cover material.

4.4 Constraints

The principal constraint on the project is the selection of the mode of storage. Other constraints include public acceptability and the period of storage.

5.0 CONCEPT AND OPTIONS

5.1 Concept

The concept for storage is to provide an engineered facility that will protect the ditch materials and R-10 overburden from the weather and from inadvertent intrusion. The facility should be designed to last for a period of 20 to 25 years with minimal maintenance. Further, it should provide a means of surveillance of the stored materials and be accessible for direct loading and unloading.

5.2 Identification of Options

The options considered for storage of the ditch materials and R-10 overburden include

- temporary impoundment on roadways using polymeric sheeting to enclose the materials,
- use of open areas for on the ground storage using polymeric sheeting to enclose the materials
- construction of facilities with reinforced concrete decks and walls with a polymeric sheet covering,
- packaging of materials in drums, special containers and railroad cars,
- use of existing structures and foundations, and
- use of volume reduction techniques to reduce the quantities to be stored.

5.2.1 Temporary Storage Areas

The volume of soil and vegetation to be excavated from off-site drainage ditches is estimated to be 25,800 cu yds. Temporary impoundment of materials to be dredged from the off-site drainage ditches will be necessary because there are no presently available facilities for longer term impoundment or storage. Preliminary estimates of the material quantities to be removed from the off-site and on-site ditches are shown in Appendix D.

The immediate options for temporary impoundment facilities are limited to the use of some of the unused roadways on the site, most of which are overgrown with vegetation and in generally poor condition, or an on-site clearing. The temporary impoundments must be able to contain as much as 25,800 yds³ though the figure could be as high as 29,800 yds³. The volume will be divided between an undetermined amount of subsurface vegetation root systems and decomposing surface vegetation and a remaining volume of soil and silt. It appears necessary to segregate the two volumes because of the decomposition of the organic materials. Total separation of all vegetation is not feasible from a practical or an economic viewpoint. Significant volume reduction of these wastes can be achieved by drying followed by incineration. Also to be considered is the disposition of vegetation which will be cut or otherwise cleared in preparation for dredging the silt from the ditches. This material can also be incinerated or allowed to decay in a designated area. Determination of the actual activity of the material will decide the method of disposal.

Storage Options for Ditch Materials

Option 1: Use of Roadways for Temporary Storage

These roadways would be covered with a polymeric sheeting to contain the water which will drain from the silt, sludge, and debris removed from the off-site ditches. A bare minimum approach would be to spread the contaminated material on the polymeric sheet to a depth of perhaps 5 ft, if it will pile that high in its wet condition, and then wrap the sheet up and over the pile, followed by an overlapping covering sheet which would then be covered with about 6 inches of gravel from off-site. It is not recommended at this time to dig covering material from on-site locations. The gravel covering is necessary to protect the polymeric sheeting from the environment. Care must be taken to not overload the sheeting. Option 1 is illustrated in Figure 5-1.

Option 2: Use of Roadways for Temporary Storage

An improvement to the preceding option would be to border the designated roadways with dikes on both sides of the road to a height of 2 to 3 ft as a means of better retaining the contaminated materials. Again, the polymeric sheeting would be laid across the roadway and the ditches with sufficient edge distance to permit overlapping the sludge. As before, a top covering sheet would be placed over everything and covered with about 6 inches of gravel to protect and anchor the polymeric sheet. A sketch of Option 2 is shown below in Figure 5-2.

Option 1

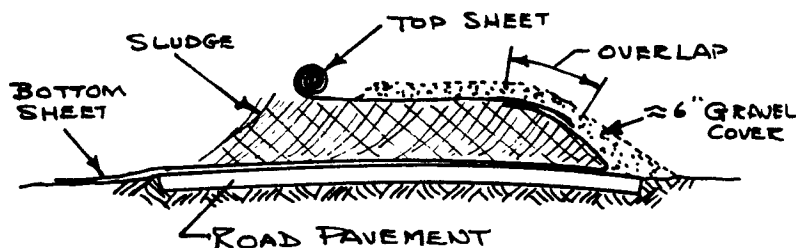


FIGURE 5-1. ROADWAY STORAGE, OPTION 1

Option 2

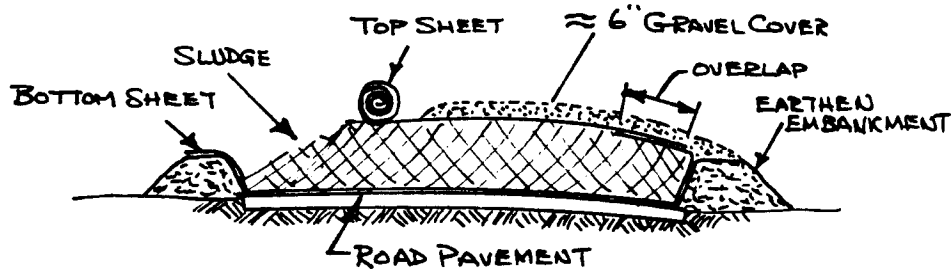


FIGURE 5-2. ROADWAY STORAGE, OPTION 2

Option 3: Use of Cleared Areas for Temporary Storage

The quantities of material estimated in the off-site ditches will require more roadway space than may be desirable from a road-use standpoint. Therefore, a third option using a cleared site between "N" and "O" streets and west of Campbell Boulevard (Figure 5-3) is presented. The site selected for temporary (1 yr) impoundment of the off-site ditch dredgings will be cleared of trees, brush, and debris. It will be leveled and rolled flat to eliminate any protrusions which might pierce the polymeric sheeting to be used to contain the sludge and organic materials. The site should not be excavated below the prevailing grade unless adequate drainage can be provided around the site to the regular site drainage system. It may be necessary to haul in fill dirt to raise the grade to provide satisfactory drainage.

The simplest approach would be to cover the prepared sites with polymeric sheeting upon which the contaminated materials will be dumped as in Options 1 and 2. The edge of the sheet would then be pulled up and onto the sludge pile and a top cover sheet placed over the pile. A cover layer of gravel will serve to protect and anchor the polymeric sheet. Care may be needed not to overload the mound because it may be somewhat fluid and subject to spreading out.

If the sludge proves to be too fluid to be able to pile it to a depth of 4 or 5 ft, or if it is deemed necessary to provide a higher degree of containment, dikes must be provided on the prepared site as done in Option 2. The remaining procedures would be the same.

A means of monitoring any possible leakage from the impoundment areas must also be provided.

5.2.2 Intermediate-Term Storage Areas

The total volumes of NFSS material and spoils to be stored on an interim basis has been estimated to be in excess of 130,000 cu yds. It will have to be impounded in a manner to keep it from further contaminating the environment and also to keep it protected from weather and intrusion.

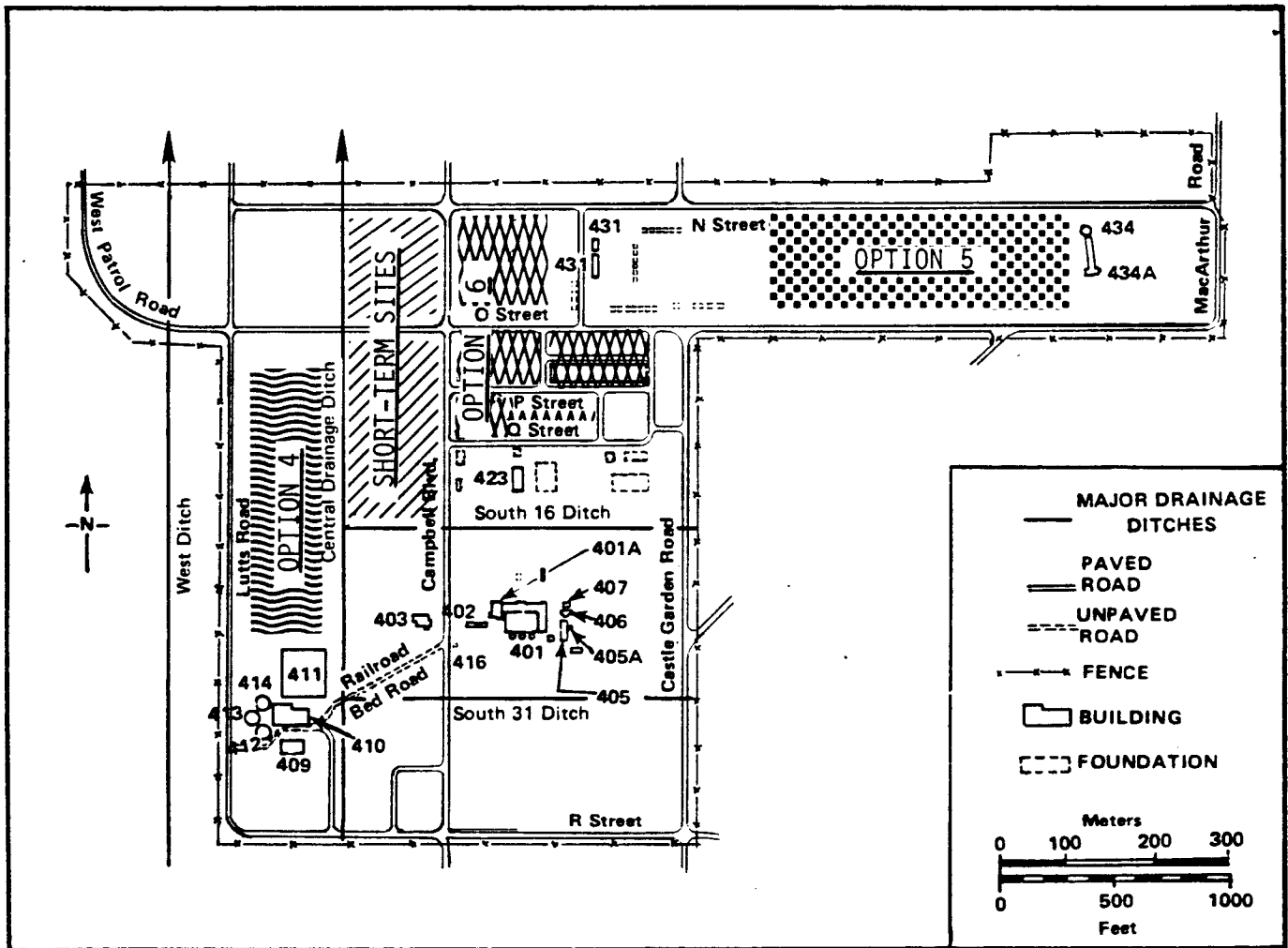


FIGURE 5-3. DIAGRAM OF THE DOE-NIAGARA FALLS STORAGE SITE SHOWING POTENTIAL SHORT- AND INTERIM-STORAGE SITES

The nature of the terrain affords few sites with significant advantages over any other site.

Option 4

The area between Lutts Road and the Central Drainage Ditch as shown on the map, Figure 5-3, has the advantage of bringing all of the storage areas into one compact site. Cleanup of the K-65 residues in Building 434 and other scattered areas of contamination would permit the release of the eastern leg of the site for other uses. The construction of storage pads, or buildings, adjacent to the R-10 spoils pile will require close surveillance of the construction to prevent inadvertent displacement or invasion of the contaminated spoils or R-10 residues. Removal of the R-10's would eliminate this concern. Five or more storage pads or buildings similar in size to Building 430 could be constructed on this site. Construction access would be via Lutts Road.

Option 5

The site between "N" and "O" streets from Coordinate 24E to Coordinate 51E is also suggested for the location of four to five intermediate term impoundments (see Figure 5-3). This site could be extended eastward to Coordinate 62E if required. The site offers the convenience of two access roads on the north and south as well as a former railroad spur along the south side. Additionally, there are no major drainage ditches through the site. The elevation of this site is generally 1 to 2 ft above the terrain on all four sides, thereby providing a slight advantage in drainage. The addition of a crushed rock base and/or a concrete pad would further enhance the drainage.

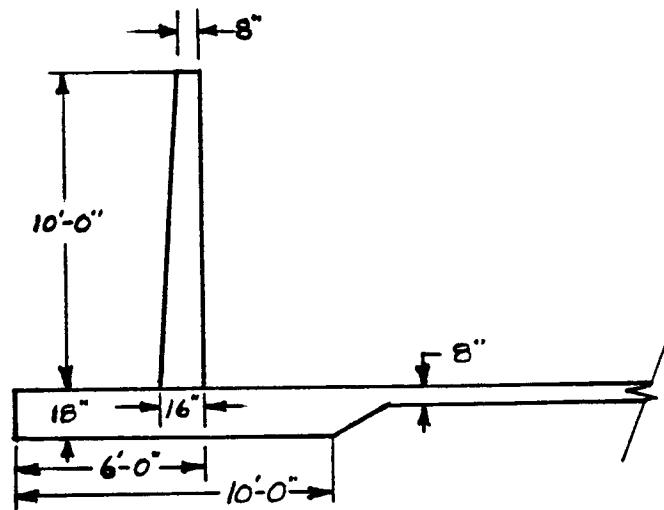
Option 6

The third site under consideration is bounded by "N" Street on the north, "Q" Street on the south, Campbell Avenue on the west and

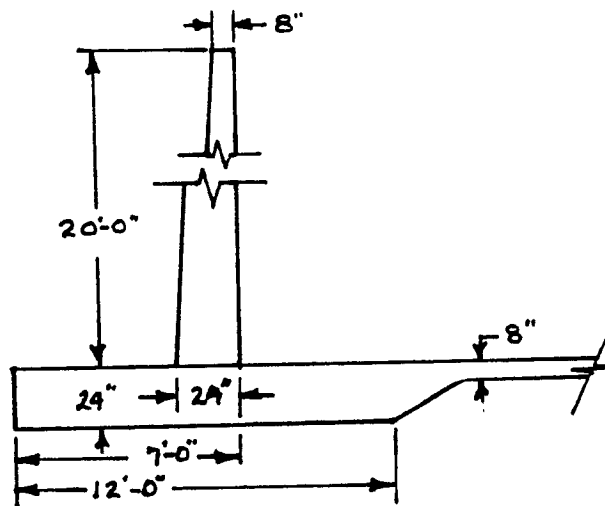
Coordinate 8E on the east (see Figure 5-3). Additionally, Building 430 is included in this site. Four impoundments, each approximately the size of Building 430, would be constructed on an east-west orientation (parallel to 430). Two would be located between "N" and "O" streets, one between "O" and "P" streets, and one between "P" and "Q" streets. This site is bisected by the "K" drainage ditch (east-west) and has several small building foundations which would be broken up and used for foundations. Access is by roads on all sides and the roadbed for a rail spur is still partially intact. In order to accommodate the estimated 130,000 cu yds of contaminated material on the basis of five 400 x 80 ft foundations, the vertical walls would have to be approximately 20 ft high.

Preliminary cost estimates are presented in Appendix B for two basic designs for intermediate-term (5-25 years) storage facilities (Figures 5-4 and 5-5). These facilities are intended for the bulk storage of packaged materials. Both designs have an 80' x 400' floor plan. The wall to floor junctures will be sealed with an asphaltic or similar material to minimize leakage through the joint in either direction.

It will be desirable to backfill outside the walls and grade to the top of the walls in order to assure that the walls remain vertical. Any tendency to lean will break the seal between the floor slab and the walls. Such grading will also serve to make this and other storage sites less conspicuous from off-site. Once the concrete walled impoundments have been completely filled and the till material compacted and graded to a contour designed to provide runoff, a covering of a polymeric sheeting such as Hypalon[®], would be spread over the fill and the top of the impoundment walls to provide a water barrier. This polymeric sheeting would then be covered with a layer of 2 to 3 ft of soil to anchor and protect it from the elements. The final fill would be planted with native vegetation to stabilize the soil and prevent erosion. It should be noted that fill areas continue to settle for periods of up to 15 yrs and may require regrading at some future time.



Design Ia



Design Ib

FIGURE 5-4. DESIGN I INTERMEDIATE STORAGE FACILITY

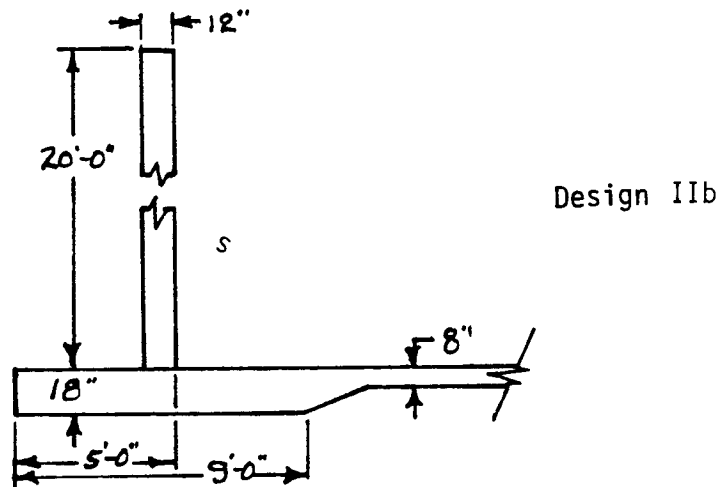
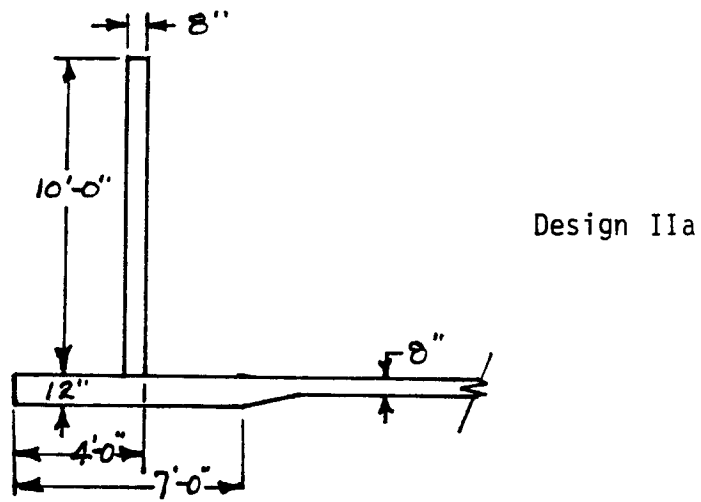


FIGURE 5-5. DESIGN II INTERMEDIATE STORAGE FACILITY

Provisions will be made for a drainage collection system under the footers of the impoundment walls to a sump where any potential leakage of radionuclides can be detected. Additionally, provisions will be made for collecting and venting any volatiles. The prospect of radon as a by-product of decay must be considered.

The preliminary cost estimates are based on the following assumptions:

1. Soil test borings showing bearing strength of soil are not included in the wall price.
2. The area to be used is clear--no buildings, trees, roads, or pipes to be removed.
3. Excavation includes only:
 - clearing 24 ft of topsoil
 - leveling site--assumes 12 ft of cut or fill over the entire area
 - running a compactor over the entire site.
4. A monolithic concrete structure is not required. This estimate is figured using standard construction joints with waterstops and caulking.
5. No real finish is applied to the concrete walls to aid in water-tightness. Finishing price includes removing form ties and patching holes.
6. Design II assumes that both sides of the wall are backfilled at the same rate and time.

5.2.3 Packaging as a Storage Option

Option 7. Packaging as a storage option must be viewed from two aspects. On the one hand it prepares the contaminants to be transported on short notice when a permanent repository has been designated. This would appear to be an attractive option, one which signifies that the waste forms will indeed be transported elsewhere. On the other hand, the packaging process in itself represents a radiological hazard. The handling of the waste material in the packaging operation exposes a larger number of workers to radiation. Add to this the need for repackaging every 4 to 5 yrs and the radiological hazard is increased several times. Additionally, a repacking facility will be required. This constitutes not only

an added radiological hazard but also eventually another waste form to be disposed of after the ditch wastes have been disposed of and the facility decommissioned.

The storage of packaged material would require prepared platforms, accessibility for periodic inspection, a monitoring system for leaks, environmental protection, and very importantly, a facility to repackage the wastes as the initial package is corroded beyond viability. Such a facility would mean an increase in the level of radiological hazard to workers as well as increasing the opportunity for a spill and added costs.

The process of selecting a suitable waste container has been briefly investigated. Standard steel drums have a rather short life. Corrosion usually begins as soon as the drum is exposed to the environment. This will be compounded by the packaging of some materials which may attack the drum material itself. The use of polymeric liners would serve to reduce the chances of internal corrosion but is no guarantee and is an additional complication and cost in the packaging procedure. Special containers such as the modified M-111 bin developed by Argonne National Laboratories (ANL) were also considered. This container holds 67 ft³ or 8,000 lbs. The density of the waste forms under consideration would generally fill the container and still fall within the weight limit. The bin is fabricated of 12 gauge steel (0.10 in.), approximately 1-1/2 times the thickness of the standard 55-gal steel drum but susceptible to the same environmental corrosion. The use of plastic containers does not currently appear to be a viable alternative.

Option 8. The use of railroad hopper cars would provide the ultimate in ready-to-transport containers. Used cars of 2,700 cu ft capacity are available for about \$10,000 while new cars cost between \$30,000 and \$45,000. It appears that 168 such cars would be required for off-site drainage ditch dredgings alone if it becomes necessary to dispose of them in their entirety. As many as 2,600 cars could be required to store all of the contaminated material on-site. Higher capacity cars are also available at a commensurately higher price though the load limit may negate any seeming advantage. Sand and clay weigh approximately

120 lbs per cu ft which would result in a 162 ton load for a 2,700 cu ft car. The maximum load limit for such a car is 75 tons. Such cars are as susceptible to corrosion as any other carbon steel container though protective measures such as a polymeric liner or painting, along with top covers to exclude rain and snow could extend their service life. The comparable total cost of the cars is about one-sixth that of equivalent Argonne M-111 containers and the trucks and couplers have a tangible resale value. The cost of building a suitable railroad yard on-site would, of course, have to be factored into such a project.

5.2.4 Use of Existing Structures and Foundations As Temporary or Interim-Storage Facilities

Option 9. Studies of the existing structures and foundations at the NFSS indicate that maximum storage capacity is approximately 50,500 yds³.

Such a capacity is predicated upon the construction of 20 ft high walls on the foundations of Buildings 401, 410, and 430, and utilization of Building 409 as is with its 15 ft high walls. The first three buildings would be razed, salvaging the steel work from 401 and the usable timbers from 410 and 430. Building 409 was constructed as a reservoir with a 15 ft usable depth and, as such, is already suited for the storage of waste materials. Building 401 was formerly a multi-storied steam generation plant with steel framing and corrugated composition walls and roof. It would be ill-suited, as it now stands, for the efficient storage and ultimate retrieval of contaminated soils and radioactive materials. Building 410 was designed for use as a water treatment and pumping plant. Construction is reinforced concrete and concrete block with a wooden supply tower. The building has numerous levels, cells, and dividing walls which would interfere with the emplacement of contaminated materials. It, like 401, would be unsuited for efficient storage as it stands.

The suggested use of Buildings 401 and 410 is as foundations for impoundment facilities. All superstructures should be razed and salvaged

where feasible. All piping connections, particularly in 410, must be sealed before razing to ensure that all pathways have been blocked. Building 410 will require draining of numerous holding tanks and possibly decontamination of areas currently inaccessible due to high water levels. The below grade sections of 410 can be filled with rubble from the razing operations and sealed with concrete to provide an essentially level platform. Both 401 and 410 appear to have industrial thickness floors which should need no further strengthening preparatory to the construction of retaining walls at the perimeter of each foundation. The height of the retaining walls will be determined as the quantities of materials to be stored are defined. Twenty-foot walls were considered for the volume calculations given previously. This height may prove unnecessary, in which case 10 or 15 ft walls can be considered for 50 to 75 percent of the contained volumes, respectively.

Building 430 has floor space roughly equivalent to the total for Buildings 401 and 410. However, the floor slab is only 5 inches thick and may require reinforcement by a second poured slab depending on the volume and weight of material to be stored therein. At the present time, 430 is enclosed with a timber truss roof and wood column walls. A large percentage of the wall area is given to windows. This building can be refurbished as it stands by repairing roof and wall damage and planning other necessary maintenance to insure that it will remain intact for at least 25 years. This building can then be used to store drums of contaminated materials. Such an arrangement would necessarily require continued surveillance as well as periodic maintenance.

5.3 Evaluation of Options

5.3.1 Short-Term Options

The short-term options for storage on the roadways, Options 1 and 2, are viable only for small quantities of material. The use of the roadways for this purpose should be restricted to those side streets that

are not necessary for access to other sites. The principal advantage is one of having a site immediately available for an unexpected storage requirement. These options should remain available for just such an exigency during the cleanup of the site.

The short-term option for storage in areas along side of the roadways is suggested for temporary storage of ditch materials only. These areas will require the clearing of brush, trees, and other debris, leveling by a bulldozer or grader and probably rolling to eliminate protuberances which might puncture the polymeric sheeting. The use of a side berm to contain the materials to be stored is recommended. It is anticipated that the sediment and soil excavated from the ditches will be in the form of a watery sludge.

Options 4, 5, and 6 are rated about equal. Option 4 has the advantage of pulling all of the storage into the southwest corner of the site close to the stored Afrimet residues. It is, however, accessible on one side only and would require an early cleanup of the R-10s, overburden, and contaminated subsurface soils. Option 5 provides a location on the highest ground in the site and is accessible by two roadways and had a railroad siding which could be rebuilt for rail shipment of the stored materials at some future date. Option 6 provides ready accessibility on all four sides by roadways and could be accessible by an extension of the former rail siding from the site for Option 5. It has the added advantage of being farthest removed from three of the site boundaries.

Option 7, storage of packaged material, prepares the material for future transportation to a disposal site. However, the principal disadvantages are: (1) short package life (i.e., 5-10 yrs), (2) the necessity for periodic repackaging, and (3) the radiological hazards of the packaging process itself. Additionally, the used packages become additional waste for disposal.

Option 8, storage in railroad cars, has the unique advantage of a "ready-to-roll" storage system. It would require the construction of a small freight yard and considerably more maintenance than the engineered

storage pads. Further, the package life of the rail cars would be not more than twice that of the smaller containers considered in Option 7.

Option 9, use of existing structures and foundations, offers a limited capacity for storage which could be used as initial storage area while additional engineered pads are under construction. Approximately one-third of the estimated requirements for storage might be satisfied by the available foundations. If packaged storage should be selected as the preferred option, these foundations could be prepared to house drums or bins. None, except Building 430, would appear to be a very efficient repository.

5.4 Identification of Recommended Concept

The recommended concept is to use the site designated for Option 6, bounded by N and Q streets and Campbell Blvd. for the construction of engineered storage pads. The site can be expanded to the east or to the west, across Campbell, if desired. On the assumption that excavation of the drainage system will begin in 1981, it is recommended that the site designated for short-term storage be used for the storage of ditch materials with the vegetation from the ditches being segregated for future incineration. Further, the short-term storage site should be prepared by clearing and grading and be compacted by rolling and a peripheral berm should be constructed to contain the ditch materials.

6.0 UNCERTAINTIES

The engineering design of the storage facilities using existing, or newly built reinforced concrete pads will use conventional construction methods and hence present no identifiable uncertainties. The use of polymeric sheeting for both a top covering and a ground covering poses the questions of material life and the possibility of undetected puncture during the process of covering. In the options where it is used for

temporary storage, that is 1 to 2 yrs, the material life will be ample and the amount of leakage should be small. The post-cleanup radiological survey would detect any contamination of the ground below the puncture. The use of a polymeric sheeting as a cover for the intermediate-storage facilities can be justified on usage at the EG&G storage site in Idaho Falls, Idaho. The anticipated 20- to 25-yr storage falls well within the reputed 40-yr life with an overburden to protect it from the elements.

7.0 PRELIMINARY ASSESSMENTS

7.1 Safety and Health

The construction of the storage facilities poses no unusual safety problems. A radiological check of the areas selected for the storage site will determine the need for any preconstruction removal of contaminated soils or other material.

A health physics program will be required for contractor personnel engaged in the removal, transportation and storage of ditch materials and the R-10 overburden. A continuing monitoring program of the work areas, travelways, and construction and material handling equipment will be required. A health physic program prepared for the removal, transportation and storage on-site of off-site ditch residues is attached as Appendix A.

7.2 Quality Assurance

A complete quality assurance program which is in compliance with both NRC and DOE requirements will be necessary for this project.

7.3 Environmental

The engineered storage pads will present no significant adverse environmental impact. The recommended sites are level and drained by ditches. The planting of ground cover to protect the earthen embankments will provide protection from erosion and degradation of the embankments. The use of existing structures for packaged storage would not make any change in the environment. If the option for storing the contaminated material in railroad cars is selected, there could be an adverse visual impact. This area is already committed to DOE use for the foreseeable future and therefore the temporary use of the site for storage will not have any significant impact.

The short-term storage options pose a potential adverse environmental impact in the event of a puncture of the polymeric sheeting enclosing the stored materials. This is discussed in Section 6.0, Uncertainties.

8.0 METHOD OF ACCOMPLISHMENT

The project will be accomplished using conventional construction methods. Emphasis will be placed on the health physics aspects in the areas where the radiological survey indicates that precautionary measures must be taken.

9.0 COST ESTIMATE

The cost estimates for removal of the ditch materials and the construction of short and intermediate-term storage areas are reported in Appendix B. The cost estimate for removal of the R-10 overburden is included in the total cost for removal of the R-10's, overburden, contaminated subsurface soil, and backfilling. It is reported in the Task 2 report.

10.0 DESIGN STANDARDS

Standard construction and good workmanship practices will be used on this project. An NRC and DOE approved quality assurance program will be in force.

11.0 REFERENCE DATA

Reference data for soil characterization are presented as Appendix C.

12.0 APPENDICES

Appendix A--Health Physics Program

Appendix B--Summary of Costs Estimates

Appendix C--Soil Core Analysis

Appendix D--Preliminary Estimates of Materials To Be
Removed From Ditches

APPENDIX A

HEALTH PHYSICS PROGRAM

APPENDIX A

HEALTH PHYSICS PROGRAM

Health Physics Program Associated with the
Removal, Transportation, and 1-Yr Storage On-Site
of Off-Site Drainage Ditch Residues

Health Physics Program--Personnel

A comprehensive health physics program for contractor personnel engaged in removal, transportation, and storage of off-site drainage ditch residues shall be required. Although radiation exposures will be quite minimal monitoring program will be necessary for substantiation/documentation purposes.

In addition a radiation safety training program specifically related to the minimal radiological health impact of the operations shall be conducted. Emphasis shall be placed on the minimal radiological concerns and comparisons should be made with typical everyday activities.

A program of monitoring personnel for external radioactive material contamination shall also be conducted. Appropriate decontamination techniques shall be employed whenever contamination is found.

Health Physics Program--Environmental
Removal of Off-Site Ditch Residues

During removal of ditch residues, an environmental monitoring program will be necessary to substantiate impact of the removal operations.

Air Monitoring/Sampling

An air monitoring sampling program at the ditch excavation site will be required. The program shall include initial, interim, and post-operational radiological assessments. Particulates as well as gaseous airborne components shall be measured where appropriate. The selection of sampling locations shall be predetermined before startup operations.

Meteorological conditions shall be observed and documented during sampling. It will be most important to coordinate air sampling events with particular operations in order to accurately assess the environmental impact.

Monitoring of External Radiation Levels at the Excavation Site

A program of monitoring external gamma radiation levels around the disturbed area of the off-site ditches shall be performed to assess the effects of excavation operations. The program shall include initial, interim, and post-operational measurements.

Water Sampling

A water sampling program shall be conducted at runoff locations for waterborne radionuclides. The program will include initial, interim, and post-operational measurements. Sampling shall be performed at pre-selected locations where runoff will be known or suspected to occur.

Transportation of Ditch Residues

Air Monitoring/Sampling

An air monitoring/sampling program shall be conducted for the residues transportation route. The program shall include initial, interim, and post-operational radiological assessments. Particulates as well as gaseous airborne components shall be collected where appropriate. The selection of sampling locations shall be predetermined before startup operations. Meteorological conditions shall be documented during the program.

Monitoring of External Radiation Levels Along the Transport Route

External gamma radiation levels along the transport route shall be monitored. Initial, interim, and post-operational measurements shall be conducted.

Contamination Survey of Transport
Route Roadway Surfaces

All roadway and immediately contiguous surfaces shall be surveyed for possible spillage or loss of residues during transportation. Surfaces shall be instrumentally surveyed. Any spillage observed will be sampled and removed to acceptable levels.

Observations

The selection of any of the options presented for cleaning the ditches, construction of short- or intermediate-term storage facilities, packaging or bulk storage of contaminated materials, and improvements for the future detection and containment of contaminants on the DOE-Niagara Falls Storage Site should take into consideration the scheduling of the disposal of the sources of those contaminants. Prior elimination of the sources (e.g., R-10 residues) followed by adequate cleanup of the drainage system will largely eliminate the more costly options for monitoring, filtering, and continued contaminant disposal.

APPENDIX B

SUMMARY OF COSTS
RELATED TO PHASE I, TASK 3

APPENDIX B

SUMMARY OF COSTS
RELATED TO PHASE I, TASK 3

Cost figures are presented here for various options associated with the cleanup of the DOE-NFSS ditches, both off-site and on-site, as well as for short- and intermediate-term storage areas and for an optional water treatment plant.

Costs of Cleaning Off-Site Ditches

Costs are presented for the excavation of soil and vegetation from the off-site ditches and also for the hauling and short-term storage of these materials. Table B-1 presents the costs for the Central Drainage Ditch based on a presumed necessity for cleaning the entire length from the north site boundary to the intersection of Fourmille Creek. Figures are shown for cleaning to depths of 2 and 4 ft. The use of unit costs will permit the extrapolation of costs to other depths as determined by the final soil sample analysis. The table has also been divided into three sections based on the width of the ditch bottom. Construction drawings were not available for the West Drainage Ditch; and so, on the basis of similarity to the Central Drainage Ditch, the excavation, hauling, and storage costs for soil and vegetation were based on a ratio of the lengths of the two ditches ($5,300/15,000 = 0.35$).

Table B-2 presents the costs of hauling and storage of soils and vegetation from the Central Drainage Ditch. The costs for the Central and West Drainage ditches' cleanup are presented in Table B-3.

Costs of Cleaning On-Site Ditches

The costs for cleaning, hauling, and storing the excavated materials from the on-site ditches are based on the same estimated unit costs used for the off-site ditches. There may be some slight savings

TABLE B-1. COSTS OF EXCAVATING CENTRAL DRAINAGE DITCH OFF-SITE

	STATION (100 FT)	WIDTH(FT)	DEPTH OF CUT(FT)	VOLUME(YDS)	UNIT COST, \$1/YD	COSTS (\$1000)
EXCAVATION	0 + 00 — 36 + 60	20	2	5,420	12.20	\$ 66.2
	36 + 60 — 55 + 60	20	2	2,815	12.20	34.3
	55 + 60 — 61 + 60	20	4	1,780	12.20	21.7
	61 + 60 — 110 + 00	20	2	7,170	12.20	87.5
	110 + 00 — 132 + 00	14	2	2,280	12.20	27.8
	132 + 00 — 150 + 00	12	2	1,600	12.20	19.5
TOTALS	0 + 00 — 150 + 00			21,065		\$257.0

TABLE B-2. COSTS OF HAULING AND STORAGE OF SOIL AND VEGETATION FROM CENTRAL DRAINAGE DITCH

	VOLUME(YDS)	UNIT COST, \$1/YD	COST (\$1000)
Hauling-Soil	21,065	4.16	\$ 87.6
Storage-Soil	21,065	0.84	17.7
Hauling-Vegetation (25% of Soil Volume)	5,270	4.16	21.9
Storage-Vegetation	5,270	0.84	4.4
			TOTAL \$131.6

TABLE B-3. COSTS OF C.D.D. AND W.D.D. CLEANUP

	Two-Foot Cut
Central Drainage Ditch Excavation	\$257,000
Hauling and Storage	131,600
West Drainage Ditch Excavation (.35 x CDD costs)	90,000
Hauling and Storage (.35 x CDD costs)	<u>46,000</u>
TOTAL	\$524,600

in the operation because it will be conducted on-site and because of the short hauls required. Estimated costs are shown in Table B-4.

TABLE B-4. ESTIMATED COSTS OF EXCAVATING, HAULING, AND STORAGE OF SOIL AND VEGETATION FROM ON-SITE DITCHES

	Unit Cost (\$)	Quantity (YD ³)	Cost (\$1000)
Excavation	12.20	4,022	\$49.1
Hauling	4.16		16.7
Storage Site	0.84		<u>3.4</u>
TOTAL			\$69.2

Short-Term Storage Area Costs

The costs for preparing a short-term storage area as described in Options 1 through 3 are presented in Table B-5. For costing purposes, an area 80 by 320 ft was used. The costs can be applied to both the roadway Options 1 and 2 or to the open area of Option 3. Transportation costs

for the fill dirt to be used as berms are not included. If a burrow pit on-site is available, the costs will be only those of digging and moving it to the storage site.

TABLE B-5. COSTS FOR SHORT-TERM STORAGE AREAS

300 yd ³ fill	\$ 1,700
Clear 80' x 320' area and form 3' wall with fill	2,100
18 rolls polyethylene 40' x 100' @ \$14 per roll	3,600
500 yd ³ gravel	4,400
Laborer - 100 hrs @ \$18 per hr	1,800
Total	<u>\$13,600</u>

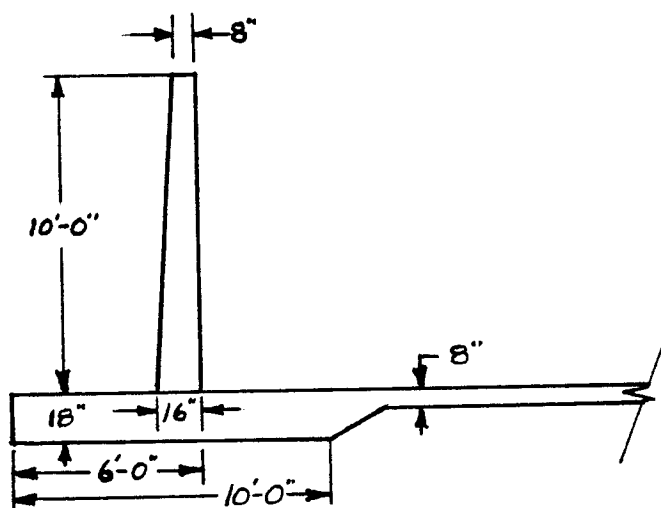
Totals include indirect costs and contingencies, ≈40 percent.

A maximum of eleven 80 x 320 ft storage areas will be needed to store 6,500 yds³ of vegetation and 26,000 yds³ of soil from the off-site ditches.

$$11 \times \$13,600 = \$149,600$$

Intermediate-Term Storage Facility Costs

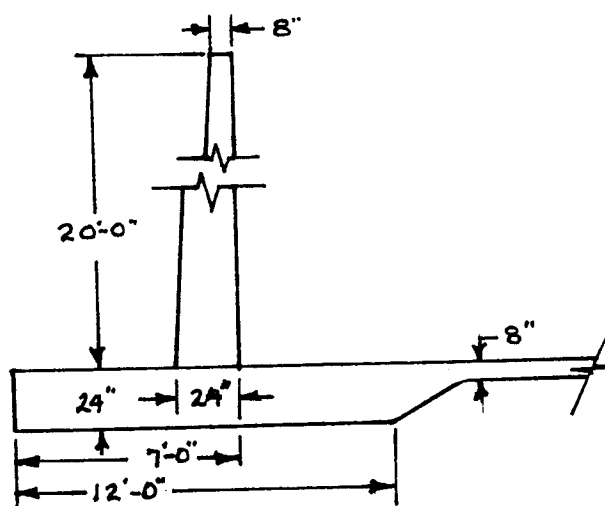
Preliminary cost estimates have been prepared for two basic designs for intermediate-term (5 to 25 yrs) storage facilities (Figures B-1 and B-2). These facilities are intended for the bulk storage of spoils piles, soil excavated from ditches, and other contaminated areas, e.g., Navy dump site. With modification, they could be used for the storage of packaged materials. Both designs have an 80'-0" x 400'-0" floor area. The walls to floor juncture will be sealed with an asphaltic or similar material to minimize leakage through the joint in either direction.



Design B-Ia

1. Excavation	\$ 19,000
2. Slab underwall	75,200
3. Remaining 8" slab	84,900
4. 10'-0" wall	120,600
5. Finish wall	7,900
6. Waterstop and caulk	22,600
Total	<u>\$330,200</u>

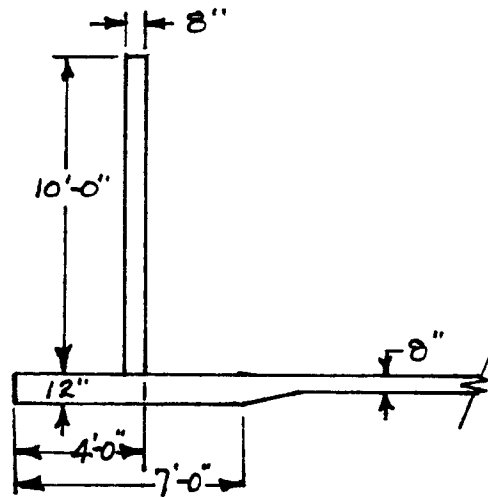
Costs include design contingency and inflation factor to May, 1981.



Design B-Ib

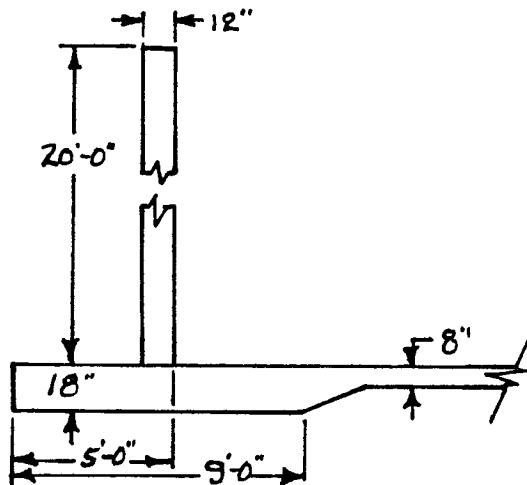
1. Excavation	\$ 19,000
2. Slab underwall	113,700
3. Remaining 8" slab	84,900
4. 20'-0" wall	279,200
5. Finish wall	18,400
6. Waterstops and caulk	26,700
Total	<u>\$541,900</u>

FIGURE B-1. DESIGN I INTERMEDIATE STORAGE FACILITY



Design B-IIa

1. Excavation	\$ 19,000
2. Slab underwall	41,100
3. Remaining 8" slab	84,900
4. 10'-0" wall	93,600
5. Finish wall	7,900
6. Waterstop and caulk	22,600
Total	<u>\$269,100</u>



Design B-IIb

1. Excavation	\$ 19,100
2. Slab underwall	69,900
3. Remaining 8" slab	84,900
4. 20'-0" wall	227,200
5. Finish wall	18,400
6. Waterstop and caulk	26,700
Total	<u>\$446,200</u>

FIGURE B-2. DESIGN II INTERMEDIATE STORAGE FACILITY

Costs for Passive Systems

The estimated costs for constructing a settling basin and weir are presented in Table B-6.

TABLE B-6. COST OF SETTLING BASIN

Excavation	\$ 3,300
Concrete work (weir and baffles)	7,000
Bentonite base	25,400
Miscellaneous grading	<u>700</u>
Total	\$36,400

These costs include contingency and design factors and inflation to May, 1981.

The costs for each of the passive system options are summarized in Table B-7. The costs of digging the ditches surrounding the Building 410 complex are predicated upon the R-10 spoils pile remaining as is. The costs associated with the installation of the filter screen system are not included here because N.L.O. has already installed such a system at NFSS.

TABLE B-7. COST SUMMARY FOR PASSIVE SYSTEM OPTIONS

Option 1. Basins and weirs on the W.D. and C.D.D.	73K	
		<u>73K</u>
Option 2. Excavate connector ditch from W.D. to C.D.D.	32.5K	
Basins and weir on C.D.D.	36.4K	
Dam W.A.D. with connector materials	<u>1.0K</u>	
		69.9K
Option 3. Two basins and weirs on C.D.D.	73K	
Drainage ditches around 410 complex	<u>25K</u>	
		98K

Costs for Active SystemTABLE B-8. PRELIMINARY ESTIMATES OF COST BASED
UPON JANUARY 1, 1981 PRICES*

	Cost Estimate
Miscellaneous Items	
Low Head Dam and Apron	\$ 60,000
12 Million Gallons per day Intake Structure and Pumping Station	480,000
Electrical (power available within 1,000 feet)	60,000
2,000 Feet of 24-inch Ductile Iron Pipe	150,000
Treatment Facilities	
Site Work	190,000
Process Piping	175,000
Treatment Building	205,000
Treatment Equipment	1,210,000
Electrical and Instrumentation	<u>220,000</u>
Total Construction Cost	\$2,750,000
Engineering	250,000
Project Contingency	<u>140,000</u>
Total Project Cost	\$3,140,000

* All cost estimates include a 10 percent design contingency and a 10 percent bid margin.

Annual operation and maintenance costs for the waste treatment facility are listed in Table B-9 assuming a labor rate of \$15.00 per hour, power at \$.04 per kilowatt-hour, lime at \$48.33 per ton, polyelectrolyte at \$.10 per pound, iron (III) sulfate at \$84.25 per ton, and trisodium phosphate at \$17.75 per 100 weight. Plant equipment is amortized for 20 years at 10 percent interest.

TABLE B-9. ANNUAL OPERATION AND MAINTENANCE COSTS

Item	Cost
Labor	\$130,000
Chemical	178,000
Power	10,000
Maintenance	<u>17,000</u>
Total Annual O&M Cost	\$335,000
Amortized Project Cost	<u>369,000</u>
Total Annual Cost	<u>\$704,000</u>

APPENDIX C

SOIL CORE ANALYSIS FOR
THE DOE-NIAGARA FALLS STORAGE SITE

APPENDIX C

SOIL CORE ANALYSIS FOR
THE DOE-NIAGARA FALLS STORAGE SITESoil Core Analysis

Core samples of uncontaminated soils on the site were analyzed for the purpose of characterizing soils and determining the most suitable locations for interim storage of radioactive residues. On-site coordinates were selected for coring to represent prime areas being considered for interim storage. Coordinates selected for this analysis did not include the R-10 area, Navy dump area, and other areas known to be contaminated. Soils were cored at 2-ft intervals to a depth of 14-16 ft using a split-spoon sampler.

Sampled core increments were placed in plastic bags and shipped to BCD for analysis. Soil characteristics were determined on each sample. These included: particle size analysis, pH, cation exchange capacity, and percent organic matter. Procedures for all determinations were adapted from standard soils analysis being performed at Ohio State University.

Table C-1 shows particle size, pH, lime test index, and cation exchange capacity of uncontaminated soils within the DOE-Niagara Falls Storage Site. Throughout the site, cation exchange capacity and soil organic matter is low. Vegetation effects on shallow soils is apparent in the 0-2 ft increment only.

While migration of nuclides, rare earths, and metals should be minimal through these high clay soils, the occurrence of so many saturated zones and the large depths increases potential for lateral as well as vertical migration (Figure C-1). Even within these clay-rich soils, many areas of sand, especially in disheveled areas, were found. Figure C-2 shows percent sand, silt, and clay for cores by grid coordinate (see Figure C-1 for coordinate location).

TABLE C-1. SOIL CHARACTERISTICS OF AREAS WITHIN THE DOE-NIAGARA FALLS
STORAGE SITE WHICH ARE UNCONTAMINATED

LOCATION	DEPTH	SAND %	SILT %	CLAY %	PH	LTI	CEC	ORGANIC MATTER %	TEXTURE
N03 E24	0- 2	71.0	16.0	13.0	8.9	80	5.9	1.9	SANDY LOAM
	2- 4				8.9	80	3.4	1.4	
	4- 6	11.0	30.0	59.0	8.5	75	7.9	0.4	CLAY
	6- 8	9.0	24.0	67.0	8.5	75	7.9	0.6	CLAY
	8-10	19.0	28.0	53.0	8.5	75	8.6	0.4	CLAY
	10-12	31.0	26.0	43.0	8.5	75	6.3	0.4	CLAY
	12-14	49.0	18.0	33.0	8.6	75	4.1	0.3	SANDY CLAY LOAM
N03 E32	0- 2	49.0	28.0	23.0	8.2	74	10.1	2.0	LOAM
	2- 4	29.0	26.0	45.0	8.4	75	7.2	0.5	CLAY
	4- 6	41.0	26.0	33.0	8.6	75	5.4	0.1	CLAY LOAM
	6- 8	59.0	30.0	11.0	8.8	75	3.1	.0	SANDY LOAM
	8-10	61.0	28.0	11.0	8.9	75	2.7	.0	SANDY LOAM
	10-12	51.0	30.0	19.0	8.7	75	2.5	0.0	LOAM
N03 E40	0- 2	51.0	30.0	19.0	7.8	74	5.4	2.3	LOAM
	2- 4	57.0	30.0	13.0	8.6	75	1.9	.0	SANDY LOAM
	4- 6	55.0	32.0	13.0	8.7	75	1.8	.0	SANDY LOAM
	6- 8	59.0	28.0	13.0	8.6	75	1.4	0.1	SANDY LOAM
	8-10	63.0	24.0	13.0	8.7	75	1.6	.0	SANDY LOAM
	10-12	37.0	26.0	37.0	8.5	75	3.1	0.0	CLAY LOAM

Table C-1. (Continued)

LOCATION	DEPTH	SAND %	SILT %	CLAY %	PH	LTI	CEC	ORGANIC MATTER %	TEXTURE
N03 E48	0- 2	59.0	26.0	15.0	7.9	74	8.3	3.9	SANDY LOAM
	2- 4	31.0	52.0	17.0	8.4	75	4.0	0.5	SILT LOAM
	4- 6	31.0	26.0	43.0	8.5	75	5.2	0.3	CLAY
	6- 8	35.0	28.0	37.0	8.5	75	4.7	0.2	CLAY LOAM
	8-10	43.0	26.0	31.0	8.5	75	3.2	0.2	CLAY LOAM
	10-12	61.0	18.0	21.0	8.5	75	2.2	0.2	SANDY CLAY LOAM
N05 E28	0- 2				7.9	74	5.0	5.7	
	2- 4	43.0	26.0	31.0	8.4	75	4.7	1.5	CLAY LOAM
	4- 6	35.0	24.0	41.0	8.6	75	3.8	0.7	CLAY
	6- 8	23.0	28.0	49.0	8.7	75	3.4	0.3	CLAY
	8-10	43.0	26.0	31.0	8.4	75	3.5	1.6	CLAY LOAM
	10-12	55.0	18.0	27.0	8.7	75	2.2	0.2	SANDY CLAY LOAM
N05 E36	0- 2	53.0	12.0	35.0	7.8	73	11.9	4.3	SANDY CLAY LOAM
	2- 4				8.1	75	6.3	1.5	
	4- 6	41.0	26.0	33.0	8.5	76	6.1	0.3	CLAY LOAM
	6- 8	33.0	26.0	41.0	8.8	76	6.1	0.3	CLAY
	8-10	45.0	26.0	29.0	8.8	76	4.5	0.4	SANDY CLAY LOAM
	10-12	55.0	26.0	19.0	8.7	76	3.4	0.2	SANDY LOAM

TABLE C-1. (Continued)

LOCATION	DEPTH	SAND %	SILT %	CLAY %	PH	LTI	CEC	ORGANIC MATTER %	TEXTURE
N05 E44	0- 2	49.0	34.0	17.0	7.7	73	7.9	3.3	LOAM
	2- 4	53.0	30.0	17.0	8.0	74	4.7	0.4	SANDY LOAM
	4- 6	37.0	24.0	39.0	8.4	75	3.4	0.3	CLAY LOAM
	6- 8	35.0	28.0	37.0	8.4	75	3.6	0.1	CLAY LOAM
	8-10	41.0	28.0	31.0	8.5	75	2.9	0.1	CLAY LOAM
	10-12	61.0	20.0	19.0	8.6	75	1.7	0.1	SANDY LOAM
	12-14	67.0	16.0	17.0	8.6	75	1.7	0.1	SANDY LOAM
N07 E24	0- 2	53.0	26.0	21.0	7.6	74	9.9	5.2	SANDY CLAY LOAM
	2- 4	41.0	28.0	31.0	8.2	76	7.7	2.3	CLAY LOAM
	4- 6	25.0	28.0	47.0	8.6	77	7.0	0.6	CLAY
	6- 8	75.0	10.0	15.0	8.8	77	2.0	0.2	SANDY LOAM
	8-10	67.0	26.0	7.0	8.9	77	1.1	0.2	SANDY LOAM
	10-12	33.0	26.0	41.0	8.8	77	3.4	0.4	CLAY
	12-14	71.0	18.0	11.0	9.0	77	0.3	0.1	SANDY LOAM
N07 E32	0- 2	47.0	26.0	27.0	7.9	73	9.3	2.8	SANDY CLAY LOAM
	2- 4	27.0	26.0	47.0	8.4	75	7.6	0.2	CLAY
	4- 6	33.0	26.0	41.0	8.3	75	8.1	1.0	CLAY
	6- 8	31.0	26.0	43.0	8.5	75	5.0	0.3	CLAY
	8-10	45.0	26.0	29.0	8.0	74	8.8	0.2	SANDY CLAY LOAM
	10-12	53.0	24.0	23.0	8.5	76	2.5	0.1	SANDY CLAY LOAM
	12-14	39.0	24.0	37.0	8.4	75	2.7	0.3	CLAY LOAM

TABLE C-1. (Continued)

LOCATION	DEPTH	SAND %	SILT %	CLAY %	PH	LTI	CEC	ORGANIC MATTER %	TEXTURE
N07 E40	0- 2	49.0	28.0	23.0	8.1	74	12.2	2.8	LOAM
	2- 4	31.0	26.0	43.0	8.6	75	5.0	0.3	CLAY
	4- 6	41.0	22.0	37.0	8.7	75	4.5	0.2	CLAY LOAM
	6- 8	67.0	12.0	21.0	8.9	75	2.1	0.1	SANDY CLAY LOAM
	8-10	85.0	10.0	5.0	9.0	75	1.1	.0	LOAMY SAND
	10-12	85.0	8.0	7.0	9.0	75	0.9	0.1	LOAMY SAND
N07 E48	0- 2	57.0	26.0	17.0	6.6	67	8.6	4.2	SANDY LOAM
	2- 4	39.0	24.0	37.0	8.5	75		0.2	CLAY LOAM
	4- 6	31.0	26.0	43.0	8.4	75	4.7	0.3	CLAY
	6- 8	47.0	24.0	29.0	8.6	75	3.8	0.3	SANDY CLAY LOAM
	8-10	37.0	22.0	41.0	8.7	75	4.7	0.3	CLAY
	10-12	39.0	28.0	33.0	8.8	75	3.6	0.3	CLAY LOAM
N04 W04	0- 2	45.0	24.0	31.0	7.9	75	9.1	1.7	SANDY CLAY LOAM
	2- 4	37.0	28.0	35.0	7.9	74		1.5	CLAY LOAM
	4- 6	29.0	24.0	47.0	8.1	75	4.9	0.7	CLAY
	6- 8	23.0	26.0	51.0	9.1	75	5.8	1.1	CLAY
	8-10	25.0	26.0	49.0	8.1	75	4.9	0.7	CLAY
	10-12	27.0	26.0	47.0	8.1	75	5.8	0.7	CLAY
	12-14	33.0	22.0	45.0	8.1	75	3.1	0.7	CLAY
	14-16	35.0	24.0	41.0	8.1	75	3.4	0.8	CLAY

TABLE C-1. (Continued)

LOCATION	DEPTH	SAND %	SILT %	CLAY %	PH	LTI	CEC	ORGANIC MATTER %	TEXTURE
N04 W13	0- 2	61.0	20.0	19.0	6.5	67	11.1	3.7	SANDY LOAM
	2- 4	51.0	20.0	29.0	7.6	72	9.0	1.2	SANDY CLAY LOAM
	4- 6	35.0	26.0	39.0	8.2	75	6.1	0.3	CLAY LOAM
	6- 8	31.0	28.0	41.0	8.3	75	4.1	0.2	CLAY
	8-10	27.0	24.0	49.0	8.3	75	5.0	0.5	CLAY
	10-12	41.0	28.0	31.0	8.3	75	2.7	0.3	CLAY LOAM
	12-14	67.0	22.0	11.0	8.4	75	3.7	0.1	SANDY LOAM
	14-16	45.0	24.0	31.0	8.2	75	4.5	0.3	SANDY CLAY LOAM
N08 W04	0- 2	47.0	34.0	19.0	7.8	73	7.0	2.2	LOAM
	2- 4	19.0	28.0	53.0	8.2	74	9.0	0.4	CLAY
	4- 6	17.0	22.0	61.0	8.3	75	7.0	0.3	CLAY
	6- 8	29.0	26.0	45.0	8.3	75	4.3	0.2	CLAY
	8-10	29.0	26.0	45.0	8.4	75	2.7	0.3	CLAY
	10-12	37.0	22.0	41.0	8.3	75	11.1	0.3	CLAY
	12-14	59.0	18.0	23.0	8.5	75	9.0	0.2	SANDY CLAY LOAM
N08 W13	0- 2	61.0	20.0	19.0	7.2	71	8.8	2.3	SANDY LOAM
	2- 4	41.0	22.0	37.0	8.0	74	6.7	0.4	CLAY LOAM
	4- 6	47.0	22.0	31.0	8.0	75	5.2	0.4	SANDY CLAY LOAM
	6- 8	57.0	22.0	21.0	8.3	75	1.8	0.4	SANDY CLAY LOAM
	8-10	57.0	20.0	23.0	8.3	75	1.8	0.1	SANDY CLAY LOAM
	10-12	53.0	22.0	25.0	8.3	75	3.2	0.5	SANDY CLAY LOAM
	12-14	41.0	24.0	35.0	8.4	75	4.9	0.5	CLAY LOAM

TABLE C-1. (Continued)

LOCATION	DEPTH	SAND %	SILT %	CLAY %	PH	LTl	CEC	ORGANIC MATTER %	TEXTURE
S04 W02	0- 2	51.0	28.0	21.0	8.1	74	6.1	3.2	LOAM
	2- 4	73.0	14.0	13.0	8.3	75	4.1	0.4	SANDY LOAM
	4- 6	39.0	20.0	41.0	8.2	75	2.2	0.3	CLAY
	6- 8	45.0	20.0	35.0	8.2	75	1.6	0.3	SANDY CLAY LOAM
	8-10	59.0	14.0	27.0	8.2	75	1.4	0.1	SANDY CLAY LOAM
	10-12	61.0	18.0	21.0	8.3	75	1.6	0.2	SANDY CLAY LOAM
	12-14	65.0	16.0	19.0	8.4	75	1.5	0.4	SANDY LOAM
	14-16	63.0	20.0	17.0	8.4	75	2.2	0.2	SANDY LOAM
S04 W06	0- 2	47.0	32.0	21.0	8.1	74	4.5	1.9	LOAM
	2- 4	69.0	12.0	19.0	8.5	75	1.8	0.2	SANDY LOAM
	4- 6	71.0	10.0	19.0	8.3	75	0.9	0.2	SANDY LOAM
	6- 8	75.0	6.0	19.0	8.3	75	0.9	0.2	SANDY LOAM
	8-10	87.0	4.0	9.0	8.5	75	0.3	0.1	LOAMY SAND
	10-12	81.0	6.0	13.0	8.4	75	0.3	0.1	SANDY LOAM
	12-14	41.0	20.0	39.0	8.3	75	1.4	0.4	CLAY LOAM
	14-16	55.0	16.0	29.0	8.3	75	1.9	0.3	SANDY CLAY LOAM
S04 W10	0- 2	51.0	26.0	23.0	7.9	73	12.1	3.4	SANDY CLAY LOAM
	2- 4	41.0	20.0	39.0	8.2	74	7.0	0.7	CLAY LOAM
	4- 6	33.0	22.0	45.0	8.3	75	5.0	0.6	CLAY
	6- 8	23.0	28.0	49.0	8.3	75	3.6	0.3	CLAY
	8-10	53.0	16.0	31.0	8.4	75	1.9	0.2	SANDY CLAY LOAM
	14-16	73.0	10.0	17.0	8.4	75	2.1	0.4	SANDY LOAM

TABLE C-1. (Continued)

LOCATION	DEPTH	SAND %	SILT %	CLAY %	PH	LTI	CEC	ORGANIC MATTER %	TEXTURE
S04 W14	0- 2	45.0	22.0	33.0	7.9	73	11.5	3.3	SANDY CLAY LOAM
	2- 4	29.0	28.0	43.0	8.2	74	6.7	0.9	CLAY
	4- 6	25.0	24.0	51.0	8.3	75	7.4	0.3	CLAY
	6- 8	23.0	24.0	53.0	8.4	75	4.9	0.3	CLAY
	8-10	23.0	26.0	51.0	8.3	75	5.2	0.3	CLAY
	10-12	21.0	22.0	57.0	8.3	75	3.0	0.2	CLAY
	12-14	9.0	22.0	69.0	8.3	75	3.6	0.6	CLAY
	14-16	7.0	28.0	65.0	8.2	75	2.7	0.5	CLAY
S08 W04	0- 2	43.0	34.0	23.0	7.9	74	7.8	2.4	LOAM
	2- 4	41.0	34.0	25.0	8.1	75	6.4	0.4	LOAM
	4- 6	31.0	28.0	41.0	8.1	75	3.3	0.4	CLAY
	6- 8	53.0	28.0	19.0	8.2	75	1.9	0.2	SANDY LOAM
	8-10	25.0	24.0	51.0	8.2	75	3.3	0.4	CLAY
	10-12				8.1	75	3.5	0.6	
	12-14	27.0	30.0	43.0	8.1	75	3.3	0.7	CLAY
	14-16	31.0	30.0	39.0	8.1	75	2.6	0.6	CLAY LOAM
S08 W12	0- 2	45.0	32.0	23.0	8.1	74	8.2	3.2	LOAM
	2- 4	29.0	50.0	21.0	8.3	75	5.2	0.8	LOAM
	4- 6	29.0	30.0	41.0	8.3	75	5.5	0.3	CLAY
	6- 8	39.0	32.0	29.0	8.2	75	4.4	1.3	CLAY LOAM
	8-10	35.0	18.0	47.0	8.2	75	2.5	0.4	CLAY
	10-12	49.0	22.0	29.0	8.2	75	2.2	0.5	SANDY CLAY LOAM
	12-14	39.0	28.0	33.0	8.2	75	1.8	0.4	CLAY LOAM

TABLE C-1. (Continued)

LOCATION	DEPTH	SAND %	SILT %	CLAY %	PH	LTl	CEC	ORGANIC MATTER %	TEXTURE
S12 W02	0- 2	51.0	24.0	25.0	8.3	74	4.0	2.2	SANDY CLAY LOAM
	2- 4	33.0	26.0	41.0	8.5	75	4.5	0.6	CLAY
	4- 6	25.0	28.0	47.0	8.5	75	4.0	0.3	CLAY
	6- 8	45.0	18.0	37.0	8.5	75	2.5	0.5	CLAY LOAM
	8-10	83.0	6.0	11.0	8.8	75	2.1	0.2	LOAMY SAND
	10-12	89.0	4.0	7.0	8.9	75	0.5	0.1	SAND
	12-14	53.0	20.0	27.0	8.5	75	1.9	0.0	SANDY CLAY LOAM
	14-16	81.0	12.0	7.0	8.8	75	1.5	.0	LOAMY SAND
S12 W06	0- 2	57.0	22.0	21.0	7.9	73	7.7	3.1	SANDY CLAY LOAM
	2- 4	45.0	18.0	37.0	8.1	74	5.9	0.5	CLAY LOAM
	4- 6	61.0	18.0	21.0	8.4	75	1.6	0.1	SANDY CLAY LOAM
	6- 8	33.0	24.0	43.0	8.3	75	3.4	0.3	CLAY
	8-10	49.0	22.0	29.0	8.4	75	3.1	0.3	SANDY CLAY LOAM
	10-12	31.0	26.0	43.0	8.2	75	3.2	0.3	CLAY
	14-16	41.0	24.0	35.0	8.3	75	3.6	0.2	CLAY LOAM
S12 W14	0- 2	47.0	28.0	25.0	8.0	74	10.1	3.1	LOAM
	2- 4	27.0	24.0	49.0	8.4	75	4.7	0.4	CLAY
	4- 6	25.0	26.0	49.0	8.4	75	5.5	0.6	CLAY
	6- 8	21.0	26.0	53.0	8.4	75	5.2	0.4	CLAY
	8-10	23.0	26.0	51.0	8.4	75	4.7	0.4	CLAY
	10-12	25.0	24.0	51.0	8.4	75	4.0	0.3	CLAY
	12-14	25.0	24.0	51.0	8.3	75	3.5	0.3	CLAY
	14-16	27.0	24.0	49.0	8.3	75	3.0	0.7	CLAY
	16-18	21.0	28.0	51.0	8.3	75	3.3	0.7	CLAY

TABLE C-1. (Continued)

LOCATION	DEPTH	SAND %	SILT %	CLAY %	PH	LTI	CEC	ORGANIC MATTER %	TEXTURE
S02 E10	0- 2	49.0	24.0	27.0	8.3	75	7.9	2.6	SANDY CLAY LOAM
	2- 4	55.0	22.0	23.0	8.6	75	5.0	0.3	SANDY CLAY LOAM
	4- 6	51.0	20.0	29.0	8.7	76	2.3	0.1	SANDY CLAY LOAM
	6- 8	47.0	24.0	29.0	8.7	76	2.5	0.1	SANDY CLAY LOAM
	8-10	53.0	20.0	27.0	8.7	76	2.4	0.3	SANDY CLAY LOAM
	10-12	43.0	26.0	31.0	8.6	76	2.0	0.3	CLAY LOAM
	12-14	49.0	24.0	27.0	8.6	76	2.1	0.4	SANDY CLAY LOAM
	14-16	35.0	32.0	33.0	8.5	76	2.3	0.5	CLAY LOAM
S02 E15	0- 2	51.0	26.0	23.0	8.1	74	7.7	3.4	SANDY CLAY LOAM
	2- 4	29.0	28.0	43.0	8.4	75	6.5	0.4	CLAY
	4- 6	25.0	24.0	51.0	8.7	75	3.2	0.3	CLAY
	6- 8	43.0	28.0	29.0	8.7	75	1.6	0.1	CLAY LOAM
	8-10	37.0	24.0	39.0	8.6	75	2.7	0.3	CLAY LOAM
	10-12	51.0	24.0	25.0	8.7	75	3.5	0.1	SANDY CLAY LOAM
	12-14	53.0	30.0	17.0	8.6	75	2.0	0.1	SANDY LOAM
	14-16	55.0	26.0	19.0	8.6	75	1.6	0.1	SANDY LOAM
S02 E19	0- 2	53.0	34.0	13.0	7.5	72	7.9	5.6	SANDY LOAM
	2- 4	33.0	28.0	39.0	8.2	75	4.1	0.3	CLAY LOAM
	4- 6	29.0	24.0	47.0	8.3	76	2.7	0.2	CLAY
	6- 8	29.0	26.0	45.0	8.5	76	2.8	0.2	CLAY
	8-10	31.0	24.0	45.0	8.5	76	2.9	0.2	CLAY
	10-12	83.0	8.0	9.0	8.6	76	1.7	0.2	LOAMY SAND
	12-14	51.0	20.0	29.0	8.5	76	2.0	0.2	SANDY CLAY LOAM
	14-16	81.0	10.0	9.0	8.6	76	2.2	0.1	LOAMY SAND

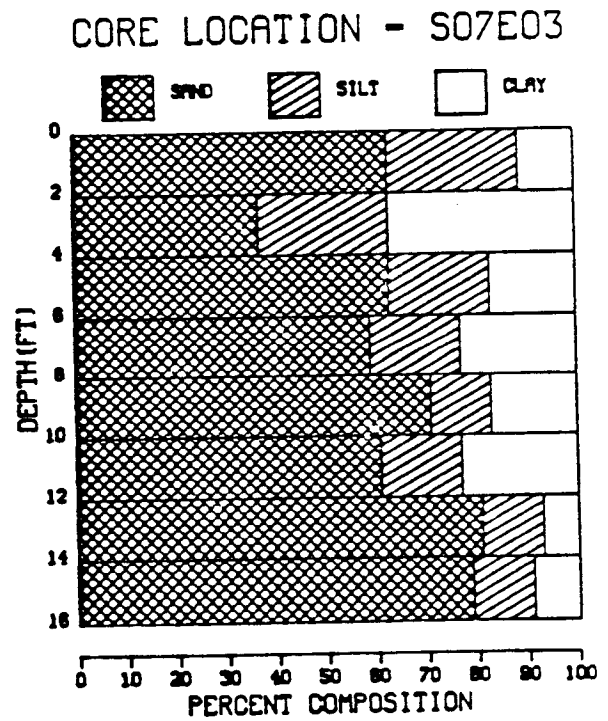
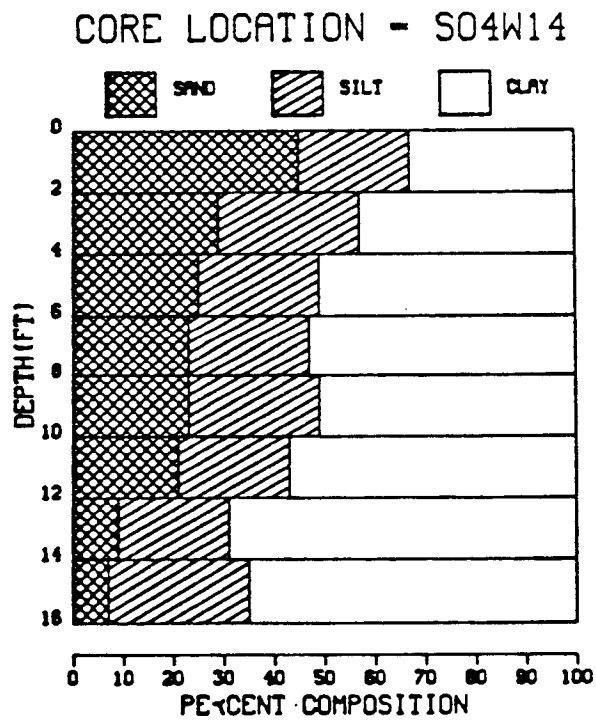
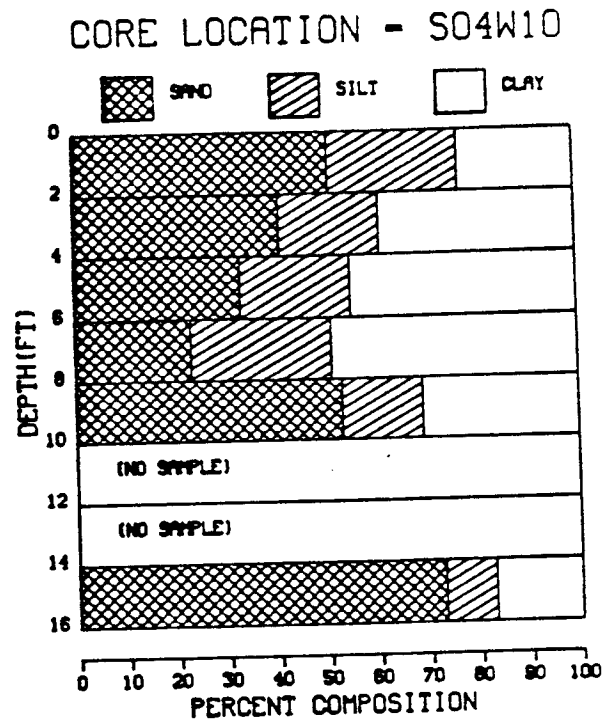
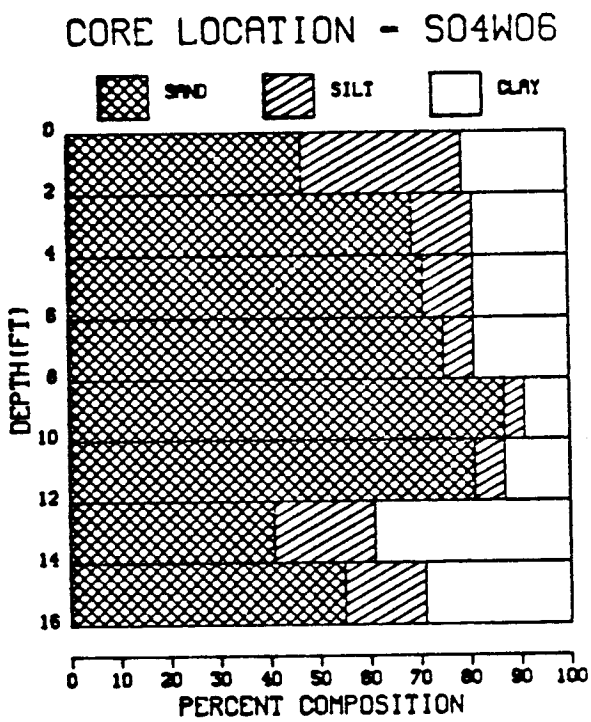


FIGURE C-2. (Continued)

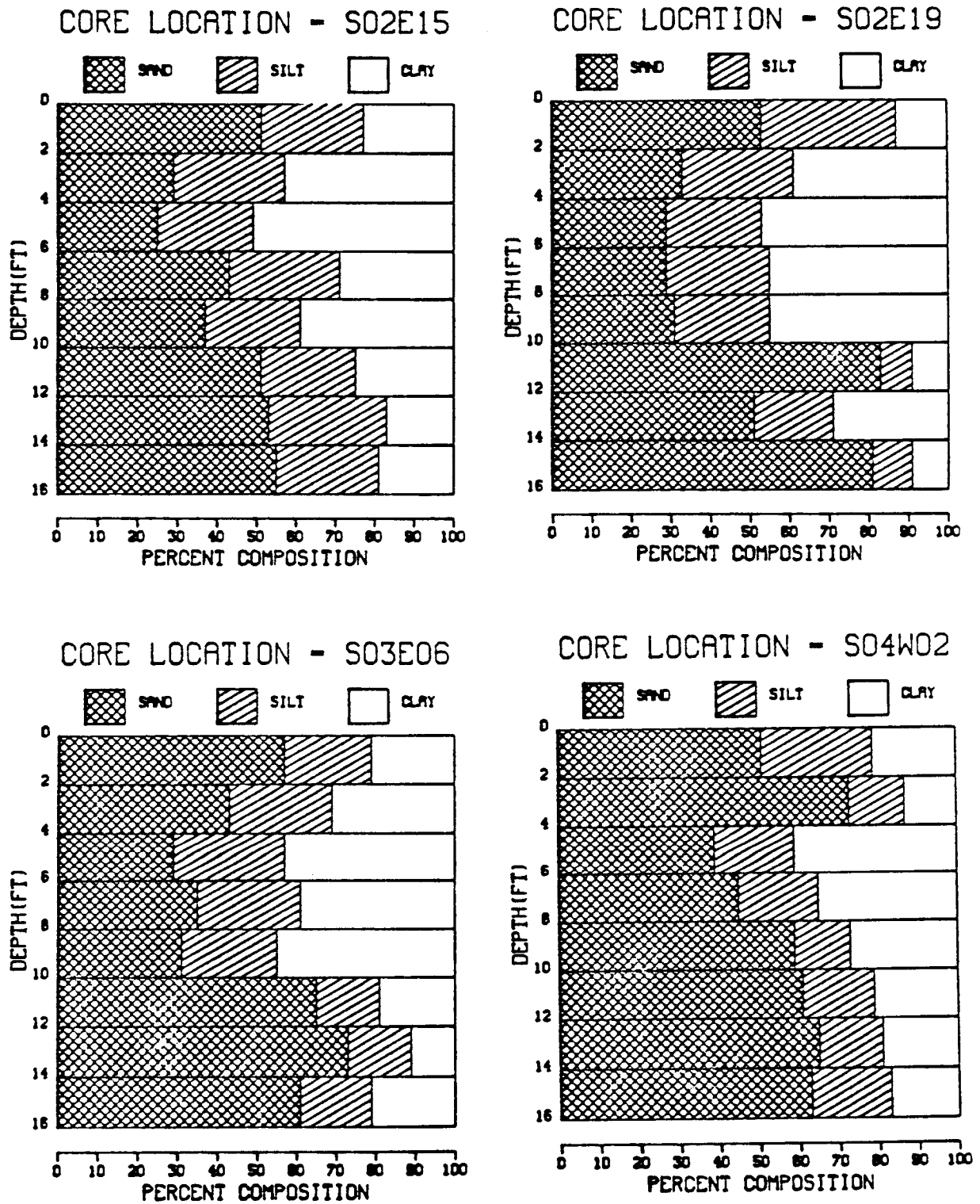


FIGURE C-2. (Continued)

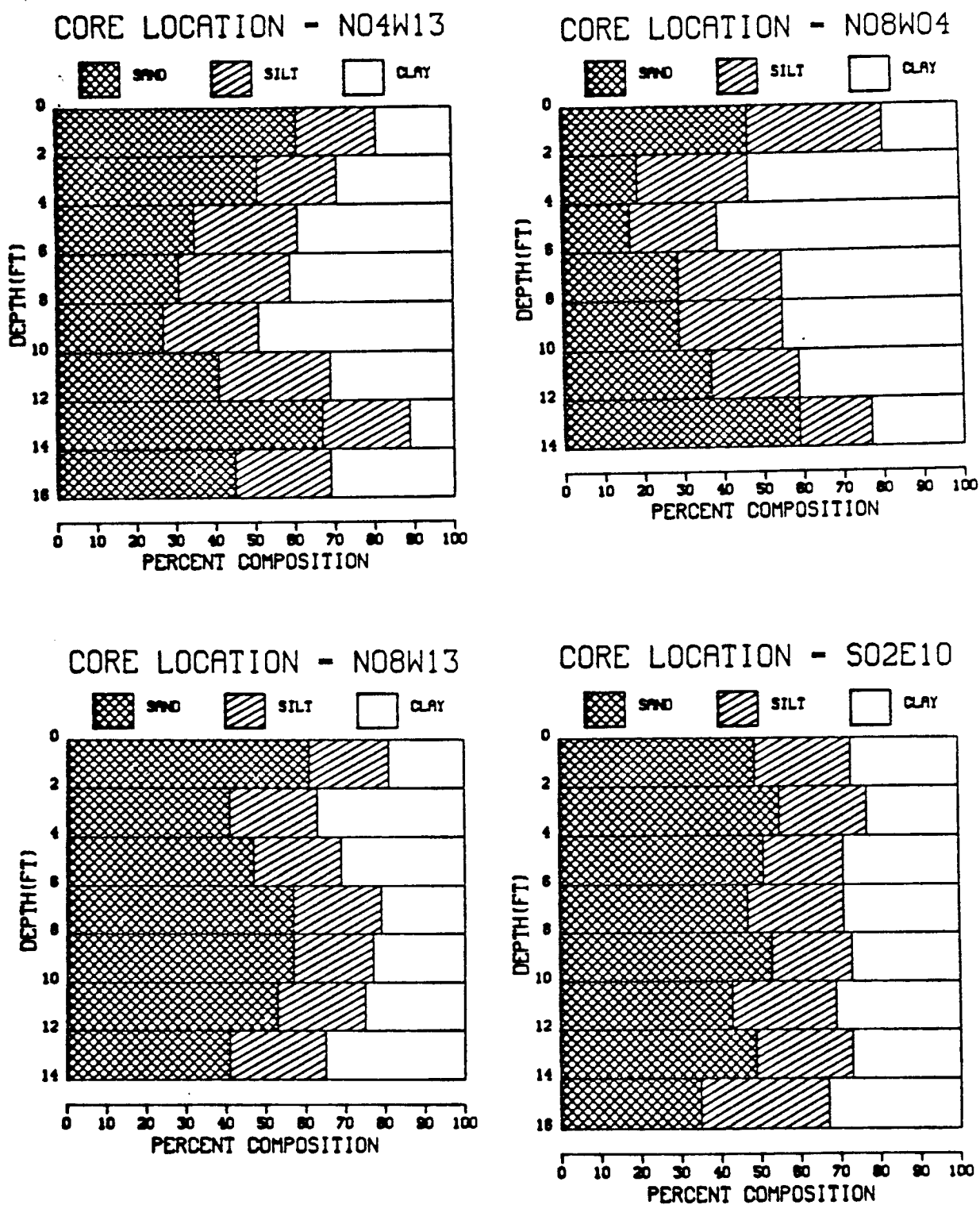


FIGURE C-2. (Continued)

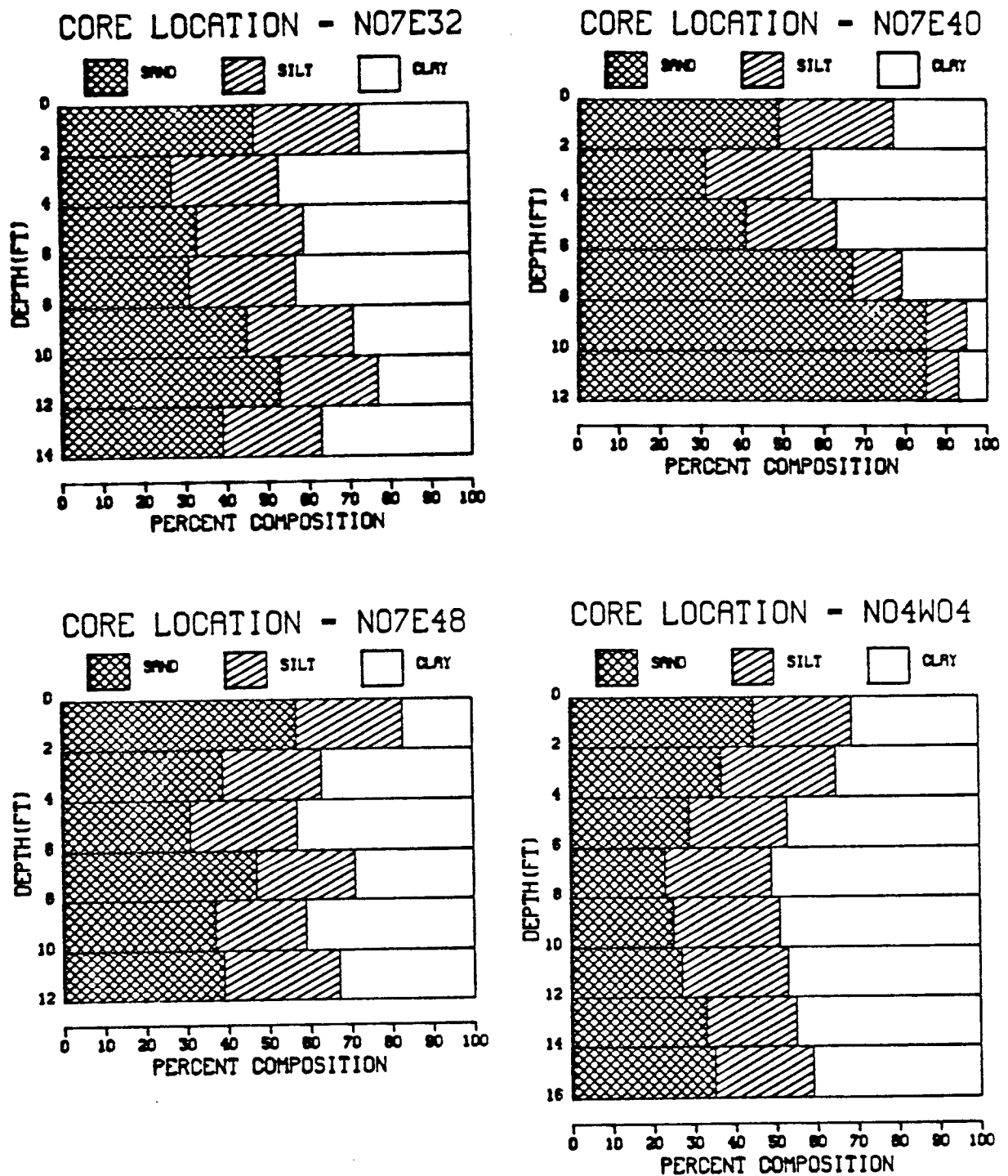


FIGURE C-2. (Continued)

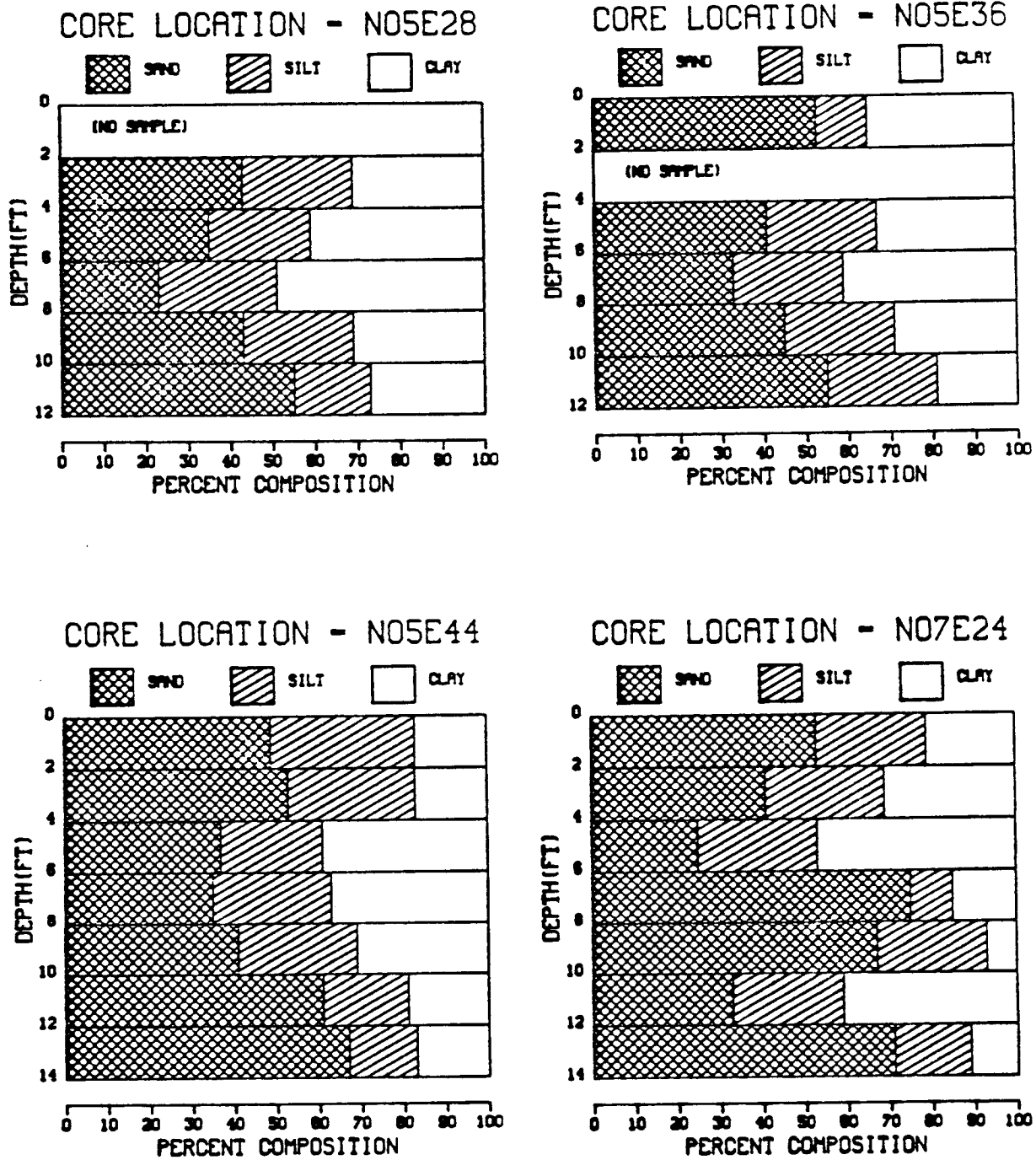


FIGURE C-2. (Continued)

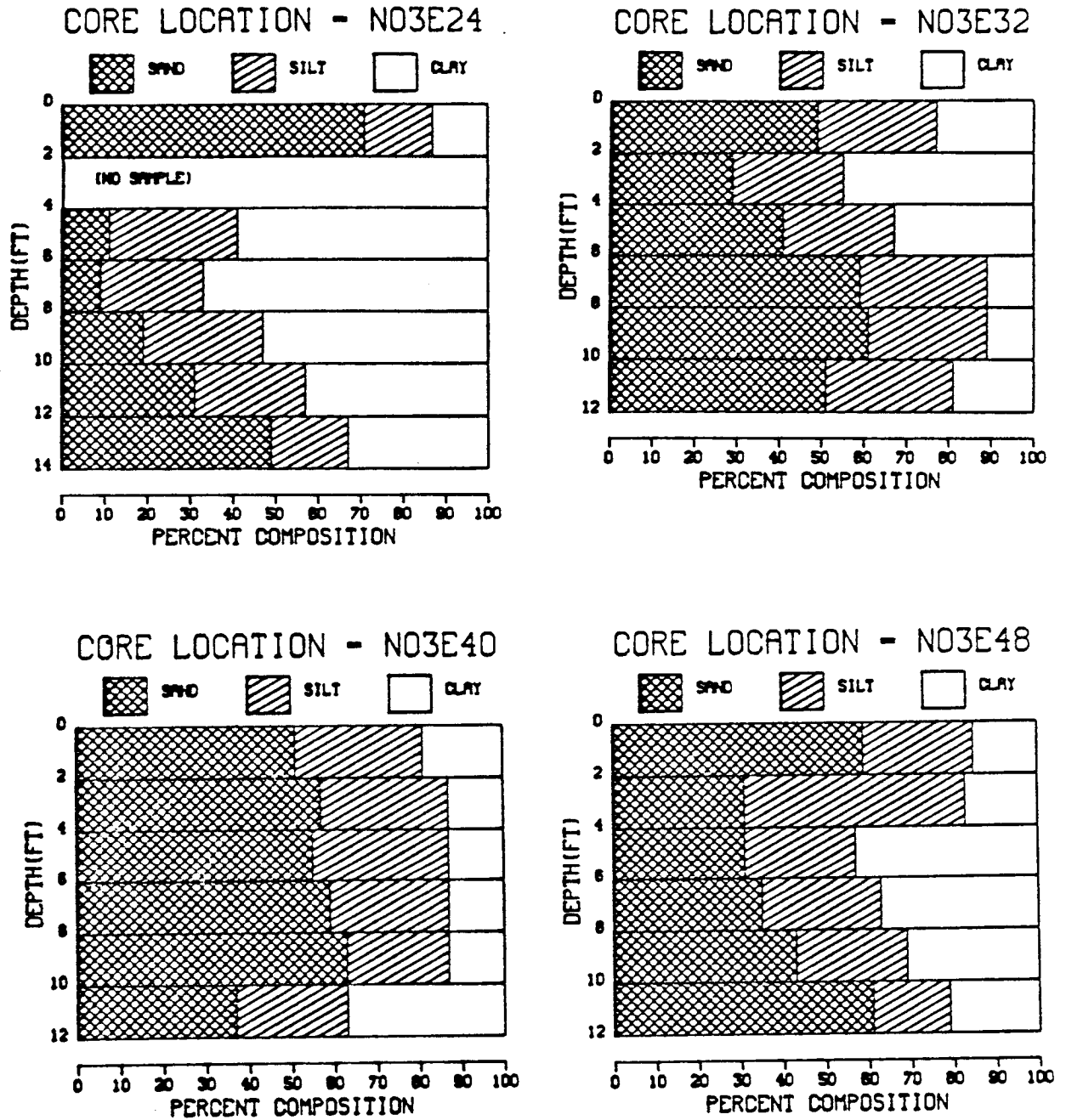


FIGURE C-2. PERCENT SAND, SILT, CLAY IN SOILS IN UNCONTAMINATED AREAS OF THE DOE-NIAGARA FALLS STORAGE SITE

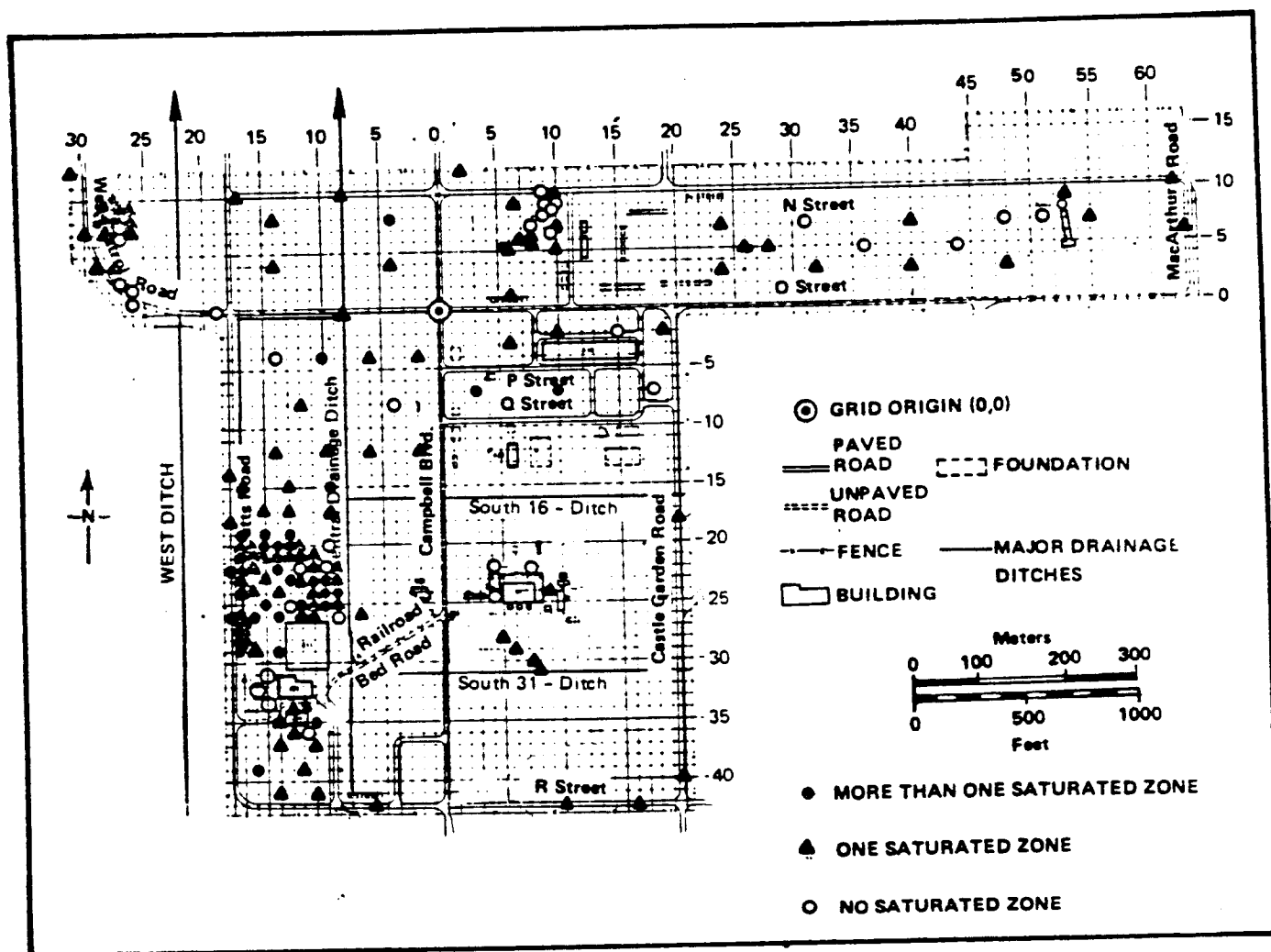


FIGURE C-1. LOCATIONS OF SPLIT-SPOON SAMPLED WELLS AND CORES ON THE DOE-NIAGARA FALLS STORAGE SITE DURING 1979-1980
(Frequency of saturated zones are indicated.)

TABLE C-1. (Continued)

LOCATION	DEPTH	SAND %	SILT %	CLAY %	PH	LTI	CEC	ORGANIC MATTER %	TEXTURE
401 E	0- 2	51.0	24.0	25.0	8.0	74	7.9	3.1	SANDY CLAY LOAM
	2- 4	35.0	26.0	39.0	8.3	75	9.0	1.9	CLAY LOAM
	4- 6	33.0	28.0	39.0	8.3	75	19.2	1.7	CLAY LOAM
	6- 8				8.1	76	8.4	2.0	
	8-10	51.0	18.0	31.0	8.2	76	5.2	0.8	SANDY CLAY LOAM
	10-12	55.0	24.0	21.0	8.1	76	3.2	0.6	SANDY CLAY LOAM
	12-14	59.0	20.0	21.0	8.1	76	3.1	0.4	SANDY CLAY LOAM
	14-16	39.0	28.0	33.0	8.1	76	3.4	0.5	CLAY LOAM
401 S	0- 2	45.0	20.0	35.0	7.7	74	5.8	2.5	SANDY CLAY LOAM
	2- 4	41.0	24.0	35.0	8.0	74	6.5	1.0	CLAY LOAM
	4- 6	41.0	20.0	39.0	8.4	76	5.9	1.1	CLAY LOAM
	6- 8	45.0	24.0	31.0	7.9	75	5.2	1.1	SANDY CLAY LOAM
	8-10	45.0	24.0	31.0	7.9	75	4.1	0.8	SANDY CLAY LOAM
	10-12	53.0	26.0	21.0	8.1	75	2.7	0.4	SANDY CLAY LOAM
	12-14	49.0	28.0	23.0	8.1	75	2.7	0.6	LOAM
	14-16	49.0	28.0	23.0	8.1	75	1.8	0.5	LOAM
401 W	0- 2	57.0	24.0	19.0	8.3	75	14.9	2.5	SANDY LOAM
	2- 4	41.0	24.0	35.0	8.3	76	7.6	1.1	CLAY LOAM
	4- 6	37.0	24.0	39.0	8.2	76	9.0	1.9	CLAY LOAM
	6- 8	29.0	24.0	47.0	8.3	76	7.0	1.0	CLAY
	8-10	17.0	22.0	61.0	8.3	75	5.2	0.5	CLAY
	10-12	33.0	24.0	43.0	8.2	76	7.2	1.7	CLAY
	12-14	21.0	30.0	49.0	8.3	76	4.1	0.7	CLAY
	14-16	21.0	30.0	49.0	8.3	76	5.2	0.8	CLAY

TABLE C-1. (Continued)

LOCATION	DEPTH	SAND %	SILT %	CLAY %	PH	LTl	CEC	ORGANIC MATTER %	TEXTURE
S07 E18	0- 2	29.0	42.0	29.0	8.5	75	3.8	0.9	CLAY LOAM
	2- 4	63.0	14.0	23.0	8.5	76	3.4	0.7	SANDY CLAY LOAM
	4- 6	35.0	40.0	25.0	8.5	76	2.7	0.3	LOAM
	8-10	65.0	24.0	11.0	8.6	76	1.5	0.1	SANDY LOAM
	10-12	33.0	26.0	41.0	8.5	76	2.5	0.3	CLAY
	12-14	37.0	24.0	39.0	8.5	76	3.0	0.3	CLAY LOAM
	14-16	57.0	20.0	23.0	8.5	76	1.5	0.4	SANDY CLAY LOAM
401 NW	0- 2	43.0	22.0	35.0	8.1	74	6.4	1.5	CLAY LOAM
	2- 4	47.0	22.0	31.0	8.0	74	7.1	2.3	SANDY CLAY LOAM
	4- 6	37.0	24.0	39.0	8.0	75	6.7	1.6	CLAY LOAM
	6- 8	35.0	24.0	41.0	8.0	75	5.2	1.3	CLAY
	8-10	33.0	26.0	41.0	8.1	75	5.2	0.9	CLAY
	10-12	25.0	28.0	47.0	8.1	75	4.0	0.6	CLAY
	12-14	25.0	28.0	47.0	7.9	75	6.8	0.8	CLAY
	14-16	13.0	24.0	63.0	7.8	75	6.5	0.7	CLAY
401 NE	0- 2				7.2	73	6.8	10.9	
	2- 4	75.0	14.0	11.0	7.8	74	6.8	7.5	SANDY LOAM
	4- 6	49.0	26.0	25.0	8.1	75	6.5	1.5	SANDY CLAY LOAM
	6- 8	29.0	30.0	41.0	8.0	75	6.8	1.1	CLAY
	8-10	35.0	26.0	39.0	7.9	75	6.9	1.4	CLAY LOAM
	10-12	33.0	28.0	39.0	7.9	75	5.9	1.2	CLAY LOAM
	12-14	23.0	26.0	51.0	7.9	75	6.8	1.2	CLAY
	14-16	21.0	40.0	39.0	8.0	75	3.6	0.7	CLAY LOAM

TABLE C-1. (Continued)

LOCATION	DEPTH	SAND %	SILT %	CLAY %	PH	LTI	CEC	ORGANIC MATTER %	TEXTURE
S03 E06	0- 2	57.0	22.0	21.0	8.2	74	7.9	2.3	SANDY CLAY LOAM
	2- 4	43.0	26.0	31.0	8.5	75	6.5	0.3	CLAY LOAM
	4- 6	29.0	28.0	43.0	8.5	76	4.3	0.4	CLAY
	6- 8	35.0	26.0	39.0	8.5	75	3.8	1.5	CLAY LOAM
	8-10	31.0	24.0	45.0	8.6	75	4.0	0.3	CLAY
	10-12	65.0	16.0	19.0	8.6	75	1.8	0.1	SANDY LOAM
	12-14	73.0	16.0	11.0	8.7	75	1.8	0.1	SANDY LOAM
	14-16	61.0	18.0	21.0	8.6	76	2.8	0.1	SANDY CLAY LOAM
S07 E03	0- 2	63.0	26.0	11.0	7.3	72	13.7	5.7	SANDY LOAM
	2- 4	37.0	26.0	37.0	8.3	75	2.7	0.4	CLAY LOAM
	4- 6	63.0	20.0	17.0	8.5	76	4.1	0.3	SANDY LOAM
	6- 8	59.0	18.0	23.0	8.5	76	2.3	0.3	SANDY CLAY LOAM
	8-10	71.0	12.0	17.0	8.7	76	1.8	0.2	SANDY LOAM
	10-12	61.0	16.0	23.0	8.5	76	2.1	0.2	SANDY CLAY LOAM
	12-14	81.0	12.0	7.0	8.8	76	1.4	0.3	LOAMY SAND
	14-16	79.0	12.0	9.0	8.9	76	1.1	0.2	LOAMY SAND
S07 E10	0- 2	47.0	26.0	27.0	8.4	75	4.7	2.3	SANDY CLAY LOAM
	2- 4	41.0	28.0	31.0	8.4	75	6.1	0.4	CLAY LOAM
	4- 6	35.0	28.0	37.0	8.6	76	1.2	0.3	CLAY LOAM
	6- 8	37.0	22.0	41.0	8.6	76	3.2	0.3	CLAY
	8-10	31.0	22.0	47.0	8.5	76	3.3	0.5	CLAY
	10-12	61.0	16.0	23.0	8.7	76	1.8	0.3	SANDY CLAY LOAM
	12-14	83.0	6.0	11.0	8.8	76	2.3	0.1	LOAMY SAND
	14-16	75.0	10.0	15.0	8.8	76	1.1	0.1	SANDY LOAM

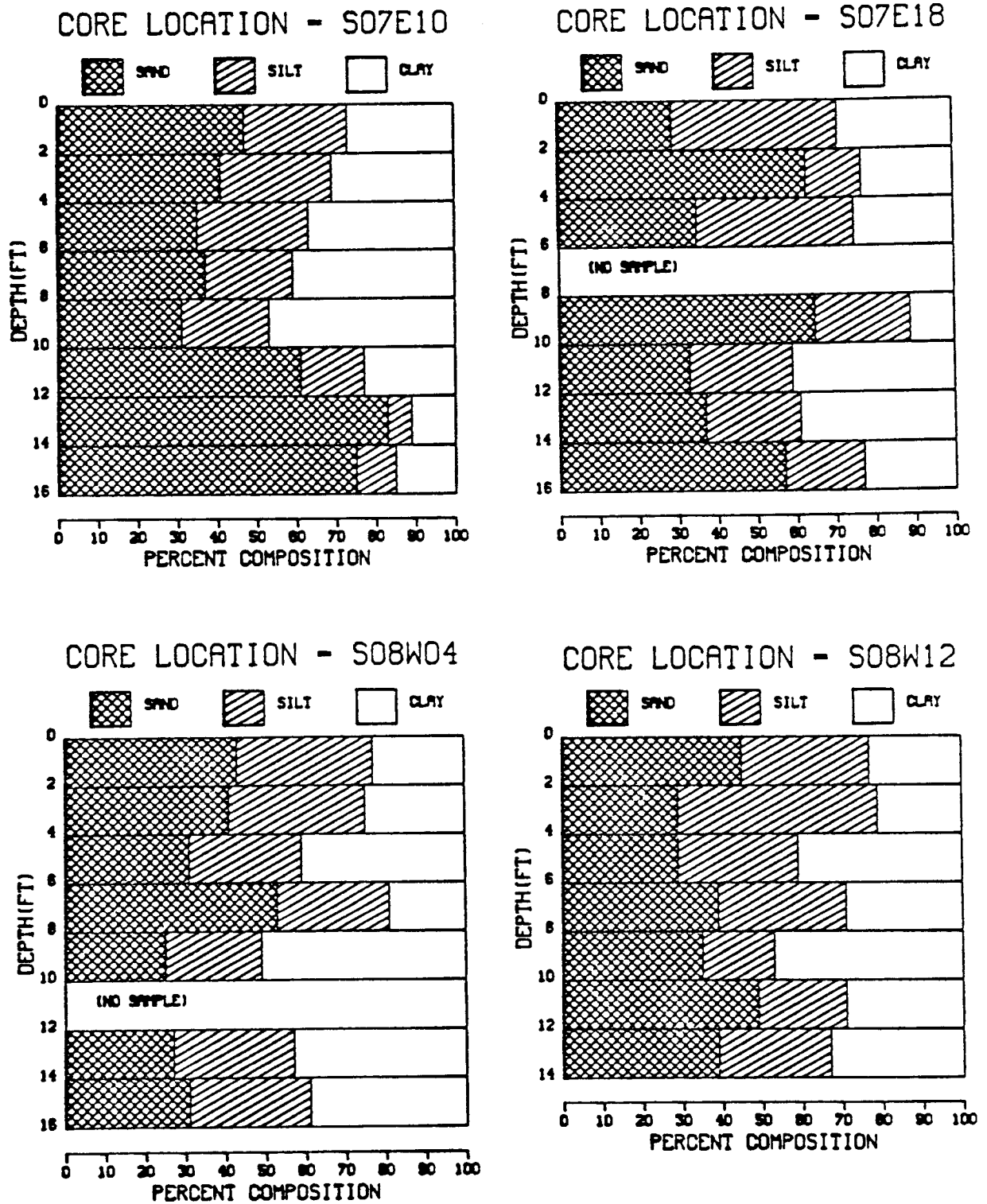


FIGURE C-2. (Continued)

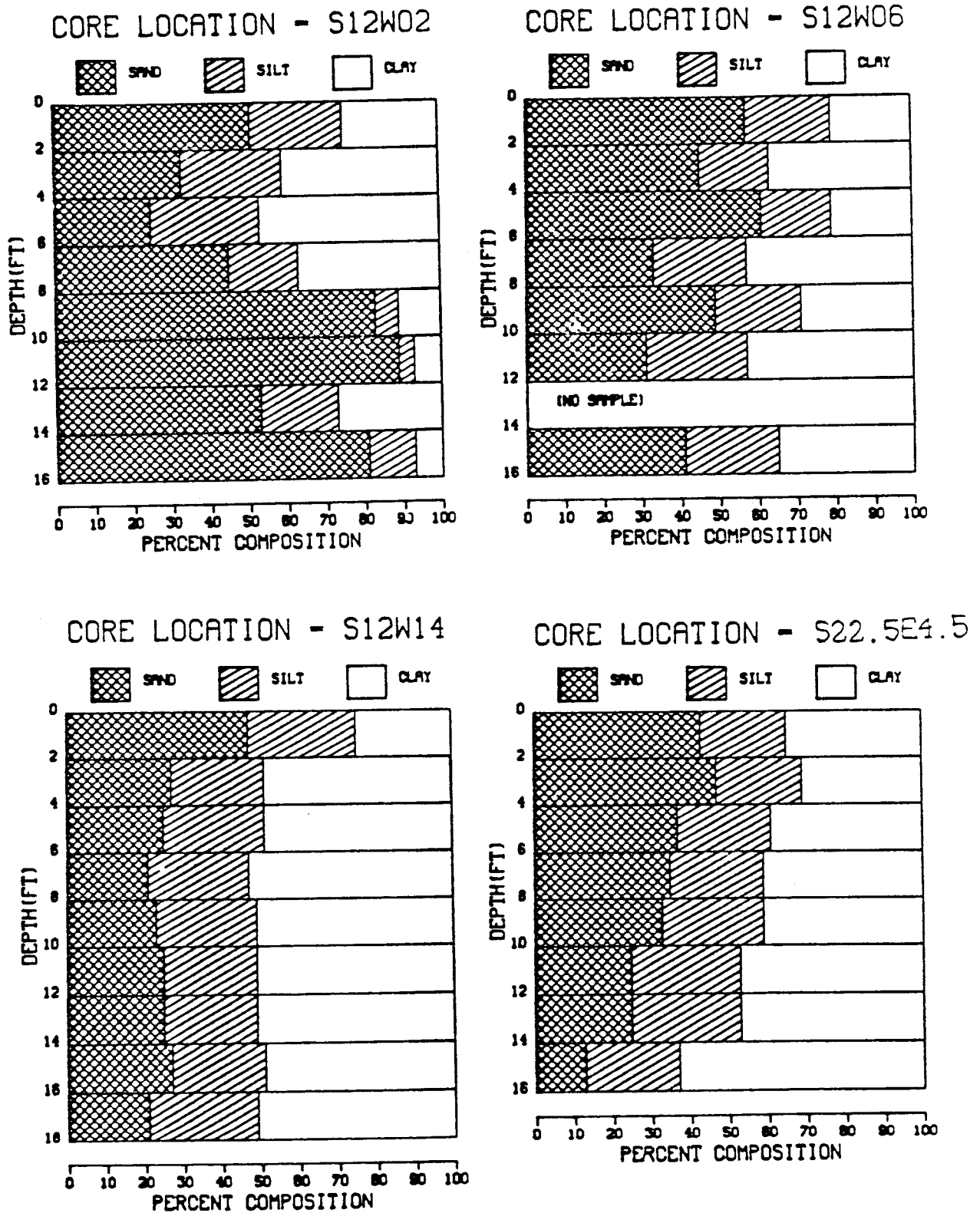


FIGURE C-2. (Continued)

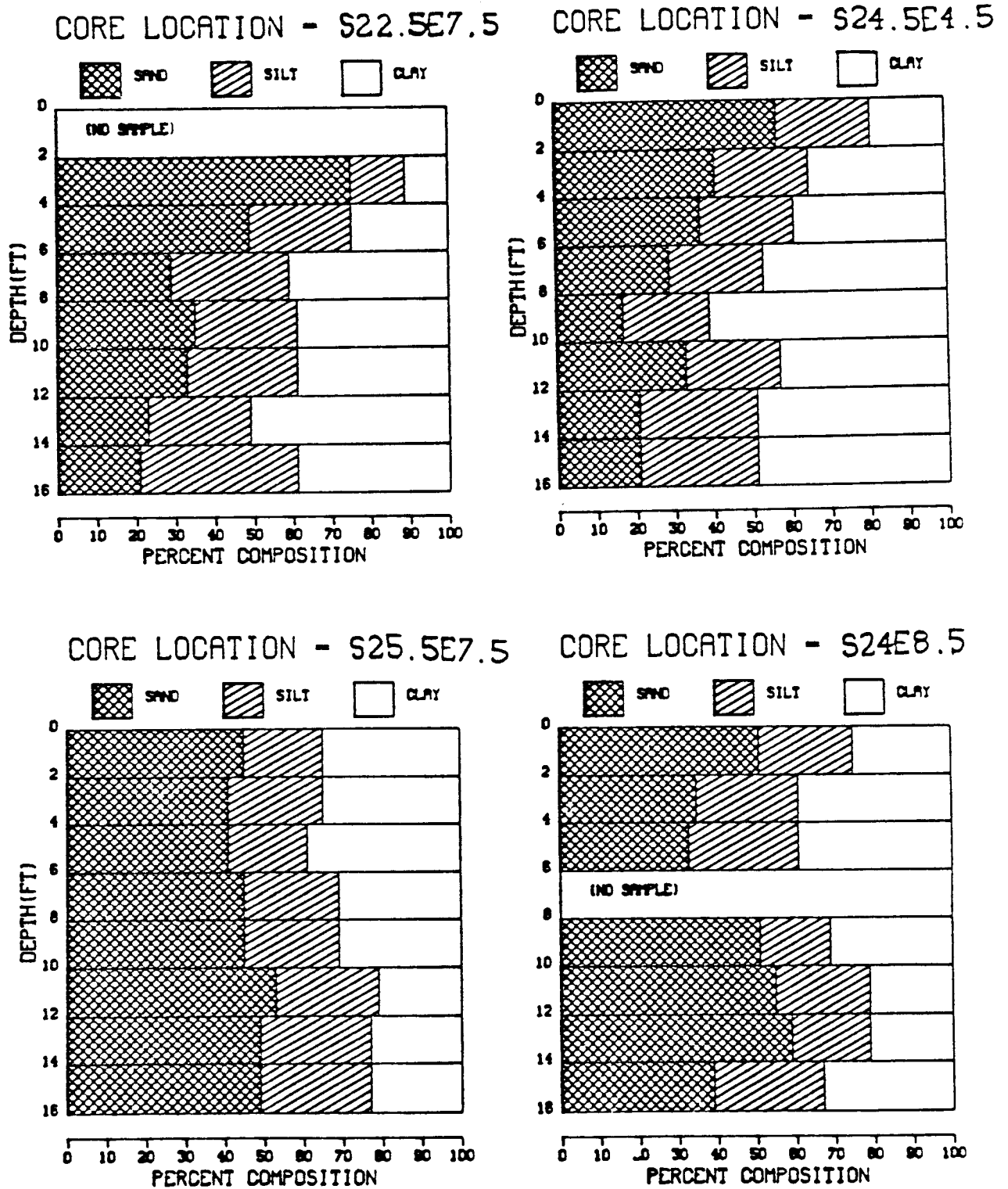


FIGURE C-2. (Continued)

APPENDIX D

PRELIMINARY ESTIMATES OF MATERIALS
TO BE REMOVED FROM DITCHES

APPENDIX D

PRELIMINARY ESTIMATES OF MATERIAL TO BE
REMOVED FROM DITCHES

The quantity of contaminated soil and debris to be removed from the drainage ditches will be dependent upon several factors. These factors include:

- the distance which contamination has migrated from the site;
- the length of the contaminated ditches on site;
- the depth to which contamination has penetrated the bottoms of the ditches;
- conditions of the ditches, a weather factor; and
- the permissible level of contamination.

Preliminary estimates of the quantity of soil to be removed are based on a limited number of soil samples taken along the ditches. Analysis of the entire group of samples will permit a refinement of the estimate, though it is not expected to differ greatly from the present estimate. Small variations in the penetration will not have a significant effect on the total material that will be removed due to the limitations of the work equipment.

Off-Site Cleanup

The greatest quantity of soil will result if it is necessary to clean the entire off-site length of the Central Drainage Ditch (CDD). The distance from the intersection with Fourmile Creek to the north site boundary is approximately 15,000 ft. Station 0 + 00 is the intersection of the ditch with Fourmile Creek. The depth of the ditch below grade, as dug, varies from 20 ft near the creek to less than 6 ft at the southern end within the site. The bottom width also varies according to available charts as follows.

	<u>Distance (100 ft)</u>	<u>Width (ft)</u>
Station	0 + 00 to 110 + 00	20
	110 + 00 to 132 + 00	14
	132 + 00 to 150 + 00	12

Quantities of Material To Be
Removed From Off-Site Ditches

Calculations are shown in Table D-1 for the removal of 2 ft of soil from the bottom of the ditch. The 2-ft depth assumes that there is some penetration and that the process of removing the contaminated soil and vegetation will involve some mixing with the layer of soil immediately beneath. The 4-ft excavation between Stations 55 + 60 and 61 + 60 may require some backfilling to restore the grade.

TABLE D-1. QUANTITIES OF SOIL TO BE REMOVED
FROM CDD - OFF-SITE

Stations	Width (ft)	Depth (ft)	Volume (yd ³)
0 + 00 to 36 + 60	20	2	5,420
36 + 60 to 55 + 60	20	2	2,815
55 + 60 to 61 + 60	20	4	1,780
61 + 60 to 110 + 00	20	2	7,170
110 + 00 to 132 + 00	14	2	2,280
132 + 00 to 150 + 00	12	2	1,600
TOTALS 15,000 feet			21,065

Similarly, the West Drainage Ditch (WDD) has been contaminated for approximately 5300 ft. Profiles are not presently available for this ditch. The quantities of soil to be removed are based on a length of 5300 ft, a width of 12 ft, and depths of 1 and 2 ft (Table D-2).

TABLE D-2. QUANTITIES OF SOIL TO BE REMOVED
FROM WDD - OFF-SITE

Length (ft)	Width (ft)	Depth (ft)	Volume (yd ³)
5,300	12	1	2,355
		2	4,710

Total off-site volume to be removed is summarized in Table D-3 below.

TABLE D-3. TOTAL VOLUME OF SOIL TO BE
REMOVED FROM OFFSITE DITCHES

Ditch	Yd ³
CDD	21,065
WDD	<u>4,710</u>
TOTAL (ft ³)	25,775

Transportation - Off-Site Areas to On-Site Storage

Transportation of soil and vegetation from the off-site ditches will require the cooperation of local community officials. Permits must be required for the covering of certain roads for crossing purposes as well as for the transportation of contaminated materials. Additionally, the project requires coordination of digging, loading, dumping, and clearing schedules.

The intersection of the Central Drainage Ditch (CDD) with Fourmile Creek is approximately 3 mi from the proposed temporary storage site. The southern 2 mi of the CDD from the north boundary to North Patrol Road is paralleled by Lutts Road which continues into the site with convenient connections to the proposed temporary storage sites. The 6,000 ft section from North Patrol Road to Fourmile Creek does not have a parallel road. It is proposed that the top of the west embankment

of the CDD be cleared of brush and other obstructions in order to serve as an inbound travelway for loaded vehicles. There are one or two locations on the property between the north boundary and Balmer Road, approximately 1 mi, where buildings are located at the edge of the CDD. It will be necessary at those points to detour west onto Lutts Road for incoming loads. These obstructions will also create a minor problem in loading the vehicles. It will also be necessary to temporarily remove sections of chain-link fences to permit passage of vehicles. These sections must be restored upon completion of the cleanup program.

Incoming vehicles will dump their loads at the temporary storage site and then be washed to remove any residual contamination prior to returning for a new load. Acceptable cleaning and health physics procedures must be established. Vehicles returning for reloading will use Lutts Road to the intersection with the CDD and through the use of flagmen proceed along the west bank of the ditch to the loading area.

As the soil removal crew moves upstream, it will be necessary to restore the bottom of the ditch to an established gradient. Additionally, radiation surveys must be made to ascertain that the residual contamination has been reduced to acceptable levels.

Quantities of Material To Be Removed From On-Site Ditches

The cleanup of the on-site ditches will require additional planning because of the depths to which contamination has penetrated. Portions of the Central Drainage Ditch (CDD) will be excavated to 7 ft below the existing grade and a portion of the S-31 (also known as the "M") Ditch will be excavated to 2 ft below the existing grade. It may be necessary to backfill most of the on-site excavations with gravel or clay to restore the gradient to existing elevations for continued runoff.

Approximately 2700 ft of the CDD from the north boundary fence extending southward are contaminated. The section between stations 150 + 00 and 167 + 00 are generally contaminated deep enough to require removal of about 2 ft of bottom silt and soil. The section between Stations 167 + 00 and 170 + 00 is contaminated to a depth of 4-5 ft requiring removal of 6 ft of soil. Most of the on-site ditches are also heavily grown with

vegetation ranging from grasses to cattails and brush. This vegetation will require removal as a separate cleaning operation and segregation for eventual disposal. Incineration appears to be the most favorable method of disposal. Contamination has also deeply penetrated the bed of the S-31 Ditch. Up to 2 ft will require removal for a length of about 900 ft starting from the intersection with the CDD and running easterly past the site of the former slurry pond. It will also be necessary to stabilize the embankment of the fill material dumped into the slurry pond. This fill material continues to wash into the S-31 Ditch. The quantities of soil to be removed are estimated in Tables D-4 and D-5 below.

TABLE D-4. QUANTITIES OF SOIL TO BE REMOVED
FROM CDD - ON-SITE

Stations (100 ft)	Width (ft)	Depth (ft)	Volume (yd ³)
150 + 00 to 167 + 00	12	2	40,800
167 + 00 to 170 + 00	12	6	21,600
170 + 00 to 177 + 00	10	2	<u>14,000</u>
TOTALS 2,700 Feet			76,400

TABLE D-5. QUANTITIES OF SOIL TO BE REMOVED
FROM S-31 DITCH - ON-SITE

Stations (100 ft)	Width (ft)	Depth (ft)	Volume (yd ³)
0 + 00 to 9 + 00	10	2	18,000

The total on-site removal is summarized in Table D-6.

TABLE D-6. TOTAL VOLUME OF SOIL AND VEGETATION
TO BE REMOVED FROM ON-SITE DITCHES

Ditch	Yd ³
Soil	
CDD	76,400
S-31	18,000
Vegetation	<u>14,200</u>
TOTAL	<u>108,600</u>