SOLAR EVAPORATION PONDS

CLOSURE PLAN

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN, COLORADO

JULY 1, 1988

VOL. I

ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
ROCKY FLATS PLANT

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TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Description of the Rocky Flats Plant

1.1.1 Location and Operator

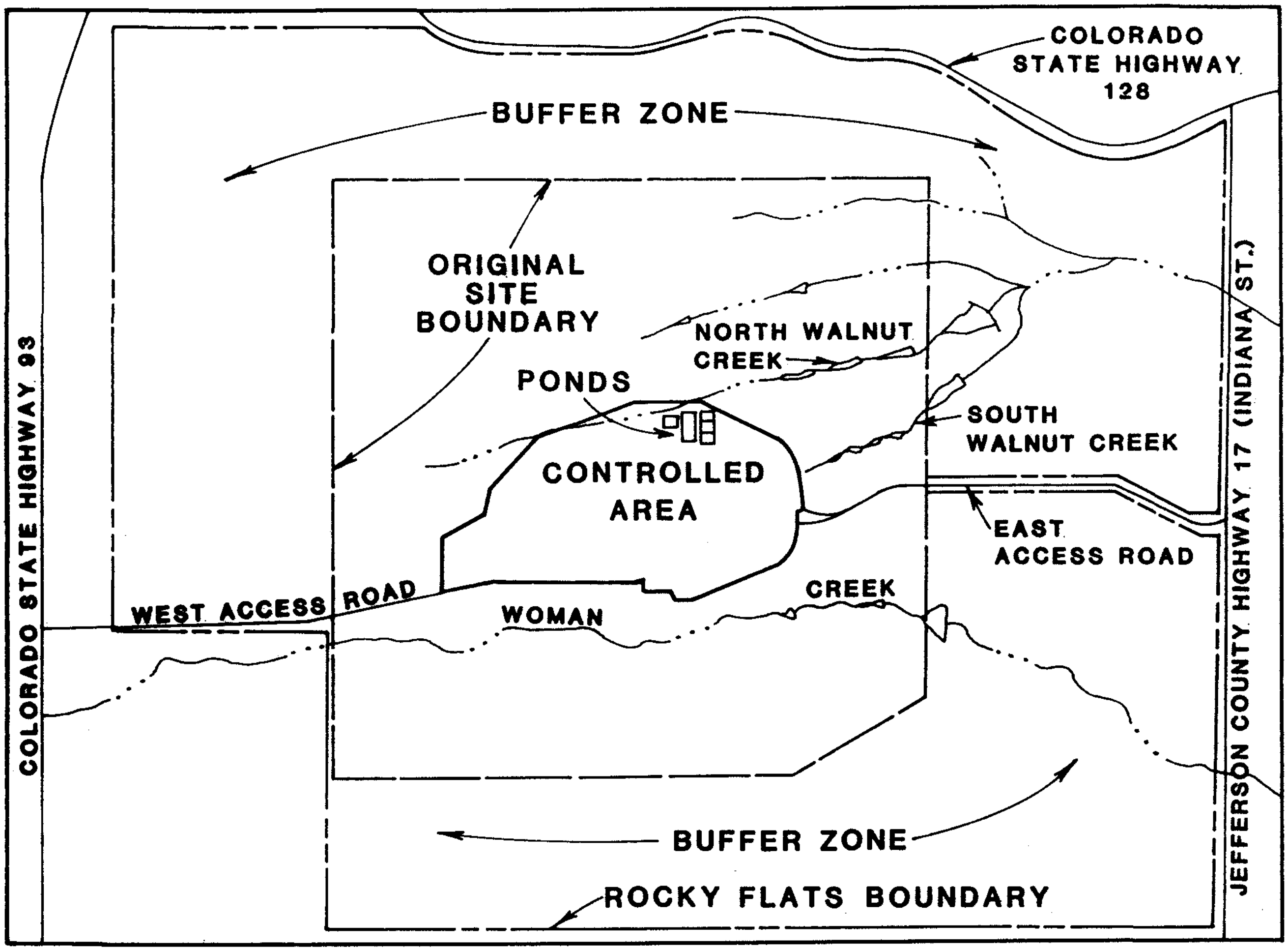
The U.S. Department of Energy's Rocky Flats Plant is located in north-central Colorado, northwest of the City of Denver (Figure 1). The Plant is located in Sections 1 through 4 and 9 through 15 of T. 2 S., R. 70 W. The facility's EPA identification number is CO7890010526. The mailing address is:

U.S. Department of Energy
Rocky Flats Plant
P.O. Box 928
Golden, Colorado 80402

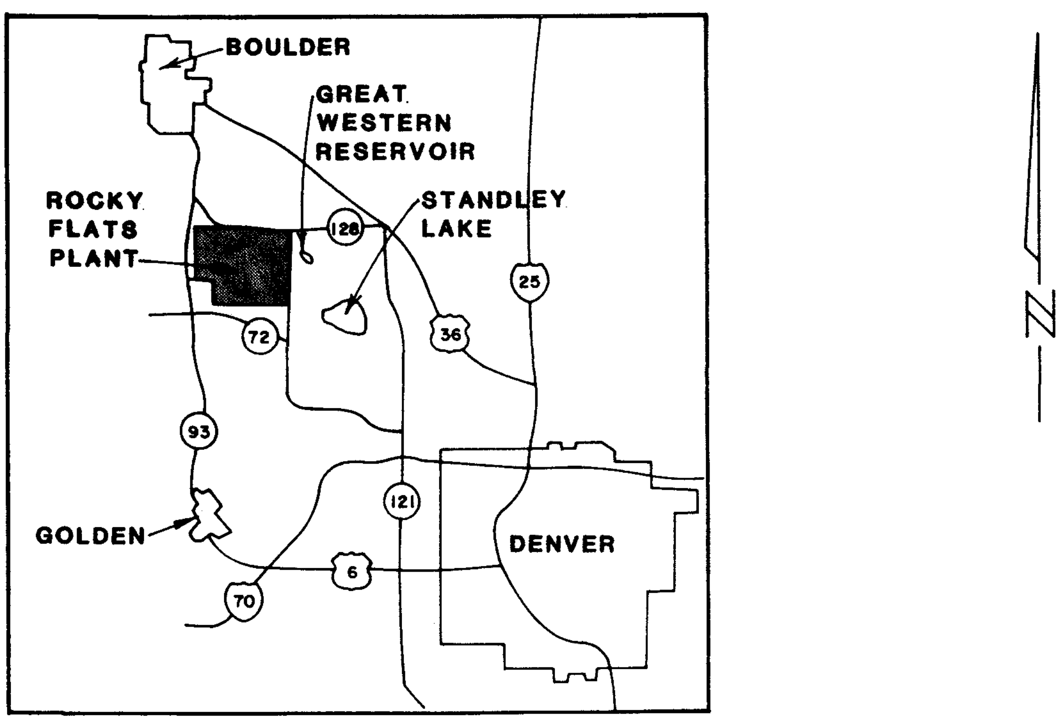
The facility contact is:

Albert E. Whiteman, Area Manager
Phone: (303) 966-2025

The facility covers approximately 6,550 acres of federally owned land in northern Jefferson County, Colorado, which is centered at 105° 11' 30" west longitude, 39° 53' 30" north latitude. The facility is approximately 16 miles northwest



APPROXIMATE SCALE 1"=3,300'



APPROXIMATE SCALE 1"=40,000'

6 033 88	Chen & Associates	VICINITY MAP	Fig. 1

of Denver and nine to 12 miles from the neighboring communities of Boulder, Broomfield, Golden and Arvada. It is bounded on the north by State Highway 128, on the west by a parcel of land east of State Highway 93, on the south by a parcel of land north of State Highway 72 and on the east by Jefferson County Highway 17. Access to the plant is from an east access road exiting from Jefferson County Highway 17 and a west access road exiting from State Highway 93.

The facility is situated at an elevation of approximately 6,000 feet. It is on the eastern edge of a geological bench known locally as Rocky Flats. The bench is approximately five miles wide and flanks the eastern edge of the foothills of the Rocky Mountains.

1.1.2 Mission

The Rocky Flats Plant is a government-owned and contractor-operated facility. It is part of a nationwide nuclear weapons research, development and production complex administered by the Albuquerque Operations Office of the U.S. Department of Energy (DOE). The prime operating contractor for the Rocky Flats Plant is Aerospace Operations of Rockwell International.

The facility produces metal components for nuclear weapons; therefore, its product is directly related to national defense. The facility fabricates components from plutonium, uranium, beryllium and stainless steel. Other production activities include chemical recovery and purification of recyclable transuranic radionuclides, metal fabrication and assembly and related quality control functions. Other activities include research and development in metallurgy, machining, non-destructive testing, coatings, remote engineering, chemistry and physics. Parts made at the plant are shipped elsewhere for final assembly (U.S. Department of Energy, 1987a).

1.1.3 Brief History

Construction of the Rocky Flats Plant was approved by the U.S. Government in 1951 as an addition to the nation's nuclear weapons production complex. Operations began in 1952 under direction of the Atomic Energy Commission. The original facility covered an area of approximately 2,520 acres (Figure 1).

A buffer zone was added in 1974-1975 to enlarge the plant to its present size of approximately 6,550 acres. The buffer zone had been used for grazing cattle and horses and is enclosed within a cattle fence which is posted with signs indicating restricted access. Two office buildings, a warehouse, firebreaks, holding ponds along three water courses, environmental monitoring instrumentation, a sanitary landfill area, a salvage yard, power lines, inactive gravel pits, clay pits and two target ranges are located in the buffer zone. Additionally, a former wind energy test site now used as an office building and a Ground Wave Emergency Network (GWEN) tower being installed by the U.S. Air Force are located in the buffer zone.

Major facility structures are located in a 400-acre controlled area near the center of the property. Production, research and development facilities at the plant are located in the controlled area which contains approximately 134 structures with a combined floor space of approximately 2.67 million square feet.

1.2 Description of the 207 Solar Evaporation Ponds

1.2.1 Construction History

The original solar evaporation pond consisted of a clay-lined impoundment constructed in December 1953. Figure 2 shows the locations of the original solar pond as dashed perimeter lines in the vicinity of existing Pond 207-C. The bottom of this pond consisted of a rolled subgrade lined with four inches of clay or silt. This clay-lined pond had a maximum of two containments measuring 100 by 200 feet and 200 by 200 feet, respectively, and was operated until 1956 when its regular use was discontinued. However, one of the two cells held liquids at least once since 1963 (Drawing 1-3398-207, Appendix 1). These ponds were entirely removed in 1970 (Aerial Photographs, 1953 to 1986) when the existing 207-C pond was constructed.

Pond 207-A was placed in service in August 1956. The pond was originally lined with asphalt planking, which is believed to have been approximately half-inch thick. This is the thickness of the asphalt planking originally used at the 207-B ponds. Ponds 207-B North, Center and South were placed in service in June 1960. These ponds were also originally lined with asphalt planking. Pond 207-C was placed in service in December 1970. The original lining is the existing lining.

Modifications to the ponds' linings have been made since the original construction because of cracking and slumping of the existing linings and leakage of pond contents. Pond 207-A was relined in November 1963, when the asphalt planking was replaced with asphaltic concrete. At this time, the interior berm slopes of the pond were modified to less steep slopes (1:3.7 as opposed to 1:2). The bottom slope of the pond was also modified to slope to the northeast corner of the pond. The bottom of this pond now consists of a four-inch thick aggregate base course laid over subgrade; over the base course is an asphalt prime coat under 1 1/2 inches of asphalt concrete under an asphalt tack coat under 1 1/2 inches of asphalt concrete under an asphalt tack coat under a catalytically blown asphalt seal coat.

The 207-B ponds were relined shortly after being placed in service. The asphalt planking was covered with asphaltic concrete at 207-B South in November 1960, and at 207- B North and Center in August 1961.

During these repairs, four-inch diameter underdrains were installed at the 207-B ponds. These underdrains were laid so that any waste leaking through the asphaltic concrete would be collected in these drains. These drains drain to the east where any water is collected in a header pipe daylighting at the northeast corner of the 207-B ponds (see Figures 3 and 4). The location at which this pipe daylights was provided with a sump and pump system (Sump #1) to return the water to 207-B North in approximately 1974.

An unsuccessful attempt to fill cracks on the side walls found at the 207-B ponds with mastic was made in April 1967. The 207-B North pond side walls had cracks successfully repaired with burlap and asphalt covering in November 1967. In October 1968, the 207-B Center pond had side walls successfully repaired with burlap and asphalt covering, and an additional coat of asphalt was applied to 207-B North pond. In September 1969 and October 1969, the side walls were covered with burlap and asphalt in Ponds 207-B North and 207-B Center, respectively. The side walls of 207-B South were covered with burlap and asphalt in September 1970. The side walls of 207-B North and Center were covered with Petro-mat and hydraulic sealant in October 1971. The side walls and bottom of 207-B South and 207-B North were relined with Petro-mat and hydraulic sealant in October 1972 and September 1973, respectively.

In 1976, preliminary sludge removal work was conducted in Pond 207-B South. This work was done in relation to completely renovating the 207-B solar ponds. These ponds had held process waste up to that time, but were now intended for use related to the Reverse Osmosis (RO) Plant. The 207-B ponds were to hold and evaporate treated sanitary effluent prior to processing through the RO Plant, and also to hold and evaporate RO Plant backwash.

In 1977, all of the 207-B ponds were cleaned of sludge which was disposed off site. The Petro-mat linings of Ponds 207-B South and 207-B Center were removed, bagged, cemented, and disposed. 207-B North had a minimal amount of sludge, and the Petro-mat lining was, therefore, not removed. All of the 207-B ponds were relined, with Pond 207-B South receiving a synthetic Hypalon liner of 45-mil thickness. This pond was also provided with a leak detection system between the Hypalon liner and the asphalt concrete liner. Pond 207-C has not been relined.

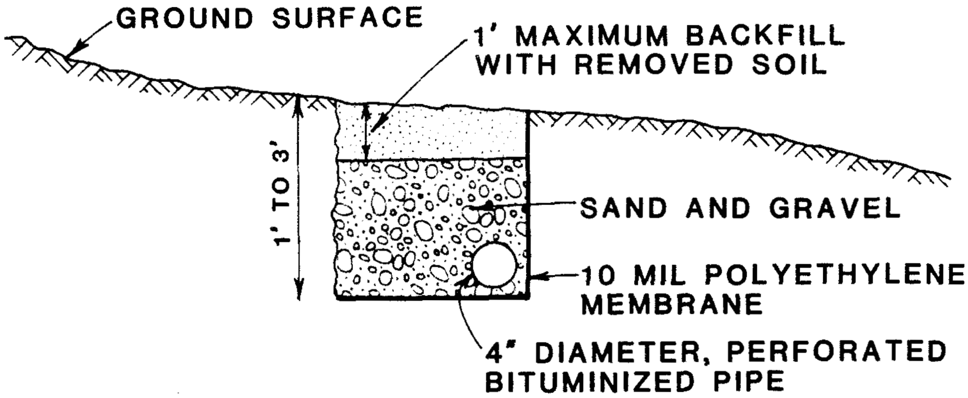
The liner of Pond 207-C consists of prepared subgrade with a four-inch aggregate base course, an asphalt prime coat, 1 1/2 inches of asphalt concrete, an asphalt tack coat, 1 1/2 inches of asphalt concrete, an asphalt tack coat and a surface of catalytically blown asphalt seal coat. This pond is provided with a leak detection pipe as shown on Figures 5 and 6. The existing linings of the other four ponds generally consists of asphaltic concrete, Petro-mat (trademark), burlap and asphalt.

Six interceptor trenches and a "french drain" system (Rockwell, 1983a and 1983b) have been constructed on the hillside north of the solar ponds to prevent natural seepage and pond leakage from entering North Walnut Creek. The six interceptor trenches, shown on Figure 2, were constructed north of the ponds in the 1970's. Trenches 1 and 2 were installed in October 1971, Trench 3 in September 1972, Trenches 4 and 5 in April 1974 and Trench 6 in July 1974 (Maas, 1986). Trench 5 drained by gravity to Trench 4. Trench 4 pumped water to Trench 3, and Trench 3 returned the water to Pond 207-A. Trenches 1 and 2 pumped water uphill into Sumps 1 and 2, respectively. Sumps 1 and 2 were intended to collect water blowing out of pipes in the area. These pipes are further discussed below. These sumps then returned the water to Ponds 207-B North and 207-A, respectively.

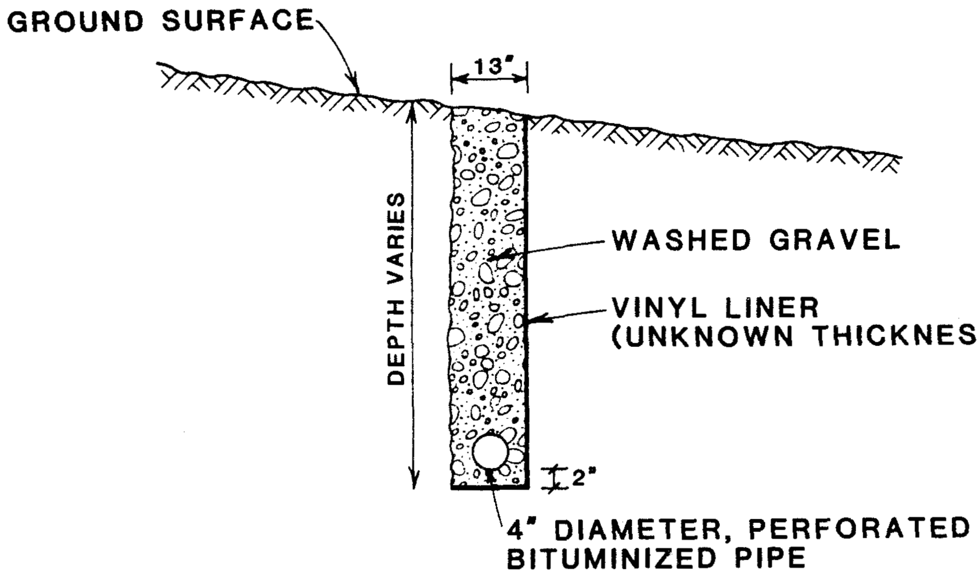
The six trenches are no longer in operation. Operation of these trenches ceased with the placing in service of the current french drain system. Figure 7 shows a typical trench and french drain cross-section (Maas, 1986).

The current french drain system, the location shown on Figure 2, is currently in use. The drain system was installed in the hillside north of the solar evaporation ponds and became active in April 1981. At this time, operation of the previous six trenches and two sumps was discontinued. Figure 7 shows a typical cross-section of the french drain system (Rockwell, 1983a). Rockwell, 1983a and other solar pond design drawings are presented in Appendix 1. The depth of the drains range from approximately one to 27 feet below the ground surface with a typical depth of four to 16 feet.

Liquid collected in the system flows by gravity to the interceptor trench pump house. The liquid from the pump house is currently pumped to Pond 207-B North. The current amount of intercepted seepage collected by the french drain



TYPICAL TRENCH CROSS-SECTION
(NOT TO SCALE)



TYPICAL FRENCH DRAIN CROSS-SECTION
(NOT TO SCALE)
(ROCKWELL, 1983a)

6 033 88	Chen & Associates	TYPICAL TRENCH AND FRENCH DRAIN CROSS-SECTIONS	Fig. 7

system is estimated at approximately four million gallons per year. The maximum amount of water collected in any one week was 700,000 gallons in June, 1987 (Rockwell, 1988).

1.2.2 Past Use

The solar evaporation ponds were constructed primarily to store and treat (by evaporation) low level radioactive process wastes containing high nitrates and treated acidic wastes containing aluminum hydroxide. During their use, these ponds are known to have received additional wastes such as sanitary sewage sludge, lithium metal, sodium nitrate, ferric chloride, lithium chloride, sulfuric acid, ammonium persulfates, hydrochloric acid, nitric acid, hexavalent chromium and cyanide solutions.

Solvents and other organics have not been routinely discharged to the ponds. It was felt that organics would lead to algae growth which would diminish solar evaporation. However, low concentrations of solvents may have been present as a minor constituent in other aqueous wastes.

As described in Section 1.2.1, the use of the 207-B solar ponds changed in 1977. Up to that time, the three 207-B solar pond cells had held process waste. In 1977, after preliminary work in 1976, the sludge of all the 207-B solar ponds was removed. The liners of the 207-B Center and South ponds were also removed and disposed off site. New liners were laid in these ponds. The 207-B North pond, having almost no sludge present, did not have the liner removed, but had the existing liner repaired. These activities were related to construction of the Reverse Osmosis (RO) facility and the related plant water recycle activities. After the 1977 cleanout, the 207-B solar ponds have not contained process waste. Since 1977 these ponds have held treated sanitary effluent, treated water from the RO facility, backwash (brine) from the RO facility, and contaminated ground water pumped back to the solar ponds from the french drain system. Ponds 207-B Center and South were sampled in the summer of 1986 when they each held approximately eight inches of liquid and sediments. The waste most recently stored in 207-B Center had been tertiary treated sanitary effluent. In 1987, the 207-B Center and South ponds received approximately one million gallons each of intercepted seepage from the french drain system.

Pond 207-C was constructed to provide additional storage capacity and to enable the transfer and storage of liquids from the other ponds in order to perform repair work on them.

1.2.3 Current Use

The following describes the current prevailing usage of the solar ponds. During closure, water will be transferred from pond to pond on an "as needed" basis. Pond 207-A is currently used for storage purposes only; the placement of waste materials directly into this pond ceased in 1986. The only ongoing activities are the evaporation of liquids being held and the removal and solidification of pond sludge (Rockwell, 1988). The current combined inventory of sludge and water in Pond 207-A is approximately 28,050 gallons.

Ponds 207-B North, Center and South are used to store intercepted seepage water collected by the french drain system north of the ponds (Figure 2). The intercepted water is pumped to Pond 207-B North from a pump house located at the northern end of the french drain system. The water is periodically transferred from Pond 207-B North to Pond 207-B Center. This water can also be placed in Pond 207-A, Pond 207-B South and Pond 207-C.

Pond 207-C is currently used for emergencies and to store and evaporate filtered liquid from Pond 207-A.

1.2.4 Size and Volume of Impoundments

Cross-sections through the solar ponds are shown on Figure 8. The locations of the cross-sections are shown on Figure 2. Historical drawings of the solar ponds are presented in Appendix 1.

Pond 207-A is approximately 250 feet by 525 feet at the crest. Pond 207-A and the other solar ponds are operated with a minimum freeboard of two feet. When operating at its maximum allowable level, the pond's liquid covers an area of approximately 230 feet by 505 feet. This corresponds to a surface area of approximately 116,200 square feet, or 2.7 acres. The maximum operating depth is approximately 7 1/2 feet (Rockwell, 1976 and Rockwell, 1977a).

Ponds 207-B North, Center and South are each approximately 180 feet by 253 feet at the crest. When operating at their maximum allowable level, the ponds' liquids cover areas of approximately 175 feet by 245 feet. This corresponds to surface areas of approximately 42,900 square feet each, or

0.98 acre. Ponds 207-B North and Center have maximum operating depths of approximately 6 1/2 feet. Pond 207-B South has a maximum operating depth of approximately 5 1/2 feet (Benson-Lord, 19??; Rockwell, 1976 and Rockwell, 1978a).

Pond 207-C is approximately 160 feet by 250 feet at the crest. When operating at its maximum allowable level, the pond's liquid covers an area of approximately 155 feet by 245 feet. This corresponds to a surface area of 38,000 square feet, or 0.87 acres. The pond has a depth of approximately seven feet (Rockwell, 1976; Rockwell, 1977a and Rockwell, 1978a).

The maximum operating volumes of Ponds 207-A, 207-B South and 207-C are approximately 5.1, 1.5 and 1.3 million gallons, respectively. The maximum operating volumes of Ponds 207-B North and Center are approximately 1.7 million gallons each. These maximum operating volumes given above assume a two-foot freeboard. Calculations of the maximum operating volumes of the ponds are presented in Appendix 2, and provided by Rockwell, 1988.

1.3 Maximum Waste Inventory

A closure plan must include "an estimate of the maximum inventory of wastes in storage and in treatment at any time during the life of the facility" [6 CCR 1007-3, Section 265.112(a)(2)]. The estimate of the maximum waste inventory should "always be high enough to ensure that if an inspector came onto the facility, the amount of wastes in storage as well as the amount of liquid in the impoundments would not exceed the estimate in the plan, assuming normal operating conditions" (U.S. Environmental Protection Agency, 1981). The intent of 6 CCR 1007-3, Section 265.112(a)(2), as clarified by the U.S. Environmental Protection Agency, 1981, and as applicable to this facility is to provide an estimate of the maximum waste inventory from this date until closure.

1.3.1 Waste Inventory Volumes

The maximum waste inventory expected on site from this date until closure, assuming normal operating conditions, is shown on Table I. The wastes include liquids in all the ponds, sludges in Pond 207-A, and sediments which have accumulated in the remaining ponds. Maximum waste inventory calculations are presented in Appendix 2.

TABLE I
MAXIMUM WASTE INVENTORY ANTICIPATED
AT ANY TIME PRIOR TO CLOSURE

Waste	207-A	207-B North	207-B Center	207-B South	207-C
Liquids(a) (million gallons)	5.05	1.55	1.55	1.40	1.15
Sludges (cubic yards)	approx. 250(b)	none	none	none	none
Sediments (cubic yards)(c)	none	750	750	720	745

Notes:
(a) Maximum capacity estimates by Rockwell, 1988.
(b) Volume estimate includes potential sediments in Pond 207-A. Volume is based on dry sludge, i.e., does not include pond liquid. Volume estimate by Rockwell, 1988.
(c) Volume estimates are based on visual estimates of a depth of 8 inches of sediment across the bottoms of the ponds, and quantities by Rockwell, 1988.

Pond-crete is the solid material resulting from combining Pond 207-A sludge with portland cement and calcium chloride. The maximum amount of inside storage for curing of pond-crete undergoing solidification is currently 240 boxes. Each box holds approximately 15 cubic feet of pond-crete. Prior to October 1986, the maximum amount of inside pond-crete storage for solidification was 120 boxes. A new building for the pond-creting facility was completed by

October 1986 allowing this increase in solidification storage capacity (Brady, 1986).

Solidified pond-crete is currently stored on-site. The maximum amount of on-site storage for solidified pond-crete is 26,906 boxes. Approximately 19,000 boxes of solidified pond-crete are currently held on site. Further details of this storage are discussed in Section 2.3.5.

Ponds 207-B Center and South and 207-C contain accumulations of sediments. Additionally, Pond 207-B North is anticipated to contain sediments. The sediments are apparently soil particles which have been transported into the ponds by wind and surface water runoff from the berm area (Shirk, 1986). The composition of the sediments is presented in Appendix 6. Based on the sampling and analyses results, the closure schedule includes removal, treatment and disposal of accumulated sediments using existing pond-creting methods. The sediment volumes given in Table I are based on an estimated eight inches of sediments observed in Ponds 207-B Center and South when these ponds were almost empty of liquids in the summer of 1986. Pond 207-B North was full of liquid at the time, but is also anticipated to have eight inches of sediment.

1.3.2 Waste Inventory Composition

Since 1984, several indicator parameters were monitored on weekly or quarterly bases in the solar ponds. Summaries of the laboratory results are discussed below and presented on Tables II and III at the end of this section. Detailed laboratory results are presented in Appendices 3 and 4.

1.3.2.1 Analyses in 1984 and 1985

Quarterly analyses of Ponds 207-A and 207-C liquid included pH, nitrates, cyanide, beryllium and radiochemical parameters. Chemical and radiochemical analyses were conducted on a sample of Pond 207-A sludge taken in May 1985.

Weekly analyses of Ponds 207-B North and Center liquids included pH, nitrates, gross alpha and gross beta. During the period of weekly monitoring, samples for metals analyses were collected twice from Ponds 207-B North and Center. Separate summaries of each set of analyses are presented in Appendix 3, Tables 3-I, 3-II, 3-III, and 3-IV.

1.3.2.2 Analyses in 1986, 1987 and 1988

During April and May 1986, liquid and sludge in Pond 207-A and liquid in Pond 207-B North were sampled and analyzed for volatile organics, radionuclides, metals, phenols, RCRA hazardous characteristics, hexavalent chromium and total cyanide. A description of the sample codes and copies of the laboratory data sheets are presented in Appendix 4 and summarized in Tables 4-I and 4-II.

Acetone was found in three samples of Pond 207-A sludge, ranging in concentration from 5 to 4,680 ug/kg. Acetone was found in two of three laboratory blanks as well as the samples. Tetrachloroethene (PCE) was found in two of three samples of Pond 207-A sludge at 200 and 1,200 ug/kg; PCE in the third sample was undetected. PCE was at 1,800 ug/kg found in both laboratory blanks for the samples with detectable concentrations. The levels of acetone and PCE in the blanks cannot be determined from the available data.

Methylene chloride was found in a field blank at 71 ug/l and was found in three samples from Pond 207-B North liquid at values ranging from 19 to 35 ug/l. Methylene chloride was detected in all four laboratory blanks at unknown concentrations; however, the methylene chloride concentration in the field blank indicates possible laboratory contamination on the order of the sample concentration levels.

Radiochemical analyses were conducted on samples of Pond 207-A liquid and sludge, and Pond 207-B North liquid in April and May, 1986. Plutonium-239 and Americium-241 were not identified in the Pond 207-B North liquid. Storage in Pond 207-B North consists of water returned from the french drain system north of the solar ponds.

Metals and phenols analyses were conducted on samples of Pond 207-A liquid and sludge, and Pond 207-B North liquid in April and May, 1986. The samples tested did not exhibit the RCRA characteristics of ignitability, corrosivity or reactivity. One sludge sample from Pond 207-A was EP toxic for cadmium.

Hexavalent chromium and total cyanide were found in Pond 207-A and Pond 207-B North liquids at values ranging from below the detection limit to 0.02 mg/l and from 9.4 to 17 mg/l, respectively. Hexavalent chromium and total cyanide were found in a sample of Pond 207-A sludge at 0.01 mg/l and 6.5 ug/g, respectively.

Separate summaries of each set of analyses are presented in Appendix 4, Tables 4-I and 4-II. The cumulative data from the Appendix 4 tables was used in Tables II and III at the end of this section.

Sporadic quarterly and weekly analyses of liquids in Solar Ponds 207-A, 207-B North and Center, and 207-C were taken between August 1987 and June 1988. These results are included in the summary of Table II. The data is presented in Appendix 4.

Summary: Data from the solar pond liquid and sludge analyses can be summarized as follows:

Pond 207-A: Although it is presently nearly empty and cleaned of sludge, it used to contain high concentrations of nitrate, metals, and radionuclides in the liquid which were approximately two orders of magnitude higher than those in Ponds 207-B North and Center. Specifically, Pond 207-A liquid was characterized by high levels of:

Nitrates	Metals	Radionuclides
as Nitrogen	Al, Aluminum	Plutonium
	Cr, Chromium	Americium
	Cu, Copper	Uranium
	Fe, Iron	Tritium
	K, Potassium	
	Na, Sodium	
	Ni, Nickel	
	Sn, Tin	

Pond 207-A liquid was generally more contaminated than Pond 207-C except for plutonium and americium. The liquid had particularly high levels of chromium and nickel and a slightly to very alkaline pH ranging from 8.3 to 11.0.

Pond 207-A sludge analyses showed high levels of nitrates, metals and radionuclides similar to the pond liquids. In addition to the high analyte concentrations found in the liquid, calcium and magnesium were also found in high concentrations in the sludge. Radionuclides up to 14,000 pCi/g of gross alpha and 4,400 pCi/g of americium were found.

Samples of the pond-crete, which are comprised of solidified sludge from Pond 207-A, and the sludge from Pond 207-A, were tested for organics February 1988. The test results, presented in Appendix 4, indicate scattered trace organics, including:

Sample: Pond-crete

Acetone 10U-37 ug/kg
2-Butanone 10U-23 ug/kg
Tetrachloroethene 5U-26 ug/kg

Sample: Soil Matrix (sludge)

Fluoroanthene 161-1,683 ug/kg
di-n-Butyl Phthalate 330U-590 ug/kg
bis(2-ethylhexyl)Phthalate 330U-14,949 ug/kg

Organics are not a component of the process wastes and are not considered a characteristic constituent of the sludge. It is difficult to draw any conclusions concerning organic levels in the pond liquids due to limited data and high detection limits, but the occasional identification of organic compounds in the sludge indicates that organics may be present at very low levels in the liquid.

Pond 207-B North and Center have generally low concentrations of nitrates, metals and radionuclides. Nitrate concentration in the pond liquids averaged 380 mg/l. Metal concentrations in the pond liquids are at or below drinking water standards.

Gross alpha in the pond liquids averaged 104 pCi/l; however, plutonium and americium were not detected in these two ponds. Tritium was found in Pond 207-B North ranging from 1,200 (300) to 1,300 (300) pCi/l. Ponds 207-B North and Center have a slightly to very alkaline pH ranging from 7.3 to 11.3.

Pond 207-C liquid contaminants are approximately two orders of magnitude higher than those in Pond 207-B North and Center for nitrate, metals and radionuclides. However, Pond 207-C liquid is generally less contaminated than the analyzed liquid in Pond 207-A, except for plutonium and americium which are approximately ten times higher in Pond 207-C. The pond liquid has a slight to alkaline pH ranging from 7.7 to 12.5.

TABLE II
LIQUID CHARACTERIZATION SUMMARY 1984 - 1988

"( )" - Test Result Reference Number

ANALYTE	UNITS	POND 207-A	POND 207-B NORTH	POND 207-B CENTER	POND 207-B SOUTH	POND 207-C
pH		(1) 8.3 - 11.0 (9) 10.1	(2) 7.5 - 9.6 (10)8.0 - 8.5	(2) 7.3 - 11.3 (10)9.6 - 10.5	-----	(1) 7.7 - 12.5 (9) 10.5 - 11.3
Nitrate as Nitrogen	(mg/l)	(1) ND - 21,739 (9) 19,200	(2) 335 - 1,367 (10)212 - 507	(2) ND - 15.6 (10)346.4 - 1221	-----	(1) 0.4 - 18,841 (9) 9650 - 21,400
Total Disolved Solids	(mg/l)	(9) 127,000	-----	-----	-----	(9) 93,859 - 175,800
Cyanide	(mg/l)	(1) ND - 1.7 (9) 0.1	-----	-----	-----	(1) ND - 1.9 (9) 0.48 - 0.5
Gross Alpha	(pCi/l)	(1) 32(16) - 56,000(0.0) (4) 46,000(4,000) - 80,000(6,000) (9) 80,000(1,000)	(2) 13(50) - 323(33) (4) 74(58) - 120(50) (10)52(20) - 200(80)	(2) 4(0) - 59(23) (10)57(21) - 2,500(400)	-----	(1) 10,000(17,000) - 15,000(3,000) (9) 13,000(1,000) - 46,000(8,000)
Gross Beta	(pCi/l)	(1) 2(27) - 27,000(600) (4) 35,000(2,000) - 40,000(2,000) (9) 2,100(200)	(2) 5(25) - 163(25) (4) 56(32) - 100(92) (10)67(3) - 200(80)	(2) 8(11) - 73(0) (10)72(16) - 1,500(200)	-----	(1) 405(79) - 11,000(2,000) (9) 3,400(100) - 44,000(4,000)
Pu, Plutonium 239	(pCi/l)	(1) 0.0(420) -240(100) (4) 56(16) - 660(50)	(4) ND	-----	-----	(1) 210(320) - 1,400(300) (9) 300(130) - 2,100(300)
Am, Americum 241	(pCi/l)	(1) 0.0(1,000) - 200(120) (4) ND - 45(14)	(4) ND	-----	-----	(1) 12 - 13,000(1,000) (9) 0.0(27) - 2,900(300)
U, Uranium	(pCi/l)	(1) 0.69(0.79) - 26,000(2,000)	-----	-----	-----	(1) 1,800(300) - 15,000(1,000) (9) 1,400(900) - 40,000(2,000)
U, Uranium 233 + 234	(pCi/l)	(4) 14,000(1,000) - 20,000(1,000)	(4) 50(2) - 53(2)	-----	-----	-----
U, Uranium 238	(pCi/l)	(4) 21,000(1,000) - 28,000(1,000)	(4) 31(1) - 33(1)	-----	-----	-----
Tritium	(pCi/l)	(1) 620(230) - 3,000(800) (4) 240(180) - 930(260)	(4) 1,200(300) - 1,300(300)	-----	-----	(1) 0.0(0.0) - 6,400(600)
Al, Aluminum	(mg/l)	(5) 2.31 - 2.64	(3) 0.16 (3) 1 (5) ND (7) <.0028 (8) <.003	(3) 0.15 (3) 2. (7) <.0032 (8) <.0035	-----	-----
Sb, Antimony	(mg/l)	-----	(7) <.028 (8) <.03	(7) <.032 (8) <.035	-----	-----
As, Arsenic	(mg/l)	(5) 0.150	(5) ND (7) <.01 (8) <.01	(7) <.01 (8) <.01	-----	-----

TABLE II
LIQUID CHARACTERIZATION SUMMARY 1984 - 1988

"( )" - Test Result Reference Number

ANALYTE	UNITS	POND 207-A	POND 207-B NORTH	POND 207-B CENTER	POND 207-B SOUTH	POND 207-C
Ba, Barium	(mg/l)	(5) ND	(5) ND - 0.220 (7) <1.0 (8) <1.0	(7) <1.0 (8) <1.0	-----	-----
Be, Beryllium	(mg/l)	(1) ND - 0.1 (5) 0.027 - 0.043 (9) .002	(5) ND (7) <.05 (8) .06	(7) <.05 (8) <.05	-----	(1) ND - 0.6 (9) 0.1
Bi, Bismuth	(mg/l)	-----	(7) <.014 (8) <.015	(7) <.016 (8) <.018	-----	-----
B, Boron	(mg/l)	-----	(3) 0.29 (3) 0.31 (7) .14 (8) .09	(3) 0.24 (3) 0.67 (7) 0.13 (8) .071	-----	-----
Cd, Cadmium	(mg/l)	(5) 0.070 - 0.150	(5) ND (7) <.01 (8) .01	(7) <.01 (8) .01	-----	-----
Ca, Calicum	(mg/l)	(5) ND	(3) 20.0 (3) 290 (5) 176 - 198 (7) 96.0 (8) 180.0	(3) 2.9 (3) 45.0 (7) 95.0 (8) 66.0	-----	-----
Ce, Cerium	(mg/l)	-----	(7) <2.8 (8) <3.	(7) <3.2 (8) <3.5	-----	-----
Cs, Cesium	(mg/l)	-----	(3) ND (3) ND (7) <.28 (8) <.3	(3) ND (3) 0.041 (7) <.32 (8) .35	-----	-----
Co, Cobalt	(mg/l)	(5) 0.200 - 0.500	(5) ND (7) <.014 (8) <.015	(7) <.016 (8) <.018	-----	-----
Cr, Chromuim	(mg/l)	(5) 13.7 - 16.7	(5) ND (7) <.05 (8) <.05	(7) <.05 (8) <.05	-----	-----
Cu, Copper	(mg/l)	(5) 1.61 - 1.80	(3) ND (3) ND (5) ND (7) <.014 (8) <.015	(3) 0.016 (3) 0.037 (7) <.016 (8) <.018	-----	-----

TABLE II
LIQUID CHARACTERIZATION SUMMARY 1984 - 1988

"( )" - Test Result Reference Number

ANALYTE	UNITS	POND 207-A	POND 207-B NORTH	POND 207-B CENTER	POND 207-B SOUTH	POND 207-C
Ge, Germanium	(mg/l)	-----	(7) <.014 (8) <.015	(7) <.016 (8) <.018	-----	-----
Fe, Iron	(mg/l)	(5) 1.50 - 8.00	(3) 0.28 (3) 0.29 (5) ND (7) .057 (8) <.03	(3) 0.074 (3) 0.2 (7) 0.13 (8) <.035	-----	-----
Pb, Lead	(mg/l)	(5) ND	(3) ND (3) 0.0035 (5) ND (7) <.0028 (8) <.003	(3) ND (3) 0.002 (7) <.0032 (8) <.0035	-----	-----
Li, Lithium	(mg/l)	-----	(3) 0.37 (3) 3.5 (7) 1.7 (8) 6.	(3) 0.052 (3) 0.41 (7) 2.9 (8) 3.5	-----	-----
Mn, Manganese	(mg/l)	(5) 0.095 - 0.115	(3) ND (3) ND (5) ND - 0.015 (7) <.0028 (8) <.003	(3) 0.022 (3) 0.081 (7) <.0032 (8) <.0035	-----	-----
Mg, Magnesium	(mg/l)	(5) ND	(3) 87.0 (3) 120.0 (5) 66.4 - 72.6 (7) 88 (8) 80.0	(3) 3.9 (3) 13.0 (7) 86.0 (8) 91.0	-----	-----
Hg, Mercury	(mg/l)	(5) ND - 0.0002	(5) ND (7) <.002 (8) <.002	(7) <.002 (8) <.002	-----	-----
Mo, Molybdenum	(mg/l)	-----	(3) ND (3) 0.0069 (7) <.0028 (8) .003	(3) 0.016 (3) 0.037 (7) .019 (8) .0035	-----	-----
Ni, Nickel	(mg/l)	(5) 1.90 - 2.00	(3) ND (3) ND (5) ND - 0.050 (7) <.028 (8) <.03	(3) 0.015 (3) 0.016 (7) <.032 (8) <.035	-----	-----
Nb, Niobium	(mg/l)	-----	(7) <.14 (8) <.15	(7) <.16 (8) <.18	-----	-----

TABLE II
LIQUID CHARACTERIZATION SUMMARY 1984 - 1988

"( )" - Test Result Reference Number

ANALYTE	UNITS	POND 207-A	POND 207-B NORTH	POND 207-B CENTER	POND 207-B SOUTH	POND 207-C
P, Phosphorous	(mg/l)	-----	(3) ND (3) ND (7) <.14 (8) <.15	(3) 0.074 (3) 0.2 (7) <.16 (8) 0.18	-----	-----
K, Potassium	(mg/l)	(5) 13,200 - 14,300	(3) 82.0 (3) 120 (5) 56.1 - 62.7 (7) 89.0 (8) 64.0	(3) 30.0 (3) 36.0 (7) 98.0 (8) 110.0	-----	-----
Rb, Rubidium	(mg/l)	-----	(7) <.28 (8) <.3	(7) <.32 (8) <.35	-----	-----
Se, Selinium	(mg/l)	(5) ND	(3) 0.01 (3) 0.02 (5) 0.009 (7) <.01 (8) .024	(3) ND (3) ND (7) <.01 (8) .019	-----	-----
Si, Silicon	(mg/l)	-----	(3) 2.1 (3) 5.6 (7) 2.1 (8) <.5	(3) 2.4 (3) 5.5 (7) 1.4 (8) 1.6	-----	-----
Ag, Silver	(mg/l)	-----	(3) ND (3) 0.082 (5) ND (7) <.0028 (8) <.003	(3) 0.0016 (3) 0.015 (7) <.0032 (8) <.0035	-----	-----
Na, Sodium	(mg/l)	(5) 36,300 - 42,900	(3) 370.0 (3) 620.0 (5) 363 - 451 (7) 820. (8) 770.0	(3) 67.0 (3) 250.0 (7) 800.0 (8) 650.0	-----	-----
Sr, Strontium	(mg/l)	-----	(3) 1.2 (3) 3.5 (7) 0.14 (8) .21	(3) 0.28 (3) 0.52 (7) .15 (8) .14	-----	-----
Ta, Tantalum	(mg/l)	-----	(7) <.028 (8) <.03	(7) <.032 (8) <.035	-----	-----
Te, Tellurium	(mg/l)	-----	(7) <.28 (8) <.3	(7) <.32 (8) <.35	-----	-----

TABLE II
LIQUID CHARACTERIZATION SUMMARY 1984 - 1988

"( )" - Test Result Reference Number

ANALYTE	UNITS	POND 207-A	POND 207-B NORTH	POND 207-B CENTER	POND 207-B SOUTH	POND 207-C
Tl, Thallium	(mg/l)	-----	(7) <.014 (8) <.015	(7) <.016 (8) <.018	-----	-----
Th, Thorium	(mg/l)	-----	(7) <.028 (8) <.03	(7) <.032 (8) <.035	-----	-----
Sn, Tin	(mg/l)	(5) 7.00 - 13.00	(5) ND (7) <.028 (8) <.03	(7) <.032 (8) <.035	-----	-----
Ti, Titanium	(mg/l)	-----	(7) <.014 (8) <.015	(7) <.016 (8) <.018	-----	-----
W, Tungsten	(mg/l)	-----	(7) <1.4 (8) <1.5	(7) <1.6 (8) <1.8	-----	-----
U, Uranium	(mg/l)	-----	(7) <1.4 (8) <1.5	(7) <1.6 (8) <1.8	-----	-----
V, Vanadium	(mg/l)	(5) 0.10 - 0.20	(3) ND (3) ND (5) ND (7) <.028 (8) <.03	(3) ND (3) 0.0081 (7) <.032 (8) <.035	-----	-----
Zn, Zinc	(mg/l)	(5) 0.62 - 0.78	(3) ND (3) ND (5) ND - 0.022 (7) <.14 (8) <.15	(3) 0.041 (3) ND (7) <.16 (8) <.18	-----	-----
Zr, Zirconium	(mg/l)	-----	(3) ND (3) ND (7) <.028 (8) <.03	(3) 0.0041 (3) ND (7) <.032 (8) <.035	----	-----
Tritium	(mg/l)	-----	(3) ND (3) 0.069	(3) 0.022 (3) 0.041	-----	-----
Phenols	(mg/l)	(5) 0.013 - 0.035	(5) 0.003 - 0.046	-----	-----	-----

TABLE III
SLUDGE CHARACTERIZATION SUMMARY 1984 - 1988

"( )" - Test Result Reference Number

ANALYTE	UNITS	POND 207-A	POND 207-B NORTH	POND 207-B CENTER	POND 207-B SOUTH	POND 207-C
pH		(6) 9.5				
Nitrate as Nitrogen	(mg/l)	(6) 8,800				
Gross Alpha	(pCi/g)	(4) 4,700(200) - 14,000(1,000)				
	(pCi/l)*	(6) 860,000				
Gross Beta	(pCi/g)	(4) 160(20) - 1,400(100)				
Pu, Plutonium 239	(pCi/g)	(4) 1,000(100) - 3,700(100)				
Am, Americum 241	(pCi/g)	(4) 1,400(200) - 4,400(100)				
U, Uranium 233 + 234	(pCi/g)	(4) 70(10) - 570(30)				
U, Uranium 235	(pCi/l)*	(6) 28(19)				
U, Uranium 238	(pCi/g)	(4) 130(10) - 480(30)				
	(pCi/l)*	(6) 520(90)				
Tritium	(pCi/g)	(4) 1,300(500) - 12,000(1,000)				
Al, Aluminum	(mg/kg)	(5) 11,000 - 11,900				
As, Arsenic	(mg/kg)	(5) ND				
Ba, Barium	(mg/kg)	(5) ND				
Be, Beryllium	(mg/kg)	(5) 309 - 1,570				
		(6) 170				
Cd, Cadmium	(mg/kg)	(5) 1,110 - 10,500				
Ca, Calicum	(mg/kg)	(5) 19,600 - 50,000				
Co, Cobalt	(mg/kg)	(5) ND				
Cr, Chromuim (Total)	(mg/kg)	(5) 1,010 - 19,700				
Cr, Chromium (Hex.)	(mg/kg)	(6) <1.0				
Cu, Copper	(mg/kg)	(5) 425 - 1,590				
Fe, Iron	(mg/kg)	(5) 3,590 - 6,900				
Pb, Lead	(mg/kg)	(5) 65 - 455				
Mn, Manganese	(mg/kg)	(5) 153 - 595				
Mg, Magnesium	(mg/kg)	(5) 6,100 - 21,000				
Hg, Mercury	(mg/kg)	(5) 7.5 - 25				
Ni, Nickel	(mg/kg)	(5) 124 - 1,320				
K, Potassium	(mg/kg)	(5) 50,000 - 65,300				
Se, Selinium	(mg/kg)	(5) ND				
Ag, Silver	(mg/kg)	(5) 153 - 237				
Na, Sodium	(mg/kg)	(5) 130,000 - 166,000				
Sn, Tin	(mg/kg)	(5) ND				
V, Vanadium	(mg/kg)	(5) ND				
Z, Zinc	(mg/kg)	(5) 227 - 595				
Phenols	(mg/kg)	(5) ND - 3.3				

NOTES FOR TABLES II AND III

ND = Not Detected

(pCi/l)* = Units as shown on data provided for sludge in Pond 207-A

( ) = Test result reference ranging from 1 to 10, described below.

TEST RESULT REFERENCE NUMBER:

1 Summary of quarterly sampling 1984 and 1985, Appendix 3 Table 3-I.

2 Summary of weekly sampling for Ponds 207-B North and Center liquids, Appendix 3, Table 3-II.

3 Summary of two sets of metals analyses of Ponds 207-B North and Center liquids, October 1984 and April 1985, Appendix 3, Table 3-III.

4 Summary of radiochemical analyses, April and May 1986, Appendix 4, Table 4-I.

5 Summary of metals and phenols testing, April and May, 1986, Appendix 3, Table 3-IV.

6 Summary of parameters monitored in Pond 207-A sludge in May 1985, Appendix 4, Table 4-III

7 207-B Solar Pond North and Center quarterly metals analysis, August 14, 1987, Lab No. E87-3918, Appendix 4

8 207-B Solar Pond North and Center quarterly metals analysis, November 30, 1987, Lab No. E87-4254, Appendix 4

9 207-A and 207-C Solar Pond quarterly analysis results (liquids), March 1987 to March 1988, Appendix 4

10 207-B Solar Pond weekly analysis results (liquids), October 1987 to June 1988.

1.4 Description of Auxiliary Equipment

The equipment regularly used in the Pond 207-A pond-creting operation consists of a Mud Cat pumper with an agitator and a pump on a pontoon supported raft. The pump pumps the sludge from Pond 207-A into a 25,000-gallon steel Gardner Denver/Stearns Roger thickener tank. A rake enclosed in the base of the tank directs the sludge to a drain at the bottom of the tank. After the settling process, which takes about ten to 12 hours, is completed, the liquid is decanted from the tank back into Pond 207-A. The thickener is designed to allow a continuous overflow passing over an adjustable weir and flowing through a four-inch diameter pipe discharging into Pond 207-A. The thickener is vented to the atmosphere.

The sludge is then pumped from the base of the tank by a high pressure diaphragm slurry pump through rubber piping to the back end of a steel "pug mill." A series of surge pins, screw augers and paddle wheels lift and mix the sludge with portland cement, which is fed in from an adjacent silo. The mixed sludge and cement flows over a weir, through a chute and into plastic lined boxes.

To increase the capacity of the pond-crete production operation, additional equipment was purchased in 1986. The major pieces of additional equipment are a concrete mixer truck and a front end loader. The concrete mixer truck (7.5 cubic yards, Boardman Model No. 805LD, 1980) receives a transfer of four cubic yards of concentrated pond sludge from the existing thickener. The sludge is transferred to the mixer truck by an existing pump through a two-inch diameter line at 25 gpm. Type I portland cement is then pneumatically transferred to the mixer truck from a portable cement silo with a pneumatic transfer system. The cement and sludge is mixed by rotating the mixer. The mixture is then discharged into a 2.5 cubic yard hopper mounted on a concrete grout pump, which pumps the cement/sludge mixture through the building wall and discharges it into boxes.

The front end loader is used to transfer sludge from the bottom of Pond 207-A and dump it into a concrete pumper for transfer to the thickener. The front end loader is also used to move sludge from the shallow end of the pond to the deep end.

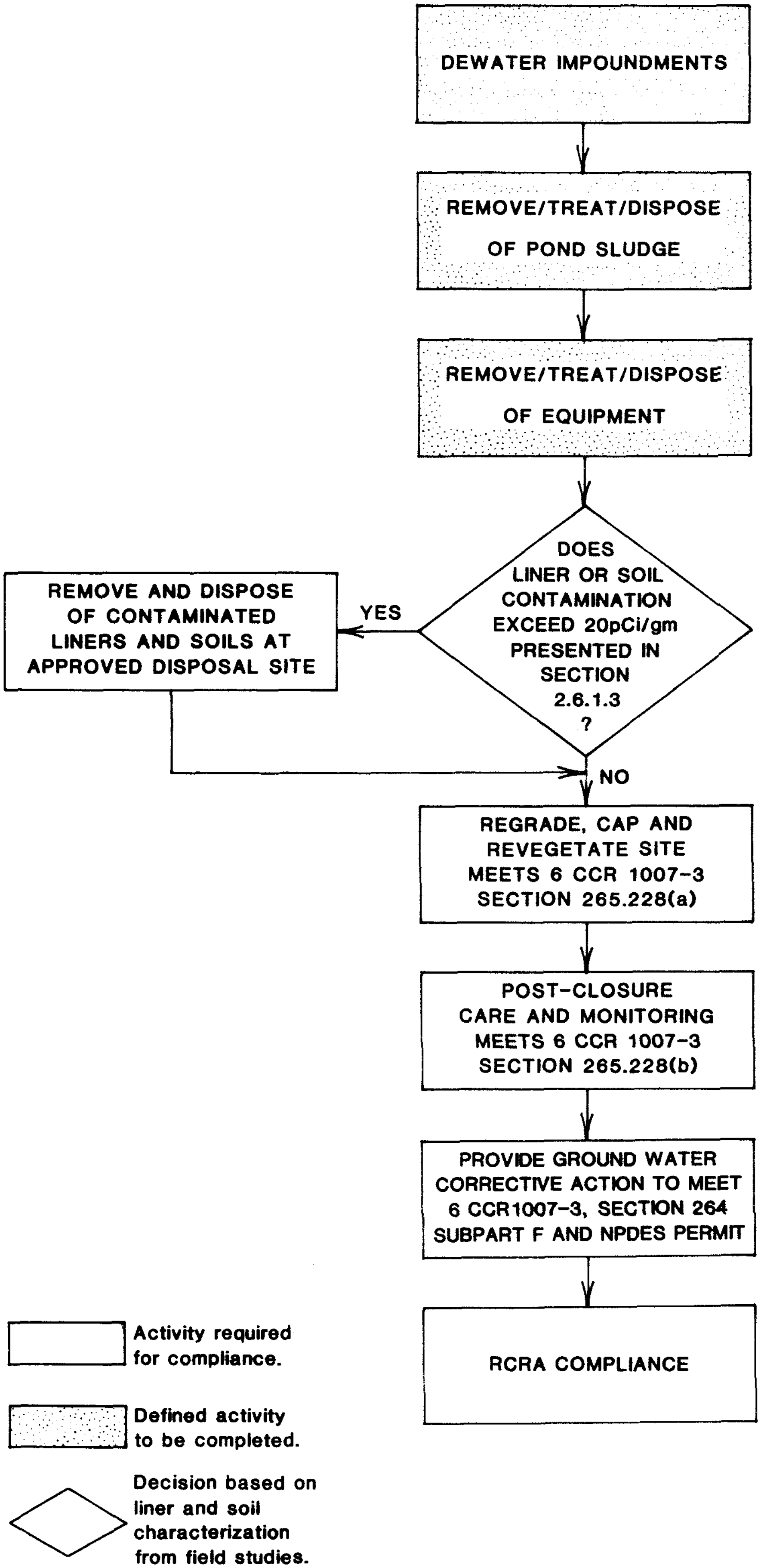
The equipment used in the Pond 207-A pond-creting operation will be used in other areas at the Rocky Flats Plant once closure of the solar ponds is completed. The pond-creting facility is being permitted under the RCRA Part B Operating Permit Application (U.S. Department of Energy, 1986a) and is identified as Unit 48 in that document. The only auxiliary equipment at the solar ponds requiring closure under the RCRA Post-Closure Care Permit Application (U.S. Department of Energy, 1986c) includes equipment at the solar ponds that is not associated with the pond-creting operation. Solar pond equipment not associated with the pond-creting facility includes a portable pump to pump liquids from one pond to another and the pontoon supported raft.

1.5 Final Closure Plan Summary

1.5.1 Closure Objectives

This closure plan has been prepared to meet the performance standards of 6 CCR 1007-3, Section 265.111. The promulgated standards require a facility must be closed in a manner that:

- minimizes the need for further maintenance, and
- controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous



6 033 88	Chen & Associates	CLOSURE PLAN ACTIVITY FLOW DIAGRAM	Fig. 9

waste, hazardous waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground or surface waters or to the atmosphere.

1.5.2 Closure Plan

The activities necessary to complete closure and comply with the ground-water corrective action requirements of 6 CCR 1007-3, Section 264 Subpart F are shown on the diagram in Figure 9. Figure 2 shows the project boundary and indicates the maximum extent of closure activities for the solar evaporation ponds. The northern edge of the project boundary is currently placed approximately 50 feet south of North Walnut Creek, at approximately the downgradient edge of the french drain system.

Solid Waste Management Units (SWMU) covered under the solar evaporation ponds closure plan are as follows:

SWMU No.	Description
101	207 Solar Evaporation Ponds
121*	Original Process Waste Line
138	Cooling Tower Blowdown-Building 779
149	Effluent Pipe
150.8	Radioactive Liquid Leaks Northeast of Building 779

* - The solar pond closure plan addresses only the portion of the original process waste line within the project boundary.

The listed SWMUs are described in Appendix 1 of the Part B RCRA Permit, dated November, 1986.

The closure activities on Figure 9 that can be defined at this time are shown as shaded rectangles. These closure activities relate to waste inventory removal and will be completed. They include:

- dewatering the impoundments,
- removing, treating and disposing of the pond sludges and sediments, and
- removing, treating and disposing the equipment used at the solar ponds.

"Undefined" closure activities, indicated on Figure 9 as unshaded rectangles associated with a series of decision diamonds, are based on the characterization of liner and soil contamination at the solar evaporation ponds. The evaluation of liner and soil contamination at the site will be performed as part of the field and engineering studies during closure.

The site characterization report from engineering studies completed in accordance with the Compiance Agreement (U.S. Department of Energy, 1986b) is presented in Appendix 6.

The site characterization results are the basis for determining the concentration of contaminants in the soil and bedrock. The levels of contamination for a selected group of indicator parameters determined the implementation of:

- No action;
- Placement of a multi-layer cap;
- Removing and disposing of the soil off site;
- Soil treatment; and
- Alternative technologies.

Discussion of site contamination and closure alternatives, including closure performance standards for liner and soil removal, are presented in Section 2.6.1.2.

Closure activities for contaminated soils and bedrock will comply with 6 CCR 1007-3, Section 265.228. Closure alternatives for the solar evaporation ponds are presented in Section 2.6.1.2. In general, contaminated soils and bedrock will be:

- Regraded to promote surface runoff,
- Covered with a multi-layer cap, and
- Revegetated.

Post-closure care and monitoring will be required as for a landfill under 6 CCR 1007-3, Section 265 Subpart G and 265.310. This type of closure, where wastes remain in place, meets 6 CCR 1007-3, Section 265.228.

Ground-water quality has been evaluated and corrective action is required to meet 6 CCR 1007-3, Section 264 Subpart F or the NPDES permit for North and South Walnut Creeks. Ground-water corrective action will be implemented, perhaps incorporated as part of an area-wide ground-water corrective action, as discussed in Section 2.7.2.

Compliance with the Resource Conservation and Recovery Act (RCRA), with respect to solar pond closure, will be achieved by meeting 6 CCR 1007-3, Sections 265.228 and Section 264 Subpart F.

1.5.3 Closure Schedule

The schedule of activities selected for closure are summarized on Figure 10 and described below. These activities are based upon current conditions and projections of the time required for activities. The critical activity for closure of the solar ponds is removal/evaporation/ treatment of the liquid currently held in the solar ponds and the disposition of incoming water from the french drain system.

The schedules presented are based upon resumption of pond-creting operations by the end of July 1988. Pond-crete solidification/destabilization problems were first identified on May 23, 1988, when approximately 0.25 ft^3 of pond-crete was spilled onto the 904 pad (RCRA Storage Unit #15). Pond-crete production ceased upon identification of this problem. The RCRA Contingency Plan was implemented, and the required written report was made on June 7, 1988, 15 days after RCRA Contingency Plan implementation. The cause of the unsolidified pond-crete is still being investigated.

If this schedule, as presented, cannot be met, the Colorado Department of Health and Environmental Protection Agency will be notified of this problem, and these schedules revised, within 30 days of identification of the problem.

Evaporation of liquids in all of the ponds was assumed to begin in June 1987 for purposes of calculating a closure schedule. Placement of any liquid in the solar ponds will cease in December 1990. As previously explained, removal, treatment and disposal of sludge in Pond 207-A began in June 1985 and are not yet complete. Removal of this sludge is expected to be complete in July 1988. Removal, treatment, and disposal of sediments in Ponds 207-B North, Center and South and Pond 207-C will begin in August 1988 and will be completed by November 1989. Radiochemical evaluation of the ponds' liners will begin in August 1989 and will be completed in February 1991. If necessary, removal of pond liners will begin in April 1990 and will be completed by June 1991. If required, partial removal and disposal of contaminated soil will begin in April 1990 and will be completed by June 1991. The required cap will be placed and revegetated between June 1991 and November 1991. Closure will be certified in November and December 1991.

The closure schedule is dependent on receiving approval of final design within 90 days of submission to the Colorado Department of Health. The final schedule of activities required for closure will be defined based on receipt of design approval.

1.5.4 Justification for Extension of Schedule

The regulations in 6 CCR 1007-3, Section 265.113(a) require:

> "Within 90 days after receiving the final volume of hazardous wastes, or 90 days after approval of closure plan, if that is later, the owner or operator must treat, remove from the site, or dispose of on-site all hazardous wastes in accordance with the approved closure plan."

The intent of this regulation is to avoid causing serious environmental damage due to accumulating inventory over long periods of time. Additional regulations outlined in 6 CCR 1007-3, Section 265.113(b), require:

> "The owner or operator must complete closure activities in accordance with the approved closure plan and within 180 days after receiving the final volume of wastes or 180 days after approval of the closure plan, if that is later."

The activities required to treat, store and remove all wastes and to complete final closure at the solar evaporation ponds will take longer than schedules required by the referenced regulations. The rate determining process that controls the progress of closure is the liquid evaporation. However, sludge and sediment solidification can only be completed approximately three months before completion of liquid evaporation. Evaporation of liquids from the ponds was increased in June 1987 above the previous rate by the use of forced evaporators on site. Sludge solidification was increased by approximately 60 percent in the fall of 1986 by the increase in storage space for curing pond-crete. Detailed justifications are provided for the schedule in Section 2.0.

1.5.5 Protection of Human Health and the Environment

Threats to human health and the environment from the solar ponds will be addressed during closure by:

- continuing to limit access to the solar ponds, as discussed in Section 8.0,
- continuing to collect and treat liquid intercepted by the french drain system,
- minimizing windblown releases during closure activities, as discussed in Sections 2.4.3.2, 2.5.3 and 2.6.3, and
- continuing to collect and store, in surface drainage ponds located downgradient of the solar ponds, surface runoff from the solar ponds area until the requirements of an NPDES permit are met.

Additional protection is provided by the routine monitoring activities conducted at Rocky Flats and by restricted access to the facility. Specific details of the routine monitoring program are summarized in the "Annual Environmental Monitoring Report" (Rockwell, 1986b). This document is reviewed and updated on an annual basis. Brief discussions of the monitoring activities that are conducted and the security procedures at the plant are presented below.

The routine environmental monitoring program includes the sampling and analysis of airborne effluents, ambient air, surface and ground water, and soil. External penetrating gamma radiation exposures are also measured using thermoluminescent dosimeters. Samples are collected from on-site, boundary and off-site locations.

Particulate and tritium sampling of building exhaust systems is conducted continuously. For immediate detection of abnormal conditions, ventilation systems that service areas containing plutonium are equipped with Selective Alpha Air Monitors. These monitors trigger an alarm automatically if out-of-tolerance conditions are experienced. Particulate samples are collected from ambient air samplers operated continuously on site. The ambient air samples are analyzed for Total Long-Lived (TLL) Alpha activity or for plutonium activity. There are currently 52 of these ambient air samplers. Twenty-three are located within and adjacent to the Rocky Flats exclusion area, 14 are located in nearby communities.

The majority of the water used at the Rocky Flats Plant (RFP) for plant process operations and sanitary purposes is treated and evaporated and/or reused for cooling tower makeup or steam plant use. The discharge of water off-site is minimized to the greatest extent possible. Water discharges from the RFP are monitored for compliance with appropriate CDH standards and EPA National Pollutant Discharge Elimination System (NPDES) permit limitations. Surface runoff from precipitation is collected in surface water control ponds and discharged off site after monitoring. Routine water monitoring is conducted for two downstream reservoirs and for drinking water sources in nine communities. Ground-water monitoring was conducted during 1987 at approximately 160 ground-water sampling locations.

Soil samples were collected during 1987 from 40 sites located on radii from Rocky Flats at distances of 1.6 and 3.2 kilometers (one and two miles). The purpose of this soil sampling is to determine if there are any changes in plutonium concentrations in the soil around the plant.

When higher concentrations than usual are found in any of the routine monitoring activities or when out-of-compliance conditions are identified, the cause of the problem is investigated. If the solar ponds are found to be the cause of an out-of-compliance condition, then this closure plan will be revised within 30 days.

Access to the plant is limited by:

- a three-strand barbed wire cattle fence surrounding the facility (Figure 1) posted to identify the land as a government reservation/ restricted area,
- a fence surrounding and guards posted 24 hours per day at two gates to the controlled area of the facility (Figure 1),
- a six-foot high chain link fence topped by two feet of three-strand barbed wire surrounding and guards posted 24 hours per day at gates to the perimeter security zone (PSZ),
- guards patrolling the controlled area and the PSZ 24 hours per day, and
- surveillance by security cameras 24 hours per day.

The existing fences and gates are operated and maintained by the U.S. Department of Energy.

The monitoring and security measures outlined above are designed to protect human health and the environment by threats posed by the RFP as a whole. More specifically, they protect human health and the environment from threats posed by the solar ponds.

1.5.6 Administration of Closure Plan

The closure plan for the solar evaporation ponds will be kept at the Rocky Flats Area Office, Building 111, U.S. Department of Energy. The person responsible for storing and updating this copy of the closure plan is:

Mr. A.E. Whiteman
Area Manager

His address and phone number are:

U.S. Department of Energy
Rocky Flats Plant
P.O. Box 928
Golden, Colorado 80402
Phone: (303) 966-2025

Mr. Whiteman is also responsible for updating other copies of the closure plan held off-site by sending additions or revisions by registered mail.

1.5.7 Closure Cost Estimates and Financial Assurance

State and Federal governments are exempt from the financial requirements imposed by Subpart H of 6 CCR 1007-3, Section 265.140(c). Because the Rocky Flats Plant is a federally-owned facility, no cost estimates or financial assurance documentation are required. However, cost estimates are presented in Table IV for regrading and construction of a multi-layered cover over the solar pond area. The estimates are provided for planning, budgeting and informational purposes. These estimates can in no way be considered binding.

Activities omitted from the cost estimate due to unknown scheduling and construction details include:

- Liner disposal at an off-site facility;
- Removal/disposal of 207-C embankment;
- Removal/disposal of contaminated soil, if required; and
- Decontamination of construction and auxiliary equipment.

TABLE IV

COST ESTIMATE FOR MULTI-LAYERED COVER*
FOR SOLAR POND CLOSURE

Item	Quantity	Unit Cost**	Total
Liner Removal and Container-ization	10,000 yd^3	$13/cy	$130,000
Regrading	60,000 yd^3	$4/cy	$240,000
Clay (Import, Place & Compact)	30,000 yd^3	$28/cy	$840,000
Membrane	750,000 ft^2	$0.90/ ft^2	$675,000
Sand Drain (Import & Place)	18,000 yd^3	$32/cy	$576,000
Compacted On-Site Soil (Cut, Haul Place & Compact)	55,000 yd^3	$7/cy	$385,000
Topsoil (On-Site Haul and Place)	30,000 yd^3	$5/cy	$150,000
Revegetate	800,000 ft^2	$0.17/ ft^3	$136,000
			$3,132,000
	10% Engineering		$ 313,000
			$3,445,000
	15% Contingency		$ 516,980
	TOTAL		$3,962,000

* Section 4.0 discusses regrading, cover and vegetation; typical cover section is shown on Figure 16.

** Unit costs include a 1.3 multiplier to account for work conducted inside the perimeter security zone (PSZ).

2.0 REMOVAL, TREATMENT AND DISPOSAL OF WASTES, LINERS, SOILS AND GROUND WATER

2.1 Introduction

This section of the closure plan responds to 6 CCR 1007-3, Section 265.112(a)(2) through (4) by providing the following information:

- Estimates of the maximum inventory of wastes expected during the closure period. Waste inventory for the solar evaporation ponds is composed of free liquids, sludges and sediments, and portions of the liners and embankment soils.
- Discussion of the volumes, removal methods, treatment procedures, and disposal plans for each of the solar evaporation pond wastes.
- Time schedules for closure activities.

Briefly, the solar evaporation ponds will be closed by concurrently evaporating the pond liquids and removing the pond sludges and sediments. The sludges and sediments in the ponds will be solidified to form pond-crete which will be transported to and disposed of at an approved off-site disposal facility or the Nevada Test Site (NTS).

Contaminated pond liners and soil (including embankment soil) will be partially removed in the vicinity of the source areas to meet the removal criteria presented in Section 2.6.1.2. The pond liners and soil will be sampled and analyzed in accordance with Section 2.6.1.3 to establish if removal is required. Lining materials which are left below the cap will be broken up into pieces less than 12 inches in size.

Ground water in the solar pond area requires treatment in order to meet the ground-water protection standards. The french drains and interceptor trench pump house (ITPH) system is currently used for ground-water collection. Applicable ground-water requirements and removal, treatment and disposal of contaminated ground water are discussed in Section 2.7.

Evaporation of the ponds' liquids was selected as the removal/treatment mechanism for the liquids because evaporation is environmentally acceptable, technically feasible, and a cost-effective treatment method. Natural evaporation has been supplemented periodically in the past with forced evaporation. Forced evaporation has been available for regular, part-time use since June 1987. Liquid evaporation is the rate-determining closure activity. This rate determining step is impacted by the ground-water corrective action program since the ITPH system returns approximately four million gallons of contaminated water to the solar ponds annually.

The sludge and sediments in the ponds requires solidification for disposal. Solidifying pond sludges and sediments into pond-crete was selected because the basic technology has been used and proven to be effective, the plant has experience with the process, the material meets the requirements of the Department of Transportation (DOT) regulations for shipping, and the material meets requirements of the Nevada Test Site for solidification of radioactive waste.

Pond-crete from the pond sludges and sediments was disposed of at the Nevada Test Site (NTS) until the fall of 1986 when this material was identified as a mixed hazardous and radioactive waste. Since the fall of 1986, the pond-crete has been stored on site on two asphalt paved pads awaiting permitting of an approved disposal facility.

2.2 Free Liquids

2.2.1 Background

Ponds 207-A and 207-C are no longer receiving liquids on a regular basis. Ponds 207-A and 207-C received wastes from the plant on an emergency basis until June 1987 when two tanks were constructed for the storage of liquids prior to processing. Ponds 207-B North, Center and South are receiving water from the french drain interceptor system.

Liquid from the solar ponds have been pumped to Building 374 for forced evaporation on a regular, part-time basis since June 1987. Between September 1986, and June 1987, intermittent liquids approaching the maximum operating level in Pond 207-B North were transferred to Building 374 for forced evaporation or transferred to Pond 207-B Center or South.

2.2.2 Volume of Free Liquids

The approximate volume of liquids held in the ponds on April 20, 1988, is shown on Table V.

TABLE V

VOLUME OF LIQUIDS AND SEDIMENTS/SLUDGES IN THE
SOLAR EVAPORATION PONDS
ON APRIL 20, 1988

Pond	Liquid Volume (Million Gallons)	Sediment/Sludge Volume (Million Gallons)	Total Capacity (Million Gallons)
207-A	0.05	0.05	5.10
207-B			
North	1.55	0.15	1.70
Center	1.55	0.15	1.70
South	1.00	0.10	1.50
207-C	0.85	0.15	1.30

Water intercepted by the french drain system is placed in the 207-B ponds. Since Ponds 207-B North and Center are currently full, intercepted water will be placed in Pond 207-B South. The average amount of water collected by the french drain system over the course of a year is estimated to be four million gallons based on observations made in 1987. A meter on the force main from the ITPH was installed in June 1988, providing the capability for more accurate flow measurements.

2.2.3 Removal of Free Liquids

The free liquids in the ponds have been removed by a combination of natural evaporation and forced evaporation. Natural evaporation will continue during the closure period as one mechanism for removal of free liquids.

The forced evaporator in Building 374 has been used on a part-time basis to evaporate solar pond liquids since June 1987. The forced evaporator is currently used for treated process wastes at the plant. However, additional capacity is available for forced evaporation on a part-time basis. Therefore, the forced evaporator is used for solar pond and intercepted water on an as available basis.

The forced evaporator can process 40,000 gallons of liquid per day on a long term basis. This capacity, and other demands on the evaporator, allows average long-term processing of interceptor trench pump house water equivalent to approximately one day per week. Upon completion of an evaporator upgrade project in the start of calendar year 1989, the average evaporator processing capacity will increase to approximately 57,000 gallons per day. This increase, and other demands on the evaporator, were considered in scheduling closure of these solar ponds.

2.2.4 Treatment of Free Liquids

Treatment of the free liquids in the ponds by natural and forced evaporation is discussed in Section 2.2.3.

2.2.5 Disposal of Free Liquids

Natural and forced evaporation will remove all free liquids from the ponds; therefore, no liquids will remain for disposal.

2.2.6 Schedule

The schedule for liquid evaporation from the solar evaporation ponds is shown on Table VI. The schedule is also shown graphically on Figure 11. Calculations for the evaporation schedules are presented in Appendix 2.

TABLE VI

SCHEDULE FOR EVAPORATION OF LIQUIDS IN THE SOLAR EVAPORATION PONDS

Pond	End of Evaporation
207-A	June 1990
207-B	
North	June 1990
Center	June 1990
South	December 1990
207-C	August 1989

The schedule for liquid evaporation is based on long-term climatic data for the vicinity of the Rocky Flats Plant (Cowie, 1986) and the capacity of the forced evaporator. Based on the climatic data, an average monthly net evaporation rate of 1.3 gallons per square foot was calculated. Data used to calculate this evaporation rate are presented in Appendix 2. A non-toxic, non-radioactive dye may also be added to the water in the solar ponds to increase heat gain and thereby increase solar evaporation. The Material Safety Data Sheet (MSDS) for this dye is on file at the Rocky Flats Plant. Use of the forced evaporator is described in Section 2.2.3.

The calculated natural evaporation rate was applied to the volumes of free liquids in the ponds (Section 2.2.2) to obtain the estimated completion dates. A decrease in evaporation rate is anticipated as evaporation progresses and total dissolved solids increase. The decreased natural evaporation rate was considered by increasing the time required for natural evaporation by one-third.

In order to minimize the time necessary for closure, liquid from some of the ponds will be transferred to other ponds for natural evaporation. Liquid transfer will maximize the combined surface area and will allow other closure activities to begin in some ponds while liquids are still evaporating from the other ponds. A description of the transfer of liquids is presented in Appendix 2 and briefly discussed below.

The evaporation schedule activities described herein are anticipated, but utilization of the ponds will vary as necessary. The schedule is not binding in any way.

Pond 207-A: Liquid in Pond 207-A will be naturally and force evaporated until June 1990. In October 1988, liquid from Pond 207-B North and Pond 207-B Center will be transferred into Pond 207-A. In August 1989, liquids from Pond 207-B South and the interceptor trench pump house (ITPH) will be transferred into Pond 207-A. Inflows will cease in February 1990. Natural and forced evaporation will remove Pond 207-A liquids by June 1990.

Pond 207-B North: Liquid from the interceptor trench pump house (ITPH) will be placed in Pond 207-B North for natural and forced evaporation until October 1988. ITPH liquid will be subsequently transferred to Pond 207-B South. One million gallons were directed from Pond 207-B North to the forced evaporator in calendar year 1987 (Rockwell, 1988). ITPH flows which exceed the capacity of Pond 207-B South and Building 374 evaporator will be transferred to Pond 207-A after October 1988. Previous excess flows were transferred to Ponds 207-B Center and South as necessary. From August 1989 until February 1990, Pond 207-A will take ITPH flows.

Subsequent to February 1990 the ITPH flows will go to the forced evaporator in Building 374 directly, or via emergency storage of liquids in the 207-B South pond until December 1991. After December 1991, excess ITPH flows will be directed to a planned four million-gallon interceptor trench water (ITW) surge tank, which will then be fed to the forced evaporator in Building 374.

Pond 207-B Center: Liquid in Pond 207-B Center will be natural and force evaporated until October 1988. The remaining liquid will be transferred to Pond 207-A in October 1988.

Pond 207-B South: ITPH liquid inflows will be transferred from Pond 207-B North in October 1988, assuming four months for ITPH piping charge. Liquid in Pond 207-B South will natural and force evaporated until August 1989. The remaining liquid and ITPH flows will be transferred to Pond 207-A in August 1989. Pond 207-B South will be maintained during closure for emergency storage of interceptor trench water (ITW) since its liner incorporates a hypolon geomembrane and the pond liner is considered most competent of the existing pond liners.

Pond 207-C: Liquid in Pond 207-C will be naturally evaporated until January 1989. Natural and forced evaporation will occur from January 1989 until August 1989.

Solar pond liquids are being treated on a regular part-time basis by forced evaporation in Building 374. Two million gallons are scheduled for treatment in fiscal year 1988 (October, 1987 to October, 1988); four million gallons are scheduled for fiscal year 1989. The total interceptor trench water (ITW) will be routed to Building 374 in February 1990 with available surge storage in Pond 207-B South. Construction of ITW storage tanks will be completed by December 1990, replacing Pond 207-B South for surge storage.

Eventually, water collected in the interceptor trench pump house may be treated in a facility constructed for area-wide ground-water corrective action. This could be accomplished by completing the ground-water treatment unit before the area-wide ground-water collection system so the treatment unit could initially treat water from the pump house. Completion of the treatment unit is tentatively planned for November 1991.

Another option may be to process the intercepted water in the on-site sewage treatment plant. Treatment in this plant will decrease the time required for liquid evaporation. However, without regulatory authorization for this option at this time, the time for treatment of the ponds' liquids will be estimated assuming only natural and forced evaporation.

2.3 Sludges and Sediments

2.3.1 Background

Pond 207-A is currently the only pond containing sludges which are a residual of the process waste stream at the plant. Ponds 207-C and 207-B Center and South appear to contain sediments. Pond 207-B North is also assumed to contain sediments; however, this cannot be confirmed by visual inspection.

Removal, treatment and disposal of sludges from Pond 207-A began June 19, 1985. Treatment progressed for approximately three months prior to a temporary cessation of operations due to the inability of the pond-crete to solidify during cold weather. During the approximate three-month working period, 866 boxes of pond-crete were produced. The boxes of pond-crete contained approximately ten percent sludge, by weight (Brady, 1986; Eng, 1987 and Gaskins, 1986).

Pond-creting operations resumed in June 1986. From June 1986 until September 30, 1986, 3,000 boxes of pond-crete were completed. From October 1, 1986 until January 12, 1987, 1,927 boxes of pond-crete were completed. The boxes contained approximately ten percent sludge solids, by weight (Eng, 1987).

The production goal of the pond-creting operation prior to October 1986 was 112 boxes per week. The capacity of the covered curing facility available at that time was 120 boxes. The production goal was increased to 240 boxes per week in October 1986 when a new storage building for the pond-crete curing facility was completed.

Pond-creting through May 1, 1988, has resulted in a total of 16,199 boxes of pond-crete stored on site at two pads designated RCRA Unit Nos. 15 and 25. Scheduled pond-creting rates for fiscal year 1988 are as follows:

Month	Rates per Month
January	600
February	750
March	750
April	870
May	870
June	870
July	870
August	870
September	870
October	750
November	600
December	600

Actual processed quantities slightly exceeded scheduled rates from September 1987, to May 1988 until the pond-crete problem was identified on May 23, 1988. For this period, 4,746 boxes were scheduled and 5,082 were processed.

The solidified pond-crete is stored on site at two locations. Pad #1 (RCRA Unit #25) is located at Parking 750 and has a total storage capacity of 14,906 boxes; as of May 1, 1988, the remaining storage capacity was 3,108 boxes. Pad #2 is located east of Building 886, designated the 904 pad (RCRA Unit #15), with a total capacity of 12,000 boxes and a remaining storage capacity of 7,599 boxes. The total remaining storage availability on May 1, 1988, was 10,707 boxes.

Production at the pond-creting facility is or has been impacted by:

- Cold weather causing a retarding of pond-crete solidification and causing the liquids in the ponds and the dewatering unit to freeze. Cold weather decreases production to approximately 150 boxes per week (Brady, 1986 and Eng, 1987).
- The capacity to store the pond-crete boxes while the contents are solidifying before approval for off-site shipment is given, and
- Periodic equipment failure.

2.3.2 Volume of Sludges and Sediments

The volume of sludges in Pond 207-A on April 20, 1988, was approximately 250 cubic yards (Rockwell, 1988). The sludges are scheduled to be completely removed by July 1, 1988, as shown on Figure 10. The volume of sediments in 207-A is included in the volume of sludges. The estimated 250 cubic yards of sludge is based on the dry weight volume of sludges. The actual volume of the sludge mixed with pond liquid at the bottom of the pond is approximately 1,136 cubic yards.

Twenty-four samples of sludge/liquid were taken from the bottom of Pond 207-A between May 1985 and June 1986 and tested for percent solids. The percent of solids of the sludge/liquid mixture at the bottom of the pond ranged from eight percent to 34 percent, averaging 22 percent. The volume calculations are presented in Appendix 2.

The volume of sediments in Ponds 207-B North, Center and South and Pond 207-C are estimated to be 705, 705, 720 and 745 cubic yards based on dry weight, respectively. The sediment volumes are based on visual estimates of a depth of eight inches of sediment in Ponds 207-B South and Center and 207-C. Pond 207-B North is also anticipated to contain approximately eight inches of sediments. The volume calculations are presented in Appendix 2.

The sludges in Pond 207-A were sampled and characterized in 1985. The results of the tests are presented in Section 1.3.2 and Appendix 3. All of the pond sludges and sediments will be removed, solidified using the pond-creting procedures, and disposed of at an approved mixed waste disposal facility.

2.3.3 Removal of Sludges and Sediments

The sludges from the bottom of the ponds have been and will be removed by a Mud Cat pumper floatation handling unit controlled by an operator from the berm of the pond. The unit is propelled by an electrical traverse winch system. The unit transfers the sludge to the sludge thickener. The sludge thickener overflow is decanted and placed back into the pond. A solids handling, submersible pump is being used to pump the sludge from one location in the pond to the Mud Cat pumper.

A backup system utilizing a sludge pump to pump the sludge from the pond to the sludge thickener was completed in the spring of 1987. Figures 12 and 13 show the physical layout of the pond-creting facility and the flow diagram for the facility, respectively.

The sediments in Ponds 207-B North, Center and South and Pond 207-C will be removed and processed in the pond-creting facility in the same manner as the sludge in Pond 207-A.

The schedule for closure activities allows removal of sludge and sediments to be conducted while some liquid remains in the ponds. The presence of liquids in the ponds will keep the sludge and sediments from drying and blowing out of the ponds, thereby eliminating windblown releases of the sludge and sediments.

2.3.4 Treatment of Sludges and Sediments

The pond sludge and sediments from the sludge thickener is transferred to the pug mill where sludge and portland cement chloride are mixed to form pond-crete. The pond-crete flows over a weir, through a chute and into boxes for packaging. The portland cement handling system has pneumatic transfer and metering capabilities. The boxes are made of triple wall fiberboard, are lined with 0.011-inch plastic and have a capacity of approximately 15 cubic feet. Boxes of immobilized sludge are stored in a prefabricated metal building for curing, labeling and shipment to two asphalt paved pads, RCRA Units #15 and #25 (Brady, 1986; Eng, 1987 and Gaskins, 1986).

The backup system allows sludge from the sludge thickener to be transferred to a mobile concrete mixer truck. Unsolidified sludge will then discharge into a 2.5 cubic yard hopper mounted on a concrete grout pump, which pumps the unsolidified sludge through the building wall and discharges it into triple wall fiberboard boxes. A second cement silo is available for the backup system.

The sediments in Ponds 207-B North, Center and South and Pond 207-C will be treated and solidified in the same manner as the sludges from Pond 207-A.

2.3.5 Disposal of Sludges and Sediments

The pond-crete from Pond 207-A was disposed of at the Nevada Test Site until the fall of 1986 when this waste was identified as mixed low-level radioactive and hazardous waste. Since the fall of 1986, the pond-crete has been stored on-site on an asphalt paved pad. The boxes of pond-crete have been completely wrapped with tarps made of plastic-lined canvas. These boxes of pond-crete are arranged in arrays of 72 boxes each. As of May 1, 1988, 11,798 boxes of pond-crete were being held on the asphalt pavement at Pad #1 (RCRA Unit #25), which is located at Parking 750. A total of 14,906 boxes can be held on the pad. A second asphalt paved storage area is located east of Building 886. Designated Pad #2 (RCRA Unit #15), it has a total storage capacity of 12,000 boxes, with 4,401 boxes in storage on May 1, 1988. On-site storage in this manner will continue until all pond-crete is disposed off site. Disposal is expected to take place at an approved off-site facility or the Nevada Test Site.

2.3.6 Schedule

The schedule for removal, treatment and/or disposal of sludges from Pond 207-A is shown on Table VI. The tentative schedule for removal, treatment and disposal of sediments from the remaining ponds is also shown on Table VII. The schedule is shown graphically on Figure 7.

TABLE VII

SCHEDULE FOR REMOVAL, TREATMENT AND DISPOSAL
OF SLUDGES AND SEDIMENTS IN THE
SOLAR EVAPORATION PONDS

Pond	Start of Removal, Treatment and Disposal	End of Removal, Treatment and Disposal
207-A	June 1985	July 1988
207-B North	August 1989	November 1990
207-B Center	August 1988	November 1990
207-B South	August 1988	November 1990
207-C	January 1989	August 1989

2.4 Liners

2.4.1 Background

In December 1953, one clay-lined evaporation pond was constructed in the area now occupied by existing Pond 207-C. The pond had a surface area of approximately 100 by

100 feet. This pond was enlarged to 100 by 200 feet in 1955 with an adjacent cell to the south measuring 200 by 200 feet. The cells were removed from regular service by 1956; however, one of the cells received liquid at least once prior to both cells being removed in 1970 for construction of Pond 207-C. Soil from the area of the old clay-lined pond was possibly used in the construction of Pond 207-C (Aerial Photographs, 1953 to 1986). The original solar pond locations are shown on Figure 2 as dashed lines in the vicinity of existing Pond 207-C.

Pond 207-A was placed in service in August 1956. Ponds 207-B North, Center and South were placed in service in June 1960. Pond 207-C was placed in service in December 1970. These ponds were all lined with asphalt planking and/or asphaltic concrete. The history of the ponds is discussed in Section 1.2.1.

Pond 207-A is currently lined with four inches of asphaltic concrete. The lip of the embankments are lined with Petro-mat.

Engineering drawings (Benson-Lord, 19??) indicate Pond 207-B North is lined with 1 1/2 inches of asphalt surfacing overlying a 1 1/2-inch asphalt binder. The binder is underlain by four inches of granular aggregate known as base course. The base course is underlain by two inches of sand. The top three inches of asphalt surfacing and binder extends past the top of the slope by 18 inches. A cross-section of the lining is included in the drawings presented in Appendix 1 and shown on Figure 4.

Engineering drawings (Rockwell, 1977a; Rockwell, 1978a and Rockwell, 1978b) indicate Pond 207-B South is lined with two, 1 1/2-inch layers of asphaltic concrete overlying four inches of base course. The base course is underlain by two, 1/2-inch layers of asphalt planks. The planks, whose exact composition is unknown, are underlain by two inches of sand. The top three inches of asphaltic concrete extends three feet past the top of the embankment on the east, south and west sides of the pond and one foot past the top of the embankment on the north side of the pond. Cross-sections of the lining are included in the drawings presented in Appendix 1.

The liner of Pond 207-C consists of a catalytically blown asphalt seal coat and an asphalt tack coat overlying 1 1/2 inches of asphaltic concrete. The asphaltic concrete is underlain by another layer of asphalt tackcoat and 1 1/2 inches of asphaltic concrete. The second asphaltic concrete layer is underlain by an asphalt prime coat and four inches of base course. A cross-section of the lining is included in the drawings presented in Appendix 1 and is shown on Figure 6.

2.4.2 Volume of Liners

Based on the data available, on existing drawings and the references given in the previous sections, volumes were calculated for the liners. The volumes include the liner and underlying granular soils. The volume calculations are presented in Appendix 2.

The lining of Pond 207-A consists of approximately 1,700 cubic yards of asphaltic concrete.

The liners in Ponds 207-B North and Center each consist of approximately 430 cubic yards of asphaltic concrete, 72 cubic yards of asphalt planking, 1,160 cubic yards of base course and 290 cubic yards of sand. The 18-inch wide asphaltic concrete apron that extends past the tops of the sidewalls has a volume of approximately 11 cubic yards.

The liner of Pond 207-B South consists of approximately 430 cubic yards of asphaltic concrete, 140 cubic yards of asphalt planks, 580 cubic yards of base course and 290 cubic yards of sand. The asphaltic concrete apron extending past the tops of the sidewalls is approximately 18 cubic yards in volume.

The liner of Pond 207-C consists of approximately 385 cubic yards of asphaltic concrete and 500 cubic yards of base course.

The total volume of liners in the ponds is estimated to be approximately 8,000 cubic yards. A contingency of approximately 25 percent of the liner volume or 2,000 cubic yards is assumed to require removal.

2.4.3 Removal of Liners

Liner removal criteria will be the same as the underlying soil, as discussed in Section 2.6.1.2. Briefly, this will include performing sampling and analyses on the liners and comparing with permissible contamination levels to determine whether the liners can remain in place beneath the cap or will have to be removed. If removal is necessary, the liners will be disposed of at an approved disposal facility. The closure schedule presented in this closure plan includes the time required for removal and off-site disposal.

The liners and underlying soil will be evaluated for removal concurrently at each pond location in accordance with the schedule shown on Figure 11. Soil removal will be based on the criteria presented in Section 2.6.1.2. A sampling plan for evaluating the liners and underlying soils will be submitted not later than May 1, 1989.

2.4.3.1 Construction

Prior to conducting the sampling plan to evaluate the liners and underlying soils for removal, the surface of the liners will be decontaminated with a high pressure spray. Fluids which result from the spray will be pumped to Pond 207-B South prior to December 1990 and to the ITW tank and forced evaporation after that date.

The solar pond liner which must be removed will be reduced in size for packaging prior to off-site disposal.

Based on current construction technologies, one of the methods available for liner removal includes removal by backhoes and/or front-end loaders. The excavated material may be hauled to an area where the material can be reduced in size by a portable crusher. Only the amount of material that can be crushed and packaged in one day will be moved from the ponds to the size reduction/packaging area.

The uncrushed stockpiled material will be placed in a hopper with a screen by a small loader. The screen will allow small size material to be removed prior to being processed through the crusher. Material in the hopper will be transferred to the crusher or directly to the packaging boxes, depending on material size, by conveyers. Material processed by the crusher will be transferred to the boxes by conveyer.

Filling the containers will require hand labor to provide rearrangement of particles and to pick up any spillage. The prepared containers will be moved, by forklift, from the packaging area to a holding area.

The size reduction/packaging area will be located east of the northeast corner of Pond 207-B North. This area will be approximately 100 feet by 200 feet in size.

The hopper, portable crusher, three conveyers and packaging boxes will be placed on a concrete pad to provide equipment support and to allow rapid clean up of any spilled material. The concrete pad will be large enough to cover the area that could potentially be exposed to spills during crushing and packaging.

In the event of precipitation, any material stockpiled in the packaging area will be securely covered with a plastic-lined canvas tarp.

Other removal and size reduction technologies may be considered based on technological and cost effectiveness.

The liner which will not be removed from the site will be reduced in size to pieces not greater than 12 inches. The size reduction procedures for the on-site material will be left to the contractor.

2.4.3.2 Health and Safety Plan

A site specific Health and Safety Plan will be prepared by February 1990, two months before liner removal begins. The Health and Safety Plan will be guided by the Rocky Flats Plant Operational Safety Analysis (OSA) procedure. The plan will be submitted to the Colorado Department of Health for information. The procedures presented below are guidelines that will be followed during closure activities. Additional procedures and details will be presented in the site specific Health and Safety Plan. Worker safety guidelines, such as OSHA regulations, DOE orders and Rocky Flats Plant policies will be followed. Protective clothing will be similar in nature to:

- hardhats,
- hard-toe boots,
- Tyvek over-boots,
- Tyvek suits, and
- dust masks.

The intent of this equipment is to provide a barrier to inhalation, ingestion and absorption of dust particles and material fragments. Appropriate protective gloves will be used.

Air monitoring will be conducted in the working area. Airborne contamination may require upgrading dust masks to air-purifying respirators or self-contained breathing apparatus. Sudden increases in airborne contamination due to excavation in localized highly contaminated areas may be addressed by a temporary cessation in work until natural dissipation reduces contamination.

Windblown releases from the site will be minimized with dust abatement measures. Dust suppressants will be applied to the work area, as necessary. If necessary, the liner material will also be sprayed prior to processing in the crusher.

2.4.4 Treatment of Liners

Treatment of the liners will not be conducted prior to disposal, if disposal is required based on analysis and testing.

2.4.5 Disposal of Liners

The containerized liner material will be shipped to a permitted facility for disposal. If the liner material qualifies as a mixed hazardous and radioactive waste, it will be disposed at the Nevada Test Site.

2.4.6 Schedule

If necessary, removal of the pond liners will begin after the liquids are evaporated from the ponds, the sludges and sediments are removed and the liners are sampled and analyzed. Sampling of the pond liners will take approximately two months including laboratory analyses. Liner removal in some of the ponds will begin and be completed before the liquids and sediments are removed from other ponds. This sequence will improve the efficiency of removal, reduce the time necessary for closure and avoid unnecessary mobilizations and demobilizations. The schedule for liner removal is shown in Table VIII and on Figure 11.

TABLE VIII

SCHEDULE FOR LINER REMOVAL AND DISPOSAL

Pond	Start of Liner Removal and Disposal	End of Liner Removal and Disposal
207-A	September 1990	June 1991
207-B North	September 1990	June 1991
207-B Center	September 1990	June 1991
207-B South	February 1990	June 1991
207-C	April 1989	September 1990

2.5 Embankment Soils

2.5.1 Background

The extent of removal required for all embankment soils will be determined by soil sampling, testing and comparison with the permissible contaminant levels and discussed in Section 2.6.1.2. The soil sampling is discussed in Section 2.6.1.3.

2.5.2 Volume of Embankment Soils

The volume of embankments soils assumed to require removal is 2,700 cubic yards. The volume calculation presented in Appendix 2 uses the 207-C pond embankment as a possible embankment removal candidate since it may have been constructed with soil from the original clay-lined pond.

2.5.3 Removal of Embankment Soils

If necessary, the embankment soils will be removed and packaged using the same construction sequence discussed for liners (Section 2.4.3). However, the requirements for material size reduction are not anticipated to be necessary.

Only the amount of material that can be packaged in one day will be excavated on any given day and moved to the packaging area. The health and safety plan outlined in Section 2.4.3.2 will be followed for removal of embankment soils.

2.5.4 Treatment of Embankment Soils

The embankment soils may be treated as discussed in Section 2.6.4.

2.5.5 Disposal of Embankment Soils

If removed, the embankment soils will be placed in approved containers and shipped to the Nevada Test Site (NTS) or other permitted off-site facility for disposal, depending on the soil characteristics.

2.5.6 Schedule

If necessary, removal of the embankment soil in Pond 207-C will begin after the liner from that pond has been removed. Liner and embankment removal will begin in April 1990 and end by June 1991 as shown on Figure 10.

2.6 Underlying and Surrounding Contaminated Soil

2.6.1 Background

Soil and bedrock characterization in the vicinity of the solar ponds have been conducted by two investigations in 1986 and 1987. The results of these investigations are presented in Appendix 6. This section presents a brief summary of the soil characterization information, discusses the selective alternatives to protect human health and the environment and presents an outline of testing to be performed during closure. Briefly, the closure actions selected include a multi-layered cap in the vicinity of the source areas. Prior to placing the cap, pond liners and underlying soil will be removed for off-site disposal if it exceeds 20 pCi/gm of combined plutonium and americium activity. Sampling and analyses will be conducted prior to pond liner and soil removal to identify those areas which require removal and off-site disposal.

On-site treatment of contaminated soils and liners will be considered as an alternative to removal and off-site disposal. Potential soil treatment procedures are currently being evaluated and if a procedure appears technically and economically feasible for the soils and for the liners at the solar ponds, it will be implemented as an alternative to off-site removal.

2.6.1.1 Soil Characterization

The first investigation was conducted in 1986 and consisted of soil and bedrock chemical and radiochemical analyses from five soil boring holes:

18-86
20-86
22-86
25-86
27-86

In 1987, extensive soil and bedrock sampling was conducted in 16 borings within the solar pond project area. The locations of these borings are shown on Plate 5-1, Appendix 6, identified as SP01-87 through SP16-87. The soils were analyzed for a comprehensive suite of metals, organics, radionuclides and other inorganics as shown on Table 4-8 in Appendix 6.

The results of the 1986 and 1987 soil characterization studies are presented in Appendix 6. Briefly, the results of the soil characterization studies indicated elevated metal concentrations near the solar ponds. Elevated metal concentrations exceeding three times background were identified at soil borings in the immediate vicinity of the solar ponds. This information is summarized in Section 4 of Appendix 6.

2.6.1.2 Closure Alternatives

Based on the results of the soil characterization, a multi-layered cap has been located to cover the solar pond source areas and the immediate vicinity. The cap extends to the southwest to cover an area of the original clay lined solar pond. In addition, the cap has been extended down the slope north of the solar ponds in order to provide continuous surface runoff to the existing surface drainage ditch system. The cap completely covers the existing and historic pond areas and all of the test hole locations in the vicinity of the ponds where elevated metal concentrations in soils were identified during the 1986 and 1987 soil characterization.

Closure performance standards have been established for the removal of pond liners, pond embankment soils and in-place soils beneath the ponds. This standard is based on the radioactivity of plutonium and americium. Plutonium and Americium were considered together since the U.S. EPA, in consultation with other federal agencies, has developed interim recommendations to be used for protection of public health in areas where significant contamination by Pu, Am and other transuranium elements exist. The recommendations are intended to provide long-term radiation protection for all exposed persons in a "critical segment of the general population" and specify that both the individual and collective radiation doses should be "as-low-as-reasonably-achievable (ALARA)." These interim recommendations present a soil screening level of 0.2 microcuries of transuranics per square meter in the upper 1 cm of soil. This represents a combined inhalation and ingestion incremental cancer risk of 1×10^{-6}. At activity levels greater than this, additional evaluation is recommended to determine the actual dose rates to exposed persons (U.S. Environmental Protection Agency, 1986). Assuming a soil density of 1 gm/cm^3, this activity level translates to 20 picocuries per gram (pCi/gm) of soil. A soil sampling analysis plan will be conducted prior to liner and soil removal to evaluate the areas that are requiring removal.

Soil treatment may be selected as an alternate to disposal off-site if the results of ongoing studies prove it to be economical and protective of human health and the environment. Other currently unidentified technologies that are shown to be viable alternatives prior to implementing the closure activities for soil contamination may also be considered.

2.6.1.3 Testing to be Performed During Closure

The lateral and vertical extent of soil contamination requiring capping has been evaluated and is discussed in the site characterization presented in Appendix 6. A field sampling program will be necessary to evaluate the requirements for liner and soil removal. The liners and underlying soils will be evaluated for removal concurrently at each pond location in accordance with the schedule shown on Figure 11. Soil removal will be based on the 20 pCi/gm criteria presented in Section 2.6.1.2. A sampling plan for evaluating the liners and underlying soils will be submitted not later than May 1, 1989.

2.6.2. Volume of Contaminated Soils

The volume of contaminated soil requiring removal has not been estimated. Based on the removal criteria of 20 pCi/gm and the site characterization, the volume of soil to be removed is anticipated to be small. In Appendix 6, which expands on areas of soil contamination, only one soil sample was found with soil contamination exceeding 20 pCi/gm of combined plutonium and americium activity.

2.6.3 Removal of Contaminated Soils

If required, contaminated soils will be removed and disposed at an approved off-site facility or the Nevada Test Site (NTS).

2.6.4 Treatment of Contaminated Soils

On-site treatment of contaminated soils will be considered as an alternative to removal and off-site disposal. Studies have been conducted at Rocky Flats to develop and demonstrate decontamination of soils contaminated with transuranic elements (Olsen, 1980 and Rockwell, 1982a and b). Results have shown that after soil removal and treatment to remove transuranics, the bulk of the soil can be returned to its natural environment, while the remaining fraction would be packaged for shipment off-site and disposal.

Several soil conditions exist at Rocky Flats that are advantageous to soil decontamination processes (Olsen, 1980):

- the soil is granular,
- the contamination exists on the surface of the soil grains, and
- the surface-contaminated soil contains only approximately 20 percent clay and organic matter.

The decontamination procedures described in the studies may not be effective for contaminated claystone bedrock.

Processes that have been studied at Rocky Flats include:

- wet screening at high pH,
- attrition scrubbing with a surfactant at high pH,
- attrition scrubbing with a surfactant at low pH,
- vibratory grinding with water,
- vibratory grinding with a high pH solution,
- vibratory grinding with a surfactant and a weak acid solution, and
- vibratory grinding with a strong acid.

In wet screening at high pH, up to 60 to 70 percent of the +35 mesh material by weight (greater than 420 microns) was decontaminated to less than 30 pCi/gm of plutonium. In attrition scrubbing with a surfactant at high pH, approximately 80 percent of the material by weight was decontaminated to below federal guidelines and was returned to the natural environment. Typically, attrition scrubbing with a surfactant at low pH decontaminated 84 percent of the soil tested from 45,000 dpm/g of plutonium to less than 5 dpm/g. The decontaminated portion of the soil was returned to its natural environment. The remaining 16 percent was packaged and disposed of off-site.

All four of the scrub solutions combined with vibratory grinding reduced the amount of plutonium-239 from 7,000 dpm/g to 30 dpm/g or less for the +35 mesh portion of the sample. The experiments decontaminated 85 percent of the Rocky Flats soil tested to levels that met EPA screening levels for unrestricted use. The decontaminated portion of the soil was returned to its natural environment. The remaining 16 percent was packaged and disposed of off-site.

Decontamination methods will be considered for use on transuranic-contaminated granular soil. Determination of the applicability of these methods for use at the solar ponds will be based on soil characterization and the lateral and vertical extent of contaminated granular soil.

It is possible that the methods used to treat soil contaminated with transuranics will also be effective in removing other contaminants. An effective combination might be using a low pH scrubbing solution with a surfactant. The low pH would serve to solubilize the metals which are adsorbed onto the soil. The surfactant would increase the solubility of the organic compounds. Both the metals and organics could then be removed with the scrubbing solution. In addition, the other radionuclides of interest, uranium and strontium-90 (if it is present) would probably be removed.

Potential soil treatment procedures will be evaluated between July 1988 and June 1989. If one or more procedures are selected, they will be implemented beginning in January 1991.

2.6.5 Disposal of Contaminated Soils

Any underlying and surrounding contaminated soils removed for disposal will be disposed at a permitted off-site disposal facility or at the Nevada Test Site.

2.6.6 Schedule

Underlying and surrounding soil closure activities will be conducted between April 1990 and June 1991. If conducted, soil treatment procedures will be implemented by January 1991.

2.7 Ground Water

2.7.1 Background

2.7.1.1 Summary of Applicable Requirements

As discussed in Section 2.7.1.2, the available ground-water data from recent studies at the solar evaporation ponds indicate that ground-water corrective action will be required to meet 6 CCR 1007-3, Section 264, Subpart F. Due to the complexity of potential ground-water contamination resulting from other potential sources in the vicinity of the solar ponds, the required ground-water corrective action may be integrated with an area-wide program.

2.7.1.2 Ground-Water Quality

The results of ground-water analyses from wells in the vicinity of the solar ponds performed between the fall of 1986 and the first quarter of 1988 are presented in Appendix 6 of this closure plan. Briefly, the results indicate the ground water in the hillside north of the solar ponds has been affected by leakage from the ponds. The plan to mitigate ground-water impacts is discussed in the next section.

2.7.2 Removal of Ground Water

The ground water in the hillside north of the solar ponds will be collected and treated in two systems. First, ground water north of the perimeter security zone (PSZ) will be collected in the existing french drain system as part of the ground-water corrective action. Secondly, ground-water flows directly north of the solar ponds will be collected by an interceptor drain at the downgradient toe of the final cover as discussed in Section 4.3.11.

The collected ground water will be pumped from the interceptor drain system and the french drain to the solar ponds and the forced evaporation system in Building 374 as discussed in Section 2.2.6.

2.7.3 Volume of Ground Water

The volume of ground water that may require treatment after collection in the existing french drain system and the proposed interceptor drain is currently being evaluated. Ground water collected from adjacent Solid Waste Management Units (SWMUs) may also be treated in the process streams used for the solar ponds.

2.7.4 Treatment of Ground Water

Based on data collected to date, it appears the evaporative treatment process currently employed is an adequate treatment method considering the characteristics of the ground water collected to date in the existing french drain system north of the solar ponds. Eventually, water collected in the interceptor trench pump house may be treated in a facility constructed for area-wide ground-water corrective action. Completion of the treatment unit is tentatively planned for November 1991.

2.7.5 Disposal of Ground Water

Disposal methods for the treated ground water have not been established; however, reintroduction to the ground water and discharge to surface streams will be evaluated on an ongoing basis. No changes will be made with respect to ground-water discharge or surface water discharge without first seeking regulatory approval.

2.7.6 Schedule

Evaluations are currently being conducted to develop criteria for final design of the ground-water collection and treatment system at the solar evaporation ponds. The information being developed includes the required depths of drains, the flow quantities which can be anticipated from the geologic formations, the adequacy of the existing pipes to adequately handle the flow and seasonal variations in flow rates which may require surge tank holding capacity. Required modifications to the existing french drain system are being evaluated, including whether the existing east-west trench on the south end of the system can adequately serve as the interceptor drain at the downgradient toe of the final cover. The results of these evaluations will be completed in time to be incorporated into the final design.

3.0 DECONTAMINATION OF EQUIPMENT

3.1 Introduction

As required by 6 CCR 1007-3, Sections 265.112(b)(4) and 265.114, auxiliary and construction equipment used at or during closure of the solar evaporation ponds will be decontaminated. Decontamination will involve the procedures described in the following section.

3.2 Decontamination Procedures

All construction equipment involved with removing and regrading contaminated soils at the solar ponds will be scraped or brushed to remove chunks of soil or debris whenever the equipment leaves the excavation area. The area used for scraping or brushing will be raked and/or swept to collect all removed material. The collected material will initially be handled as a mixed waste. A representative sample of this waste will be obtained and analyzed and the material handled appropriately based on the results of this analysis. If this waste qualifies as a mixed waste, it will be shipped off site to an approved treatment or disposal facility.

Construction equipment will then move to an adjacent wash down area consisting of a pre-clean area and a final clean area. The pre-clean and final clean areas will be located in a portion of Pond 207-B South. The existing hypolon liner will be maintained in the wash down area, which will be located downslope in the pond area to contain rinsate. The pre-clean area will be used for the general removal of soil from auxiliary and construction equipment.

The final clean area will consist of a concrete wash rack overlying a portion of the hypolon liner in Pond 207-B South. This area will measure approximately 30 feet by 50 feet in plan dimension. A gravel pad will be placed around the area for ease of working. The equipment will be driven or placed on the rack from the pre-clean area and the appropriate decontamination procedure for radioactive or hazardous material will be conducted. The rinsate will be collected and will be transferred to a holding tank. The rinsate will be characterized according to the procedures outlined in the Waste Management and Waste Analysis Plan, Section C of the RCRA Part B Operating Permit Application (U.S. Department of Energy, 1986d). Upon characterization, the rinsate will be treated on site in the appropriate Rocky Flats process waste treatment facility.

Following final use of the wash down area, the pond liner will be decontaminated following the procedures outlined in Section 2.4.3. If the liner cannot be fully decontaminated, it will be packaged in approved containers and shipped to the Nevada Test Site. Equipment used for demolition of the wash down area will be of proper size to be subsequently decontaminated in Building 889. This facility is currently equipped to decontaminate up to moderately sized construction equipment. The facility is planned to be enlarged by January 1989 to accommodate slightly larger construction equipment.

At the wash down area and in Building 889, equipment will be triple rinsed with a spray system. The decontamination spray system to be used will heat water to approximately 350^{o}F under 250 pounds per square inch gauge pressure. The super-heated, high-pressure stream will be sprayed on the contaminated surface through a series of nozzles incorporated into the vacuum/spray cleaning head. The exact equipment used for decontamination will vary depending on contractor selection. The decontamination equipment used will provide for adequate decontamination of the construction equipment.

3.3 Auxiliary Equipment

As discussed in Section 1.4, the only auxiliary equipment at the solar ponds requiring decontamination under this closure plan is a portable pump that pumps liquids from one pond to another and a pontoon supported raft.

3.4 Construction Equipment Used During Closure

In addition to the equipment described in Section 3.3, construction equipment anticipated to be used during closure may include backhoes, large front-end loaders, small loaders, hoppers, conveyers and forklifts. The large quantities of regrading and earth movement required may necessitate additional equipment, such as haul trucks and scrappers. All equipment exposed to contaminated soils will be decontaminated according to the procedures presented in Section 3.2.

Equipment, such as the forced evaporators located in Building 374 that will be used to evaporate liquids in the ponds and/or the interceptor trench pump house, are included in the RCRA Part B Operating Permit Application (U.S. Department of Energy, 1987a) and are identified as Unit 42.

4.0 REGRADING, COVER AND VEGETATION

4.1 Introduction

The solar evaporation ponds will be closed with wastes remaining in place, meeting 6 CCR 1007-3, Section 265.228(c). Portions of the site will require regrading to establish final surface contours. A final cover will be placed and revegetated. This section discusses regrading the site, the final cover and vegetation.

4.2 Regrading

Regrading will be required in the solar evaporation pond area prior to placement of a final cover. The grading will be performed to reshape the ground surface in the vicinity of the ponds to minimize surface water infiltration and control erosion from runoff. If the embankments of the solar ponds do not require removal and disposal at an off-site location, it is anticipated that they will be used as a fill material for regrading beneath the cover. The area requiring regrading extends to the limits of the cover shown on Figure 14.

The surface grading will be designed to reduce ponding and subsequent infiltration. In addition, slopes will be kept to a minimum to reduce erosion as a result of surface runoff velocities. Based on estimated quantities to balance cut and fill at the site, approximately 60,000 cubic yards will require removal and replacement within the limits of the cover.

Embankment soils will be cut and placed as fill in the pond areas to achieve a uniform grade. In addition, cuts up to approximately ten feet deep in the soils and bedrock adjacent to the north embankments of the ponds will reduce final surface slopes at the slope crest. These additional cut materials will also be required to fill the ponds without importing additional materials.

Regrading will result in cover subgrade contours that tie in uniformly with existing contours near the cover boundaries. Run-on will be controlled by constructing the 4.5-foot thick cover on the regraded surface, effectively forming a "berm" around the west, south and east limits of the cover. At the north end, the ground surface will be overexcavated a depth equivalent to the liner thickness to permit transition with a maximum 20 percent slope.

4.3 Final Cover

The final cover has been designed to meet performance standards set forth in Sections 265.228 and 265.310. The final cover will be a multi-layered section, designed and constructed to:

- Provide long-term minimization of the migration of liquids through the closed impoundment;
- Function with minimum maintenance;
- Promote drainage and minimize erosion or abrasion of the cover;
- Accommodate settling and subsidence so that the cover's integrity is maintained; and
- Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

To meet these standards, the cover will be comprised of three components:

- Erosion control in the form of minimum slope grades and vegetation;
- Drainage layer to expedite removal of surface infiltration and maintain cover stability;
- Infiltration barrier, including both a flexible membrane liner (FML) and low permeability compacted clay.

Due to the previous history of ground-water seepage daylighting on the slope surface north of the ponds, and the low permeability barrier component of the cover, an additional drainage layer will be added to the cover section for that portion of the cover located north of the existing ponds. This component will be discussed separately in Section 4.3.10.

4.3.1 Extent of Final Cover

The extent of the final cover will include all of solar evaporation ponds 207-A, 207-B North, Center and South, and 207C. In addition, the cover will extend down the slope north of the ponds to the perimeter security zone (PSZ). The total cover area is approximately 670,000 square feet. The extent of the cover is based on the site characterization (Appendix 6) as summarized in Section 2.6. The extent of the final cover is shown on Figure 14.

The topography after regrading of the ground surface for the final cover is presented on Figure 15. The final cover elevations will be elevated equivalent to the cover thickness based on the actual regraded surface of the solar ponds at time of closure.

4.3.2 Type of Materials

The design of the multi-layered cap will conform to the performance standards in 6 CCR 1007-3, Section 265.310. The specified performance standards will be achieved on the solar evaporation ponds site by utilizing a multi-layered cap. A typical cross section of the final cover is shown on Figure 16.

Sand: The sand drain layer will be comprised of hard, durable sands or gravels having no more than five percent passing the U.S. standard No. 200 sieve. Final gradation of the drain material will be based on the gradations of the compacted soil layer material selected in final design. The sand drain layer will be designed to act as a filter against the compacted soil layer. During final design, characteristics of the compacted soil layer, anticipated hydraulic heads at the interface with the filter and required hydraulic conductivities for the drain material will be considered in selecting filter design criteria.

The sand drain layer will also serve a dual function as a bedding layer against the underlying synthetic membrane preventing the membrane from being damaged during the placement and compaction of the erosion control layers. The sand specified for the drainage layer(s) will be imported to the site or screened from on-site borrow areas. The sand may be ASTM C-33 fine aggregate (concrete sand), or equivalent, tentatively meeting the following gradation:

Sieve Size	Percent Passing
No. 4 (4.75 mm)	100
No. 8 (2.36 mm)	80 - 100
No. 16 (1.18 mm)	50 - 85
No. 30 (600 um)	25 - 60
No. 50 (300 um)	10 - 30
No. 100 (150 um)	2 - 10
No. 200 (75 um)	0 - 5

In addition to ASTM C-33 fine aggregate, an equivalent gradation is American Association of State Highway and Transportation Officials (AASHTO) Class C filter material, provided 100 percent passes the No. 4 sieve. Since the drain material will be placed against the synthetic liner in portions of the multi-layer cover, the maximum aggregate size is limited to 1/4 inch to prevent punctures.

Clay: Clay beneath the synthetic liner will have a hydraulic conductivity of 10^{-7} centimeters per second when compacted in the laboratory to 95 percent of the maximum standard Proctor density (ASTM D-698). The clay will be compacted between plus or minus two percent of optimum moisture content. The specified moisture content at compaction will promote low permeability and decrease the potential for cracks resulting from a brittle compacted structure.

Suitable clay will be imported to the site or obtained from on-site borrow sources if the location of suitable soils are identified prior to construction. Previous studies at the site indicate local sources of available material; however, large quantities suitable for borrow without contamination of higher permeability materials may require import from an off-site location. Published data (Hunt, 1984) indicate a hydraulic conductivity of 10^{-7} centimeters per second will be achieved with soils containing 30 to 50 percent colloidal clay fraction (percentage less than two micrometers). The clay will have a liquid limit less than 50 to reduce potential for shrinkage cracks prior to placement of the membrane.

Compacted Soil: Published data and site investigation reports indicate that natural clay soils available on the site classify as A-6 and A-7 in accordance with the AASHTO classification system (U.S. Department of Agriculture, 1984 and Woodward-Clevenger, 1974). The A-6 and A-7 soils are silty and sandy clays. The 24-inch compacted soil zone in the final cover section serves the following purposes:

- Provides protection of the low permeability sections from surface damage.
- Insulates the "functioning" sections, i.e., sand, drain and low permeability barrier, from frost penetration.
- Fortifies erosion protection beneath the topsoil by affording increased water erosion velocities.
- Permits deep root penetration to promote vigorous vegetation growth in an arid climate without affecting the "functioning" sections.

The on-site soil used in the compacted zone beneath the topsoil and above the sand drain will have more than 35 percent passing the No. 200 sieve, with a liquid limit greater than 30 and a plasticity index greater than 10. This soil layer will be placed in uniform eight-inch loose lifts, compacted to at least 95 percent of the maximum standard Proctor density near optimum moisture content (ASTM D-698).

Topsoil: The 12-inch topsoil layer will be constructed using on-site soils to which 300 pounds per cubic yard of organic fertilizer and natural pumice will be added. The topsoil mixture will then be spread over the entire cover area to be vegetated. Vegetation of the cover is discussed in Section 4.4. The topsoil will be placed in a single uniform 12-inch loose (uncompacted) lift.

Synthetic Membrane: A 30-mil high density polyethylene (HDPE) synthetic membrane will be placed above the low permeability clay and beneath the sand drain as shown on the cross section on Figure 16. The membrane will be manufactured from virgin first quality resin designed and formulated specifically for use in hazardous waste environments. The HDPE membrane will meet the following minimum specifications:

Property	Test Method	Test Value
Density (g/cc)	ASTM D-792	0.935
Environmental Stress Crack (min., hrs.)	ASTM D-1693 Condition C	1,500
Low Temp Brittleness	ASTM D-746	-75°C
Thickness	ASTM D-2103 ASTM D-751	-5% to +10%
Tensile Strength at Yield (psi)	ASTM D-638	2,000
Elongation at Yield	ASTM D-638	13%
Tear Resistance (lb)	ASTM D-1004 Die C	20 for 30-mil 40 for 60-mil
Carbon Black	ASTM D-1603	2% to 3%

4.3.3 Depth of Materials

The depth of the materials were determined to provide the specified performance for protection of human health and the environment while maintaining an efficient design. The sand drain layers will be six inches thick. The sand drain above the synthetic membrane is sized based on infiltration and drainage calculations using the HELP computer model (Schroeder, 1983). Results of the modeling are presented in Appendix 2. Based on the maximum drain length and finished slopes, and using a conservatively low hydraulic conductivity on order of 1×10^{-3} centimeters per second, the six-inch sand drain will more than accommodate design flows.

The sand drain beneath the low permeability barrier will be placed only on the steeper slope north of the solar pond locations. The sand drain will intercept potential ground-water seepage which historically has daylighted on the slope. The sand drain is sized to a minimum thickness of six inches for constructability purposes. The drain will carry less flow than the existing interceptor french drain system. Estimated flows at the interceptor trench pump house are approximately four million gallons per year as discussed in Section 2.2.2.

The low permeability clay is a "second" component beneath the synthetic membrane to minimize surface infiltration. The 12-inch thick clay soil will have a maximum hydraulic conductivity of 1×10^{-7} centimeters per second. The clay will be placed in two, six-inch lifts, which will permit good quality control during construction to achieve the design performance.

The compacted on-site soil above the synthetic membrane and sand drain will be placed 24 inches thick. Adequate frost protection and protection from surface abrasion is provided by the combined 12 inches of topsoil and 24 inches of compacted on-site soil. The 12-inch topsoil depth is typical for support of native vegetation in the semi-arid region.

4.3.4 Volume of Materials

The material volumes for the final cover are estimated as follows:

Material	Quantity
Sand Drain (above synthetic membrane)	14,000 yd^3
Sand Drain (below clay, north slope)	4,000 yd^3
Clay (10^{-7} centimeters per second; compacted volume)	30,000 yd^3
Compacted On-Site Soil (A-6 or A-7; compacted volume)	55,000 yd^3
Topsoil	30,000 yd^3
30-mil HDPE	750,000 ft^2

The material volumes may vary slightly depending on final design and construction.

4.3.5 Source of Materials

The sand drain material and low permeability clay may be imported to the site or obtained from on-sit borrow sources. The materials specified are commonly available through local suppliers from borrow sources in the region. Maximum haul distances will range up to 15 miles. The topsoil and compacted on-site soil will come from borrow sources at the Rocky Flats Plant in the vicinity of the landfill and/or west spray fields. The distance to these borrow sources is approximately 0.5 and 1.5 miles, respectively.

Materials will be brought to the site and placed in sequence for construction of the final cover to avoid stockpiling and double handling.

4.3.6 Final Cover Design

Slope of Cover: The minimum slope of the cover will be two percent to promote surface runoff and reduce ponding and surface water infiltration. The minimum slopes will occur along the south boundary of the cover where existing slopes are nearly level. The maximum slope for the cover is 20 percent and will occur near the north boundary where existing slopes are steep and excavation into the hillside is necessary to merge the cover thickness with the existing contours. A maximum 20 percent slope will control surface erosion for the vegetated cover.

Slope Length: Slope lengths along the cover range from 500 to 900 feet. Grading is specified to result in gradual transition of slopes along the surface runoff paths to avoid flow concentrations and gully erosion.

Erosion Protection: Final cover vegetation will provide erosion protection from surface runoff. Calculations to determine maximum surface velocities relative to permissible velocities for vegetated soil cover are presented in Appendix 2. Velocities were calculated using the rational formula for surface runoff assuming a 100-year, 60-minute storm event, adjusted for the time of concentration for the longest flow path on the cover. An area equal to the longest flow length, having a unit width, was used in conjunction with a flow concentration factor (Nelson, 1986) of 3.0 to account for potential gully erosion from sheet flow conditions. Flow velocities of 2.7 feet per second were calculated using Manning's equation. Maximum velocities will occur along the limits of the cover on the north slope. Permissible flow velocities below which surface erosion will not occur were obtained from referenced sources (Nelson, 1986; NAVFAC, 1982). The average permissible velocity for the conditions anticipated on the cover is three feet per second. Therefore, the erosion of the soil and vegetation cover is not anticipated as a result of the design storm event.

In addition, the compacted on-site soil beneath the 12 inches of topsoil contains sand and gravel sized particles, which are generally present in the Rocky Flats Alluvium. In addition to the higher flow velocities permitted for compacted soil, the larger gradation will provide self-armoring should flow velocities increase until the on-site compacted soil layer begins to erode. As a result, the compacted soil layer will provide additional erosion control for the final cover in the event the vegetative cover is eroded or lost on portions of the cover between maintenance periods.

4.3.7 Final Cover Stability

The stability of the final cover design was evaluated for the maximum slope of 20 percent (five horizontal to one vertical). An infinite slope analysis was performed to evaluate the sliding potential of the overlying drainage and erosional layers on the synthetic membrane. The synthetic membrane is considered the critical surface for sliding since the frictional resistance between the membrane and overlying sand material is approximately 60 percent of that in the sand itself. In addition, seepage forces may be present within the sand drain which act to further reduce stability. Using conservative assumptions for sliding resistance and seepage forces within the sand drain, the final cover has a factor of safety against sliding in excess of 1.5. Calculations for cover stability are presented in Appendix 2.

4.3.8 Differential Settlement

Differential settlement is not anticipated to be a concern for closure of the solar evaporation ponds. Maximum depth of fill placement during regrading will be on the order of ten feet. The fill will be relatively compact as a result of construction activities during closure. Since the fill consists entirely of earthen materials, and the depths of fill are relatively shallow, significant long-term settlement is not a concern. Therefore, evaluation of the cover stability as a result of differential settlement was not evaluated.

4.3.9 Infiltration Control

Infiltration through the final cover will initially be reduced by surface grading, evapotransporation by the vegetation cover and the reduced permeability of the compacted soil layer. However, it is recognized that some waters will infiltrate beneath compacted layers. Further infiltration of the water will be reduced by placing a 30-mil HDPE synthetic membrane below the six-inch sand drain layer. Infiltrating waters will therefore be diverted through the sand drain and out the cover.

Although the intact HDPE material is for practical purposes impermeable, field seaming of the membrane panels, other construction defects and construction damage may occur to the liner. As a result, there will be an effective permeability of the liner based on the percentage area of defects to the overall liner area. For purposes of the computer modeling, it was conservatively assumed that for every 100 feet of seam, there was one foot having a hairline opening or an equivalent hole opening of 1,000ths of a square foot. Opening in the membrane will be minimized by QA/QC procedures. In any event, the assumed openings are considered a "worst case" analysis.

Based on the proposed final cover and the assumed inefficiency of the synthetic membrane, the Hydrologic Evaluation of Landfill Performance (HELP) computer model (Schroeder, 1983) was run and no significant quantity of water infiltrated through the synthetic membrane on a yearly basis. In comparison it is estimated that 103,687 cubic feet (12.77 percent of precipitation) infiltrates the cover and discharges at the base on an annual basis. Output from the analysis is in Appendix 2.

4.3.10 Surface Drainage Control

Surface runoff from the final cover will be collected in the existing drainage channel south of the existing road which parallels the Perimeter Security Zone (PSZ). Surface drainage is presently collected in a shallow retention pond and routed through a culvert beneath the road and onto the ground surface in the PSZ. Since total surface runoff volumes will not be substantially increased, additional protection of the channel beyond the toe of the cover is not anticipated as a result of the solar evaporation pond closure.

4.3.11 Subsurface Drainage Control

An interceptor drain is shown on the cross section of the final cover on Figure 12 near the north, downslope toe of the cover. The drain is connected to the sand layer beneath the synthetic membrane. The interceptor drain will isolate ground-water migration from beneath the cover to permit handling or treatment separate from the french drain system. Separate handling may be driven by:

- Large quantities of ground water intercepted by the existing french drain system;
- Limited ground-water treatment capacity; and
- Ground-water contaminant contributions possibly isolated to the solar pond area.

The interceptor drain will extend along the entire length of the toe of the cover and discharge into a sump where the water can be pumped to the forced evaporators at Building 374, and eventually to the ground-water treatment process facility when it is completed. The interceptor drain may consist of the existing upslope french drain lateral if its integrity can be economically maintained during regrading.

The sand layer extends downslope of the interceptor drain location to allow abandoning the drain in place at some future date when treatment of the water is no longer required. The interceptor drain may fill with water and overflow through the sand layer without generating hydrostatic pressure beneath the cover.

4.3.12 Construction Equipment

Regrading, fill placement, and compaction will be possible with conventional earth moving equipment. Moisture adjustments will be accomplished with water truck and hose application methods. Compaction of the low permeability clay will be accomplished with a minimum 50,000-pound smooth drum vibratory roller. The final lift of the low permeability clay will be rolled smooth to provide a suitable bedding surface for the synthetic membrane. Equipment will not be allowed to operate directly on the synthetic membrane. Stopping or turning of equipment on slopes steeper than five percent will not be permitted during construction to avoid damage to the liner.

4.4 Vegetation

The surface of the cap will be stabilized to decrease erosion by wind and water and contribute to the development of a stable surface environment. This will be accomplished by establishing a vegetative cover on the cap.

The area requiring vegetation will consist of the 750,000 square foot cover and ten percent additional area for the surrounding perimeter where construction activities extend beyond the final cover.

Vegetation of the cover will be conducted by seeding with a mixture of native grasses. The mixture will consist of:

Grass	Quantity (pounds)
Western Wheatgrass	6.0
Thickspike Wheatgrass	3.0
Little Bluestem	2.0
Green Needlegrass	2.0
Canby or Canada Bluegrass	1.0
	14.0 pounds/acre

The properties of the native grass mix are:

- A root structure which will not penetrate the cover;
- Require no irrigation after the grass has been established;
- Be capable of withstanding the temperature range experienced at Rocky Flats;
- Require little fertilization after initial seeding, and
- Be compatible with the soil properties, such as pH, of the vegetative layer.

Preparation of the topsoil layer will include ripping of the upper six inches, applying two tons per acre of weed free native hay mulch and crimping the mulch with a crimper disc. The fertility of the topsoil layer will be analyzed in the first year and appropriate fertilizers applied to the cover in the second year, if needed. Irrigation will not be required.

Additional periodic maintenance will be performed, including reseeding and weed control as necessary. The solar pond cover and vegetative growth will be inspected quarterly as specified in the Part B Post-Closure Care Permit. During this inspection, trees and bushes will be removed, and the condition of the vegetation will be observed.

4.5 Quality Assurance/Quality Control Procedures

A quality assurance/quality control manual will be completed by July 1989 as shown on the Summary of Solar Pond Closure Activities, Figure 10.

Detailed plans and specifications for the solar pond capping activities will be completed by July 1989. These plans and specifications will conform to the performance criteria given in this document, and will be incorporated into the appendices of this closure plan. These plans and specifications will be submitted to the Colorado Department of Health and Environmental Protection Agency for review when available.

4.5.1 Quality Control

Quality control of the closure of the solar ponds will include materials, lines and grades, and placement. The method for controlling the quality of each of these areas will be presented in the final construction specifications.

Control of material quality will be by random sampling at specified intervals. Earthen materials will be tested for their characteristics such as gradation, atterberg limits, moisture-density relation, specific gravity and durability. Manufactured materials will be certified by the manufacturer to meet the required specifications. Throughout the closure of the solar ponds, materials utilized will be visually observed during placement to see that the materials meet the intended use and project specifications.

Control of lines and grades during closure will be by surveying. Surveys will be conducted under the supervision of a registered land surveyor. Deviation from construction drawings will be indicated and as-built drawings showing constructed lines and grades will be prepared upon completion.

Control placement will overall be by visual observation of the methods, equipment and practices utilized for placement of materials. Earthen materials shall also be tested for proper placement by in-place testing of moisture, densities and gradations, as applicable. Manufactured materials shall be tested, as appropriate, to determine that field installation methods have produced the required quality of product. The synthetic membrane shall have all field seams tested in accordance with the manufacturer's recommendations. As a minimum, all field seams will be visually inspected.

Quality control testing will be performed in accordance with ASTM or other recognized test procedures.

4.5.2 Quality Assurance

To assure that the quality control plan is being implemented during closure of the facility, a quality assurance plan will also be set forth as part of the final construction documents. The quality assurance plan will set forth the time intervals between quality assurance reviews, information to be reviewed and procedures for correction of quality control problems if present. The quality assurance plan will be dependent on the final quality control specifications and the time schedule set for closure. It is anticipated that the certifying engineer for closure will provide quality assurance reviews.

4.6 Health and Safety Plan

A site specific Health and Safety Plan, or such health and safety procedures identified in the Rocky Flats Plant Operational Safety Analysis (OSA) procedure, covering liner and contaminated soil removal will be prepared two months before liner and soil removal activities begin. The plan will be submitted to the Colorado Department of Health for information and will comply with all applicable requirements. The procedures presented below are guidelines that will be followed during closure activities. Additional procedures and details will be presented in the site specific Health and Safety Plan or the OSA. Worker safety guidelines, such as OSHA regulations, DOE orders and Rocky Flats Plant policies will be followed. Protective clothing will be similar in nature to:

- hardhats,
- hard-toe boots,
- Tyvek overboots,
- Tyvek suits,
- dust masks, and
- air-purifying respirators or self-contained breathing apparatus (optional).

The intent of this equipment is to provide a barrier to inhalation, ingestion and absorption of contaminated materials. Appropriate protective gloves will be used based on the contamination found at any particular site.

Air monitoring will be conducted in the work area. Portable high-volume (40 cfm) samplers or fixed radioactive ambient air samplers (25 cfm) will be located around the excavation area, including at probable downwind locations.

Air monitoring will also be conducted using hand-held photoionization detectors. The site specific health and safety plan or OSA will present levels, which if exceeded, will require some action be taken, such as increasing respiratory protection or work cessation.

A Rocky Flats Environmental Sciences representative will be monitoring conditions during excavation activities. This person will have the authority and responsibility to terminate the work if any of the following events occur.

- Wind speeds exceed 24 km/hr (15 mph).
- Any visible dust is present or there is any indication that dust control measures are inadequate.
- The total long-lived alpha concentrations measured on filters from high-volume samplers exceed 0.06 pCi/m^3 in order to re-evaluate dust control procedures.
- Power failure.
- Heavy rainfall or snow.

Airborne contamination may require upgrading dust masks to air-purifying respirators or self-contained breathing apparatus. Sudden increases in airborne contamination due to excavation in localized highly contaminated areas may be addressed by a temporary cessation of work until natural dissipation reduces contamination.

4.7 Maintenance

Maintenance of the final cover is required to meet the performance standards of 6 CCR 1007-3, Section 265.111. Continuing maintenance of the final cover is not anticipated. Periodic maintenance of the final cover will be conducted as required. Periodic maintenance may include:

- regrading to maintain slope and grade
- fertilization
- mowing
- irrigation
- reseeding
- control of rodents.

The amount of periodic maintenance will depend largely on the extent to which the cap is protected against erosion damage by vegetation. Routine repair of the cap may be needed to prevent ponding and drainage problems due to minor subsidence of the solar ponds.

Periodic visual inspection of the final cover will be conducted on a quarterly basis until final closure and then biannually thereafter during the post-closure care period.

5.0 GROUND-WATER MONITORING

Ground-water contamination at the Rocky Flats Plant has been the subject of ongoing investigations being performed pursuant to the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the U.S. DOE Comprehensive Environmental Response Program (CERP). In addition to the solar evaporation pond facilities, other solid waste management units (SWMUs) in the vicinity of and upgradient of the ponds have likely impacted ground-water quality.

An assessment of the ground-water contamination resulting from solar pond leakage was conducted as part of the hydrogeological site characterization presented in Appendix 6. Ground-water monitoring wells installed for the assessment will be utilized to meet the closure ground-water monitoring requirements of 6 CCR 1007-3, Section 265.90 et seq. The wells are: (SP=Alluvial Well; BR=Bedrock Well)

13-86SP	23-86BR	31-86BR
14-86BR	24-86SP	32-86BR
15-86SP	25-86BR	21-87SP
16-86BR	26-86SP	22-87BR
17-86SP	27-86BR	37-87SP
18-86SP	28-86SP	38-87SP
20-86SP	29-86SP	39-87BR
22-86SP	30-86BR	56-87SP

Ground-water protection standards are presented in Appendix 6.

6.0 CLOSURE CERTIFICATION

6.1 Certification Requirements

Closure certification requirements are outlined in 6 CCR 1007-3, Section 265.115 and 40 CFR 265.115:

> "Within 60 days of completion of closure of each hazardous waste surface impoundment, waste pile, land treatment, and landfill unit, and within 60 days of completion of final closure, the owner or operator must submit to the Department of Health/Regional Administrator by registered mail, a certification that the hazardous waste management unit or facility, as applicable, has been closed in accordance with the specifications in the approved closure plan. The certification must be signed by the owner or operator and by an independent registered professional engineer."

Certification by an independent registered professional engineer does not guarantee the adequacy of the closure procedures and does not necessarily involve detailed testing and analyses. It implies that, based on periodic facility inspections, closure has been completed in accordance with the specifications in the approved closure plan (U.S. Environmental Protection Agency, 1981).

6.2 Activities Requiring Inspections by a Registered Professional Engineer

The following closure activities will require inspections by a registered professional engineer:

- Completion of liquid evaporation,
- Removal, treatment and disposal of pond sludges and sediments,
- Removal and disposal of pond liners, if required,
- Decontamination of equipment used at the ponds,
- Removal, treatment and disposal of contaminated soil, if required, and
- Construction activities related to cap, ground-water collection, Interceptor Trench Pump House (ITPH) system.

A summary of these activities and the dates when they occurred will be presented in the closure certification report.

The engineer will obtain and review the results of chemical testing which provide a record of the progress and effectiveness of the implemented closure plan. Documentation supporting closure certification will be included in the certification report. This documentation will include hazardous waste manifests, surveying records verifying final slopes and contours, and records of equipment decontamination. Any deviations from the closure plan and their resolutions will be documented by the engineer performing the closure certification.

6.3 Anticipated Schedule of Inspections by a Registered Professional Engineer

An independent registered professional engineer will periodically review the closure operations listed in Section 6.2 in order that a final certification of closure can be developed which states that the closure has been carried out according to the plan. The engineer will observe construction activities and be present during performance and completion of key closure activities.

The independent registered professional engineer and the owner will, at the end of closure, inspect the site and certify that the closure plan was carried out as described. Prior to final certification, deficiencies noted by the engineer will be corrected. When deficiencies have been corrected, the engineer will issue a written report to the regulatory agencies certifying that the facility has been closed according to this closure document. The certification of closure, signed by the owner and the independent registered professional engineer, will be mailed to the CDH within 60 days after completing closure of the ponds.

7.0 LEACHATE AND GAS COLLECTION AND TREATMENT

The applicable standards (U.S. Environmental Protection Agency, 1981) require systems to collect, remove and treat leachate and to collect gas if these systems are required during the operation of the impoundment. Leachate and gas collection and treatment systems are not and have not been present at the solar evaporation ponds. Nitrates and the attendant compounds from the process wastes will not produce methane gas because organic compounds and biodegradation are not present. Additionally, leachate and gas are not expected to be generated since all the waste inventory will be removed for closure.

Therefore, leachate and gas collection and treatment systems are not required at this facility.

8.0 SITE SECURITY

The existing security measures at the Rocky Flats plant include:

- a three-strand barbed wire cattle fence surrounding the facility (Figure 1) posted to identify the land as a government reservation/ restricted area,
- a fence surrounding and armed guards posted 24 hours per day at two gates to the controlled area of the facility (Figure 1),
- a 6-foot high chain link fence topped by 2 feet of three-strand barbed wire surrounding and guards posted 24 hours per day at gates to the perimeter security zone (PSZ),
- guards patrolling the controlled area and the PSZ 24 hours per day, and
- surveillance by security cameras 24 hours per day.

The existing security measures are sufficient to meet the requirements of 6 CCR 1007-3, Section 265.14.

The existing fences and gates are operated and maintained by the U.S. Department of Energy. Maintenance requirements will be performed by the U.S. Department of Energy, regardless of the activities at the solar evaporation ponds.

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APPENDIX 1

ENGINEERING DRAWINGS

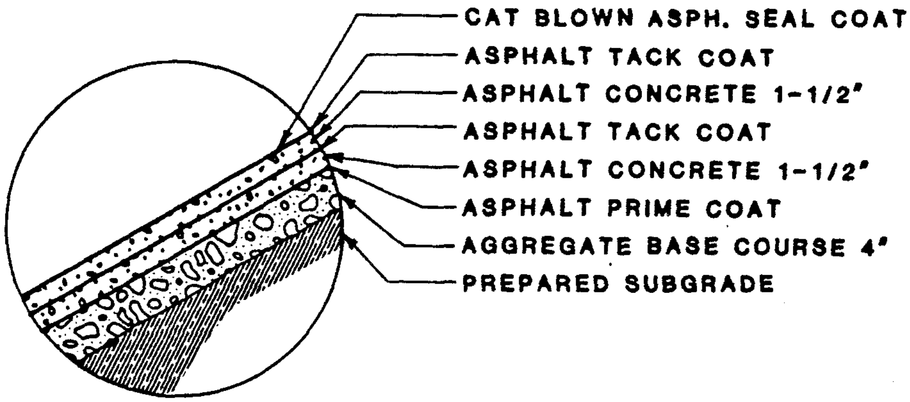


FIGURE D-8 LINER PLACEMENT IN LAYERS
POND 207-C

Nov. 8, 1985

NOTE: The solar pond systems depicted in Drawings 25787-C01 and 25976-D01 were not constructed. Therefore, these drawings have been deleted from Appendix 1.

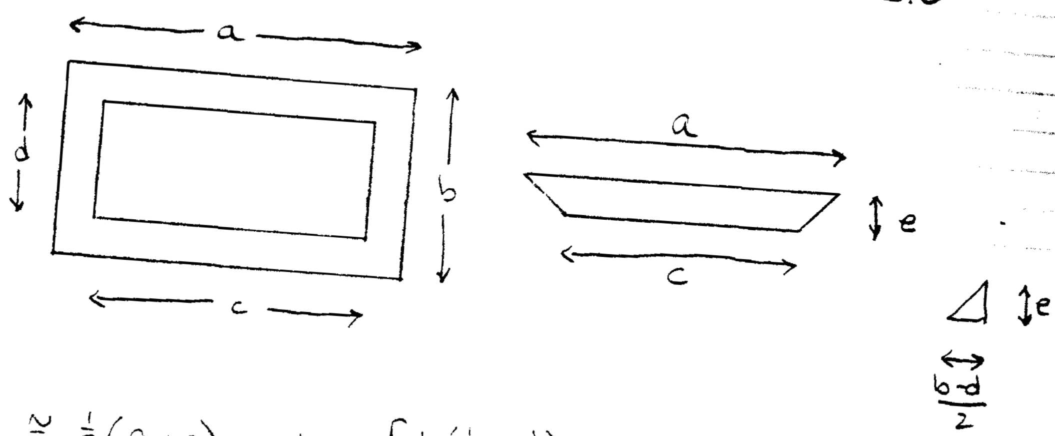
APPENDIX 2

VOLUME, SCHEDULE AND COVER DESIGN CALCULATIONS

Chen & Associates
Consulting Geotechnical Engineers

JOB NO. 6-002-87 JOB TITLE ROCKY FLATS
SUBJECT VOLUME OF SURFACE IMPOUNDMENTS DATE 1/29/87 BY KAJ
CHECKED BJF 1-30-87 SHEET 1 OF 1

POND	MAXIMUM DIMENSIONS OF LIQUID SURFACE* (FT.) a b	SURFACE AREA (FROM TOP OF CREST TO TOP OF CREST) FT.	ACRES	BOTTOM DIMENSIONS (FT.) c d	MAXIMUM DEPTH OF LIQUID* (FT.) e
207-A	230 X 505	131,250	3.0	195 X 460	
207-B					7.5
NORTH	245 X 175	45,540	1.0	205 X 135	
CENTER	245 X 175	45,540	1.0	205 X 135	6.5
SOUTH	245 X 175	45,540	1.0	210 X 135	6.5
207-C	245 X 155	40,000	0.92	210 X 120	5.5
					5.0



$$\text{Volume} \cong \tfrac{1}{2}(a+c)e * d + 2\left[\tfrac{1}{2}\left(\tfrac{b-d}{2}\right) * e\right] * \tfrac{1}{2}(a+c)$$

POND	VOLUME (FT³)	(MILLION GALLONS)
207-A	769,000.	5.7.
207-B		
NORTH	226,700.	1.7.
CENTER	226,700.	1.7.
SOUTH	193,900.	1.5.
207-C	156,400.	1.2.

* ASSUMES 2 FEET OF FREEBOARD.

chen and associates, inc.
CONSULTING ENGINEERS

JOB NO. 6-017-86 JOB TITLE ROCKY FLATS DATE 8/21/86 BY KAJ
[SUBJ]ECT EVAPORATION RATES CHECKED BJF 2-12-87 SHEET 1 OF 11

CSU Information 491-1101

State Climatology Center

Jim Cowie, Colorado Climate Center 491-8545.

Cherry Creek monthly averages
↳ Closest station to Rocky Flats

Pan Evaporation
Monthly average 1959 - 77

	Actual	estimated
Jan		0.80
Feb		1.00
Mar		1.76
Apr	4.34"	
May	6.91	
June	8.66	
July	9.52	
Aug	8.85	
Sep	6.31	
Oct	4.30	
Nov		2.17
Dec		1.04
Total	48.89"	6.77"

Gross evap rates

Ann. lake evap @ RF; decreases from Cherry Ck to RF

SE Denver (Cherry Ck = ~~42~~ 43"
NW @ RF = 40"

Total = 55.66" pan evap
* 0.74 = 41.19" lake evap

Apply 0.74 for Rocky Flats to convert from pan evaporation to lake evaporation

Chen & Associates
Consulting Geotechnical Engineers

JOB NO. ________ JOB TITLE ________ DATE 2/11/87 BY KN
SUBJECT Evap. Rates CHECKED BJF 2-12-87 SHEET 2 OF 11

Pond 207-B North received 4" (measured down the slope) of liquid from the ITPH from Jan. 27, 1987 till the morning of Feb 9, 1987 (13 days)

Slope of pond 207-B North = 52" : 24" or 2.2:1.

Vertical height of 4" on slope = $\frac{4}{2.2}$ = 1.82"

Vol. of liquid received = $\left(\frac{1.82''}{12}\right)$(245' * 175')

= 6,500 ft^3 = 48,600 gal

Rate of inflow = $\frac{48600 \text{ gal}}{13 \text{ day}}$ = 3,740 gal/day
= 2.6 gal/min (gpm)

Assume a rate of 3.0 gpm is put into the 207-B ponds between now (2/9/87) and June 1, 1987 (for 112 days). You accumulate $\left(3.0\frac{\text{gal}}{\text{min}}\right)\left(\frac{1440 \text{ min}}{\text{day}}\right)$ * 112 days

= 483,840 gal.

(Prior to 1/27/87 - 2/9/87 period we had a lot of snow w/ cold temps, suddenly warming w/ a lot of snow melt & runoff)

Chen & Associates
Consulting Geotechnical Engineers

JOB NO. ______ JOB TITLE ______ DATE 2/9/87 BY KAJ
SUBJECT Evap. Rates CHECKED BJF 2-12-87 SHEET 3 OF 11

Assumptions:

Ponds 207-A and -C:

- Used for emergency purposes until new tanks are ready in June 1987.
- Vol. of liquids in ponds in June 1987 is the same as in the ponds now.
- Pond / Volume (gal) (based on liquid levels read on Feb. 9, 1987 and reported by Garvin Hewitt)

Pond	Volume (gal)
-A	2,038,300
-C	491,800

Pond 207-B North, Center & South

- B-North & Center: currently receiving liquid from the ITPH. This water goes into North first, then into Center
- Max. & current vol of North = 1.7 million gal.
- Current vols of Center & South are 1.4 and 0.10 million gals.
- Assume Pond 207-B Center takes 0.5 million gals of liquid more between now and June 1, 1987 (see pg 2)
- Vol. of liquids in pond in June 1987 is:

Pond	Volume (million gal)
-B North	1.7
-B Center	1.4+0.3=1.7
-B South	0.10+0.2=0.30

Pond-creting the sludge & sediments will take until March 1989. So all pond liquid will have to be naturally evaporated or forced evaporated by ~that time.

Forced evap. can occur @ a max of 65,000 gal/day. (Blaha, 1987). They'll only use force evap. for solar ponds once a wk. Due to down time, use long-term average of 40,000 gal/wk.

From data on pg 1: Lake evap @ Rocky Flats = 40"/yr.

From AEMR, 1985, precip @ 2F = 15"/yr (avg precip. from 1953-1976). Net evap = 25"/yr.

$$\left(\frac{25''}{yr}\right)\left(\frac{1\,yr}{12\,mos}\right)\left(\frac{1\,ft}{12''}\right) = \frac{0.1736\,ft}{mo.} = \left(\frac{0.1736\,ft^3}{mo\text{-}ft^2}\right)\left(\frac{7.48\,gal}{ft^3}\right)$$

$$= 1.3\ gal/ft^2\text{-}mo.$$

POND 207-A

Vol. of liquid as of June 1987 = 2.0 million gal

Send all liquids to forced evaporator

Surface area @ 1/4 height = $\frac{1}{2}[\frac{1}{2}(230*505+195*460)+195*460] = 96,300 ft^2$

Natural + forced evap rate =
$\left(1.3\frac{gal}{ft^2\text{-}mo}\right)(96,300 ft^2)/(1.33 \text{ F.S.}) + \left(40,000\frac{gal}{wk}\right)\left(\frac{52 wk}{12 mo}\right) = 94,000\frac{gal}{mo} + 173,300\frac{gal}{mo} = 267,000\frac{gal}{mo}$

Time for natural + forced evap = $\frac{2,000,000 gal}{267,000 gal/mo} = 7.5 mo.$

End of evap = mid-Jan 1988.

POND 207-C

Vol. of liquid as of June 1987 = 500,000 gal.

Surface area @ 1/4 - height =
$\frac{1}{2}[\frac{1}{2}(245*125+210*120)+210*120] = 28,400 ft^2$

Use natural evap till middle of Jan 1988

Vol. that can be naturally evap from 6/87 - mid 1/88

$= \frac{(7.5 mo.)(1.3\frac{gal}{ft^2\text{-}mo})(28,400 ft^2)}{1.33} = 208,000 gal$

→ Factor of safety

Vol. left in mid Jan. 1988 = 500,000 - 208,000 = 292,000 gal

Nat + forced evap rate = $(1.3\frac{gal}{ft^2\text{-}mo})(28,400 ft^2)/1.33 + 173,300\frac{gal}{mo} = 201,000 gal/mo.$

Time for remaining evap = $\frac{292,000 gal}{201,000 gal/mo} = 1.5 mo.$

End of evap = beginning Mar. 1988.

POND 207-B NORTH & CENTER (each)

Vol. of liquid in ea. pond as of June 1987 = 1,700,000 gal

Surface area of ea. pond @ mid-height:

$\frac{1}{2}(245 * 175 + 205 * 135) = 35,300 \text{ ft}^2$

Time for evap for ea. pond:

$$\frac{1,700,000 \text{ gal}}{\left(1.3 \frac{\text{gal}}{\text{ft}^2\text{-mo}}\right)(35,300 \text{ ft}^2)} = 37 \text{ mo.}$$

Increase evap time by 1/3 = 49 mo.

By mid Jan 1988, vol. that can be naturally evap (in ea. pond):

$$= \frac{(7.5 \text{ mo})\left(1.3 \frac{\text{gal}}{\text{ft}^2\text{-mo}}\right)(35,300 \text{ ft}^2)}{1.33} = 259,000 \text{ gal.}$$

Vol. remaining in ea. pond in mid-Jan 1988:

= 1,700,000 - 259,000 gal = 1,441,000 gal.

<u>However</u>: water is accumulating in the ponds @ 3.0 gal/min or 30,200 gal/wk or 131,000 gal/mo.

So, in 7 1/2 mo. ea. pond has $\frac{131,000 \text{ gal/mo} (7.5 \text{ mo})}{2 \text{ ponds}} = 491,000$ gal ea.

<u>OR</u> ea. pond has 1,441,000 gal + 491,000 gal = 1,932,000 gal by mid Jan 1988

Vol. of liquid that can be naturally evap from Pond 207-A from mid Jan 1988 till mid-Sept 1989 (20 mos.)

$$= \frac{20 \text{ mos.} \left(\frac{1.3 \text{ gal}}{\text{ft}^2\text{-mo}}\right)(96,300 \text{ ft}^2)}{1.33} = 1,883,000 \text{ gal.}$$

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JOB NO. ______ JOB TITLE ______ DATE 2/17/87 BY KAJ
SUBJECT Evap. Rates CHECKED [initials] 2-20-87 SHEET 7 OF 11

Amt. of liquid that can be naturally and forced evaporated from Pond 207-B North from mid-Jan 1988 till Mar 1989

- mid Jan 1988 - March 1988:

  Evaporate: $\left(1.3 \frac{gal}{ft^2\text{-}mo}\right)(35{,}300 ft^2)(1.5 mo)/1.33 = 51{,}800$

  Take in from ITPH: $(1.5 mo)(131{,}000\ gal/mo) = 196{,}500 gal$

  Net: increase $196{,}500 - 51{,}800 = 144{,}700 gal.$

- March 1988 - Mar 1989 (12 mos):

$$= (12 mo)\left[\left(1.3 \frac{gal}{ft^2\text{-}mo}\right)(35{,}300 ft^2)/1.33 + \left(10{,}000 \frac{gal}{wk}\right)\left(\frac{52 wk}{12 mos}\right)\right]$$

$$= (12 mo)\left(34{,}500 + 43{,}300 \frac{gal}{mo}\right) = 934{,}000 gal.$$

- Net change:

  $-934{,}000 gal + 144{,}700 gal = -789{,}000 gal.$

<u>So</u>, out of the 1,883,000 gal that 207 A can take in mid Jan 1988, take 1,932,000 - 789,000 = 1,143,000 gal from 207-B North.

Take the remaining 1,883,000 - 1,143,000 = 740,000 gal from 207-B Center

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JOB NO. ______ JOB TITLE ______ DATE 2/17/87 BY KAJ
SUBJECT Evap rates CHECKED KB 2-20-87 SHEET 8 OF 11

Vol. remaining in mid-Jan. 1988 after transfer

	from -BN	from B Center	
207-A	1,143,000 +	740,000	= 1,883,000

207-BNorth 1,932,000 − 1,143,000 = 789,000 gal

207-B Center 1,932,000 − 740,000 = 1,192,000

Do natural evap for 1½ more month out of 207-BN & C

Vol. evap in 1½ mo.

$$= \frac{(1.5 mo)\left(1.3 \frac{gal}{ft^2\text{-}mo}\right)(35{,}300 ft^2)}{1.33} = 51{,}700 \text{ gal ea.}$$

Vol. remaining @ beginning Mar. 1988

207-BNorth 789,000 − 51,700 = 737,000 gal

207-BCenter 1,192,000 − 51,700 = 1,140,000 gal

However, 196,500 gal has been put in Pond 207-BNorth from ITPH (for 1.5 mo. period)

Vol 207-BN = 737,000 + 196,500 = 934,000 gal

From beginning of Mar. 1988, assume 30,000 gal/wk of liquid accumulating in the ITPH is pumped to 207-BNorth and immediately to the 2 tanks or to Bldg 374 for forced evap. ∴ after 3/88, the capacity of the forced evap is decreased from 40,000 gal/wk to 10,000 gal/wk.

Vol. of liquid that can be naturally evap. from Pond 207-B Center from beginning Mar. 1988 till beginning of May 1989

$$(14 mo) = \frac{(14 mo)\left(\frac{1.3 gal}{ft^2\text{-}mo}\right)(35{,}300 ft^2)}{1.33} = 483{,}000 gal$$

Vol. of liquid that can be forced evap from 207-B Center from 3/89 -5/89 = (10000 gal/wk)(5.2 wk/mo)(2 mo) = 86,700 gal

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JOB NO. ______ JOB TITLE ______ DATE 2/17/87 BY KN
PROJECT Evap Rates CHECKED 2-20-87 SHEET 9 OF 11

However, there is 1,140,000 gal in 207-B Center.
1,140,000 - 483,000 - 86,700 = 570,000 gal needs to go elsewhere.

Pond 207-C can evap. (from beginning Mar 88 - beginning Nov. 1988) - 8 mo:

$$\frac{(8\,mo)\left(1.3\frac{gal}{ft^2\text{-}mo}\right)(28,400\,ft^2)}{1.33} = 222,000\,gal.$$

So, transfer 222,000 gal from 207-B Center to 207-C @ the beginning of Mar. 1988. This leaves 570,000 - 222,000 gal = 348,000 gal to be dealt with.

Pond 207-B South had 300,000 gal in it in June 1987.

Surface area of 207 B-South @ 1/4 height =
$$\frac{1}{2}\left[\frac{1}{2}(245*175 + 210*135) + 210*135\right] = 32,000\,ft^2$$

Time to evap the 300,000 gal
$$= \frac{300,000\,gal}{\left(1.3\frac{gal}{ft^2\text{-}mo}\right)(32,000\,ft^2)} * 1.33 = 9.5\,mo.$$

or from 6/87 - mid Mar. 1988.

Amt that can be naturally evap. from mid-March 1988 till end Feb 1989 (11½ mo)
$$= (11\tfrac{1}{2}\,mo)\left(1.3\frac{gal}{ft^2\text{-}mo}\right)(32,000\,ft^2)/1.33 = 360,000\,gal.$$

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JOB NO. ______ JOB TITLE ______ DATE 2/17/87 BY KW
PROJECT Evap Rates CHECKED [initials] 2-20-87 SHEET 10 OF 11

So, transfer the 348,000 gal of liquid from 207-B Center to 207-B South in mid March 1988

Time to evaporate 348,000 gal. in 207-B Center:

$$\frac{348{,}000 \text{ gal}}{\left(1.3 \frac{\text{gal}}{\text{ft}^2 \cdot \text{mo}}\right)\left(32{,}000 \text{ ft}^2\right)} * 1.33 = 11 \text{ mo.}$$

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JOB NO. ______ JOB TITLE ______ DATE 2/17/87 BY KAJ
SUBJECT Evap Rates CHECKED JEB 2.20.87 SHEET 11 OF 11

SUMMARY

POND 207-A

NAT'L & FORCED EVAP: 6/87 – mid 1/88
TAKE 1,143,000 GAL. FROM 207-B NORTH: mid 1/88
TAKE 740,000 GAL. FROM 207-B CENTER: mid 1/88
NAT'L EVAP: mid 1/88 – mid 9/89

POND 207-B NORTH

TAKES ITPH LIQUID: 6/87 – 3/88
NAT'L EVAP: 6/87 – 3/88
NAT'L & FORCED EVAP: 3/88 – 3/89
SEND 1,143,000 GAL. TO 207-A: mid 1/88

POND 207-B CENTER

TAKES ITPH LIQUID: 6/87 – 1/88
NAT'L EVAP: 6/87 – 3/89
SEND 740,000 GAL. TO 207-A: mid 1/88
NAT'L & FORCED EVAP.: 3/89 – 5/89
SEND 222,000 GAL TO 207-C 3/88
SEND 348,000 GAL TO 207-B SOUTH mid 3/88

POND 207-B SOUTH

NAT'L EVAP: 6/87 – mid 3/88
TAKES 348,000 GAL FROM 207-B CENTER: mid 3/88
NAT'L EVAP: mid 3/88 – mid 3/89

POND 207-C

NAT'L EVAP: 6/87 – mid 1/88
NAT'L & FORCE EVAP: mid 1/88 – 3/88
TAKE 222,000 GAL. FROM 207-B CENTER: 3/88
NAT'L EVAP: 3/88 – 11/88

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JOB NO. 6-002-87 JOB TITLE ROCKY FLATS DATE 1/30/87 BY KAJ
SUBJECT SOLAR PONDS VOL. OF SEDIMENT CURRENTLY IN PONDS 207-B NORTH, CENTER & SOUTH AND 207-C. CHECKED BJF 1-30-87 SHEET 1 OF 1

Assume ea. pond has 8" of sediment

Based on 3:1 side slopes

Pond	Dimension of Sediment Surface (ft) a × b	Btm. Dimensions (ft) c × d	Depth of Sediment (in) e	Volume (ft³)	Volume (yd
207-B North	210 x 140	205 x 135	8	19,000	705
Center	210 x 140	205 x 135	8	19,000	705
South	215 x 140	210 x 135	8	19,500	720
207-C	215 x 125	210 x 120	8	17,400	645

$$Volume \cong \tfrac{1}{2}(a+c) * e * d + 2\left[\tfrac{1}{2}\left(\tfrac{b-d}{2}\right) * e\right] * \tfrac{1}{2}(a+c)$$

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JOB NO. 6-002-87 JOB TITLE ROCKY FLATS DATE 1/27/87 BY KAJ
SUBJECT SOLAR PONDS: REMOVAL & TREATMENT OF SLUDGES & SEDIMENTS. CHECKED BJF 1-29-87 SHEET 1 OF 3

POND 207-A:
From Eng, 1986:

Volume of sludge in Pond 207-A = 153,287 ft^3 ✓

✓ Assume average in-place % solids of sludge in pond 207-A = 22%. (See attachment 1)

Dry sludge in pond = 0.22 * 153,287 ft^3 = 33,723 ft^3

= 1,250 cy

From personal communication w/ F. Blaha on 1/20 & 23/87:

Time Period	Average % solids (by weight) (coming out of the thickener)	# of boxes of pond-crete
6/85 - 9/85	15	866
10/1/85 - 9/30/86	15	3000
10/1/86 - 1/12/87	15	1927

Ideally, each 15 ft^3 of pond-crete contains a total of 1200 lbs (= 800 lbs of sludge and water + 400 lbs of cement)

$G_{s\,cement} = 3.15$ ✓, $\gamma_{cement} = 3.15 * 62.4 = 197\ lb/ft^3$ ✓

$$V_{cement} = \frac{400\ lb}{197\ lb/ft^3} = 2\ ft^3$$

If % solids (of sludge/water) = 15, then 0.15 * 800 = 120 lbs of sludge in each box. % of sludge in box = $\frac{120\ lbs}{1,200\ lbs}$ = 10%

Wt. of water = 800 - 120 = 680 lbs

$$V_{water} = \frac{680 \text{ lbs}}{62.4 \text{ lbs/ft}^3} \approx 11 \text{ ft}^3$$

$$V_{sludge} = 15 \text{ ft}^3 - 2 \text{ ft}^3 - 11 \text{ ft}^3 = 2 \text{ ft}^3$$

Time Period	# of boxes	Amt. of sludge removed (ft^3)
6/85 - 9/85	866	1,732
10/1/85 - 9/30/86	3000	6,000
10/1/86 - 1/12/87	1927	3,854

Rate of removal in future

598 boxes/month in cold weather

240 boxes/week in warm weather.

Assume ea. rate is applicable for 6 mos. of the year.

Amount of sludge left to remove = 33,723 - 1,732 - 6,000 - 3,854

= 22,137 ft^3

Avg. rate of removal (= weighted rate of removal)

$$= \left[\left(240 \frac{\text{boxes}}{\text{wk.}}\right)\left(\frac{4 \text{ wk}}{1 \text{ mo}}\right) + 598 \frac{\text{boxes}}{\text{mo}}\right] / 2$$

$\approx$ 780 boxes/mo.

$$= 780 \frac{\text{boxes}}{\text{mo.}} * 2 \frac{\text{ft}^3}{\text{box}} = 1{,}560 \text{ ft}^3/\text{mo}$$

Begin removal of remaining 22,137 ft^3 in mid-Jan. 1987

$$\text{Time to complete} = \frac{22{,}137 \text{ ft}^3}{1560 \text{ ft}^3/\text{mo}} \approx 14 \text{ mos.}$$

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JOB NO. ______ JOB TITLE ______ DATE ______ BY ______
SUBJECT ______ CHECKED ______ SHEET 3 OF 3

End middle of March 1988

POND 207-C

Begin middle of March 1988

Amt of sediment/water = 17,400 cf

Amt of dry sediment = 0.22 * 17,400 = 3,828 cf

Time to complete = $\frac{3,828 \text{ cf}}{1,560 \text{ cf/mo}}$ = 2.5 mo.

End: beginning June 1988

PONDS 207-B NORTH, CENTER & SOUTH

POND	VOL OF SEDIMENTS (cf)	DRY VOL. OF SEDIMENTS (cf)	TIME TO COMPLETE (MO)	BEGIN	END
B-NORTH	19,000	4,180	2.7 ≅ 3	Beginning June 1988	Beginning Sept 198[illegible]
B-CENTER	19,000	4,180	2.7 ≅ 3	Beginning Sept 1988	Beginning Dec. 198[illegible]
B-SOUTH	19,500	4,290	2.75 ≅ 3	Beginning Dec 1988	Beginning March 19[illegible]

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ATTACHMENT 1

JOB NO. 6-002-87 JOB TITLE ROCKY FLATS, SOLAR PONDS DATE 2/11/87 BY KAN
SUBJECT SLUDGE IN POND 207-A CHECKED ____ SHEET 1 OF 1

Provided by Frank Blaha over the phone.

Date Sample was Taken	Total Suspended Solids (mg of solid/l of liquid in sample of sludge/liquid at bottom of Pond 207-A)
6/17/85	139,376
7/21/85	126,000
6/29/85	120,000
7/18/85	290,000
7/24/85	247,000
7/31/85	244,000
8/8/85	239,350
8/13/85	271,000
8/20/85	260,000
5/20/85	129,100
9/11/85	282,300
9/18/85	241,221
9/27/85	243,613
10/7/85	338,586
10/21/85	281,061
10/30/85	280,345
11/6/85	276,120
10/16/85	301,405
11/26/85	276,584
12/4/85	276,120
11/25/85	225,571
6/86	85,900
6/11/86	83,200
6/30/86	128,000

Average = 22%

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JOB NO. 6-017-86 JOB TITLE ROCKY FLATS DATE 7/25/86 BY KN
SUBJECT SOLAR PONDS - LINING SYSTEM CHECKED ✓ SHEET 1 OF 5

GENERAL DESCRIPTION

207-A 1963 Asphalt ?

207-B North
1973 Petro-mat & hydraulic sealant, on sidewalls
1971 Petro-mat & hydraulic sealant, on side walls
1969 Burlap & asphalt, on all sidewalls
1968 Asphalt
1967 Burlap & asphalt, on side walls, in cracking are[a] only
1961 Asphalt concrete
1960 Asphalt planking

207-B Center
1971 Petro-mat & hydraulic sealant, on sidewalls
1969 Burlap & asphalt, all sidewalls
1968 Burlap & asphat, on sidewalls, in cracking are[a]
1961 Asphalt concrete
1960 Asphalt planking

207B-South
Membrane
1972 Petro-mat & hydraulic sealant, btm & sidew[alls]
1970 Burlap & asphalt, all sidewalls
1960 Asphalt concrete
1960 Asphalt planking

207-C 1970 Asphalt concrete

Notes: (1) Materials are from the top to the bottom
(2) the references do not indicate that any of the above layers were removed prior to the installation of the subsequent layer

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JOB NO. ______ JOB TITLE ______ DATE 7/25/86 BY KAJ
SUBJECT ______ CHECKED DCC SHEET 2 OF 5

LINING SECTIONS (FROM ENGINEERING DRAWINGS)

207-B North

1½" Asphalt surface } Extend 18" past top of slope
1½" asphalt binder }
4" base course
2" sand
½" asphalt planking
4" base course

Total Thickness of liner = 13½"

Above section is for bottom and sidewalls.

207-B South

1½" asphalt concrete } Goes 3' past top of slope on East, South & West sides and 1' past top of slope on North side.
1½" asphalt concrete }
4" base course
½" asphalt planks
½" asphalt planks
2" sand

Total thickness of liner = 10"

207-C

Cat blown asphalt seal coat
Asphalt tack coat
1½" asphalt concrete
Asphalt tack coat
1½" asphalt concrete
Asphalt prime coat
4" Base course

Total thickness of liner = 7"

207-B Center

Since repairs and relining were performed generally the same as 207-B North, Assume 207-B Center has the same cross-section as 207-B North.

207-A

4" asphalt (8/11/86)

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JOB NO. ______ JOB TITLE ______ DATE 7/25/86 BY KN

SUBJECT ______ CHECKED DCC SHEET 3 OF 5

207-B North & Center

Surface area of liner:

$$= 220 \times 150 + 2\left[\tfrac{1}{2}(220+253)\left(\sqrt{7.5^2+\left[\tfrac{1}{2}(180-150)\right]^2}\right)\right]$$

$$+ 2\left[\tfrac{1}{2}(180+150)\left(\sqrt{7.5^2+\left[\tfrac{1}{2}(253-220)\right]^2}\right)\right]$$

$$= 33{,}000 + 7{,}900 + 6{,}000$$

$$= \underline{46{,}900} \text{ sq. ft.}$$

Volume of

Asphalt: $\left(\frac{3''}{12}\right)(46{,}900 \text{ sq. ft.}) = 11{,}725 \text{ ft}^3 = 434$ cu. yd

OK Asphalt planking: $\left(\frac{1/2''}{12}\right)(46{,}900 \text{ sq. ft.}) = 1954 \text{ ft}^3 = 72$ cu. yd

Base course: $\left(\frac{8''}{12}\right)(46{,}900 \text{ ft}^2) = 31{,}267 \text{ ft}^3 = 1158$ cu. yd.

Sand: $\left(\frac{2''}{12}\right)(46{,}900 \text{ ft}^2) = 7817 \text{ ft}^3 = 290 \text{ yd}^3$

Total $= 1954 \text{ yd}^3$

For the part of the liner that extends past the top of the slope by 18"

Surface area $= 2\left[\tfrac{1}{2}(253+220)(1.5)\right] + 2\left[\tfrac{1}{2}(180+150)(1.5)\right]$

$$= 709.5 + 495$$

$$= 1{,}200 \text{ sq. ft.}$$

Volume of:

Asphalt: $\left(\frac{3''}{12}\right)(1200 \text{ ft}^2) = 300$ sq. ft. = 11 yd

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JOB NO. ________ JOB TITLE ________ DATE 7/25/86 BY KAJ
SUBJECT ________ CHECKED DCL SHEET 4 OF 5

207-B South

Surface Area of liner

$$= (220)(150) + 2\left[\tfrac{1}{2}(180+150)\left(\sqrt{7.0^2+\left[\tfrac{1}{2}(253-220)\right]^2}\right)\right]$$

$$+ 2\left[\tfrac{1}{2}(253+220)\left(\sqrt{7.0^2+\left[\tfrac{1}{2}(180-150)\right]^2}\right)\right]$$

$$= 33{,}000 + 5900 + 7{,}800$$

$$= 46{,}700 \text{ sq. ft.}$$

Volume of

Asphalt: $(\frac{3''}{12})(46{,}700 \text{ sq. ft.}) = 11{,}675 \text{ ft}^3 = 432 \text{ yd}^3$

Asphalt planks: $(\frac{1''}{12})(46{,}700 \text{ sq ft.}) = 3{,}892 \text{ ft}^3 = 144 \text{ yd}^3$

Base course: $(\frac{4''}{12})(46{,}700 \text{ sq. ft.}) = 15{,}567 \text{ ft}^3 = 577 \text{ y}$

Sand: $(\frac{2''}{12})(46{,}700 \text{ ft}^2) = 7{,}783 \text{ ft}^3 = 288 \text{ yd}^3$

Total = 1441 yd^3

For the part of the liner that extends past the top of th
slope by 3' on east, south and west sides and 1' on north sic

Surface area $= 1\left[\tfrac{1}{2}(253+220)(3)\right] + 2\left[\tfrac{1}{2}(180+150)\right.$

$$+ 1\left[\tfrac{1}{2}(253+220)(1)\right] = 709.5 + 990 + 236.$$

$$= 1{,}900 \text{ ft}^2$$

Volume of

Asphalt: $(\frac{3''}{12})(1900 \text{ ft}^2) = 475 \text{ ft}^3 = 17\tfrac{1}{2} \text{ yd}^3$

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JOB NO. ____ JOB TITLE ____ DATE 7/25/86 BY KAJ
SUBJECT ____ CHECKED DCC SHEET 5 OF 5

207-C

Surface Area of Liner

$= (220)(120) + 2\left[\tfrac{1}{2}(250+220)\left(\sqrt{8.0^2+\left[\tfrac{1}{2}(160-120)\right]^2}\right)\right.$

$+ 2\left[\tfrac{1}{2}(160+120)\left(\sqrt{8.0^2+\left[\tfrac{1}{2}(250-220)\right]^2}\right)\right.$

$= 26{,}400 + 10{,}100 + 4{,}800$

$= 41{,}300\ ft^2$

Volume of

Asphalt $= \left(\frac{3''}{12}\right)(41{,}300\ ft^2) = 10{,}400\ ft^3 = 385\ yd^3$

Base course: $\left(\frac{4''}{12}\right)(41{,}300\ ft^2) = 13{,}800\ ft^3 = 500\ yd^3$

Total $= 900\ yd^3$

207-A

Surface area of Liner

$= (220)(495) + 2\left[\tfrac{1}{2}(220+250)\left(\sqrt{10.5^2+\left[\tfrac{1}{2}(525-495)\right]^2}\right)\right]$

$+ 2\left[\tfrac{1}{2}(525+495)\left[\sqrt{10.5^2+\left[\tfrac{1}{2}(250-220)\right]^2}\right]\right.$

$= 108{,}900 + 8605 + 18{,}676$

$= 136{,}180\ ft^2$

Vol. of

Asphalt $= \left(\frac{4''}{12}\right)(136{,}180\ ft^2) = 45{,}400\ ft^3 = 1{,}700\ yd^3$

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JOB NO. 6-002-87 JOB TITLE ROCKY FLATS DATE 1/27/87 BY KAJ

SUBJECT SOLAR PONDS: EXCAVATION & REMOVAL OF LINERS CHECKED BJF 1/29/87 SHEET 1 OF 7

Liners of ponds will be excavated in bulk, packaged in 15 cf boxes for disposal @ an approved out-of-state disposal facility.

Tasks:

- Excavate
- Process for packaging
- Package

Excavation
- Use large hoe for side slopes
- Use front end loader for bottom of excavation, stockpiling and crusher feed
- Assume 25% bulking by excavation
- Assume 2" of overexcavation below liner
- Liners includes all gravel sections

Processing
- Crush material to -3/4" to facilitate packing and improve volume reduction in packing, use 250 tons/hr (top end).
- Crushed material would be stockpiled in a secure area for packaging
- Front end loader feed and conveyor belt output to stockpile.

Packing
- Working in a secure area, package crushed material from stockpile
- Place in boxes with Bobcat loader & hand fillings get a little compaction with hand tamper
- 58 boxes per truck. Assume 1 truck per shift.
- Assume no reduction in bulk volume.

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JOB NO. ______ JOB TITLE ______ DATE 1/27/87 BY KAJ
PROJECT ______ CHECKED BJF 1-29-87 SHEET 2 OF 7

POND 207-B NORTH & CENTER

Total liner volume = 1965 cy = 53,055 ft³

Overexcavate 2" = 290 cy = 7,817 ft³

2255 cy   60,872

Bulked volume (+25%) ≅ 2819 cy = 76,090 ft³

Remove ~2 cy/min or ~23½ hrs. total time for ea.

Use 70% efficiency or 33 hrs. for removal

say 4 shifts @ 8 hrs/shift.

Processing 250 tons/hr or ~170 cy/hr

Total time to process = $\frac{2819 \text{ cy}}{170 \text{ cy/hr}}$ ≅ 16½ hrs.

Use 80% efficiency or 21 hrs

say 3 shifts @ 8 hrs/shift

Packing

Volume = 76,090 ft³

Pack 58 boxes/truck * $\frac{15 \text{ ft}^3}{\text{box}}$ * 1 truck/shift

= 870 ft³/shift

$\frac{76,090 \text{ ft}^3}{870 \text{ ft}^3/\text{shift}}$ = 88 shifts

or @ 2 $\frac{\text{shifts}}{\text{day}}$ = 44 days

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JOB NO. ______ JOB TITLE ______ DATE 1/27/87 BY KAJ
PROJECT ______ CHECKED AJF 1-29-87 SHEET 3 OF 7

Total Time (w/ 2 shifts/day)

Excavation	2 days
Processing (concurrent w/ excavation)	(1½ days)
Packing	44 days
Total days	46 days
Total weeks (5 days/wk)	9 weeks. (each)

* See pg 7 for Note.

POND 207-B SOUTH

Total liner volume = 1459 cy = 39,393 ft³
Overexcavate 2" = 288 cy = 7,776 ft³
1747 cy = 47,169 ft³
Bulked volume (+25%) = 2184 cy = 58,961 ft³
Removal @ 2 cy/min

$$\frac{2184 \text{ cy}}{2 \text{ cy/min}} = 18 \text{ hrs.}$$

Use 70% efficiency or 26 hrs.

say 3½ shifts @ 8 hrs/shift

Processing 250 tons/hr or ~170 cy/hr

Total time to process = $\frac{2184 \text{ cy}}{170 \text{ cy/hr}}$ = 12.8 hrs ≅ 13 hrs

Use 80% efficiency = 16 hrs.

Say 2 shifts @ 8 hrs/shift.

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JOB NO. ______ JOB TITLE ______ DATE 1/27/87 BY KAN

PROJECT ______ CHECKED GJF 1-29-87 SHEET 4 OF 7

Packing

Volume = 58,961 ft^3

Pack $58 \frac{boxes}{truck} * \frac{15\ ft^3}{box} * 1 \frac{truck}{shift}$

$= 870\ ft^3/shift$

$\frac{58{,}961\ ft^3}{870\ ft^3/shift} = 68$ shifts

or @ $\frac{2\ shifts}{day} = 34$ days

Total time (w/ 2 shifts/day)

Excavation	2 days
Processing (concurrent w/ excavation)	(1 day)
Packing	34 days
Total days	36 day
Total weeks (5 days/wk)	7 weeks

* See pg 7 for note

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JOB NO. ______ JOB TITLE ______ DATE 1/27/87 BY KAJ

PROJECT ______ CHECKED WF 1-29-87 SHEET 5 OF 7

POND 207-C

Total liner volume = 900 cy = 24,300 ft^3

Overexcavate 2" = 255 cy = 6,885 ft^3

1155 cy = 31,183 ft^3

Bulked volume (+25%) = 1444 cy = 38,979 ft^3

Removal @ 2cy / min

$$\frac{1446 \text{ cy}}{2 \text{ cy/min}} = 12 \text{ hrs}$$

Use 70% efficiency or ~ 17 hrs

say 2 shifts @ 8 hrs/shift

Processing 170 cy/hr

Total time to process = $\frac{1444 \text{ cy}}{170 \text{ cy/hr}}$ = 8.5 hrs.

Use 80% efficiency ≅ 10 ½ hrs or ~ 1 ½ shifts @ 8 hrs/shift

Packing

Volume = 38,979 ft^3

Pack 870 ft^3/shift

$$\frac{38,979 \text{ ft}^3}{870 \text{ ft}^3/\text{shift}} \cong 45 \text{ shifts}$$

or @ $\frac{2 \text{ shifts}}{\text{day}}$ = 22 ½ days

Total time (w/ 2 shifts/day)

Excavation	1 day
Processing (concurrent w/ excavation)	(~1 day)
Packing	22½ days
Total days	23½ days
Total weeks (5 days/wk)	~5 weeks

* See pg 7 for note

POND 207-A

Total liner volume = 1700 cy
Overexcavate 2" = 850 cy
2,550 cy

Bulked volume (+25%) = 3188 cy = 86,063 ft^3

Removal @ 2 cy/min

$\frac{3188 \text{ cy}}{2 \text{ cy/min}}$ = 26½ hrs

Use 70% efficiency = 38 hrs

say 5 shifts @ 8 hrs/shift

Processing 170 cy/hr

Total time to process = $\frac{3188 \text{ cy}}{170 \text{ cy/hr}} \cong$ 19 hr

Use 80% efficiency = 23½ hr

say 3 shifts @ 8 hrs/shift

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JOB NO. ______ JOB TITLE ______ DATE 1/27/87 BY KAJ
SUBJECT ______ CHECKED BJF 1-29-87 SHEET 7 OF 7

Packing

Volume = 86,063 ft³

Pack 870 ft³/shift

$$\frac{86,063 \text{ ft}^3}{870 \text{ ft}^3/\text{shift}} = 99 \text{ shifts}$$

$$\text{or @ } 2 \frac{\text{shifts}}{\text{day}} = 49\tfrac{1}{2} \text{ days}$$

Total time (w/ 2 shifts / day)

Excavation	2 ½ days
Processing (concurrent w/ excavation)	(1 ½ days)
Packing	49 ½ days
Total days	52 days
Total weeks (5 days/wk)	~ 11 weeks

Note: Cost and schedule estimators @ Rocky Flats reviewed these estimates and increased total times by 57%.

Basis:

- Working in the PSZ decreases productivity by 20%
- Experience @ the plant on projects to remove sediment from the drained retention ponds.

Pond	Total time (wks)	Total time (mos)
A	17	4.25
B North	14	3.5
B Center	14	3.5
B South	11	2.75
C	8	2

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JOB NO. 6-017-86 JOB TITLE ROCKY FLATS DATE 8/15/86 BY KAJ
SUBJECT VOLUME OF 207-C EMBANKMENT CHECKED BJF 1-29-87 SHEET 1 OF 3

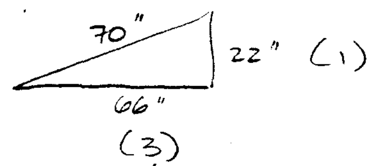
Based on Rockwell, 1976

Height of embankment ~2' & 5½'

Perimeter of 207C = 2(250) + 2(160) = 820 ft.

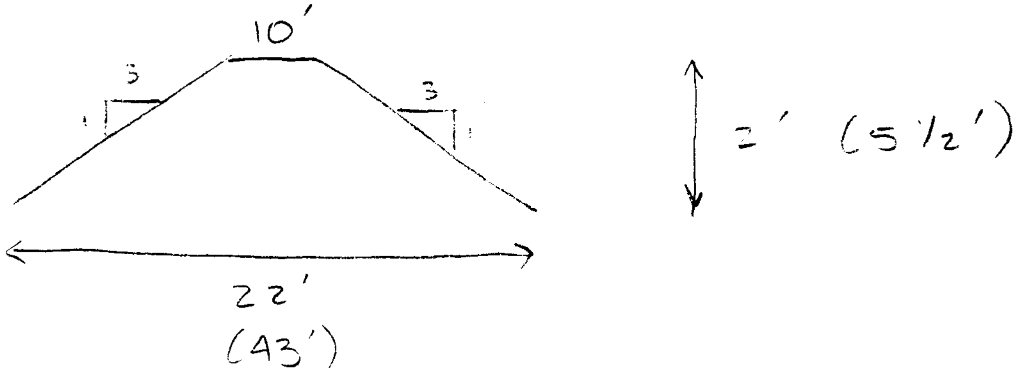
Assume half of embankment is 5½' high and half of the embankment is 2' high.

Interior sideslopes are (Ficklin, 1986)



Assume exterior & interior sideslopes are all 3:1

– Top of crest = 10' (Rockwell, 1977a)



X-sectional area

For 2' depth: $2[\frac{1}{2}(2)(6)] + (10)(2) = 32\ ft^2$

For 5' depth $= [\frac{1}{2}(5\frac{1}{2})(16\frac{1}{2})] + (10)(5\frac{1}{2}) = 146 ft^2$

Volume $= (410 ft)(32 ft^2) + (410 ft)(146 ft^2)$

$= 13,120 + 59860$

$= 72,980\ ft^3 \cong 2,700\ yd^3$

Time to remove and package embankment of Pond 207-C

Embankment will be excavated, packaged in 15 cf boxes and sent to an approved out-of-state disposal facility.

Excavation

- Use backhoe and/or front end loader
- Assume 25% bulking by excavation

Packing

- Place in boxes w/ Bobcat loader and hand filling, achieve a little compaction w/ a hand tamper.
- 58 boxes/truck, assume 1 truck per shift.

POND 207-C EMBANKMENT:

Bulked volume = (2700 cy)(1.25) = 3375 cy = 91,125 ft^3

Removal ~ 2 cy/min

$$\frac{3375 \text{ cy}}{2 \text{ cy/min}} \cong 28 \text{ hrs.}$$

Use 70% efficiency or 40 hrs

say 5 shifts @ 8 hrs/shift

Packing

Volume = 91,125 ft^3

Pack $58 \frac{\text{boxes}}{\text{truck}} * 15 \frac{\text{cf}}{\text{box}} * 1 \frac{\text{truck}}{\text{shift}} = 870 \frac{\text{ft}^3}{\text{shift}}$

$$\frac{91{,}125 \text{ ft}^3}{870 \text{ ft}^3/\text{shift}} \cong 105 \text{ shifts or } 52\tfrac{1}{2} \text{ days}$$

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JOB NO. ______ JOB TITLE ______ DATE 8/15/86 BY KN
SUBJECT ______ CHECKED BJF 1-29-87 SHEET 3 OF 3

Total time

Excavate	2 1/2 days
Packing	52 1/2 days
Total days	55. days
Total weeks (5 days/wk)	11 weeks

Note: Cost and schedule estimaters @ Rocky Flats reviewed the estimates and increased total times by 57%
Basis:
- Working in the PSZ decreases productivity by 20%
- Experience @ the plant on projects to remove sediment from the drained retention ponds.

Total time: 17 wks = 4.25 mos

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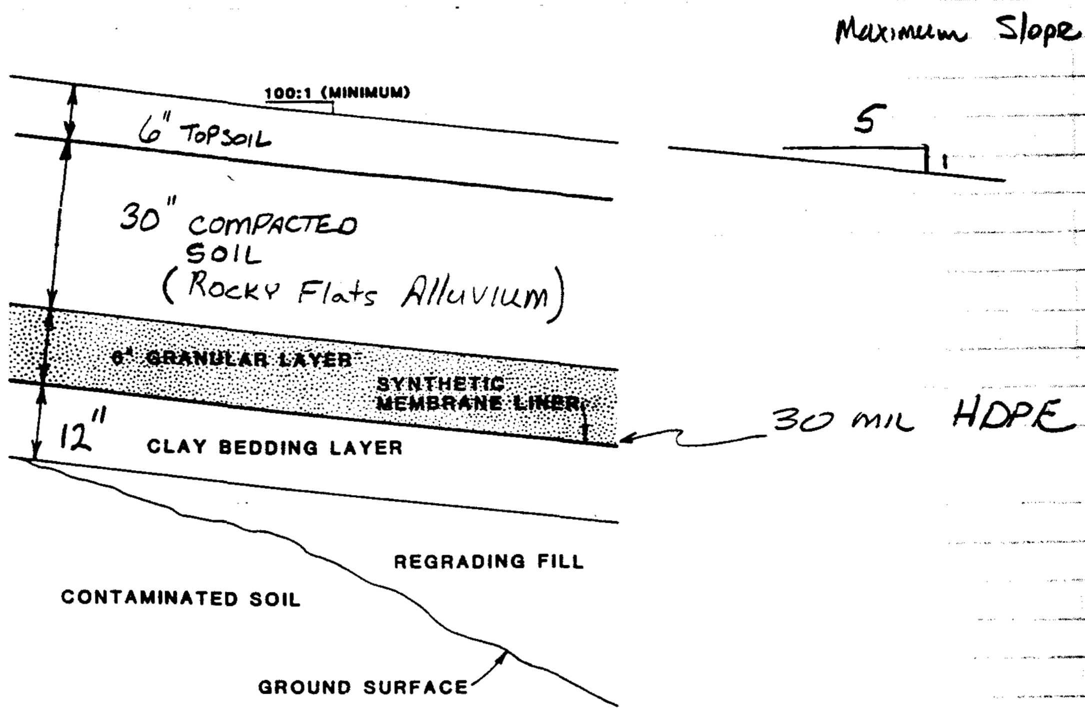
JOB NO. 6-033-88 JOB TITLE RF Solar Ponds DATE 5/12/88 BY GTJ
SUBJECT Stability of Cap CHECKED JAS SHEET 1 OF 9



Reference: "University of California, Department of Civil Engineering Manual for Slope Stability", by J.M. Duncan and A.L. Buchignani, March 1975

Assumptions:
- Flow is parallel to slope
- Depth of flow is 6" (depth of drainage layer)
- Filter and natural soil are assumed low permeability with no flow
- Flow in granular layer is not confined
- ϕ' sand = 30°
  ϕ' clay bedding = 25°
  c' clay bedding = 200 psf
  γ_{total} (soil) = 125 pcf

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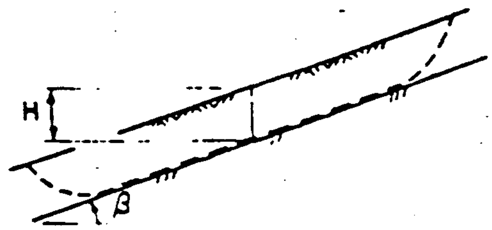
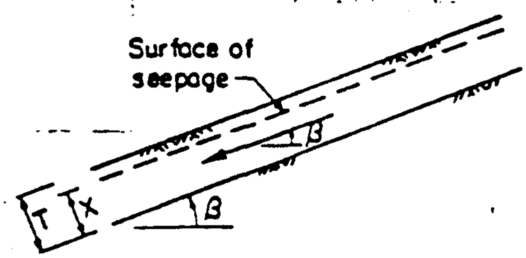
JOB NO. 6-033-88 JOB TITLE RF SOLAR PONDS DATE 5/13/88 BY GTJ

PROJECT CHECKED JAS SHEET 2 OF 9





γ = total unit weight of soil

γ_w = unit weight of water

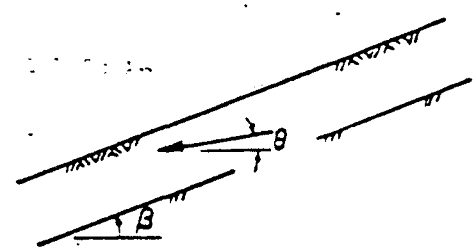
c' = cohesion intercept } Effective
ϕ' = friction angle } Stress

r_u = pore pressure ratio = $\frac{u}{\gamma H}$

u = pore pressure at depth H

Seepage parallel to slope

$$r_u = \frac{X}{T}\frac{\gamma_w}{\gamma}\cos^2\beta$$

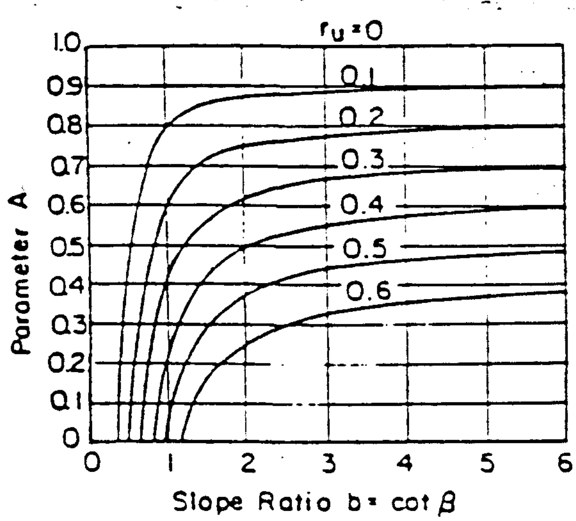


Seepage emerging from slope

$$r_u = \frac{\gamma_w}{\gamma}\,\frac{1}{1+\tan\beta\tan\theta}$$

Steps:

1. Determine r_u from measured pore pressures or formulas at right
2. Determine A and B from charts below
3. Calculate $F = A\frac{\tan\phi'}{\tan\beta} + B\frac{c'}{\gamma H}$



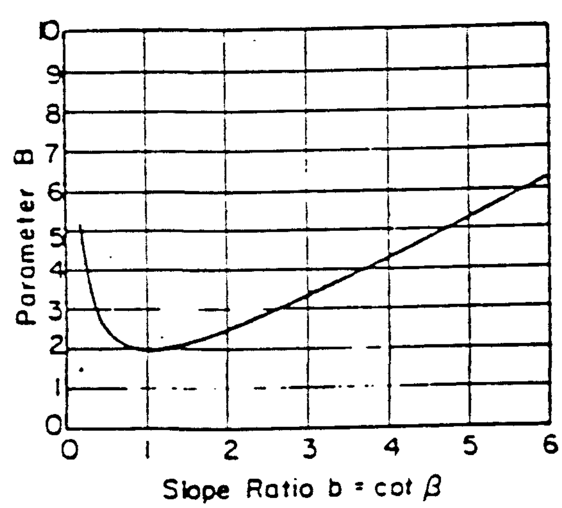


Fig. 10 STABILITY CHARTS FOR INFINITE SLOPES.

(REF: J.M. DUNCAN, et. al.)

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JOB NO. 6-033-88 JOB TITLE SF SOLAR PONDS DATE 5/13/88 BY GTJ

[PROJ]ECT ______ CHECKED JAS SHEET 3 OF 9

Step 3, FIG. 10: SAND ON MEMBRANE

F = FACTOR OF SAFETY = $A \dfrac{\tan\phi'}{\tan\beta} + B \dfrac{c'}{\gamma H}$

Assume SEEPAGE PARALLEL TO SLOPE:

$r_u = \dfrac{X}{T} \dfrac{\gamma_w}{\gamma} \cos^2\beta$

$r_u = \left(\dfrac{6''}{42''}\right)\left(\dfrac{62.4 \text{ pcf}}{125 \text{ pcf}}\right) \cos^2(\tan^{-1} 1/5) = 0.069$

$r_u \approx 0.1 \qquad \cot\beta = \dfrac{1}{\tan\beta} = \dfrac{1}{(1/5)} = 5$

PARAMETER $A = 0.9$

$\tan\phi' = \tan\delta$ (FRICTION BETWEEN sand/HDPE)

$\tan\phi' = \tan\delta = E_\phi \tan\phi$ where

* $E_\phi = 0.60$ for sand

$\phi = 30°$ "SP", TABLE 3.31, R.E. HUNT (ASSUME UNCOMPACTED FOR DRAINAGE)

c' = COHESION (ASSUMED ZERO FOR SAND)

$\therefore \; F = A \dfrac{\tan\phi'}{\tan\beta} + 0$

(LAMBE + WHITMAN) $F = \dfrac{\tan\lambda}{\tan\beta} = \dfrac{\frac{\gamma_B}{\gamma_T} \cdot \tan\phi'}{\tan\beta} = \dfrac{\frac{62.6.3}{420} * .6(\tan 30°)}{(1/5)}$

$F = 0.9 \dfrac{(0.60)(\tan 30°)}{(1/5)} \doteq 1.56 \rightarrow 1.6$

---

* REFERENCE IN-house laboratory testing and from

"Experimental Friction Evaluation of Slippage Between Geomembranes, Geotextiles and Soils", J.B. Martin, R.M. Koerner, and J.E. Whitty, INTERNATIONAL CONFERENCE ON GEOMEMBRANES, Denver, U.S.A. P 191-196.

GEOTECHNICAL ENGINEERING INVESTIGATION MANUAL

ROY E. HUNT
Consulting Engineer

McGraw-Hill Book Company
New York St. Louis San Francisco Auckland Bogotá Hamburg Johannesburg London Madrid Mexico Montreal New Delhi Panama Paris São Paulo Singapore Sydney Tokyo Toronto

TABLE 3.31
TYPICAL PROPERTIES OF COMPACTED SOILS*

Group symbol	Soil type	Range of maximum dry unit weight, pcf	Range of optimum moisture, %	Typical value of compression: Percent of original height — At 1.4 tsf (20 psi)	At 3.6 tsf (50 psi)	Typical strength characteristics: Cohesion (as compacted), psf	Cohesion (saturated), psf	Effective stress envelope ϕ, degrees	tan ϕ	Typical coefficient of permeability, ft/min	Range of CBR values	Range of subgrade modulus k_s, lb/in³
GW	Well-graded clean gravels, gravel-sand mixtures	125–135	11–8	0.3	0.6	0	0	>38	>0.79	5×10^{-2}	40–80	300–500
GP	Poorly graded clean gravels, gravel-sand mix	115–125	14–11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30–60	250–400
GM	Silty gravels, poorly graded gravel-sand silt	120–135	12–8	0.5	1.1	. . .	. . .	>34	>0.67	$>10^{-6}$	20–60	100–400
GC	Clayey gravels, poorly graded gravel-sand-clay	115–130	14–9	0.7	1.6	. . .	. . .	>31	>0.60	$>10^{-7}$	20–40	100–300
SW	Well-graded clean sands, gravelly sands	110–130	16–9	0.6	1.2	0	0	38	0.79	$>10^{-3}$	20–40	200–300
SP	Poorly-graded clean sands, sand-gravel mix	100–120	21–12	0.8	1.4	0	0	37	0.74	$>10^{-3}$	10–40	200–300
SM	Silty sands, poorly graded sand-silt mix	110–125	16–11	0.8	1.6	1050	420	34	0.67	5×10^{-5}	10–40	100–300
SM-SC	Sand-silt clay mix with slightly plastic fines	110–130	15–11	0.8	1.4	1050	300	33	0.66	2×10^{-6}	. . .	
SC	Clayey sands, poorly graded sand-clay mix	105–125	19–11	1.1	2.2	1550	230	31	0.60	5×10^{-7}	5–20	100–300
ML	Inorganic silts and clayey silts	95–120	24–12	0.9	1.7	1400	190	32	0.62	10^{-5}	15 or less	100–200
ML-CL	Mixture of inorganic silt and clay	100–120	22–12	1.0	2.2	1350	460	32	0.62	5×10^{-7}	. . .	
CL	Inorganic clays of low to medium plasticity	95–120	24–12	1.3	2.5	1800	270	28	0.54	10^{-7}	15 or less	50–200
OL	Organic silts and silt-clays, low plasticity	80–100	33–21	. . .	. . .	. . .	. . .	. . .	. . .	. . .	5 or less	50–100
MH	Inorganic clayey silts, elastic silts	70–95	40–24	2.0	3.8	1500	420	25	0.47	5×10^{-7}	10 or less	50–100
CH	Inorganic clays of high plasticity	75–105	36–19	2.6	3.9	2150	230	19	0.35	10^{-7}	15 or less	50–150
OH	Organic clays and silty clays	65–100	45–21	. . .	. . .	. . .	. . .	. . .	. . .	. . .	5 or less	25–100

6" GRANULAR LAYER → (SP)

6" CLAY BEDDING LAYER → (CL)

*From NAVFAC Manual DM 7 (1971).[8] All properties are for condition of "standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density. Typical strength characteristics are for effective strength envelopes and are obtained from USBR data. Compression values are for vertical loading with complete lateral confinement. (. . .) Indicates insufficient data available for an estimate.

HDPE ON CLAY

$r_u = 0$ $A = 1$ $B = 5.3$

$\phi' = 25°$ TABLE 3.31, R.F. HUNT (ASSUME COMPACTED TO 95% STANDARD PROCTOR DENSITY; SEE NOTE AT BOTTOM OF TABLE 3.31)

$c' = 200$ psf TABLE 3.31 95% STANDARD PROCTOR (SATURATED CONDITIONS AT CONTACT POSSIBLE FROM CONDENSATION)

FRICTION EFFICIENCY = $E_\phi = 0.60$

ADHESION (HDPE TO CLAY) EFFICIENCY = 1.0
REF NAVFAC DM-7.2; TABLE 1
(COHESION 200 psf → adhesion = 200 psf)

$$F = A \frac{\tan \phi'}{\tan \beta} + B \frac{c'}{\gamma H}$$

$$F = (1) \frac{0.60 \tan(25°)}{(1/5)} + \frac{5.3\ (200\ \text{psf})}{(125\ \text{pcf})(3.5')}$$

$$F = 1.399 + 2.42 = 3.82$$

PAGE 7 of 4

NAVFAC DM-7.2
MAY 1982

APPROVED FOR PUBLIC RELEASE

FOUNDATIONS AND EARTH STRUCTURES

DESIGN MANUAL 7.2

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
200 STOVALL STREET
ALEXANDRIA, VA. 22332

TABLE 1
Ultimate Friction Factors and Adhesion for Dissimilar Materials

Interface Materials	Friction factor, tan δ	Friction angle, δ degrees
Mass concrete on the following foundation materials:		
Clean sound rock..................................	0.70	35
Clean gravel, gravel-sand mixtures, coarse sand...	0.55 to 0.60	29 to 31
Clean fine to medium sand, silty medium to coarse sand, silty or clayey gravel....................	0.45 to 0.55	24 to 29
Clean fine sand, silty or clayey fine to medium sand..	0.35 to 0.45	19 to 24
Fine sandy silt, nonplastic silt..................	0.30 to 0.35	17 to 19
Very stiff and hard residual or preconsolidated clay..	0.40 to 0.50	22 to 26
Medium stiff and stiff clay and silty clay........	0.30 to 0.35	17 to 19
(Masonry on foundation materials has same friction factors.)		
Steel sheet piles against the following soils:		
Clean gravel, gravel-sand mixtures, well-graded rock fill with spalls..........................	0.40	22
Clean sand, silty sand-gravel mixture, single size hard rock fill................................	0.30	17
Silty sand, gravel or sand mixed with silt or clay	0.25	14
Fine sandy silt, nonplastic silt..................	0.20	11
Formed concrete or concrete sheet piling against the following soils:		
Clean gravel, gravel-sand mixture, well-graded rock fill with spalls..........................	0.40 to 0.50	22 to 26
Clean sand, silty sand-gravel mixture, single size hard rock fill................................	0.30 to 0.40	17 to 22
Silty sand, gravel or sand mixed with silt or clay	0.30	17
Fine sandy silt, nonplastic silt..................	0.25	14
Various structural materials:		
Masonry on masonry, igneous and metamorphic rocks:		
Dressed soft rock on dressed soft rock..........	0.70	35
Dressed hard rock on dressed soft rock..........	0.65	33
Dressed hard rock on dressed hard rock..........	0.55	29
Masonry on wood (cross grain)......................	0.50	26
Steel on steel at sheet pile interlocks...........	0.30	17

Interface Materials (Cohesion)	Adhesion C_a (psf)
Very soft cohesive soil (0 - 250 psf)	0 - 250
Soft cohesive soil (250 - 500 psf)	250 - 500
Medium stiff cohesive soil (500 - 1000 psf)	500 - 750
Stiff cohesive soil (1000 - 2000 psf)	750 - 950
Very stiff cohesive soil (2000 - 4000 psf)	950 - 1,300

- DEEPER INFINITE FAILURE SURFACES WILL HAVE A HIGH F.S. DUE TO HIGHER COHESION (PARTIALLY SATURATED CONDITIONS)

- SHALLOWER FAILURE SURFACES (ABOVE SAND/HDPE) WILL HAVE HIGHER F.S. SINCE r_u DECREASES; FRICTION EFFICIENCY IS 1.0 (VS 0.60 AT HDPE INTERFACE)

∴ EVALUATED LINER IS STABLE FOR SLOPE UP TO 5 HORIZONTAL TO 1 VERTICAL (20%).

REF: METHODOLOGIES FOR EVALUATING LONG TERM STABILIZATION DESIGNS OF URANIUM MILL TAILINGS IMPOUNDMENTS

NUREG/CR-4620
ORNL/TM-10067

SECTION 4.8 "COVER EROSION RESISTANCE PROTECTION"

Apply Rational Method to evaluate peak discharge using sheetflow

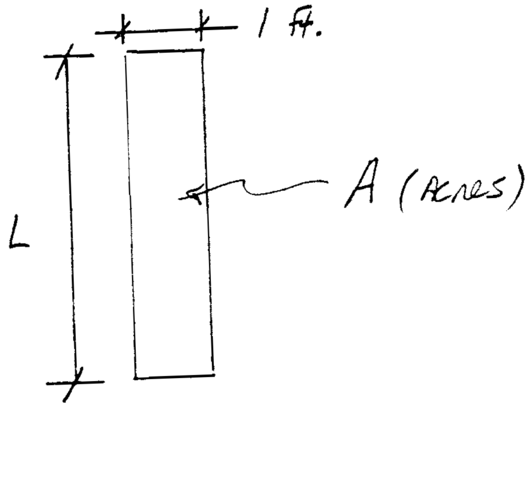
1) $Q = FCiA$ (cfs)

C = runoff factor ≈ 0.4 for natural ground (see TABLE 4.5 of reference)

i = rainfall intensity (inches / hour) for duration equal to time of concentration

A = area in acres
F = CONCENTRATION FACTOR - GULLEY EROSION IN SHEETFLOW (SECTION 4.9; reference)

ASSUME UNIT WIDTH APPROACH:



$A = (L)(1') \; 1/43560 \; ft^2/acre$

$q_{(unit\ flow)} = \frac{CiL}{43560}$

$q = 0.000022957 \; CiL$

100 year 60 minute Storm event = 2.55 inches (NOAA ATLAS)

DURATION	RATIO to 1-hr	Rainfall (IN.)	i (IN/hr)
60 MIN.	1.0	2.550	2.55
30 MIN.	0.79	2.015	4.03
15 MIN.	0.57	1.454	5.81
10 MIN.	0.45	1.148	6.89
5 MIN.	0.29	0.740	8.87

Rainfall intensity ⇒ duration = time of concentration

$$t_c = 0.00013 \frac{L^{0.77}}{S^{0.385}} \quad (\text{hrs})$$

L = 850' = length of basin (longest flow path); ft.

S = average slope of basin

$$S = \frac{\text{Max. cover elevation} - \text{lowest elevation}}{\text{Length of Slope}}$$

$$S = \frac{5981' - 5928'}{850'} = 0.0624$$

$$t_c = 0.00013 \frac{(850)^{0.77}}{(0.0624)^{0.385}} = 0.068 \text{ hr} = 4.09 \text{ MIN.}$$

∴ USE 5 MIN. STORM DURATION

i = 8.87 IN/hR

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JOB NO. ______ JOB TITLE ______ DATE ______ BY ______
PROJECT ______ CHECKED ______ SHEET 3 OF 25

Calculate flow velocity assuming sheet flow, combining the Rational formula and Manning's Equation:

RATIONAL FORMULA

1) $q = 0.000022957 \; FCiL$

Manning's Equation

For sheet flow

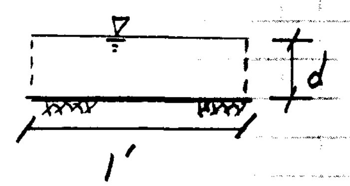
$y = \left[\frac{Q n}{1.486 \, S^{\frac{1}{2}}}\right]^{3/5}$

$\therefore y = 0.077 \text{ ft} = 9''$

$V = Q/A = 0.208/0.077 = 2.7 \text{ fps}$

$v = \frac{1.486}{n} R^{2/3} S^{1/2}$

SHEET FLOW



n = Manning's Roughness Coefficient

use $n = 0.025$
(TABLE 4.3; reference)

R = hydraulic radius $= \frac{A}{P} = \frac{\text{CROSS SECTION AREA}}{\text{wetted perimeter}}$

$R = \frac{A}{P} = \frac{(1') \, d}{1'} = d$

← only bottom is "wetted"

S = average slope

2) $v = \frac{1.486}{n} d^{2/3} S^{1/2}$

To solve for velocity, must calculate depth of flow, "d". From Eq 2)

3) $q = v d$

COMBINE Eq 1 & 3:

$$0.000022957\,FCiL = \left(\frac{1.486}{n}\, d^{2/3}\, S^{1/2}\right) d$$

$$d = \left((0.000022957\,FCiL) \cdot \frac{n}{1.486\, S^{1/2}}\right)^{3/5}$$

$\therefore$ (Eq 2) $$v = \frac{1.486}{n}\left(\left(\left(0.000022957\,FCiL\,\frac{n}{1.486\,S^{1/2}}\right)^{3/5}\right)^{2/3} S^{1/2}\right)$$

$$v = \frac{0.017684}{n}\left(\frac{FCiLn}{S^{1/2}}\right)^{0.4} S^{1/2}$$

$$v = \frac{0.017684}{n^{0.6}}\; S^{0.3}\; (FCiL)^{0.4}$$

CALCULATE MAXIMUM VELOCITY
AT THE DOWNSLOPE TOE OF
THE COVER

$n = 0.025$ (TABLE 4.3; REFERENCE)

$S = 0.0624$ (average slope)

$C = 0.40$ (TABLE 4.5; reference)

$i = 8.87$ in/hour

$L = 850$ feet (max. flow length)

$F = 3$ CONCENTRATION FACTOR (SECTION 4.9; reference)

$v = 2.7$ ft/sec → MAXIMUM EROSION VELOCITY ON COVER AS A RESULT OF STORM EVENT

(see pg. 3)

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Consulting Geotechnical Engineers

NO. ____ JOB TITLE ____ DATE ____ BY ____
CT ____ CHECKED ____ SHEET 5 OF 25

MAXIMUM PERMISSIBLE VELOCITIES:

TABLE 4.7*	FIRM LOAM	3.50 ft/sec
TABLE 4.8*	FIRM LOAM, CLAY LOAM	3.00 – 3.75 ft/sec
TABLE 4.9*	SANDY CLAY (FAIRLY COMPACT)	2.95 ft/sec
TABLE 4.10*	Buffalograss (easily-eroded soils @ over 10% SLOPE)	3 ft/sec
DM-7 TABLE 4	6" TO 10" VEGETATION CLAY LOAM	3.0 - 4.0 ft/sec

*TABLES IN reference document shown ON SHEET 1 of 5 OF THESE CALCULATIONS

∴ SINCE THE MAXIMUM VELOCITY ON THE CAP IS LESS THAN THE PERMISSIBLE VELOCITIES, THE PROPOSED VEGETATION COVER IS ACCEPTABLE AND WILL NOT REQUIRE RIPRAPPING.

NUREG/CR-4620
ORNL/TM-10067

Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments

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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
NRC FIN B0279

where d_{50} is the mean rock size in feet. A graphical representation for determining n is presented in Figures 4.12 and 4.13. However, these values were developed for uniform flow condition over submerged riprap. When overtopping flows on steep slopes begin to cascade, n values will increase and may range from 0.07 to 0.09 or higher. (Abt and Ruff, 1985 and COE, 1970).

Table 4.2. Manning Coefficient, n.

Channel Material	Manning Coefficient, n
Fine sand, colloidal	0.020
Sandy loam, non-colloidal	0.020
Silt loam, non-colloidal	0.020
Alluvial silts, non-colloidal	0.020
Ordinary firm loam	0.020
Volcanic ash	0.020
Stiff clay, very colloidal	0.025
Alluvial silts, colloidal	0.025
Shales and hardpans	0.025
Fine gravel	0.020
Graded loam to cobbles, non-colloidal	0.030
Graded silts to cobbles, colloidal	0.030
Coarse gravel, non-colloidal	0.025
Cobbles and shingles	0.035

Source: Morris and Wiggert, 1972.

4.8 COVER EROSION RESISTANCE EVALUATION

The cover design should be evaluated to determine if the unprotected slopes(s) can withstand overland or sheet flow with a minimum of erosion. Based upon the site-specific cover and precipitation parameters, the design sheet flow velocity should be estimated. A comparison of the design flow velocity with the cover permissible flow velocity can be performed. Furthermore, the design velocity can be used to determine the sediment discharge using the Universal Soil Loss Equation (Chapter 5) and for sizing stone protection (Section 4.2).

The design velocity will usually be determined from the peak discharge generated from the Probable Maximum Flood (PMF). The PMF can be estimated by

(a) Using computer models, i.e., HEC-1 (COE, 1974), that are widely accepted by the engineering profession.

Table 4.3. Manning Coefficient, n, for natural channels.

Natural Channel Conditions	Value of n
Smoothest natural earth channels, free from growth with straight alignment	0.017
Smooth natural earth channels, free from growth, little curvature	0.020
Average, well-constructed, moderate-sized earth channels in good condition	0.0225
Small earth channels in good condition, or large earth channels with some growth on banks or scattered cobbles in bed	0.025
Earth channels with considerable growth, natural streams with good alignment and fairly constant section, or large floodway channels well maintained	0.030
Earth channels considerably covered with small growth, or cleared but not continuously maintained floodways	0.035
Mountain streams in clean loose cobbles, rivers with variabel cross-section and some vegetation growing in banks, or earth channels with thick aquatic growths	0.050
Rivers with fairly straight alignment and cross-section, badly obstructed by small trees and underbrush or aquatic growth	0.075
Rivers with irregular alignment and cross-section, moderately obstructed by small trees and underbrush	0.100
Rivers with fairly regular alignment and cross-section, heavily obstructed by small trees and underbrush	0.100
Rivers with irregular alignment and cross-section, covered with growth of virgin timber and occasional dense patches of bushes and small trees, some logs and dead fallen trees	0.125
Rivers with very irregular alignment and cross-section, many roots, trees, large logs, and other drift on bottom, trees continually falling into channel due to bank caving	0.200

Source: DOI, 1975.

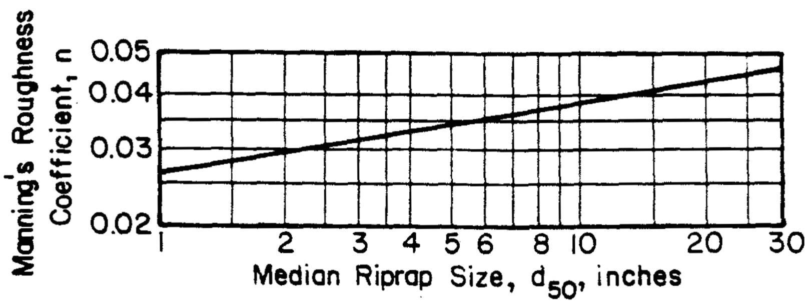

Fig. 4.12. Manning's coefficient for riprap. *Source:* SCS, 1975.

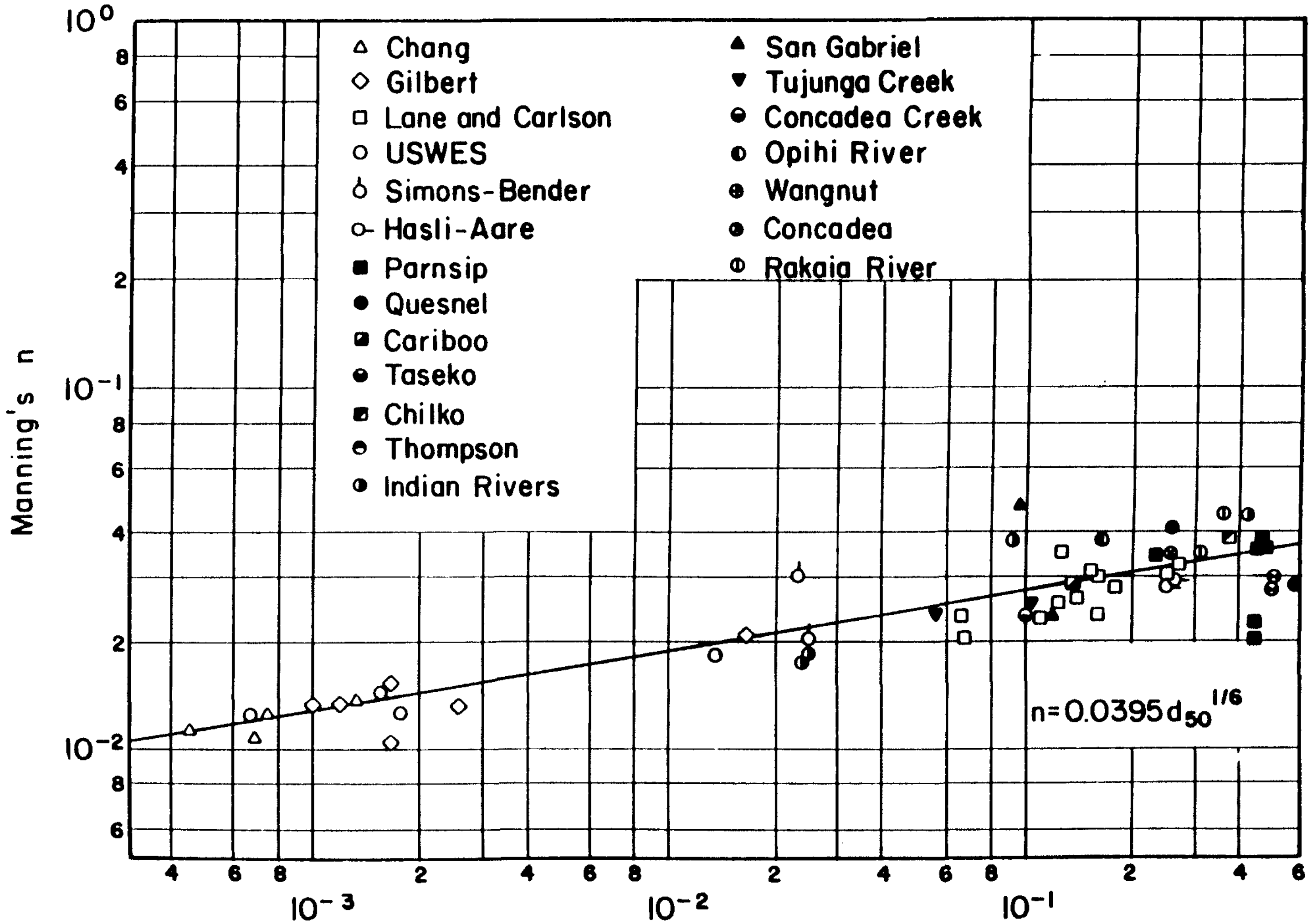

Fig. 4.13. Variation of Manning's *n* with size of stone comprising the bed.

(b) Applying the Rational Method for tributary areas that are less than approximately one square mile in area.

The Rational formula is commonly expressed as

$$Q = CiA \tag{4.42}$$

where Q is the maximum or design discharge in cfs, C is a runoff coefficient dependent upon the characterization of the drainage basin, i is the rainfall intensity expressed in inches per hour and A is the tributary area expressed in acres. When a unit width approach is taken, the area A_w is the slope(s) length times the unit width. Therefore, Equation 4.42 would be presented as

$$q = CiA_w \tag{4.43}$$

for a unit width analysis.

4.8.1 Runoff Coefficient

The runoff coefficient, C, is related to the climatic conditions and type of terrain characteristic of the watershed including soil materials, permeability and storage potential. Values of the coefficient C are presented in Table 4.4 (Lindsley et al., 1958), Table 4.5 (Chow, 1964), and Table 4.6 (ASCE, 1970 and Seelye, 1960).

Table 4.4. Values of Coefficient C.

Type Area	Value of C
Flat cultivated land, open sandy soil	0.20
Rolling cultivated land, clay-loam soil	0.50
Hill land, forested, clay loam soil	0.50
Steep, impervious slope	0.95

Source: Lindsley, et al, 1958.

The selection of a coefficient value requires considerable judgment as it is a tangible aspect of using the rational formula. It is recommended that a conservative value of C be applied for PMF estimation since infiltration and storage comprise a low percentage of the runoff. Furthermore, the C values presented were derived for storms of 5-100 year frequencies. Therefore, less frequent, higher intensity storms will require the use of a higher C value (Chow, 1964). It is recommended that a runoff coefficient of 1.0 be used for PMF applications in very small watersheds since the effects of localized storage and infiltration will be small.

Table 4.5. Values of C for Use in Rational Formula.

Soil Type	Watershed Cover		
	Cultivated	Pasture	Woodlands
With above-average infiltration rates; usually sandy or gravelly	0.20	0.15	0.10
With average infiltration rates; no clay pans; loams and similar soils	0.40	0.35	0.30
With below-average infiltration rates; heavy clay soils or soils with a clay pan near the surface; shallow soils above impervious rock	0.50	0.45	0.40

Source: Chow, 1964.

4.8.2 Rainfall Intensity

In order to determine the rainfall intensity, i, the time of concentration, t_c must be estimated. The time of concentration can be approximated by:

(a) Applying one of the many accepted empirical formulae such as

$$t_c = 0.00013 \frac{L^{0.77}}{S^{0.385}} \tag{4.44}$$

where L is the length of the basin in feet measured along the watercourse from the upper end of the watercourse to the drainage basin outlet and S is the average slope of the basin. Time of concentration is expressed in hours. This procedure is not applicable to rock covered slopes. This expression was

Table 4.6. Values of runoff coefficient C.

Character of Surface	Runoff Coefficients	
	Range	Recommended
Pavement--asphalt or concrete	0.70-0.95	0.90
Gravel, from clean and loose to clayey and compact	0.25-0.70	0.50
Roofs	0.70-0.95	0.90
Lawns (irrigated) sandy soil		
Flat, 2 percent	0.05-0.15	0.10
Average, 2 to 7 percent	0.15-0.20	0.17
Steep, 7 percent or more	0.20-0.30	0.25
Lawns (irrigated) heavy soil		
Flat, 2 percent	0.13-0.17	0.15
Average, 2 to 7 percent	0.18-0.22	0.20
Steep, 7 percent	0.25-0.35	0.30
Pasture and non-irrigated lawns		
Sand		
Bare	0.15-0.50	0.30
Light vegetation	0.10-0.40	0.25
Loam		
Bare	0.20-0.60	0.40
Light vegetation	0.10-0.45	0.30
Clay		
Bare	0.30-0.75	0.50
Light vegetation	0.20-0.60	0.40
Composite areas		
Urban		
Single-family, 4-6 units/acre	0.25-0.50	0.40
Multi-family, >6 units/acre	0.50-0.75	0.60
Rural (mostly non-irrigated lawn area)		
<1/2 acre - 1 acre	0.20-0.50	0.35
1 acre - 3 acres	0.15-0.50	0.30
Industrial		
Light	0.50-0.80	0.65
Heavy	0.60-0.90	0.75
Business		
Downtown	0.70-0.95	0.85
Neighborhood	0.50-0.70	0.60
Parks	0.10-0.40	0.20

Source: ASCE, 1970 and Seelye, 1960.

designed for and applicable to small drainage basins (Kirpich, 1940).

(b) Using the Soil Conservation Service (SCS) Triangular Hydrograph Theory (DOI, 1977), the time of concentration is

$$t_c = \frac{11.9\ L^3}{H}\left(0.385\right) \qquad (4.45)$$

where L is the length (miles) of the longest watercourse from the point of interest to the tributary divide, H is the difference in elevation (feet) between the point of interest and the tributary divide. The time of concentration will be expressed in hours. The SCS procedure is most applicable to drainage basins of at least 10 square miles.

Once the rainfall duration or time of concentration is determined, the rainfall depth can be computed based on the PMP intensity values estimated in Section 2.1.2.

4.8.3 Tributary Area

The tributary area may be expressed in a unit width format for design of rock protection on an embankment. Therefore, the area is the length of the longest expected or measured water course multiplied by the unit width. This procedure is primarily applicable to Zones I, II, and III and is not applicable for drainage ditch design. It should be noted that a unit width approach to drainage and diversion ditch design is not effective. Ditch design requires an entire basin analysis in which a composite inflow hydrograph is determined and is routed along the channel. From the inflow hydrograph, water surface profiles (i.e., HEC-2) can be estimated to determine flow depth and velocities for riprap design (COE, 1982).

4.8.4 Sheet Flow Velocity

The design velocity for sheet flow on an embankment slope can be estimated by solving the Manning formula presented in Equation 4.39. It is assumed that the hydraulic radius, R, is approximately equal to the flow depth, y, and that the design discharge is equal to that estimated by the Rational Method. Therefore, the depth of flow is

$$y = \left[\frac{Qn}{1.486\ S^{1/2}}\right]^{3/5} \qquad (4.46)$$

where Q is the discharge, S is the slope, and n is the Manning coefficient.

Therefore, the design velocity can be estimated as

$$V_{Design} = Q/A \text{ (feet/sec)} \quad (4.47)$$

where A is the cross-sectional area of flow.

4.9 FLOW CONCENTRATIONS

Despite the extensive efforts of the impoundment reclamation designer, reviewer, contractor and inspector, the topographic features of the cover will alter over time without continual maintenance (Powledge and Dodge, 1985). Cover modifications will result from differential settlement, collapsing soils, marginal quality control in cover placement, erosion, major hydrologic events and monitoring disturbance. Because of these unpredictable and generally uncontrollable events, tributary drainage areas evolve that were not originally designed or constructed. The result is that the peak discharge and volume of runoff exceed design levels and increase the erosion potential.

Abt and Ruff (1985) conducted a series of flume experiments on a 1V:5H prototype embankment protected by riprap with median rock sizes of 2 inches to 6 inches in diameter. It was observd that 2-4 inch diameter riprap were highly susceptible to sheet flows converging along the face of the embankment into channels. The discharge in the channel(s) was compared to the total discharge over the embankment by

$$CF = \frac{1}{1 - (Q_c - Q)} \quad (4.48)$$

where CF is the concentration factor, Q_c is the discharge in the channel and Q is the total discharge over the embankment. The concentration factors ranged from 1.1 to 3.2 where flows were less than the failure discharge. These preliminary results indicate that riprap designed for sheet flow conditions may be subjected to flow channelizations that concentrate 3 times the discharge in a single location.

The peak discharge along a crest or at a design point is a function of the amount of precipitation, the tributary drainage area, the slope of the drainage basin, the basin contouring, the cover material and cover protection. Any modification in one or more of these parameters can impact the outlet peak discharge. The cover design must account for these potential changes in the form of a concentration or safety factor. Therefore, a flow concentration factor may be incorporated into the design process to adequately evaluate the soil resistance to erosion, to adequately select and evaluate alternative protective measures and to size riprap when warranted.

It is difficult to accurately predict the value of the flow concentration factor since limited information is currently available to substantiate design limits. However, it is reasonable to assume that values between 2 and 3 are attainable with only a slight evolutionary change in cover. Unless it can be shown that design procedures such as overbuilding can compensate for differential settlement, it is recommended that a conservative concentration factor be used until additional research can justify a more reasonable range of values.

To incorporate the flow concentration factor into the stone sizing procedure of any riprap design method, multiply the design peak discharge by the flow concentration factor. All subsequent computations, i.e., velocity and depth estimate, stone size determination, etc., will reflect the influence of the flow concentration.

4.10 PERMISSIBLE VELOCITIES

Evaluation of proposed reclamation alternatives should include an analysis of the critical erosion potential of the cover material. Erosion potential can be determined based upon the properties of the reclamation materials as well as the degree of compaction in which the material is placed. The permissible velocity approach consists of specifying a velocity criterion that will not erode the cover or channel and will prevent scour. A comparison of the actual or design flow velocities to the permissible velocities associated with overland flows, sheetflows or channel flows determines the erosion potential. When the design flow velocity meets or exceeds the permissible velocity, cover protection should be considered.

The permissible velocity values presented were developed from experiments performed primarily in canals and stream beds. Therefore, the following permissible velocities should provide a conservative estimate for evaluating the erosion resistance of the reclaimed covers over long term periods. In cases where a range of permissible velocities are presented, it is recommended that the lower velocity be used for determining erosion potential.

A series of permissible maximum canal velocities was developed by Fortier and Scobey (1926) and adapted by Lane (1955). The maximum permissible velocities presented in Table 4.7 are applicable to colloidal silts. These velocity values were developed for channels without sinuosity. Lane recommended a reduction of the velocities in Table 4.7 by 13 percent if the canal/channel is moderately sinuous. The maximum allowable velocities for sandy-based materials are given in Table 4.8. Table 4.9 provides limiting velocities for cohesive materials according to compactness for materials with less than 50 percent sand content. The Soil Conservation Service maximum permissible velocities (SCS, 1984) for well maintained grass covers are presented in Table 4.10.

It is important to recognize that limited information is available pertaining to permissible velocities on covers under sheet flow conditions.

Table 4.7. Maximum permissible velocities in erodible channels.

Channel Material	Water Transporting Colloidal Silts v (ft/sec)
Fine sand, colloidal	2.50
Sandy loam, non-colloidal	2.50
Silty-loam, non-colloidal	3.00
Alluvial silts, non-colloidal	3.50
Firm loam	3.50
Volcanic ash	3.50
Stiff clay, colloidal	5.00
Alluvial silts, colloidal	5.00
Shales and hardpans	6.00
Fine gravel	5.00
Graded loam to cobbles, non-colloidal	5.00
Graded silts to cobble, colloidal	5.50
Coarse gravel, non-colloidal	6.00
Cobbles and shingles	5.50

Source: Lane 1955.

Table 4.8. Maximum allowable velocities in sand-based material.

Material	Velocity (ft/sec)
Very light sand of quicksand character	0.75 to 1.00
Very light loose sand	1.00 to 1.50
Coarse sand to light sandy soil	1.50 to 2.00
Sandy soil	2.00 to 2.50
Sandy loam	2.50 to 2.75
Average loam, alluvial soil, volcanic ash	2.75 to 3.00
Firm loam, clay loam	3.00 to 3.75
Stiff clay soil, gravel soil	4.00 to 5.00
Coarse gravel, cobbles and shingles	5.00 to 6.00
Conglomerate, cemented gravel, soft slate, tough hardpan, soft sedimentary rock	6.00 to 8.00

Source: Lane, 1955.

Therefore, the permissible velocities developed for channels is usually extended to overland flow situations. When design velocities reach or exceed those indicated in Tables 4.7 through 4.10, protection is warranted.

Table 4.9. Limiting Velocities in Cohesive Materials.

	Compactness of Bed			
	Loose	Fairly Compact	Compact	Very Compact
Principle Cohesive Material	Velocity (ft/sec)	Velocity (ft/sec)	Velocity (ft/sec)	Velocity (ft/sec)
Sandy clay	1.48	2.95	4.26	5.90
Heavy clayey soils	1.31	2.79	4.10	5.58
Clays	1.15	2.62	3.94	5.41
Lean clayey soils	1.05	2.30	3.44	4.43

Source: Lane, 1955.

The materials presented in Tables 4.7 through 4.9 can be referenced to the Unified Soil Classification System as presented by Wagner (1957). An engineering analysis of the cover material can provide an approximation of the permissible velocities that the alternative cover materials may withstand without supplemental protection.

4.11 PERMISSIBLE VELOCITY EXAMPLE

A tailings disposal site located in the northwest corner of New Mexico has prepared a reclamation plan for review. The reclamation plan indicates that a 10 foot thick cap will be placed atop the tailings at a slope of 2.4% with a compaction of 95% of optimum. The cap will be graded as shown in Figure 4.14 and shall transition into side slopes of 1V:10H. It is proposed that the cap will be composed of a sandy clay with a coarse gravel cover. Along the crest, a 12 inch thick layer of riprap will be placed for at least 8 feet upslope and downslope of the crest to stabilize the transition. The riprap will have a median stone size of 6 inches. The gravel cover will have a median rock size of 1.5 inches. The design reviewer must verify that the gravel cover will resist the potential velocities that may result on the cap.

Table 4.10. Maximum Permissible Velocities in Feet per Second (fps) for Channels Lined With Uniform Stands of Various Well-Maintained Grass Covers.

Cover	Maximum Permissible Velocities[a]: Slope Range %	Erosion-Resistant Soils	Easily-Eroded Soils
Bermudagrass	0-5	8	6
	5-10	7	5
	Over 10	6	4
Buffalograss, Kentucky bluegrass, Smooth brome, Blue grama[b]	0-5	7	5
	5-10	6	4
	Over 10	5	3
Grass mixture[b]	0-5	5	4
	5-10	4	3
Lespedeza sericea, Weeping lovegrass, Yellow bluestem[c], Kudzu, Alfalfa, Crabgrass	0-5	3.5	2.5
Common lespedeza[c,d], Sudangrass[d]	0-5	3.5	2.5

[a]Use velocities over 5 fps only where good covers and proper maintenance can be obtained.

[b]Do not use on slopes steeper than 10 percent.

[c]Use on slopes steeper than 5 percent is not recommended.

[d]Annuals are used on mild slopes or as temporary protection until permanent covers are established.

Source: SCS, 1984.

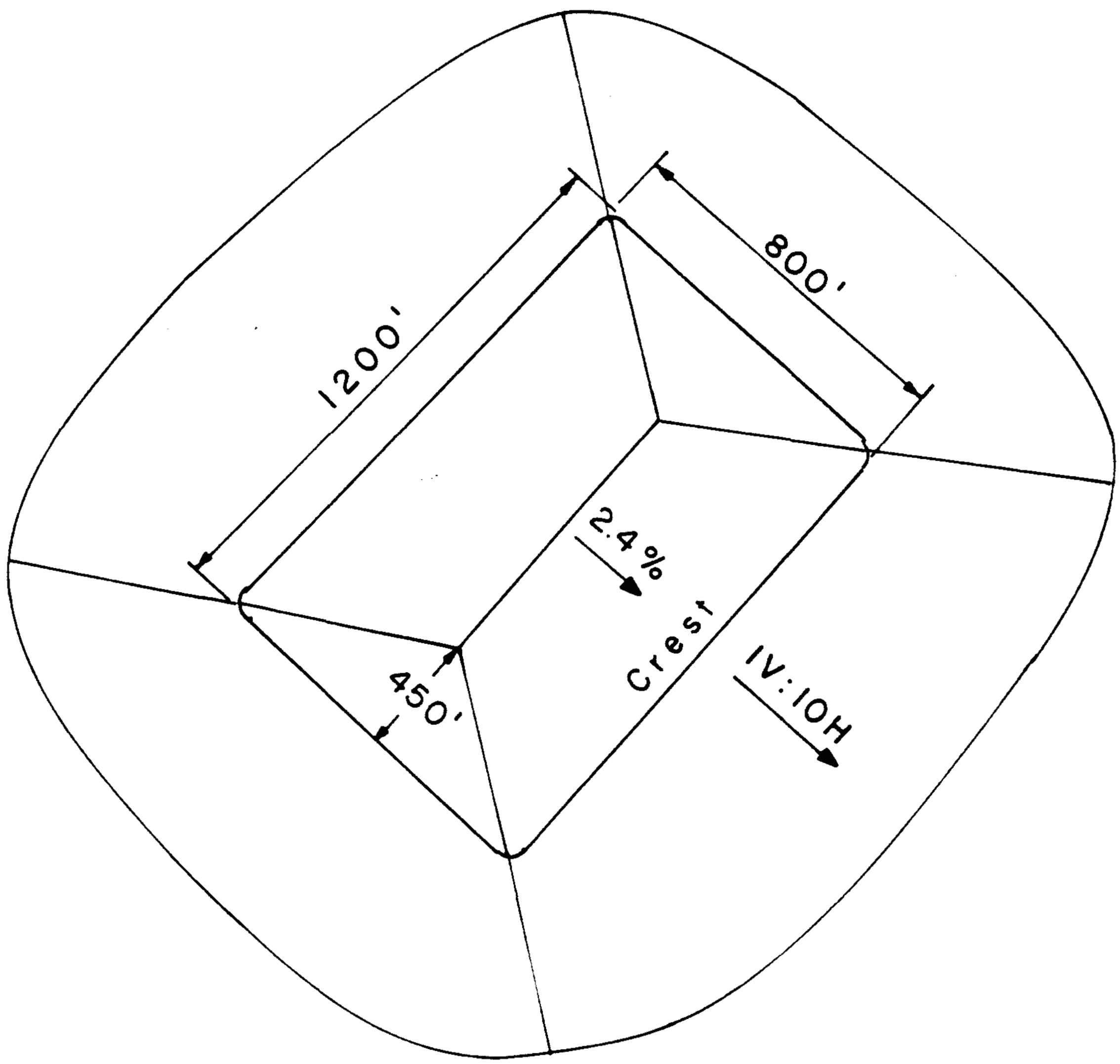

Fig. 4.14. Representative reclaimed tailing pile—example problem.

In order to assess the stabilization of the cap against erosion due to overland flow, information provided in Sections 4.6 through 4.10 of this report must be utilized. One alternative means of reviewing the design is presented in the following analysis.

4.11.1 Estimation of Peak Runoff

The peak runoff can be estimated using the Rational formula presented in Equation 4.43. The three components of the Rational formula that require consideration are: the runoff coefficient, C; the rainfall intensity, i; and the tributary area, A.

The runoff coefficient can be estimated by examining Tables 4.4 through 4.6. Since the cap will be composed of a compacted clay, the infiltration and localized storage will be low. The peak runoff is a direct function of the estimated localized PMF. Therefore, a reasonable C value is 1.0.

The rainfall intensity can be estimated by determining the 1-hr, 1-mi^2 local storm PMP value and adjusting the rainfall depth in accordance with the percentages presented in Table 2.1. For northwest New Mexico, the 1-hr, 1-mi^2 PMP is estimated to be 9.5 inches after the appropriate elevation and area adjustments are performed.

The time of concentration, t_c, should be estimated. Using Equation 4.44, the t_c can be estimated where the longest flow path is approximately 450 feet as

$$t_c = 0.00013 \frac{(450)^{0.77}}{(0.024)^{0.385}} \qquad (4.49)$$

and

$$t_c = 0.06 \text{ hrs} = 3.62 \text{ minutes} \qquad (4.50)$$

The rainfall depth for variable rainfall durations can be estimated using the values presented in Table 2.1 which are applicable to northwest New Mexico. Since the time of concentration is 3.6 minutes, the percent of the 1-hr PMP can be interpolated to be approximately 35 percent. The rainfall depth is computed using Equation 2.1 to be

$$\text{Rainfall depth} = (0.35) \times 9.5 \text{ inch} = 3.33 \text{ inches} \qquad (4.51)$$

A conservative estimate of the rainfall intensity is determined by applying Equation 2.2.

$$i = 3.33 \text{ inches} \times \frac{60}{3.6} = 55.5 \text{ inches/hr} \qquad (4.52)$$

The tributary area, A, can be estimated using a unit width approach presented in Section 4.8. Since the longest flow path is 450 feet with a unit width of one foot, the tributary area is 450 square feet. The tributary area can be converted to acres by dividing by 43,560 square feet/acre resulting in an area of 0.0103 acres.

The peak sheet flow unit discharge at the transition can be computed by using the Rational formula presented in Equation 4.43.

$$q = (1.0)\ (55.5)\ (0.0103) = 0.57 \text{ cfs} \qquad (4.53)$$

4.11.2 Sheet Flow Velocity

The sheet flow design velocity can be estimated by first determining the depth of flow. The depth of flow, y, can be calculated using Equation 4.46. However, the Manning surface roughness coefficient, n, must be determined. From Equation 4.41, the Manning n value can be calculated as

$$n = 0.0395\ (0.125)^{1/6} = 0.028 \qquad (4.54)$$

The depth of flow is then computed to be

$$y = \left[\frac{(0.57)\ 0.028}{1.486\ (0.024)^{1/2}}\right]^{3/5} = 0.202 \text{ feet} \qquad (4.55)$$

or

$$y = (0.202 \text{ ft})\ (12 \text{ in/ft}) = 2.42 \text{ inches} \qquad (4.56)$$

The design sheet flow velocity is calculated using Equation 4.47.

$$V = \frac{0.57}{(1.0)(0.20)} = 2.82 \text{ feet/sec} \qquad (4.57)$$

where 0.57 is the unit discharge, 1.0 is the width of flow in feet and 0.20 is the depth of flow in feet. It should be noted that the flow concentration factor was not incorporated into this computation.

4.11.3 Cover Permissible Velocity

The permissible velocity for the clay cap covered with gravel has been determined to be 5.0-6.0 feet/sec as presented in Table 4.8. Since the design sheet flow velocity was calculated to be 2.9 feet/sec, the cover should be able to withstand the design flow.

NAVFAC DM-7.1
MAY 1982

SOIL MECHANICS

DESIGN MANUAL 7.1

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
200 STOVALL STREET
ALEXANDRIA, VA. 22332

25 of 25

TABLE 4
Limiting Flow Velocities to Minimize Erosion

PERMISSIBLE VELOCITY				
		With Channel Vegetation		
Soil Type	Bare Channel	6" to 10" in height	11" to 24" in height	Over 30" in height
Sand, Silt, Sandy loam, Silty loam	1.5	2.0 to 3.0	2.5 to 3.5	3.0 to 4.0
Silty clay loam, Silty clay	2.0	3.0 to 4.0	3.5 to 4.5	4.0 to 5.0
Clay	2.5	3.0 to 5.0	3.0 to 5.5	3.0 to 6.0

HELP MODEL

****
****

PROPOSED COVER
ROCKY FLATS - SOLAR PONDS
JUNE 1, 1988

****
****

FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER		
THICKNESS	=	6.00 INCHES
EVAPORATION COEFFICIENT	=	3.300 MM/DAY**0.5
POROSITY	=	0.4010 VOL/VOL
FIELD CAPACITY	=	0.1290 VOL/VOL
WILTING POINT	=	0.0750 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	3.00000000 INCHES/HR

LAYER 2

VERTICAL PERCOLATION LAYER		
THICKNESS	=	30.00 INCHES
EVAPORATION COEFFICIENT	=	3.100 MM/DAY**0.5
POROSITY	=	0.5235 VOL/VOL
FIELD CAPACITY	=	0.4365 VOL/VOL
WILTING POINT	=	0.3780 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	0.00325000 INCHES/HR

LAYER 3

LATERAL DRAINAGE LAYER

SLOPE	=	6.00 PERCENT
DRAINAGE LENGTH	=	900.0 FEET
THICKNESS	=	6.00 INCHES
EVAPORATION COEFFICIENT	=	3.300 MM/DAY**0.5
POROSITY	=	0.3890 VOL/VOL
FIELD CAPACITY	=	0.1990 VOL/VOL
WILTING POINT	=	0.0660 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	6.61999989 INCHES/HR

LAYER 4

BARRIER SOIL LAYER WITH LINER

THICKNESS	=	12.00 INCHES
EVAPORATION COEFFICIENT	=	3.100 MM/DAY**0.5
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.4500 VOL/VOL
WILTING POINT	=	0.3600 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	0.00014200 INCHES/HR

LAYER 5

WASTE LAYER

THICKNESS	=	300.00 INCHES
EVAPORATION COEFFICIENT	=	3.100 MM/DAY**0.5
POROSITY	=	0.3898 VOL/VOL
FIELD CAPACITY	=	0.2893 VOL/VOL
WILTING POINT	=	0.2000 VOL/VOL
EFFECTIVE HYDRAULIC CONDUCTIVITY	=	0.00420000 INCHES/HR

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	69.76
TOTAL AREA OF COVER	=	750000. SQ. FT
EVAPORATIVE ZONE DEPTH	=	10.00 INCHES
LINER LEAKAGE FRACTION	=	0.000001
EFFECTIVE EVAPORATION COEFFICIENT	=	3.285 MM/DAY**0.5
UPPER LIMIT VEG. STORAGE	=	4.5000 INCHES
INITIAL VEG. STORAGE	=	2.2410 INCHES

CLIMATOLOGIC DATA FOR DENVER COLORADO

MONTHLY MEAN TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	30.56	37.46	47.76	58.69	67.33
71.35	69.69	62.79	52.49	41.56	32.92

MONTHLY MEANS SOLAR RADIATION, LANGLEYS PER DAY

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
218.56	274.45	355.05	438.77	503.16	530.98
514.77	458.88	378.28	294.57	230.17	202.35

LEAF AREA INDEX TABLE

DATE	LAI
1	0.00
124	0.00
140	0.61
156	0.99
172	0.99
188	0.99
205	0.99
221	0.99
237	0.89
253	0.65
269	0.32
285	0.17
366	0.00

FAIR GRASS

WINTER COVER FACTOR = 0.60

****

AVERAGE MONTHLY TOTALS FOR 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	0.38	0.45	1.23	1.65	1.68	1.39
	2.19	1.17	0.67	0.89	0.94	0.35
RUNOFF (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION (INCHES)	0.421	0.525	0.896	1.485	1.421	1.417
	1.760	1.109	0.562	0.564	0.653	0.401
PERCOLATION FROM BASE OF COVER (INCHES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION FROM BASE OF LANDFILL (INCHES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DRAINAGE FROM BASE OF COVER (INCHES)	0.116	0.073	0.054	0.072	0.128	0.159
	0.156	0.193	0.188	0.161	0.161	0.198
DRAINAGE FROM BASE OF LANDFILL (INCHES)	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

****

****

AVERAGE ANNUAL TOTALS FOR 74 THROUGH 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	12.99	812000.	100.00
RUNOFF	0.000	0.	0.00
EVAPOTRANSPIRATION	11.214	700860.	86.31
PERCOLATION FROM BASE OF COVER	0.0000	0.	0.00
PERCOLATION FROM BASE OF LANDFILL	0.0000	0.	0.00
DRAINAGE FROM BASE OF COVER	1.659	103687.	12.77
DRAINAGE FROM BASE OF LANDFILL	0.000	0.	0.00

****

****

PEAK DAILY VALUES FOR 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	1.79	111875.0
RUNOFF	0.000	0.0
PERCOLATION FROM BASE OF COVER	0.0000	0.1
PERCOLATION FROM BASE OF LANDFILL	0.0000	0.0
DRAINAGE FROM BASE OF COVER	0.020	1270.4
DRAINAGE FROM BASE OF LANDFILL	0.000	0.0
HEAD ON BASE OF COVER	3.9	
HEAD ON BASE OF LANDFILL	0.0	
SNOW WATER	0.63	39553.7

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3605

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1959

****
****

APPENDIX 3

CHEMICAL AND RADIOCHEMICAL ANALYSES OF SOLAR EVAPORATION POND LIQUID AND SLUDGE

TABLE 3-I

SUMMARY OF QUARTERLY MONITORING OF PONDS 207-A AND 207-C LIQUIDS DURING 1984 AND 1985

ANALYSIS	POND 207-A	POND 207-C
pH	range 8.3-11.0	range 7.7-12.5
Nitrate-Nitrogen (ppm)	range ND[a]-21,739 average 9,000[b] (1/7)[c]	range 0.4-18,841 average 6,600 (0/7)
Cyanide (ppm)	range ND-1.7 average 1.2 (5/7)	range ND-1.9 average 1.9 (2/3)
Beryllium (ppm)	range ND-0.1 average 0.1 (4/7)	range ND-0.6 average 0.6 (2/3)
Gross Alpha (pCi/L)	range 32-56,000 average 13,400 (0/7)	range ND-15,000 average 6,300 (1/7)
Gross Beta (pCi/L)	range ND-27,000 average 11,100 (3/7)	range 405-11,000 average 3,500 (0/7)
Pu-239 (pCi/L)	range ND-240 average 110 (1/6)	range ND-1,400 average 410 (1/6)
Am-241 (pCi/L)	range ND-650 average 300 (3/6)	range ND-13,000 average 2,700 (1/6)
Uranium (pCi/L)	range ND-26,000 average 9,200 (1/6)	range 1,800-15,000 average 6,500 (0/6)
Tritium (pCi/L)	range 620-4,300 average 2,200 (0/6)	range 0-6,400 average 2,400 (1/6)

TABLE 3-I

SUMMARY OF QUARTERLY MONITORING OF PONDS 207-A AND 207-C
LIQUIDS DURING 1984 AND 1985

(a) ND indicates less than detection limit or less than error limit.

(b) Average presented is for reported concentrations greater than the detection limits.

(c) Fraction represents number of non-detectable samples/ total number of samples.

TABLE 3-II

SUMMARY OF PARAMETERS MONITORED
IN POND 207-A SLUDGE IN MAY 1985

ANALYSIS	POND 207-A SLUDGE
pH	9.5
Nitrate-Nitrogen (ppm)	8,800
Beryllium (ppm)	170
Hexavalent Chromium (ppm)	ND[a]
Gross Alpha (pCi/L)[b]	860,000
U-235 (pCi/L)[b]	28
U-238 (pCi/L)[3]	520

(a) ND indicates less than detection limit.

(b) Units of pCi/l indicated on lab results.

TABLE 3-III

SUMMARY OF PARAMETERS MONITORED
WEEKLY DURING 1984 AND 1985
FOR PONDS 207-B NORTH AND CENTER LIQUIDS

ANALYSIS	POND 207-B NORTH	POND 207-B CENTER
pH	range 7.5 - 9.6	range 7.3 - 11.3
Nitrate (as N) (ppm)	range 335 - 1367 average 629 (0/71)[a]	range ND[b] - 15.6 average (4.7)[c] (30/77)
Gross Alpha (pCi/l)	range ND - 323 average (144) (2/71)	range ND - 59 average (24) (45/77)
Gross Beta (pCi/l)	range ND - 163 average (63) (13/71)	range ND - 74 average (30) (60/77)

(a) Fraction represents number of non-detectable samples/ total number of samples.

(b) ND indicates less than detection limit or less than error limit.

(c) Average presented is for reported concentrations greater than the detection limits.

TABLE 3-IV

SUMMARY OF TWO SETS OF METAL ANALYSES OF
PONDS 207-B NORTH AND CENTER LIQUIDS
TAKEN IN OCTOBER 1984 AND APRIL 1985

ELEMENT	POND 207-B NORTH (mg/L)	POND 207-B CENTER (mg/L)
Aluminum	0.16, 1	0.15, 2
Boron	0.29, 0.31	0.24, 0.67
Calcium	20.0, 290	2.9, 45.0
Cesium	ND[(a)]	ND, 0.041
Copper	ND	0.016, 0.037
Iron	0.28, 0.29	0.074, 0.2
Lead	ND, 0.0035	ND, 0.002
Lithium	0.37, 3.5	0.052, 0.41
Manganese	ND	0.022, 0.081
Magnesium	87.0, 120.0	3.9, 13.0
Molybdenum	ND, 0.0069	0.016, 0.037
Nickel	ND	0.015, 0.016
Phosphorous	ND	0.074, 0.2
Potassium	82.0, 120.0	30.0, 36.0
Selenium	0.01, 0.02	ND
Silicon	2.1, 5.6	2.4, 5.5
Silver	ND, 0.082	0.0016, 0.015
Sodium	370.0, 620.0	67.0, 250.0
Strontium	1.2, 3.5	0.28, 0.52

TABLE 3-IV (CONT)

SUMMARY OF TWO SETS OF METAL ANALYSES
PONDS 207-B NORTH AND CENTER LIQUIDS
TAKEN IN OCTOBER 1984 AND APRIL 1985

ELEMENT	POND 207-B NORTH (mg/L)	POND 207-B CENTER (mg/L)
Tritium	ND, 0.069	0.022, 0.041
Vanadium	ND	ND, 0.0081
Zinc	ND	ND, 0.041
Zirconium	ND	ND, 0.0041

(a) ND indicates concentration below detection limit.

TABLE OF CONTENTS

CODO78343407

Date: November 8, 1985
Revision No.: 0

POND 207A DATA

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. T. Illsley, HS&E T452B
R. L. Henry, HS&E T452B
File

LAB NUMBER: M85-2224
DATE: 10-03-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

207 A and C Solar Pond - Quarterly - Received: 9-11-85

ANALYSIS RESULTS

Analysis	207 A	207 C
pH (S.U.)	10.0	12.5
NO_3^- as N (mg/L)	21739	18841
T. D. S. (mg/L)	171976	171135
CN^- (ppm)	1.7	<0.1
Be (ug/ml)	0.1	0.6
Gross Alpha (pCi/L)	$(5.6 \pm 0.0) \times 10^4$	$(8.8 \pm 0.6) \times 10^3$
Gross Beta (pCi/L)	$(2.7 \pm 0.6) \times 10^4$	$(6.4 \pm 1.1) \times 10^3$
Pu-239 (pCi/L)	$(0.0 \pm 4.2) \times 10^2$	$(1.4 \pm 0.3) \times 10^3$
Am-241 (pCi/L)	$(0.0 \pm 1.0) \times 10^3$	$(1.3 \pm 0.1) \times 10^4$
U (pCi/L)	$(2.6 \pm 0.2) \times 10^4$	$(1.8 \pm 0.3) \times 10^3$
^3H (pCi/L)	$(3.0 \pm 0.8) \times 10^3$	$(7.2 \pm 0.9) \times 10^2$

1.6.

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

✓C. T. Illsley, HS&E T-452B
File

LAB NUMBER: M85-1557
DATE: 7-11-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Pond 207A & 207C - Quarterly Received: 6-25-85

ANALYSIS RESULTS

Analysis	207A	207C
pH (S.U.)	10.1	10.7
NO_3^- as N (mg/L)	14800	8000
T.D.S. (mg/L)	10360	6420
Be (ug/ml)	0.1	<0.1
Gross Alpha (pCi/L)	2.4×10^4	6.5×10^3
Gross Beta (pCi/L)	$(5.2 \pm 1.0) \times 10^3$	$(1.1 \pm 0.2) \times 10^4$
CN^- (mg/L)	<0.01	<0.01

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. T. Illsley, HS&E T452B
R. L. Henry, HS&E T452B
✓File

LAB NUMBER: M85-0499
DATE: 4-25-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

207-A Solar Pond - Quarterly - Received: 3-5-85

ANALYSIS RESULTS

Analysis	Results
pH (S.U.)	10.0
NO_3^- as N (mg/L)	7300
T. D. S. (mg/L)	5340
CN^- (ppm)	<0.1
Be (ug/ml)	0.1
Gross Alpha (pCi/L)	$(8.4 \pm 0.3) \times 10^3$
Gross Beta (pCi/L)	$(1.2 \pm 0.1) \times 10^4$
Pu-239 (pCi/L)	$(1.3 \pm 0.6) \times 10^2$
Am-241 (pCi/L)	$(0.0 \pm 1.5) \times 10^2$
U (pCi/L)	$(9.2 \pm 1.1) \times 10^3$
^3H (pCi/L)	$(1.0 \pm 0.4) \times 10^3$

/ 6
INFO

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. T. Illsley, HS&E T452B
R. L. Henry, HS&E T452B
File

LAB NUMBER: M84-2975
DATE: 12-24-84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Pond 207A - Received: 12-5-84

ANALYSIS RESULTS

ANALYSIS	RESULTS	
pH (S.U.)	8.3	
NO_3 as N (mg/L)	5.0	
T.D.S. (mg/L)	929	
Be (mg/L)	<0.1	
CN^- (mg/L)	<0.05	
Gross Alpha (pCi/L)	204 ± 120	204
Gross Beta (pCi/L)	21 ± 26	
Pu (pCi/L)	$(1.6 \pm 0.7) \times 10^2$	160
U (pCi/L)	$(8.6 \pm 7.0) \times 10^1$	86
Am (pCi/L)	$(0.0 \pm 7.6) \times 10^1$	
H^3 (pCi/L)	$(6.2 \pm 2.3) \times 10^2$	620

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. T. Illsley, T452B HS&E
File

LAB NUMBER: M84-2275
DATE: 9-27-84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Pond 207A - Quartley Sample - Received: 9-13-84

ANALYSIS RESULTS

Analysis	Results
pH	11.0
NO_3 as N (mg/L)	<1.0
TDS (mg/L)	403
Be (ug/L)	<0.1
CN^- (mg/L)	<0.1
Tritium (pCi/L)	$(2.8 \pm 1.0) \times 10^3$
Gross Alpha (pCi/L)	32 ± 16
Gross Beta (pCi/L)	39 ± 40
Pu (pCi/L)	$(2.4 \pm 1.0) \times 10^2$
Am (pCi/L)	$(2.0 \pm 1.2) \times 10^2$
U (pCi/L)	$(6.9 \pm 7.9) \times 10^{-1}$

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. T. Illsley T-452B
R. L. Henry T-452B
N. D. Hoffman T-452B
R. D. Gaskins 374
File

LAB NUMBER: M84-1416
DATE: 8/16/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION

207A Solar POnd - Quarterly Sample Received: 6/5/84

Analysis	Result
pH (S.U.)	9.9
NO_3 as N (mg/L)	5150
Total Dissolved Solids (mg/L)	4383
Be (mg/L)	< 0.1
CN^- (mg/L)	0.6
Gross Alpha (pCi/L)	$(3.5 \pm 2.9) \times 10^3$
Gross Beta (pCi/L)	2 ± 27
Pu - 239 (pCi/L)	$(1.1 \pm 2.4) \times 10^1$
Am - 241 (pCi/L)	$(3.8 \pm 2.8) \times 10^1$
U (pCi/L)	$(6.5 \pm 0.4) \times 10^3$
^3H (pCi/L)	$(4.3 \pm 0.8) \times 10^3$

NDH

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:
R. L. Henry T452B
✓C. T. Illsley T452B
File

LAB NUMBER: M84-558
DATE: 4-10-84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207A - Monthly Sample
Received 3-5-84

ANALYSIS RESULTS

Analysis	Result
Gross Alpha (pCi/L)	$(1.9 \pm 1.1) \times 10^3$
Gross Beta (pCi/L)	$(2.2 \pm 0.6) \times 10^2$
Plutonium (pCi/L)	1.2×10^1
Americium (pCi/L)	6.5×10^2
Uranium (pCi/L)	4.0×10^3
Beryllium (mg/L)	<0.1
pH	10.5
NO_3 as N (mg/L)	5000
TDS (mg/L)	36000
CN^- (ppm)	<0.1
Tritium (pCi/L)	1.3×10^3

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

R. D. Gaskins, Liq Waste Oper, 374
T. Greengard, HS&E T452B

File

LAB NUMBER: M85-1236
DATE: 10-07-85
ACCOUNT NO: 371

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

207A Solar Pond Water Sludge
(REF: Req No. 2-59838) Received: 5-21-85

ANALYSIS RESULTS

Analysis	Result
pH (S.U.)	9.5
NO_3^- as N (mg/L)	8800
Total Dissolved Solids (mg/L)	77300
Total Solids (mg/L)	108700
Specific Gravity (g/ml)	1.08
Be (mg/L)	170
Cr^{+6} (mg/L)	<1.0
Total Alpha	8.6×10^5
U-235 (pCi/L)	$(2.8 \pm 1.9) \times 10^1$
U-238 (pCi/L)	$(5.2 \pm 0.9) \times 10^2$ } 548
F^- (g/L)	<0.75
Cl^- (g/L)	2.0
PO_4^{-3} (g/L)	<1.0
NO_3^- (g/L)	36
SO_4^{-2} (g/L)	2.2

See attached sheet for elemental analysis results.

POND 207-A TCLP SLUDGE ANALYSES

WESTON

Client: Rockwell
RFW Batch: 8803-875

Determination of Methanol in TCLP Leachates.

The leachate was analyzed by Packed Column Gas Chromatography with a Flame Ionization Detector.

GC Conditions:

Column: Six Foot x 1/4 inch glass, pack with 20% Carbowax 20M on Supelcoport (80/100 mesh)

Oven Temp: 70°C Isothermal

Injector Temp: 200°C

Detector Temp: 200°C

RFW #	CLIENT ID	METHANOL
8803-875-002	TCLP Leachate of S-Pond	<15 ug/mL
8803-875-002	TCLP Leachate of S-Pond Dup	<15 ug/mL
	TCLP Blank	<15 ug/mL

Date Collected: 03-21-88
Date Leached: 03-28,29-88
Date Analyzed: 03-31-88

The leachate was also screened for cyclohexanone, 1-butanol, ethylether and ethyl acetate. These analytes were not detected in the leachates (estimated detection limit of 200 ug/mL).

[signature] 4-1-88

Carter P. Nulton, Ph.D. DATE
Manager
Lionville Analytical Laboratory

SAMPLE NUMBER S-POND-03-21-88

DATE 3/25/88

TOTAL SPECIFIC ACTIVITY

ELEMENT	nCi/G
Gross α	0.452
Gross β	0.354
Pu (total)	0.45
Am^{241}	< 6.0*
$U^{233/234/238}$	0.02

TOTAL VOLUME 520 ml

DENSITY ~ 1.0

MASS 520g

TOTAL ACTIVITY < 3.3 μCi

TOTAL nCi/G < 6.47

SIGN OFF Jenny Menard
per verbal report by Lou Eng
Rockwell International
Rocky Flats Plant
written confirmation to fol.

* detection limit for rad screening

WESTON Analytics
ROCKWELL
RFW # 8803-875, VOA's Only (Special List)
W.O.# 2029-21-01

1. The following qualifiers are used on the data summary:

   U - Indicates that the compound was analyzed for but not detected. The detection limit for the sample (not the method detection limit) is reported with the U (e.g., 10U).

   J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed or where the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero (e.g., 10J). If limit of detection is 10 ug/l and a concentration of 3 ug/l is calculated, it is reported as 3J.

   BS - Indicates blank spike in which reagent grade water is spiked with the CLP matrix spiking solutions and carried through all the steps of the method. Spike recoveries are reported.

   BSD - Indicates blank spike duplicate.

   MS - Indicates matrix spike.

   MSD - Indicates matrix spike duplicate.

   DL - Indicates that surrogate recoveries were not obtained because the extract had to be diluted for analysis.

   NA - Not applicable.

   DF - Dilution factor.

   NR - Not reported.

2. Samples Collected: 03-21-88
   Leaching Date : 03-28-88
   Analysis Date : 03-29,31-88

3. Samples were analyzed by the USEPA Method 8240.

4. Several Tentatively Identified Compounds (TIC's) were detected in the method blank and the sample.

[signature] 4-1-88

Carter P. Nulton, Ph.D. DATE
Manager
Lionville Analytical Laboratories

WESTON ANALYTICS
GC/MS DATA SUMMARY
VOLATILE HAZARDOUS SUBSTANCE LIST COMPOUNDS

RFW Batch Number: 8803-875 Client: ROCKWELL (TCLP)

Sample Information	Cust ID:	BLANK 3/29	TCLP BLK	S-POND	BLANK 3/31	TCLP BLK	S-POND
	RFW#:	VWBLK	BLANK	002	VWBLK	BLANK	002
	Matrix:	Water	Leachate	Leachate	Water	Leachate	Leachate
	D.F.:	1	1	1	1	1	1
	Units:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surrogate Recovery (%)	Toluene-d8:	97 %	98 %	96 %	94 %	98 %	99 %
	Bromofluorobenzene:	95 %	94 %	86 %	98 %	101 %	104 %
	1,2-Dichloroethane-d4:	83 %	91 %	76 %	97 %	96 %	101 %
		fl	fl	fl	fl	fl	fl
Methylene Chloride		7	15 B	15 B	8	4 JB	6 B
Acetone		19	8000 B	5000 B	16	4200 B	5100 B
Carbon Disulfide		5 U	5 U	5 U	5 U	5 U	5 U
2-Butanone		10 U	10 U	10 U	10 U	10 U	10 U
Carbon Tetrachloride		5 U	5 U	5 U	5 U	5 U	5 U
1,1,1-Trichloroethane		1 J	6 B	3 JB	5 U	5	2 J
4-Methyl-2-pentanone		10 U	17	2 JB	10 U	18	10 U
Tetrachloroethene		5 U	5 U	6	5 U	5 U	6
Trichloroethene		5 U	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane		5 U	5 U	5 U	5 U	5 U	5 U
Toluene		5 U	10	2 JB	3 J	9 B	2 JB
Chlorobenzene		5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene		5 U	4 J	5 U	5 U	3 J	5 U
Total Xylenes		5 U	31	5 U	5 U	29	5 U
1,2-Dichlorobenzene		5 U	5 U	5 U	5 U	5 U	5 U
Isobutanol (a)		20 U	20 U	20 U	20 U	20 U	20 U
n-Butanol (a)		ND	ND	ND	ND	ND	ND
Cyclohexanone (a)		ND	ND	ND	ND	ND	ND
Ethyl Acetate (a)		ND	ND	ND	ND	ND	ND
Ethyl Ether (a)		ND	ND	ND	ND	ND	ND
1,1,2-Trichloro-1,2,2-trifluoroethane (a)		ND	1400	290 B	ND	890	260 B

(a) By Library Search only

U=Analyzed, not detected. B=Present in blank. NRP=Not Reported
J=Present at less than detection limit. NR=Not requested.

DATA SUMMARY FOR: ROCKWELL

R.F.W. NO.: 8803-875-TCLP BLANK

SAMPLE DESCRIPTION: TCLP BLANK 03-28

TENTATIVELY IDENTIFIED COMPOUNDS
(VOA FRACTION)

COMPOUND	SCAN #	CONCENTRATION (ug/L)
C_6-ALKENES/CYCLOALKANES	427	120 J
UNKNOWN	488	25 J
ALKANES	546	180 J
C_6-ESTER	665	4 J
C_7-ESTER	748	10 J

DATA SUMMARY FOR: ROCKWELL

R.F.W. NO.: 8803-875-002

SAMPLE DESCRIPTION: TCLP S-POND

TENTATIVELY IDENTIFIED COMPOUNDS
(VOA FRACTION)

COMPOUND	SCAN #	CONCENTRATION (ug/L)
C_6-CYCLOALKANES/OLEFINS	427	140 J
MIXED HYDROCARBONS	488	14 J
>C_6-ALKANES	546	110 J
C_7-ESTER	749	5 J

DATA SUMMARY FOR: ROCKWELL

R.F.W. NO.: 8803-875-TCLP BLANK

SAMPLE DESCRIPTION: TCLP BLANK 03-28

TENTATIVELY IDENTIFIED COMPOUNDS
(VOA FRACTION)

COMPOUND	SCAN #	CONCENTRATION (ug/L)
C_6-CYCLOALKANES	272	88 J
UNKNOWN	329	12 J
UNKNOWN	336	9 J
UNKNOWN	388	190 J
UNKNOWN	442	5 J
UNKNOWN	600	18 J

DATA SUMMARY FOR: ROCKWELL

R.F.W. NO.: 8803-875-002

SAMPLE DESCRIPTION: TCLP S-POND

TENTATIVELY IDENTIFIED COMPOUNDS
(VOA FRACTION)

COMPOUND	SCAN #	CONCENTRATION (ug/L)
C_6-CYCLOALKANES	269	120 J
UNKNOWN	327	10 J
UNKNOWN	387	130 J
UNKNOWN	600	8 J

POND 207B DATA

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File

LAB NUMBER: 85-2220
DATE: 10-08-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample) — 1) North 1) Center
Received: 9-17-85

Analysis	North	Center
pH (S.U.)	9.3	9.3
NO_3^- as N (mg/L)	727	1.4
Gross Alpha (pCi/L)	209 ± 21	7 ± 3
Gross Beta (pCi/L)	109 ± 63	59 ± 4

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LAB NUMBER: M85-2157
DATE: 9-30-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B 1) North 1) Center
(Weekly Sample) Received: 9-10-85

Analysis	North	Center
pH (S.U.)	9.2	9.7
NO_3^- as N (mg/L)	746	<1.0
Gross Alpha (pCi/L)	268 ± 89	24 ± 5
Gross Beta (pCi/L)	23 ± 16	-4 ± 25

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File

LAB NUMBER: M85-2096
DATE: 9-30-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 8-27-85

Analysis	North	Center
pH (S.U.)	9.0	10.3
NO_3^- as N (mg/L)	716	<1.0
Gross Alpha (pCi/L)	323 ± 33	-4 ± 0
Gross Beta (pCi/L)	96 ± 25	-8 ± 11
Pu-239 (pCi/L)	71.2	*
U- Total (pCi/L)	82.6	*
Am-241 (pCi/L)	57.6	*

* Not requested

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LAB NUMBER: M85-2035
DATE: 9-30-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 8-20-85

Analysis	North	Center
pH (S.U.)	8.7	10.6
NO_3^- as N (mg/L)	676	<1.0
Gross Alpha (pCi/L)	113 ± 38	19 ± 5
Gross Beta (pCi/L)	41 ± 10	6 ± 16

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LAB NUMBER: M85-1973
DATE: 9-30-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 8-13-85

Analysis	North	Center
pH (S.U.)	8.8	9.6
NO_3^- as N (mg/L)	615	<1.0
Gross Alpha (pCi/L)	110 ± 6	0 ± 0
Gross Beta (pCi/L)	77 ± 5	9 ± 4

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LAB NUMBER: M85-1915
DATE: 9-30-85
ACCOUNT NO: 331

APPROVED: [signature]
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SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 8-6-85

Analysis	North	Center
pH (S.U.)	9.1	10.0
NO_3^- as N (mg/L)	590	<1.0
Gross Alpha (pCi/L)	166 ± 31	6 ± 2
Gross Beta (pCi/L)	115 ± 7	29 ± 8

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LAB NUMBER: M85-1860
DATE: 8-9-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample) 1) North 1) Center
Received: 7-30-85

Analysis	North	Center
pH (S.U.)	9.1	9.9
NO_3^- as N (mg/L)	627	2.0
Gross Alpha (pCi/L)	200 ± 86	38 ± 20
Gross Beta (pCi/L)	57 ± 12	34 ± 39

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File

LAB NUMBER: M85-1787
DATE: 7-29-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample) 1) North 1) Center
Received: 7-23-85

Analysis	North	Center
pH (S.U.)	8.9	10.3
NO_3^- as N (mg/L)	625	<1.0
Gross Alpha (pCi/L)	169 ± 14	18 ± 11
Gross Beta (pCi/L)	52 ± 15	11 ± 0

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LAB NUMBER: M85-1733
DATE: 7-19-85
ACCOUNT NO: 331

APPROVED: [signature]
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SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 7-16-85

Analysis	North	Center
pH (S.U.)	8.8	10.0
NO_3^- as N (mg/L)	718	<1.0
Gross Alpha (pCi/L)	215 ± 14	22 ± 12
Gross Beta (pCi/L)	45 ± 24	22 ± 23

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File

LAB NUMBER: M85-1662
DATE: 7-19-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)

1) North 1) Center
Received: 7-9-85

Analysis	North	Center
pH (S.U.)	8.4	10.4
NO_3^- as N (mg/L)	662	<1.0
Gross Alpha (pCi/L)	112 ± 16	6 ± 9
Gross Beta (pCi/L)	52 ± 42	-3 ± 21

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LAB NUMBER: M85-1615
DATE: 7-23-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 7-2-85

Analysis	North	Center
pH (S.U.)	8.7	11.0
NO_3^- as N (mg/L)	634	<1.0
Gross Alpha (pCi/L)	118 ± 10	19 ± 10
Gross Beta (pCi/L)	88 ± 20	26 ± 36

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LAB NUMBER: M85-1555
DATE: 7-11-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)   1) North   1) Center
Received: 6-25-85

Analysis	North	Center
pH (S.U.)	8.6	10.7
NO_3^- as N (mg/L)	815	<1.0
Gross Alpha (pCi/L)	70 ± 0	7 ± 9
Gross Beta (pCi/L)	95 ± 13	5 ± 0

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LAB NUMBER: M85-1499
DATE: 6-26-85
ACCOUNT NO: 331

APPROVED: [signature]
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SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 6-18-85

Analysis	North	Center
pH (S.U.)	9.1	10.2
NO_3^- as N (mg/L)	658	<1.0
Gross Alpha (pCi/L)	231 ± 19	18 ± 0
Gross Beta (pCi/L)	44 ± 17	33 ± 15

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LAB NUMBER: M85-1433
DATE: 6-20-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 6-11-85

Analysis	North	Center
pH (S.U.)	7.5	9.2
NO_3^- as N (mg/L)	732	<1.0
Gross Alpha (pCi/L)	175 ± 16	27 ± 7
Gross Beta (pCi/L)	39 ± 0	45 ± 55

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LAB NUMBER: M85-1360
DATE: 6-20-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)

1) North 1) Center
Received: 6-4-85

Analysis	North	Center
pH (S.U.)	9.1	9.4
NO_3^- as N (mg/L)	616	<1.0
Gross Alpha (pCi/L)	88 ± 27	8 ± 9
Gross Beta (pCi/L)	50 ± 24	49 ± 9

ANALYTICAL REPORT

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File

LAB NUMBER: M85-1292
DATE: 6-7-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)

1) North 1) Center
Received: 5-28-85

Analysis	North	Center
pH (S.U.)	9.3	10.6
NO_3^- as N (mg/L)	660	<1.0
Gross Alpha (pCi/L)	29 ± 14	19 ± 18
Gross Beta (pCi/L)	118 ± 34	20 ± 44

ANALYTICAL REPORT

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File

LAB NUMBER: M85-1233
DATE: 6-7-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 5-21-85

Analysis	North	Center
pH (S.U.)	9.4	10.9
NO_3^- as N (mg/L)	632	<1.0
Gross Alpha (pCi/L)	165 ± 9	32 ± 14
Gross Beta (pCi/l)	80 ± 0	12 ± 8

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LAB NUMBER: M85-1160
DATE: 5-22-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)

1) North 1) Center
Received: 5-14-85

Analysis	North	Center
pH (S.U.)	8.6	11.0
NO_3^- as N (mg/L)	662	<1.0
Gross Alpha (pCi/L)	161 ± 15	41 ± 2
Gross Beta (pCi/L)	43 ± 24	-9 ± 4

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File

LAB NUMBER: M85-1082
DATE: 5-17-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 5-7-85

Analysis	North	Center
pH (S.U.)	9.2	11.0
NO_3^- as N (mg/L)	557	<1.0
Gross Alpha (pCi/L)	195 ± 19	7 ± 14
Gross Beta (pCi/L)	37 ± 7	9 ± 3

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File

LAB NUMBER: M85-1003
DATE: 5-16-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 4-30-85

Analysis	North	Center
pH (S.U.)	9.0	10.7
NO_3^- as N (mg/L)	656	1.8
Gross Alpha (pCi/L)	129 ± 10	29 ± 22
Gross Beta (pCi/L)	30 ± 28	-5 ± 3

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File

LAB NUMBER: M85-0947
DATE: 5-3-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 4-23-85

Analysis	North	Center
pH (S.U.)	9.2	10.8
NO_3 as N (mg/L)	651	2.4
Gross Alpha (pCi/L)	149 ± 23	27 ± 4
Gross Beta (pCi/L)	47 ± 33	31 ± 0

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File

LAB NUMBER: M85-0892
DATE: 4-25-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample) 1) North 1) Center
Received: 4-16-85

Analysis	North	Center
pH (S.U.)	9.3	10.1
NO_3 as N (mg/L)	615	3.2
Gross Alpha (pCi/L)	154 ± 4	14 ± 2
Gross Beta (pCi/L)	20 ± 6	7 ± 14

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File

LAB NUMBER: M85-0824
DATE: 4-19-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 4-9-85

Analysis	North	Center
pH (S.U.)	9.2	8.9
NO_3 as N (mg/L)	630	4.3
Gross Alpha (pCi/L)	108 ± 3	14 ± 4
Gross Beta (pCi/L)	64 ± 13	10 ± 10

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File

LAB NUMBER: M85-0766
DATE: 4-15-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)   1) North   1) Center
Received: 4-2-85

Analysis	North	Center
pH (S.U.)	9.1	8.5
NO_3 as N (mg/L)	540	5.3
Gross Alpha (pCi/L)	33 ± 0	18 ± 2
Gross Beta (pCi/L)	86 ± 0	20 ± 28

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File

LAB NUMBER: M85-0712
DATE: 4-15-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 3-26-85

Analysis	North	Center
pH (S.U.)	9.2	10.1
NO_3 as N (mg/L)	492	5.1
Gross Alpha (pCi/L)	186 ± 105	26 ± 7
Gross Beta (pCi/L)	156 ± 54	17 ± 2

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File

LAB NUMBER: M85-0642
DATE: 3-28-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 3-14-85

Analysis	North	Center
pH (S.U.)	9.0	10.8
NO_3 as N (mg/L)	585	2.9
Gross Alpha (pCi/L)	230 ± 56	16 ± 3
Gross Beta (pCi/L)	163 ± 25	25 ± 22

ANALYTICAL REPORT

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File

LAB NUMBER: M85-0573
DATE: 3-26-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 3-12-85

Analysis	North	Center
pH (S.U.)	8.8	10.7
NO_3 as N (mg/L)	390	2.2
Gross Alpha (pCi/L)	$(1.3 \pm 0.4) \times 10^2$	19 ± 13
Gross Beta (pCi/L)	$(1.6 \pm 0.1) \times 10^2$	31 ± 16

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File

LAB NUMBER: M85-0501
DATE: 3-26-85
ACCOUNT NO: 331

APPROVED: [signature]
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SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 3-5-85

Analysis	North	Center
pH (S.U.)	*	10.1
NO_3 as N (mg/L)	*	15.6
Gross Alpha (pCi/L)	*	59 ± 23
Gross Beta (pCi/L)	*	73 ± 0

* No sample received - Pond Frozen

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File

LAB NUMBER: M85-0433
DATE: 3-26-85
ACCOUNT NO: 331

APPROVED: [signature]
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SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 2-26-85

Analysis	North	Center
pH (S.U.)	*	10.4
NO_3 as N (mg/L)	*	3.4
Gross Alpha (pCi/L)	*	-2 ± 10
Gross Beta (pCi/L)	*	38 ± 19

* No sample received - Pond Frozen.

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File

LAB NUMBER: M84-3027
DATE: 12-24-84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample) 1) North 1) Center
Received: 12-11-84

Analysis	North	Center
pH (S.U.)	*	9.2
NO_3 as N (mg/L)	FROZEN	4.1
Gross Alpha (pCi/L)	NO	4 ± 11
Gross Beta (pCi/L)	SAMPLE	3 ± 21

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File

LAB NUMBER: M84-2952
DATE: 12-12-84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 12-4-84

Analysis	North	Center
pH (S.U.)	*	10.0
NO_3 as N (mg/L)	*	4.0
Gross Alpha (pCi/L)	*	6 ± 17
Gross Beta (pCi/L)	*	3 ± 26

* Pond frozen

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File

LAB NUMBER: M84-2888
DATE: 12-12-84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 11-27-84

Analysis	North	Center
pH (S.U.)	8.1	10.7
NO_3 as N (mg/L)	579	2.9
Gross Alpha (pCi/L)	160 ± 63	1 ± 11
Gross Beta (pCi/L)	29 ± 29	5 ± 24

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File

LAB NUMBER: M84-2855
DATE: 12-12-84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 11-20-84

Analysis	North	Center
pH (S.U.)	8.0	10.6
NO_3 as N (mg/L)	579	5.5
Gross Alpha (pCi/L)	217 ± 80	34 ± 19
Gross Beta (pCi/L)	11 ± 24	17 ± 26

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File

LAB NUMBER: M84-2787
DATE: 11-29-84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 11-13-84

Analysis	North	Center
pH (S.U.)	8.3	10.8
NO_3 as N (mg/L)	500	<1.0
Gross Alpha (pCi/L)	203 ± 94	20 ± 14
Gross Beta (pCi/L)	46 ± 43	-2 ± 28

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File

LAB NUMBER: M84-2724
DATE: 11-29-84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)   1) North   1) Center
Received: 11-6-84

Analysis	North	Center
pH (S.U.)	8.3	10.7
NO_3 as N (mg/L)	570	2.7
Gross Alpha (pCi/L)	143 ± 55	11 ± 16
Gross Beta (pCi/L)	19 ± 37	-5 ± 23

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File

LAB NUMBER: M84-2664
DATE: 11-7-84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample) 1) North 1) Center
Received: 10-30-84

Analysis	North	Center
pH (S.U.)	8.2	10.5
NO_3 as N (mg/L)	535	2.2
Gross Alpha (pCi/L)	165 ± 62	5 ± 10
Gross Beta (pCi/L)	53 ± 44	-5 ± 22

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File

LAB NUMBER: M84-2604
DATE: 11-7-84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 10-23-84

Analysis	North	Center
pH (S.U.)	8.2	10.6
NO_3 as N (mg/L)	530	<1.0
Gross Alpha (pCi/L)	116 ± 42	11 ± 12
Gross Beta (pCi/L)	48 ± 47	3 ± 26

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File

LAB NUMBER: M84-2541
DATE: 10/22/84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 10/17/84

Analysis	North	Center
pH (S.U.)	7.8	10.5
NO_3 as N (mg/L)	600	1.6
Gross Alpha (pCi/L)	123 ± 50	2 ± 11
Gross Beta (pCi/L)	39 ± 35	3 ± 23

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File

LAB NUMBER: M84-2479
DATE: 10/22/84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 10/9/84

Analysis	North	Center
pH (S.U.)	8.3	10.9
NO_3 as N (mg/L)	570	< 1.0
Gross Alpha (pCi/L)	124 ± 54	8 ± 9
Gross Beta (pCi/L)	39 ± 39	-3 ± 24

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File

LAB NUMBER: M84-2425
DATE: 10/22/84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B 1) North 1) Center
(Weekly Sample) Received: 10/2/84

Analysis	North	Center
pH (S.U.)	8.3	10.9
NO_3 as N (mg/L)	720	< 1.0
Gross Alpha (pCi/L)	97 ± 38	4 ± 15
Gross Beta (pCi/L)	44 ± 38	2 ± 26

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File

LAB NUMBER: M84-2377
DATE: 10-05-84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)   1) North   1) Center
Received: 9-25-84

Analysis	North	Center
pH (S.U.)	8.4	11.1
NO_3 as N (mg/L)	335	<1.0
Gross Alpha (pCi/L)	98 ± 45	8 ± 14
Gross Beta (pCi/L)	38 ± 45	8 ± 29

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File

LAB NUMBER: M84-2312
DATE: 10-05-84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B 1) North 1) Center
(Weekly Sample) Received: 9-18-84

Analysis	North	Center
pH (S.U.)	8.4	11.1
NO_3 as N (mg/L)	560	2.6
Gross Alpha (pCi/L)	126 ± 56	15 ± 16
Gross Beta (pCi/L)	39 ± 50	-8 ± 27

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File

LAB NUMBER: M84-2247
DATE: 9-27-84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample) 1) North 1) Center
Received: 9-11-84

Analysis	North	Center
pH (S.U.)	8.7	11.1
NO_3 as N (mg/L)	852	<1.0
Gross Alpha (pCi/L)	157 ± 63	3 ± 13
Gross Beta (pCi/L)	30 ± 44	17 ± 30

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File

LAB NUMBER: M84-2173
DATE: 9-13-84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 9/4/84

Analysis	North	Center
pH (S.U.)	8.9	10.7
NO_3 as N (mg/L)	340	<1.0
Gross Alpha (pCi/L)	15 ± 79	30 ± 22
Gross Beta (pCi/L)	60 ± 45	13 ± 26

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LAB NUMBER: M84-2124
DATE: 9-13-84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample) 1) North 1) Center
Received: 8/28/84

Analysis	North	Center
pH (S.U.)	9.0	10.6
NO_3 as N (mg/L)	590	<1.0
Gross Alpha (pCi/L)	13 ± 50	4 ± 8
Gross Beta (pCi/L)	24 ± 43	8 ± 31

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File

LAB NUMBER: M84-2043
DATE: 8/28/84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 8/21/84

Analysis	North	Center
pH (S.U.)	9.0	10.2
NO_3 as N (mg/L)	682	1.2
Gross Alpha (pCi/L)	87 ± 42	24 ± 20
Gross Beta (pCi/L)	61 ± 52	24 ± 33

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N. D. Hoffman T452B
File

LAB NUMBER: M84-1992
DATE: 8/20/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 8/14/84

Analysis	North	Center
pH (S.U.)	9.3	10.2
NO_3 as N (mg/L)	676	< 1.0
Gross Alpha (pCi/L)	141 ± 66	18 ± 25
Gross Beta (pCi/L)	16 ± 32	-2 ± 26

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File

LAB NUMBER: M84-1938
DATE: 8/20/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample) 1) North 1) Center
Received: 8/7/84

Analysis	North	Center
pH (S.U.)	8.4	7.4
NO_3 as N (mg/L)	647	< 1.0
Gross Alpha (pCi/L)	95 ± 46	1 ± 16
Gross Beta (pCi/L)	15 ± 38	20 ± 29

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LAB NUMBER: M84-1884
DATE: 8/15/84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)

1) North 1) Center
Received: 7/31/84

Analysis	North	Center
pH (S.U.)	8.9	11.0
NO_3 as N (mg/L)	765	1.2
Gross Alpha (pCi/L)	117 ± 74	30 ± 24
Gross Beta (pCi/L)	27 ± 43	0 ± 29

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File

LAB NUMBER: M84-1815
DATE: 7/30/84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 7/24/84

Analysis	North	Center
pH (S.U.)	9.0	10.9
NO_3 as N (mg/L)	743	<1.0
Gross Alpha (pCi/L)	80 ± 32	15 ± 19
Gross Beta (pCi/L)	20 ± 40	17 ± 30

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File

LAB NUMBER: M84-1751
DATE: 7/24/84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 7/17/84

Analysis	North	Center
pH (S.U.)	8.5	10.4
NO_3 as N (mg/L)	575	< 1.0
Gross Alpha (pCi/L)	143 ± 58	7 ± 19
Gross Beta (pCi/L)	61 ± 66	25 ± 32

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R. D. Gaskins 374
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File

LAB NUMBER: M84-1690
DATE: 7/24/84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 7/10/84

Analysis	North	Center
pH (S.U.)	9.3	11.2
NO_3 as N (mg/L)	690	< 1.0
Gross Alpha (pCi/L)	90 ± 38	12 ± 18
Gross Beta (pCi/L)	52 ± 46	37 ± 39

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File

LAB NUMBER: M84-1650
DATE: 7/24/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample) 1) North 1) Center
Received: 7/3/84

Analysis	North	Center
pH (S.U.)	9.2	10.9
NO_3 as N (mg/L)	633	3.7
Gross Alpha (pCi/L)	153 ± 70	6 ± 23
Gross Beta (pCi/L)	62 ± 55	20 ± 35

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File

LAB NUMBER: M84-1593
DATE: 7/6/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 6/26/84

Analysis	North	Center
pH (S.U.)	9.6	8.9
NO_3 as N (mg/L)	675	1.9
Gross Alpha (pCi/L)	124 ± 67	43 ± 25
Gross Beta (pCi/L)	67 ± 49	-6 ± 27

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File

LAB NUMBER: M84-1523
DATE: 7/6/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 6/19/84

Analysis	North	Center
pH (S.U.)	9.3	8.2
NO_3 as N (mg/L)	674	1.9
Gross Alpha (pCi/L)	250 ± 132	7 ± 20
Gross Beta (pCi/L)	55 ± 51	11 ± 33

ANALYTICAL REPORT

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GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

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C. T. Illsley T452B
R. D. Gaskins 374
N. D. Hoffman T452B
File

LAB NUMBER: M84-1467
DATE: 7/24/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 6/12/84

Analysis	North	Center
pH (S.U.)	8.9	7.7
NO_3 as N (mg/L)	667	1.0
Gross Alpha (pCi/L)	84 ± 49	10 ± 16
Gross Beta (pCi/L)	35 ± 39	23 ± 30

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File

LAB NUMBER: M84-1417
DATE: 8/15/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION

207B Solar Pond - Quarterly Sample Received: 6/5/84

Analysis	Result
pH (S.U.)	9.6
NO_3 as N (mg/L)	2650
Total Dissolved Solids (mg/L)	2109
Gross Alpha (pCi/L)	2886 $\pm$ 2423
Gross Beta (pCi/L)	722 $\pm$ 250
Pu - 239 (pCi/L)	$(3.0 \pm 1.9) \times 10^1$
Am - 241 (pCi/L)	$(9.7 \pm 3.4) \times 10^1$
U (pCi/L)	$(3.3 \pm 0.2) \times 10^3$
^3H (pCi/L)	$(6.4 \pm 0.6) \times 10^3$

ANALYTICAL REPORT

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R. D. Gaskins 374
√N. D. Hoffman T452B
File

LAB NUMBER: M84-1410
DATE: 6/14/84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 6/5/84

Analysis	North	Center
pH (S.U.)	8.6	8.2
NO_3 as N (mg/L)	600	3.1
Gross Alpha (pCi/L)	142 ± 63	8 ± 15
Gross Beta (pCi/L)	58 ± 46	29 ± 31

ANALYTICAL REPORT

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DISTRIBUTION:

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R. D. Gaskins 374
✓N. D. Hoffman T452B
File

LAB NUMBER: M84-1347
DATE: 6/14/84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 5/29/84

Analysis	North	Center
pH (S.U.)	8.7	9.6
NO_3 as N (mg/L)	600	1.7
Gross Alpha (pCi/L)	145 ± 64	20 ± 19
Gross Beta (pCi/L)	37 ± 37	8 ± 25

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BUILDING 881

DISTRIBUTION:

R. L. Henry T452B
C. T. Illsley T452B
R. D. Gaskins 374
N. D. Hoffman T452B
✓File

LAB NUMBER: M84-1298
DATE: 6/7/84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 5/22/84

Analysis	North	Center
pH (S.U.)	8.7	10.8
NO_3 as N (mg/L)	628	5.8
Gross Alpha (pCi/L)	134 ± 59	6 ± 14
Gross Beta (pCi/L)	47 ± 56	17 ± 33

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DISTRIBUTION:

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R. D. Gaskins 374
N. D. Hoffman T452B
File

LAB NUMBER: M84-1221
DATE: 6/7/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample) — 1) North 1) Center
Received: 5/15/84

Analysis	North	Center
pH (S.U.)	8.5	10.9
NO_3 as N (mg/L)	605	6.1
Gross Alpha (pCi/L)	132 ± 59	12 ± 13
Gross Beta (pCi/L)	51 ± 41	-11 ± 26

ANALYTICAL REPORT

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DISTRIBUTION:

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R. D. Gaskins 374
N. D. Hoffman T452B
✓File

LAB NUMBER: M84-1158
DATE: 6/7/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)
1) North 1) Center
Received: 5/8/84

Analysis	North	Center
pH (S.U.)	8.2	10.3
NO_3 as N (mg/L)	628	3.2
Gross Alpha (pCi/L)	121 ± 53	18 ± 19
Gross Beta (pCi/L)	51 ± 31	5 ± 25

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DISTRIBUTION:

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C. T. Illsley T452B
R. D. Gaskins 374
N. D. Hoffman T452B
✓File

LAB NUMBER: M84-1091
DATE: 5/18/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)   1) North   1) Center
Received: 5/1/84

Analysis	North	Center
pH (S.U.)	8.5	11.2
NO_3 as N (mg/L)	561	4.8
Gross Alpha (pCi/L)	105 ± 48	-3 ± 12
Gross Beta (pCi/L)	43 ± 32	0 ± 24

ANALYTICAL REPORT

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...STRIBUTION:

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..T. Illsley T452B
..D. Gaskins 374
..D. Hoffman T452B
..le

LAB NUMBER: M84-1012
DATE: 5/9/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

...MPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)

1) North 1) Center
Received: 4/24/84

...alysis	North	Center
... (S.U.)	8.3	11.0
...$_3$ as N (mg/L)	645	4.8
...oss Alpha (pCi/L)	162 ± 70	18 ± 14
...oss Beta (pCi/L)	49 ± 33	23 ± 26

ANALYTICAL REPORT

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ISTRIBUTION:

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. T. Illsley T452B
. D. Gaskins 374
. D. Hoffman T452B
ile

LAB NUMBER: M84-963
DATE: 5/9/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

AMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)

1) North 1) Center
Received: 4/17/84

alysis	North	Center
H (S.U.)	8.4	11.1
O_3 as N (mg/L)	563	5.5
ross Alpha (pCi/L)	98 ± 48	6 ± 17
ross Beta (pCi/L)	71 ± 41	21 ± 25

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C. T. Illsley T452B
R. D. Gaskins 374
✓File

LAB NUMBER: M84-902
DATE: 4-16-84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION
Solar Evaporation Pond 207B
Samples: 1) North 2) Center
Received: 4-10-84

ANALYSIS RESULTS

Analysis	North	Center
Gross Alpha (pCi/L)	209 ± 91	2 ± 16
Gross Beta (pCi/L)	53 ± 42	12 ± 27
pH (S.U.)	8.5	11.1
NO_3 as N (mg/L)	537	3.9

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ANALYTICAL REPORT

Account No. 331 Date 4-10-84 Lab. No. M84-825

Henry T452B
Illsley T452B
Gaskins 374
Hoffman T452B

Reported by
Approved J. A. Palcic

Description

Solar Evaporation Pond 207B - 1) North 2) Center

Received: 4-3-84

Results

Analysis	North	Center
Ph (S.U.)	8.2	10.2
NO_3 as N (mg/L)	531	4.7
Gross Alpha (pCi/L)	283 ± 133	18 ± 21
Gross Beta (pCi/L)	72 ± 47	21 ± 29

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ANALYTICAL REPORT

Account No. 331 Date 4-3-84 Lab. No. M84-766

L. Henry T452B
T. Illsley T452B
D. Gaskins 374
D. Hoffman T452B

Reported by

Approved J. A. Palcic

Description

Solar Evaporation Pond 207B - Samples North & Center

Received: 3-27-84

Results

Analysis	North	Center
Gross Beta (pCi/L)	53 ± 40	3 ± 23
Gross Alpha (pCi/L)	139 ± 63	12 ± 15
pH	8.1	10.5
NO_3 as N (mg/L)	510	7.1

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ANALYTICAL REPORT

o | Account No. 331 | Date 3-27-84 | Lab. No. M84-688

R. L. Henry T452B
C. T. Illsley T452B
R. D. Gaskins 374
N. D. Hoffman T452B
File

Reported by
Approved J. A. Palcic

mple Description

Solar Evaporation Pond 207B - Samples North and Center

Received 3-20-84

nalysis Results

	North	Center
Gross Alpha (pCi/L)	144 ± 74	6 ± 21
Gross Beta (pCi/L)	45 ± 36	3 ± 24
pH	8.6	11.3
NO_3 as N (mg/L)	570	9.6

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ANALYTICAL REPORT

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Account No. 331 Date 3-27-84 Lab. No. M84-635

.. Henry T452B
. Illsley T452B
.. Gaskins 374
.. Hoffman T452B

Reported by

Approved J. A. Palcic

Description

Solar Evaporation Pond 207B - Samples North and Center

Received 3-13-84

Results

	North	Center
Alpha (pCi/L)	151 ± 81	2 ± 16
Beta (pCi/L)	37 ± 33	13 ± 22
	8.0	9.9
as N (mg/L)	1367	6.7

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ANALYTICAL REPORT

L. Henry - T452B Account No. 331 Date 3-23-84 Lab. No. M84-573
T. Illsley - T452B
D. Gaskins - 374
D. Hoffman - T452B
'e

Reported by

Approved J. A. Palcic

Description
B North and Center Solar Ponds.
Received: 3-6-84

Results

	207B North	201B Center
Gross Alpha (pCi/L)	80 ± 42	3 ± 15
Gross Beta (pCi/L)	51 ± 40	12 ± 30
	8.2	10.9
as N (mg/L)	569	8.6

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ANALYTICAL REPORT

1R. L. Henry - T452B C. T. Illsley - T452B R. D. Gaskins - 374 Y. D. Hoffman - T452B c/c	Account No. 331	Date 3-23-84	Lab. No. M84-514
		Reported by	
		Approved J. A. Palcic	

e Description

207B North Solar Pond. Received 2-28-84

sis Results

Analysis	Result
Gross Alpha (pCi/L)	76 ± 33
Gross Beta (pCi/L)	66 ± 41
pH	8.3
NO_3 as N (mg/L)	420

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ANALYTICAL REPORT

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To R.L. Henry 452
C.T. Illsley 452
R.D. Gaskins 374
N.D. Hoffman 452
File

Account No. 331

Date 2/29/84

Lab. No. M84-451

Reported by

Approved J.A. Palcic

Sample Description

SOLAR EVAP. POND 207B CENTER & NORTH

Received: 2/21/84

Analysis Results

ANALYSIS	RESULTS North	RESULTS Center
Gross Alpha (pCi/L)	70±31	6±15
Gross Beta (pCi/L)	34±32	9±22
pH	8.4	10.6
NO_3^- as N	550	8.2

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ANALYTICAL REPORT

To
R.L. Henry 452
C.T. Illsley 452
R.D. Gaskins 374
N.D. Hoffman 452
File

Account No. 331

Date 2/27/84

Lab. No. M84-395

Reported by

Approved J.A. Palcic

Sample Description

SOLAR EVAP. POND 207 B NORTH & CENTER

Received: 2/14/84

Analysis Results

ANALYSIS	RESULTS North	Center
pH	8.1	9.7
NO_3^- as N (mg/L)	579	8.6
Gross Alpha (pCi/L)	110±56	2±16
Gross Beta (pCi/L)	25±31	3±24

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ANALYTICAL REPORT

To
R.L. Henry 452
C.T. ILlsley 123
R.D. Gaskins 374
N.D. Hoffman 452
File

Account No. 331

Date 2/16/84

Lab. No. M84-311

Reported by

Approved J.A. Palcic

Sample Description

SOLAR EVAP. POND 207B CENTER

Received: 2/7/84

Analysis Results

ANALYSIS	RESULTS
Alpha (pCi/L)	5±14
Beta (pCi/L)	2±22
pH	9.1
NO_3^- as N (mg/L)	7.1

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ANALYTICAL REPORT

To
R.L. Henry 452
C.T. Illsley 123
R.D. Gaskins 374
N.D. Hoffman 452
File

Account No. 331

Date 2/8/84

Lab. No. M84-248

Reported by

Approved J.A. Palcic

Sample Description

SOLAR EVAP. POND 207B CENTER

Received: 1/31/84

Analysis Results

ANALYSIS	RESULTS
Gross Alpha (pCi/L)	20±23
Gross Beta (pCi/L)	23±26
pH	8.4
NO_3^- as N (mg/L)	5.5

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ANALYTICAL REPORT

.. Henry 452
. Illsley 123
. Gaskins 374
. Hoffman 452
le

Account No. 331

Date 2/6/84

Lab. No. M84-0182

Reported by

Approved J.A. Palcic

Description

SOLAR EVAP. PONE 207 B CENTER

Received: 1/24/84

Results

ANALYSIS	RESULTS
Gross Alpha (pCi/L)	6±12
Gross Beta (pCi/L)	5±25
pH	7.3
NO_3^- as N (mg/L)	10.1

ANALYTICAL REPORT

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File

LAB NUMBER: M85-0949
DATE: 5-24-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Quarterly Sample)   1) North   1) Center
Received: 4-23-85

Elemental analysis results are reported on attached sheets.

LAB NO: M85-0949
DATE: MAY 23, 1985

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ROCKY FLATS PLANT
881 GENERAL LABORATORY

ANALYSIS REPORT

TO: C.T.ILLSLEY
CC: FILE

BLDG: T 452B
DEPT: ENV. ANALYSIS

CHARGE: 331

SAMPLE DESCRIPTION:

SOLAR POND (NORTH)

EMISSION SPECTROGRAPHIC RESULTS

ELEMENT		Mg/L	ELEMENT		Mg/L
Ag		.082	Mo		<.0041
Al		.16	Na	*	620.0
As	*	<.01	Nb		<.2
B		.29	Ni		<.041
Ba	*	<1.0	P		<.2
Be	*	<.05	Pb		<.0041
Bi		<.02	Rb		<.41
Ca	*	290	Sb		<.041
Cd	*	<.01	Se	*	.02
Ce		<4.1	Si	*	2.1
Co		<.02	Sn		<.041
Cr	*	<.05	Sr		1.2
Cs		<.41	Ta		<.041
Cu		<.02	Te		<.41
Fe		.29	Th		<.041
Ge		<.02	Ti		<.02
Hg	*	<.002	Tl		<.02
K	*	120.0	U		<2
Li		.37	V		<.041
Mg	*	120.0	W		<2
Mn		<.0041	Zn		<.2
			Zr		<.041

* ATOMIC ABSORPTION SPECTROPHOTOMETRIC RESULTS.
** NOT RUN

TOTAL SOLIDS: 4084

ANALYSIS BY: R2D,DLP

PLATE NO: 2994

APPROVED BY R.A. Silva

LAB NO: M85-0949
DATE: MAY 23, 1985

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ROCKY FLATS PLANT
881 GENERAL LABORATORY

ANALYSIS REPORT

TO: C.T.ILLSLEY — BLDG: T 452B — CHARGE: 331
CC: FILE — DEPT: ENV. ANALYSIS

SAMPLE DESCRIPTION:

SOLAR POND (CENTER)

EMISSION SPECTROGRAPHIC RESULTS

ELEMENT		Mg/L	ELEMENT		Mg/L
Ag		.015	Mo		.037
Al		.15	Na	*	250.0
As	*	<.01	Nb		<.037
B		.67	Ni		.015
Ba	*	<1.0	P		.074
Be	*	<.05	Pb		<.0007
Bi		<.0037	Rb		<.074
Ca	*	45.0	Sb		<.0074
Cd	*	<.01	Se	*	<.01
Ce		<.74	Si	*	5.5
Co		<.0037	Sn		<.0074
Cr	*	<.05	Sr		.52
Cs		<.074	Ta		<.0074
Cu		.037	Te		<.074
Fe		.074	Th		<.0074
Ge		<.0037	Ti		.022
Hg	*	<.002	Tl		<.0037
K	*	36.0	U		<.37
Li		.052	V		<.0074
Mg	*	13.0	W		<.37
Mn		.022	Zn		<.037
			Zr		<.0074

* ATOMIC ABSORPTION SPECTROPHOTOMETRIC RESULTS.
** NOT RUN

TOTAL SOLIDS: 744

ANALYSIS BY: R2D,DLP

PLATE NO: 2994

APPROVED BY R.C. Silva

ANALYTICAL REPORT

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File

LAB NUMBER: M84-2608
DATE: 11-28-84
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B 1) North 2) Center
Received: 10/23/84

ANALYSIS RESULTS

Elemental analysis results are reported on attached sheets.

LAB NO: M84-2608
DATE: NOVEMBER 21,1984

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ANALYSIS REPORT

TO: R.L.HENRY
CC: FILE

BLDG: T452B
DEPT: ENV.ANALYSIS

CHARGE: 331

SAMPLE DESCRIPTION:

SOLAR POND B (CENTER)

EMISSION SPECTROGRAPHIC RESULTS

ELEMENT		Mg/L	ELEMENT		Mg/L
Ag		.0016	Mo		.016
Al		2	Na	•	67.0
As	•	<.01	Nb		<.02
B		.24	Ni		.016
Ba	•	<1.0	P		.2
Be	•	<.05	Pb		.002
Bi		<.002	Rb		.041
Ca	•	2.9	Sb		<.0041
Cd	•	<.01	Se	•	<.01
Ce		<.41	Si	•	2.4
Co		<.002	Sn		<.0041
Cr	•	<.05	Sr		.28
Cs		.041	Ta		<.0041
Cu		.016	Te		<.041
Fe		.2	Th		<.0041
Ge		<.002	Ti		.041
Hg	•	<.002	Tl		<.002
K	*	30.0	U		<.2
Li		.41	V		.0081
Mg	*	3.9	W		<.2
Mn		.081	Zn		.041
			Zr		.0041

• ATOMIC ABSORPTION SPECTROPHOTOMETRIC RESULTS.
** NOT RUN

TOTAL SOLIDS: 406

ANALYSIS BY: R2D,DLP

PLATE NO: 2884

APPROVED BY R. A. Silva

LAB NO: M84-2608
DATE: NOVEMBER 21,1984

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ANALYSIS REPORT

TO: R.L.HENRY   BLDG: T452B   CHARGE: 331
CC: FILE   DEPT: ENV.ANALYSIS

SAMPLE DESCRIPTION:

SOLAR POND B (NORTH)

EMISSION SPECTROGRAPHIC RESULTS

ELEMENT		Mg/L	ELEMENT		Mg/L
Ag		<.0035	Mo		.0069
Al		1	Na	*	370.0
As	•	<.01	Nb		<.17
B		.31	Ni		<.035
Ba	*	<1.0	P		<.17
Be	•	<.05	Pb		.0035
Bi		<.017	Rb		<.35
Ca	•	20.0	Sb		<.035
Cd	•	<.01	Se	*	.01
Ce		<3.5	Si	•	5.6
Co		<.017	Sn		<.035
Cr	*	<.05	Sr		3.5
Cs		<.35	Ta		<.035
Cu		<.017	Te		<.35
Fe		.28	Th		<.035
Ge		<.017	Ti		.069
Hg	•	<.002	Tl		<.017
K	*	82.0	U		<1.7
Li		3.5	V		<.035
Mg	•	87.0	W		<1.7
Mn		<.035	Zn		<.17
			Zr		<.035

• ATOMIC ABSORPTION SPECTROPHOTOMETRIC RESULTS.
** NOT RUN

TOTAL SOLIDS: 3459

ANALYSIS BY: R2D,DLP

PLATE NO: 2884   APPROVED BY ...R. A. Silva...

POND 207C DATA

207C

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. T. Illsley, HS&E T452B
R. L. Henry, HS&E T452B
File

LAB NUMBER: M85-2224
DATE: 10-03-85
ACCOUNT NO: 331

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

207 A and C Solar Pond - Quarterly - Received: 9-11-85

ANALYSIS RESULTS

Analysis	207 A	207 C
pH (S.U.)	10.0	12.5
NO^-_3 as N (mg/L)	21739	18841
T. D. S. (mg/L)	171976	171135
CN^- (ppm)	1.7	<0.1
Be (ug/ml)	0.1	0.6
Gross Alpha (pCi/L)	$(5.6 \pm 0.0) \times 10^4$	$(8.8 \pm 0.6) \times 10^3$
Gross Beta (pCi/L)	$(2.7 \pm 0.6) \times 10^4$	$(6.4 \pm 1.1) \times 10^3$
Pu-239 (pCi/L)	$(0.0 \pm 4.2) \times 10^2$	$(1.4 \pm 0.3) \times 10^3$
Am-241 (pCi/L)	$(0.0 \pm 1.0) \times 10^3$	$(1.3 \pm 0.1) \times 10^4$
U (pCi/L)	$(2.6 \pm 0.2) \times 10^4$	$(1.8 \pm 0.3) \times 10^3$
^3H (pCi/L)	$(3.0 \pm 0.8) \times 10^3$	$(7.2 \pm 0.9) \times 10^2$

LAB NO: M85-1236
DATE: JULY 12, 1985

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
ROCKY FLATS PLANT
881 GENERAL LABORATORY

ANALYSIS REPORT

TO: R.D.GASKINS JR.
CC: FILE

BLDG: 374
DEPT: LIQ. WASTE OPER.

CHARGE: 371

SAMPLE DESCRIPTION:

WATER SLUDGE

EMISSION SPECTROGRAPHIC RESULTS

ELEMENT	Mg/L	ELEMENT	Mg/L
Ag	4.3	Mo	.87
Al	>1100	Na	>11000
As	<5.4	Nb	11
B	11	Ni	22
Ba	3.3	P	760
Be	9.8	Pb	7.6
Bi	<.54	Rb	11
Ca	>1100	Sb	<1.1
Cd	33	Se	** 0
Ce	<110	Si	220
Co	.98	Sn	<1.1
Cr	65	Sr	54
Cs	<11	Ta	<1.1
Cu	43	Te	<11
Fe	110	Th	<1.1
Ge	<.54	Ti	9.8
Hg	<1.1	Tl	<.54
K	>11000	U	<54
Li	98	V	<1.1
Mg	1100	W	<54
Mn	6.5	Zn	7.6
		Zr	2.2

* ATOMIC ABSORPTION SPECTROPHOTOMETRIC RESULTS.
** NOT RUN

TOTAL SOLIDS: 108700

ANALYSIS BY: R2D

PLATE NO: 3020

APPROVED BY R. A. Silva

207 C

7.6

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

✓C. T. Illsley, HS&E T-452B
File

LAB NUMBER: M85-1557
DATE: 7-11-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Pond 207A & 207C - Quarterly Received: 6-25-85

ANALYSIS RESULTS

Analysis	207A	207C
pH (S.U.)	10.1	10.7
NO_3^- as N (mg/L)	14800	8000
T.D.S. (mg/L)	10360	6420
Be (ug/ml)	0.1	<0.1
Gross Alpha (pCi/L)	2.4×10^4	6.5×10^3
Gross Beta (pCi/L)	$(5.2 \pm 1.0) \times 10^3$	$(1.1 \pm 0.2) \times 10^4$
CN^- (mg/L)	<0.01	<0.01

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. T. Illsley, HS&E T452B
R. L. Henry, HS&E T452B
File

LAB NUMBER: M85-0718
DATE: 4-25-85
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

207-C Solar Pond - Quarterly - Received: 3-25-85

ANALYSIS RESULTS

Analysis	Results
pH (S.U.)	7.7
NO^{-}_{3} as N (mg/L)	2593
T. D. S. (mg/L)	27304
CN^{-} (ppm)	1.9
Be (ug/ml)	<0.1
Gross Alpha (pCi/L)	$(2.5 \pm 0.4) \times 10^{3}$
Gross Beta (pCi/L)	$(4.3 \pm 0.3) \times 10^{3}$
Pu-239 (pCi/L)	$(2.1 \pm 3.2) \times 10^{1}$
Am-241 (pCi/L)	$(1.1 \pm 0.5) \times 10^{2}$
U (pCi/L)	$(3.7 \pm 0.4) \times 10^{3}$
^{3}H (pCi/L)	0.0 ± 0.0

INFO

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. T. Illsley, HS&E T452B
R. L. Henry, HS&E T452B
File

LAB NUMBER: M84-2976
DATE: 12-24-84
ACCOUNT NO: 331

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

Solar Pond 207C - Received: 12-5-84

ANALYSIS RESULTS

ANALYSIS	RESULTS
pH (S.U.)	9.8
NO_3 as N (mg/L)	7050
T.D.S (mg/L)	66432
Gross Alpha (pCi/L)	$(1.5 \pm 0.3) \times 10^4$
Gross Beta (pCi/L)	405 ± 79
Pu (pCi/L)	$(4.6 \pm 1.3) \times 10^2$
U (pCi/L)	$(1.5 \pm 0.1) \times 10^4$
Am (pCi/L)	$(0.4 \pm 1.0) \times 10^2$
H^3 (pCi/L)	$(1.5 \pm 0.6) \times 10^3$

/ 5

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

✓C. T. Illsley, T452B HS&E
File

LAB NUMBER: M84-2276
DATE: 9-27-84
ACCOUNT NO: 331

APPROVED: J. A. Blair
J. A. Blair

SAMPLE DESCRIPTION

Solar pond 207C - Quarterly sample - Received: 9-13-84

ANALYSIS RESULTS

Analysis	Results
pH (S. U.)	10.0
NO_3 as N (mg/L)	7100
TDS (mg/L)	66757
Gross Alpha (pCi/L)	$(1.0 \pm 1.7) \times 10^4$
Gross Beta (pCi/L)	771 ± 227
Pu (pCi/L)	$(1.2 \pm 0.8) \times 10^2$
Am (pCi/L)	$(1.4 \pm 0.9) \times 10^2$
U (pCi/L)	$(1.3 \pm 0.1) \times 10^4$
Tritium (pCi/L)	$(1.2 \pm 0.4) \times 10^3$

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. T. Illsley T-452B
N. D. Hoffman T-452B
R. L. Henry T-452B
R. D. Gaskins 374
File

LAB NUMBER: M84-1417
DATE: 8/15/84
ACCOUNT NO: 331

APPROVED: J. A. Palcic

SAMPLE DESCRIPTION

207C Solar Pond - Quarterly Sample Received: 6/5/84

Analysis	Result
pH (S.U.)	9.6
NO_3 as N (mg/L)	2650
Total Dissolved Solids (mg/L)	2109
Gross Alpha (pCi/L)	2886 $\pm$ 2423
Gross Beta (pCi/L)	722 $\pm$ 250
Pu - 239 (pCi/L)	$(3.0 \pm 1.9) \times 10^1$
Am - 241 (pCi/L)	$(9.7 \pm 3.4) \times 10^1$
U (pCi/L)	$(3.3 \pm 0.2) \times 10^3$
^3H (pCi/L)	$(6.4 \pm 0.6) \times 10^3$

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
P.O. BOX 464
GOLDEN, COLORADO 80401

ANALYTICAL REPORT

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. T. Illsley T-452B
N. D. Hoffman T-452B
File

LAB NUMBER: M84-712
DATE: 5/9/84
ACCOUNT NO: 331

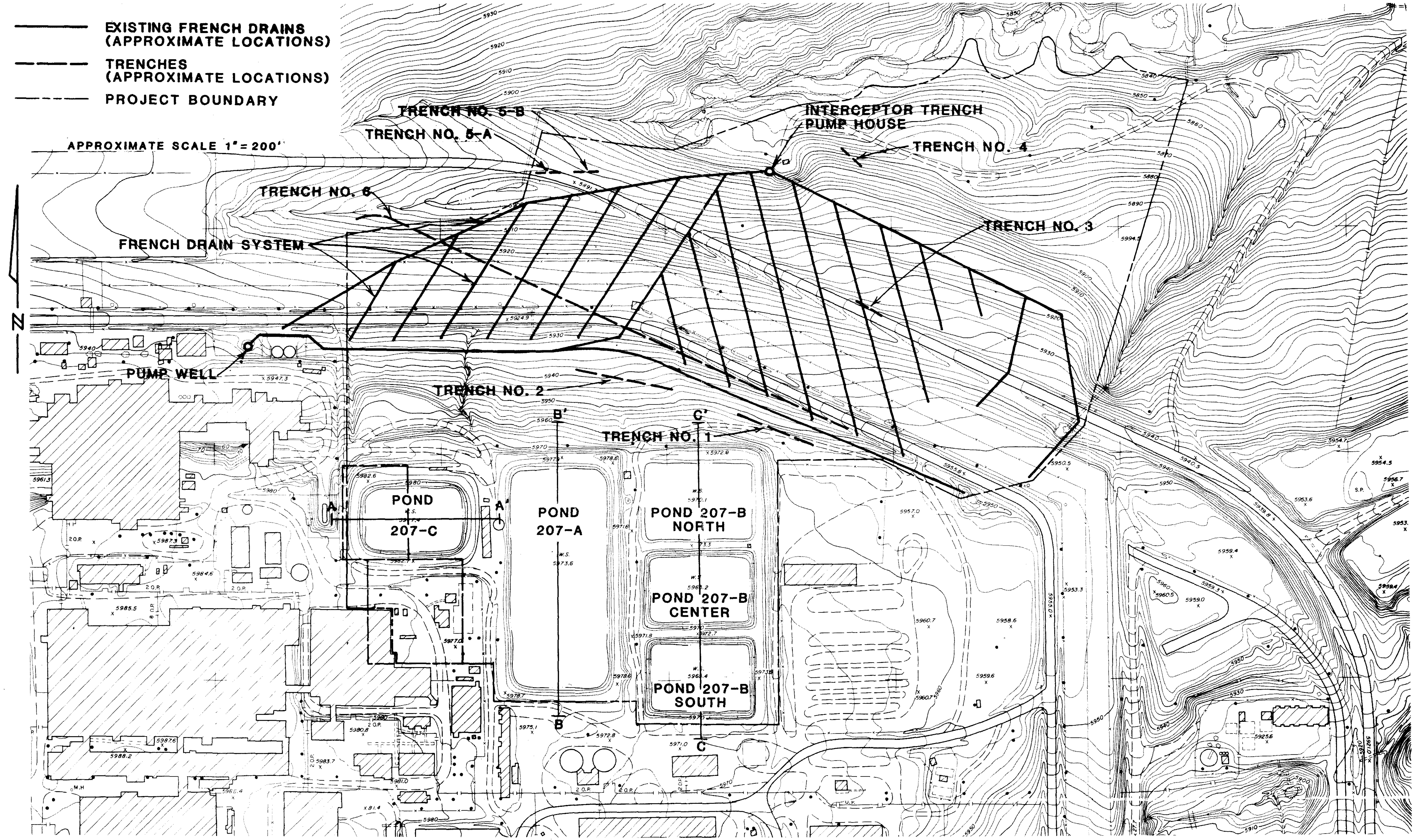
APPROVED: /J. A. Palcic

SAMPLE DESCRIPTION

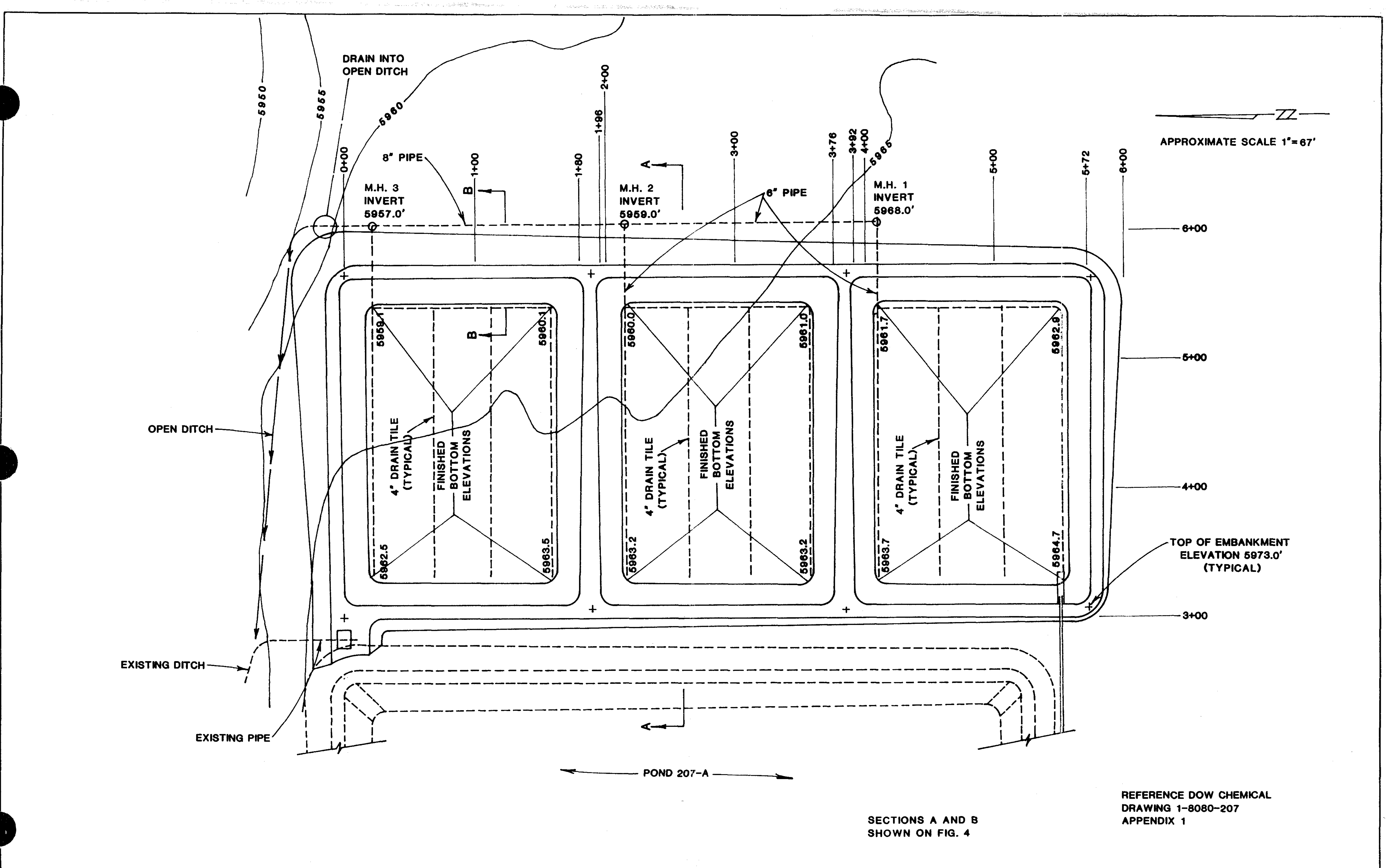
Solar Pond 207C - Monthly

Received: 3/22/84

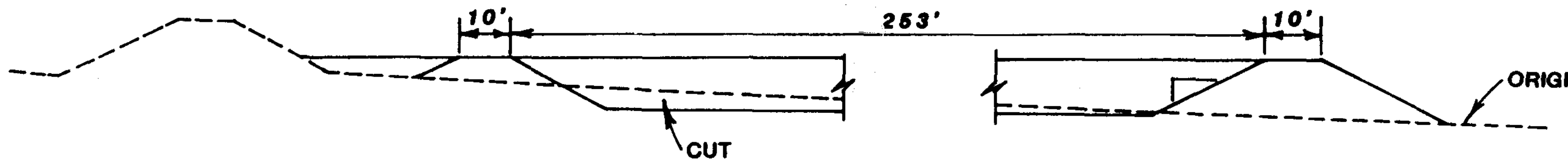
Analysis	Result
pH (S.U.)	9.7
NO_3 as N (mg/L)	0.4
T.D.S. (mg/L)	2090
Gross Alpha (pCi/L)	$(2.1 \pm 1.5) \times 10^3$
Gross Beta (pCi/L)	$(6.2 \pm 1.7) \times 10^2$
H^3 (pCi/L)	$(4.0 \pm 1.7) \times 10^2$
Pu (pCi/L)	4.9×10^1
Am (pCi/L)	1.2×10^1
U (pCi/L)	2.3×10^3



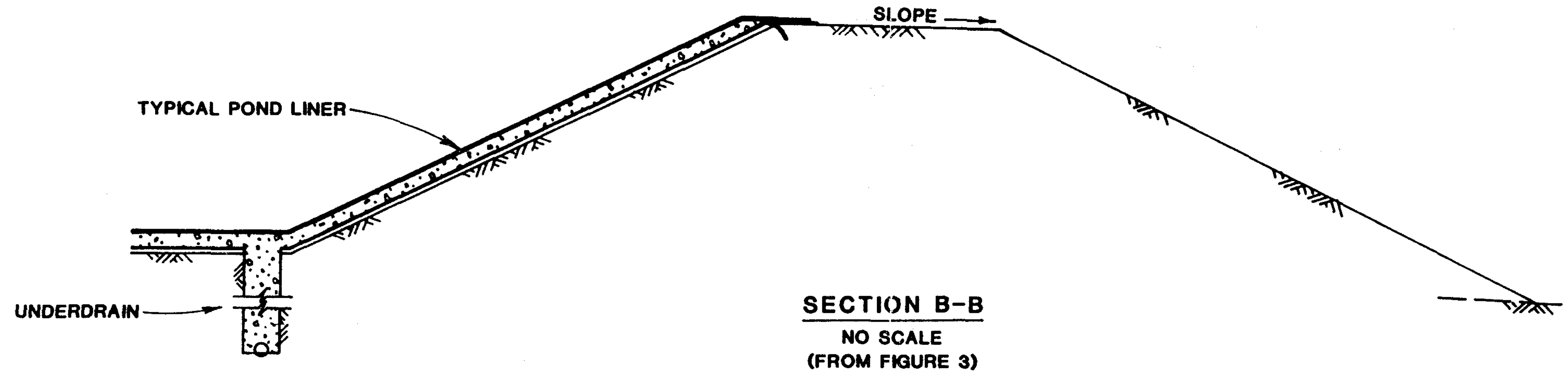
6 033 88	Chen & Associates	ROCKY FLATS SOLAR EVAPORATION PONDS	LOCATION MAP	Fig. 2



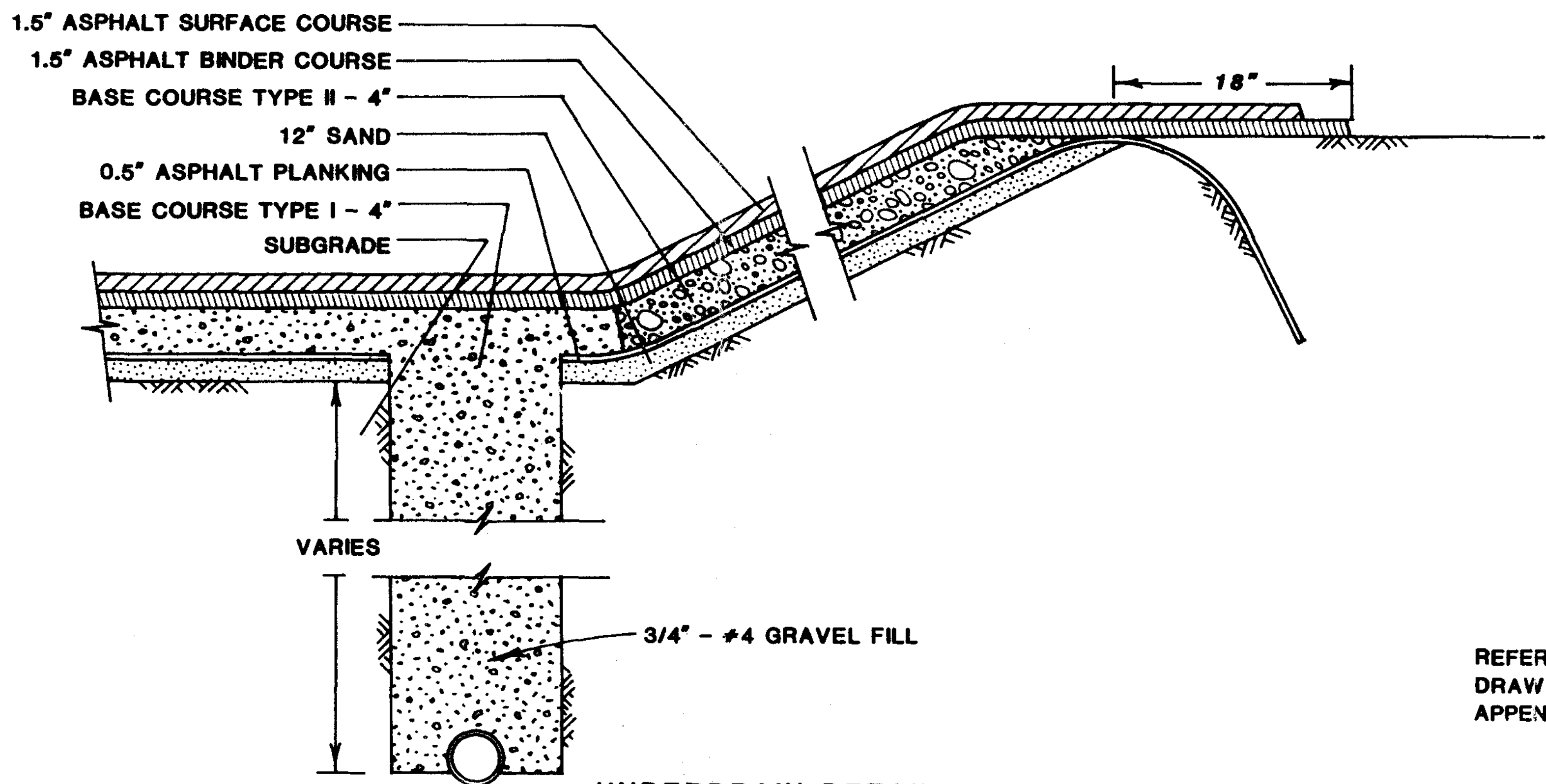
6 033 88	Chen & Associates	PLAN SOLAR PONDS 207-B	Fig. 3



SECTION A-A
NO SCALE
(FROM FIGURE 3)



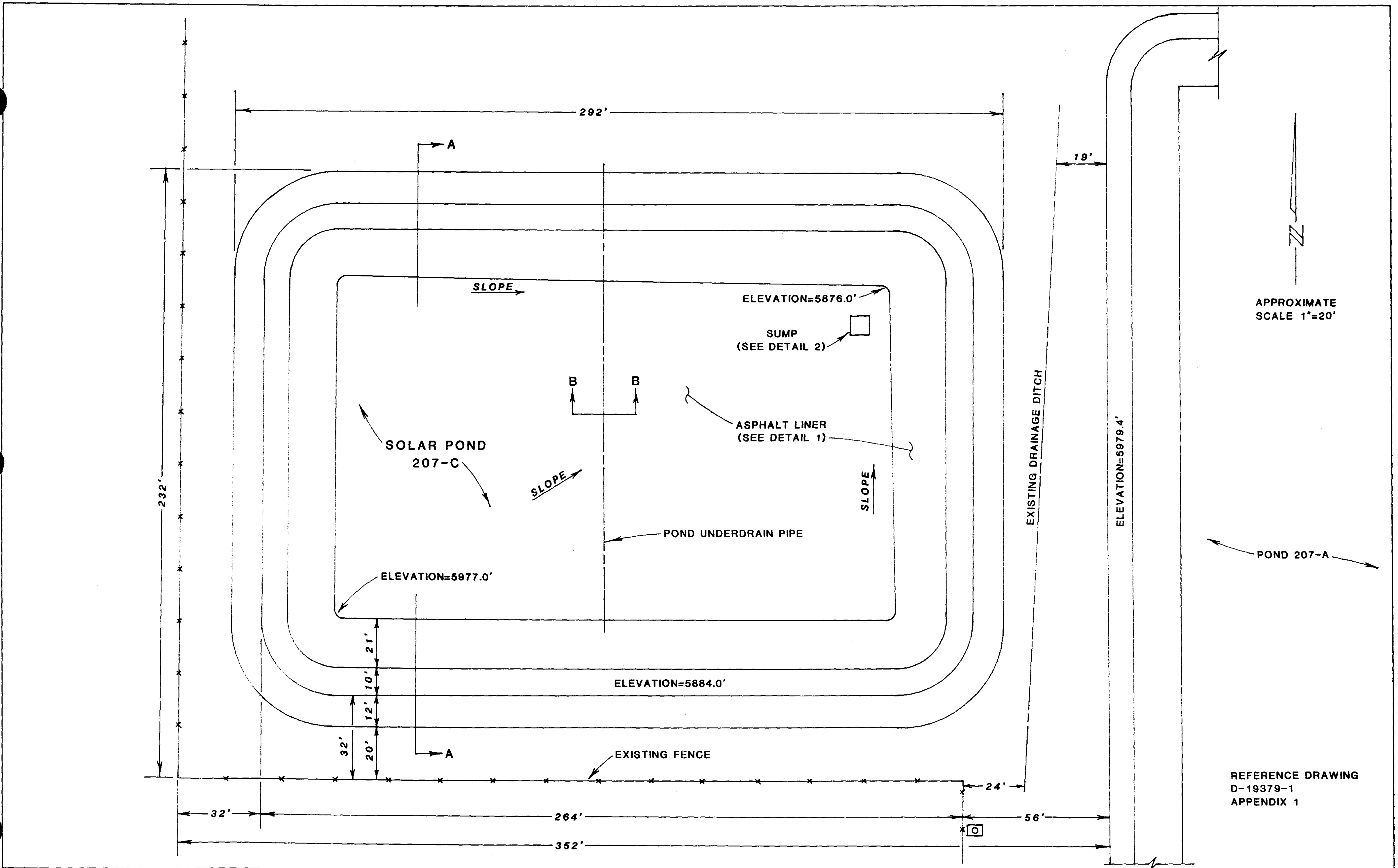
SECTION B-B
NO SCALE
(FROM FIGURE 3)



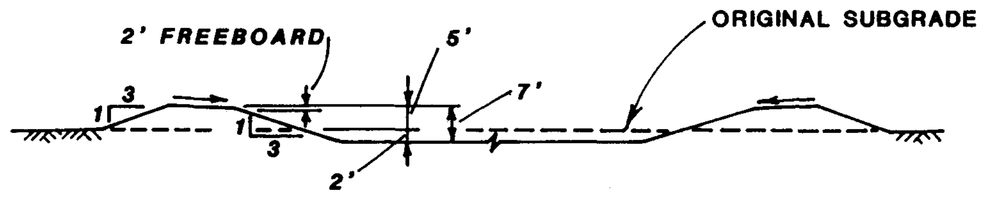
UNDERDRAIN DETAIL
NO SCALE

REFERENCE DOW CHEMICAL
DRAWING 1-8080-207
APPENDIX 1

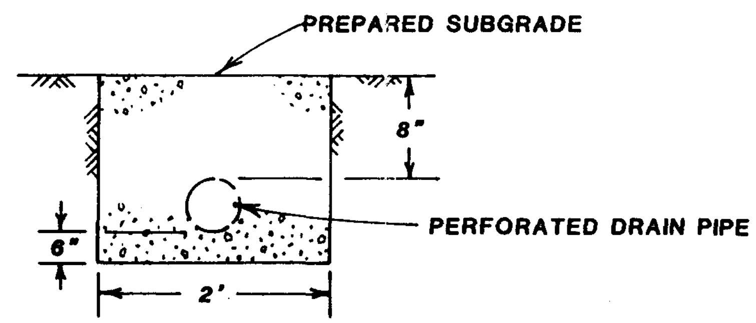
6 033 88	Chen & Associates	SECTIONS AND DETAILS - SOLAR PONDS 207-B	DETAILS SOLAR PONDS 207-B	Fig. 4



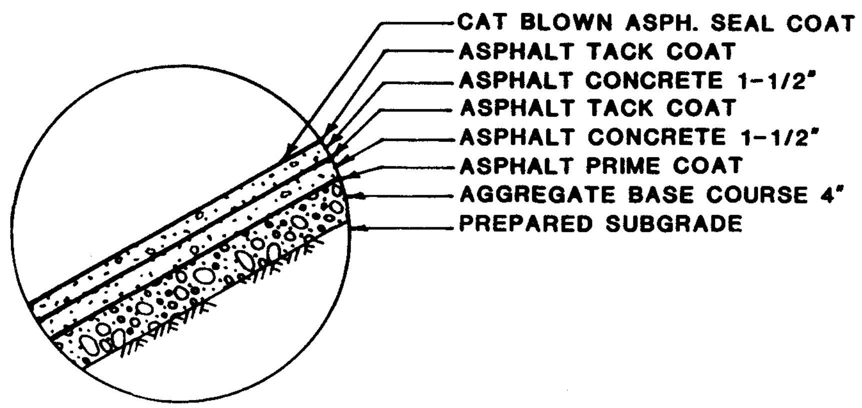
6 033 88 | Chen & Associates | SOLAR POND 207-C, ROCKY FLATS | PLAN SOLAR POND 207-C | Fig. 5



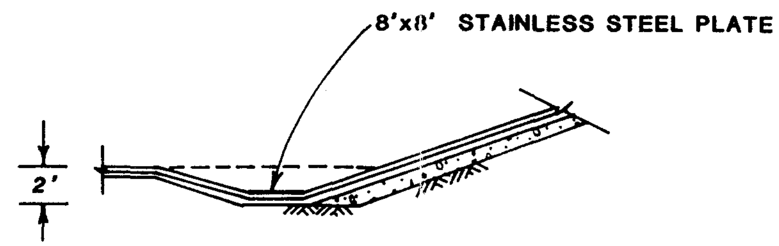
SECTION A-A
APPROXIMATE SCALE 1"=40'



SECTION B-B
NO SCALE



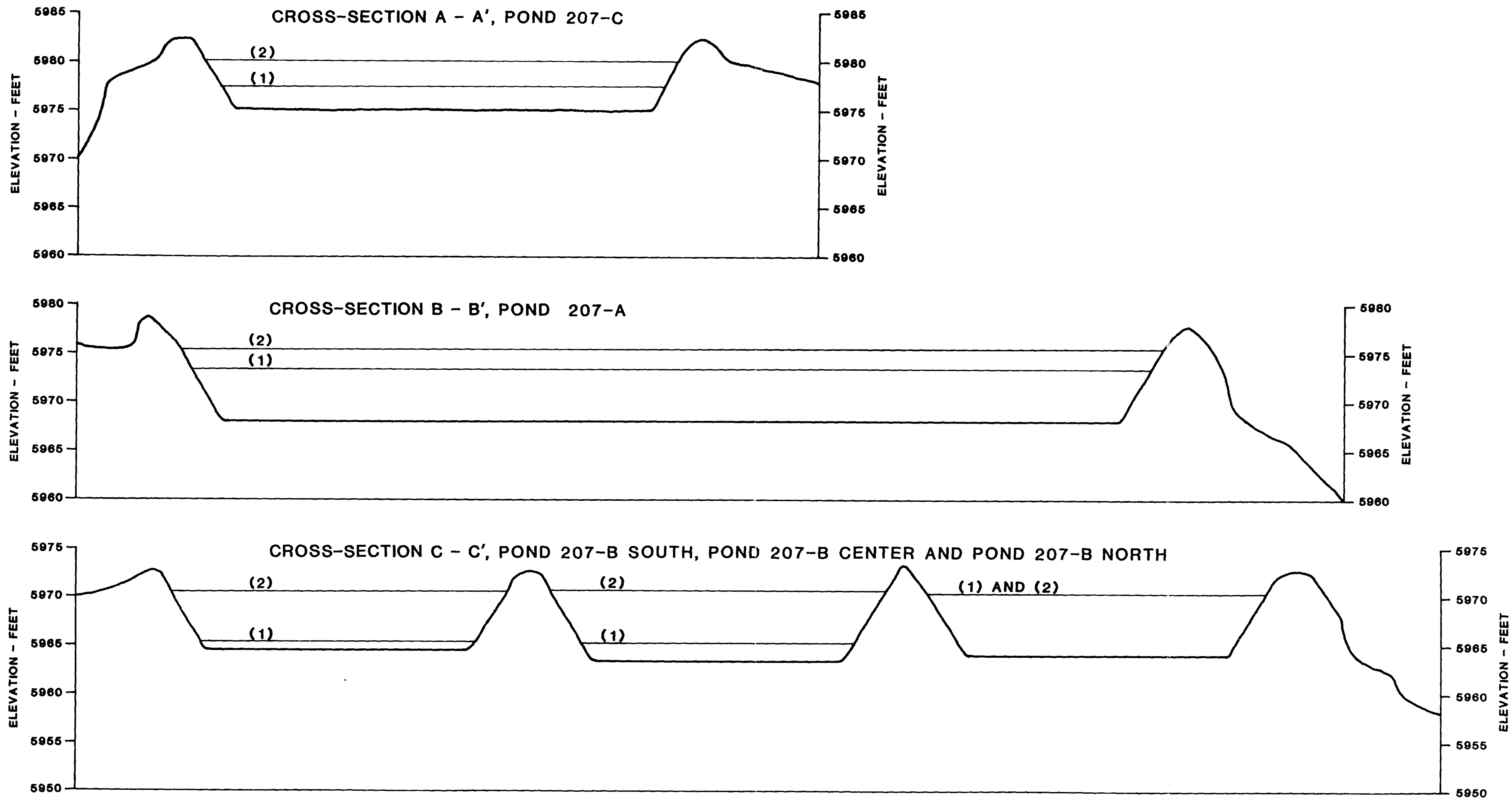
DETAIL 1 - ASPHALT LINER
NO SCALE



DETAIL 2 - SUMP
NO SCALE

REFERENCE DRAWING
D-19379-1
APPENDIX 1

6 033 88	Chen & Associates	SOLAR POND 207-C, ROCKY FLATS	DETAILS SOLAR POND 207-C	Fig. 6



VERTICAL SCALE 1"=10′
HORIZONTAL SCALE 1"=50′

NOTES:

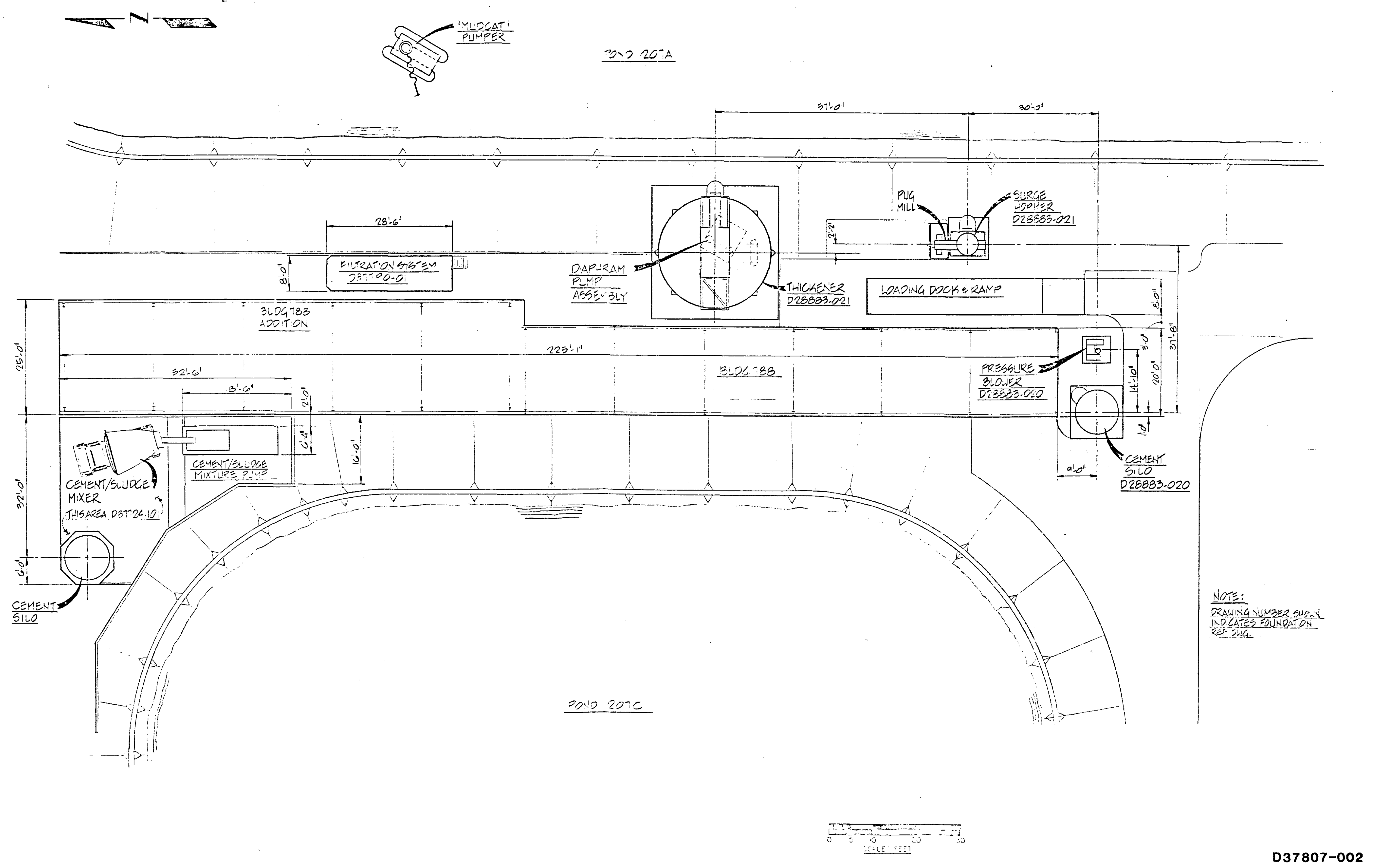
(1) WATER SURFACE ELEVATION ON MAY 20, 1986.

(2) MAXIMUM WATER SURFACE ELEVATION ANTICIPATED DURING CLOSURE, TABLE I.

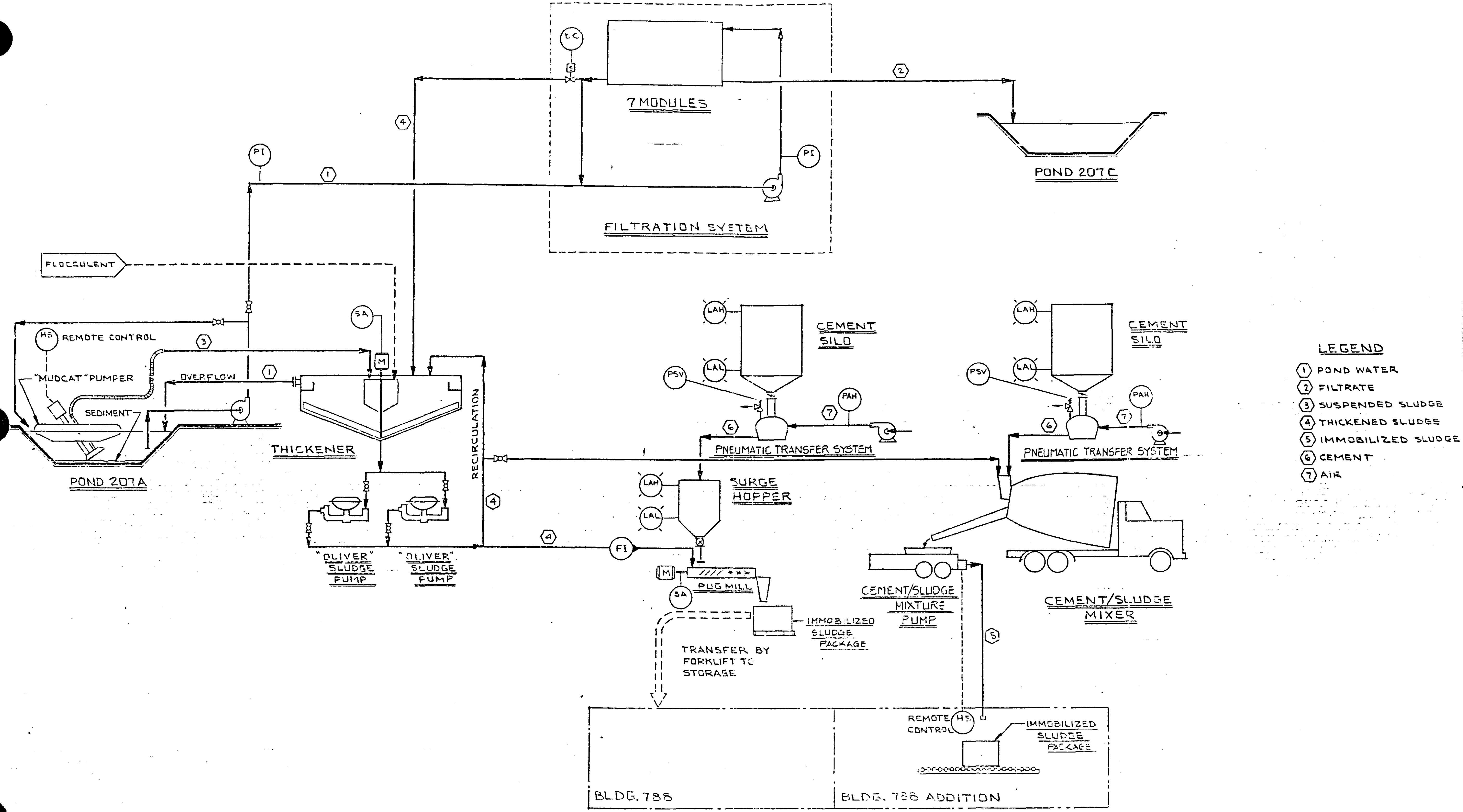
3. WATER SURFACE ELEVATIONS AND TOPOGRAPHY GENERATED FROM TOPOGRAPHY TAKEN MAY 20, 1986.

4. SEE FIGURE 2 FOR LOCATIONS OF CROSS-SECTIONS.

6 033 88	Chen & Associates	ROCKY FLATS SOLAR EVAPORATION PONDS	CROSS-SECTIONS THROUGH THE SOLAR EVAPORATION PONDS	Fig. 8

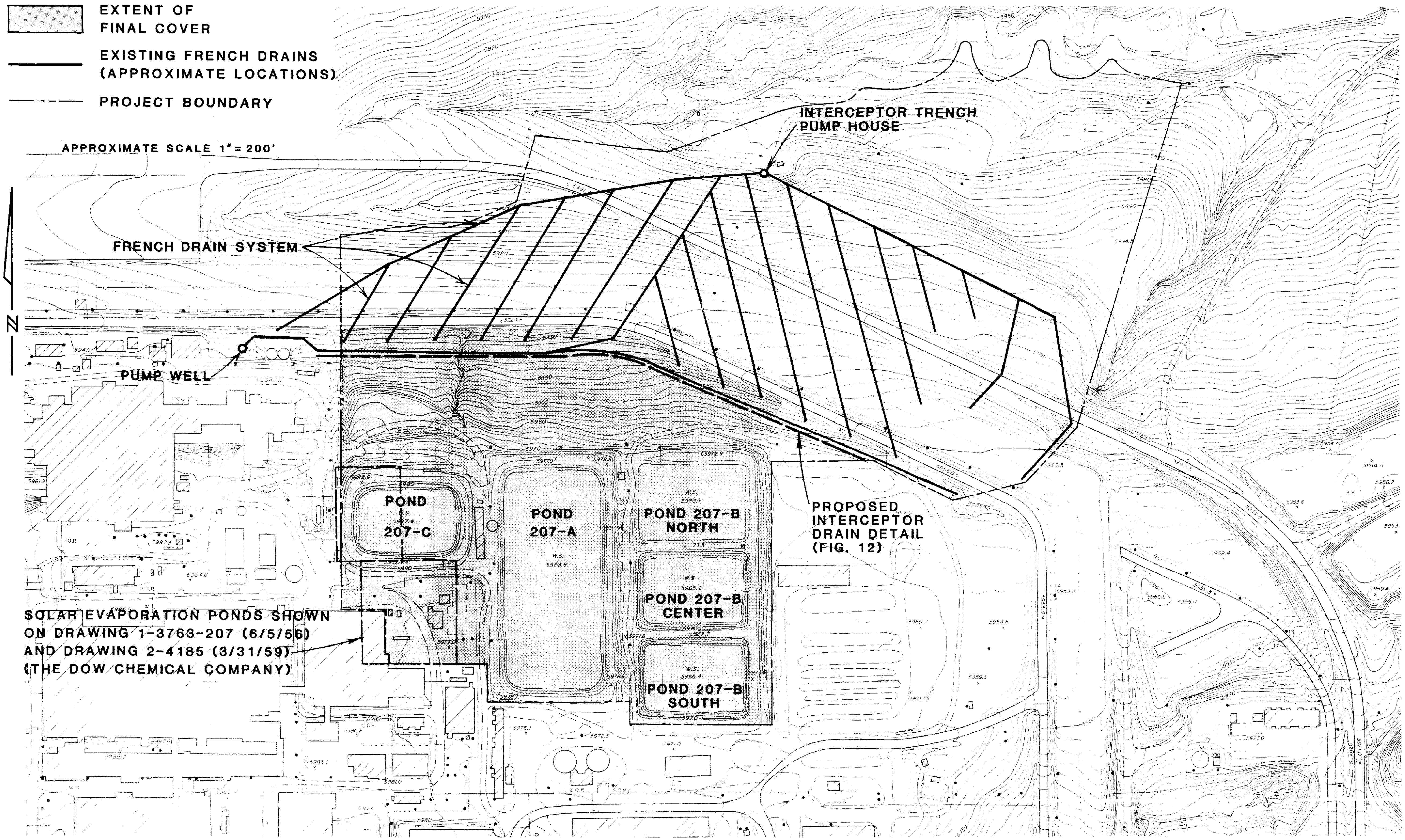


6 033 88	Chen & Associates	ROCKY FLATS SOLAR EVAPORATION PONDS	POND-CRETING FACILITY LAYOUT	Fig. 12

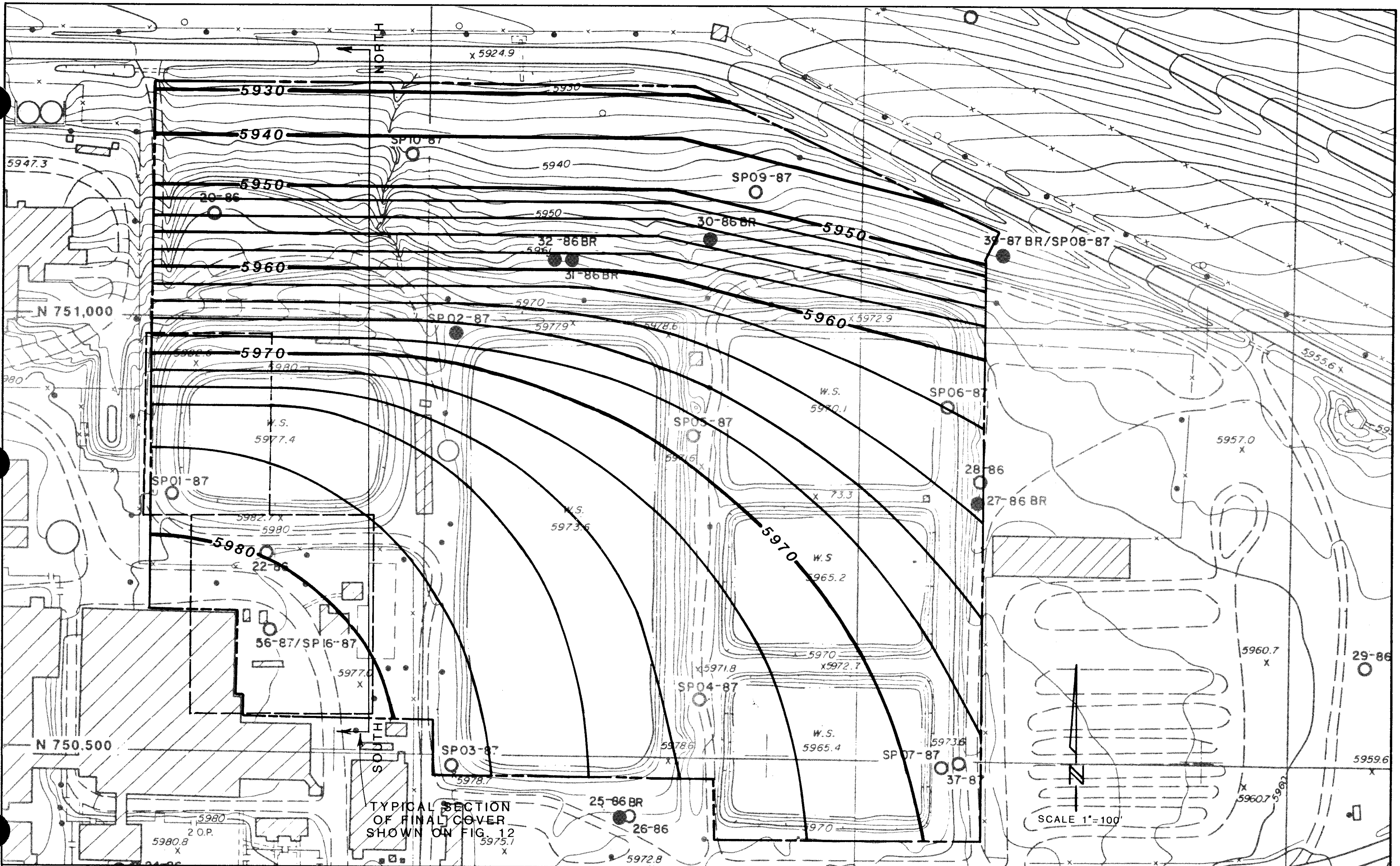


37807-001

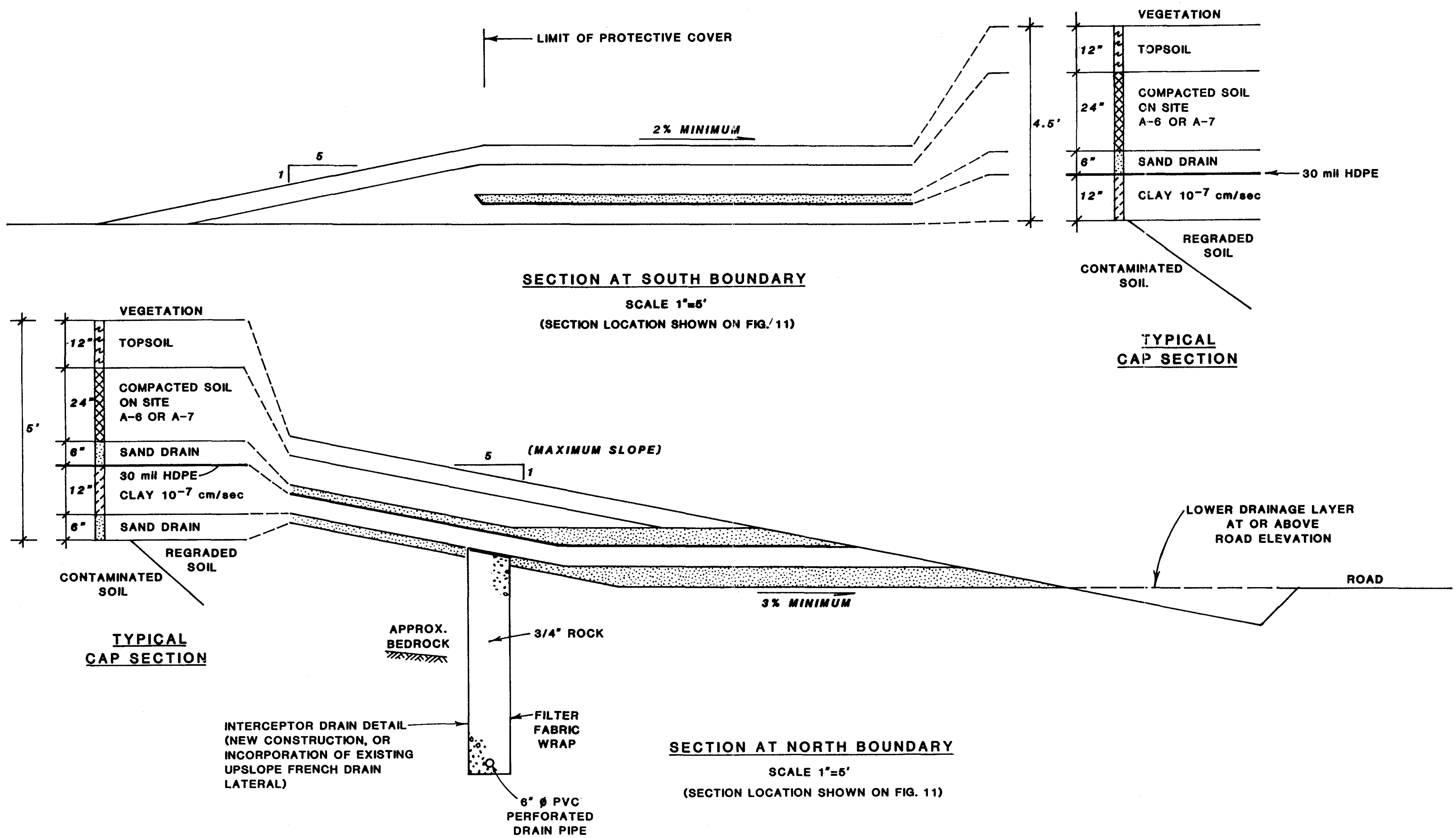
6 033 88	Chen & Associates	ROCKY FLATS SOLAR EVAPORATION PONDS	POND-CRETING FACILITY FLOW DIAGRAM	Fig. 13



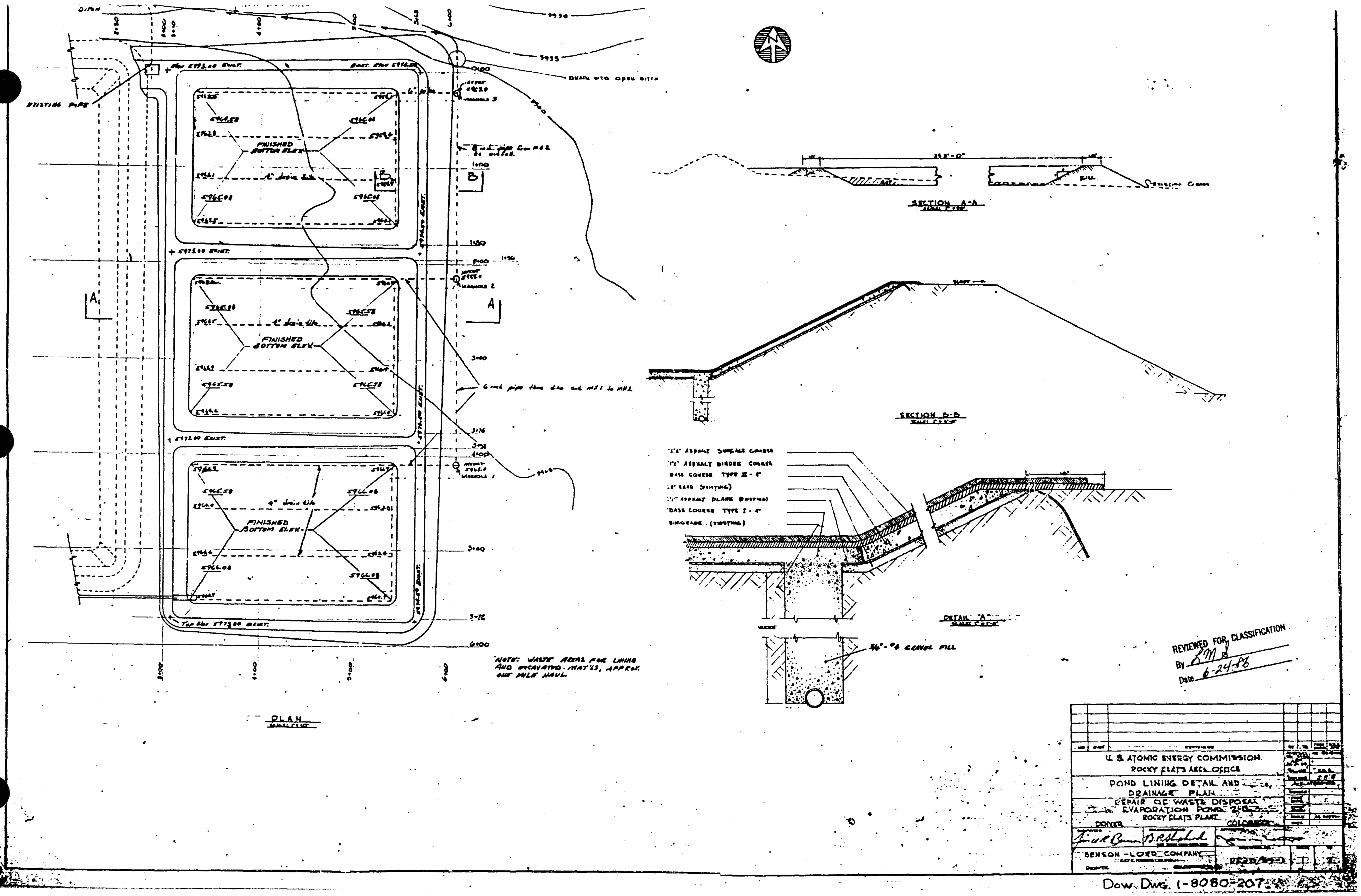
6 033 88	Chen & Associates	ROCKY FLATS SOLAR EVAPORATION PONDS	EXTENT OF FINAL COVER	Fig. 14



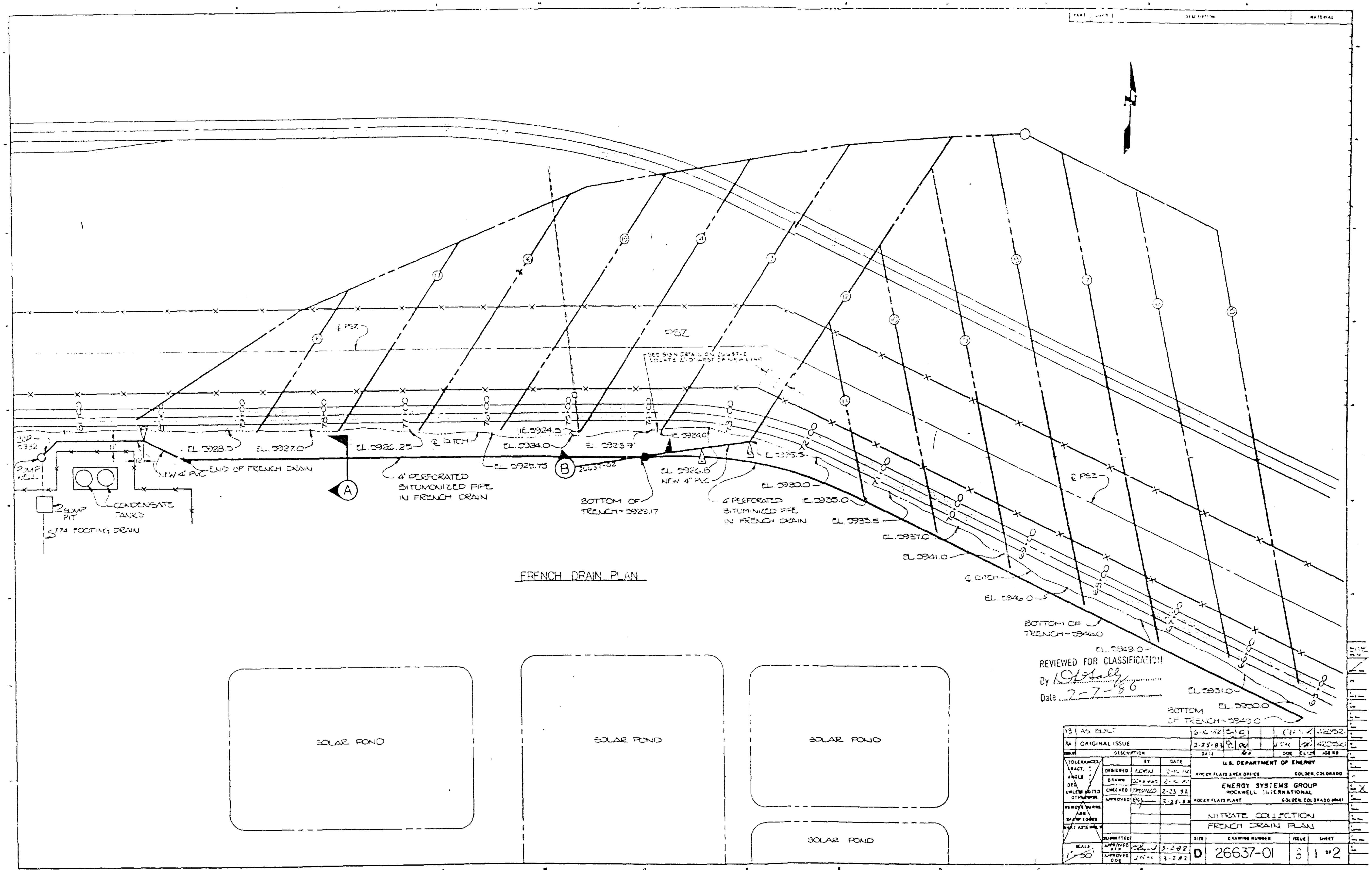
6 033 88	**Chen & Associates**	ROCKY FLATS SOLAR EVAPORATION PONDS	PLAN AND CONTOURS OF REGRADING FOR FINAL COVER	Fig. 15



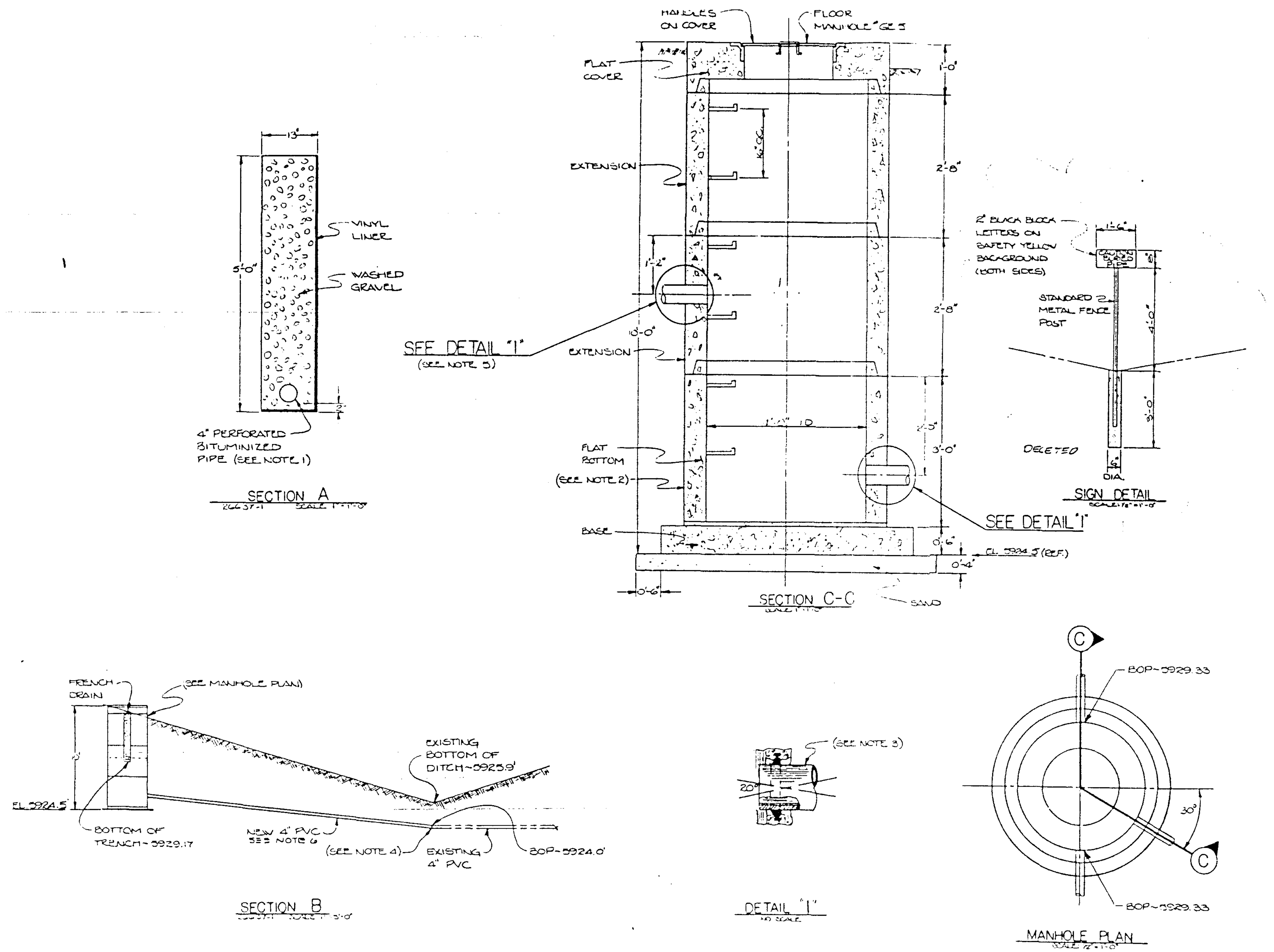
6 033 88	Chen & Associates	ROCKY FLATS SOLAR EVAPORATION PONDS	TYPICAL CROSS-SECTION OF FINAL COVER	Fig. 16



FINISHED BOTTOM ELEV.
4" drain tile
EXISTING PIPE
DRAIN INTO OPEN DITCH
DITCH
Top Elev 5972.00 EXIST.
6 inch pipe thru dike and MH 1 to MH 2
NOTE: WASTE AREAS FOR LINING AND EXCAVATED MAT'LS, APPROX. ONE MILE HAUL
PLAN
SECTION A-A
SECTION B-B
DETAIL "A"
1 1/2" ASPHALT SURFACE COURSE
1 1/2" ASPHALT BINDER COURSE
BASE COURSE TYPE II - 4"
SUBGRADE (EXISTING)
3/4"-1 1/2" GRAVEL FILL
REVIEWED FOR CLASSIFICATION
By
Date 6-24-88
U. S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE
POND LINING DETAIL AND DRAINAGE PLAN
REPAIR OF WASTE DISPOSAL EVAPORATION POND
ROCKY FLATS PLANT
DENVER
COLORADO
BENSON-LORD COMPANY
Dow Dwg. 1-8080-207



FRENCH DRAIN PLAN
PSZ
℄ PSZ
℄ DITCH
SEE SIGN DETAIL ON 26637-2 LOCATE 5'-0" WEST OF NEW LINE
EL. 5928.5
EL. 5927.0
EL. 5926.25
EL. 5925.75
EL. 5924.0
IE. 5924.5
EL. 5923.9
IE. 5924.0
EL. 5926.8
NEW 4" PVC
EL. 5930.0
IE. 5935.0
EL. 5933.5
EL. 5937.0
EL. 5941.0
EL. 5946.0
EL. 5949.0
EL. 5951.0
EL. 5950.0
BOTTOM OF TRENCH ~ 5923.17
BOTTOM OF TRENCH ~ 5946.0
BOTTOM OF TRENCH ~ 5949.0
4" PERFORATED BITUMINIZED PIPE IN FRENCH DRAIN
NEW 4" PVC
END OF FRENCH DRAIN
PUMP WELL
SUMP PIT
CONDENSATE TANKS
774 FOOTING DRAIN
SOLAR POND
SOLAR POND
SOLAR POND
SOLAR POND
REVIEWED FOR CLASSIFICATION
Date 2-7-86
AS BUILT
ORIGINAL ISSUE
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE
GOLDEN, COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT
GOLDEN, COLORADO
NITRATE COLLECTION
FRENCH DRAIN PLAN
D
26637-01
1 OF 2
1" = 83'



PART	ITEM	DESCRIPTION	MATERIAL

NOTES:

1. PLACE 4" PERFORATED BITUMINIZED PIPE WITH PERFORATIONS DOWN.
2. WALL THICKNESS – 5".
3. PIPE TO MANHOLE SEAL, A LOA GASKET PER ASTM RUBBER GASKET SPECS C-443 CAST INTEGRALLY IN MANHOLE WALL AND LOCATED AS REQUIRED. JOINT ALLOWS 0° OMNIDIRECTIONAL DEFLECTION.
4. INSTALL COUPLING BETWEEN NEW AND EXISTING 4" PVC.
5. 4" PERFORATED BITUMINIZED PIPE (BOTH SIDES)
6. BED NEW 4" PVC PIPE W/ 6" SAND BASE.

LEGEND:

-------	EXISTING
———	NEW
BOP	BOTTOM OF PIPE
ID	INSIDE DIAMETER
PVC	POLYVINYL CHLORIDE
IE	INVERT ELEVATION
▷	UNDERGROUND UTILITIES POST

REVIEWED FOR CLASSIFICATION
By D. Gelly
Date 7-7-90

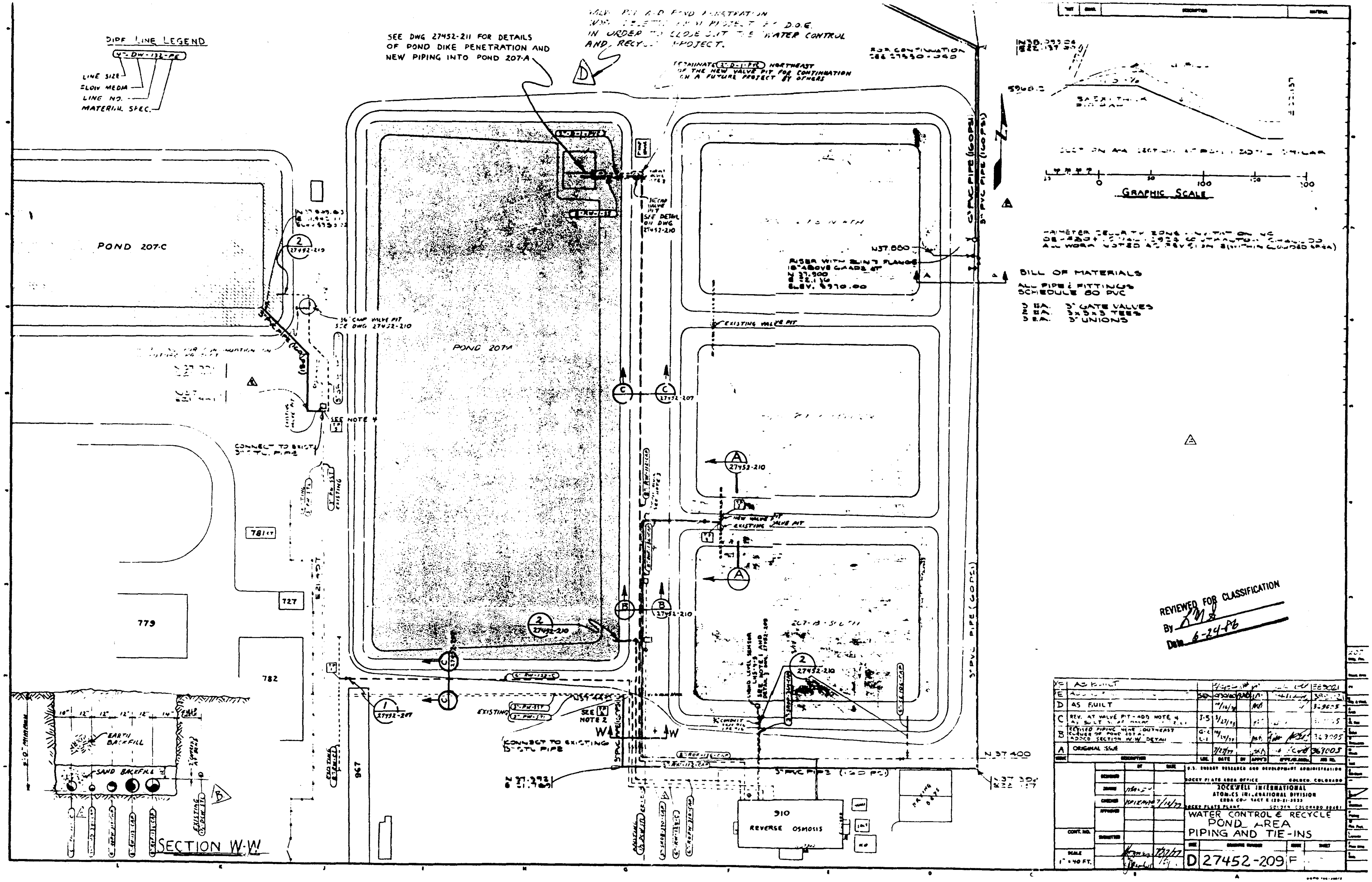
B	AS BUILT	6-16-89		JSH	42952
A	ORIGINAL ISSUE	3-26-82			42092

DESIGNED: FEEN 2-16-82
DRAWN: 2-17-82
CHECKED: 2-23-82
APPROVED: 3-25-82

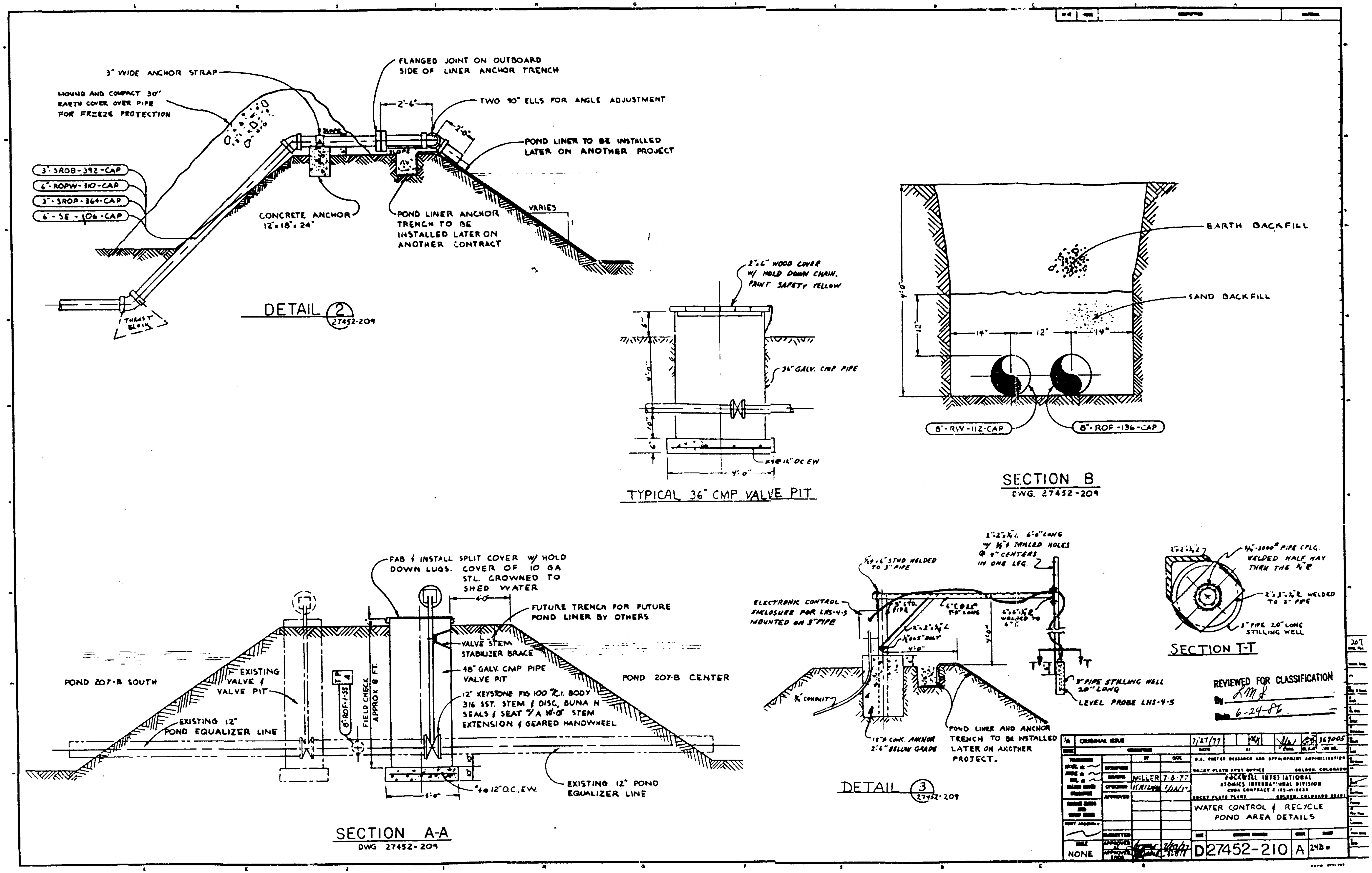
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE — GOLDEN, COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT — GOLDEN, COLORADO

NITRATE COLLECTION
DETAILS AND SECTIONS

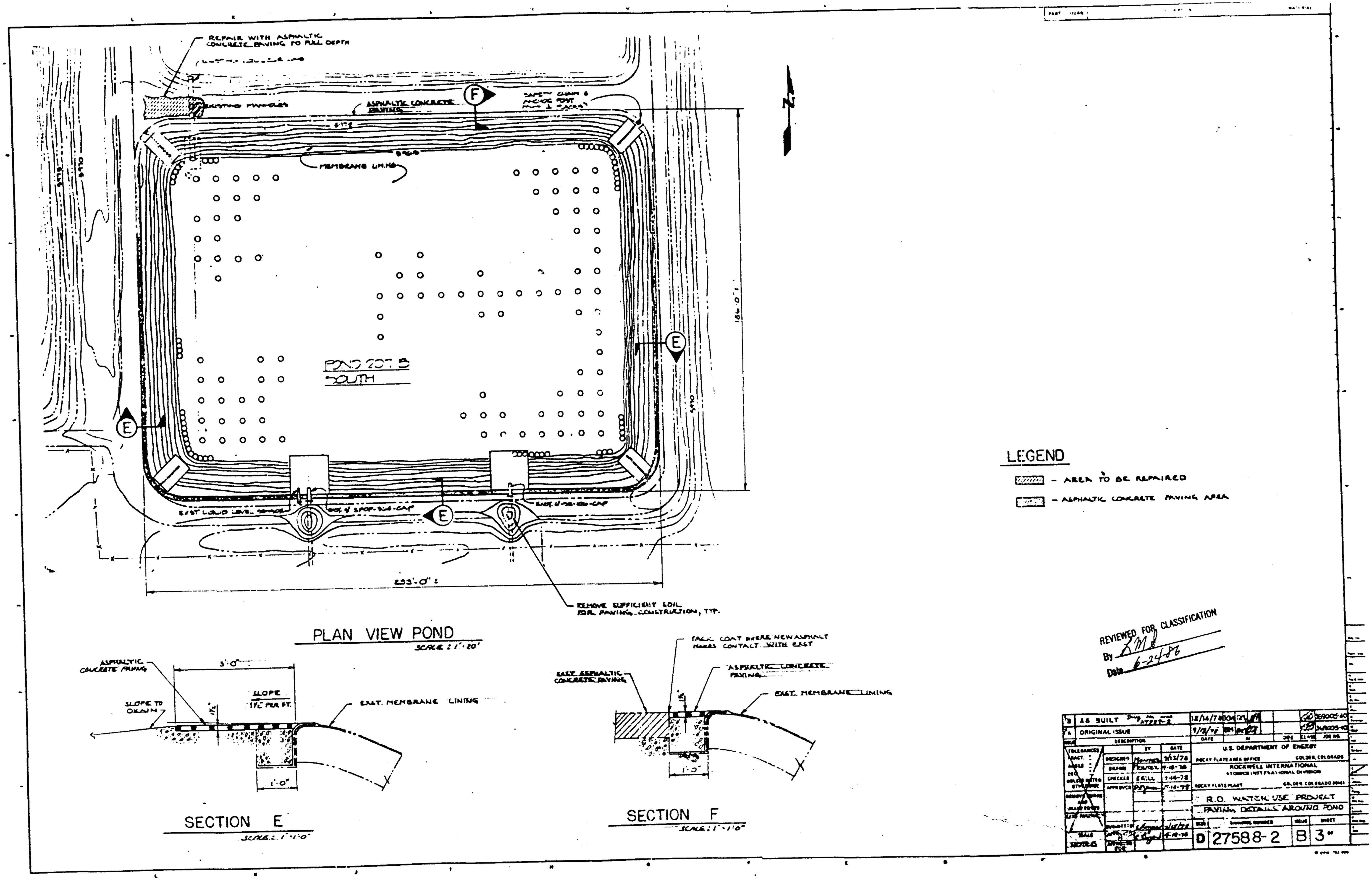
SCALE: NOTED | SIZE: D | DRAWING NUMBER: 26637-02 | ISSUE: 6 | SHEET: 2



PIPE LINE LEGEND
LINE SIZE
FLOW MEDIA
LINE NO.
MATERIAL SPEC.
SEE DWG 27452-211 FOR DETAILS OF POND DIKE PENETRATION AND NEW PIPING INTO POND 207-A
IN ORDER TO CLOSE OUT THE WATER CONTROL AND RECYCLE PROJECT.
TERMINATE NORTHEAST OF THE NEW VALVE PIT FOR CONTINUATION IN A FUTURE PROJECT BY OTHERS
POND 207-C
POND 207-A
SEE NOTE 4
CONNECT TO EXIST'G 3" PVC PIPE
RISER WITH BLIND FLANGE 18" ABOVE GRADE AT
ELEV. 5970.00
N 37,000
EXISTING VALVE PIT
NEW VALVE PIT
BILL OF MATERIALS
ALL PIPE & FITTINGS SCHEDULE 80 PVC
3" GATE VALVES
3x3x3 TEES
3" UNIONS
GRAPHIC SCALE
0
50
100
150
200
3" PVC PIPE (160 PSI)
3" PVC PIPE (60 PSI)
N 37,400
CONNECT TO EXISTING 3" PVC PIPE
EXISTING
NOTE 2
910
REVERSE OSMOSIS
779
782
727
781
967
EARTH BACKFILL
SAND BACKFILL
SECTION W-W
2'-0" MINIMUM
REVIEWED FOR CLASSIFICATION
By
Date 6-24-96
A ORIGINAL ISSUE
B REVISED PIPING NEAR SOUTHEAST CORNER OF POND 207-A. ADDED SECTION W-W DETAIL
C REV. AT VALVE PIT - ADD NOTE 4. AS BUILT
D AS BUILT
E AS BUILT
F AS BUILT
U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
ROCKY FLATS AREA OFFICE
GOLDEN, COLORADO
ROCKWELL INTERNATIONAL
ATOMICS INTERNATIONAL DIVISION
ROCKY FLATS PLANT
WATER CONTROL & RECYCLE
POND AREA
PIPING AND TIE-INS
D 27452-209 F
1" = 40 FT.

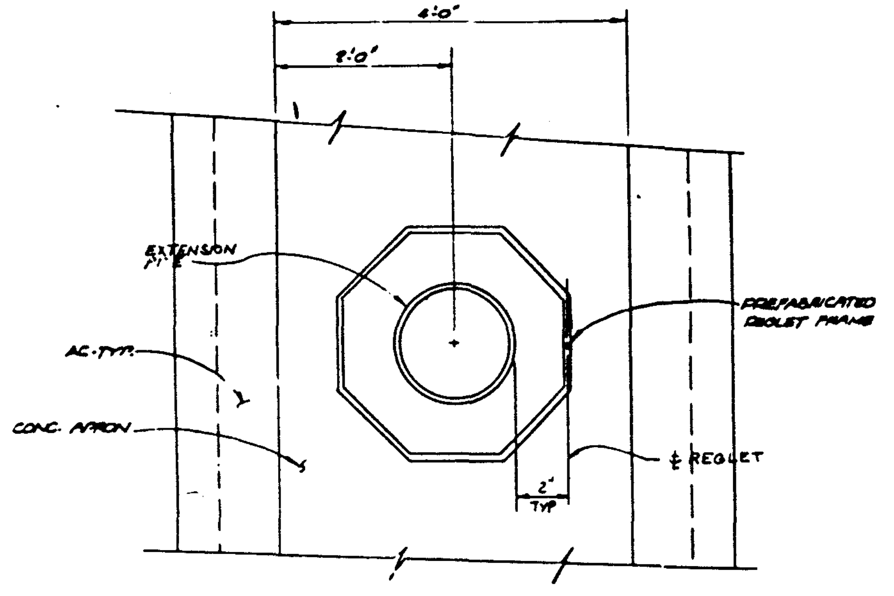


DETAIL 2 27452-209
3" WIDE ANCHOR STRAP
MOUND AND COMPACT 30" EARTH COVER OVER PIPE FOR FREEZE PROTECTION
FLANGED JOINT ON OUTBOARD SIDE OF LINER ANCHOR TRENCH
TWO 90° ELLS FOR ANGLE ADJUSTMENT
POND LINER TO BE INSTALLED LATER ON ANOTHER PROJECT
3"-SROB-392-CAP
6"-ROPW-310-CAP
3"-SROP-364-CAP
6"-SE-106-CAP
CONCRETE ANCHOR 12"x18"x24"
POND LINER ANCHOR TRENCH TO BE INSTALLED LATER ON ANOTHER CONTRACT
VARIES
THRUST BLOCK
TYPICAL 36" CMP VALVE PIT
2"x6" WOOD COVER W/ HOLD DOWN CHAIN. PAINT SAFETY YELLOW
36" GALV. CMP PIPE
4'-0"
SECTION B DWG. 27452-209
EARTH BACKFILL
SAND BACKFILL
8"-RW-112-CAP
8"-ROF-136-CAP
SECTION A-A DWG 27452-209
FAB & INSTALL SPLIT COVER W/ HOLD DOWN LUGS. COVER OF 10 GA STL. CROWNED TO SHED WATER
FUTURE TRENCH FOR FUTURE POND LINER BY OTHERS
VALVE STEM STABILIZER BRACE
48" GALV. CMP PIPE VALVE PIT
12" KEYSTONE FIG 100 C.I. BODY 316 SST. STEM & DISC, BUNA N SEALS & SEAT W/ A 10'-0" STEM EXTENSION & GEARED HANDWHEEL
POND 207-B SOUTH
POND 207-B CENTER
EXISTING VALVE & VALVE PIT
EXISTING 12" POND EQUALIZER LINE
EXISTING 12" POND EQUALIZER LINE
FIELD CHECK APPROX 8 FT.
8"-ROF-1-55
DETAIL 3 27452-209
ELECTRONIC CONTROL ENCLOSURE FOR LHS-4-5 MOUNTED ON 3" PIPE
3/4" CONDUIT
POND LINER AND ANCHOR TRENCH TO BE INSTALLED LATER ON ANOTHER PROJECT.
5" PIPE STILLING WELL 20" LONG
LEVEL PROBE LHS-4-5
SECTION T-T
3" PIPE 20" LONG STILLING WELL
REVIEWED FOR CLASSIFICATION
By LMS
Date 6-24-86
ORIGINAL ISSUE 7/27/77
ROCKWELL INTERNATIONAL ATOMICS INTERNATIONAL DIVISION
ROCKY FLATS PLANT GOLDEN, COLORADO
WATER CONTROL & RECYCLE POND AREA DETAILS
MILLER 7-8-77
NONE
D 27452-210 A



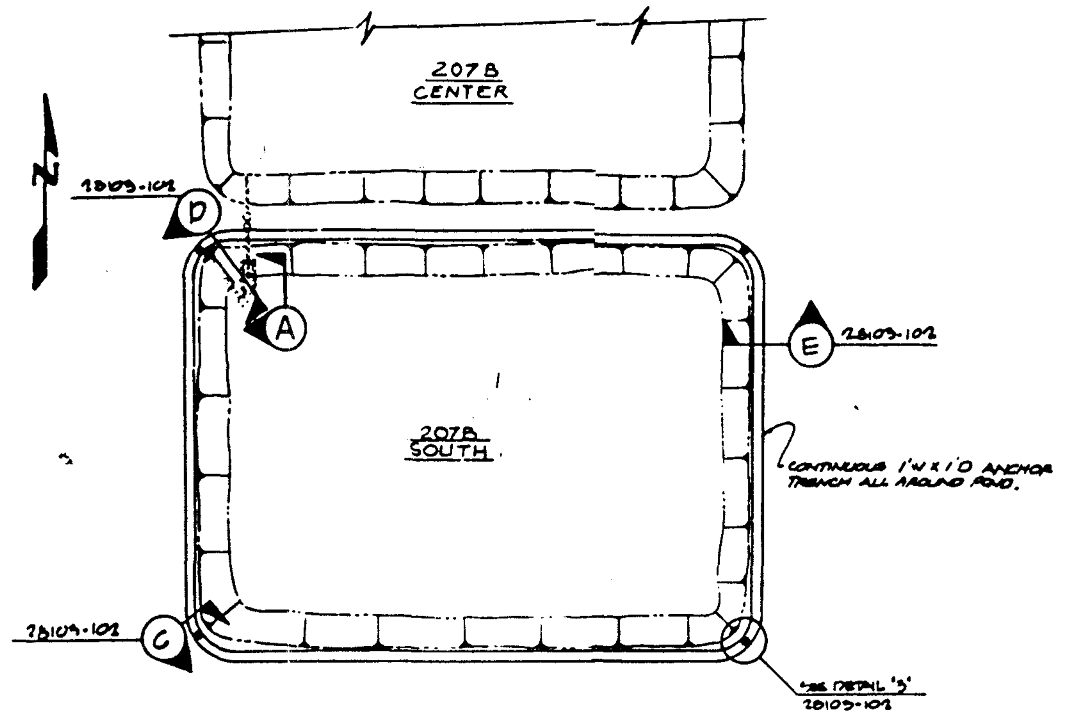
REPAIR WITH ASPHALTIC CONCRETE PAVING TO FULL DEPTH
EXISTING MANHOLES
ASPHALTIC CONCRETE PAVING
SAFETY CHAIN & ANCHOR POST
MEMBRANE LINING
POND 207 B SOUTH
186'-0"±
233'-0"±
REMOVE SUFFICIENT SOIL FOR PAVING CONSTRUCTION, TYP.
PLAN VIEW POND
SCALE: 1"=20'
ASPHALTIC CONCRETE PAVING
SLOPE TO DRAIN
3'-0"
SLOPE 1½" PER FT.
EXIST. MEMBRANE LINING
1'-0"
SECTION E
SCALE: 1"=1'-0"
TACK COAT WHERE NEW ASPHALT MAKES CONTACT WITH EXIST
EXIST. ASPHALTIC CONCRETE PAVING
ASPHALTIC CONCRETE PAVING
EXIST. MEMBRANE LINING
1'-0"
SECTION F
SCALE: 1"=1'-0"
LEGEND
- AREA TO BE REPAIRED
- ASPHALTIC CONCRETE PAVING AREA
REVIEWED FOR CLASSIFICATION
By
Date 6-24-86
AS BUILT
ORIGINAL ISSUE
DESCRIPTION
DATE
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE
GOLDEN, COLORADO
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT
R.O. WATER USE PROJECT
PAVING DETAILS AROUND POND
D 27588-2 B 3

GENERAL NOTES:
1. THE EXISTING POND LINING IS CONSTRUCTED AS SHOWN IN SECTION A.



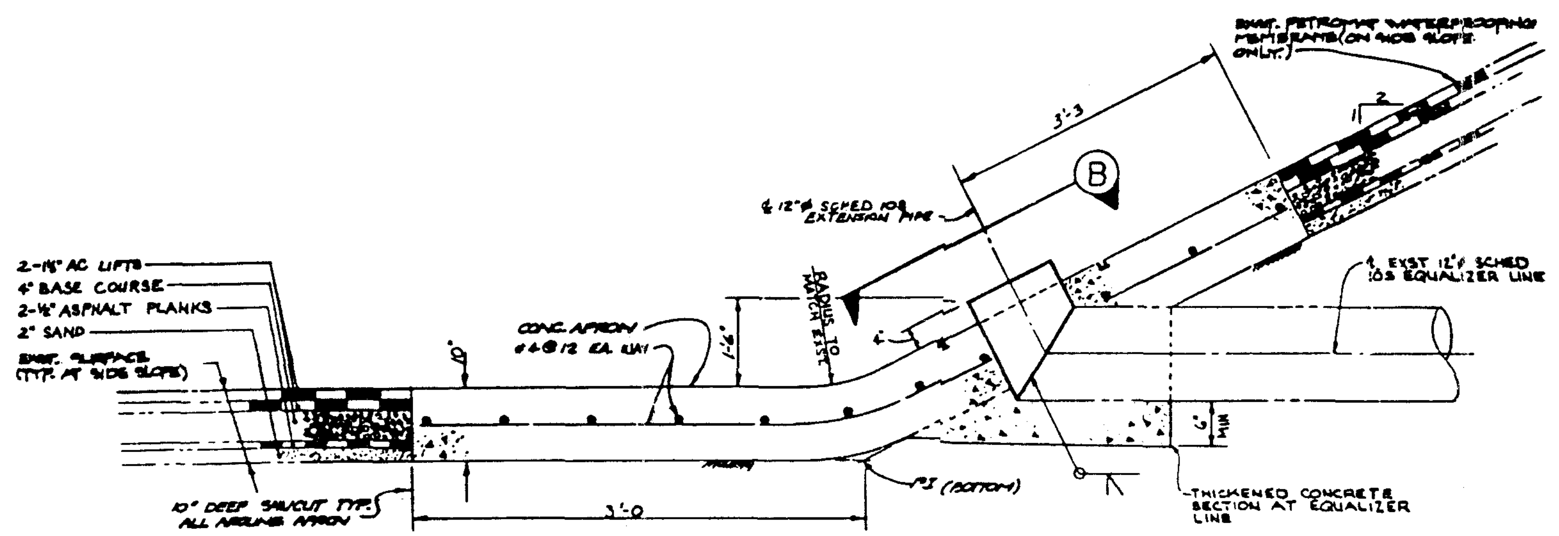
VIEW B

SCALE: NONE



PLAN/POND 207B SOUTH

SCALE: 1"=40'



SECTION A

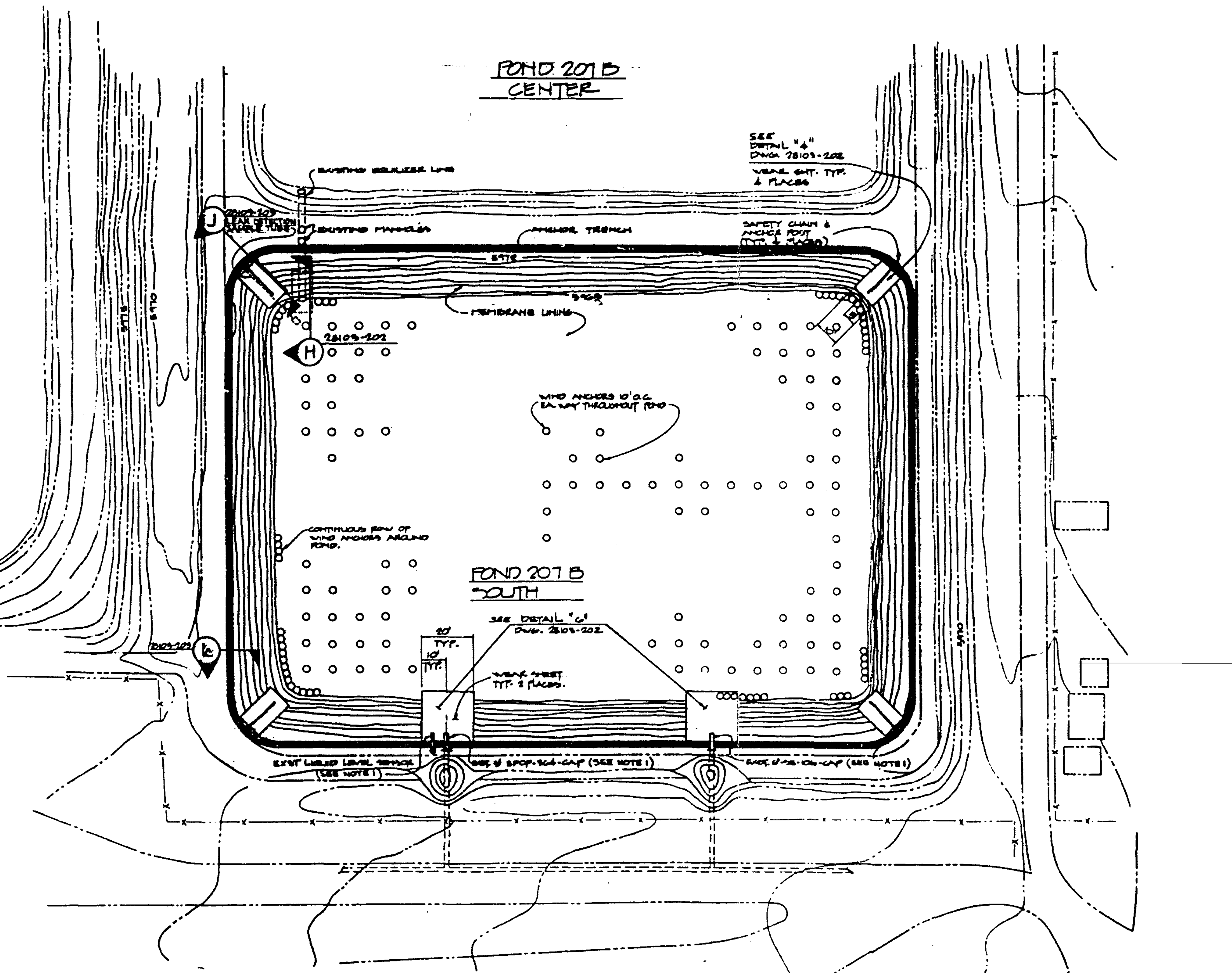
SCALE: NONE

REVIEWED FOR CLASSIFICATION
By
Date 6-24-86

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE, GOLDEN, COLORADO
ROCKWELL INTERNATIONAL
ATOMICS INTERNATIONAL DIVISION
ROCKY FLATS PLANT, GOLDEN, COLORADO

MEMBRANE POND LINER
PHASE I
PLAN AND SECTIONS

D 28103-101 A 2



GENERAL NOTES:

1. THE FOLLOWING POND PREPARATION WORK HAS BEEN DONE BY OTHERS:
   - A. INSTALLATION OF PIPING.
   - B. INSTALLATION OF ANCHOR POSTS.
   - C. INSTALLATION OF LEAK DETECTION SAMPLE TUBES.
   - D. PREPARATION OF ANCHOR TRENCH FOR PLACEMENT OF MEMBRANE LINING.
   - E. INSTALLATION OF CONCRETE APRON AROUND EQUALIZER LINE.

NOTES: (THIS DWG ONLY)

1. THE EXISTING LIQUID LEVEL SENSOR AND POND FILL LINES (3"SPOP-364-CAP & 6"-32-106-CAP) MAY BE TEMPORARILY DISCONNECTED AT THEIR FLANGES TO FACILITATE WORK AT THE ANCHOR TRENCH.

REVIEWED FOR CLASSIFICATION
By [signature]
Date 6-24-78

A ORIGINAL ISSUE 3/27/78

U. S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
ROCKWELL INTERNATIONAL
ATOMICS INTERNATIONAL DIVISION
ROCKY FLATS PLANT GOLDEN, COLORADO

DESIGNED 11-8-77
DRAWN 11-10-77
CHECKED 2-6-78
APPROVED 2-13-77

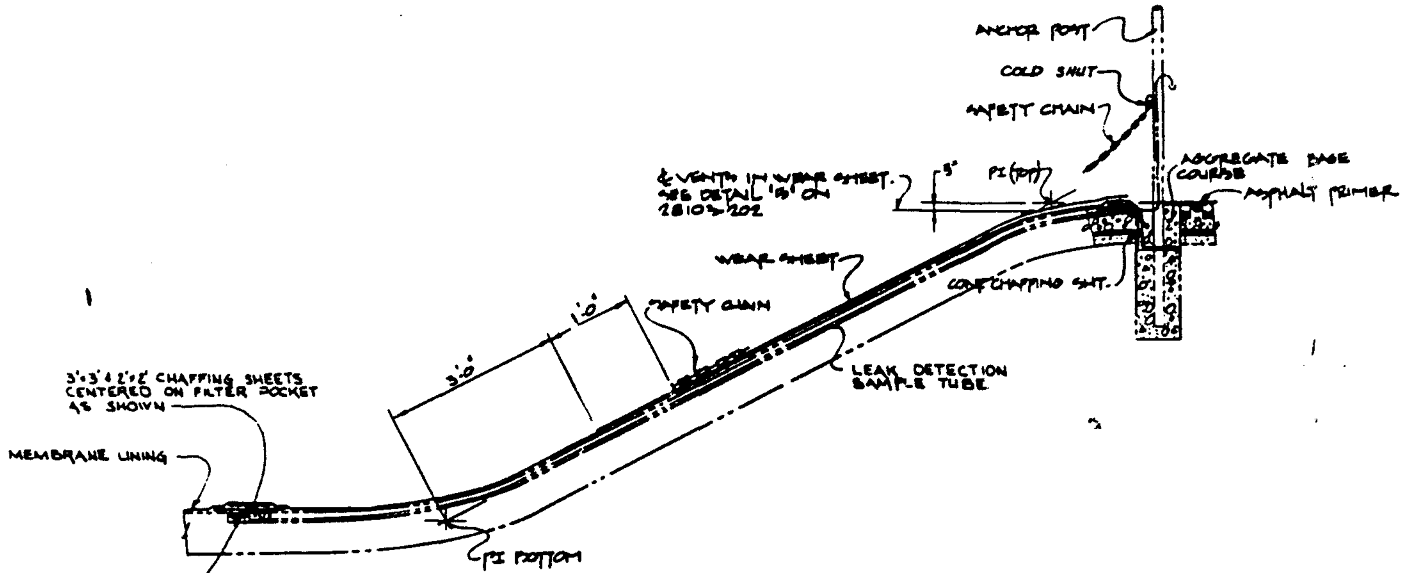
MEMBRANE POND LINER
PHASE I
PLAN

SCALE 1" = 20'

D 28103-201 A 4

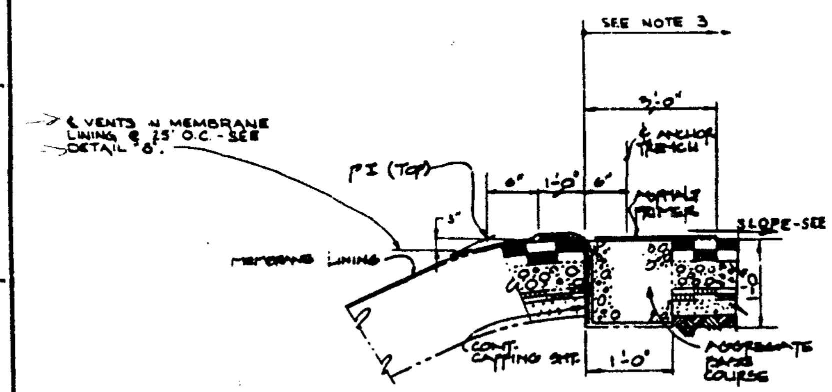
NOTES: (THIS DWG ONLY)

1. BOND RAIN CAP TO REINF PATCH WITH 2" WIDE x 3" LONG FIELD LAP JOINTS.
2. REINF PATCH, RAIN CAP AND MEMBRANE LINING ARE MADE FROM THE SAME MATERIALS.
3. SLOPE SURFACE OF ANCHOR TRENCH 2% AWAY FROM POND ON THE EAST, WEST AND SOUTH POND BANKS.



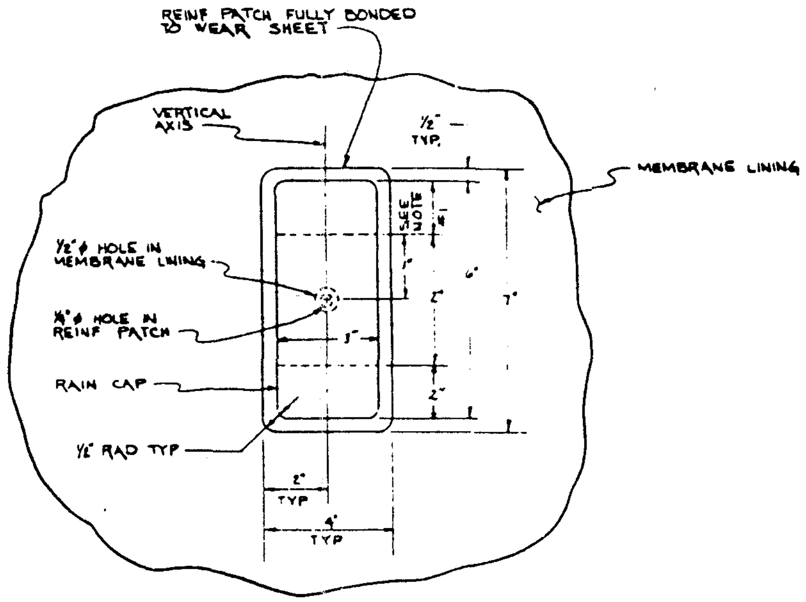
SECTION J

28103-201 SCALE: NONE



SECTION K

28103-201 SCALE: 1"=1'-0"



DETAIL '8'

SCALE: NONE

(SEE NOTE 2)

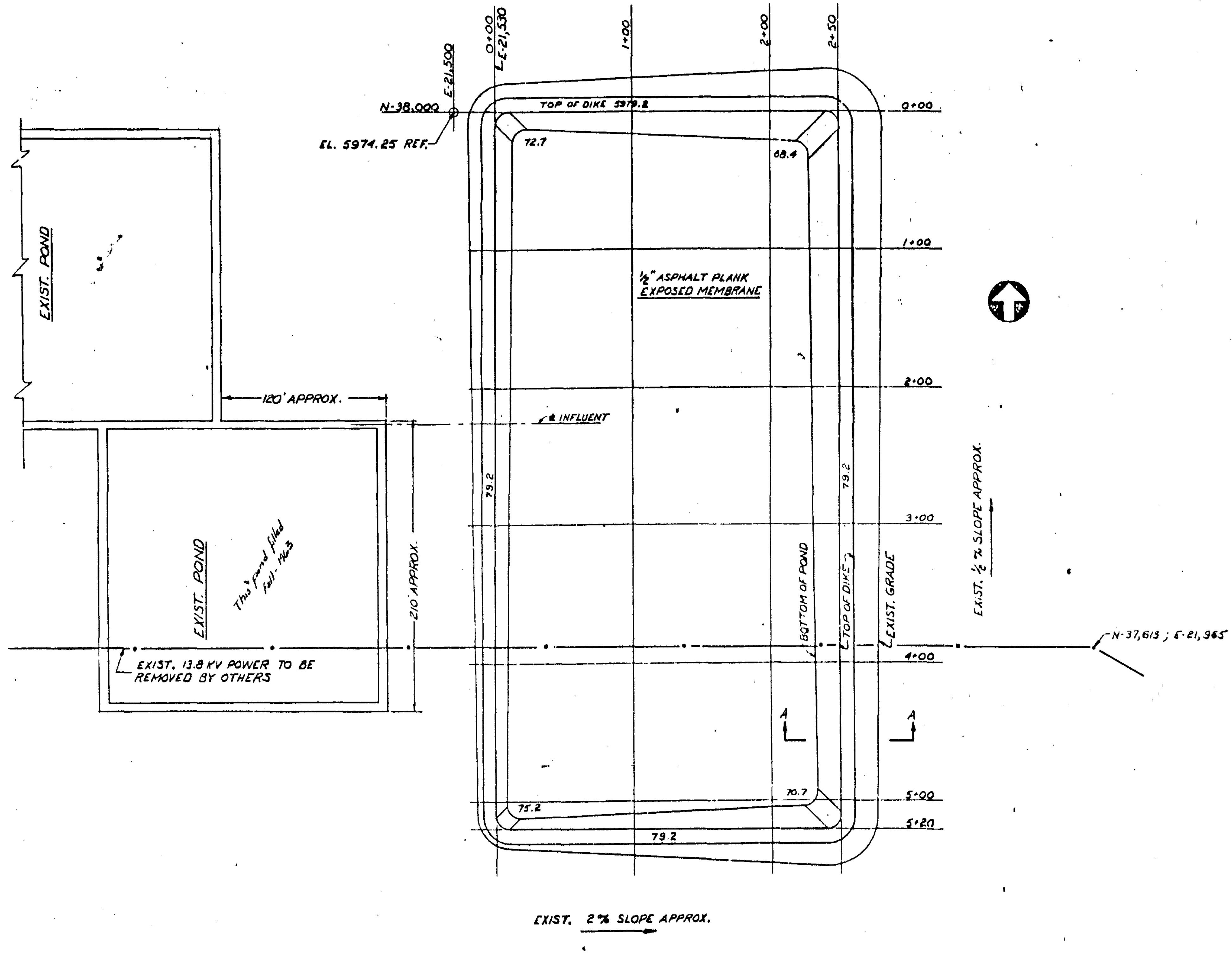
REVIEWED FOR CLASSIFICATION
By [signature]
Date 6-24-86

A	ORIGINAL ISSUE	3/27/78	
DRAWN		1-30-77	
CHECKED		2-6-78	
APPROVED		1-12-78	
APPROVED		3/14/78	
		3/13/78	

U. S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
ROCKWELL INTERNATIONAL
ATOMICS INTERNATIONAL DIVISION
ROCKY FLATS PLANT GOLDEN, COLORADO

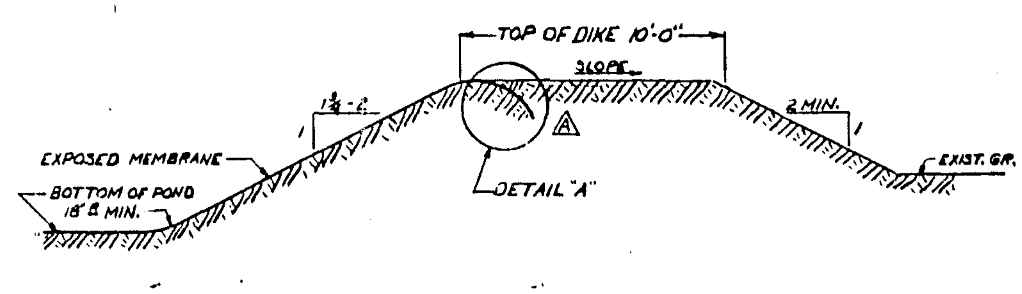
MEMBRANE POND LINER
PHASE I
SECTIONS AND DETAILS

D 28103-203 A 6

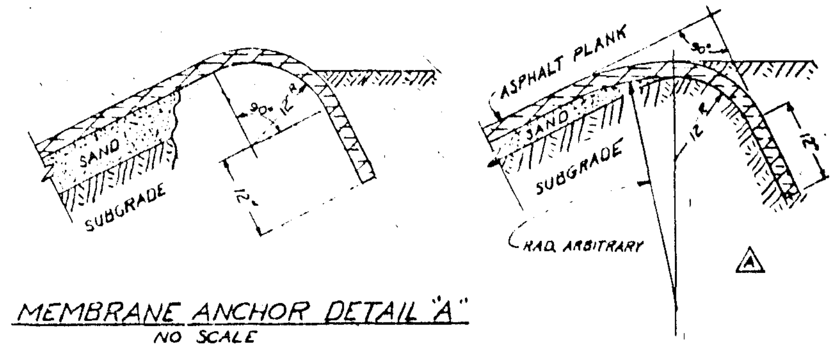


PLAN
SCALE: 1" = 40'

NOMINAL AREA - 3 ACRES
NOMINAL CAP. - 17 ACRE-FEET



SECTION A-A (TYP.)
NO SCALE



MEMBRANE ANCHOR DETAIL "A"
NO SCALE

NOTES:

1. MAT'LS & CONSTR. TO CONFORM WITH PROVISIONS OF THE SPECS.
2. INSIDE CORNERS OF POND, TOP & BOTTOM OF DIKE, TO BE 10' RAD.
3. A DOUBLE THICKNESS OF ASPHALT PLANK SHALL BE USED AT THE LOCATION OF THE INFLUENT. THE ADDITIONAL LAYER SHALL BE A MIN. OF 3' WIDE & SHALL EXTEND FROM THE TOP OF THE DIKE TO THE BOTTOM OF THE POND & A DISTANCE OF AT LEAST 10' ALONG THE BOTTOM
4. POND INFLUENT LINE FROM 200,000 GAL. STORAGE TANK BY OTHERS.

WORK AND DRAWINGS MUST AGREE
IF CHANGES ARE DESIRED CO-OPERATE
WITH ENG. DEPT. AND HAVE SAME O.K'D.

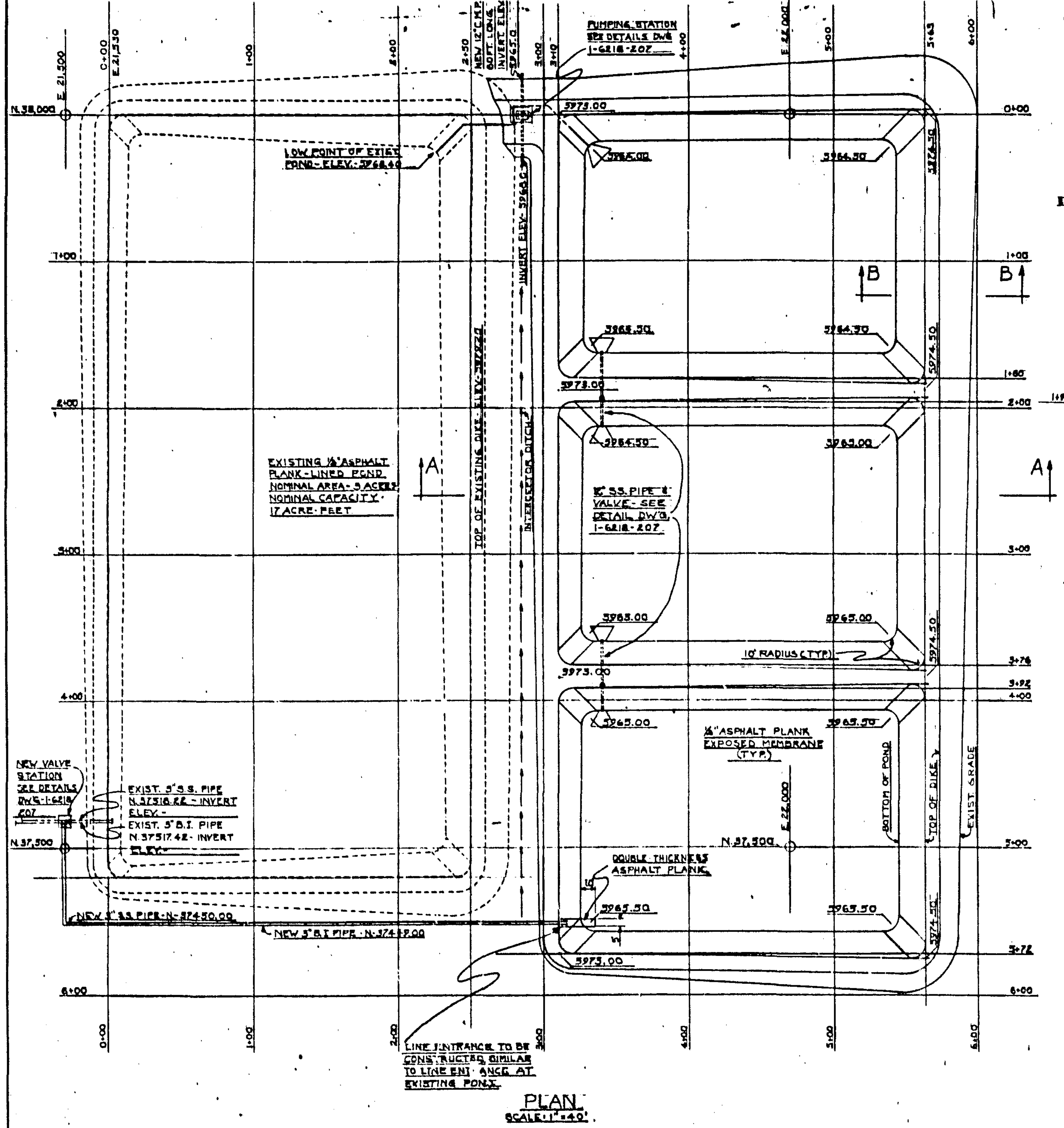
NO.	LOC'N	REVISIONS	BY	DATE	O.K.
A	K-4	CHANGED DET. A.	RG	4-26-58	[illegible]

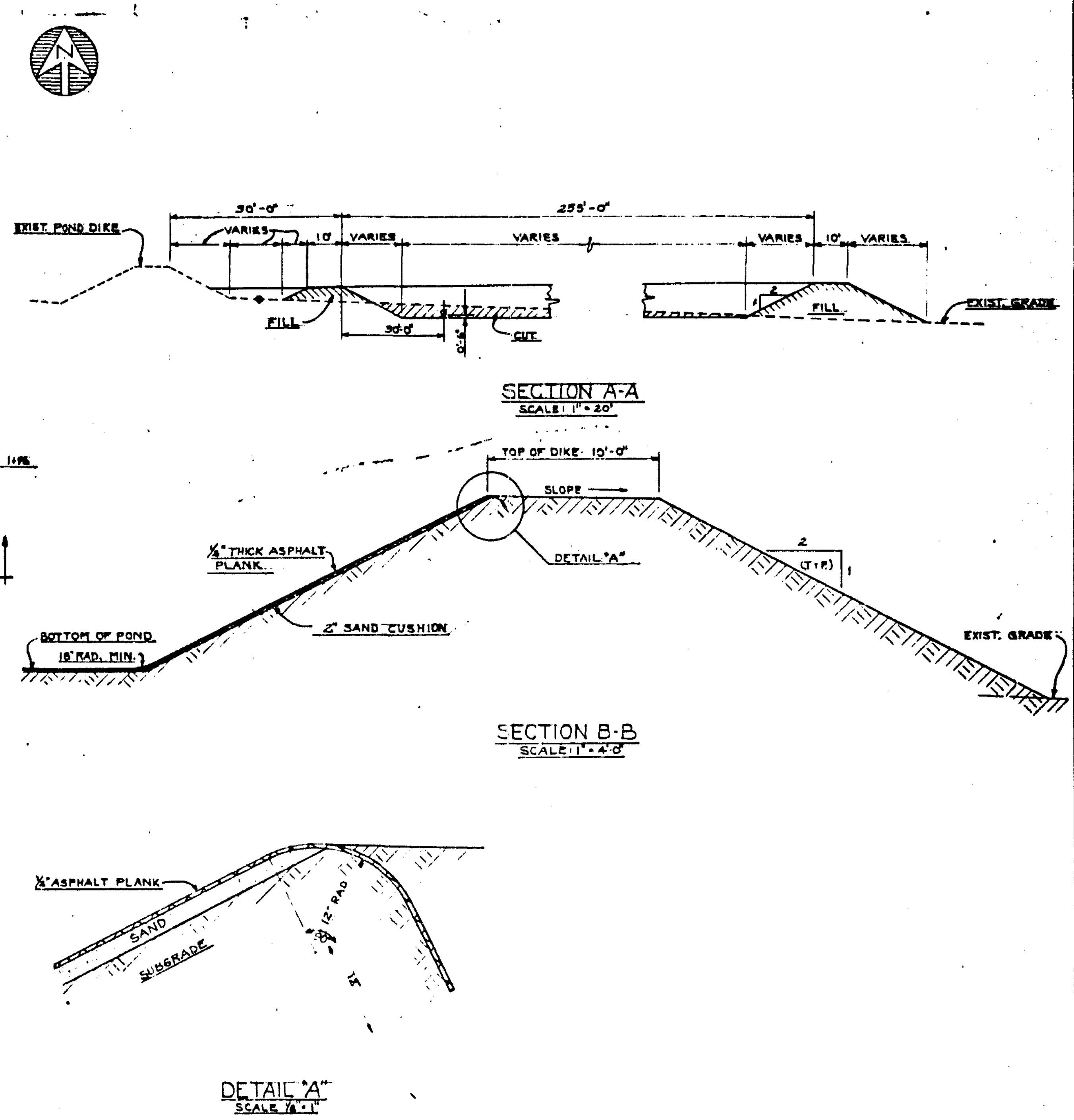
JOB COMPLETE IN SHEETS NUMBERED

THE DOW CHEMICAL COMPANY
A.E.C. CONTRACT AT (29-1)-1106
ROCKY FLATS PLANT DENVER, COLORADO

IND. WASTE FAC. 207
3 ACRE EVAPORATION POND
PLAN & SECTION

DRAWN RDB CHECKED
DATE 12-6-55 O.K.
SCALE AS SHOWN
1-3398-207

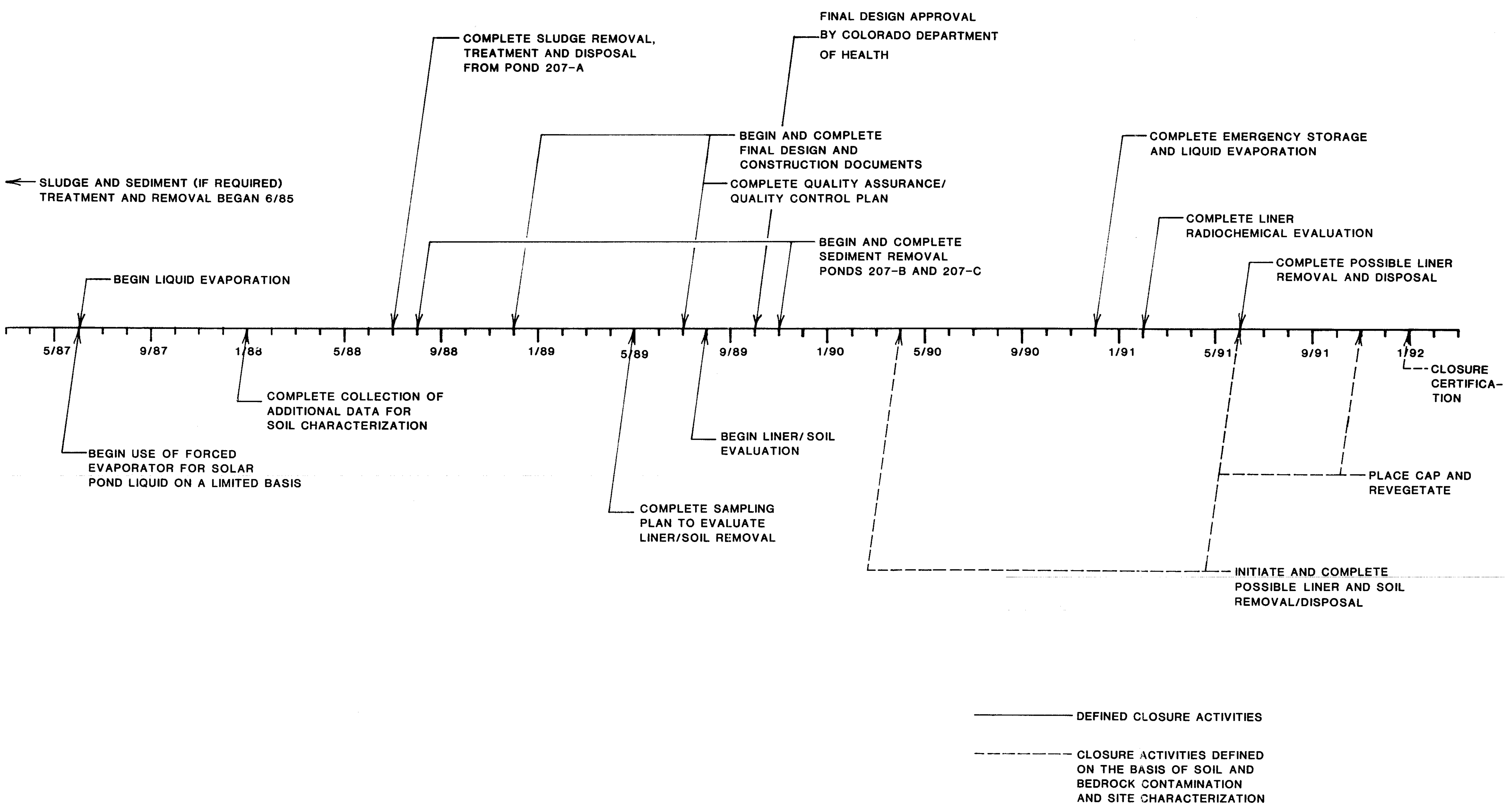




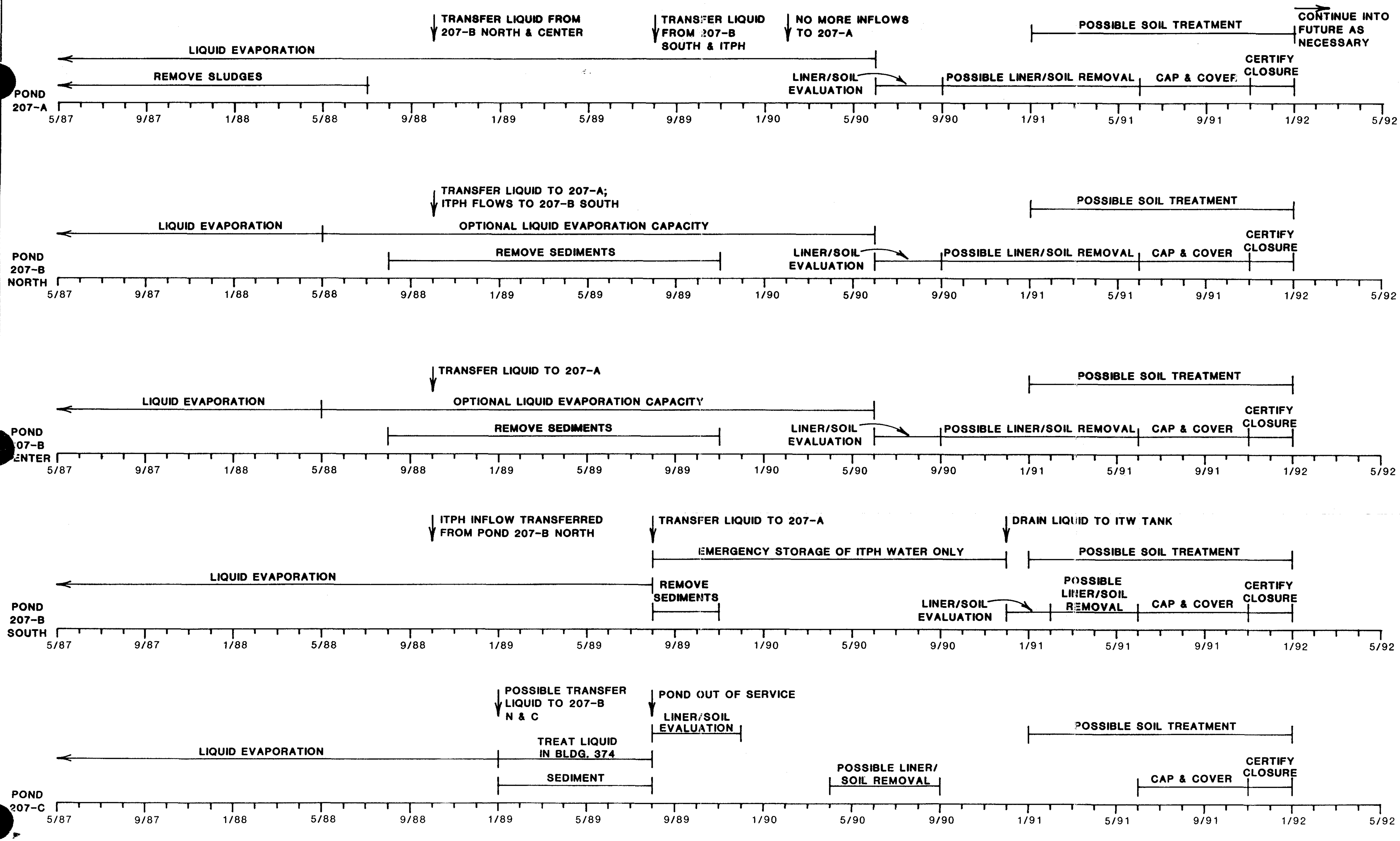
NOTES:

1. EMBANKMENT AND EXCAVATION ARE APPROXIMATELY BALANCED. IF ADDITIONAL EMBANKMENT IS REQUIRED, A BORROW AREA WILL BE DESIGNATED IN THE ADJACENT AREA AND IF EXCAVATION IS GREATER THAN NEEDED, THE SURPLUS SHALL BE DEPOSITED ON THE EXTERIOR SIDE OF THE NORTH AND EAST DIKES.
2. ALL PIPING FOR PUMPING STATION WILL BE STAINLESS STEEL 304 - EL.C.
3. ALL EXPOSED MILD STEEL SHALL BE GIVEN ONE COAT OF SHOP PRIMER AND 2 COATS OF MACHINERY GREY PAINT.

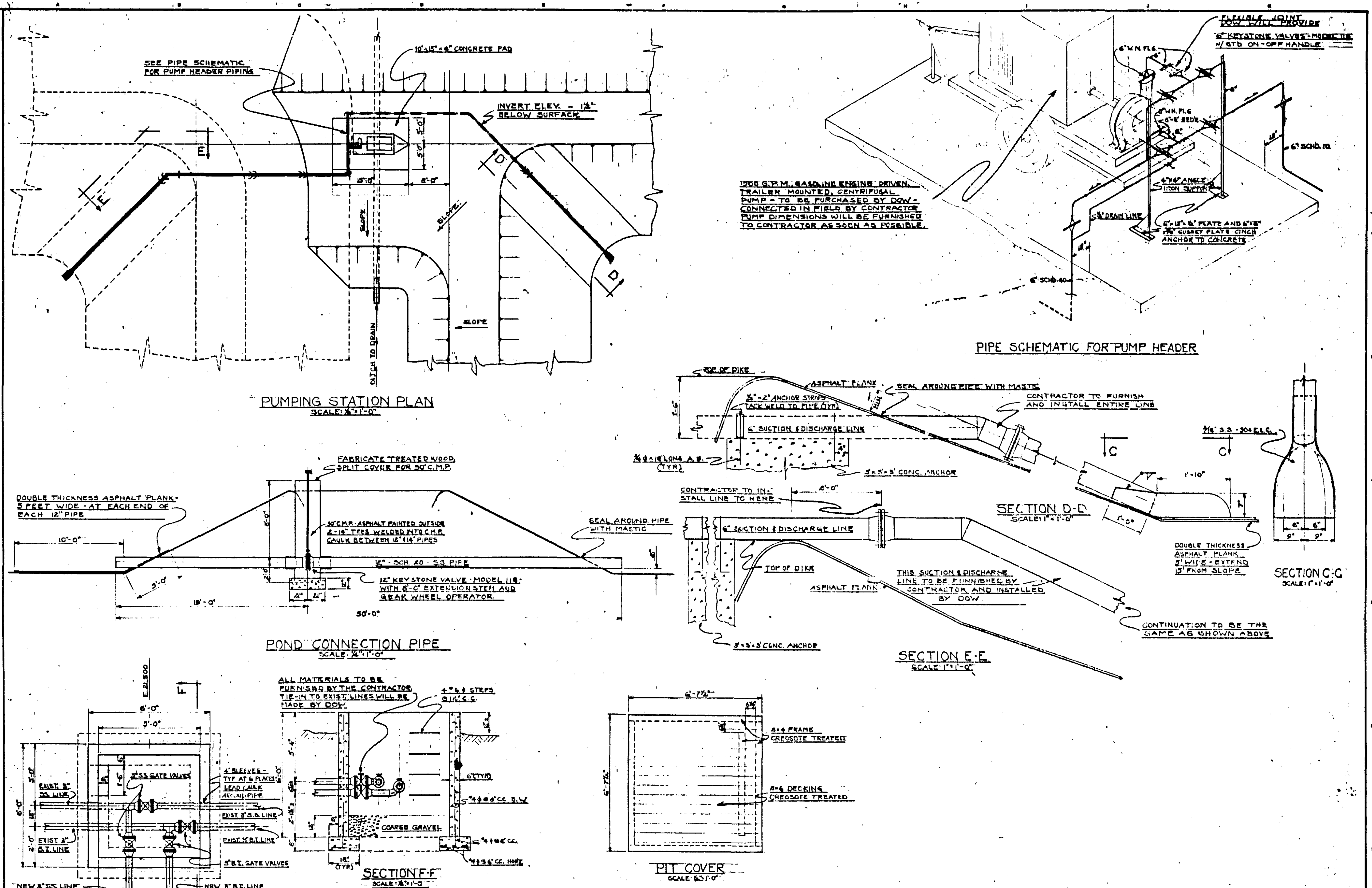
THE DOW CHEMICAL COMPANY ROCKY FLATS PLANT DENVER, COLORADO A.E.C. CONTRACT NO. AT (29-1)-1106	RECOMMENDED: D. P. Shepherd 9-10-59 APPROVED: L. McGrew 9-23-59	U. S. ATOMIC ENERGY COMMISSION ROCKY FLATS AREA OFFICE DENVER, COLORADO	IND. WASTE FAC. 207 3-1 ACRE EVAPORATION POND ADDITION PLAN, SECTIONS & DETAILS DATE 9-10-59 DRAWN ST. JOHN SCALE AS NOTED	DWG NO. 1-6217-207



6 033 88	Chen & Associates	ROCKY FLATS SOLAR EVAPORATION PONDS	SUMMARY OF SOLAR POND CLOSURE ACTIVITIES	Fig. 10



6 033 88	Chen & Associates	ROCKY FLATS SOLAR EVAPORATION PONDS	CLOSURE SCHEDULE TIME LINE	Fig. 11



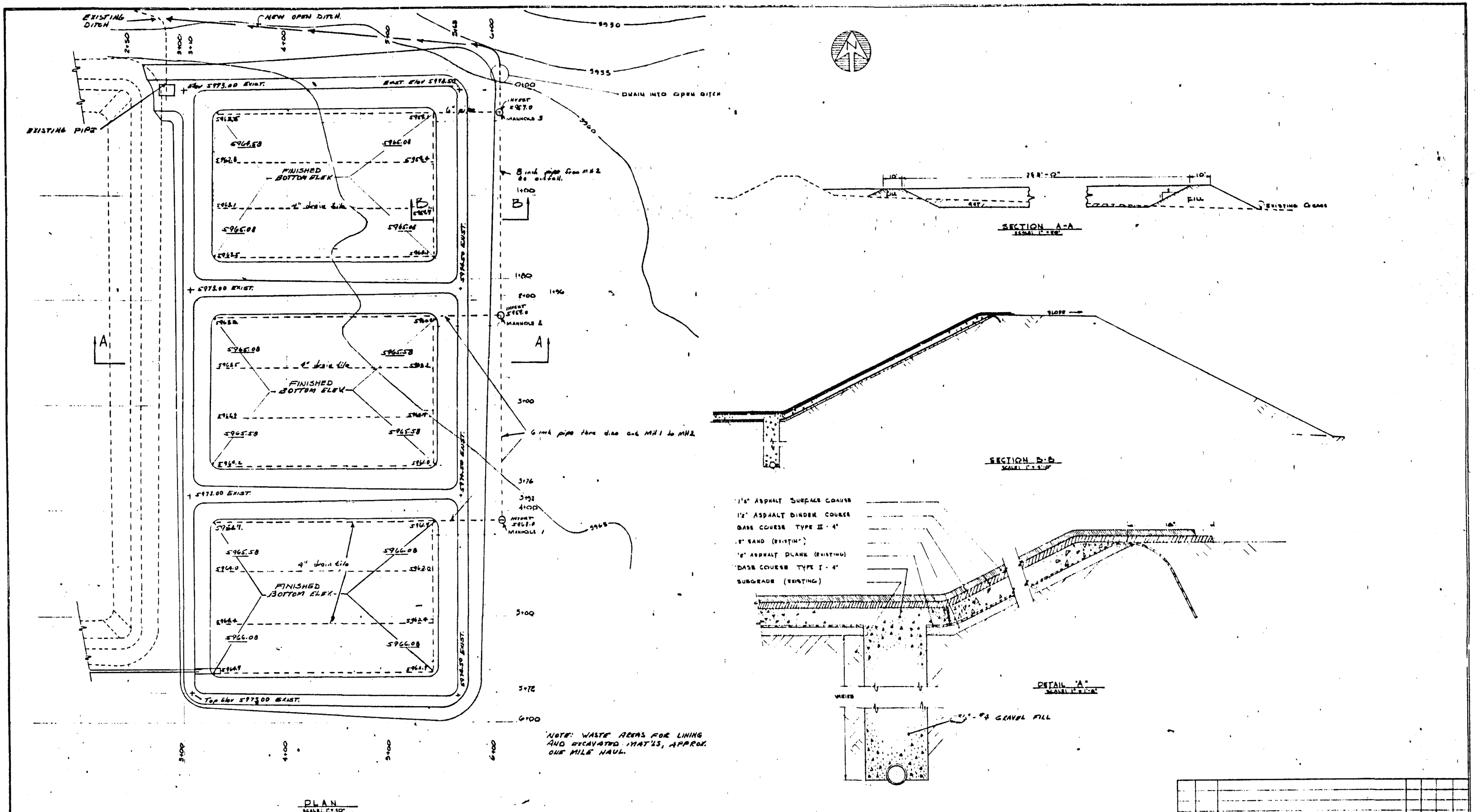
CHANGE NO.	REVISION	INITIAL DATE	INITIAL DATE	INITIAL DATE	INITIAL DATE

THE DOW CHEMICAL COMPANY
ROCKY FLATS PLANT
DENVER, COLORADO
A.E.C. CONTRACT NO. AT (29-1)-1106

RECOMMENDED: A. P. Sighed 9-23-59
APPROVED: [signature] 9-23-59

U. S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE
DENVER, COLORADO

IND. WASTE FAC. 207
3-ACRE EVAPORATION POND ADDITION
DETAILS
DATE 9-22-59 DRAWN ST. JOHN
SCALE AS NOTED
DWG. NO. 1-6218-207



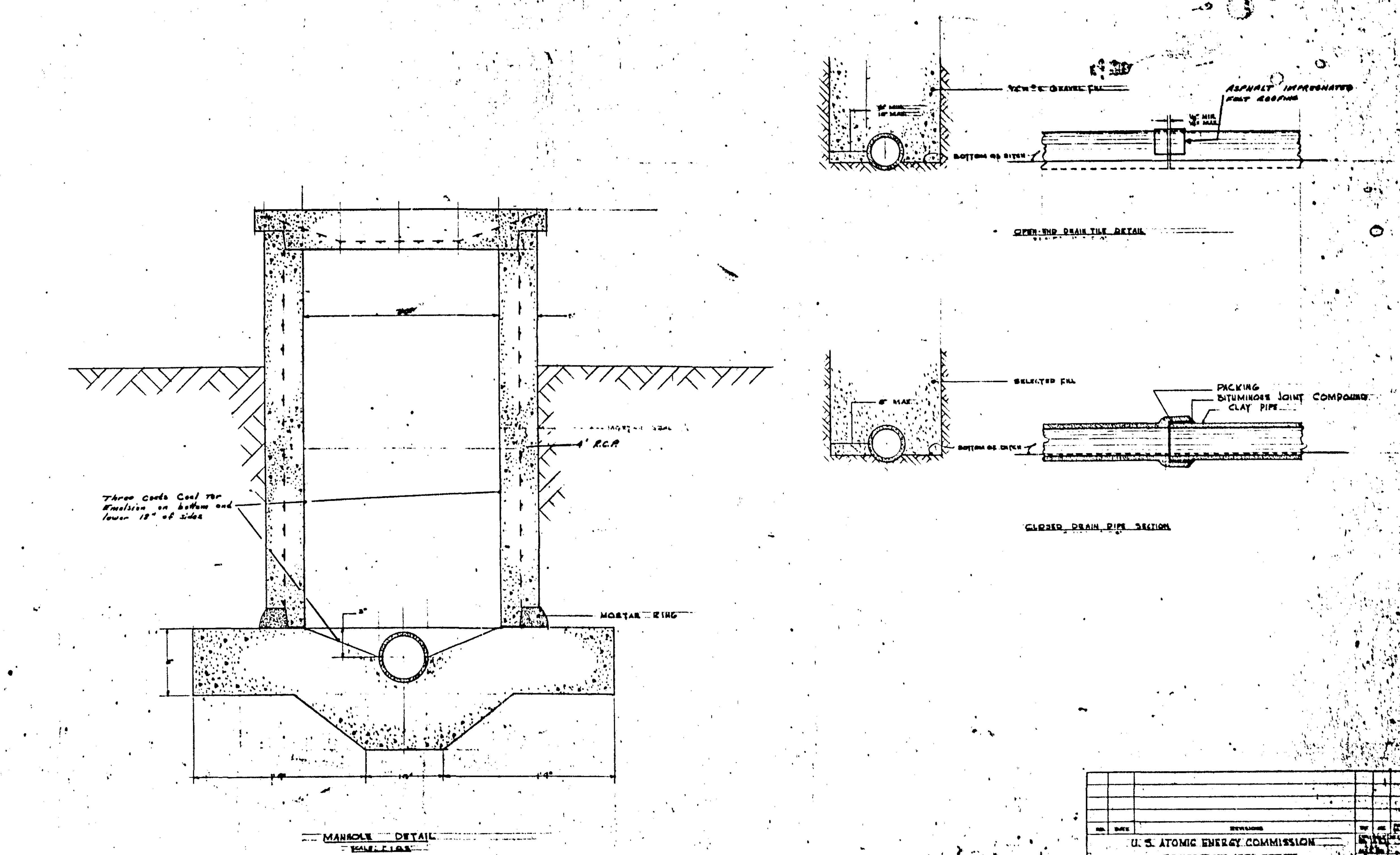
U. S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE

POND LINING DETAIL AND DRAINAGE PLAN
REPAIR OF WASTE DISPOSAL EVAPORATION POND 2-B
ROCKY FLATS PLANT
DENVER COLORADO

BENSON-LORD COMPANY
COCHRAN BLDG.
DENVER COLORADO

RF-B/39-1 | 1 | 2

Dow Dwg. 1-8080-207

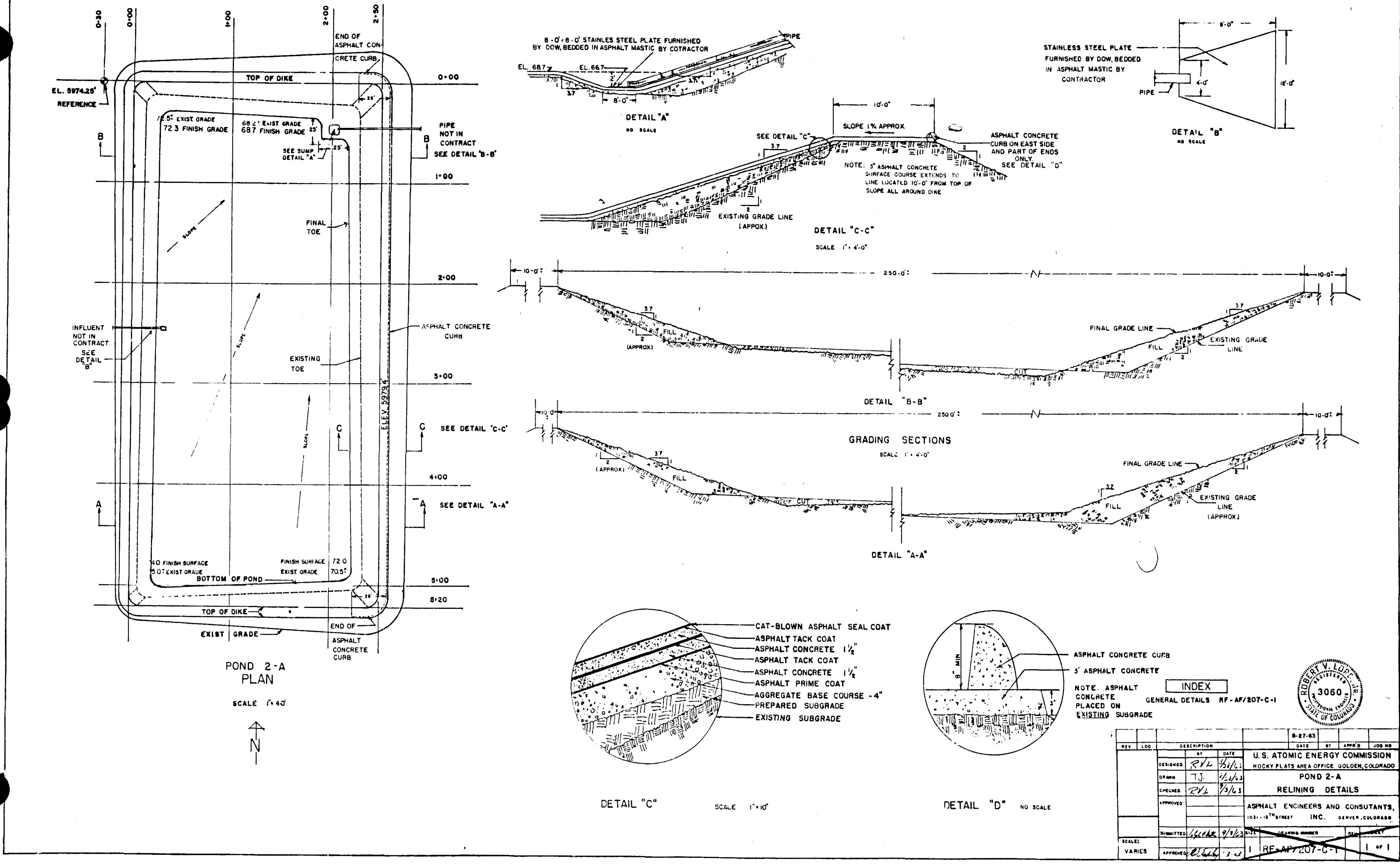


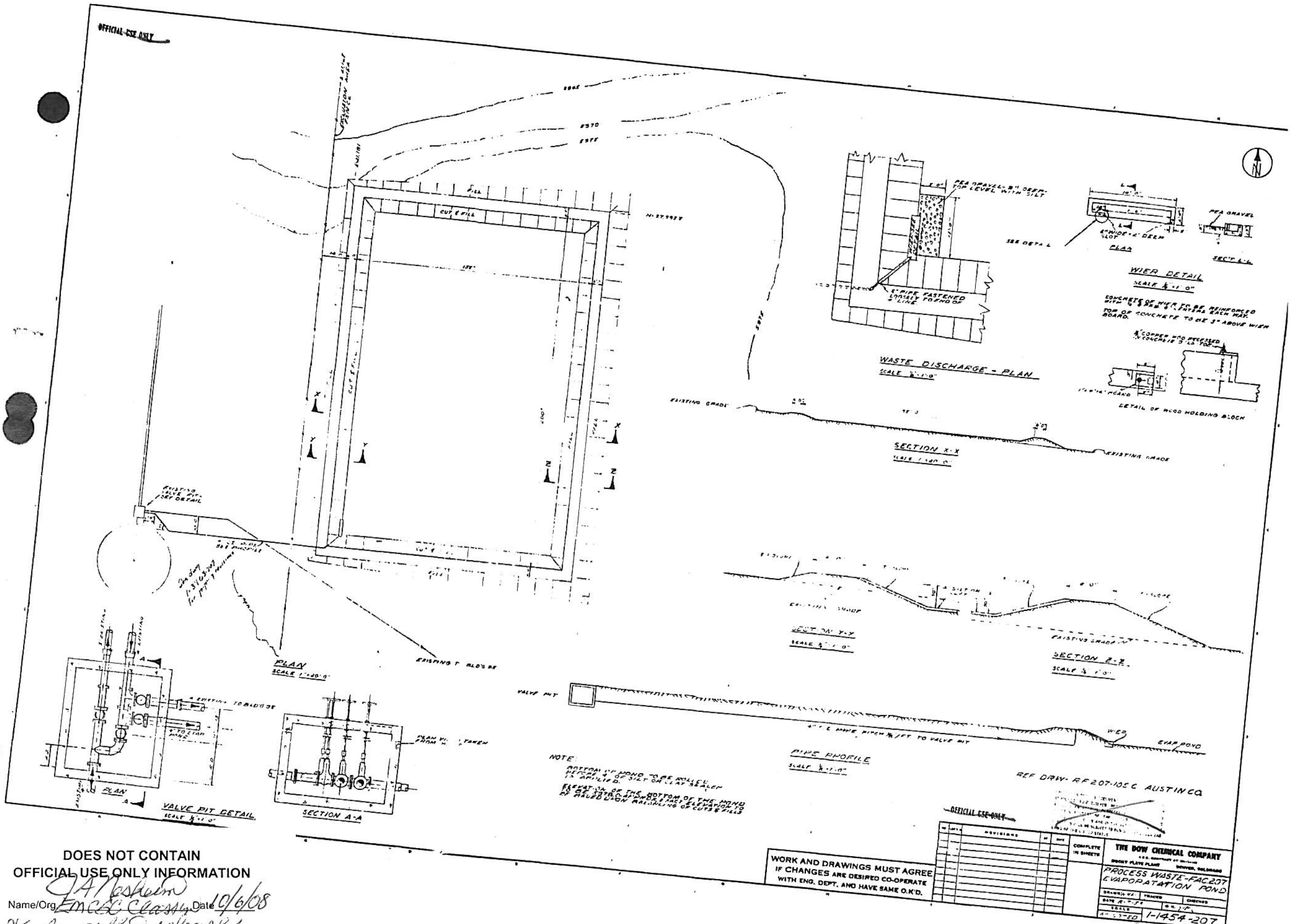
U. S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE

POND LINING DETAIL AND
DRAINAGE PLAN
REPAIR OF WASTE DISPOSAL
EVAPORATION POND
ROCKY FLATS PLANT
DENVER COLORADO

BENSON - LOBB COMPANY
DENVER COLORADO

Dow Dwg. 1-8081-20

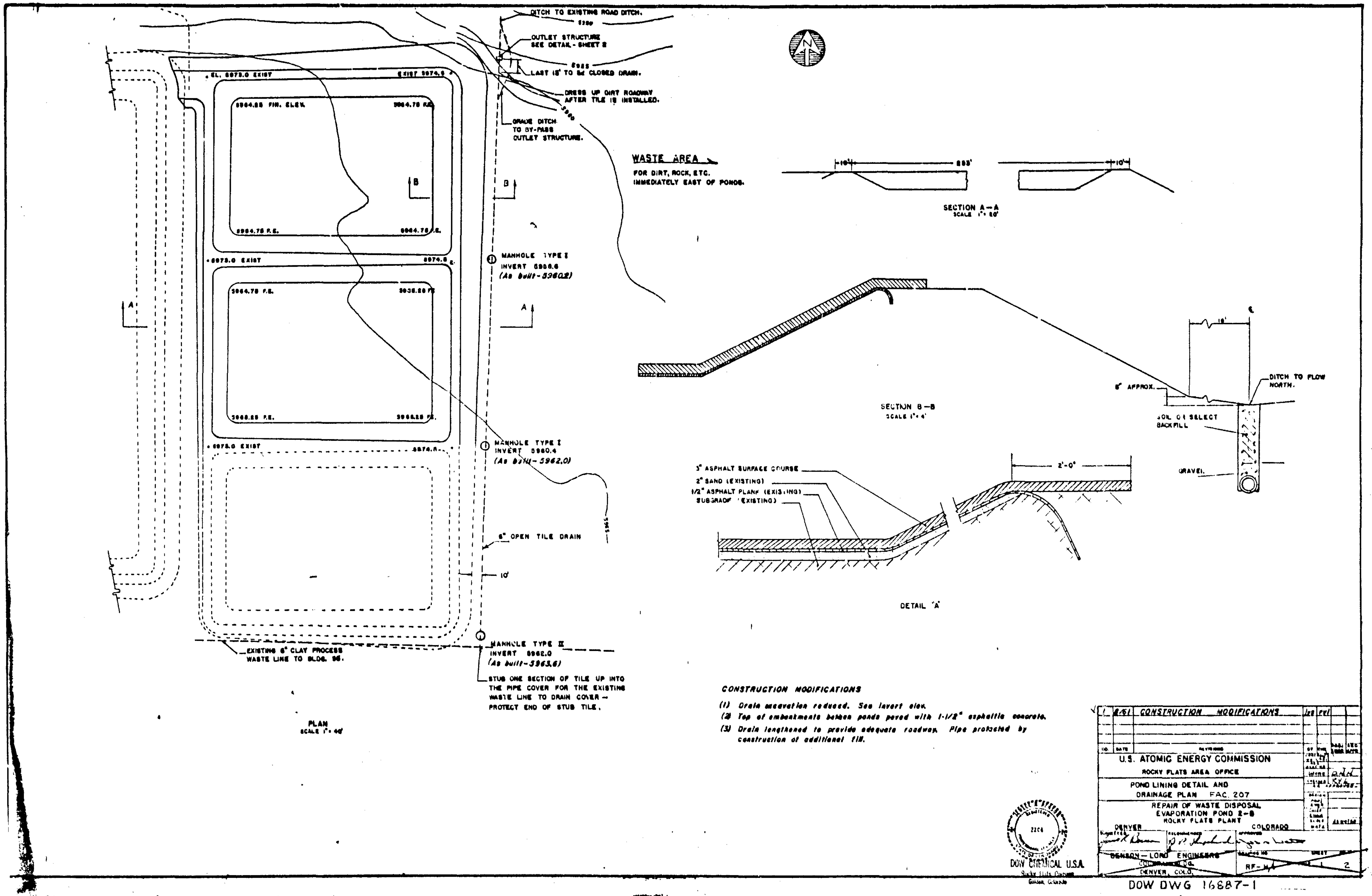

POND 2-A
PLAN
SCALE 1"=40'
EL. 5974.25' REFERENCE
TOP OF DIKE
END OF ASPHALT CONCRETE CURB
PIPE NOT IN CONTRACT SEE DETAIL "B-B"
72.5± EXIST GRADE 72.3 FINISH GRADE
68.2± EXIST GRADE 68.7 FINISH GRADE
SEE SUMP DETAIL "A"
FINAL TOE
EXISTING TOE
INFLUENT NOT IN CONTRACT SEE DETAIL "B"
ASPHALT CONCRETE CURB
ELEV. 5979.4
SEE DETAIL "C-C"
SEE DETAIL "A-A"
FINISH SURFACE 72.0
EXIST. GRADE 70.5±
BOTTOM OF POND
EXIST GRADE
0-30
0+00
1+00
2+00
2+50
3+00
4+00
5+00
5+20
8'-0" x 8'-0" STAINLESS STEEL PLATE FURNISHED BY DOW, BEDDED IN ASPHALT MASTIC BY COTRACTOR
EL. 68.7
EL. 66.7
DETAIL "A"
NO SCALE
STAINLESS STEEL PLATE FURNISHED BY DOW, BEDDED IN ASPHALT MASTIC BY CONTRACTOR
PIPE
DETAIL "B"
NO SCALE
SEE DETAIL "C"
SLOPE 1% APPROX.
ASPHALT CONCRETE CURB ON EAST SIDE AND PART OF ENDS ONLY. SEE DETAIL "D"
NOTE: 3" ASPHALT CONCRETE SURFACE COURSE EXTENDS TO LINE LOCATED 10'-0" FROM TOP OF SLOPE ALL AROUND DIKE
EXISTING GRADE LINE (APPOX.)
DETAIL "C-C"
SCALE 1"=4'-0"
250.0'±
FINAL GRADE LINE
EXISTING GRADE LINE
FILL
CUT
DETAIL "B-B"
GRADING SECTIONS
SCALE 1"=4'-0"
DETAIL "A-A"
CAT-BLOWN ASPHALT SEAL COAT
ASPHALT TACK COAT
ASPHALT CONCRETE 1½"
ASPHALT TACK COAT
ASPHALT CONCRETE 1½"
ASPHALT PRIME COAT
AGGREGATE BASE COURSE - 4"
PREPARED SUBGRADE
EXISTING SUBGRADE
DETAIL "C"
SCALE 1"=10"
ASPHALT CONCRETE CURB
3" ASPHALT CONCRETE
NOTE: ASPHALT CONCRETE PLACED ON EXISTING SUBGRADE
DETAIL "D"
NO SCALE
INDEX
GENERAL DETAILS RF-AF/207-C-1
ROBERT V. LORD, JR.
3060
STATE OF COLORADO
U.S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
POND 2-A
RELINING DETAILS
ASPHALT ENGINEERS AND CONSULTANTS, INC.
1031-15TH STREET DENVER, COLORADO
8-27-63
DESIGNED RVL
DRAWN TJ
CHECKED RVL
SCALE: VARIES
RF-AF/207-C-1
1 OF 1

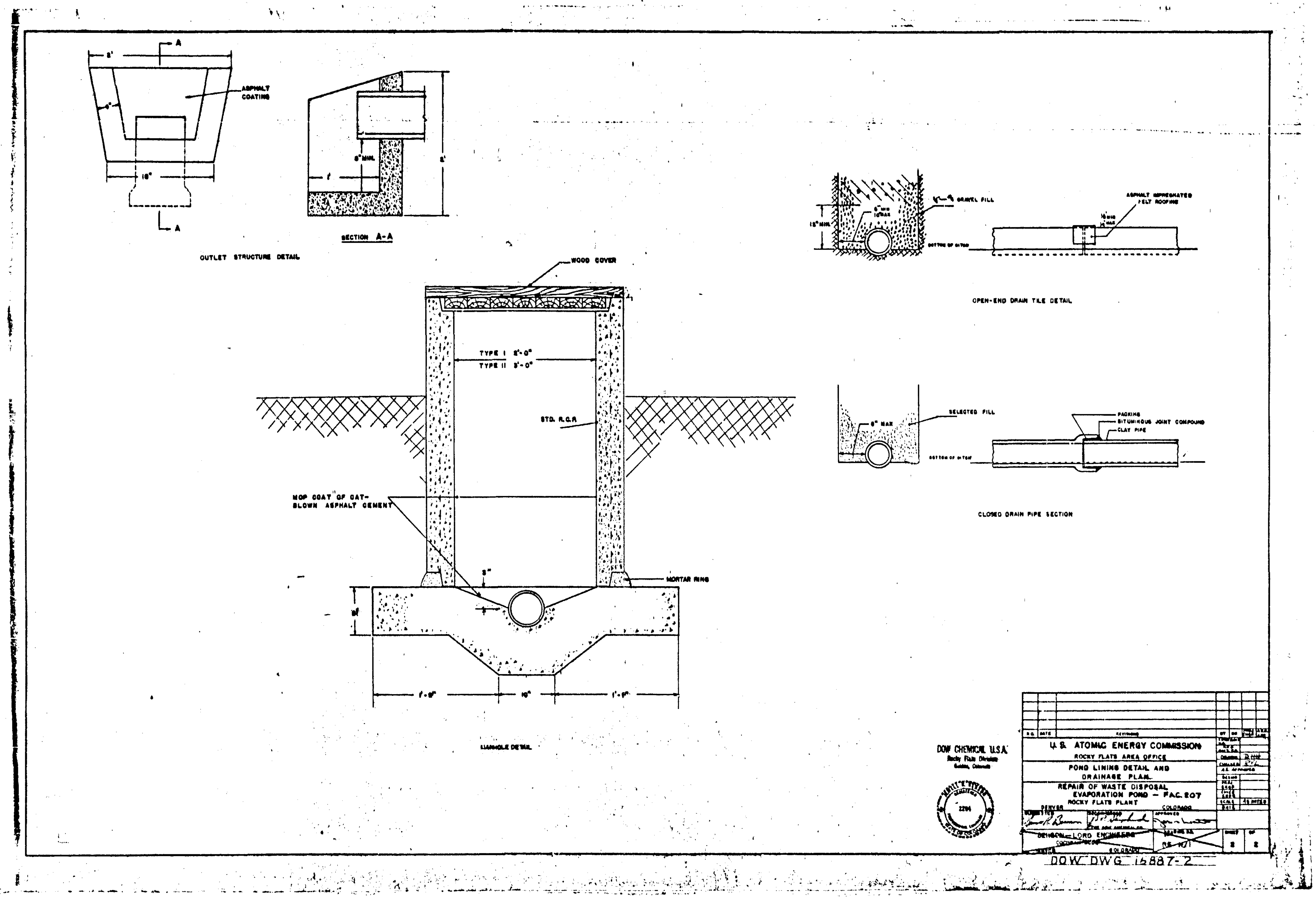


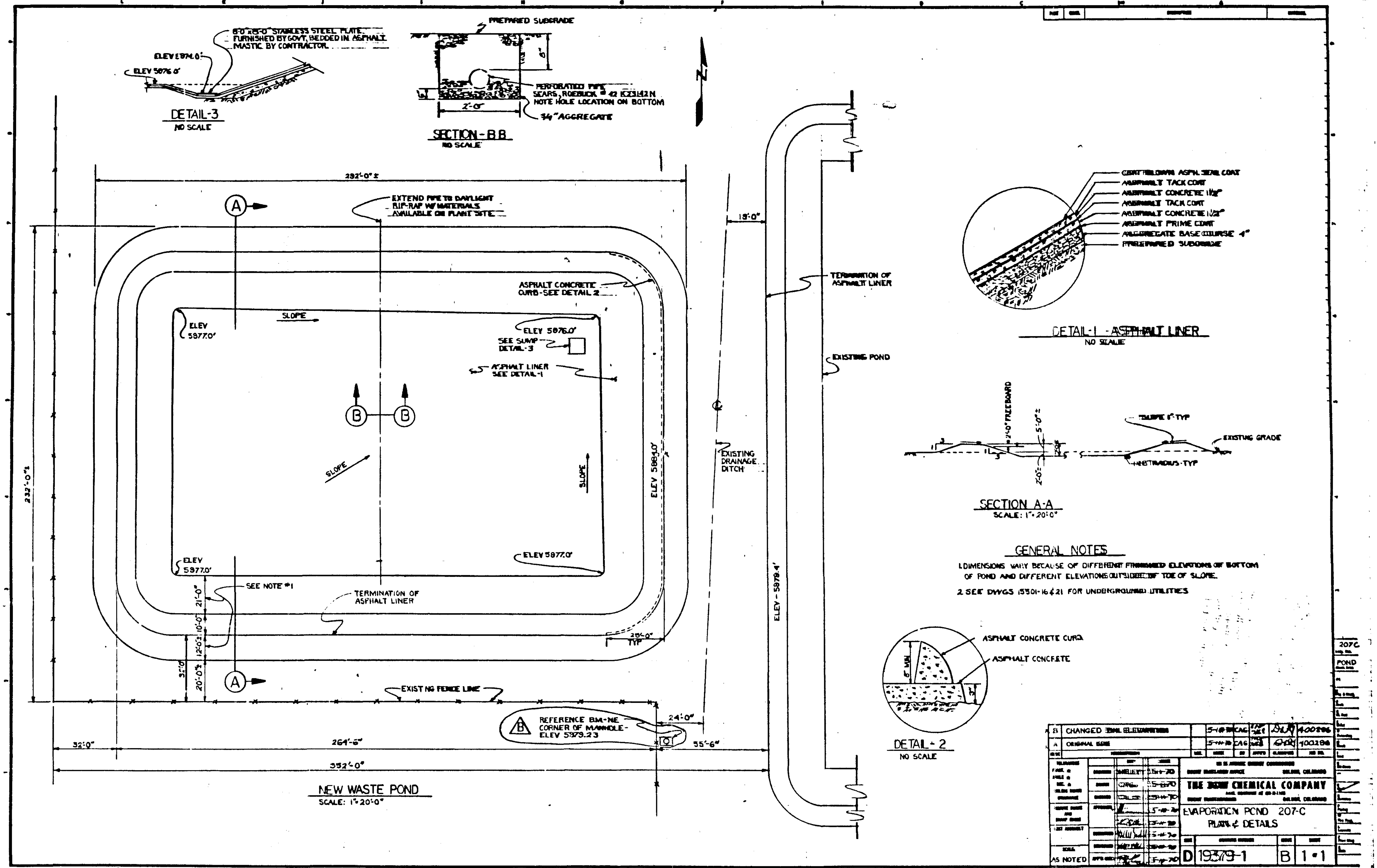
DOES NOT CONTAIN
OFFICIAL USE ONLY INFORMATION

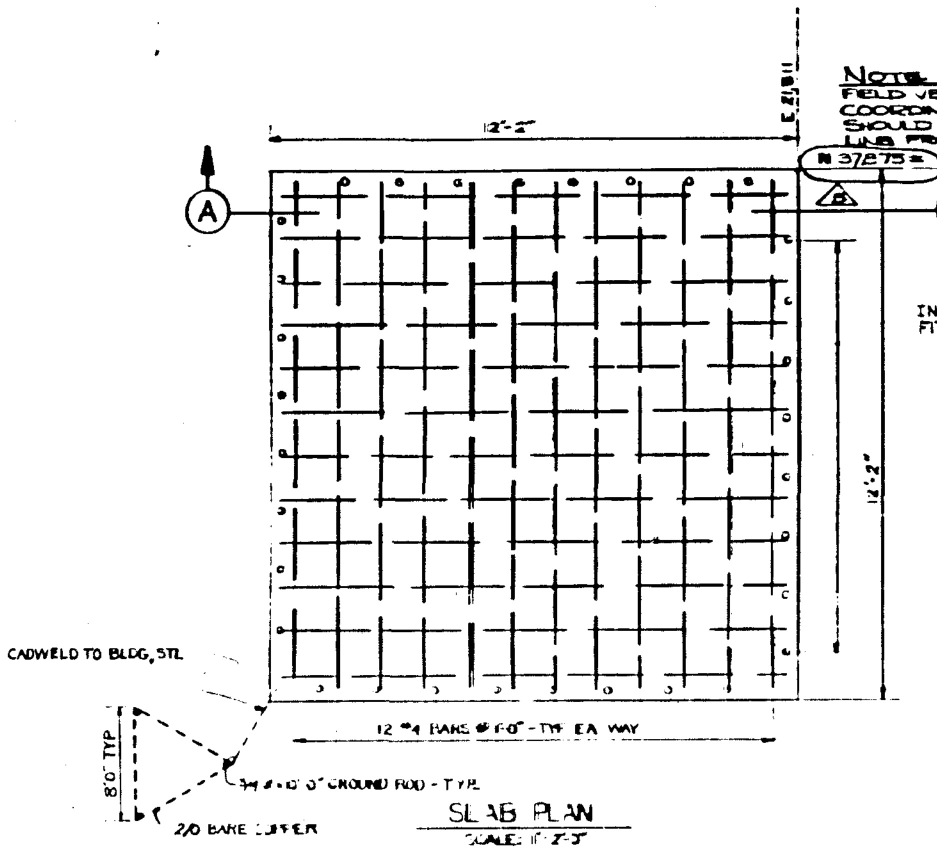
Name/Org: J A Nesheim EMCBC Classify Date: 10/6/08

OK for public release


DITCH TO EXISTING ROAD DITCH.
OUTLET STRUCTURE SEE DETAIL - SHEET 2
LAST 18' TO 8d CLOSED DRAIN.
DRESS UP DIRT ROADWAY AFTER TILE IS INSTALLED.
GRADE DITCH TO BY-PASS OUTLET STRUCTURE.
WASTE AREA
FOR DIRT, ROCK, ETC. IMMEDIATELY EAST OF PONDS.
EL. 5975.0 EXIST
EXIST 5974.5
5964.55 FIN. ELEV.
5964.75 F.E.
5975.0 EXIST
5964.75 F.E.
5965.55 F.E.
5975.0 EXIST
MANHOLE TYPE I
INVERT 5958.6
(As built-5960.2)
MANHOLE TYPE I
INVERT 5960.4
(As built-5962.0)
6" OPEN TILE DRAIN
10'
MANHOLE TYPE II
INVERT 5962.0
(As built-5963.6)
STUB ONE SECTION OF TILE UP INTO THE PIPE COVER FOR THE EXISTING WASTE LINE TO DRAIN COVER - PROTECT END OF STUB TILE.
EXISTING 6" CLAY PROCESS WASTE LINE TO BLDG. 95.
PLAN
SECTION A-A
SECTION B-B
DITCH TO FLOW NORTH.
6" APPROX.
SOIL OR SELECT BACKFILL
GRAVEL
3" ASPHALT SURFACE COURSE
2" SAND (EXISTING)
1/2" ASPHALT PLANK (EXISTING)
SUBGRADE (EXISTING)
2'-0"
DETAIL 'A'
CONSTRUCTION MODIFICATIONS
(1) Drain excavation reduced. See invert elev.
(2) Top of embankments between ponds paved with 1-1/2" asphaltic concrete.
(3) Drain lengthened to provide adequate roadway. Pipe protected by construction of additional fill.
CONSTRUCTION MODIFICATIONS
U.S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE
POND LINING DETAIL AND DRAINAGE PLAN FAC. 207
REPAIR OF WASTE DISPOSAL EVAPORATION POND 2-B
ROCKY FLATS PLANT
DENVER COLORADO
DENSON-LORD ENGINEERS
DENVER, COLO.
DOW CHEMICAL U.S.A.
DOW DWG 16887-1


ASPHALT COATING
18"
SECTION A-A
OUTLET STRUCTURE DETAIL
WOOD COVER
TYPE I 5'-0"
TYPE II 3'-0"
STD. R.C.P.
MOP COAT OF CAT-BLOWN ASPHALT CEMENT
MORTAR RING
MANHOLE DETAIL
GRAVEL FILL
ASPHALT IMPREGNATED FELT ROOFING
BOTTOM OF DITCH
OPEN-END DRAIN TILE DETAIL
SELECTED FILL
6" MAX
PACKING
BITUMINOUS JOINT COMPOUND
CLAY PIPE
CLOSED DRAIN PIPE SECTION
DOW CHEMICAL U.S.A.
Rocky Flats Division
Golden, Colorado
U.S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE
POND LINING DETAIL AND DRAINAGE PLAN
REPAIR OF WASTE DISPOSAL EVAPORATION POND – FAC. 207
ROCKY FLATS PLANT
DENVER COLORADO
DENISON-LORD ENGINEERS
SCALE AS NOTED
SHEET 2 OF 2
DOW DWG 16887-2


DETAIL-3
NO SCALE
8'-0" x 8'-0" STAINLESS STEEL PLATE, FURNISHED BY GOVT, BEDDED IN ASPHALT MASTIC BY CONTRACTOR.
ELEV 5974.0'
ELEV 5976.0'
SECTION-B-B
NO SCALE
PREPARED SUBGRADE
PERFORATED PIPE SEARS, ROEBUCK # 42 KE3142N NOTE HOLE LOCATION ON BOTTOM
3/4" AGGREGATE
2'-0"
NEW WASTE POND
SCALE: 1"=20'-0"
292'-0" ±
232'-0" ±
EXTEND PIPE TO DAYLIGHT RIP-RAP W/ MATERIALS AVAILABLE ON PLANT SITE.
ASPHALT CONCRETE CURB-SEE DETAIL 2
ELEV 5977.0'
ELEV 5976.0'
SEE SUMP DETAIL-3
ASPHALT LINER SEE DETAIL-1
SLOPE
ELEV 5983.0'
SEE NOTE #1
TERMINATION OF ASPHALT LINER
21'-0"
10'-0"
12'-0"
20'-0"
32'-0"
28'-0" TYP
EXISTING FENCE LINE
REFERENCE BM-NE CORNER OF MANHOLE-ELEV 5979.23
24'-0"
55'-6"
264'-6"
352'-0"
15'-0"
EXISTING DRAINAGE DITCH
ELEV - 5979.4'
TERMINATION OF ASPHALT LINER
EXISTING POND
DETAIL-1 - ASPHALT LINER
NO SCALE
ASPHALT TACK COAT
ASPHALT CONCRETE 1 1/2"
ASPHALT TACK COAT
ASPHALT CONCRETE 1 1/2"
ASPHALT PRIME COAT
AGGREGATE BASE COURSE 4"
PREPARED SUBGRADE
SECTION A-A
SCALE: 1"=20'-0"
2'-0" FREEBOARD
5'-0"
2'-0"
EXISTING GRADE
5'-0" RADIUS-TYP
GENERAL NOTES
1. DIMENSIONS VARY BECAUSE OF DIFFERENT FINISHED ELEVATIONS OF BOTTOM OF POND AND DIFFERENT ELEVATIONS OUTSIDE OF TOE OF SLOPE.
2. SEE DWGS 15501-16 & 21 FOR UNDERGROUND UTILITIES
DETAIL-2
NO SCALE
ASPHALT CONCRETE CURB
ASPHALT CONCRETE
6" MIN
B CHANGED
A ORIGINAL ISSUE
400296
400198
THE DOW CHEMICAL COMPANY
EVAPORATION POND 207-C
PLAN & DETAILS
D 19379-1
B 1 of 1
AS NOTED
207-C
POND

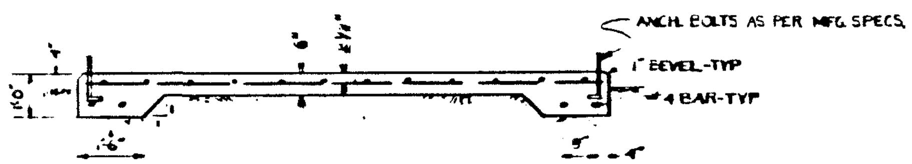


SLAB PLAN
SCALE: 1"=2'-0"

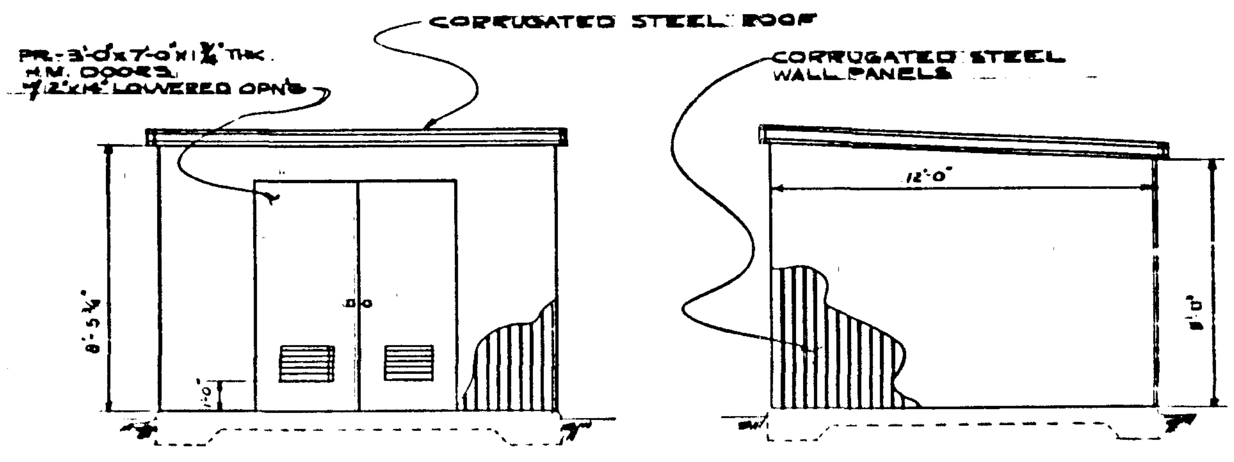
NOTE
FIELD VERIFY THESE COORDINATES - PIPING RUN SHOULD BE A STRAIGHT LINE FROM SUMP OF 207C INTO 207A

N 37,875 ±

INSTALL ANCHOR BOLTS AS REQUIRED TO FIT THE BLDG BASE.

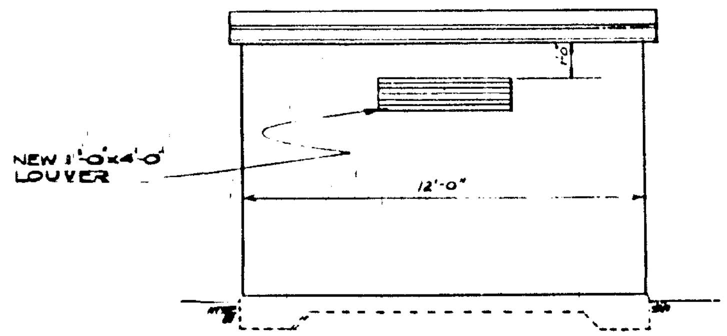


SECTION A-A
SCALE: 1"=2'-0"



SOUTH ELEVATION
SCALE 1/8"=1'-0"

EAST ELEVATION
SCALE 1/8"=1'-0"



NORTH ELEVATION
SCALE 1/8"=1'-0"

GENERAL NOTES

1. SLAB WAS DESIGNED FOR "ARMCO" LS-1 BUILDING.
2. ALL CONCRETE SHALL DEVELOP 3000 PSI COMPRESSIVE STRENGTH IN 28 DAYS.
3. THE BUILDING SHALL BE LOCATED BY THE STATIONING SHOWN ON THIS DWG. SEE DWG 1979-3 FOR REFERENCE COORDINATED

B	CHANGE COORD. & ELEV.					3999[illegible]
A	ORIGINAL ISSUE					999019

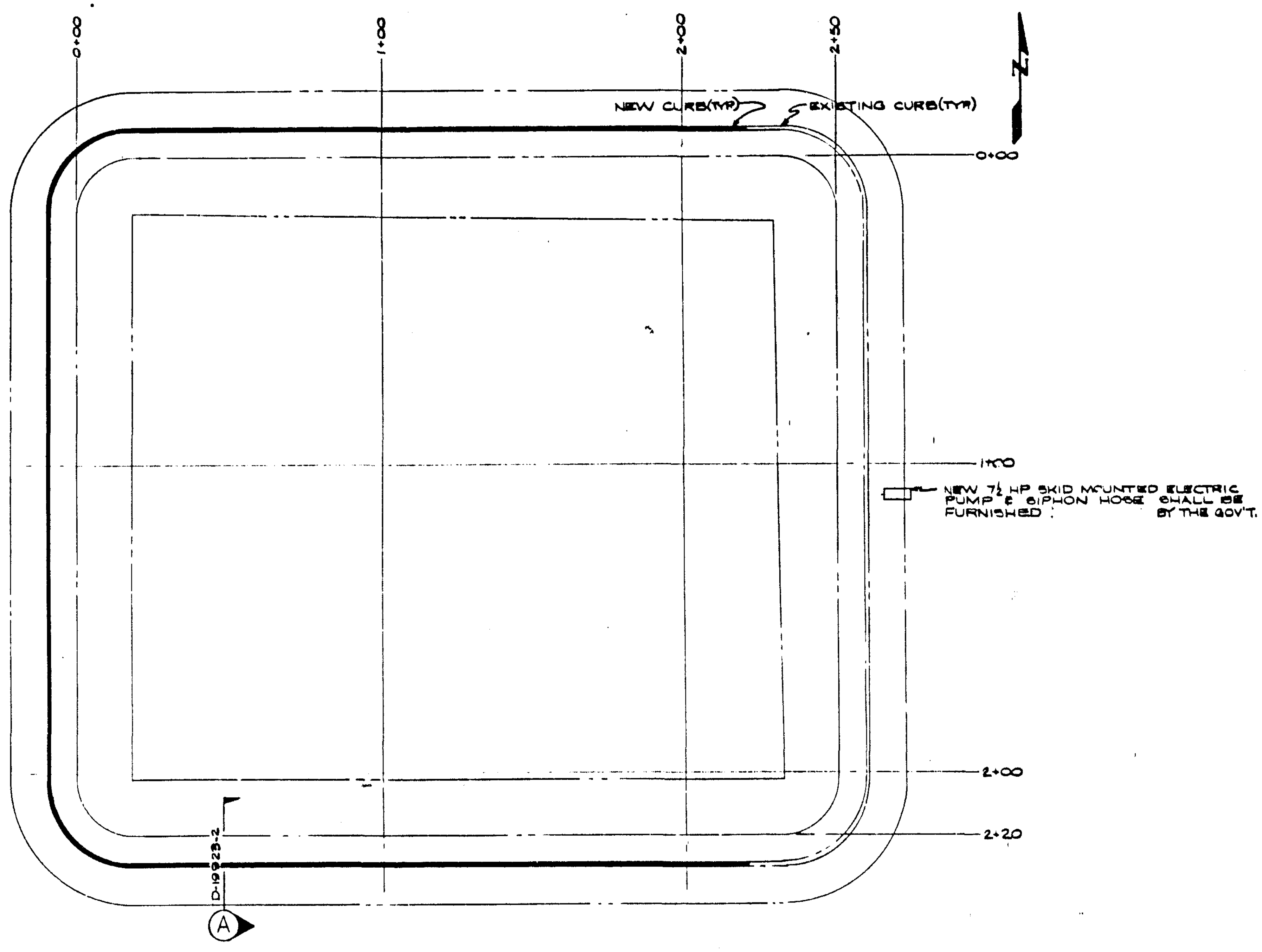
	BY	DATE
DESIGNED	[illegible]	6-3-70
DRAWN	CAG	6-8-70
CHECKED	DLS	7-7-70
APPROVED	[illegible]	7-9-70
	[illegible]	7-9-70
SUBMITTED		
RECEIVED	[illegible]	7-9-70
APPD	[illegible]	7/9/70

SCALE: AS NOTED

THE DOW CHEMICAL COMPANY

EVAPORATION POND 207C
TEMPORARY PUMP SHED
SLAB PLAN & SECT.

D 1575-2 B 2-4

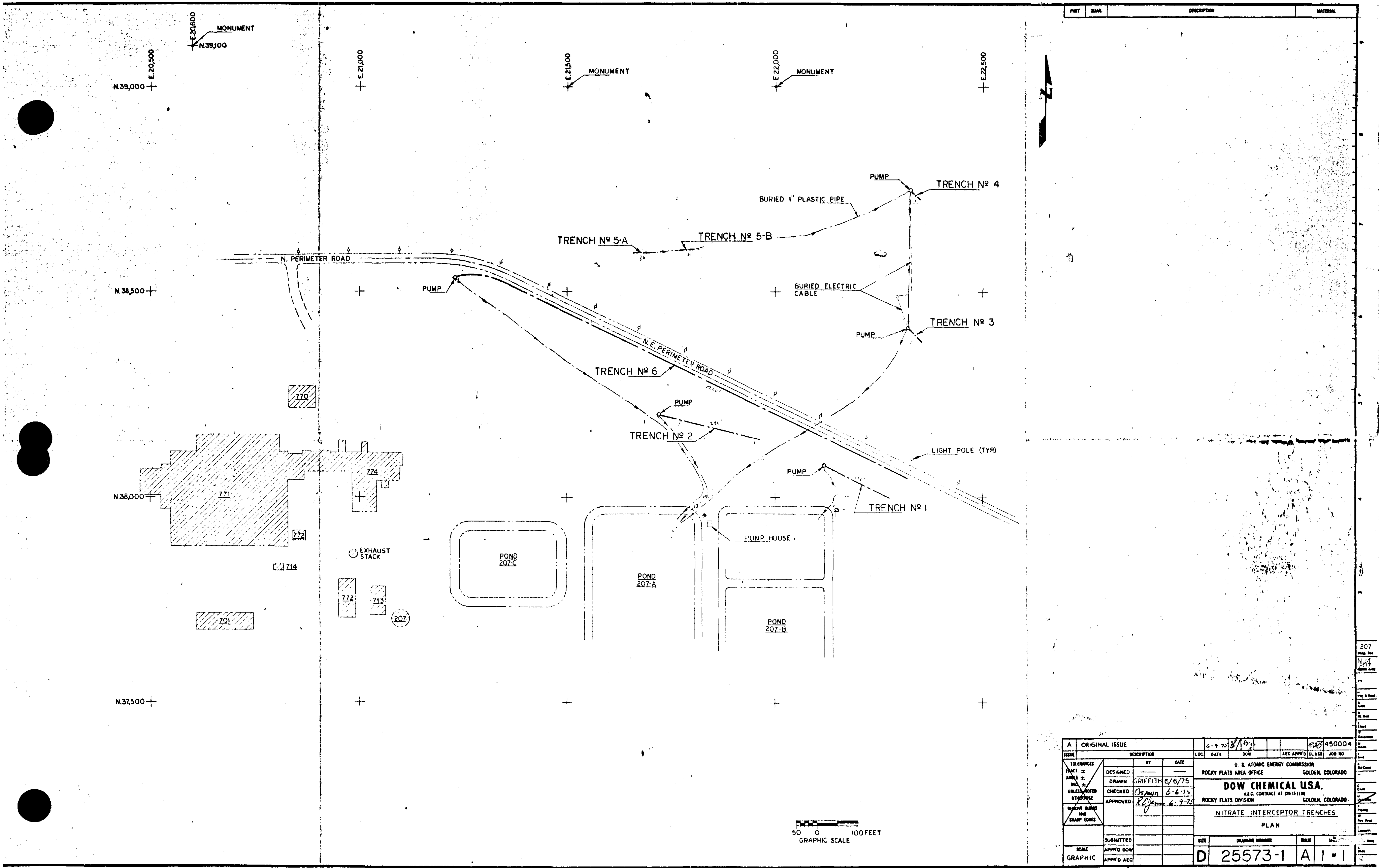


POND 207C
SCALE: 1" = 20'

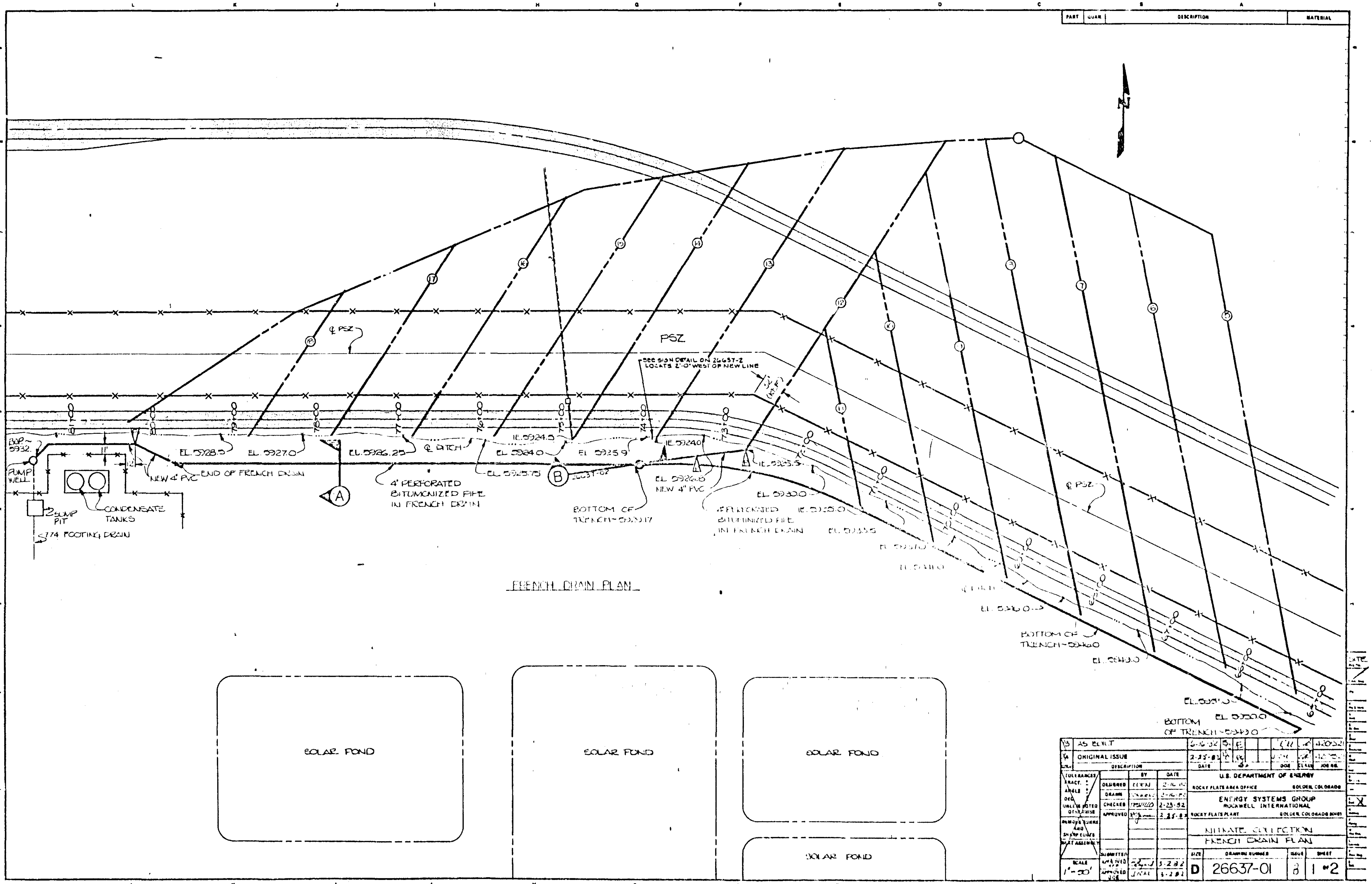
GENERAL NOTE.

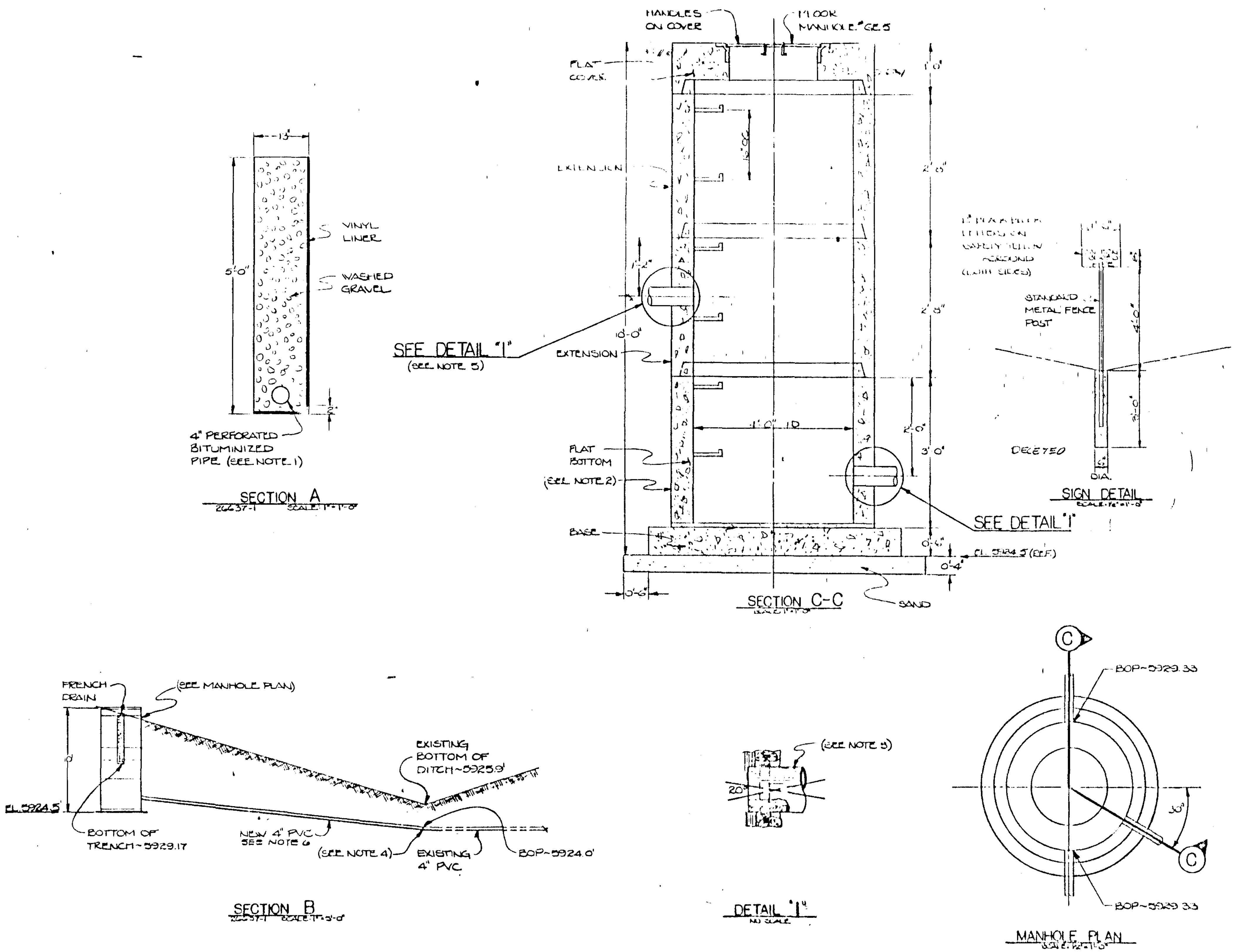
1. NO SEAL COAT WILL BE REQUIRED ON POND 207C.

A	ORIGINAL ISSUE	3-16-71	DLS			410550
DESIGNED	SHELEY	1-4-71	U. S. ATOMIC ENERGY COMMISSION ROCKY FLATS AREA OFFICE GOLDEN, COLORADO			
DRAWN	JFOH	1-4-71	THE DOW CHEMICAL COMPANY ROCKY FLATS DIVISION GOLDEN, COLORADO			
CHECKED	DLS	3-9-71				
APPROVED		3-16-71	REPAIR EVAP PONDS			
		3-16-71	POND 207C			
SUBMITTED		2-16-71				
REVIEWED		3/16/71				
SCALE AS NOTED			D	19923-2	A	2 of 5



MONUMENT
E.20,600
N.39,100
E.20,500
N.39,000
E.21,000
E.21,500
E.22,000
E.22,500
N.38,500
N.38,000
N.37,500
TRENCH Nº 4
TRENCH Nº 3
TRENCH Nº 5-A
TRENCH Nº 5-B
TRENCH Nº 6
TRENCH Nº 2
TRENCH Nº 1
PUMP
BURIED 1" PLASTIC PIPE
BURIED ELECTRIC CABLE
N. PERIMETER ROAD
N.E. PERIMETER ROAD
LIGHT POLE (TYP)
PUMP HOUSE
POND 207-A
POND 207-B
POND 207-C
EXHAUST STACK
770
771
772
774
714
713
701
207
50 0 100FEET
GRAPHIC SCALE
A ORIGINAL ISSUE
DESIGNED
DRAWN GRIFFITH 6/6/75
CHECKED 6-6-75
APPROVED 6-9-75
SUBMITTED
APPR'D DOW
APPR'D AEC
SCALE GRAPHIC
6-9-75
450004
U. S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
DOW CHEMICAL U.S.A.
ROCKY FLATS DIVISION GOLDEN, COLORADO
NITRATE INTERCEPTOR TRENCHES
PLAN
D 25573-1 A 1 of 1


FRENCH DRAIN PLAN
PSZ
℄ PSZ
SEE SIGN DETAIL ON 26637-2 LOCATE 2'-0" WEST OF NEW LINE
EL. 5928.5
EL. 5927.0
EL. 5926.25
℄ DITCH
IE. 5924.5
EL. 5924.0
EL. 5925.75
EL. 5925.9
IE. 5924.0
EL. 5926.0
NEW 4" PVC
EL. 5930.0
4" PERFORATED BITUMINIZED PIPE IN FRENCH DRAIN
BOTTOM OF TRENCH
END OF FRENCH DRAIN
NEW 4" PVC
PUMP WELL
SUMP PIT
CONDENSATE TANKS
774 FOOTING DRAIN
SOLAR POND
SOLAR POND
SOLAR POND
SOLAR POND
AS BUILT
ORIGINAL ISSUE
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE
GOLDEN, COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT
NITRATE COLLECTION
FRENCH DRAIN PLAN
SCALE 1" = 50'
D
26637-01
1 of 2



PART	QUAN	DESCRIPTION	MATERIAL

NOTES:

1. PLACE 4" PERFORATED BITUMINIZED PIPE WITH PERFORATIONS DOWN.
2. WALL THICKNESS – 5".
3. PIPE TO MANHOLE SEAL. A LOK GASKET PER ASTM RUBBER GASKET SPECS C443, CAST INTEGRALLY IN MANHOLE WALL AND LOCATED AS REQUIRED. JOINT ALLOWS 0° OMNIDIRECTIONAL DEFLECTION.
4. INSTALL COUPLING BETWEEN NEW AND EXISTING 4" PVC.
5. 4" PERFORATED BITUMINIZED PIPE (BOTH SIDES)
6. BED NEW 4" PVC PIPE W/ 3" SAND BASE.

LEGEND:

-----	EXISTING
———	NEW
BOP	BOTTOM OF PIPE
ID	INSIDE DIAMETER
PVC	POLYVINYL CHLORIDE
IE	INVERT ELEVATION
▷	UNDERGROUND UTILITIES POST

B	AS BUILT	6-16-82	420521
A	ORIGINAL ISSUE	3-26-82	420521

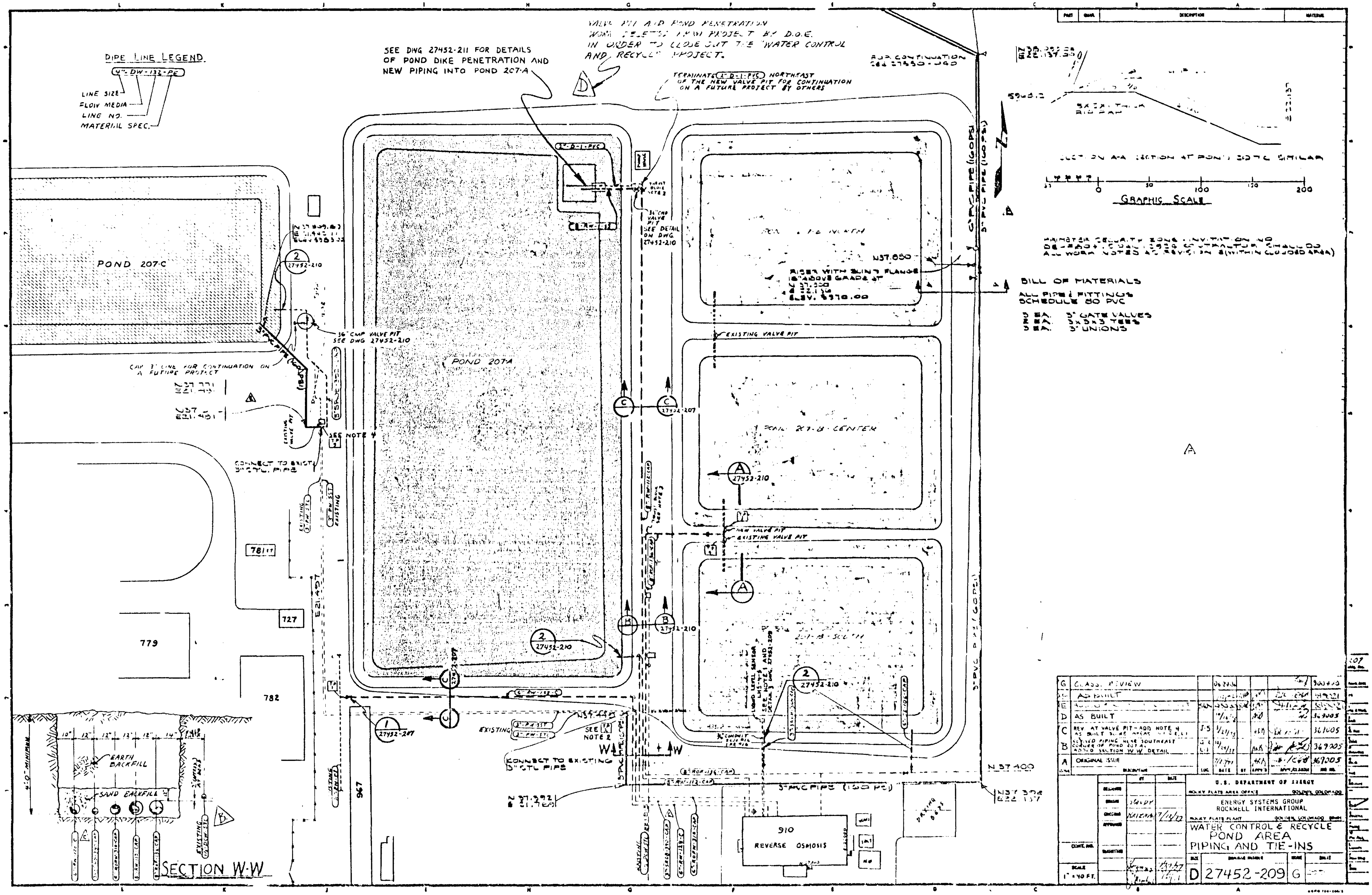
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE — GOLDEN, COLORADO

ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT — GOLDEN, COLORADO

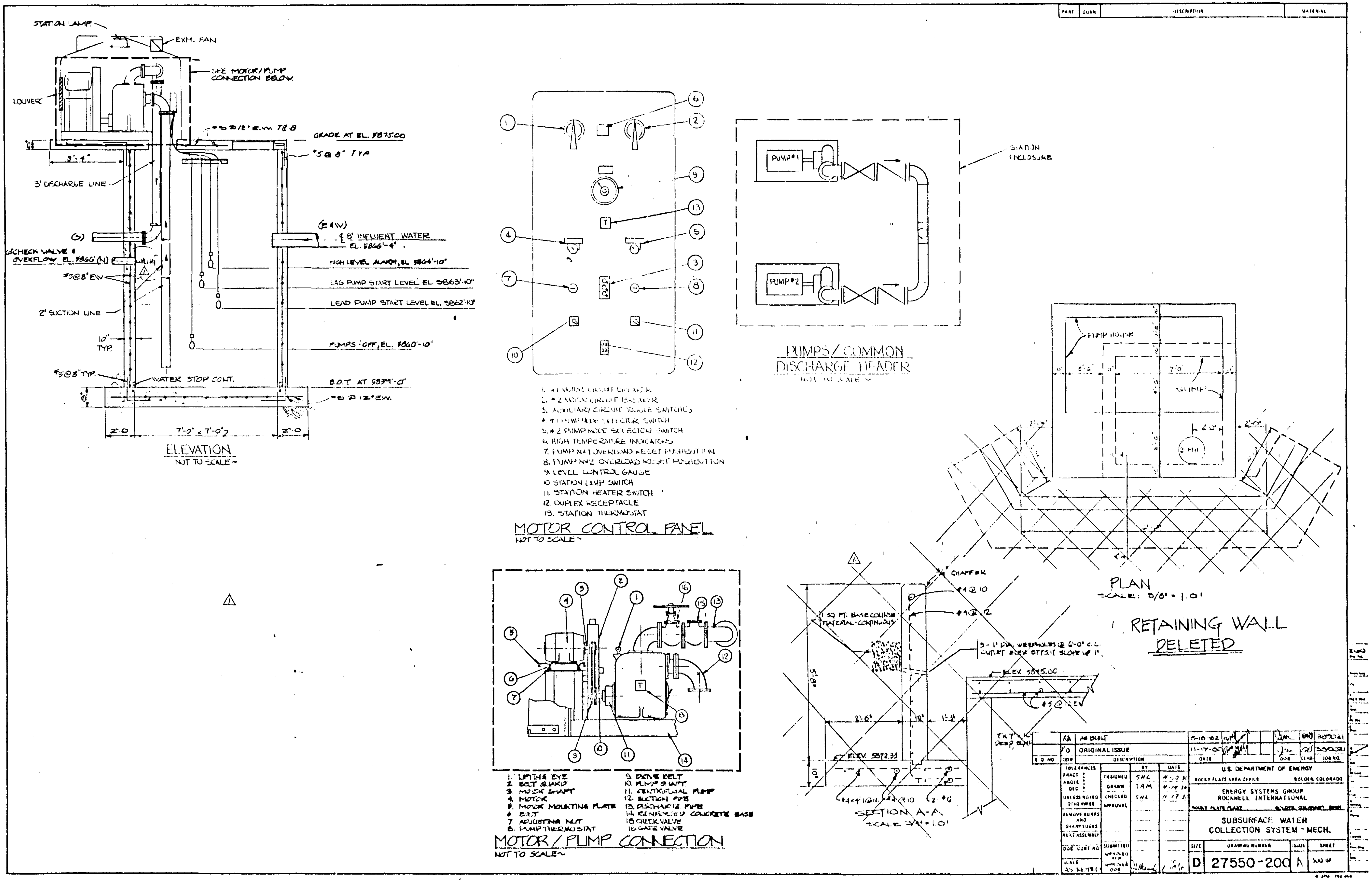
NITRATE COLLECTION
DETAILS AND SECTIONS

SIZE D — DRAWING NUMBER 26637-02 — ISSUE B — SHEET 2

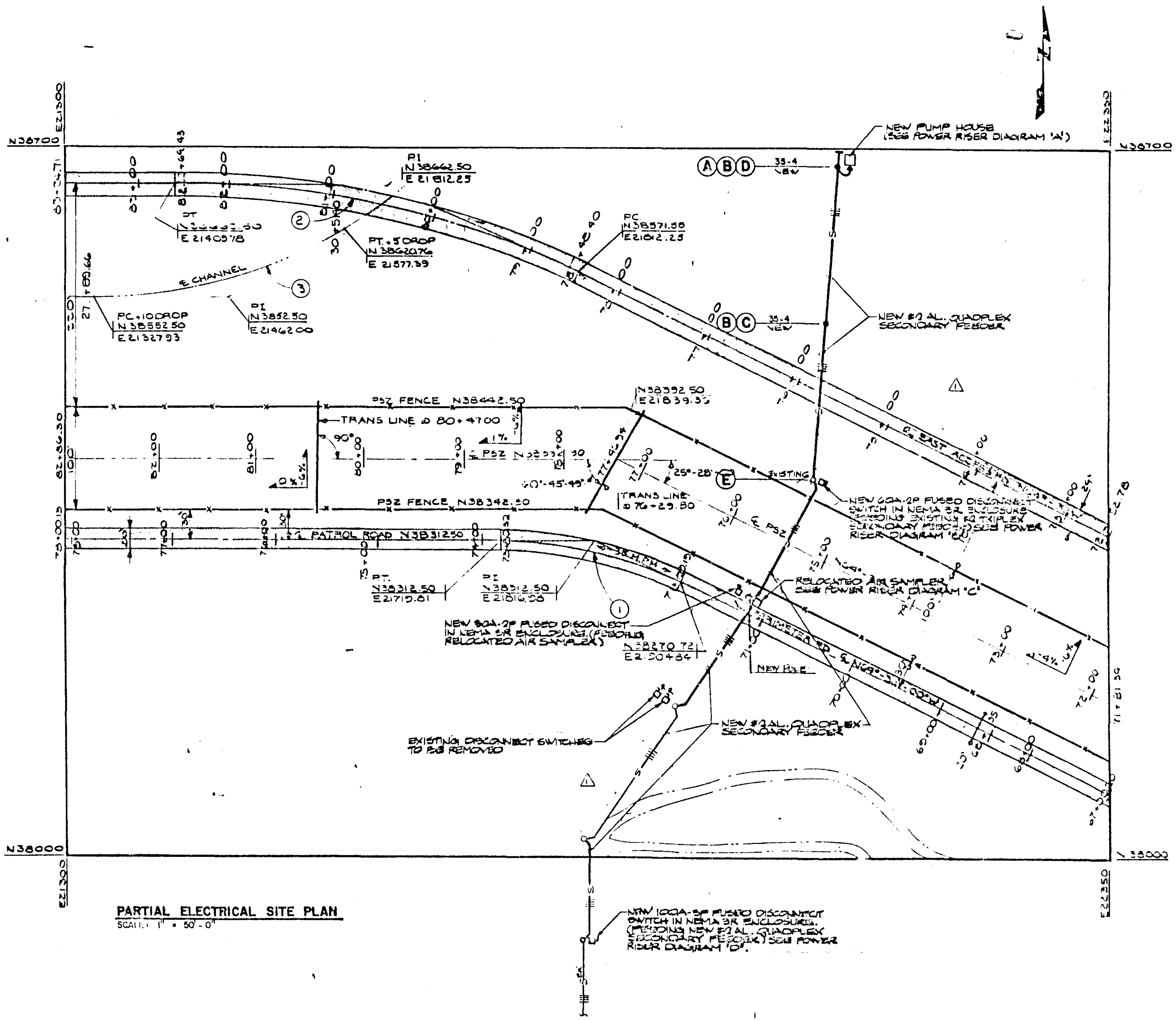
SCALE: NOTED



PIPE LINE LEGEND
4"-DW-132-PE
LINE SIZE
FLOW MEDIA
LINE NO.
MATERIAL SPEC.
SEE DWG 27452-211 FOR DETAILS OF POND DIKE PENETRATION AND NEW PIPING INTO POND 207-A
VALVE PIT AND POND PENETRATION
IN ORDER TO CLOSE OUT THE "WATER CONTROL AND RECYCLE" PROJECT.
POND 207-C
POND 207A
36" CMP VALVE PIT SEE DWG 27452-210
CAP 3" LINE FOR CONTINUATION ON A FUTURE PROJECT
SEE NOTE 4
CONNECT TO EXISTING 3" STL PIPE
EXISTING VALVE PIT
NEW VALVE PIT
EXISTING
SEE NOTE 2
N 37,400
N 37,650
RISER WITH BLIND FLANGE
BILL OF MATERIALS
ALL PIPE & FITTINGS SCHEDULE 80 PVC
3 EA. 3" GATE VALVES
3 EA. 3" UNIONS
GRAPHIC SCALE
0 50 100 150 200
910
REVERSE OSMOSIS
779
782
727
781
967
EARTH BACKFILL
SAND BACKFILL
4'-0" MINIMUM
SECTION W-W
G CLASS. REVIEW
F AS BUILT
D AS BUILT
C REV. AT VALVE PIT - ADD NOTE 4
A ORIGINAL ISSUE
U.S. DEPARTMENT OF ENERGY
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
WATER CONTROL & RECYCLE
POND AREA
PIPING AND TIE-INS
D 27452-209 G
1" = 40 FT.



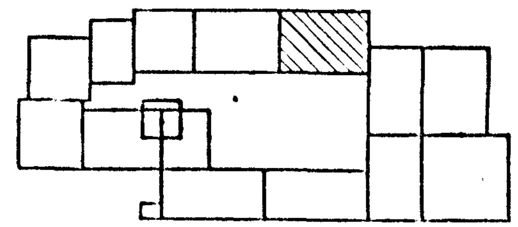
STATION LAMP
EXH. FAN
SEE MOTOR/PUMP CONNECTION BELOW.
LOUVER
GRADE AT EL. 5875.00
"5@8" TYP
3'-4"
3' DISCHARGE LINE
(S)
(E+W)
¢ 8' INFLUENT WATER EL. 5866'-4"
CHECK VALVE & OVERFLOW EL. 5866'(N)
HIGH LEVEL ALARM, EL. 5864'-10"
#5@8" EW
LAG PUMP START LEVEL EL. 5863'-10"
LEAD PUMP START LEVEL EL. 5862'-10"
2" SUCTION LINE
10" TYP.
PUMPS OFF, EL. 5860'-10"
#5@8" TYP.
WATER STOP CONT.
B.O.T. AT 5859'-0"
2'-0
7'-0" x 7'-0"
2'-0
ELEVATION
NOT TO SCALE
1. #1 MOTOR CIRCUIT BREAKER
2. #2 MOTOR CIRCUIT BREAKER
3. AUXILIARY CIRCUIT TOGGLE SWITCHES
4. #1 PUMP MODE SELECTOR SWITCH
5. #2 PUMP MODE SELECTOR SWITCH
6. HIGH TEMPERATURE INDICATORS
7. PUMP No 1 OVERLOAD RESET PUSHBUTTON
8. PUMP No 2 OVERLOAD RESET PUSHBUTTON
9. LEVEL CONTROL GAUGE
10. STATION LAMP SWITCH
11. STATION HEATER SWITCH
12. DUPLEX RECEPTACLE
13. STATION THERMOSTAT
MOTOR CONTROL PANEL
NOT TO SCALE
PUMP #1
PUMP #2
STATION ENCLOSURE
PUMPS/COMMON DISCHARGE HEADER
NOT TO SCALE
1. LIFTING EYE
2. BELT GUARD
3. MOTOR SHAFT
4. MOTOR
5. MOTOR MOUNTING PLATE
6. BELT
7. ADJUSTING NUT
8. PUMP THERMOSTAT
9. DRIVE BELT
10. PUMP SHAFT
11. CENTRIFUGAL PUMP
12. SUCTION PIPE
13. DISCHARGE PIPE
14. REINFORCED CONCRETE BASE
15. CHECK VALVE
16. GATE VALVE
MOTOR/PUMP CONNECTION
NOT TO SCALE
PUMP HOUSE
SUMP
2' MH
PLAN
SCALE: 3/8" = 1.0'
RETAINING WALL DELETED
CHAMFER
#4@10
#4@12
1 SQ FT. BASE COURSE MATERIAL - CONTINUOUS
3 - 1" DIA. WEEPHOLES @ 6'-0" C.C. OUTLET ELEV 5873.17 SLOPE UP 1"
ELEV. 5875.00
#5@12 EV
5'-8"
2'-6"
ELEV. 5872.33
SECTION A-A
SCALE 3/4" = 1.0'
A AS BUILT
0 ORIGINAL ISSUE
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE
GOLDEN, COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
SUBSURFACE WATER COLLECTION SYSTEM - MECH.
D 27550-200 A



PARTIAL ELECTRICAL SITE PLAN

SCALE: 1" = 50'-0"

KEY PLAN



CURVE DATA

	R	Δ (D M S)	T	L
1	430'	25 28-00	97.17	191.13
2	936'	25.28-00	211.51	416.03
3	490'	30.36-18	134.07	261.74

PART	QUAN	DESCRIPTION	MATERIAL

A	AS BUILT		
0	ORIGINAL ISSUE	11-17-80	
ISSUE	DESCRIPTION	DATE	

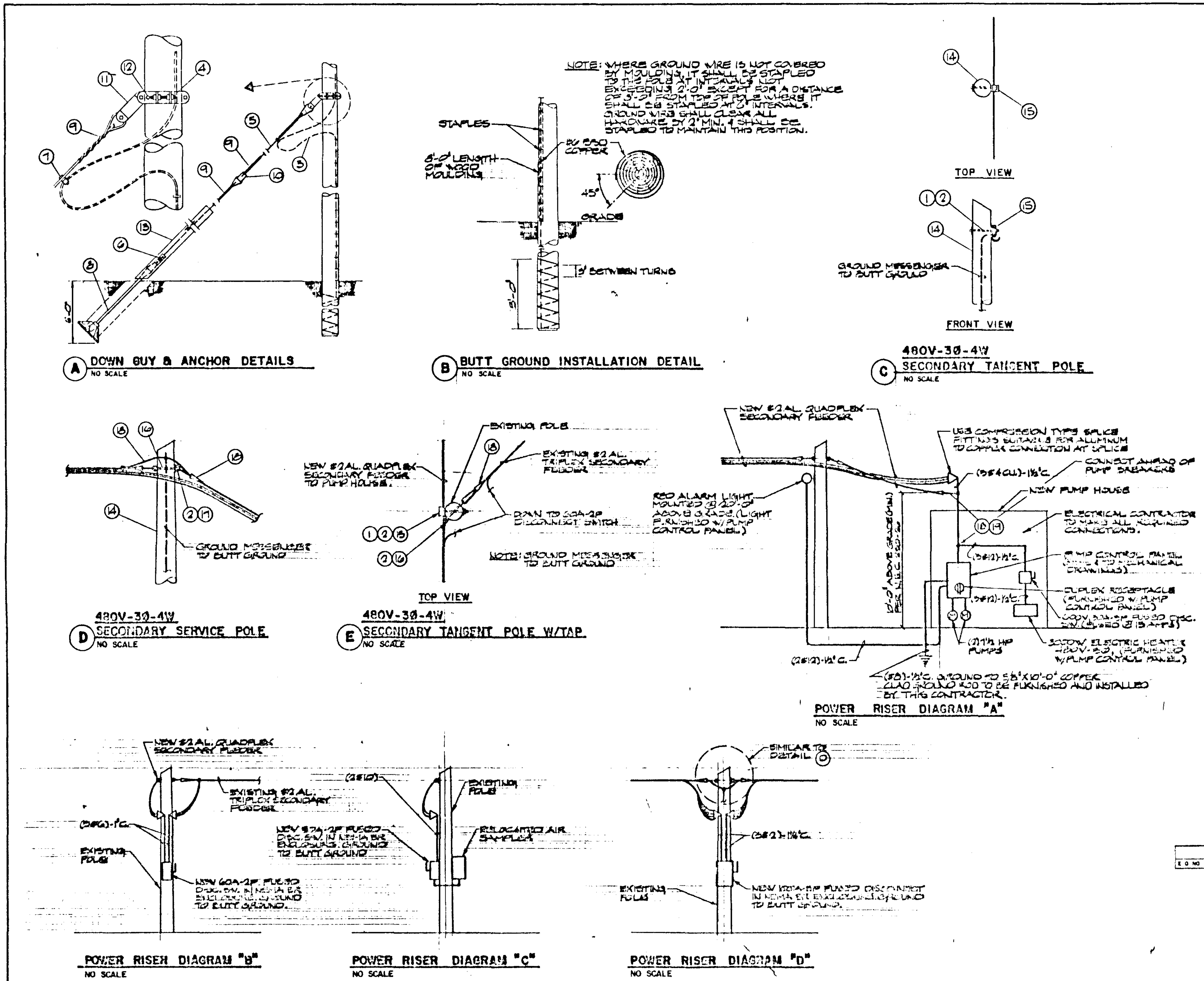
		BY	DATE
TOLERANCES	DESIGNED		11-14-80
	DRAWN	LJP	11-14-80
UNLESS NOTED OTHERWISE	CHECKED	VOT	11-14-80
	APPROVED		11-17-80
REMOVE BURRS AND SHARP EDGES			
NEXT ASSEMBLY			
DOE CONT. NO.	SUBMITTED		11-17-80
SCALE	APPROVED		

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO

ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT GOLDEN, COLORADO

SUBSURFACE WATER
COLLECTION SYSTEM-ELECT.

SIZE	DRAWING NUMBER	ISSUE	SHEET
D	275[illegible]0-201	A	301 OF



PART	QUAN	DESCRIPTION	MATERIAL
1		MACHINE BOLT, 5/8" X REQUIRED LENGTH	
2		1-3/4" X 1/4" GALV. SPRING WASHER, 11/16" HOLE	
3		COPPER GROUND CONDUCTOR	#6 BSD
4		GALV. 4-WAY POLE BAND	
5		GUY STRAND 3-M	
6		THREE BOLT CLAMP	
7		GROUND CLAMP	
8		8-WAY ANCHOR, ROD, TWINEYE	
9		FANNER GRIPS	CHANCE
10		GUY STRAIN INSULATOR	
11		GUY ATTACHMENT	
12		LAG BOLT	
13		GUY GUARD	
14		POLE C.T.S.Y.P. OR EQUAL	
15		CABLE MESSENGER HANGER	JOSLYN PJ1070
16		EYE BOLT, 5/8" X REQUIRED LENGTH	
17		EYE NUT, 5/8"	
18		FEED THRU DEAD-ENDS	RELIABLE
19		SERVICE BRACKET	OLIVER #2630

LEGEND

SYMBOL	DESCRIPTION
○	EXISTING POLE
●	NEW POLE
—S—	EXISTING AERIAL SECONDARY FEEDER, SIZE AS NOTED
—S—	EXISTING AERIAL SECONDARY FEEDER TO BE REMOVED
—S—	NEW AERIAL SECONDARY FEEDER, SIZE AS NOTED
	DISCONNECT SWITCH AS NOTED
	DOWN GUY & ANCHOR
A 22-4	POLE DESIGNATION, SIZE & CLASS OF POLE

ISS	DESCRIPTION	DATE		DOE	CLASS	JOB NO.
A	AS BUILT	12-14-82				589021
0	ORIGINAL ISSUE	11-17-80				589021

E O NO

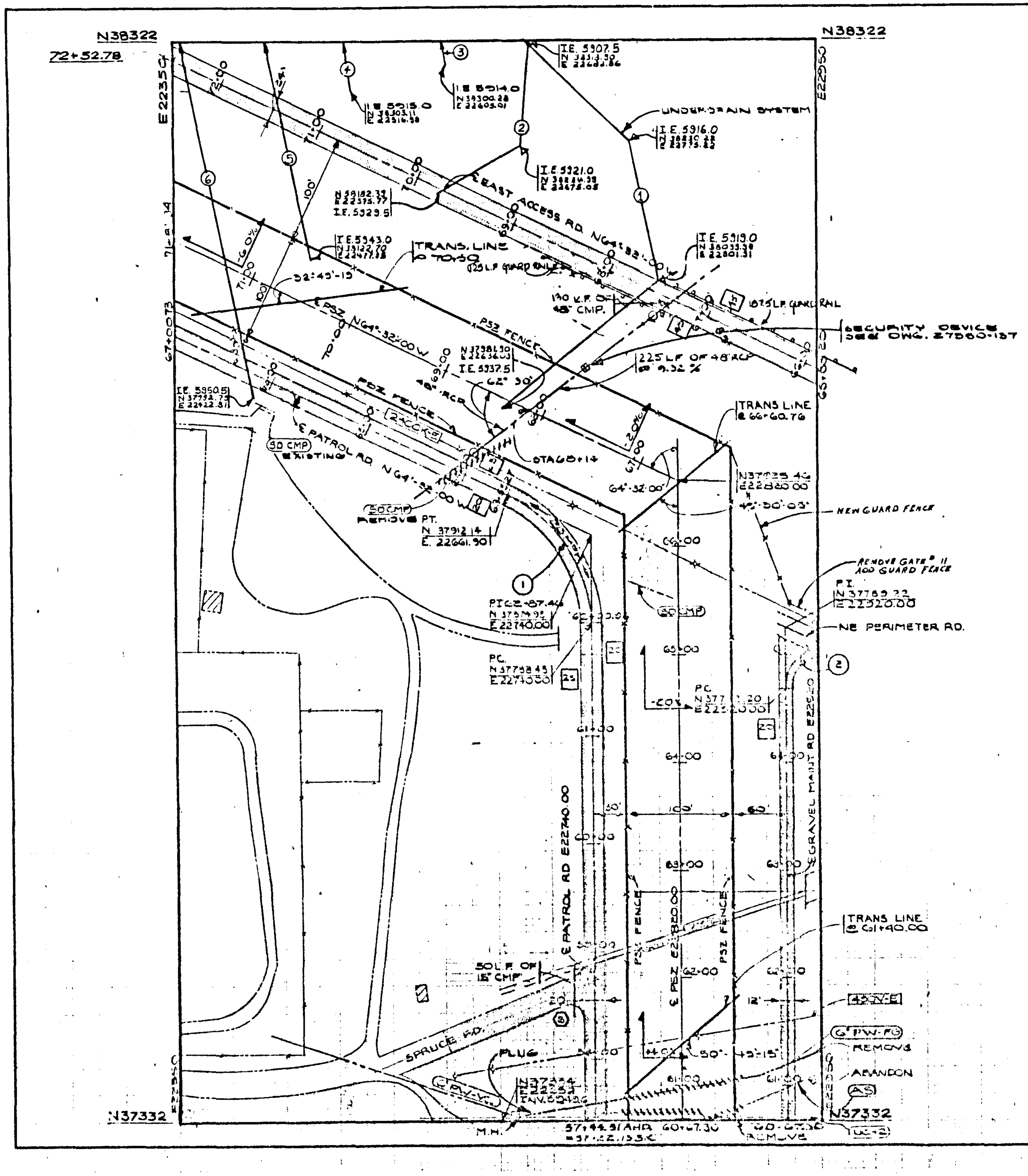
	BY	DATE
DESIGNED	CAH/CJC	11-16-80
DRAWN	LJP	11-16-80
CHECKED	VAT	11-19-80
APPROVED		11-17-80
SUBMITTED		11-17-80
APPROVED FOR DOE		

TOLERANCES FRACT ± ANGLE ± DEC ± UNLESS NOTED OTHERWISE
REMOVE BURRS AND SHARP EDGES
NEXT ASSEMBLY
DOE CONT NO
SCALE

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT

SUBSURFACE WATER COLLECTION SYSTEM- ELECT.

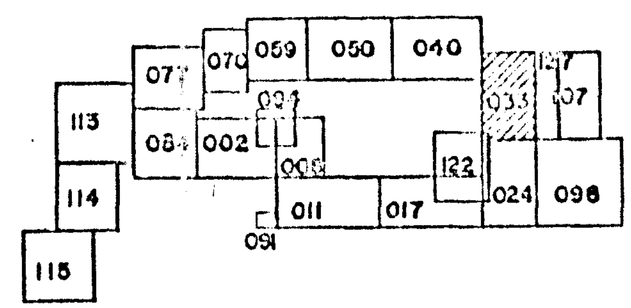
SIZE	DRAWING NUMBER	ISSUE	SHEET
D	27550-202	A	302 OF 302



CURVE DATA

◯	R	Δ(D.M.S.)	T	L
1	137'	64.3200	86.50'	154.31'
2	36'	115.2800	57.02'	72.55'

KEY PLAN

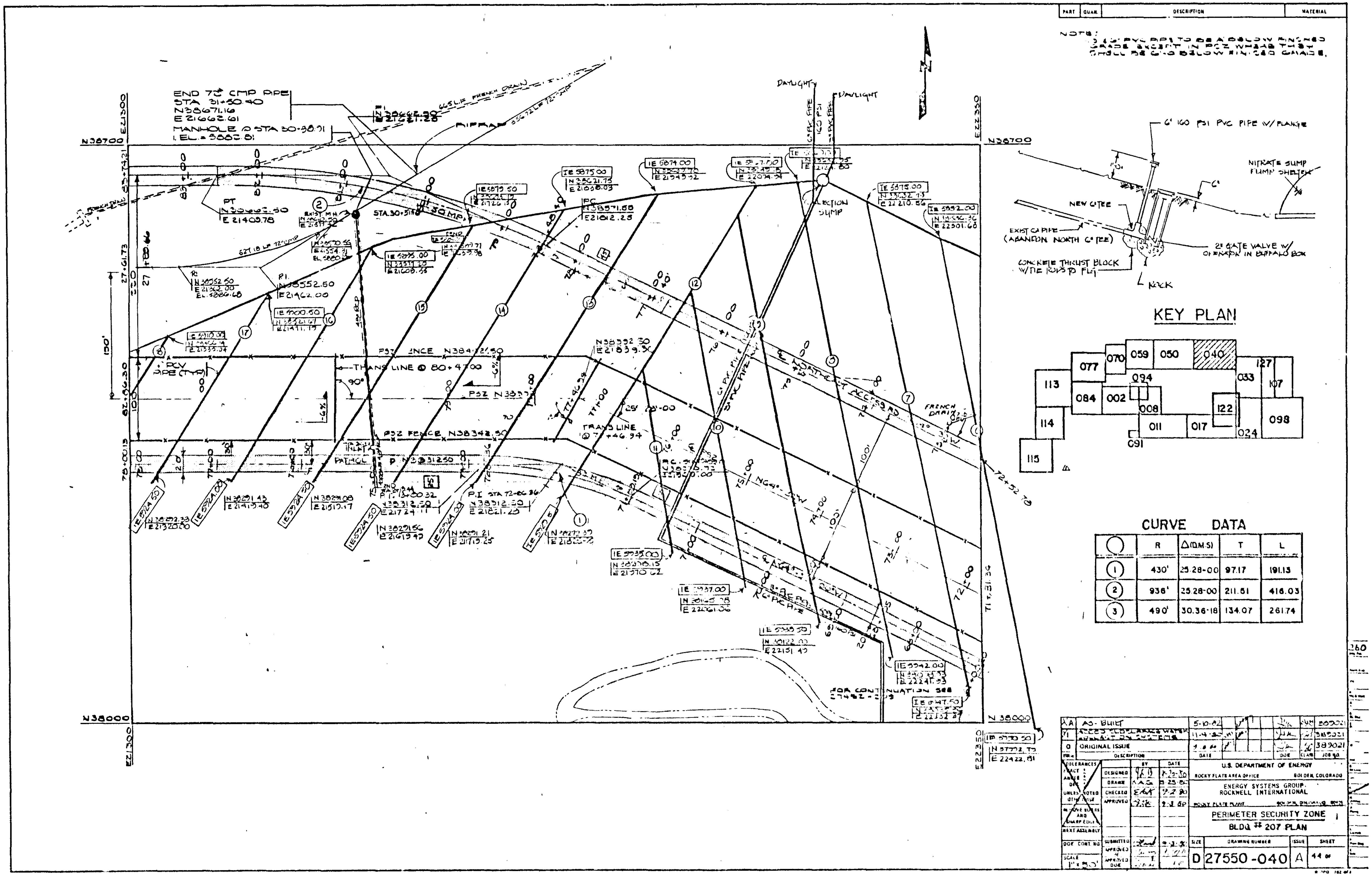


A	AS BUILT	4-30-...	
1	UNDERDRAIN & ACCESS RD	5-22-81	
0	ORIGINAL ISSUE		389021

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT

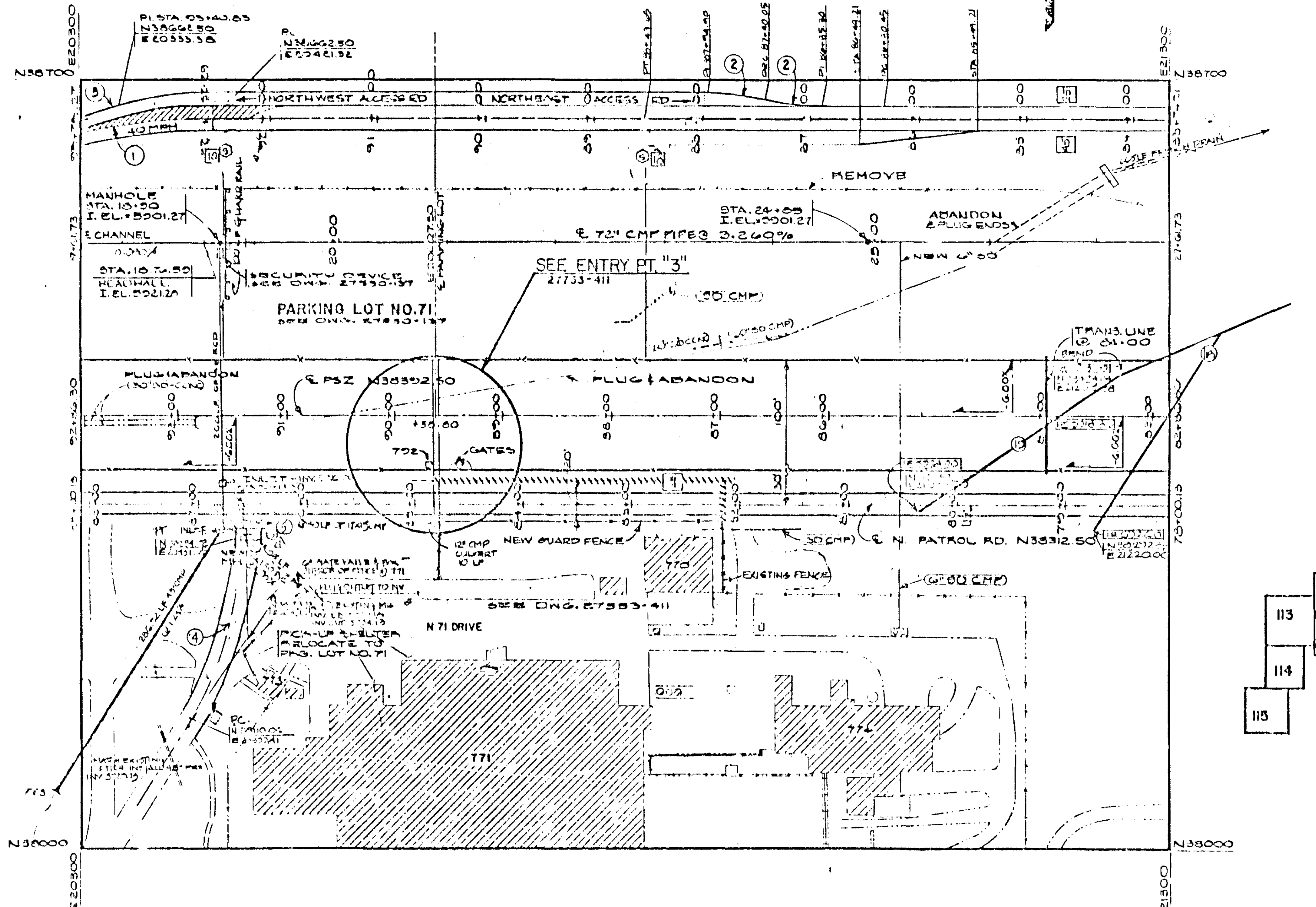
PERIMETER SECURITY ZONE
N.E. CORNER PLAN

D 27550-033 A



CURVE DATA

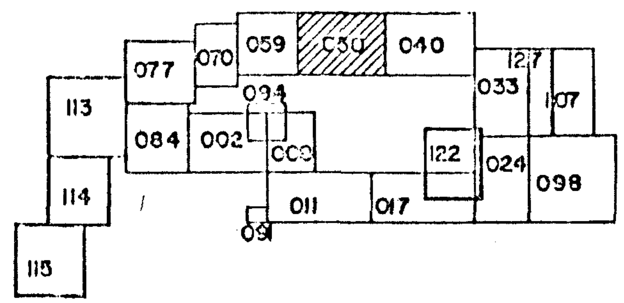
	R	Δ(D.M.S)	T	L
1	430'	25.28-00	97.17	191.13
2	936'	25.28-00	211.61	416.03
3	490'	30.36-18	134.07	261.74



CURVE DATA

	R	Δ(DMS)	T	L
1	540'	18°37'26"	88.54	175.53'
2	1000'	6.1646	54.85'	109.60'
3	334.81'	18.3726	54.90'	108.83'
4	320.57'	33°00'52"	95.00'	184.71
5	15.00'	90°00'00"	15.00'	23.56

KEY PLAN



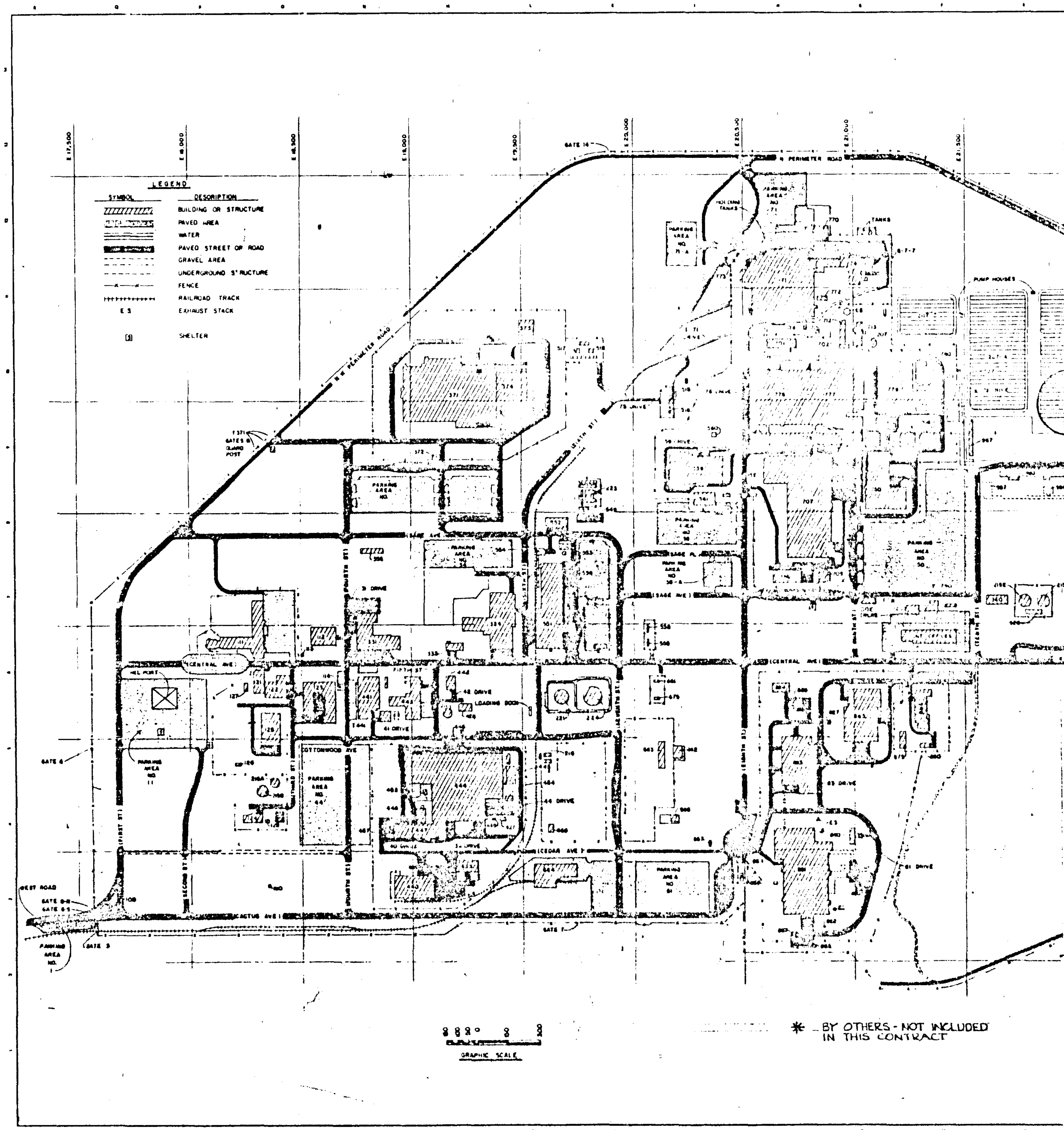
A	AS BUILT
0	ORIGINAL ISSUE

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE — GOLDEN, COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT
PERIMETER SECURITY ZONE
BLDG. # 771 PLAN

SCALE 1" = 50'

D 27550-050 A

SHEET 54



* BY OTHERS - NOT INCLUDED IN THIS CONTRACT

UNITED STATES
DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATIONS OFFICE
ROCKY FLATS AREA OFFICE

MEMBRANE POND LINER
PHASE I - POND 207-B SOUTH

INV. NO. EW-78-B-04-0129

ROCKWELL INTERNATIONAL - ATOMICS INTERNATIONAL DIVISION
ROCKY FLATS PLANT BOX 464 GOLDEN, COLORADO 80401

INDEX OF DRAWINGS

SHEET	DWG. NO.	ISSUE	TITLE
1	28103-X01	A	TITLE SHEET/AREA PLOT PLAN
* 2	28103-101	A	PLAN/POND 207 B SOUTH
* 3	28103-102	A	SECTIONS & DETAILS
4	28103-201	A	PLAN
5	28103-202	A	DETAILS & SECTIONS
6	28103-203	A	SECTIONS

A ORIGINAL ISSUE

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
ROCKWELL INTERNATIONAL
ATOMICS INTERNATIONAL DIVISION
ROCKY FLATS PLANT GOLDEN, COLORADO

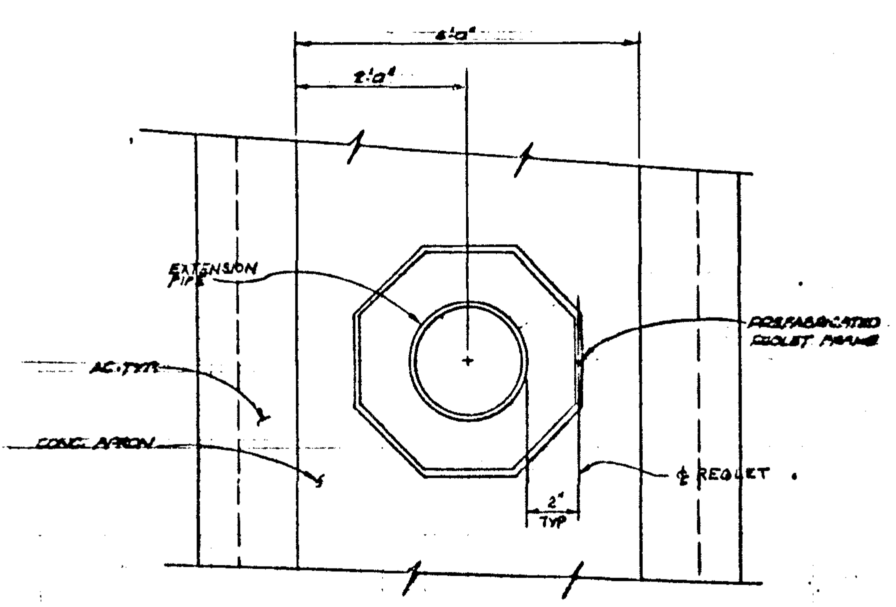
MEMBRANE POND LINER
PHASE I
TITLE SHEET/AREA PLOT PLAN

D 28103-X01 A 1 of 6

460541
Reel 26-0810

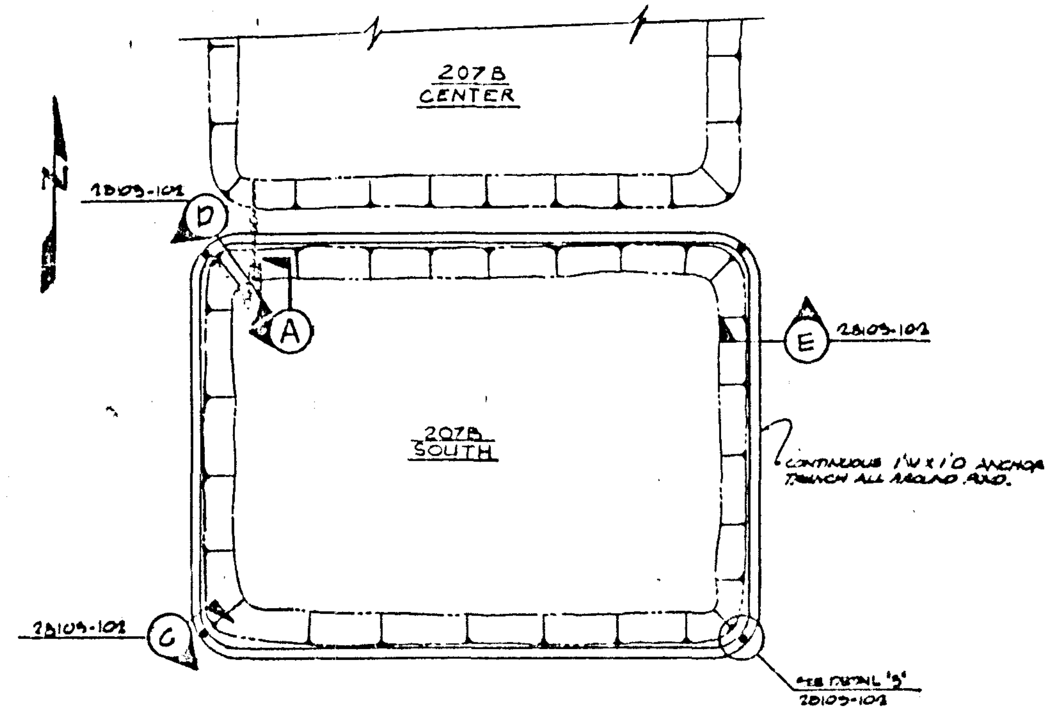
GENERAL NOTES:

1. THE EXISTING POND LINING IS CONSTRUCTED AS SHOWN IN SECTION A.



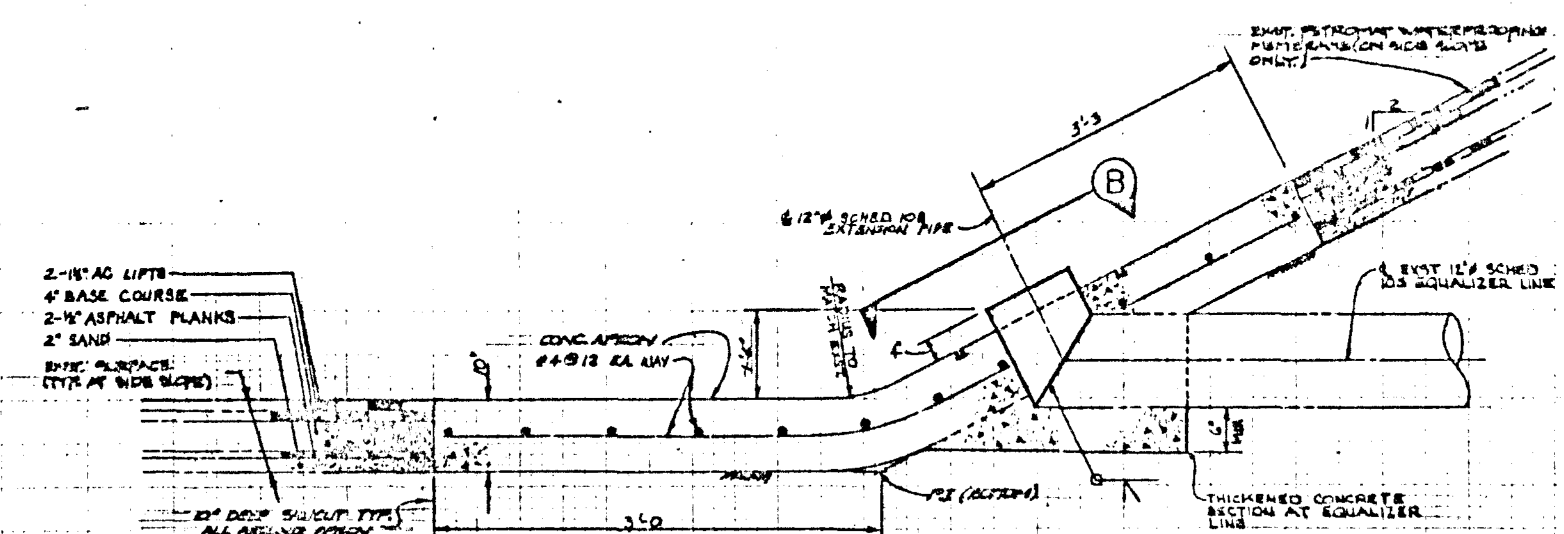
VIEW B

SCALE: NONE



PLAN/POND 207B SOUTH

SCALE: 1"=40'



SECTION A

SCALE: NONE

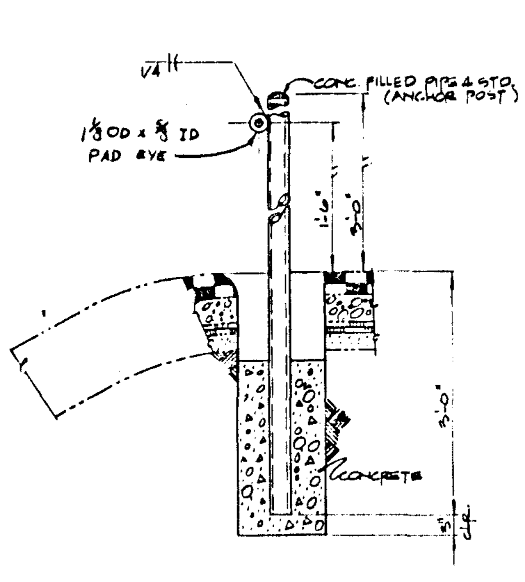
B	CLASS. REVIEW
A	ORIGINAL ISSUE

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE — GOLDEN, COLORADO
ROCKWELL INTERNATIONAL
ATOMICS INTERNATIONAL DIVISION
ROCKY FLATS PLANT — GOLDEN, COLORADO

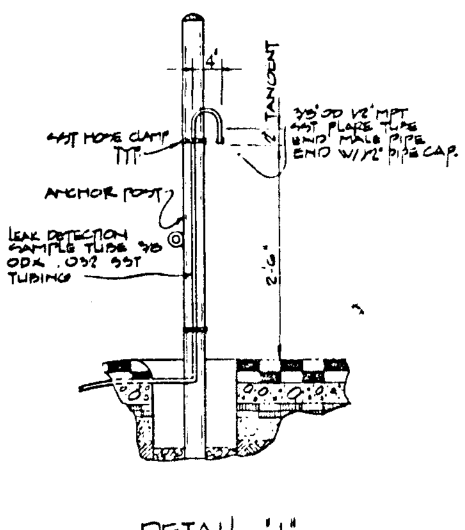
MEMBRANE POND LINER
PHASE I
PLAN AND SECTIONS

D 28103101 B 2

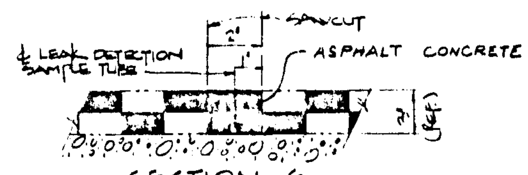
[redacted]



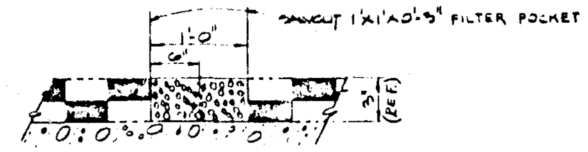
SECTION C
28103-101 SCALE 1"=1'-0"



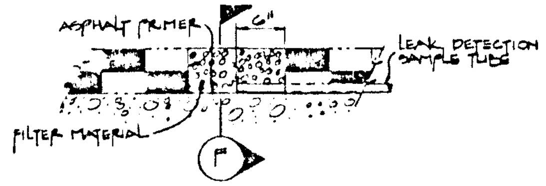
DETAIL '1'
SCALE 1"=1'-0"



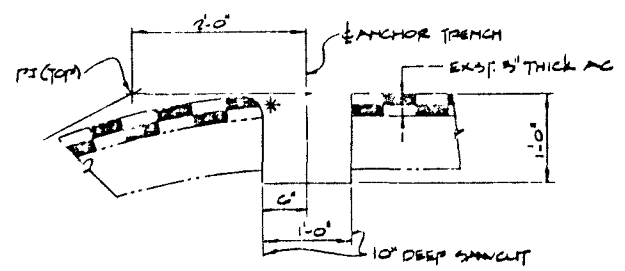
SECTION G
SCALE: NONE



SECTION F
SCALE: NONE

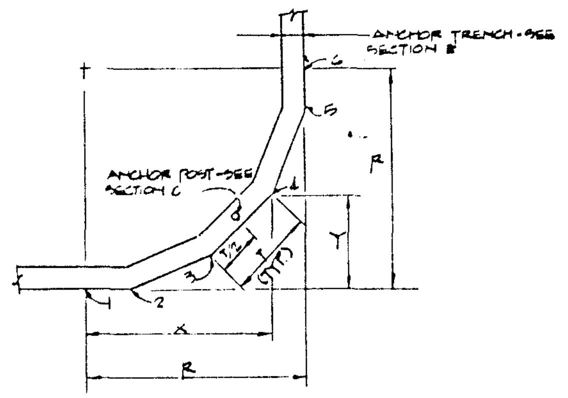


DETAIL '2'
SCALE: NONE



* ROUND CORNER TO A SMOOTH 1' RADIUS

SECTION E
28103-101 SCALE 1"=1'-0"

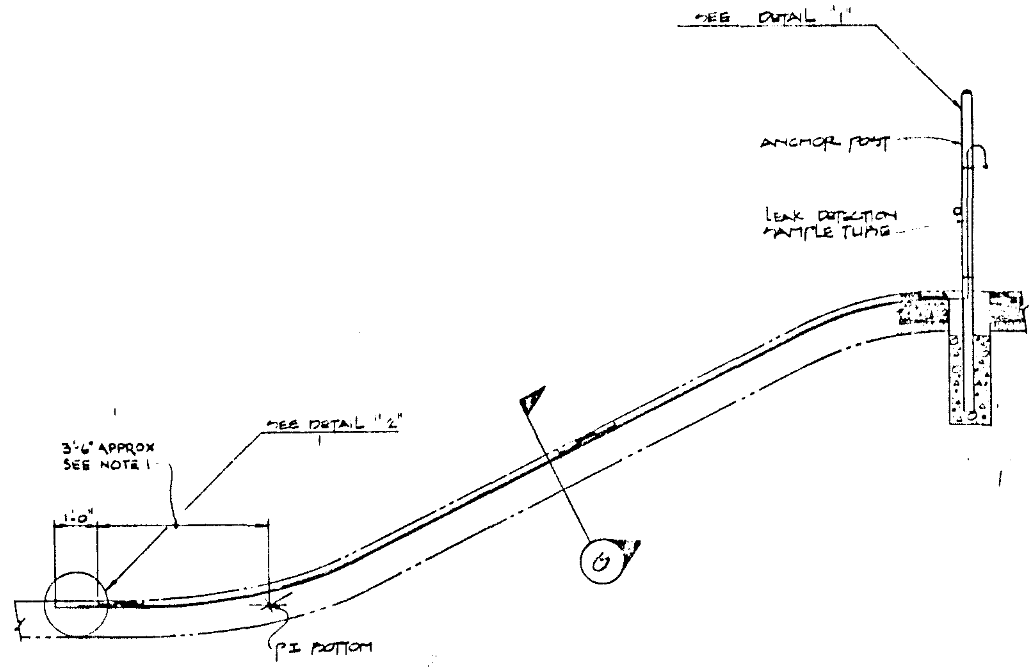


DETAIL '3'
28103-101 SCALE: NONE
(SEE TABLE A FOR DATA)

R	T	POINT	X	Y
10	3.98	1	0	0
		2	1.99	0
		3	5.67	1.52
		4	8.43	4.33
		5	10.00	8.01
		6	10.00	10.00
15	5.97	1	0	0
		2	2.98	0
		3	8.50	2.28
		4	12.72	6.50
		5	15.00	12.02
		6	15.00	15.00
20	7.96	1	0	0
		2	3.98	0
		3	11.33	3.04
		4	16.96	8.67
		5	20.00	16.02
		6	20.00	20.00
25	9.95	1	0	0
		2	4.97	0
		3	14.16	3.80
		4	21.20	10.84
		5	25.00	20.03
		6	25.00	25.00

NOTES: 1. ALL DIMENSIONS ARE IN FEET
2. THE APPROPRIATE RADIUS FOR EACH CORNER WILL BE SELECTED BY THE CONTRACTING OFFICER.

TABLE A
(REF. DETAIL "3")



SECTION D
28103-101 SCALE 1/4"=1'-0"

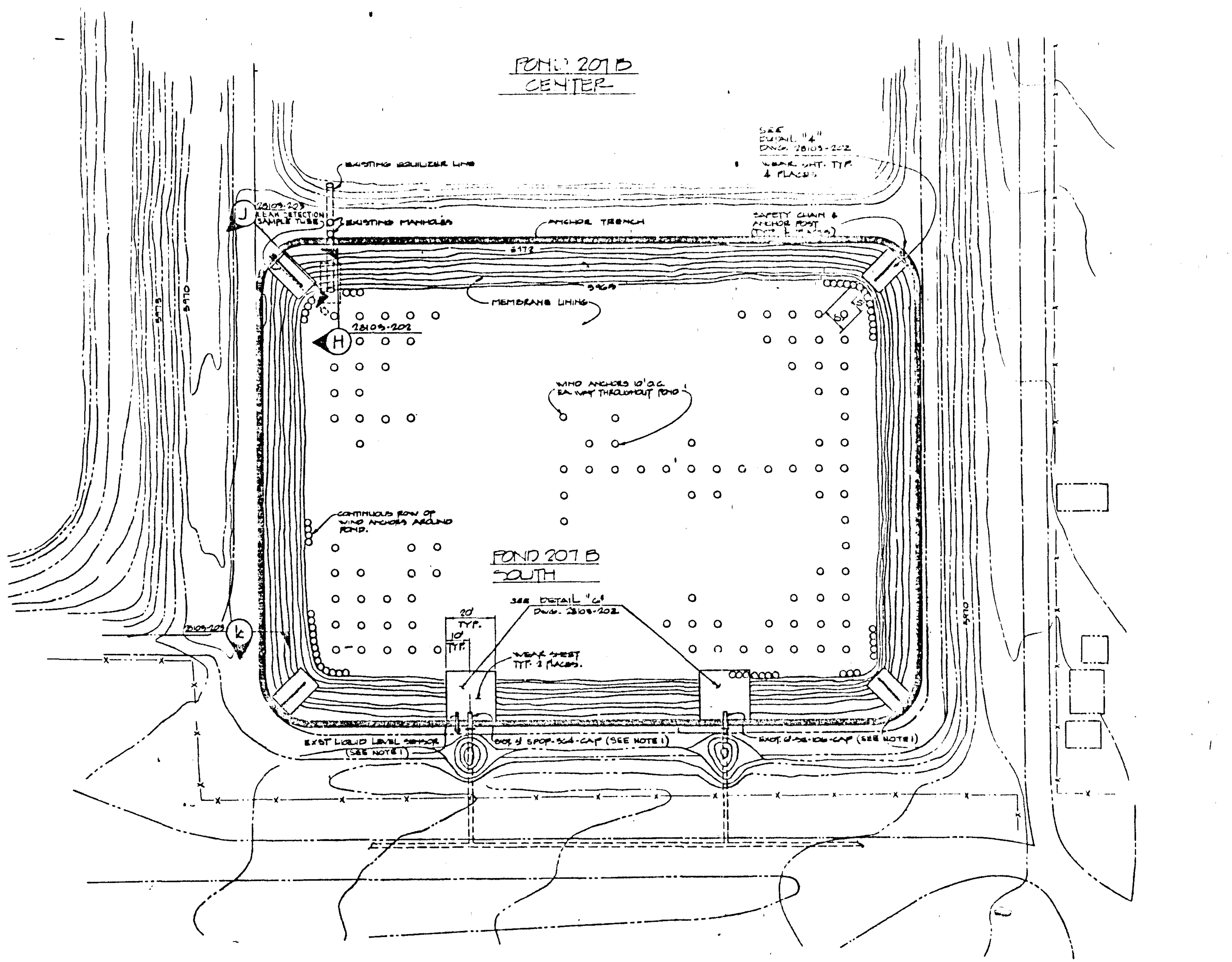
B	CLASS. REVIEW	
A	ORIGINAL ISSUE	3/27/78
ORIG	DESCRIPTION	DATE

	BY	DATE
DESIGNED		1-25-77
DRAWN		1-26-77
CHECKED		2-6-78
APPROVED		2-13-78

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
ROCKWELL INTERNATIONAL
ATOMICS INTERNATIONAL DIVISION
ROCKY FLATS PLANT GOLDEN, COLORADO 80401

MEMBRANE POND LINER
PHASE I
SECTIONS AND DETAILS

SCALE: NOTED
SIZE: D
DRAWING NUMBER: 28103-102
REV: B
SHEET: 3



GENERAL NOTES :

1. THE FOLLOWING POND PREPARATION WORK HAS BEEN DONE BY OTHERS:
   - A. INSTALLATION OF PIPING.
   - B. INSTALLATION OF ANCHOR POSTS.
   - C. INSTALLATION OF LEAK DETECTION SAMPLE TUBE.
   - D. PREPARATION OF ANCHOR TRENCH FOR PLACEMENT OF MEMBRANE LINING.
   - E. INSTALLATION OF CONCRETE APRON AROUND EQUALIZER LINE.

NOTES : (THIS DWG ONLY)

1. THE EXISTING LIQUID LEVEL SENSOR AND POND FILL LINES (3" SPOP-364-CAP & 6" SE-106-CAP) MAY BE TEMPORARILY DISCONNECTED AT THEIR FLANGES TO FACILITATE WORK AT THE ANCHOR TRENCH.

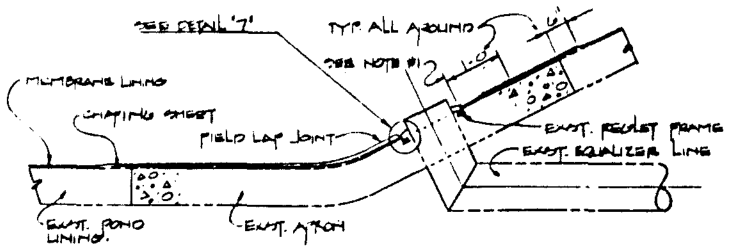
A	ORIGINAL ISSUE		
DESIGNED		11-8-77	
DRAWN		11-10-77	
CHECKED		2-6-78	
APPROVED		2-13-78	

U. S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE — GOLDEN, COLORADO
ROCKWELL INTERNATIONAL
ATOMICS INTERNATIONAL DIVISION
ROCKY FLATS PLANT — GOLDEN, COLORADO

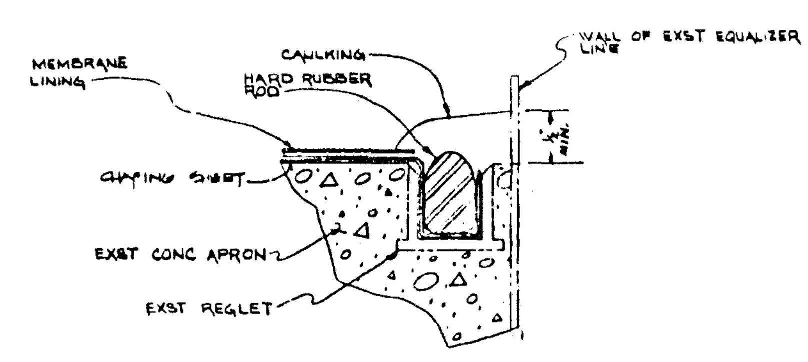
MEMBRANE POND LINER
PHASE I
PLAN

SCALE 1" = 20'

D 28103-201 | A | 4



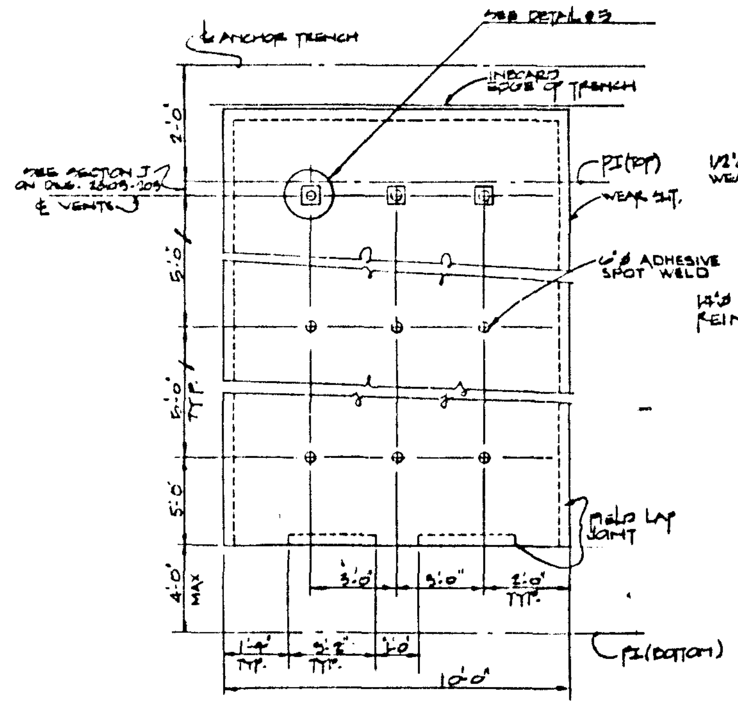
SECTION H
28103-201



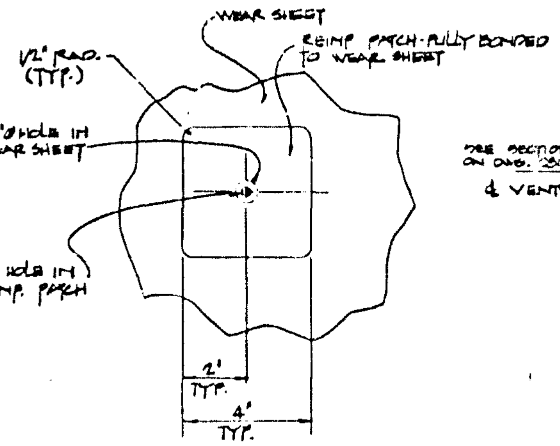
DETAIL "7"

NOTE:

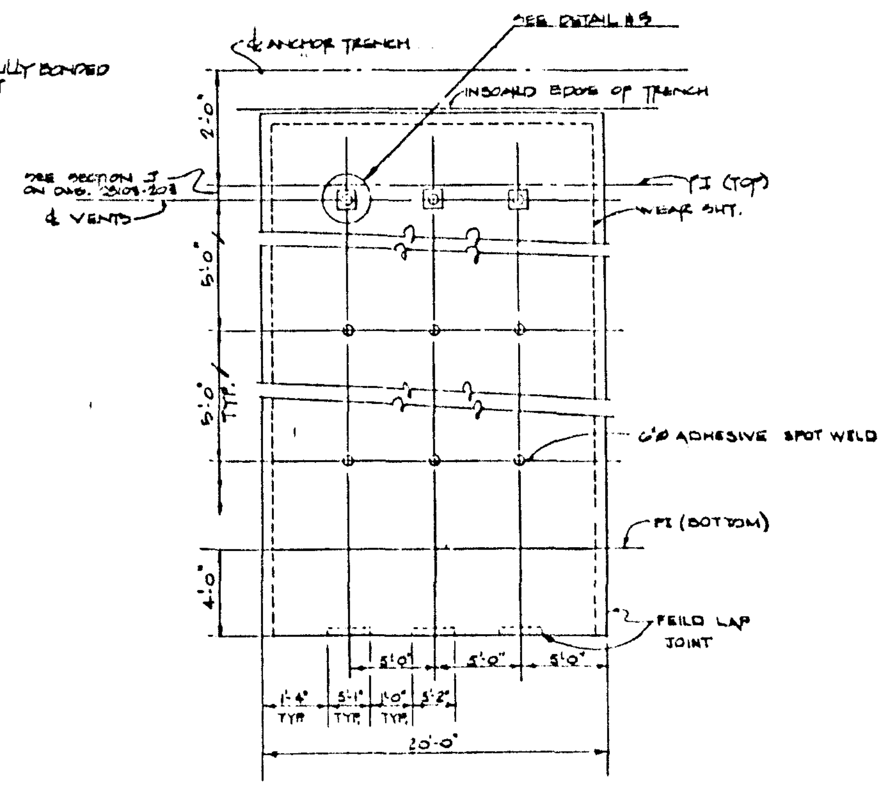
1. APPLY RUBBER TO CONCRETE ADHESIVE BETWEEN CHAFING SHEET AND CONCRETE AS SHOWN.



DETAIL "4"
28103-201



DETAIL '5'

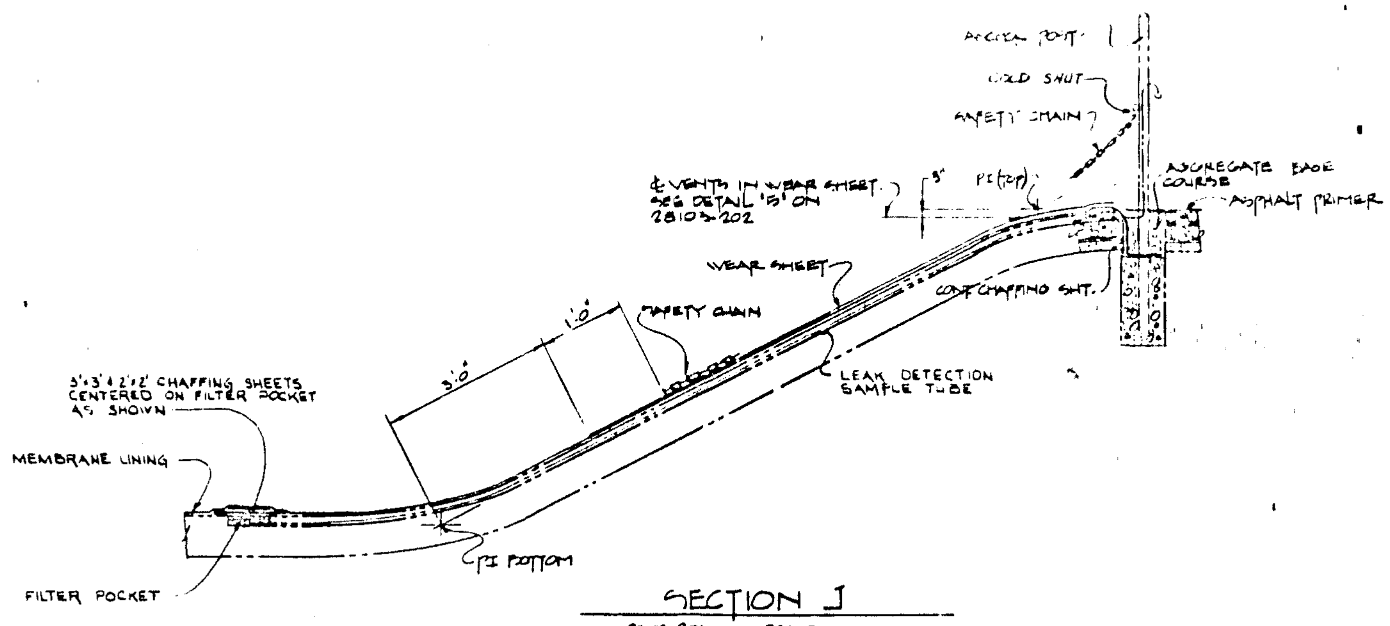


DETAIL "6"
28103-201

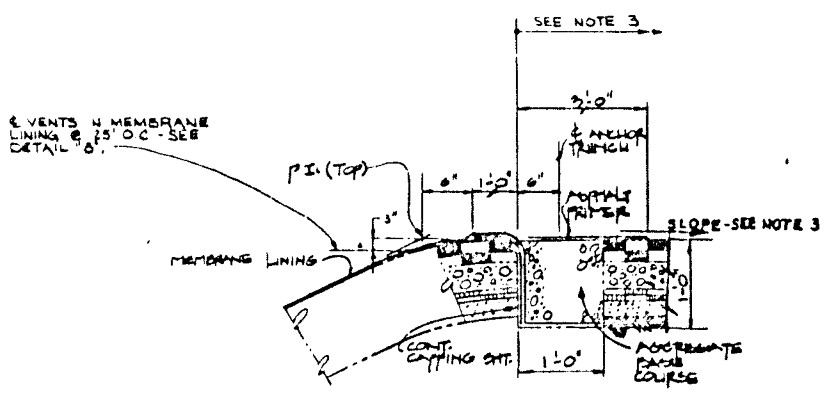
A	ORIGINAL ISSUE
U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION	
ROCKY FLATS AREA OFFICE	GOLDEN, COLORADO
ROCKWELL INTERNATIONAL	
ATOMICS INTERNATIONAL DIVISION	
ROCKY FLATS PLANT	GOLDEN, COLORADO
MEMBRANE POND LINER PHASE I	
SECTIONS AND DETAILS	
SCALE: NONE	D 28103-202 A 5

NOTES: (THIS DWG ONLY)

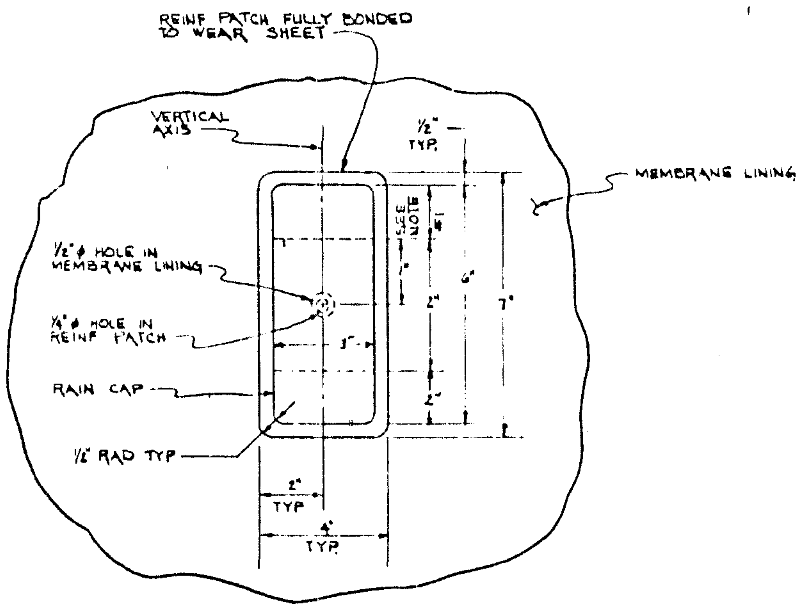
1. BOND RAIN CAP TO REINF PATCH WITH 2" WIDE x 3" LONG FIELD LAP JOINTS.
2. REINF PATCH, RAIN CAP AND MEMBRANE LINING ARE MADE FROM THE SAME MATERIALS
3. SLOPE SURFACE OF ANCHOR TRENCH 2% AWAY FROM POND ON THE EAST, WEST AND SOUTH POND BANKS.



SECTION J
28103-201 SCALE: NONE

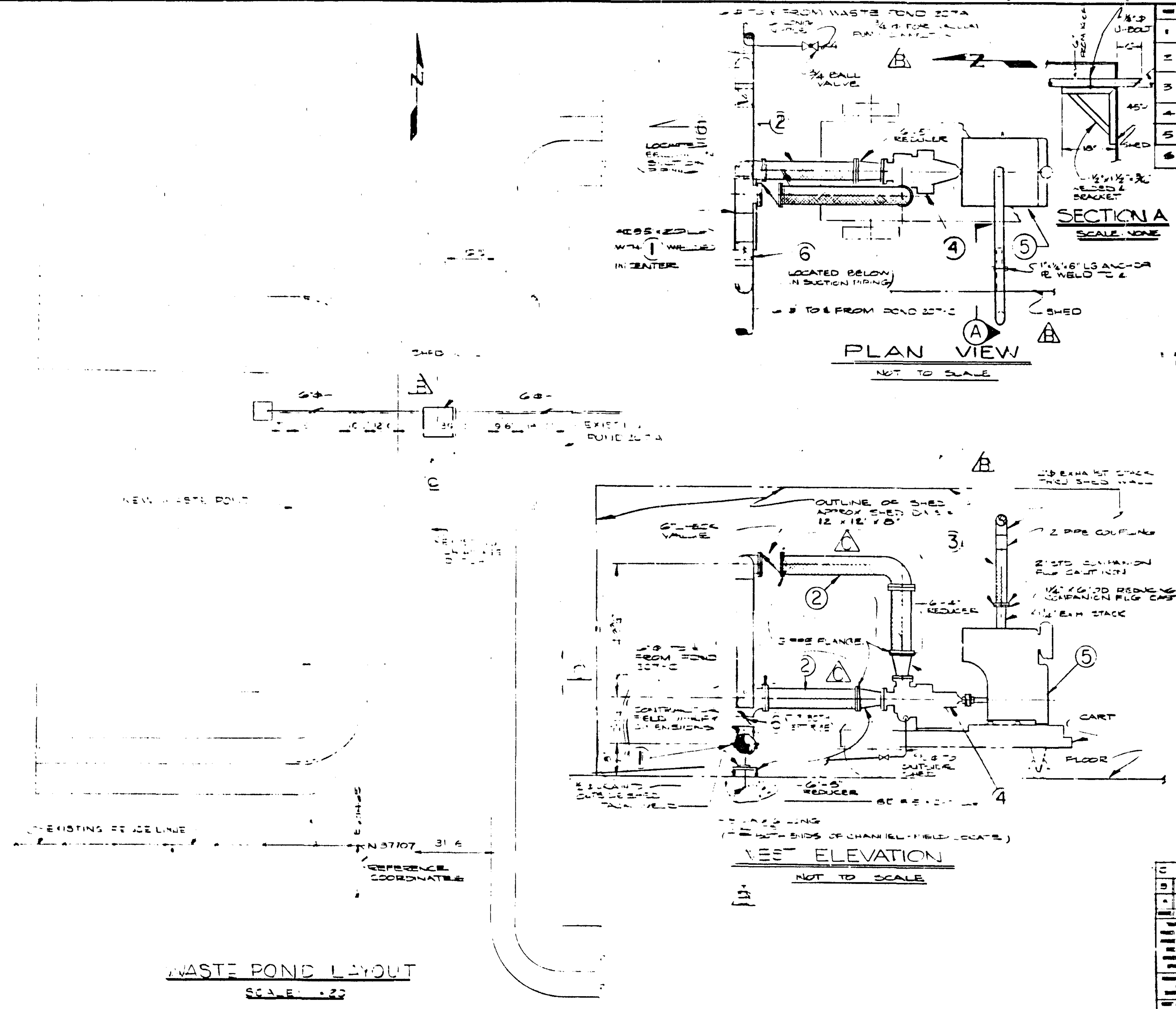


SECTION K
28103-201 SCALE: 1"=1'-0"



DETAIL '8'
SCALE: NONE
(SEE NOTE 2)

A	ORIGINAL ISSUE
	U. S. DEPARTMENT OF ENERGY
	ROCKY FLATS AREA OFFICE GOLDEN COLORADO
	ROCKWELL INTERNATIONAL
	ATOMICS INTERNATIONAL DIVISION
	ROCKY FLATS PLANT GOLDEN, COLORADO
	MEMBRANE POND LINER PHASE I
	SECTIONS AND DETAILS
SIZE	D
DRAWING NUMBER	28103-203
REVISION	A
SHEET	6



1	1	TEE & MASON FIG #145, SLIDING GUIDE PIPE SUPPORT, W/O LUGS	COMM'L
2	AS REQ'D	GATES ADAPTAPIPE" #50 HOSE WITH ENLARGED ENDS FOR 6"φ x 20" LONG PIPE & HOSE CLAMP	COMM'L
3	1	"KITTELL" FLEX CONNECTOR SIZE 2"φ x 18" LG, SEAMLESS CORRUGATED S/ST RATED 1200°F, EMPT	COMM'L
4	1	"WORTHINGTON" PUMP MODEL #4 CNE 84, 500 GPM @ 35 FT HEAD	COMM'L
5	1	"WISCONSIN" GAS ENGINE MODEL #VH4D	COMM'L
6	4	"WORCESTER, DISC-O-SEAL" 6" BUTTERFLY VALVE - BUTT WELD	COMM'L

GENERAL NOTES

1. ALL PIPING TO BE SCHEDULE 40 BLACK IRON.

C	AS BUILT.	1-4-71	LC			399019
B	RELOCATED SHED	11-4-70	MT			399019
A	ORIGINAL ISSUE	7-9-70	JSE			400296

U. S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE — GOLDEN, COLORADO

THE DOW CHEMICAL COMPANY
ROCKY FLATS DIVISION — GOLDEN, COLORADO

EVAPORATION POND 207C
PIPING SYSTEM
PLAN & DETAILS

DESIGNED: MORRIS 5-22-70
DRAWN: JSE 5-22-70
CHECKED: JENSEN 6-9-70
APPROVED: 6-25-70, 7-9-70
REVIEWED: 7-9-70

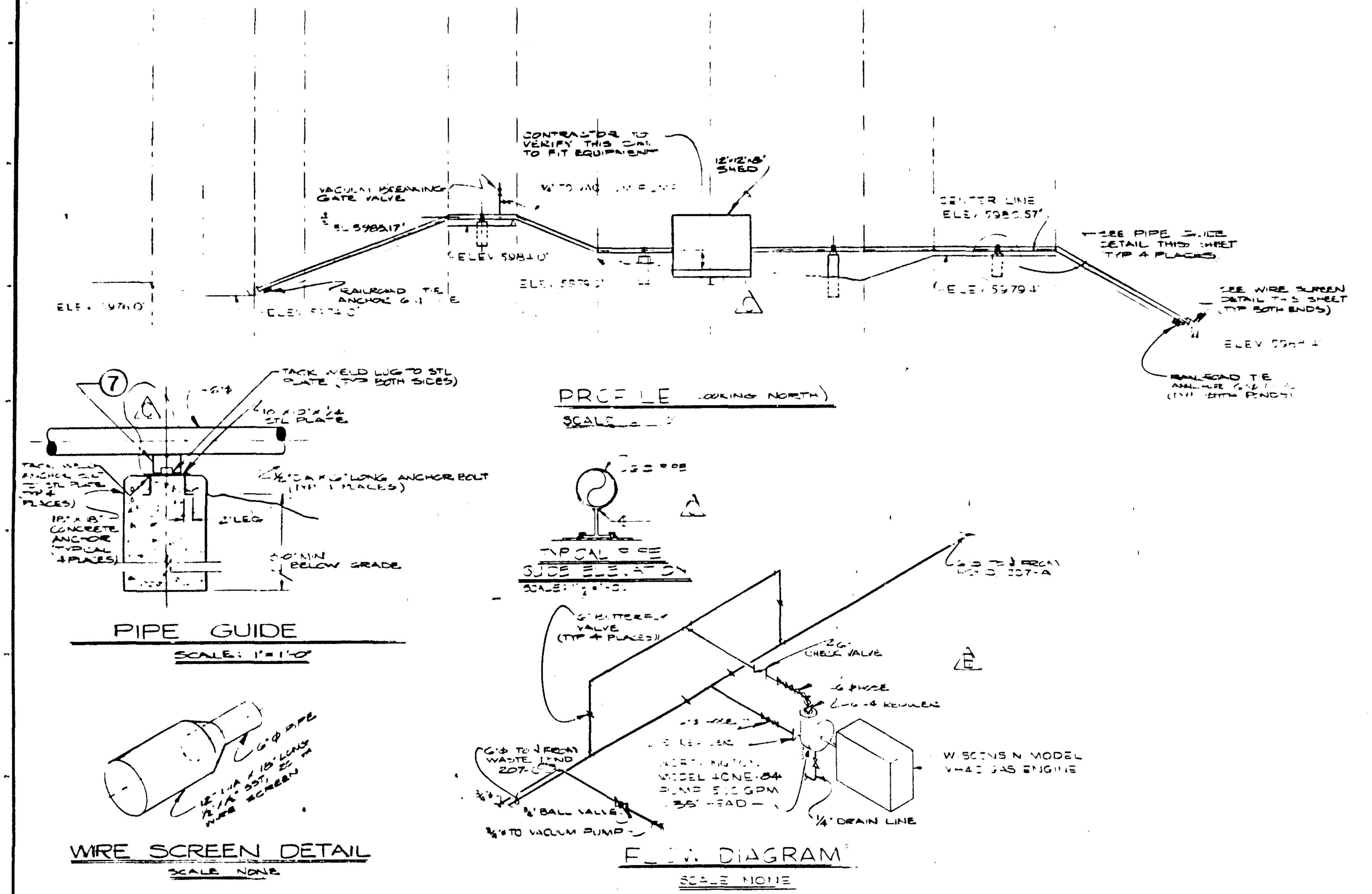
SCALE: AS NOTED

D 19379-3 B 3·4

REF	ITEM	DESCRIPTION	MATERIAL
7	4	FEE & MASON, FIG #145 SLIDING GUIDE PIPE SUPPORT W/LUGS	COMM'L

GENERAL NOTES

1. ALL PIPING TO BE SCHEDULE 40 BLACK IRON PIPING.



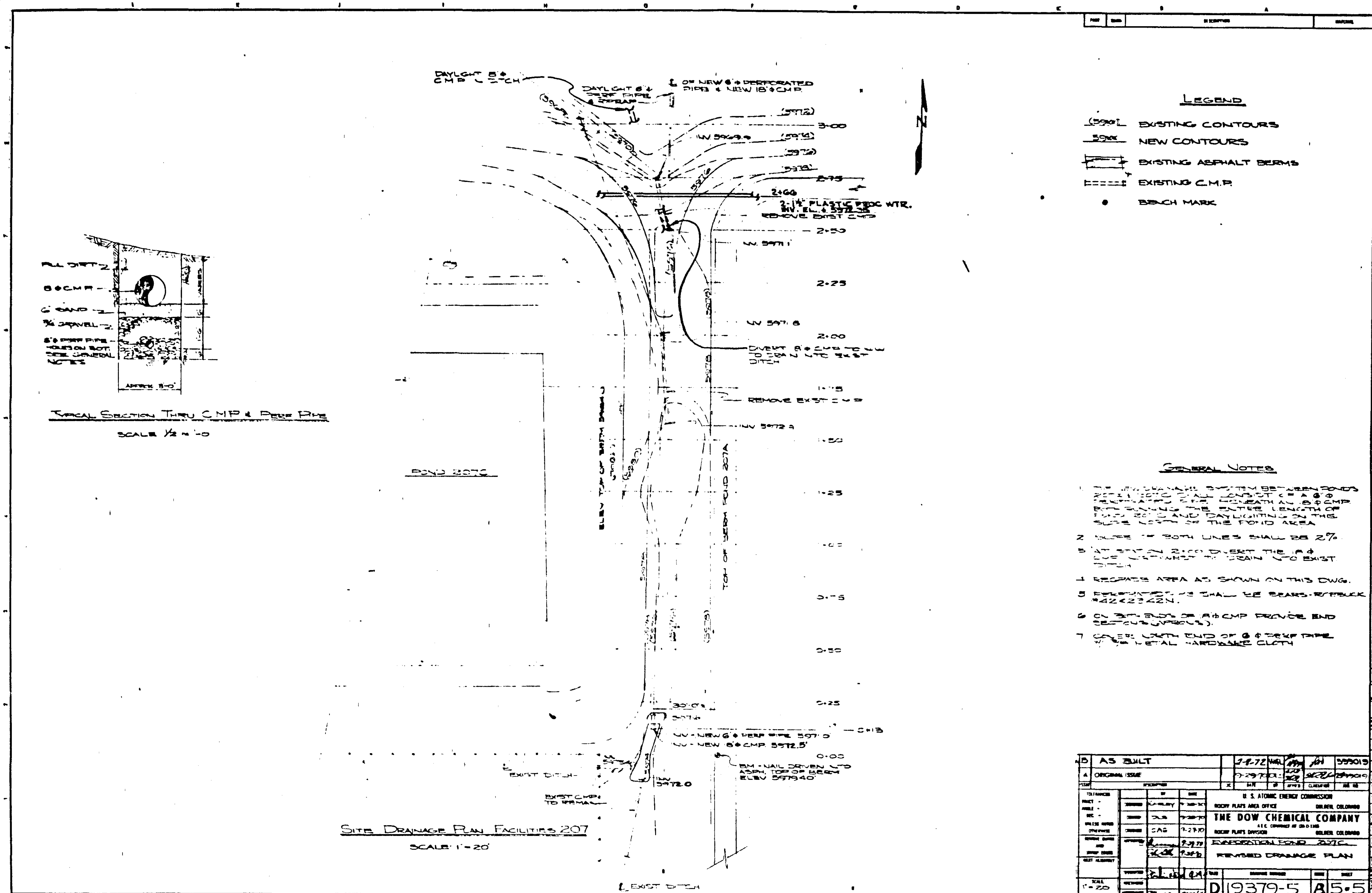
C	AS BUILT	1-4-71		399019
B	CHANGED FLOW DIAGRAM	11-4-70		399019
A	ORIGINAL ISSUE	7-9-70		400296

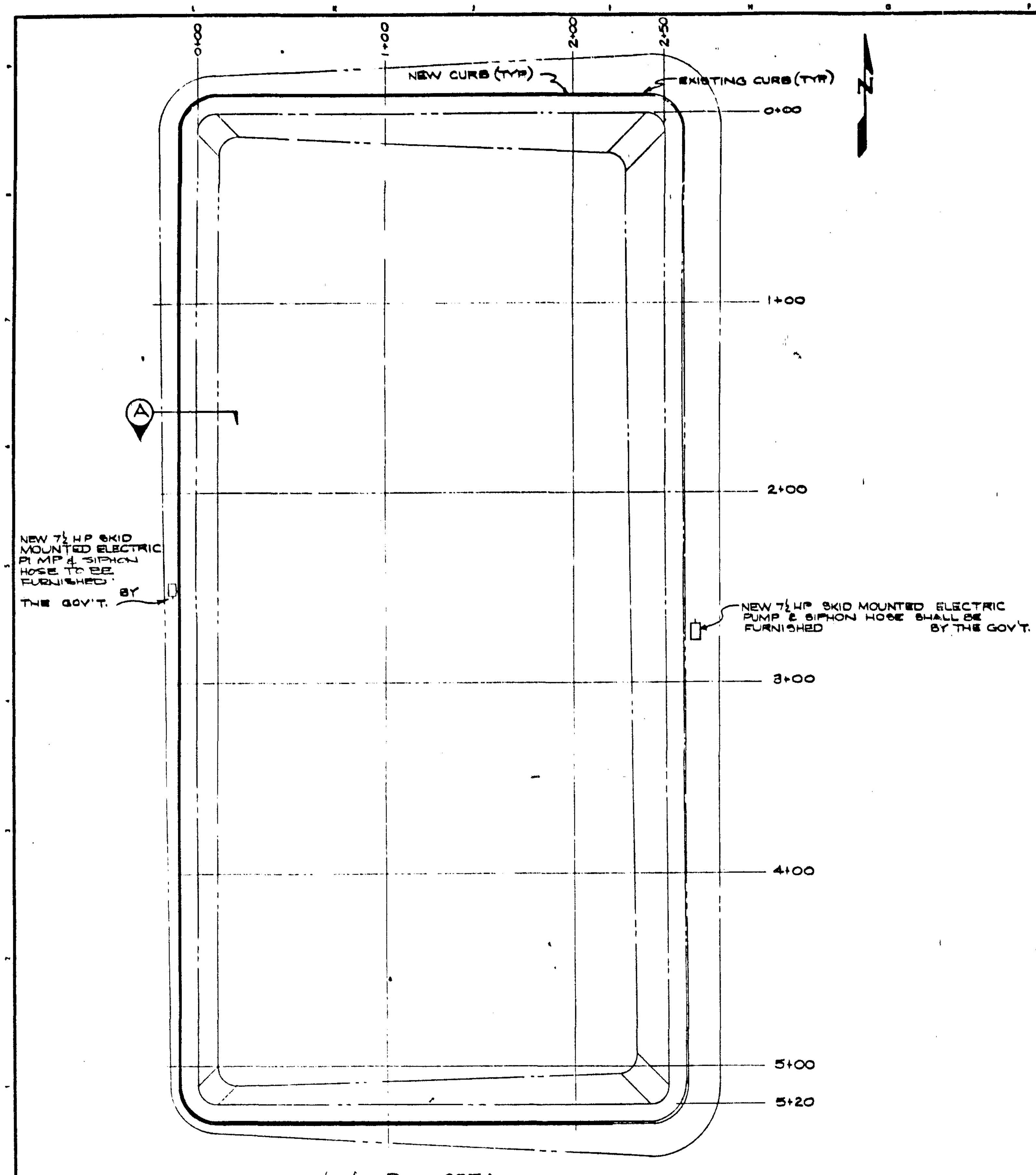
U. S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE — GOLDEN, COLORADO

THE DOW CHEMICAL COMPANY
ROCKY FLATS DIVISION — GOLDEN, COLORADO

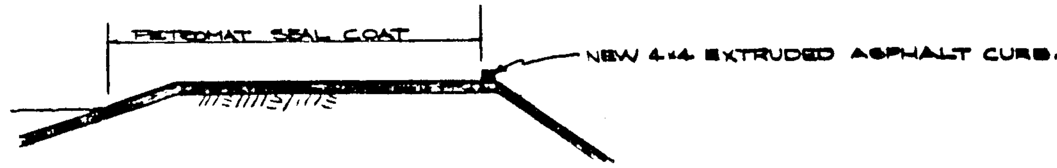
EVAPORATION POND 207C
PIPING SYSTEM
DETAILS

SIZE	DRAWING NUMBER	ISSUE	SHEET
D	19379-4	B	4 of 4


LEGEND
EXISTING CONTOURS
NEW CONTOURS
EXISTING ASPHALT BERMS
EXISTING C.M.P.
BENCH MARK
GENERAL NOTES
2 SLOPE OF BOTH LINES SHALL BE 2%
4 REGRADE AREA AS SHOWN ON THIS DWG.
7 COVER NORTH END OF 6 Φ PERF PIPE
DAYLIGHT 8Φ CMP & DITCH
DAYLIGHT 6Φ PERF PIPE & RIPRAP
℄ OF NEW 6Φ PERFORATED PIPE & NEW 18Φ CMP
2-1½" PLASTIC PROC WTR.
REMOVE EXIST CMP
REMOVE EXIST CMP
TOP OF BERM POND 207A
ELEV TOP OF BERM
POND 207C
BM - NAIL DRIVEN INTO ASPH. TOP OF BERM ELEV 5979.40'
EXIST DITCH
EXIST CMP TO REMAIN
℄ EXIST DITCH
TYPICAL SECTION THRU CMP & PERF PIPE
SCALE ½" = 1'-0"
FILL DIRT
8Φ CMP
6" SAND
¾ GRAVEL
SITE DRAINAGE PLAN FACILITIES 207
SCALE: 1" = 20'
B AS BUILT
A ORIGINAL ISSUE
U. S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
THE DOW CHEMICAL COMPANY
ROCKY FLATS DIVISION GOLDEN, COLORADO
EVAPORATION POND 207C
REVISED DRAINAGE PLAN
D 19379-5 B 5-5



POND 207A
SCALE: 1" = 30'



SECTION A (TYP)
SCALE: ⅜" = 1'-0"

GENERAL NOTES

1. SEAL COAT THE BERM OF POND 207A ONLY (APPROX. 12' WIDE) WITH 1 LAYER OF "PETROMAT" AS MANUFACTURED BY PHILLIPS PETROLEUM CO. BEDDED IN 2 COATS OF PHILLIPS HYDRAULIC ASPHALT CEMENT APPLIED AT A RATE OF 1/4 GAL/SQ.YD/COAT.
2. SEE DWGS. 20826-12A & 19923-344 FOR NEW ELECTRICAL DISTRIBUTION INTO POND AREA.

A	ORIGINAL ISSUE	3-16-71	DLS			410550

DRAWN	PEHELEY	1-4-71
DESIGN	JFBB	1-4-71
CHECKED	DLS	3-9-71
APPROVED		3-16-71
		3-16-71
SUBMITTED		3-16-71
REVIEWED		3/16/71

U. S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE — GOLDEN, COLORADO

THE DOW CHEMICAL COMPANY
ROCKY FLATS DIVISION — GOLDEN, COLORADO

REPAIR EVAP. PONDS
POND 207A

SCALE: AS NOTED

D 19923-1 — A — 1 • 5