RELIABILITY OF SUPPLEMENTAL IRRIGATION SYSTEMS

by

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B.S., University of Kansas, 1978

A MASTER'S REPORT

submitted in partial fulfillment of

the requirements for the degree

MASTER OF SCIENCE

Department of Civil Engineering

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1981

Approved:

Major Professor

SUMMARY

By daily simulation, using historic weather data, a computer model evaluates reliability of a supplemental irrigation system in Riley County, Kansas. Irrigation application rate and drainage area are found to influence system reliability.

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INTRODUCTION

Rainfall in the Manhattan area peaks during May to July and then drops off for the rest of the growing season. Stress in crops and possibly reduced yields, due to poor distribution of rainfall during the growing season, occurs. This often leads farmers to consider surface and subsurface irrigation water supplies.

Due to the topography, most irrigation in Riley County is confined to the Kansas River valley. The eastern half is often steep and rocky, typical of the flint hills. A loess mantle overlies the western half, mitigating the undulation and permitting tillage in deep silty clay loams. This mixed land use pattern offers small cropland fields interspersed with pasture and hayland.

The subject of this paper is such a watershed area. The L. and M. Jahnke farm, located in west central Riley County, has a dam site with 55 acres of contributing drainage area. The area is composed of approximately 50% cropland and 50% pasture. The proposed irrigation plot is 18 acres of alfalfa.

The proposed system is evaluated using a continuous simulation hydrologic model as presented in (1). The system is composed of a storage pond and an irrigation field plot. The pond stores runoff from the drainage area. The model pond is idealized as a trapezoidal volume. The model maintains an account of direct precipitation, evaporation, exfiltration, overflows, and irrigation demands for the pond.

The model field plot soil moisture is monitored. Irrigation applications, direct precipitation, infiltration, runoff, and interception are accounted for during the simulation period. Irrigation applications are made whenever the soil moisture drops below a specified percentage of field capacity.

DISCUSSION

The computer model was calibrated for the Manhattan area by adjusting coefficients in the Penman equation as described in (1). Adjustments were made until 15.6 inches of net evaporation were obtained. This closely matches the average annual evaporation and rainfall as in (2) and (3).

The actual drainage area is composed of Irwin and Wymore soils as shown in (4). Both are irrigation design group 1 or 0.1 inch/hour intake family as described in (6). Pasture and terraced cropland on these soils yield nearly the same runoff. Therefore, the drainage area is considered as all pasture.

The storage pond was modeled as a trapezoidal volume with 12:1 side slopes, 125 x 125 foot bottom, and 13 foot deep. This approximates actual surface area to within 0.27 acres and actual volume to within 0.07 acre-foot. Seepage was assumed to be 0.06 inches/day.

The irrigation plot is 18 acres of alfalfa on irrigation design group 2 soil. Irrigation applications were 1.5 inches/day and 1.0 inch/day for two trial simulations.

Results of Simulation

The model was run for 29 years of historic weather events on a daily basis. The pond was considered to have failed whenever an irrigation application was attempted, but the pond was empty, making the full application rate, or a fraction thereof, unavailable.

The system was checked with a 900 acre drainage area in order to determine the reliability of the system.

Reliability is defined as:

$$\text{Reliability} = \frac{\text{29 years - number of years failed}}{\text{29 years}} \times 100\%.$$

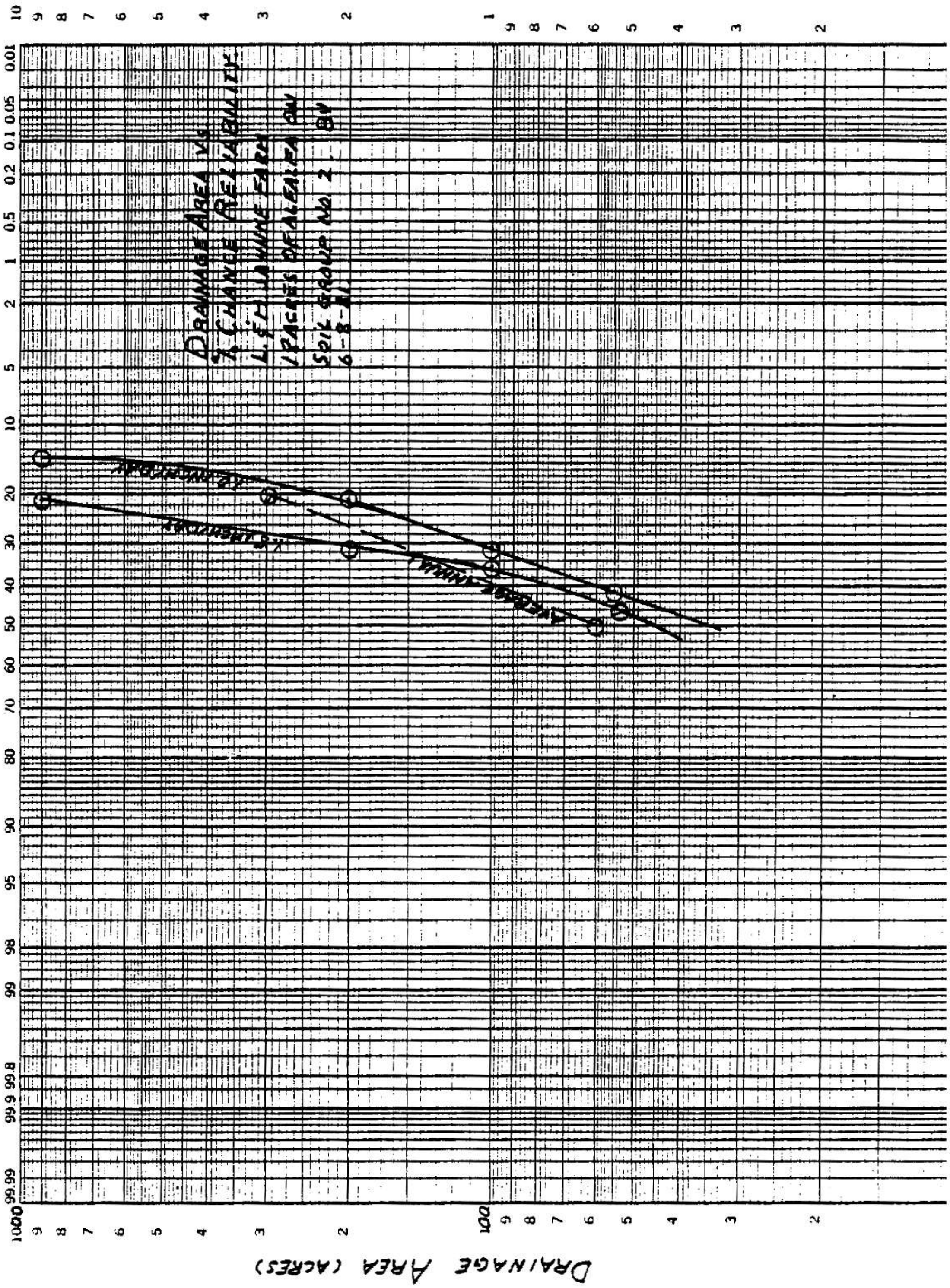
The results are shown in Figure No. 1.

The system has a 58.6% reliability with 1 inch/day applications and 55.2% reliability with 1.5 inch/day applications. Doubling the size of the drainage area yields approximately 10% increased reliability. After about 200 acres of drainage, diminishing returns of reliability occur.

Figure No. 1 shows 1.0 inch/day and 1.5 inch/day reliability curves plotted on log-normal probability paper. Also, the 80% and 50% chance yield versus required drainage area is plotted. This was computed based on net, seasonal irrigation requirements from (5) and average annual yield values from (6).

For example, the 80% chance, net, irrigation requirement for alfalfa in Riley County is 18.2 inches. Irrigating 18 acres, the operator would need 327.6 acre-inches of water stored in a pond. The 80% chance yield from a drainage area with a CN of 82 and a II AMC is 1.1 inches. The storage pond would need 327.6 acre-inches/1.1 inches or 298 acres. The 50% chance drainage area is computed similarly.

FIGURE NO. 1


DRAINAGE AREA VS
% CHANGE RELIABILITY
SOIL GROUP NO 2
DRAINAGE AREA (ACRES)

CONCLUSION

It is seen from Figure No. 1 that the 1.0 inch/day application rate yields a more reliable system, from the standpoint of water supply, than the 1.5 inch/day rate. If the operator makes 1.0 inch/day applications, he can expect to irrigate approximately 6 out of 10 years on average, without failure of the supply. This assumes a similar hydrologic cycle for the next 29 years of record.

From a management viewpoint the 1.0 inch/day application rate is advantageous. The alfalfa plot has such a slow intake rate that light but frequent applications will be necessary. Otherwise, a reduced irrigation efficiency will occur due to excessive runoff.

The reliability based on the average annual values from (5) and (6) is 49%. One reason for this difference may be that average annual values neglect the operators ability to schedule light but frequent irrigations. This strategy may allow him to conserve his supply until it rains again.

The average annual curve shows a greater reliability than the 1.5 inch/day curve for drainage areas greater than 140 acres. This may be showing that rainfall is poorly distributed through the growing season.

The model is able to account for the poor distribution but the average annual method cannot. Smaller application rates increase the reliability of the system. As more reliability is sought with greater drainage area, the effect of poor distribution of rainfall is less able to be countered or masked by better management of application.

There were some very droughty years that were not overcome even with 900 acres of drainage. During these years the pond failed four years of 29 for an 86% reliability even though 1.0 inch/day applications were made.

RECOMMENDATIONS

Model simulation should be done using applications of, say, 0.5 inch/day and starting irrigation at 75% of field capacity. Evaluating these management techniques may yield a higher system reliability. The operator should be encouraged to try this strategy for optimizing his supplemental irrigation system.

BIBLIOGRAPHY

1. Zovne, Jerome J. and James Steichen, Supplemental Irrigation System Design by Hydrologic Simulation, Paper No. 80-2088, ASAE, June 1980.

2. Evaporation Maps of the U.S., TP 37. U.S. Department of Commerce, Weather Bureau, Washington, DC, 1959.

3. Bark, L. D., Normal Annual Precipitation for Kansas, 1941-1970.

4. Soil Survey of Riley County and part of Geary County, Kansas. USDA, Soil Conservation Service and Kansas Ag. Exp. Station, Manhattan, Kansas, 1975.

5. Engineering Field Manual Notice, KS-3. USDA, Soil Conservation Service, Salina, Kansas, 1978.

6. Kansas Irrigation Guide. USDA, Soil Conservation Service, Salina, Kansas, 1977.

APPENDIX A

Years of Failure, 1948-1977

1.5 inch/day application rate:

Drainage area-

55 acres	100 acres	200 acres	900 acres
1950			
1952	1952		
1953	1953	1953	1953
1954	1954	1954	
1955	1955	1955	1955
1956	1956	1956	
1957	1957	1957	
1963	1963	1963	1963
1964	1964	1964	1964
1966	1966	1966	1966
1967	1967	1967	1967
1972	$\frac{29-10}{29} \text{x} 100\% = 65.5\%$	$\frac{29-9}{29} \text{x} 100\% = 69.0\%$	$\frac{29-6}{29} \text{x} 100\% = 79.0\%$
1977			
$\frac{29-13}{29} \text{x} 100\% = 55.2\%$			

Years of Failure, 1948-1977

1.0 inch/day application rate:

Drainage area-

55 acres	100 acres	200 acres	900 acres
1952	1952		
1953	1953	1953	
1954	1954		
1955	1955	1955	1955
1956	1956		
1957			
1959			
1963	1963	1963	1963
1964	1964	1964	
1966	1966	1966	1966
1967	1967	1967	1967
1972	$\frac{29-9}{29}$x100% = 69.0%	$\frac{29-6}{29}$x100% = 79.3%	$\frac{29-4}{29}$x100% = 86.0%
$\frac{29-12}{29}$x100% = 58.6%			

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KS-EN -400(JS), Rev. 4/79 (File Code ENG-13)

NOTE:
Do not borrow closer than ___
from upstream toe of dam.

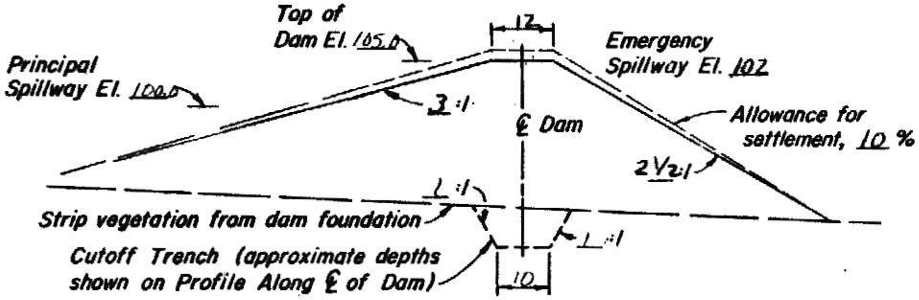
BM #1 - STEEL PIN LOCATED CENTER LINE OF DAM 900 ft NORTH OF THE TOWNSHIP ROAD AND 460 ft. WEST ALONG FENCE LINE. Elevation 107.06

Sec. 24, T 8, R 5
Riley County

LOCATION

TABLE OF QUANTITIES

ITEM	UNIT	QUANTITY
EMBANKMENT	Cu. Yds.	10,512.7
EXCAVATION: CUT OFF TRENCH	Cu. Yds.	700
EMERGENCY SPILLWAY		200
10" CSP 16 ga Galvanized	Ft.	102
48"x48" Anti Seep Plates, 16 ga.	Ft.	4
10" Connector Flanges Attached	In.	12
Mastic	Gal.	1
canopy inlet, attached	Ea.	1



TYPICAL CROSS SECTION OF DAM

RESERVOIR CAPACITY TABLE

	inches²	Elevation	Area Acres	Acre Feet	Total Ac. Ft.
	0.0	82.0	0.0	0.0	0.0
	0.40	84.0	0.09	0.09	0.09
	1.93	88.0	0.44	1.06	1.15
	6.24	92.0	1.43	3.74	4.89
	10.83	96.0	2.48	7.82	12.71
Prin. Spwy	17.89	100.0	4.11	13.18	25.89
Em. Spwy		102.0	From Curve		38.0
Top of Dam		105.0	"	"	55.0

PLAN OF DAM and RESERVOIR AREA
Approximate Scale: 1" = ___'

EARTH DAM

L & H Jahnke & Sons
SW¼ 24-8-5
Riley County Ks.
Farm Pond

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed ...	Date	Approved by Bayton Vining
Drawn ...		Title Civil Engineer 6-4-81
Traced ...		Title ...
Checked BV	5-81	Sheet No. 1 of 3 / Drawing No.

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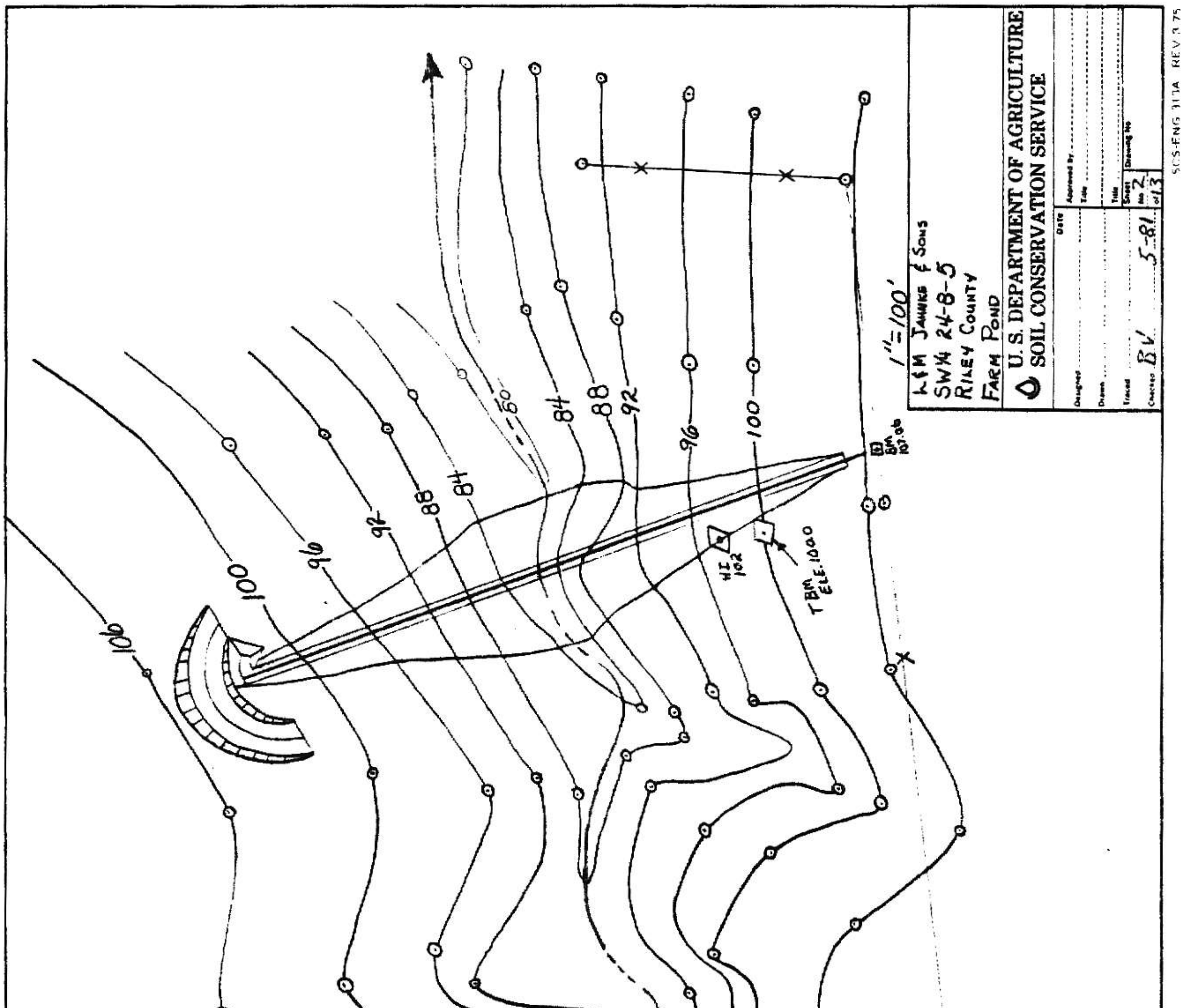
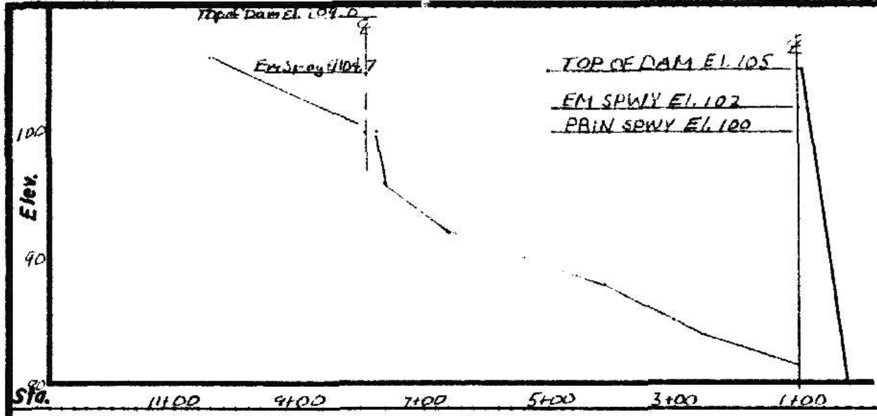
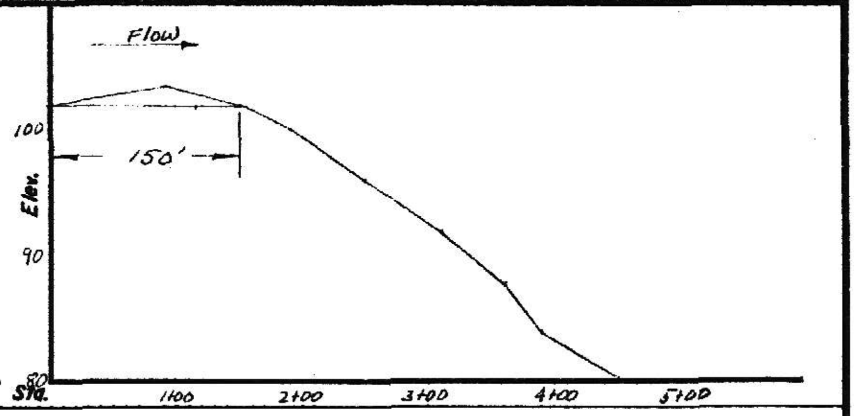

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
L & M Jahnke & Sons
SW1/4 24-8-5
Riley County
Farm Pond
1" = 100'
Traced BV
5-81
Sheet No. 2 of 3
SCS-ENG 313A REV 3-75
106
100
96
92
88
84
80
HI 102
TBM ELE. 100.0
BM 107.36
Emg. Spwy 6.9
4.13 Top Dam
2.16 Top Dam

USDA-SCS

KS-EN-401 (JS), 7/78, (File Code ENG-13)



CHANNEL PROFILE



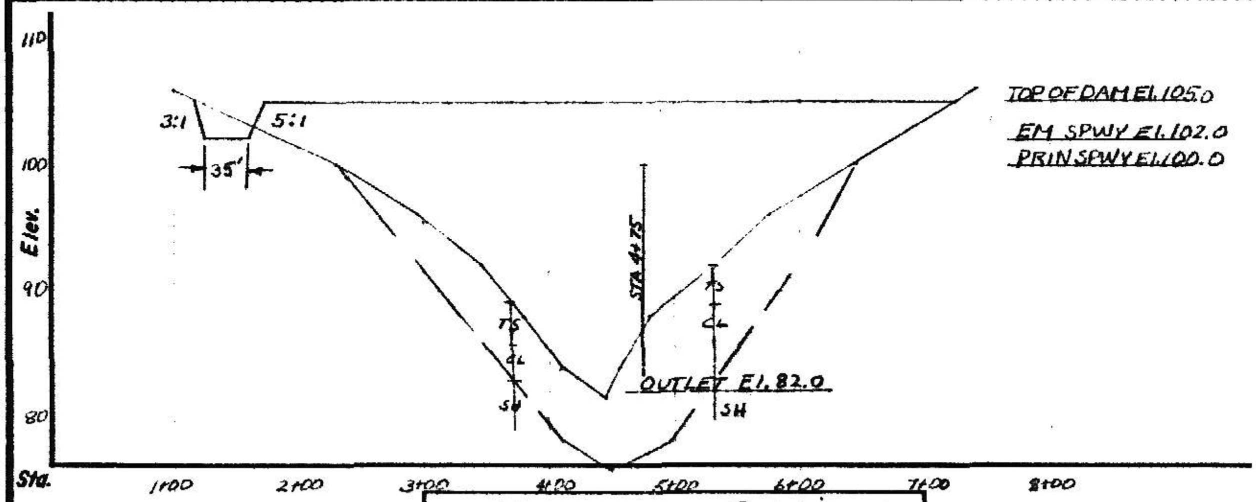
PROFILE ALONG ℄ OF EMERGENCY SPILLWAY

DESIGN DATA

T_c = — HR. or Avg. Wtsd. Slope 3.0 %
DRAINAGE AREA 55 AC. .085 SQ. MI.
SOIL COVER COMPLEX NO. 82 AMC II
AVERAGE ANNUAL YIELD:
50 % CHANCE 4.5 IN. 20.6 AC. FT.
80 % CHANCE 1.4 IN. 6.4 AC. FT.

STORAGE:
SEDIMENT BELOW EL. 100.0, 0.7 IN. 3.2 AC. FT.
OTHER BELOW EL. 100.0, 4.97 IN. 22.8 AC. FT.
RETARDING 2.64 IN. 12.1 AC. FT.
PRINCIPAL SPILLWAY DISCHARGE (MAX.):
4.75 C.F.S. 55.9 C.S.M.
TIME TO EMPTY, EL. 102.0 TO EL. 100.0 ≅ 38.0 HR.

EMERGENCY SPILLWAY:
PERCENT CHANCE OF USE ≤20%
DESIGN STORM 50 YR. FREQ. 24 HR.
RAINFALL 6.5 IN. RUNOFF 4.5 IN. II AMC
PEAK DISCHARGE 170 C.F.S.
MAXIMUM WATER SURFACE EL. 104



PROFILE ALONG ℄ OF DAM

PROFILES, CROSS SECTIONS and DESIGN DATA

L & M Jahnke & Sons
SW¼ 24-8-5
Riley County Ks
Farm Pond

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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Traced ......
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Approved by ......
Title ......
Sheet No. 3 of 3
Drawing No. ......

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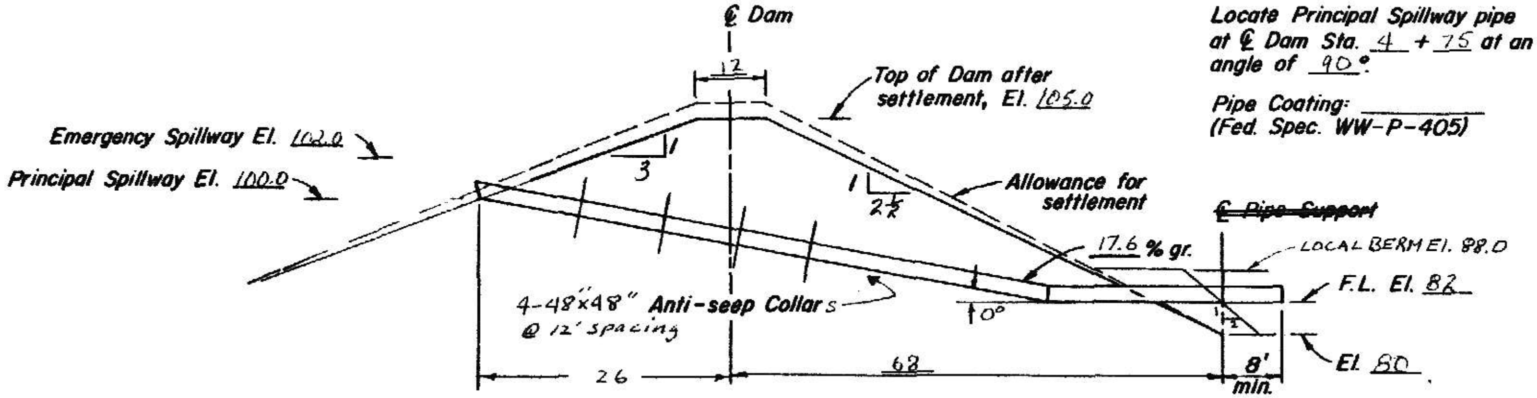
Locate Principal Spillway pipe at ℄ Dam Sta. 4 + 75 at an angle of 90°.

Pipe Coating: ______
(Fed. Spec. WW-P-405)

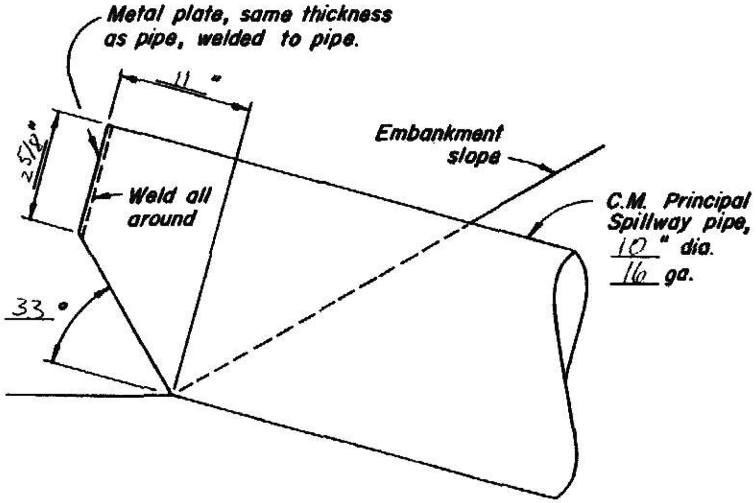


CROSS SECTION OF DAM ALONG ℄ OF PRINCIPAL SPILLWAY
(Not to Scale)

12 + 12 + 12 + 12 + 12 18 24 .

NOTES:

1. All welds and heat damaged areas to be thoroughly wire brushed and painted with two coats of zinc dust-zinc oxide primer conforming to Fed. Spec. TT-P-641, type III.
2. ~~See KS-EN - for trash rack details.~~
3. See KS-EN -406 for anti-seep collar and coupling band details.
4. ~~See KS-EN - for pipe support details.~~
5. The pipe shall be firmly and uniformly bedded so the lower one-sixth of the circumference will bear against original or compacted fill.



DETAIL OF CANOPY INLET

C.M. CANOPY INLET

Leil Tihhke & Sons
SW¼ 34-8-5
Riley County, Ks.
Farm Pond

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
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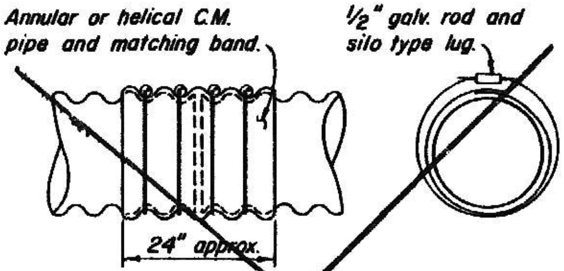
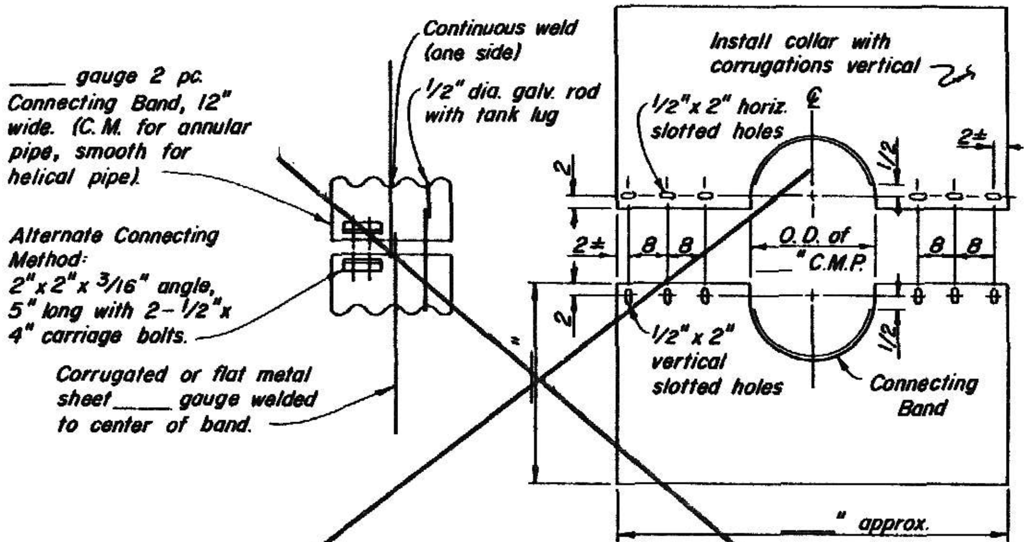


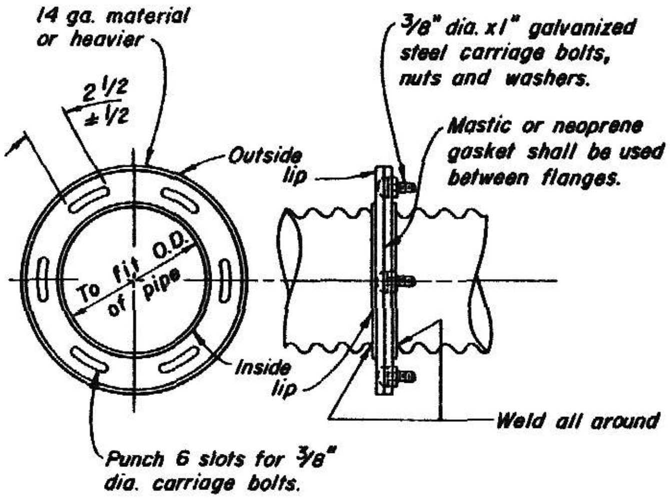
RODDED BAND FOR 12" THRU 48" DIA. C.M. PIPE

NOTES:
1. Use 3/8" thick, 6" minimum width neoprene gasket, 1/4" thick, 6" minimum width asphalt tape or asphalt mastic between pipe and coupling band.
2. Coupling bands shall be the next gauge lighter than the pipe being connected but not less than 16 gauge.
3. Coupling bands shall have the same coating specified for the pipe being used.

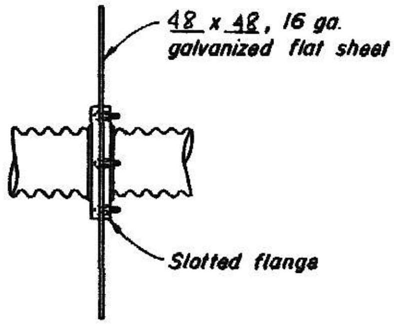


DETAILS OF METAL ANTI-SEEP COLLAR

NOTES:
1. Collars shall have the same coating as pipe.
2. Unassembled collars shall be marked by painting or tagging to identify matching pairs.
3. Use asphalt mastic at the time of installation between the half sections and between the pipe and connecting bands.
4. Fabrication dimensions are minimum dimensions and are stated to the nearest full inch.



SLOTTED FLANGE FOR ~~6", 8"~~, 10", ~~8-12~~" DIA. PIPE



ANTI-SEEP COLLAR FOR ~~6", 8"~~, 10" ~~8-12~~" DIA. HELICAL PIPE

CONNECTING BANDS and METAL ANTI-SEEP COLLAR

L & M Jahnke & Sons
SW 1/4 24-8-5
Riley County, KS
Farm pond

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved by
Drawn		Title
Traced		Title
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SPECIFICATIONS

POND (EMBANKMENT)

1. SCOPE

The work shall consist of all construction operations and furnishing all materials as required by the drawings and specifications for the complete installation of the works.

2. LOCATION

The location of the embankment, borrow area, emergency spillway, and appurtenant structures shall be as specified on the drawings.

3. SITE PREPARATION

Foundation Area: The foundation area shall be cleared of all trees, logs, stumps, roots, boulders, sod, and rubbish. Channel banks and breaks shall be sloped no steeper than 1 horizontal to 1 vertical. Topsoil containing substantial amounts of organic matter shall be stockpiled for later placement on the dam, spillway, and borrow areas located outside the pool area.

Stream channels in the foundation area shall be deepened and widened as necessary to remove stones, gravel, sand, stumps, roots, mud, or other objectionable material and to accommodate compaction equipment.

The foundation area will be thoroughly scarified to a minimum depth of 4 inches (.10 m) before placement of the fill material and moisture added, if necessary, so the first layer of fill material can be bonded to the foundation.

Waste Material: Waste material from the construction operation such as rocks, frozen soil, mud, stumps, trees, logs, roots, or rubbish shall be disposed of by piling, burying, or burning at locations outside the dam area or as directed by the inspector. Burning shall comply with Kansas State Department of Health and Environment Regulation No. 28-19-45 through 28-19-47 (Open Burning Policy).

4. EXCAVATION

To the extent they are suitable and approved by the inspector, excavated materials are to be used as fill materials.

Cutoff and Principal Spillway Trenches: These trenches shall be excavated to the lines, grades, and widths shown on the drawings or as revised by the inspector for depth adjustment during excavation.

ILLEGIBLE DOCUMENT

THE FOLLOWING DOCUMENT(S) IS OF POOR LEGIBILITY IN THE ORIGINAL

THIS IS THE BEST COPY AVAILABLE

The trenches shall be kept free of standing water during backfill operations.

Backfill shall be made with selected impervious material approved by the inspector and be placed in the same manner as specified for earth fill.

Emergency Spillway and Outlet Channel: These excavations shall conform to the lines, grades, bottom width, and side slopes shown on the drawings or as staked in the field.

Borrow: The location, extent, and depth of the borrow area shall be as shown on the drawings. The borrow pits shall be stripped of all vegetation and topsoil containing substantial amounts of organic matter. This stripped material will be stockpiled for use to topsoil areas disturbed by the construction, embankment slopes, emergency spillway, and other required topsoil areas.

Borrow pits will be excavated and dressed in a manner to eliminate steep or unstable side slopes or other hazardous conditions. Side slopes shall be no steeper than 3:1. Surfaces of the borrow pits not covered by permanent water shall be graded and shaped to prevent the ponding of water.

5. PRINCIPAL SPILLWAY

The materials and manufacture of the pipe, anti-seep collars, coupling bands, coatings, and other appurtenances shall be as shown on the drawings and shall conform to the appropriate federal or ASTM specifications suitable for the intended purpose.

The pipe shall be laid to the line and grades shown on the drawings, be placed in original earth or properly compacted earth fill, and be uniformly bedded to the depth and in the manner specified.

Selected, impervious backfill material shall be placed around the conduit and appurtenances in layers not more than 4 inches (.10 m) thick before compaction and each layer shall be thoroughly compacted by hand tamping, manually directed power tampers, or plate vibrators to the density of the surrounding material. The height of fill shall be increased at approximately the same rate on all sides of the structure. Heavy equipment shall not be operated within 2 feet (.61 m) of any structure.

* *

6. PLACEMENT OF EARTH FILL

The material placed in the fill shall be free of sod, roots, frozen soil, stones over 6 inches (.15 m) in diameter, and other objectional material.

The placing and spreading of fill material shall be started at the lowest point of the foundation and the fill brought up in horizontal layers of such thickness that the required compaction can be obtained. The fill shall be constructed in continuous horizontal layers except where openings or sectionalized fills are called for. In those cases the slope of the bonding surfaces between embankment in place and embankment to be placed will not be steeper than 3 horizontal to 1 vertical. The bonding surface is to be treated the same as that specified for the foundation so as to insure a good bond with the new fill.

The distribution and gradation of materials shall be such that there will be no lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. Where it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the center and upstream portions of the fill. Where zoned fills are specified of substantially differing materials, the zones shall be placed according to lines and grades shown on the drawings.

The completed work shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

Stockpiled topsoil strippings will be placed on the outer portion of the embankment as a part of each lift. Topsoil shall not be less than 6 inches (.15 m) nor more than 2 feet (.61 m) thick measured vertically and shall be compacted concurrently with the earth fill.

7. MOISTURE CONTROL

The moisture content of the fill material shall be such that the required compaction can be obtained. Material that is too wet shall be dried to meet this requirement, and material that is too dry shall have water added and mixed until the requirement is met. Moisture requirements will be as shown on the drawings or in the Construction Detail section of this specification.

8. COMPACTION

The construction equipment shall be operated over the areas of each lift of earth fill in a way that will result in the required compaction. Special equipment will be used when the required compaction cannot be obtained without it. Compaction requirements will be as shown on the drawings or in the Construction Detail section of this specification.

9. FOUNDATION AND EMBANKMENT DRAINS

Foundation and embankment drains, when required, will be placed to the line and grade as shown on the drawings. Gradation requirements for drain fill and filter material and material requirements for pipe will be as shown on the drawings or as specified in the Construction Details section of this specification.

10. CONCRETE

Concrete shall be Class 3000M with a maximum net water content of 6½ gallons/bag and a minimum cement content of 6 bags/cu. yd.

Portland cement shall be Type I or II. Air entraining admixture shall be used to provide an air content of 5 to 8 percent of the volume of concrete.

Coarse aggregate shall be hard, free from dirt and organic materials, and shall consist of gravel, crushed stone, or other suitable materials larger than 1/4 inch (6.4 mm). Maximum size shall be 1½ inches (38.1 mm).

Fine aggregate shall consist of natural or manufactured sand with particle gradation ranging from coarse (1/4 inch (6.4 mm) to fine (#200 sieve).

Mixing water shall be clean and free from oil, alkali, or acid.

The proportions of the aggregates shall be such to produce a concrete mixture that will work readily into the corners and angles of the forms and around steel reinforcement when consolidated. The slump at the time of placing shall be 2 to 4 inches (51 to 102 mm).

Forms shall be wood, plywood, steel, or other approved materials and shall be mortar tight. The forms shall be unyielding and shall be constructed so the finished concrete conforms to the specified dimensions and contours.

Prior to placement of concrete, the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings.

Concrete shall be conveyed from the mixer to the forms as rapidly as practical by methods that will prevent segregation of the aggregates and loss of mortar. Concrete shall not be dropped more than 5 feet (1.5 m) vertically except where suitable equipment is used to prevent segregation.

Immediately after the concrete is placed in the forms, it shall be consolidated by spading, hand tamping, or vibration as necessary to insure smooth surfaces and dense concrete.

Forms shall be removed in such a way to prevent damage to the concrete.

All exposed surfaces of the concrete shall be accurately screeded to grade and then wood floated.

Concrete shall be prevented from drying for a curing period of at least 7 days after it is placed. Exposed surfaces shall be kept continuously moist for the entire period or until curing compound is applied.

Concrete shall not be mixed nor placed when the atmospheric temperature is less than 40° F (4°C) or more than 90° F (32°C) unless facilities are provided to prevent freezing or for cooling as required.

11. VEGETATION

A protective cover of vegetation shall be established on all exposed surfaces of the embankment, spillway, outlet channel, and borrow area. Seedbed preparation, seeding, fertilizing, mulching, or other vegetation shall be as specified in the Construction Details.

12. FENCING

The embankment and spillway shall be fenced to protect the vegetation, when specified in the Construction Details. Fencing shall comply with appropriate standards and specifications.

13. MEASUREMENT

Earth Fill in Dam: The volume of earth fill completed as specified will be determined from the design dimensions as staked in the field.

The design dimensions shall be the measured surface of the foundation prior to stripping and the specified neat lines of the settled fill surface. Volume will be computed to the nearest cubic yard. No reduction in volume will be made for embedded conduits and appurtenances.

Earth Fill in Cutoff Trench: The volume of earth fill will be computed from the measured surface of the foundation prior to stripping and the bottom of the excavated cutoff trench.

Emergency Spillway and Outlet Channel: No volume measurement will be made for these excavations.

Other Component Parts: Unless otherwise specified in the Construction Detail, measurement shall be to the units shown in the bid schedule and/or the drawings.

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Field Sheet: GRASS SEEDING

KS-PS-3
Rev. 11/78
(File Code PS)

Program ______

Owner L & M Tahnke & Sons

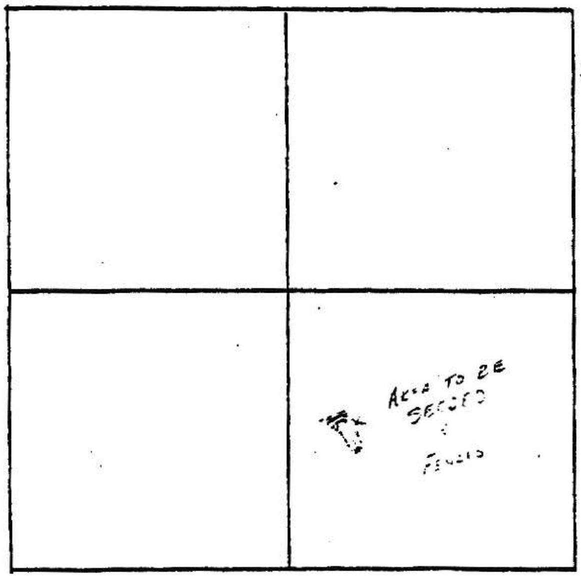
Ident. No. D-2

Operator [illegible] Tahnke

County Riley

1. Seeding Mix and Fertilizer: See back side of this field sheet.
2. Seedbed Preparation: Kind of Seedbed CLEAN
   (clean, stubble, mulched, etc.)

   For stubble show: Kind — Row Spacing — Height —
   For mulched show: Kind — Tons/Acre —
   Satisfactory: Yes ______ Or No ______
3. Method Seeding: Broadcasting
4. Approved Seeding Dates: March 15 to May 15
   Dec. 1 – May 15



Location Map, Scale [illegible]

Legal Description
SW¼ Sec. 24 T. 8 R. 5

SCS Representative
Layout by [illegible]
Date 6-4-81

Checked by ______
Date ______

(Apply Field No. to Sketch)

Method of Determining Acreage:

1) Planned:

2) Applied:

SEED

	PLANNED						APPLIED				
(1) Species	(2) Variety	(3) Lbs. PLS/ Acre	(4) % of Mix	(5) PLS Lbs./ Acre	(6) Acres	(7) Total Lbs/PLS	(8) Bulk Lbs. Seeded	(9) PLS*	(10) Total Lbs./PLS Seeded	Acres	Remarks
[illegible]	[illegible]	[illegible]	20	2.4	1.1	2.64					
[illegible]	Aldous	8.0	20	1.6	1.1	1.76					
[illegible]	Osage	2.0	15	1.8	1.1	1.98					
[illegible]	Blackwell	6.0	15	.9	1.1	.99					
[illegible] Oats	El Reno	12.0	20	2.4	1.1	2.64					
[illegible]	[illegible]	20.0	10	2.0	1.1	2.2					
						12.21-PLS					

FERTILIZER

Kind	Rate per Acre (Available)	Acres	Total Lbs. Fertilizer (Available)	Bulk Lbs. Applied	Percent Available	Total Available Applied	Acres	Remarks
			Not Necessary	0				

* PLS (pure live seed) from seed tag
or
$\frac{(\%\ \text{Germ.} + \%\ \text{Firm Seed}) \times \text{Purity}}{100}$

(1) To be obtained from specifications.
(2) May be obtained from Plant Materials Technical Notes.
(3) To be obtained from specifications.
(4) To be obtained from specifications after on-site investigation of need
(5) Multiply columns 3 and 4 and enter in column 5.
(6) Acres to be seeded.
(7) Multiply columns 5 and 6 and enter in column 7.
(8) Enter bulk pounds actually seeded (columns 9 and 10 are not needed when double the rate of brome and fescue are used in lieu of a seed test).
(9) Enter PLS (pure live seed) obtained from seed tag.
(10) Multiply columns 8 and 9 and enter in column 10. (Column 10 should equal or exceed column 7 or an appropriate adjustment made in the mixture

APPENDIX C

```
/*REGION       512K
/*TAPE9
//STEP EXEC FORTQCLG
//FORT.SYSIN DD *
C      HYDROLOGICAL WATERSHED MODEL
C      KANSAS STATE UNIVERSITY      1980
C
C
       INTEGER CROP,FROZE,SOIL,STIND,T,YEAR,YEARS,YEND,YSTART
       INTEGER PLOT,PREVYR,BYPASS,NROPTS,DARCEQ,ROTAYR
       INTEGER DGSB,DGSE,DGSBP(9),DGSEP(9),DAY,ROTATE(9)
       INTEGER DOUBLE(9),RCYCLE(9),IYRCRP(9),NRCROP(9,90)
       REAL IA,IAADD,IAET,KCROP,KS,LAKEVP,LKEVPT,LTAREA,L,M,MA,NIA,NOPERC
       REAL LI,MMAT(12),IRRVOL,IRRSUM,MAXVOL,MR,NRNOF,LZSM,MUNDIS(12)
       DIMENSION TMAV(12), YOACT(9,3,2)
       DIMENSION HUZ(9),HLZ(9),HGW(9),EO(9),T(9),SMPD(9),DISVOL(9)
       DIMENSION SM(9),SMUZ(9),SMLZ(9),SMGWZ(9),FCGW(12),CONDUZ(9)
       DIMENSION CONDLZ(9),CONDGW(9),CTP(25),ASTAT(25),CTR(25,4)
       DIMENSION AREA(9),IAREA(9,2),IPLAN(9),INCROP(9),MGSBP(9),MGSEP(9)
       DIMENSION CNS1(7),CNS3(7),CNS5(7),CNS12(7),FREQ(25),CTPR(25)
       DIMENSION CTRDAY(4),AETU(9),AETL(9),IAADD(9),IAET(9),NIA(9)
       DIMENSION JPDACT(13,14)
       DIMENSION AMONTH(13),AVLFCL(12),AVLFCU(12),C(12),FCL(12),FCU(12)
       DIMENSION KCROP(7,12),NDIM(12),PDACCT(13,14),PREC(31),PSUNS(12)
       DIMENSION PWPLZ(12),PWPUZ(12),RA(12),RCM(12,7),RCN(12,7),RHO(12)
       DIMENSION SMACCT(13,9,9),          SMSATU(12),TAVG(31),TMAX(31)
       DIMENSION TMIN(31),U(12),WIND(12),PRECAC(25,4),RUNACC(25,9)
       DIMENSION DSRNFF(9),AINTER(9),AAETRS(9),ACHSOM(9),DSPERC(9)
       DIMENSION NRNOF(9),NDPERC(9),SMSATG(12),NAMES(6),DAYSDS(9),PWG(12)
       DIMENSION IFALWT(9)
       DIMENSION RRIJAN(12),RRIFEB(12),RRIMAR(12),RRIAPR(12),RRIMAY(12),
      1RRIJUN(12),RRIJUL(12),RRIAUG(12),RRISEP(12),RRIOCT(12),RRINOV(12),
      2RRIDEC(12)
       DIMENSION RRI1(9),RRI2(9),RRI3(9),RRI4(9),RRI5(9),RRI6(9),
      1RRI7(9),RRI8(9),RRI9(9),RRI10(9),RRI11(9),RRI12(9),RIRRIG(9)
       COMPLEX*16 KROP*16(7)/'WHEAT','SORGHUM','CORN','SOY BEANS',
      1     'PASTURE','ALFALFA','FALLOW'/
       DATA CNS1/84.0,86.0,86.0,86.0,80.0,83.0,84.0/
       DATA CNS3/81.0,82.0,82.0,82.0,74.0,78.0,78.0/
       DATA CNS5/73.0,75.0,75.0,75.0,61.0,69.0,69.0/
       DATA CNS12/61.0,65.0,65.0,65.0,39.0,55.0,61.0/
       DATA NAMES/'IRR.','INT.','RNFF','PERC','AET ',' SM '/
       DATA AMONTH/'JAN.','FEB.','MAR.','APR.','MAY ','JUNE','JULY',
      1     'AUG.','SEPT','OCT.','NOV.','DEC.','TOT.'/
       DATA ASTAT/'>0.0','>0.1','>0.2','>0.3','>0.4','>0.5','>0.6',
      1     '>0.7','>0.8','>0.9','>1.0','>1.1','>1.2','>1.3','>1.4',
      2     '>1.5','>1.6','>1.7','>1.8','>1.9','>2.0','>3.0','>4.0',
      3     '>5.0','>10.'/
       DATA AVLFCU/2.6,1.5,2.5,2.4,2.5,2.6,2.4,2.4,2.4,2.2,1.5,1.0/
       DATA AVLFCL/2.7,2.9,5.7,2.5,6.7,4.2,6.6,3.3,5.2,4.1,4.1,2.5/
       DATA C/0.2,0.2,0.177,0.177,0.177,0.177,0.159,0.159,0.138,0.138,
      1     0.134,0.131/
       DATA FCU/4.6,4.4,4.5,4.6,4.5,4.3,4.0,4.0,3.8,3.5,2.3,1.7/
       DATA FCL/9.4,9.4,14.2,7.0,13.9,9.1,13.7,6.8,9.2,7.0,7.0,4.3/
       DATA FCGW/7.0,6.9,9.4,5.8,9.2,6.7,8.8,5.4,6.5,5.2,4.6,3.0/
       DATA PWPUZ/2.0,2.9,2.0,2.2,2.0,1.7,1.6,1.6,1.4,1.3,0.8,0.7/
       DATA PWPLZ/6.7,6.5,8.5,4.5,7.2,4.9,7.1,3.5,4.0,2.9,2.9,1.8/
       DATA PWG/4.3,4.7,5.2,3.3,4.6,3.3,4.3,2.6,2.7,2.1,1.8,1.3/
       DATA SMSATU/5.8,6.2,5.7,5.7,5.7,5.5,5.4,5.4,5.3,5.2,4.8,4.3/
       DATA SMSATG/8.8,8.8,11.0,6.9,10.7,8.9,10.4,6.5,9.6,9.2,9.0,8.8/
```

```
      DATA U/0.47,0.47,0.39,0.39,0.39,0.39,0.35,0.35,0.31,0.31,0.28,
     1     0.24/
      DATA NDIM/31,28,31,30,31,30,31,31,30,31,30,31/
      DATA FREQ/0.0,0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0,1.1,1.2,
     1     1.3,1.4,1.5,1.6,1.7,1.8,1.9,2.0,3.0,4.0,5.0,10.0/
      DATA PDT,SMMAXL,SMUZPR,SMPREV,EPRIM/37.5,2.2,3.25,12.60,0.5/
      DATA AVAILL,AVAILU,CM,DSCVOL,DSDAYS,EVAPLK,H,IRRSUM,
     1     PEAK,PREVDS,SNOW,TPAREA,TPREC,UZSMCH,WASTWW,WET/16*0.0/
      DATA AET,AETLZ,AETUZ,B2,DPERC,EXCESS,IA,M,MA,MR,PACK,PACKPY,PDVOL,
     1     PERC,PONVOL,P1,P2,P3,SNOMLT,TDPERC,TRNOF,T1,T2/23*0.0/
      DATA CTPDAY,WATER,STRVOL,VOLDIS,CROP,IDAY,MM,PLOT,SOIL/4*0.0,5*0/
      DATA CTP,CTPR,CTRDAY,CTR/25*0.0,25*0.0,4*0.0,100*0.0/
      NAMELIST/ALPHA/BRUNTA,BRUNTB,CROP,DORM,E,GROW,OSRATE,PAVLU,PCVMAX,
     *RCROP,MOROT,EFFIRR
      NAMELIST/BETA/NPLOTS,HMAX,INDST,L,LTAREA,MSTART,S,STORM,W,YEND,
     *YSTART,DARCEQ,ROTAYR,BYPASS,DSEPRT,MPOFOM
      NAMELIST/SEED/MODEL,WPCNT
C
C          ***** INPUTS *****
C
C***  READ PROGRAM IDENTIFIERS
      READ(5,5)  NAME,OF,CITY,AND,STATE
    5 FORMAT(20X,5A4)
      READ(5,10) WEATH,MODIF,MOD,EL
   10 FORMAT(1X,4A4)
      READ(5,15) IN,FLOW,TO,STOR,AGE,POND
   15 FORMAT(1X,6A4)
C***  READ WEATHER MODIFICATION, FEEDLOT, POND AND PLOT PARAMETERS
      READ(5,SEED)
      READ(5,ALPHA)
      READ(5,BETA)
      PREVYR=YSTART
C***  READ THE MONTHLY AVERAGE METEOROLOGICAL DATA
      READ(5,20) (PSUNS(I),RHO(I),RA(I),WIND(I),MMAT(I),I=1,12)
   20 FORMAT(2X,F2.2,F2.0,F4.2,F3.1,F3.1)
C***  READ INPUTS FOR SOIL TYPE, CROP AND AREA FOR EACH PLOT
C
C
C***  MOROT : INDICATES A SORT OF ROTATION MODEL
C***  MOROT=1 ; DON'T USE SUBROUTINE ROTATN
C***  MOROT=2 ; CROP ROTATION SYSTEM WOULD BE ESTABLISHED IN ROTATN
      IF(MOROT.EQ.2) GO TO 41
      READ(5,25) ((IAREA(I,J),J=1,2),I=1,NPLOTS)
   25 FORMAT(2X,I1,2X,I2)
      READ(5,30) (AREA(I),I=1,NPLOTS)
   30 FORMAT(1X,F6.0)
C***  READ INPUTS FOR PLAN IMPLEMENTATION AND CROP ROTATION
      READ(5,35) (IPLAN(J),ROTATE(J),J=1,NPLOTS)
   35 FORMAT(1X,2I1)
      READ(5,40) (MGSBP(I),DGSBP(I),MGSEP(I),DGSEP(I),I=1,NPLOTS)
   40 FORMAT(4I3)
   41 CONTINUE
C***  READ INPUTS FOR DARCY'S EQUATION AND MUNICIPAL DISPOSAL
      IF(DARCEQ.EQ.1)  READ(5,45)(CONDUZ(I),CONDLZ(I),CONDGW(I),HUZ(I),
     1HLZ(I),HGW(I),I=1,NPLOTS)
   45 FORMAT(3F10.2,3E10.4)
      IF(BYPASS.GE.3) READ(5,50)(MUNDIS(I),I=1,12)
   50 FORMAT(F10.2)
C
C***  RUNOFF CURVE NUMBERS FOR SOIL AND CROP TYPES
```

```
      DO 55 K=1,7
      RCN(1,K)=CNS1(K)
      RCN(2,K)=CNS1(K)
      RCN(3,K)=CNS3(K)
      RCN(4,K)=CNS3(K)
      RCN(5,K)=CNS5(K)
      RCN(6,K)=CNS5(K)
      RCN(7,K)=CNS5(K)
      RCN(8,K)=CNS5(K)
      RCN(9,K)=CNS5(K)
      RCN(10,K)=CNS5(K)
      RCN(11,K)=CNS5(K)
   55 RCN(12,K)=CNS12(K)
C***  SIZING POND VOLUME ROUTINE
      A1=L*W
      A2=S*(L+W)
      A3=4./3.*S**2
      A4=2.*A2
      A5=4.*S**2
C***  VOLMAX IS THE MAXIMUM VOLUME HELD BY THE STORAGE FACILITY
      VOLMAX=(A1*HMAX+A2*HMAX**2+A3*HMAX**3)/3630.
C***  PSAREA IS THE DIRECT RECEIVING AREA OF THE FACILITY
      PSAREA=((W+2.*S*HMAX)*(L+2.*S*HMAX))/43560.
C***  CALCULATE THE CROP COEFFICIENTS
      IF(MOROT.EQ.2) GO TO 61
      DO 60 K=1,NPLOTS
      MGSB=MGSBP(K)
      DGSB=DGSBP(K)
      MGSE=MGSEP(K)
      DGSE=DGSEP(K)
      CROP=IAREA(K,1)
      CALL CROPCO(CROP,MGSB,DGSB,MGSE,DGSE,KCROP,NDIM,MMAT)
      INCROP(K)=IAREA(K,1)
   60 CONTINUE
   61 CONTINUE
C***  INITIALIZE VARIABLES
      DO 70 I=1,25
      DO 65 J=2,9
      IF(J.LE.4) PRECAC(I,J)=0.0
   65 RUNACC(I,J)=0.0
   70 CONTINUE
      SEPSUM=0.
      PONDRY=0.
      DO 75 J=1,12
   75 KCROP(7,J)=0.0
      DO 80  II=1,NPLOTS
      TPAREA=TPAREA+AREA(II)
      T(II)=0.0
      EO(II)=0.0
      IAET(II)=0.0
      IAADD(II)=0.0
      DISVOL(II)=0.0
      DAYSDS(II)=0.0
      DSRNFF(II)=0.0
      AINTER(II)=0.0
      AAETRS(II)=0.0
      ACHSOM(II)=0.0
      DSPERC(II)=0.0
      SMLZ(II)=9.35
      SMUZ(II)=3.25
```

```
      IF(MONTH.LT.MSTART.AND.YEAR.EQ.YSTART-1900) GO TO 240
      ACTIRR=0.0
      JDAEMP=0
      JDAFLO=0
      DSDAY=0
      NDIM(2)=28
      IF(NM.EQ.2.AND.TMAX(29).LT.900) NDIM(2)=29
      NDAYS=NDIM(NM)
C
C
C        ***** ENTER DAILY LOOP *****
C
      DO 800  ND=1,NOAYS
C
C***  THE FOLLOWING STATEMENTS CORRECT  FOR MISSING DATA ON INPUT TAPE
      IF(TMAX(ND).GT.250.0) TMAX(ND)=POT+100.0
      IF(TMIN(ND).GT.250.0) TMIN(ND)=POT+100.0
      IF(PREC(ND).GT.99.97) PREC(ND)=0.0
C***  TAVG IS THE AVERAGE DAILY AIR TEMPERATURE, DEGREE FAHRENHEIT
      TAVG(ND)=(TMAX(ND)+TMIN(ND))/2.0-100.0
C***  SUBROUTINE WTHRMO ADJUSTS THE PERCIPITATION RESULTING FROM
C***  SEEDING CLOUDS
      CALL WTRMOD(PREC(ND),NM,MODEL,WPCNT)
C***  THE FOLLOWING CARD EVALUATES WHETHER THE 24 HOUR DESIGN STORM
C***  HAS BEEN EXCEEDED.
      IF(PREC(ND).GE.STORM/1.14) WRITE(6,260) NM,ND,YEAR,PREC(ND)
  260 FORMAT(20X,I2,'/',I2,'/',I2,'  CRITICAL EVENT EXCEEDED  ',
     12X,F10.2,'  INCH STORM  ')
C
C
C     *** CALCULATION OF POTENTIAL EVAPOTRANSPIRATION BY MEANS OF
C                      PENMAN EQUATION ***
C
      R=RCROP
C***  THE FOLLOWING CARD CHECKS FOR SNOW COVER
      IF(PACK.GT.0.1) R=0.70
C***  THE NEXT TWO CARDS CONVERT TAVG TO ABSOLUTE, DEGREE KELVIN
      CENT=(TAVG(ND)-32.0)*100.0/180.0
      ABST=CENT+273.16
C***  ES IS THE DAILY CALCULATED SATURATED VAPOR PRESSURE, IN MILLIBARS
      ES=33.9*((0.00738*CENT+0.8072)**8-0.000019*ABS(1.8*CENT+48)
     1  +0.001361)
      IF(ES.LE.0.0) ES=0.0
C***  ESA IS THE DAILY CALCULATED ACTUAL VAPOR PRESSURE, IN MILLIBARS
      ESA=ES*RHD(NM)/100.0
C***  RN IS THE CALCULATED DAILY NET RADIATION, IN MM OF WATER
      RN=(1-R)*RA(NM)*(0.22+0.54*PSUNS(NM))-2.010E-09*ABST**4*
     1(0.98*(1.-BRUNTA-BRUNTB*SQRT(ESA)))*(0.1+0.9*PSUNS(NM))
      IF(RN.LT.0.0) RN=0.0
C***  WINDD IS THE MONTHLY AVERAGE WINDRUN, MILES/DAY AT 2 METERS HEIGHT
      WINDD=(WIND(NM)*24)*0.555
C***  EA IS THE CONVECTIVE LOSSES, MM WATER
      EA=0.26*(E+0.01*WINDD)*(ES-ESA)
      EALAKE=0.26*(EPRIM+0.01*WINDD)*(ES-ESA)
      IF(TAVG(ND)) 270,270,280
  270 DELTA=0.0
      GO TO 290
  280 DELTA=0.039*TAVG(ND)**0.673
  290 GAMMA=1-DELTA
C***  PET IS THE CALCULATED DAILY POTENTIAL EVAPOTRANSPIRATION, INCHES
```

```
      DO 160 I=1,13
      DO 150 J=1,14
      DO 140 K=1,NPLOTS
  140 IF(J.LE.9) SMACCT(I,J,K)=0.0
  150 POACCT(I,J)=0.0
  160 CONTINUE
C***  ESTABLISH CROP ROTATIONS
      IF(MOROT.EQ.2) GO TO 195
      DO 170 K=1,NPLOTS
  170 IAREA(K,1)=INCROP(K)
      IF(ROTAYR.EQ.1) GO TO 190
      DO 180 J=1,NPLOTS
      IF(IAREA(J,1).EQ.1) GO TO 180
      IF(ROTATE(J).EQ.2) GO TO 180
      IAREA(J,1)=7
  180 CONTINUE
      ROTAYR=1
      GO TO 200
  190 ROTAYR=2
  195 CONTINUE
C***  INITIALIZE VARIABLES
  200 IDISDA=0.0
      MAXVOL=0.0
      LKEVPT=0.0
      VOLIRR=0.0
      IF(NY.GT.1) MSTART=1
      IF(MOROT.EQ.2) GO TO 215
      WRITE(6,210)
  210 FORMAT('1',46X,'***** ANNUAL SUMMARY *****')
  215 CONTINUE
C
C
C          ***** ENTER MONTHLY LOOP *****
C
      DO 840  NM=MSTART,12
C
C***  ESTABLISH CROP ROTATIONS FOR WHEAT
      IF(MOROT.EQ.2) GO TO 235
      DO 230 II=1,NPLOTS
      IF(INCROP(II).NE.1) GO TO 230
      IF(ROTATE(II).EQ.2) GO TO 230
      IF(ROTAYR.EQ.2) GO TO 220
      IF(NM.GT.MGSEP(II)) IAREA(II,1)=7
      GO TO 230
  220 IF(NM.LT.MGSBP(II)) IAREA(II,1)=7
      IF(NM.GE.MGSBP(II)) IAREA(II,1)=INCROP(II)
  230 CONTINUE
      GO TO 240
C***  CALL SUBROUTINE ROTATN TO ESTABLISH ROTATION SYSTEM FOR MODEL TWO
C***  CROP MANAGEMENT
C***
  235 CALL ROTATN (NY,NM,MMAT,NDIM,KCROP,IAREA,NPLOTS,KROP,IPLAN,MSTART,
     1DSRATE,PAVLU,RCYCLE,NRCROP,DOUBLE,IYRCRP,AREA,IFALWT)
C***  READ MONTHLY METEOROLOGICAL DATA
  240 READ(1,250,END=1520) KAN,STINO,YEAR,MONTH,(PREC(I),I=1,31),
     1(TMAX(I),I=1,31),(TMIN(I),I=1,31)
  250 FORMAT(I2,I4,2I2,31F4.2,62F3.0)
      IF(STINO.NE.INOST) GO TO 240
      IF(YEAR.LT.YSTART-1900) GO TO 240
      IF(YEAR.GT.YEND-1900) GO TO 990
```

```
      SMGWZ(II)=6.30
   80 SMPO(II)=SMLZ(II)+SMUZ(II)
      YEARS=YEND-YSTART+1
C
      DSRATE=DSRATE/EFFIRR
C***  PRINT INPUT PARAMETERS
      WRITE(6,85)  NAME,OF,CITY,AND,STATE,YSTART,YEND,WEATH,MODIF,MOD,EL
     1,IN,FLOW,TO,STOR,AGE,POND,LTAREA,STORM,L,W,S,HMAX,VOLMAX,PSAREA,
     2DSEPRT,EFFIRR
   85 FORMAT('1',10X///////////10X,'STATION:',3X,5A4,10X,I4,'   TO   ',I4,
     1////10X,'MODEL:  ',4A4//18X,6A4//18X,'FEEDLOT AREA = ',F6.2,' ACRE
     2S'////10X,'SIZE OF CRITICAL EVENT:  ',F4.2////10X,'POND VARIABLES:
     3'//25X,'(A) BASE DIMENSION-- ',F7.2,' FEET BY',F7.2,' FEET'//25X,'
     4(B) SIDE SLOPE--    RUN:RISE = ',F3.0,' : 1'//25X,'(C) MAXIMUM DEPT
     5H--  ',F5.2,'  FEET'//25X,'(D) MAXIMUM POND VOLUME--  ',F9.2,' ACR
     6E-INCHES'//25X,'(E) DIRECT RECEIVING AREA (FOR PRECIPITATION) --
     7  ',F8.2,' ACRES'//25X,'(F) DAILY SEEPAGE RATE-- ',F10.5,' INCHES/
     8DAY'////10X,'AREA VARIABLES:')
      IF(MOROT.EQ.2) GO TO 135
      DO 130 J=1,NPLOTS
      PLAREA=AREA(J)
      CROP=IAREA(J,1)
      SOIL=IAREA(J,2)
      RPAVLU=PAVLU
      IF(IPLAN(J).EQ.1) PAVLU=0.0
      WRITE(6,90)  J,PLAREA,KROP(CROP),SOIL,DSRATE,PAVLU
   90 FORMAT(//15X,'PLOT ',I1//25X,'(A) AREA--  ',F6.2,'   ACRES'//25X,'
     1(B) CROP--  ',2A8//25X,'(C) SOIL TYPE--  ',I3,'  (SCS SOIL TYPE)'/
     2/25X,'(D) IRRIGATION RATE--  ',F5.2,'  INCHES/DAY '//25X,'(E) IRRI
     3GATION MANAGEMENT--   IRRIGATION BELOW  ',F5.2,'  FIELD CAPACITY')
      IF(IPLAN(J).EQ.1) WRITE(6,95)
      IF(IPLAN(J).EQ.2) WRITE(6,100)
      IF(IPLAN(J).EQ.3) WRITE(6,110)
   95 FORMAT(/25X,'(F) PLAN IMPLEMENTED--   RUNOFF')
  100 FORMAT(/25X,'(F) PLAN IMPLEMENTED--   RUNOFF AND IRRIGATION')
  110 FORMAT(/25X,'(F) PLAN IMPLEMENTED--   IRRIGATION')
      IF(ROTATE(J).EQ.1) WRITE(6,120)
  120 FORMAT(/25X,'(G) CROP ROTATION WITH --   FALLOW')
      PAVLU=RPAVLU
  130 CONTINUE
  135 CONTINUE
C
      DO 9000 KK=1,NPLOTS
      RRIJAN(KK)=0.
      RRIFEB(KK)=0.
      RRIMAR(KK)=0.
      RRIAPR(KK)=0.
      RRIMAY(KK)=0.
      RRIJUN(KK)=0.
      RRIJUL(KK)=0.
      RRIAUG(KK)=0.
      RRISEP(KK)=0.
      RRIOCT(KK)=0.
      RRINOV(KK)=0.
 9000 RRIDEC(KK)=0.
C
C         ***** ENTER YEARLY LOOP *****
C
      DO 980  NY=1,YEARS
C
```

```
      PET=((DELTA*RN)+(GAMMA*EA))/25.4
C
C***  CALCULATE LAKE AND BARE SOIL EVAPORATION
      RNSOIL=RN*((1.0-0.20)/(1.0-R))
      RNLAKE=RN*((1.0-0.05)/(1.0-R))
      PETBS=((DELTA*RNSOIL)+(GAMMA*EA))/25.4
      LAKEVP=((DELTA*RNLAKE)+(GAMMA*EALAKE))/25.4
      POT=TAVG(ND)
      IF(TAVG(ND).LT.20.0) PET=0.0
      IF(TAVG(ND).LT.20.0) PETBS=0.0
      IF(TAVG(ND).LT.20.0) LAKEVP=0.0
      DO 300 MQ=1,NPLOTS
      IAADD(MQ)=IAET(MQ)-PET
      CCROP=IAREA(MQ,1)
      IF(KCROP(CCROP,NM).EQ.0.0) IAADD(MQ)=IAET(MQ)-PETBS
      IF(IAADD(MQ).GT.0.1) IAADD(MQ)=0.1
      IF(IAADD(MQ).LT.0.0) IAADD(MQ)=0.0
  300 CONTINUE
C***  SUBROUTINE SNOWRT CALCULATES THE MOISTURE ADDED TO THE DISPOSAL
C***  SITE DUE TO SNOWMELT ON THE AREA
      PRECIP=PREC(ND)
      SNOVAP=0.0
      WATER=PRECIP
      CALL SNOWRT(PRECIP,WATER,PACK,PET,TAVG(ND),SNOVAP)
C
C
C     *** EVALUATION OF SOIL MOISTURE AND CALCULATION
C                   OF ACTUAL EVAPOTRANSPIRATION ***
C
      STRVOL=0.0
      RUNMOS=0.0
      JJ=0
      NNN=0
  330 NNN=NNN+1
      IF(NNN.GT.NPLOTS) GO TO 650
      STRNOF =0.0
      JJ=JJ+1
  340 CROP=IAREA(JJ,1)
      SOIL=IAREA(JJ,2)
      DSAREA=AREA(JJ)
      RAIN=WATER+DISVOL(JJ)/DSAREA
      IF(DISVOL(JJ).GT.0.0.AND.PRECIP.LT.0.4) GO TO 410
      IF(RAIN.LE.0.0) GO TO 400
C***  CALCULATE SURFACE RUNOFF VOLUME BY SCS METHOD
      IF(KCROP(CROP,NM).LE.0.0) GO TO 370
      IF(SMUZ(JJ).LT.(PWPUZ(SOIL)+0.5*AVLFCU(SOIL))) GO TO 350
      IF(SMUZ(JJ).GT.(PWPUZ(SOIL)+0.8*AVLFCU(SOIL))) GO TO 360
      GO TO 380
C***  MODIFY RUNOFF CURVE NUMBER TO CONDITION I ANTECEDENT MOISTURE
  350 RCM(SOIL,CROP)=RCN(SOIL,CROP)*0.39*EXP(0.009*RCN(SOIL,CROP))
      GO TO 390
C***  MODIFY RUNOFF CURVE NUMBER TO CONDITION III ANTECEDENT MOISTURE
  360 RCM(SOIL,CROP)=RCN(SOIL,CROP)*1.95*EXP(-0.00663*RCN(SOIL,CROP))
      GO TO 390
  370 IF(SMUZ(JJ).LT.0.6*FCU(SOIL)) GO TO 350
      IF(SMUZ(JJ).GT.0.9*FCU(SOIL)) GO TO 360
  380 RCM(SOIL,CROP)=RCN(SOIL,CROP)
  390 SI=1000.0/RCM(SOIL,CROP)-10.0
      ER=RAIN-0.2*SI
      IF(ER.LT.0.0) GO TO 410
```

```
      IF(SMLZ(JJ).LE.0.3*(AVLFCL(SOIL))+PWPLZ(SOIL)) GO TO 470
  500 IF(DARCEQ.EQ.1.0) GO TO 605
      IF(PERC-SMMAXU) 510,520,520
C
C***  EVALUATE SOIL MOISTURE
  510 SMUZ(JJ)=SMUZ(JJ)+PERC-AETUZ-EXCESS
      SMLZ(JJ)=SMLZ(JJ)-AETLZ+EXCESS
      GO TO 610
  520 SMUZ(JJ)=SMUZ(JJ)+SMMAXU-EXCESS-AETUZ
  530 SMMAXL=0.9*FCL(SOIL)-SMLZ(JJ)
      IF(PERCL+EXCESS-SMMAXL) 540,540,550
  540 SMLZ(JJ)=SMLZ(JJ)+PERCL-AETLZ+EXCESS
      GO TO 610
  550 SMLZ(JJ)=SMLZ(JJ)+SMMAXL-AETLZ
      DPERC=PERCL+EXCESS-SMMAXL
      GO TO 620
C***  CALCULATE EVAPORATION FROM BARE SOIL SURFACE(SEVAP) FOR MONTHS OCTOBER
C***  THROUGH MARCH OR WHEN THE DISPOSAL AREA IS FALLOW
  560 AETUZ=0.0
      AETLZ=0.0
      IF(PACK.GT.0.0) GO TO 590
      IF(SMUZ(JJ).LT.(FCU(SOIL)-U(SOIL))) GO TO 570
      EO(JJ)=FCU(SOIL)-SMUZ(JJ)
      IF(SMUZ(JJ).GE.FCU(SOIL)) EO(JJ)=0.0
C***  CALCULATE STAGE 1 SOIL EVAPORATION
      UZEVAP=PETBS
      EO(JJ)=EO(JJ)+UZEVAP
      IF(EO(JJ).GT.U(SOIL)) UZEVAP=EO(JJ)-U(SOIL)
      T(JJ)=0.0
      GO TO 580
C***  CALCULATE STAGE 2 SOIL EVAPORATION
  570 T(JJ)=T(JJ)+1
      UZEVAP=C(SOIL)*(T(JJ)**0.5)-C(SOIL)*((T(JJ)-1)**0.5)
  580 IF(UZEVAP.GT.(PETBS-IAET(JJ))) UZEVAP=PETBS-IAET(JJ)
      IF(UZEVAP.LT.0.0) UZEVAP=0.0
      IF(SMUZ(JJ)-PWPUZ(SOIL).LT.UZEVAP) UZEVAP=SMUZ(JJ)-PWPUZ(SOIL)
      GO TO 600
  590 UZEVAP=0.0
  600 IF(DARCEQ.EQ.1) PERC=0.0
      IF(DARCEQ.EQ.1) EXCESS=0.0
      SMUZ(JJ)=SMUZ(JJ)-UZEVAP+PERC-EXCESS
      IF(SMUZ(JJ).LE.PWPUZ(SOIL)) SMUZ(JJ)=PWPUZ(SOIL)
      IF(DARCEQ.EQ.2) GO TO 530
  605 SMUZ(JJ)=SMUZ(JJ)-AETUZ
      SMLZ(JJ)=SMLZ(JJ)-AETLZ
  610 IF(SMLZ(JJ).LT.PWPLZ(SOIL)) AETLZ=AETLZ-(PWPLZ(SOIL)-SMLZ(JJ))
      IF(SMLZ(JJ).LE.PWPLZ(SOIL)) SMLZ(JJ)=PWPLZ(SOIL)
      IF(DARCEQ.EQ.1) GO TO 620
      DPERC=SMLZ(JJ)-0.9*FCL(SOIL)
      IF(DPERC.LT.0.0) DPERC=0.0
      IF(SMLZ(JJ).GT.0.9*FCL(SOIL)) SMLZ(JJ)=0.9*FCL(SOIL)
  620 AETUZ=AETUZ+UZEVAP
C***  SM IS THE SOIL MOISTURE IN THE GROWING ZONE, IN INCHES
      SM(JJ)=SMUZ(JJ)+SMLZ(JJ)
      SMACCT(NM,9,JJ)=SM(JJ)
      IAET(JJ)=IA+IAADD(JJ)
      AETU(JJ)=AETUZ
      AETL(JJ)=AETLZ
      NDPERC(JJ)=DPERC
      NIA(JJ)=IA
```

```
      NRNOF(JJ)=RNOF
      IF (IPLAN(JJ).LE.2) STRNOF = RNOF
      STRVOL = STRVOL + STRNOF*AREA(JJ)
      GO TO 330
  650 CONTINUE
C
C
C          *** EVALUATION OF VOLUME USED AS IRRIGATION ***
C
C***  T1 IS THE PREVIOUS DAY'S AVERAGE TEMPERATURE, IN FAHRENHEIT
C***  DEGREES, T2 IS THE AVERAGE TEMPERATURE OF THE DAY TWO DAYS
C***  PRIOR TO TODAY
      VOLDIS=0.0
      JDISDA=0
      NCNT=0
      JEMPDA=0
      DO 675 MS=1,NPLOTS
      DISVOL(MS)=0.0
      IF(BYPASS.NE.1) GO TO 655
      MCROP=IAREA(MS,1)
      IF(KCROP(MCROP,NM).EQ.0.) GO TO 660
  655 CONTINUE
      IF(IPLAN(MS).EQ.1) GO TO 660
      THAWED=TAVG(ND)+T1+T2
      FREEZE=TAVG(ND)+T1
      T2=T1
      T1=TAVG(ND)
      IF(FREEZE.LT.64.0) FROZE=1
      IF(THAWED.GT.114.0) FROZE=0
C***  WHEN FROZE EQUALS 1 THE SOIL IS CONSIDERED TO BE FROZEN IT IS THAWED
C***  WHEN FROZE EQUALS 0
      IF(FROZE.EQ.1) GO TO 660
C***  SMUZ IS THE SOIL MOISTURE IN THE TOP 12 INCHES OVER EACH
C***  PLOT; AVLFCU IS THE AVAILABLE WATER CAPACITY OF THAT SOIL.
C***  IRRIGATION WILL NOT OCCUR ON DAYS THAT THE SOIL MOISTURE IS AT
C***  A LEVEL GREATER THAN THAT OF THE PERCENTAGE OF AVAILABLE WATER
C***  SPECIFIED BY THE VARIABLE PAVLU.
      SOIL=IAREA(MS,2)
      IF(SMUZ(MS).GT.(PAVLU*AVLFCU(SOIL))+PWPUZ(SOIL)) GO TO 660
      JDISDA=JDISDA+1
      NCNT=NCNT+1
      IF(PONVOL.LT.PCVMAX*VOLMAX) GO TO 660
      DISVOL(MS)=DSRATE*AREA(MS)
      CALL IRROPT(MS,ND,NDAYS,NM,PRECIP,AREA,DSRATE,MCROP,
     X            BYPASS,DISVOL,SMACCT)
C***  IF THE POND VOLUME IS LESS THAN THE VOLUME REQUIRED FOR ONE FULL
C***  DAY OF IRRIGATION, IT WILL BE ASSUMED THAT NO IRRIGATION WILL OCCUR
C***  ON THAT DAY.
      PONVOL=PONVOL-DISVOL(MS)
      IF(PONVOL.LT.PCVMAX*VOLMAX) JEMPDA=1
      IF(PONVOL.GT.0.0) GO TO 670
      DISVOL(MS)=DISVOL(MS)+PONVOL
      PONVOL=0.0
      GO TO 670
  660 DISVOL(MS)=0.0
  670 SMACCT(NM,3,MS)=SMACCT(NM,3,MS)+DISVOL(MS)/AREA(MS)
      VOLDIS=VOLDIS+DISVOL(MS)
      IF(DISVOL(MS).GT.0.0) DAYSDS(MS)=DAYSDS(MS)+1.0
  675 CONTINUE
      IF(NCNT.GT.0) IDISDA=IDISDA+JDISDA/NCNT
```

```
      RNOF=ER**2/(RAIN+0.8*SI)
      GO TO 420
C***  EVALUATE INTERCEPTION STORAGE
  400 RNOF=0.0
      IA=0.0
      GO TO 430
  410 RNOF=0.0
  420 IA=0.1
      IF(IA.GT.RAIN) IA=RAIN
      IF((IA+IAADD(JJ)).GE.0.1) IA=0.1-IAADD(JJ)
C
C***  EVALUATE INFILTRATION INTO THE UPPER ZONE
  430 PERC=RAIN-RNOF-IA
      UZEVAP=0.0
      IF(DARCEQ.EQ.2) GO TO 435
C***  SUBROUTINE DARCRT EVALUATES THE FLOW WITHIN THE SOIL PROFILE
C***  BY APPLYING THE ONE-DIMENSIONAL DARCY EQUATION
      CALL DARCRT(PERC,FCU(SOIL),SMUZ(JJ),FCL(SOIL),SMLZ(JJ),FCGW(SOIL),
     1SMGWZ(JJ),OPERC,CONDUZ(JJ),CONDLZ(JJ),CONDGW(JJ),HUZ(JJ),HLZ(JJ),H
     2GW(JJ),PWPUZ(SOIL),PWPLZ(SOIL),PWG(SOIL))
      GO TO 450
C***  CALCULATE PRESENT STORAGE AVAILABLE IN UPPER ZONE
  435 SMMAXU=0.9*SMSATU(SOIL)-SMUZ(JJ)
C***  EVALUATE WATER CASCADED TO LOWER ZONE FOR STORAGE
      PERCL=PERC-SMMAXU
      IF(PERC.GT.SMMAXU) PERC=SMMAXU
      IF(PERCL.LT.0.0) PERCL=0.0
      IF (SMUZ(JJ).GT.FCU(SOIL)) GO TO 440
      EXCESS=0.0
      GO TO 450
C***  EVALUATE GRAVITATIONAL WATER IN UPPER ZONE
  440 EXCESS=SMUZ(JJ)-FCU(SOIL)
C
C***  IF THE CROP IS DORMANT OR THE SOIL LIES FALLOW, SOIL
C***  EVAPORATION IS EVALUATED
  450 IF(KCROP(CROP,NM).LE.0.0) GO TO 560
      T(JJ)=0.0
C***  MODIFY PET BY THE PLANT CONSUMPTIVE USE COEFFICIENT
      AET=KCROP(CROP,NM)*PET
      IF(PET.LE.IAET(JJ)) AET=0.0
C***  CHECK WHETHER SOIL MOISTURE LIMITS AET FROM THE UPPER ZONE
      IF(SMUZ(JJ)-(0.3*(AVLFCU(SOIL))+PWPUZ(SOIL))) 460,460,490
C***  CALCUATE AET FROM THE UPPER ZONE WHEN LIMITED BY SOIL MOISTURE
  460 AVAILU=SMUZ(JJ)-PWPUZ(SOIL)
      IF(AVAILU.LE.0.0) AVAILU=0.0
      AETUZ=0.7*AET*(AVAILU/(0.3*AVLFCU(SOIL)))
C***  EVALUATE AVAILABLE WATER IN THE LOWER ZONE
      AVAILL=SMLZ(JJ)-PWPLZ(SOIL)
      IF(AVAILL.LE.0.0) AVAILL=0.0
C***  CHECK WHETHER SOIL MOISTURE LIMITS AET FROM THE LOWER ZONE
      IF(SMLZ(JJ)-(0.3*(AVLFCL(SOIL))+PWPLZ(SOIL))) 470,470,480
C***  CALCUATE AET FROM THE LOWER ZONE WHEN LIMITED BY SOIL MOISTURE
  470 AETLZ=0.3*AET*(AVAILL/(0.3*AVLFCL(SOIL)))
      GO TO 500
  480 AETLZ=AET-AETUZ
      GO TO 500
C***  EVALUATE AET FROM BOTH ZONES UNDER WET CONDITIONS
  490 AETUZ=0.7*AET
      AETLZ=0.3*AET
      AVAILL=SMLZ(JJ)-PWPLZ(SOIL)
```

```
C***   UPDATE DISPOSAL DAY ACCOUNT
       IF(VOLDIS.GT.0.0) DSDAY=DSDAY+1
C***   UPDATE DAYS NOT TO MEET IRRIGATION DEMAND
       JDAEMP=JDAEMP+JEMPDA
       IF(BYPASS.NE.1) GO TO 680
       RUNOFF=0.0
       GO TO 730
C***   SUBROUTINE STORAG CALCULATES ADDITIONAL LOADING TO THE STORAGE
C***   POND DUE TO FEEDLOT RUNOFF OR MUNICIPALITY DISPOSAL
  680  CALL STORAG(P1,P2,P3,PRECIP,SNOW,FROZE,MONTH,GROW,DORM,RUNOFF,MUND
      1IS(NM),RUNMDS)
C
C
C      *** CALCULATION OF SURFACE AREA AND DETERMINATION OF SURFACE
C              EVAPORATION FROM STORAGE FACILITY ***
C
C***   THE FOLLOWING CALCULATION EXPRESSES THE VOLUME OF WATER IN THE
C***   STORAGE FACILITY IN CUBIC FEET.
  730  IF(PONVOL.LE.0.0) GO TO 750
       V=PONVOL*3630
C*** THE FOLLOWING CALCULATIONS DETERMINE THE SURFACE AREA OF THE STORAGE
C***   FACILITY AS A FUNCTION OF STORAGE VOLUME.  AREA IS IN SQUARE FEET
C***   VOLUME IS IN CUBIC FEET.  THE STORAGE FACILITY IS SHAPED LIKE AN INVERTE
C***   FRUSTRUM OF A PYRAMID.  INPUT PARAMETERS TO SIZE THE FACILITY ARE LENGTH
C***   (L) OF THE BASE IN FEET, WIDTH OF THE BASE(W) IN FEET AND SLOPE OF
C***   THE POND DOES NOT LEAK.  INPUTS TO THE STORAGE WILL BE NATURAL
C***   INSIDE EMBANKMENTS GIVEN AS A RATIO OF RUN TO RIS(S).  IT IS ASSUMED
C***   RUNOFF, FEEDLOT RUNOFF, MUNICIPALITY DISPOSAL AND PRECIPITATICN.
C***   LOSSES FROM THE POND INCLUDE EVAPORATION AND DISPOSAL VOLUME.
C***   B2 IS THE AREA OF THE SURFACE LIQUID IN SQUARE FEET.
       HAPRX=(PONVOL/VOLMAX)*HMAX
  740  VC=A1*HAPRX+A2*HAPRX**2+A3*HAPRX**3
       DV=V-VC
       DVDH=A1+A4*HAPRX+A5*HAPRX**2
       H=HAPRX+DV/DVDH
       IF(ABS(H-HAPRX).LT.0.1) GO TO 750
       HAPRX=H
       GO TO 740
  750  IF (H.GT.HMAX) H=HMAX
       B2=(W+2.*S*H)*(L+2.*S*H)
       IF(FROZE.EQ.1) LAKEVP=0.0
       LKEVPT=LKEVPT+LAKEVP
       SEVAP=B2*(LAKEVP/12)
C***   SEVAP IS THE VOLUME OF WATER EXTRACTED FROM THE STORAGE FACILITY BY
C***   FREE SURFACE EVAPORATION.
       IF((SEVAP/3630).GT.PONVOL) SEVAP=PONVOL*3630
       PONVOL=PONVOL-(SEVAP/3630)
       IF(PONVOL.LE.0.0) PONVOL=0.0
C***   ESTIMATION OF SEEPAGE LOSS FROM THE STORAGE FACILITY
       CALL SEEPGE(B2,PONVOL,DASEEP,DSEPRT)
C
C***   THE VOLUMES OF CALCULATED RUNOFF, FEEDLOT RUNOFF, MUNICIPALITY
C***   DISPOSAL, AND PRECIPITATION FALLING ON THE FACILITY ARE ADDED
C***   TO THE VOLUME OF WATER IN THE STORAGE FACILITY (ACRE-IN).
       PONVOL=PONVOL+(RUNOFF*LTAREA)+(PRECIP*PSAREA)+STRVOL+RUNMDS
C***   THE VOLUME OF WATER REMAINING AT THE END OF THE DAY IS EXPRESSED
C***   IN ACRE-IN.
C
C***   THE FOLLOWING STATEMENTS DETERMINE WHETHER THE STORAGE FACILITY HAS
C***   OVERFLOWED AND IF SO, THE QUANTITY DISCHARGED
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      IF(NRNOF(KI).GT.0.0) CNTR=1.0
  790 IF(NRNOF(KI).GT.FREQ(II)) CTR(II,KI)=CTR(II,KI)+1.0
  795 IF(PREC(ND).GT.FREQ(II).AND.CNTR.EQ.1.0) CTPR(II)=CTPR(II)+1.0
      NPLOTS=IPLOT
  800 CONTINUE
C
C
C         ***** EXIT DAILY LOOP *****
C
C***  UPDATE ACCOUNTS
      PDACCT(NM,1)=AMONTH(NM)
      PDACCT(NM,2)=SMACCT(NM,2,1)*PSAREA
      PDACCT(NM,6)=DSDAY
      PDACCT(NM,7)=JDAEMP
      PDACCT(NM,8)=ACTIRR
      PDACCT(NM,14)=JDAFLO
      DO 810 J=2,14
      IF(J.EQ.13) GO TO 810
      PDACCT(13,J)=PDACCT(13,J)+PDACCT(NM,J)
  810 CONTINUE
      DO 830  MP=1,NPLOTS
      DO 820  J=2,8
  820 SMACCT(13,J,MP)=SMACCT(13,J,MP)+SMACCT(NM,J,MP)
      SMACCT(NM,1,MP)=AMONTH(NM)
  830 SMACCT(13,1,MP)=AMONTH(13)
      PDACCT(13,1)=AMONTH(13)
      VOLIRR=VOLIRR+ACTIRR
      CALL MTEMP(TMAV,TAVG,NDAYS,NM)
  840 CONTINUE
C
C
C         ***** EXIT MONTHLY LOOP *****
C
      SMACCT(13,9,MP)=SMACCT(12,9,MP)
      DSNOW=PACK-PACKPY
      PACKPY=PACK
      PCWW=((PDACCT(13,2)+PDACCT(13,3)+PDACCT(13,4)+PDACCT(13,5)-PDACCT(
     113,10)-PDACCT(13,11))/(PDACCT(13,2)+PDACCT(13,3)+PDACCT(13,4)+PDAC
     2CT(13,5)))*100.
      WASTWW=WASTWW+PCWW
      SEPSUM=SEPSUM+PDACCT(13,11)
      PONDRY=PONDRY+PDACCT(13,7)
      PDACCT(13,13)=PDACCT(12,13)
      DO 850  KT=1,NPLOTS
      DSRNFF(KT)=DSRNFF(KT)+SMACCT(13,5,KT)
      AINTER(KT)=AINTER(KT)+SMACCT(13,4,KT)
      AAETRS(KT)=AAETRS(KT)+SMACCT(13,7,KT)
      ACHSOM(KT)=ACHSOM(KT)+SMACCT(13,8,KT)
  850 DSPERC(KT)=DSPERC(KT)+SMACCT(13,6,KT)
      IRRSUM=IRRSUM+VOLIRR
      TPREC=TPREC+SMACCT(13,2,1)
      IF((YEAR+1900).EQ.YSTART) DRY=SMACCT(13,2,1)
      IF(SMACCT(13,2,1).GE.WET) WET=SMACCT(13,2,1)
      IF(SMACCT(13,2,1).LE.DRY) DRY=SMACCT(13,2,1)
C
C***  PRINT POND ACCOUNT
      IF(MPOFOM.EQ.1) GO TO 1850
      WRITE(6,860) YEAR
  860 FORMAT('0',27X,'      WATER ACCOUNT FOR STORAGE FACILITY (IN ACRE-
     1INCHES)          - 19',I2//4X,'------------------------------------
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     2-------------------------------------------------------------------
     3---------------------------'/23X,'INFLOWS',55X,'OUTFLOWS'/10X,'------
     4---------------------------',26X,'-----------------------------------
     5---------'/4X,'MONTH PRECIP. MUNICIPAL FEEDLOT RUNOFF IRR. DAYS/(PO
     6ND EMPTIED) IRR. VOL. SURFACE EVAP. DISCHARGE SEEPAGE VOL. CHANGE
     7HEIGHT'/4X,'----- ------- --------- ------- ----- --------- -----
     8------- --------- ----------- --------- ------- --------- ---
     9---------')
      WRITE(6,870)  ((PDACCT(I,K),K=1,13),I=1,13)
  870 FORMAT(5X,A4,F7.1,F10.1,2F8.1,F9.1,3X,'(',F8.1,2X,')',F10.1,F12.1,
     1F11.1,F10.1,F11.1,F8.1)
      GO TO 1890
 1850 CONTINUE
      WRITE(6,1860) YEAR
 1860 FORMAT('0',28X,'      WATER ACCOUNT FOR STORAGE FACILITY (IN ACRE-
     1INCHES)                  -- 19',I2//10X,'---------------------------
     2-------------------------------------------------------------------
     3----------------'/13X,'INFLOWS',40X,'OUTFLOWS'/9X,'-----------------'
     4,23X,'---------------------------------------------------'/2X,'MONTH  PR
     5ECIP.  RUNOFF  IRR. DAYS/(POND EMPTIED)  IRR. VOL.  SURFACE EVAP.
     6 DISCHARGE  SEEPAGE  VOL. CHANGE  HEIGHT  DISCH. DAYS')
      DO 1880 I=1,13
      JPDACT(I,6)=PDACCT(I,6)
      JPDACT(I,7)=PDACCT(I,7)
      JPDACT(I,14)=PDACCT(I,14)
      WRITE(6,1870) PDACCT(I,1),PDACCT(I,2),PDACCT(I,5),JPDACT(I,6),JPDA
     1CT(I,7),PDACCT(I,8),PDACCT(I,9),PDACCT(I,10),PDACCT(I,11),PDACCT(I
     2,12),PDACCT(I,13),JPDACT(I,14)
 1870 FORMAT(3X,A4,F7.1,F9.1,I9,'   /     (',I5,' )  ',F9.1,2F13.1,F10.1,
     1F12.1,F9.1,I9)
 1880 CONTINUE
 1890 CONTINUE
C
C***  PRINT SOIL MOISTURE ACCOUNTS
      DO 910  JM=1,NPLOTS
      IF(MOROT.EQ.1) CROP=IAREA(JM,1)
      IF(MOROT.EQ.2) CROP=IYRCPP(JM)
      SOIL=IAREA(JM,2)
      WRITE(6,880)  JM,KROP(CROP),SOIL,AREA(JM)
  880 FORMAT(////,60X,'PLOT NO.',I3,////,25X,'CROP---',2A8,5X,'SOIL TYPE-
     1-',I3,5X,'PLOT AREA---',F6.2,' ACRES')
      IF(MOROT.EQ.2.AND.DOUBLE(JM).EQ.2) WRITE(6,5680)
 5680 FORMAT(' ',30X,'DOUBLE CROPPING WITH WHEAT')
      WRITE(6,890)  YEAR
  890 FORMAT('0',35X,'WATER BALANCE (INCHES) IN THE PLOT AREA - 19',
     1I2/10X,'-----------------------------------------------------------
     2-------------------------------------------------------'/32X,
     3 'INPUTS',38X,'OUTPUTS'/21X,'-----------------------------',3X,    '
     4-----------------------------------------------------'/5X,'MONTH',
     53X,'PRECIPITATION',3X,'IRRIGATION',1X,'INTERCEPTION',4X,'RUNOFF',6
     6X,'PERCOLATION',5X,'AET',4X,'CHANGE IN SM',6X,'SM')
      WRITE(6,900)  ((SMACCT(I,K,JM),K=1,9),I=1,13)
  900 FORMAT(6X,A4,8F13.2)
  910 CONTINUE
      PCRDIS=100.-PCWW
      WRITE(6,920)  PCRDIS
  920 FORMAT('0',10X,'PERCENT OF RUNOFF DISCHARGED OUT OF POND=',F10.2)
      WRITE (6,930)  IDISDA
  930 FORMAT('0',10X,'POTENTIAL IRRIGABLE DAYS=',I4)
      WRITE(6,940)  PACK,DSNOW
```

```
      DSCHRG=0.0
      IF(PONVOL-VOLMAX)  780,780,760
  760 DSCHRG=PONVOL-VOLMAX
      JDAFLD=JDAFLD+1
      DSCVOL=DSCVOL+DSCHRG
C***  VOLUME CALCULATIONS TO INCREASE THE POND SIZE
      CONTRL = 1.0
      PCNTRL = CONTRL*100.0
      VOLCHG = CONTRL*PONVOL-VOLMAX+VOLCHG
      VOLMX1 = VOLMAX+VOLCHG
      VCB = 2.0 * S * HMAX
      VCC = ((4./3.)*S**2) - (VOLMX1*3630./HMAX)
      VCD = VCB**2 - (4.*VCC)
      VC1 = SQRT(VCD)
      DIM = (VC1-VCB)/2.0
      IF(MPOFOM.EQ.1) GO TO 775
      WRITE(6,770) NM,ND,YEAR,DSCHRG,VOLMX1,PCNTRL,DIM
  770 FORMAT(/,1X,I2,'/',I2,'/',I2,' - DISCHARGE OF ',F7.2,' ACRE-IN REQ
     2UIRES VOLUME OF ',F8.2,' ACRE-IN FOR ',F6.2,' % CONTROL WHERE L =
     2W = ',F8.2)
  775 CONTINUE
      PONVOL=VOLMAX
      IF(DSCHRG.GE.PEAK) PEAK=DSCHRG
      IF(YEAR.GT.PREVYR.OR.CM.LT.1.0) MM=MM+1
      PREVYR=YEAR
      CM=CM+1.0
  780 CONTINUE
C
C***  UPDATE SOIL MOISTURE ACCOUNT FOR EACH PLOT
      DO 785  KI=1,NPLOTS
      SMACCT(NM,2,KI)=SMACCT(NM,2,KI)+PRECIP
      SMACCT(NM,4,KI)=SMACCT(NM,4,KI)+NIA(KI)
      SMACCT(NM,5,KI)=SMACCT(NM,5,KI)+NRNOF(KI)
      SMACCT(NM,6,KI)=SMACCT(NM,6,KI)+NDPERC(KI)
      SMACCT(NM,7,KI)=SMACCT(NM,7,KI)+AETU(KI)+AETL(KI)+SNOVAP
      SMACCT(NM,8,KI)=SMACCT(NM,8,KI)+SM(KI)-SMPD(KI)
      SMACCT(NM,9,KI)=SM(KI)
  785 SMPD(KI)=SM(KI)
C
C***  UPDATE POND ACCOUNT
      ACTIRR=ACTIRR+VOLDIS
      PDACCT(NM,3)=PDACCT(NM,3)+RUNMOS
      PDACCT(NM,4)=PDACCT(NM,4)+RUNOFF*LTAREA
      PDACCT(NM,5)=PDACCT(NM,5)+STRVOL
      PDACCT(NM,9)=PDACCT(NM,9)+SEVAP/3630
      PDACCT(NM,10)=PDACCT(NM,10)+DSCHRG
      PDACCT(NM,11)=PDACCT(NM,11)+DASEEP
      PDACCT(NM,12)=PDACCT(NM,12)+(PONVOL-PDVOL)
      IF(ND.EQ.NDAYS) PDACCT(NM,13)=H
      PDVOL=PONVOL
      IF(PONVOL.GT.MAXVOL) MAXVOL=PONVOL
C***  STATISTICAL PRECIPITATION AND RUNOFF FREQUENCY DATA
      IF(PREC(ND).GT.0.0) CTPDAY = CTPDAY+1.0
      IPLOT=NPLOTS
      IF(NPLOTS.GT.4) NPLOTS=4
      DO 795 II=1,25
      IF(PREC(ND).GT.FREQ(II))CTP(II)=CTP(II)+1.0
      CNTR=0.0
      DO 790 KI=1,NPLOTS
      IF(NRNOF(KI).GT.0.0.AND.II.EQ.1) CTRDAY(KI)=CTRDAY(KI)+1.0
```

```
  940 FORMAT('0',10X,'PACK ON DECEMBER 31 =',F5.2,15X,
     1'CHANGE IN SNOW STORAGE=',F5.2)
      WRITE(6,950)
  950 FORMAT('0',10X,'INPUTS-OUTPUTS-CHANGE IN SNOW STORAGE=CHANGE IN
     1SOIL MOISTURE')
      MAXVOL=MAXVOL*100.0/VOLMAX
      WRITE(6,960)  MAXVOL
  960 FORMAT('0',10X,'PERCENT OF MAXIMUM POND VOLUME REQUIRED =',F7.2)
      EVAPLK=EVAPLK+LKEVPT
      WRITE(6,970)  LKEVPT
  970 FORMAT('0',10X,'ESTIMATED LAKE EVAPCRATION, INCHES =',F6.2)
      DO 7000 KK=1,NPLOTS
      IF(IPLAN(KK).EQ.1.OR.DSRATE.EQ.0.) GO TO 7000
      RRIJAN(KK)=RRIJAN(KK)+SMACCT(1,3,KK)
      RRIFEB(KK)=RRIFEB(KK)+SMACCT(2,3,KK)
      RRIMAR(KK)=RRIMAR(KK)+SMACCT(3,3,KK)
      RRIAPR(KK)=RRIAPR(KK)+SMACCT(4,3,KK)
      RRIMAY(KK)=RRIMAY(KK)+SMACCT(5,3,KK)
      RRIJUN(KK)=RRIJUN(KK)+SMACCT(6,3,KK)
      RRIJUL(KK)=RRIJUL(KK)+SMACCT(7,3,KK)
      RRIAUG(KK)=RRIAUG(KK)+SMACCT(8,3,KK)
      RRISEP(KK)=RRISEP(KK)+SMACCT(9,3,KK)
      RRIOCT(KK)=RRIOCT(KK)+SMACCT(10,3,KK)
      RRINOV(KK)=RRINOV(KK)+SMACCT(11,3,KK)
 7000 RRIDEC(KK)=RRIDEC(KK)+SMACCT(12,3,KK)
  980 CONTINUE
C
C
C         ***** EXIT YEARLY LOOP *****
C
  990 CONTINUE
 1520 CONTINUE
C***  CALCULATE AVERAGE ANNUAL VALUES
      EVAP=EVAPLK/YEARS
      CMNEW=CM
      IF(MM.EQ.0)  MM=1
      COUNT=CM/MM
      IF(COUNT.EQ.0.0) MM=0
      IF(CM.EQ.0.0) CM=YEARS
      DSCRG=DSCVOL/CM
      CM=CMNEW
      CONTRL=WASTWW/YEARS
      IRRVOL=IRRSUM/YEARS
      APREC=TPREC/YEARS
      AVPDRY=PONDRY/YEARS
      AVSEEP=SEPSUM/YEARS
      RANGE=WET-DRY
      AVGMD=EVAP-APREC
      DO 1000 J=1,NPLOTS
      DSPERC(J)=DSPERC(J)/YEARS
      DSRNFF(J)=DSRNFF(J)/YEARS
      ACHSOM(J)=ACHSOM(J)/YEARS
      AINTER(J)=AINTER(J)/YEARS
      AAETRS(J)=AAETRS(J)/YEARS
 1000 DAYSDS(J)=DAYSDS(J)/YEARS
      IF(NPLOTS.GT.4) NPLOTS=4
      DO 1020 J=1,25
      PRECAC(J,3)=CTP(J)
      IF(CTPDAY.GT.0.0) CTP(J)=CTP(J)/CTPDAY*100.0
      PRECAC(J,1)=ASTAT(J)
```

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 5267 FORMAT(/25X,'(B) CROP--   ',14A8)
      WRITE(6,5268) SOIL,DSRATE,PAVLU
 5268 FORMAT(/25X,'(C) SOIL TYPE--  ',I3,'  (SCS SOIL TYPE)'//25X,'(D) I
     1IRRIGATION RATE--  ',F5.2,'  INCHES/DAY '//25X,'(E) IRRIGATION MANA
     2GEMENT--   IRRIGATION BELOW  ',F5.2,'  FIELD CAPACITY')
      IF(IPLAN(J).EQ.1) WRITE(6,5270)
      IF(IPLAN(J).EQ.2) WRITE(6,5280)
      IF(IPLAN(J).EQ.3) WRITE(6,5290)
 5270 FORMAT(/25X,'(F) PLAN IMPLEMENTED--    RUNOFF')
 5280 FORMAT(/25X,'(F) PLAN IMPLEMENTED--    RUNOFF AND IRRIGATION')
      IF(RCYCLE(J).EQ.1) WRITE(6,5300)
 5300 FORMAT(/25X,'(G) CROP MANAGEMENT--    NO CROP ROTATION')
 5290 FORMAT(/25X,'(F) PLAN IMPLEMENTED--    IRRIGATION')
      IF(RCYCLE(J).GE.2) WRITE(6,5310) NR
 5310 FORMAT(/25X,'(G) CROP MANAGEMENT--    CROP ROTATION WITH ** ',I1,'
     1YEAR REPETITION')
      IF(DOUBLE(J).EQ.1) WRITE(6,5325)
      IF(DOUBLE(J).EQ.2) WRITE(6,5320)
 5320 FORMAT(/25X,'(H) DOUBLE CROPPING MANAGEMENT WITH WINTER WHEAT BETW
     1EEN CROPS MENTIONED IN PART (B)')
 5325 FORMAT(/25X,'(H) SINGLE CROPPING MANAGEMENT')
      PAVLU=RPAVLU
 5330 CONTINUE
 1095 CONTINUE
C
C***  PRINT FINAL SUMMARY
      WRITE(6,1090)
 1090 FORMAT(////,47X,'***** FINAL SUMMARY *****')
      WRITE(6,1100)
 1100 FORMAT('0',10X,'METEOROLOGICAL SUMMARY')
      WRITE(6,1110) EVAP
 1110 FORMAT('0',25X,'AVERAGE ANNUAL LAKE EVAPORATION=',F6.2,' INCHES')
      WRITE(6,1120) APREC
 1120 FORMAT('0',25X,'AVERAGE ANNUAL PRECIPITATION=',F6.2,' INCHES')
      WRITE(6,1130) RANGE,DRY,WET
 1130 FORMAT('0',25X,'PRECIPITATION RANGE=',F6.2,' INCHES   (FROM A LOW
     1OF',F6.2,' INCHES  TO A HIGH OF ',F6.2,' INCHES)')
      WRITE(6,1140) AVGMD
 1140 FORMAT('0',25X,'AVERAGE ANNUAL MOISTURE DEFICIT=',F6.2,' INCHES')
      WRITE(6,1150)
 1150 FORMAT('0',10X,'SUMMARY OF POND OPERATIONS')
      WRITE(6,1160) MM
 1160 FORMAT('0',25X,'NO. OF YEARS HAVING A DISCHARGE=',I6)
      WRITE(6,1170) COUNT
 1170 FORMAT('0',25X,'AVERAGE NO. OF DISCHARGES / YEAR HAVING A DISCHARG
     1E=',F6.2)
      WRITE(6,1180) DSCRG
 1180 FORMAT('0',25X,'AVERAGE DISCHARGE=',F6.2,1X,'ACRE-INCHES')
      WRITE(6,1190) CONTRL
 1190 FORMAT('0',25X,'AVERAGE PERCENT OF DISCHARGE CONTROLLED BY EVAPORA
     1TION AND IRRIGATION=',F6.2)
      WRITE(6,1200) DSCVOL
 1200 FORMAT('0',25X,'TOTAL DISCHARGE VOLUME=',F9.2,' ACRE-INCHES')
      WRITE(6,1210) CM
 1210 FORMAT('0',25X,'TOTAL NO. OF DISCHARGES=',F4.0)
      WRITE(6,1220) PEAK
 1220 FORMAT('0',25X,'MAXIMUM DISCHARGE=',F12.2,' ACRE-INCHES')
      WRITE(6,1230) IRRVOL
 1230 FORMAT('0',25X,'AVERAGE ANNUAL VOLUME OF IRRIGATED WATER TO THE FI
     1ELD=',F8.2,' ACRE-INCHES')
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      WRITE(6,1235) AVSEEP
 1235 FORMAT('0',25X,'AVERAGE ANNUAL VOLUME OF SEEPAGE LOSS=',F10.2,' AC
     1RE-INCHES')
      WRITE(6,1236) AVPDRY
 1236 FORMAT('0',25X,'AVERAGE NO. OF DAYS NOT TO MEET IRRIGATION DEMAND=
     1',F6.1)
      WRITE(6,1240)
 1240 FORMAT('0',10X,'SUMMARY OF IRRIGATION PLOTS')
      DO 1320 J=1,NPLOTS
      WRITE(6,1250) J
 1250 FORMAT('0',15X,'PLOT ',I1)
      WRITE(6,1260) DSRNFF(J)
 1260 FORMAT('0',25X,'AVERAGE ANNUAL IRRIGATION AREA RUNOFF=',F6.2,' INC
     1HES')
      WRITE(6,1270) DSPERC(J)
 1270 FORMAT('0',25X,'AVERAGE ANNUAL IRRIGATION AREA PERCOLATION=',F6.2,
     1' INCHES')
      WRITE(6,1280) DAYSDS(J)
 1280 FORMAT('0',25X,'AVERAGE ANNUAL NO. OF IRRIGATION DAYS=',F6.1)
      WRITE(6,1290) AINTER(J)
 1290 FORMAT('0',25X,'AVERAGE ANNUAL IRRIGATION AREA INTERCEPTION=',F6.2
     1,' INCHES')
      WRITE(6,1300) AAETRS(J)
 1300 FORMAT('0',25X,'AVERAGE ANNUAL IRRIGATION AREA EVAPOTRANSPIRATION=
     1',F6.2,' INCHES')
      WRITE(6,1310) ACHSCM(J)
 1310 FORMAT('0',25X,'AVERAGE ANNUAL IRRIGATION AREA CHANGE IN SOIL MOIS
     1TURE=',F6.2,' INCHES')
      IF(IPLAN(J).LT.2) GO TO 1320
      RIRRIG(J)=DSRATE*DAYSDS(J)
      WRITE(6,1315) RIRRIG(J)
 1315 FORMAT('0',25X,'AVERAGE ANNUAL WATER VOLUME APPLIED TO THE IRRIGAT
     1ION AREA=',F6.2,'INCHES')
 1320 CONTINUE
      WRITE(6,1330)
 1330 FORMAT('0',10X,'SUMMARY OF STATISTICAL DATA')
      WRITE(6,1340)
 1340 FORMAT('0',41X,'PRECIPITATION FREQUENCY DATA',//27X,'INTENSITY',5X
     1,'FREQUENCY',5X,'FREQUENCY',5X,'RUNOFF FREQ.',/29X,'(IN.)',10X,'(%
     2)',9X,'(DAYS)',10X,'(DAYS)',/)
      WRITE(6,1350)((PRECAC(I,J),J=1,4),I=1,25)
 1350 FORMAT(29X,A4,3F15.2)
      WRITE(6,1360)
 1360 FORMAT('0',///60X,'RUNOFF FREQUENCY DATA',//27X,'INTENSITY',15X,'F
     1REQUENCY (%)',26X,'FREQUENCY (DAYS)',/29X,'(IN.)',7X,'PLOT 1    PLO
     3T 2    PLOT 3    PLOT 4',8X,'PLOT 1    PLOT 2    PLOT 3    PLOT 4',/)
      WRITE(6,1370)((RUNACC(I,J),J=1,9),I=1,25)
 1370 FORMAT(29X,A4,5X,4F9.2,4X,4F9.2)
      DO 3000 I=1,NPLOTS
      IF(IPLAN(I).EQ.1.OR.DSRATE.EQ.0.) GO TO 3000
      RRI1(I)=RRIJAN(I)/YEARS
      RRI2(I)=RRIFEB(I)/YEARS
      RRI3(I)=RRIMAR(I)/YEARS
      RRI4(I)=RRIAPR(I)/YEARS
      RRI5(I)=RRIMAY(I)/YEARS
      RRI6(I)=RRIJUN(I)/YEARS
      RRI7(I)=RRIJUL(I)/YEARS
      RRI8(I)=RRIAUG(I)/YEARS
      RRI9(I)=RRISEP(I)/YEARS
      RRI10(I)=RRIOCT(I)/YEARS
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```
      PRECAC(J,2)=CTP(J)
      PRECAC(J,4)=CTPR(J)
      DO 1010 I=1,NPLOTS
      INUM1=5+I
      RUNACC(J,INUM1)=CTR(J,I)
      IF(CTRDAY(I).GT.0.0) CTR(J,I)=CTR(J,I)/CTRDAY(I)*100.0
      INUM=I+1
 1010 RUNACC(J,INUM)=CTR(J,I)
 1020 RUNACC(J,1)=ASTAT(J)
      NPLOTS=IPLOT
C
C***  PRINT INPUT PARAMETERS
      WRITE(6,85)   NAME,OF,CITY,AND,STATE,YSTART,YEND,WEATH,MODIF,MOD,EL
     1,IN,FLOW,TO,STOR,AGE,POND,LTAREA,STORM,L,W,S,HMAX,VOLMAX,PSAREA,
     2DSEPRT
      IF(MOROT.EQ.2) GO TO 1085
      DO 1080 J=1,NPLOTS
      CROP=INCROP(J)
      PLAREA=AREA(J)
      SOIL=IAREA(J,2)
      RPAVLU=PAVLU
      IF(IPLAN(J).EQ.1) PAVLU=0.0
      WRITE(6,1030)J,PLAREA,KROP(CROP),SOIL,DSRATE,PAVLU
 1030 FORMAT(//15X,'PLOT ',I1//25X,'(A) AREA--   ',F6.2,'   ACRES'//25X,'
     1(B) CROP--   ',2A8//25X,'(C) SOIL TYPE--   ',I3,'  (SCS SOIL TYPE)'/
     2/25X,'(D) IRRIGATION RATE--   ',F5.2,'  INCHES/DAY '//25X,'(E) IRRI
     3GATION MANAGEMENT --    IRRIGATION BELOW  ',F5.2,'  FIELD CAPACITY')
      IF(IPLAN(J).EQ.1) WRITE(6,1040)
      IF(IPLAN(J).EQ.2) WRITE(6,1050)
      IF(IPLAN(J).EQ.3) WRITE(6,1060)
 1040 FORMAT(/25X,'(F) PLAN IMPLEMENTED--    RUNOFF')
 1050 FORMAT(/25X,'(F) PLAN IMPLEMENTED--    RUNOFF AND IRRIGATION')
 1060 FORMAT(/25X,'(F) PLAN IMPLEMENTED--    IRRIGATION')
      IF(ROTATE(J).EQ.1) WRITE(6,1070)
 1070 FORMAT(/25X,'(G) CROP ROTATION WITH --    FALLOW')
      PAVLU=RPAVLU
 1080 CONTINUE
      GO TO 1095
 1085 CONTINUE
      DO 5330 J=1,NPLOTS
      PLAREA=AREA(J)
      SOIL=IAREA(J,2)
      RPAVLU=PAVLU
      IF(IPLAN(J).EQ.1) PAVLU=0.0
      NR=RCYCLE(J)
      WRITE(6,5260) J,PLAREA
 5260 FORMAT(//15X,'PLOT ',I1//25X,'(A) AREA--   ',F6.2,'   ACRES')
      IF(NR.EQ.1) WRITE(6,5261) KROP(NRCROP(J,1))
      IF(NR.EQ.2) WRITE(6,5262) (KROP(NRCROP(J,K)),K=1,2)
      IF(NR.EQ.3) WRITE(6,5263) (KROP(NRCROP(J,K)),K=1,3)
      IF(NR.EQ.4) WRITE(6,5264) (KROP(NRCROP(J,K)),K=1,4)
      IF(NR.EQ.5) WRITE(6,5265) (KROP(NRCROP(J,K)),K=1,5)
      IF(NR.EQ.6) WRITE(6,5266) (KROP(NRCROP(J,K)),K=1,6)
      IF(NR.EQ.7) WRITE(6,5267) (KROP(NRCROP(J,K)),K=1,7)
 5261 FORMAT(/25X,'(B) CROP--    ',2A8)
 5262 FORMAT(/25X,'(B) CROP--    ',4A8)
 5263 FORMAT(/25X,'(B) CROP--    ',6A8)
 5264 FORMAT(/25X,'(B) CROP--    ',8A8)
 5265 FORMAT(/25X,'(B) CROP--    ',10A8)
 5266 FORMAT(/25X,'(B) CROP--    ',12A8)
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```
      RRI11(I)=RRINOV(I)/YEARS
      RRI12(I)=RRIDEC(I)/YEARS
 3000 CONTINUE
      WRITE(6,1380)
 1380 FORMAT('0',10X,'SUMMARY OF MONTHLY DISTRIBUTION OF IRRIGATION (INC
     1HES)')
      WRITE(6,1390)
 1390 FORMAT(10X,'--------------------------------------------------------
     1---------------------------------------------------------')
      WRITE(6,1400) (AMONTH(I),I=1,12)
 1400 FORMAT(10X,12(6X,A4))
      DO 1420 K=1,NPLOTS
      IF(IPLAN(K).EQ.1.OR.DSRATE.EQ.0.) GO TO 1420
      WRITE(6,1410) K,RRI1(K),RRI2(K),RRI3(K),RRI4(K),RRI5(K),RRI6(K),
     1RRI7(K),RRI8(K),RRI9(K),RRI10(K),RRI11(K),RRI12(K)
 1410 FORMAT(8X,'PLOT=',I1,11(F6.2,4X),F6.2)
 1420 CONTINUE
      STOP
      END
      SUBROUTINE ROTATN (NY,NM,MMAT,NDIM,KCROP,IAREA,NPLOTS,KROP,IPLAN,
     1MSTART,DSRATE,PAVLU,RCYCLE,NRCROP,DOUBLE,IYRCRP,AREA,IFALWT)
      INTEGER DGSB,DGSE,DGSBW,DGSEW,SOIL
      INTEGER RCYCLE(9),DOUBLE(9),CROP,DGSBP(9,9),DGSEP(9,9)
      REAL MMAT(12),KCROP(7,12),AREA(9)
      DIMENSION MGSBP(9,9),MGSEP(9,9),NDIM(12),IAREA(9,2),IYRCRP(9)
      DIMENSION IWHT(9,50),IWT(9,50),ITEMP(9,9,50),NRCROP(9,50),IFALWT(9
     1),IPLAN(9)
      COMPLEX*16 KROP*16(7)
C***  SUBROUTINE ROTATN IS USED TO DETERMINE CROPPING MANAGEMENT.
C***  ONE: FOR SINGLE-CROPPING, A SAME SORT OF CROP MAY BE ASSIGNED TO
C***       A SPECIFIC FARM PLOT CONTINUOUSLY THROUGH SIMULATION PERIOD,
C***       OR A CERTAIN SET OF DIFFERENT CROPS WITH A SPECIFIED ROTATING
C***       CYCLE UP TO SEVEN-YEAR TERM OR MORE CAN BE MANAGED ON A PLOT.
C***  TWO: FOR DOUBLE-CROPPING, THREE CROPS IN TWO YEARS CAN BE GROWN
C***       ON A PLOT,COMBINING WITH WINTER WHEAT; EX;WHEAT-CORN-FALLOW-
C***       SORGHUM,OR FALLOW-SOY BEAN-WHEAT-SORGHUM,ETC.
C***  PARTICULARLY, IT IS POSSIBLE TO GROW ONE CROP FOR EACH YEAR FOR
C***       THE FIRST THREE YEARS AND THEN THE OTHER CROP FOR THE NEXT TWO YEARS.
C***  NRCROP= CROP NAME FOR DATA INPUTS
C***  IYRCRP= NAME OF CROP DEFINED YEARLY
C***  IAREA(I,1)= CROP NAME DEFINED MONTHLY FOR SUBROUTINE ROTATN
C***  DGSBW= DAY GROWING SEASON BEGINS FOR WHEAT
C***  DGSEW= DAY GROWING SEASON ENDS FOR WHEAT
C***  RCYCLE= REQUIRED YEARS OF ROTATING CROPS ON A PLOT
C***  DOUBLE= DOUBLE CROPPING WITH WHEAT AND SOME CROP,RESERVING FALLOW
C***  TERM
C***  IWHT= TEMPORARY STORAGE FOR WHEAT OR FALLOW FOR DOUBLE CROPPING
C***  IWT = TEMPORARY STORAGE FOR WHEAT OR FALLOW FOR DOUBLE CROPPING
C***  IFALWT= IN THE FIRST YEAR OF SIMULATION, BEGIN WITH WHEAT?
C***          OR FALLOW ?
      IF(NM.GT.MSTART.OR.NY.GT.1) GO TO 110
C***  CAUTION::: IN ADDITION TO CROP TYPES,DOUBLE CROPPING,OR NOT
C***  AND ROTATION CYCLE, USERS MUST INPUT SOIL TYPE,IRRIGATION
C***  MANAGEMENT,AND AREA OF EACH PLOT
      READ(5,10) (RCYCLE(I),DOUBLE(I),IFALWT(I),IPLAN(I),IAREA(I,2),AREA
     1(I),I=1,NPLOTS)
   10 FORMAT(2X,5I2,F6.1)
C***  READ TYPES OF CROP,PLANTING AND HARVESTING DATE
      DO 40 J=1,NPLOTS
      MMM=RCYCLE(J)
```

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  170 IWHT(I,NY)=7
      IWT(I,NY)=1
      GO TO 220
  180 IWHT(I,NY)=IWHT(I,NY-2)
      IWT(I,NY)=IWT(I,NY-2)
      GO TO 220
C***  BEGINNING WITH FALLOW
  190 IF(NY.EQ.1) GO TO 200
      IF(NY.EQ.2) GO TO 210
      IF(NY.GE.3) GO TO 215
  200 IWHT(I,NY)=7
      IWT(I,NY)=1
      GO TO 220
  210 IWHT(I,NY)=1
      IWT(I,NY)=7
      GO TO 220
  215 IWHT(I,NY)=IWHT(I,NY-2)
      IWT(I,NY)=IWT(I,NY-2)
      GO TO 220
  220 CONTINUE
      IF(NM.LT.MGSBP(I,J)) IAREA(I,1)=IWHT(I,NY)
      IF(NM.GT.MGSEP(I,J)) IAREA(I,1)=IWT(I,NY)
      IF(NM.GE.MGSBP(I,J).AND.NM.LE.MGSEP(I,J)) GO TO 230
      GO TO 240
  230 IYRCRP(I)=ITEMP(I,MMM,NY)
      IAREA(I,1)=IYRCRP(I)
  240 CONTINUE
  250 CONTINUE
C
C***  PRINT DISPOSAL AREA VARIABLES
C
      IF(NM.GT.MSTART.OR.NY.GT.1) GO TO 340
      DO 330 J=1,NPLOTS
      PLAREA=AREA(J)
      SOIL=IAREA(J,2)
      RPAVLU=PAVLU
      IF(IPLAN(J).EQ.1) PAVLU=0.0
      NR=RCYCLE(J)
      WRITE(6,260) J,PLAREA
  260 FORMAT(//15X,'PLOT ',I1//25X,'(A) AREA--    ',F6.2,'    ACRES')
      IF(NR.EQ.1) WRITE(6,261) KROP(NRCROP(J,1))
      IF(NR.EQ.2) WRITE(6,262) (KROP(NRCROP(J,K)),K=1,2)
      IF(NR.EQ.3) WRITE(6,263) (KROP(NRCROP(J,K)),K=1,3)
      IF(NR.EQ.4) WRITE(6,264) (KROP(NRCROP(J,K)),K=1,4)
      IF(NR.EQ.5) WRITE(6,265) (KROP(NRCROP(J,K)),K=1,5)
      IF(NR.EQ.6) WRITE(6,266) (KROP(NRCROP(J,K)),K=1,6)
      IF(NR.EQ.7) WRITE(6,267) (KROP(NRCROP(J,K)),K=1,7)
  261 FORMAT(/25X,'(B) CROP--    ',2A8)
  262 FORMAT(/25X,'(B) CROP--    ',4A8)
  263 FORMAT(/25X,'(B) CROP--    ',6A8)
  264 FORMAT(/25X,'(B) CROP--    ',8A8)
  265 FORMAT(/25X,'(B) CROP--    ',10A8)
  266 FORMAT(/25X,'(B) CROP--    ',12A8)
  267 FORMAT(/25X,'(B) CROP--    ',14A8)
      WRITE(6,268) SOIL,DSRATE,PAVLU
  268 FORMAT(/25X,'(C) SOIL TYPE--   ',I3,'   (SCS SOIL TYPE)'//25X,'(D) I
     1RRIGATION RATE--   ',F5.2,'  INCHES/DAY '//25X,'(E) IRRIGATION MANA
     2GEMENT--    IRRIGATION BELOW   ',F5.2,'  FIELD CAPACITY')
      IF(IPLAN(J).EQ.1) WRITE(6,270)
      IF(IPLAN(J).EQ.2) WRITE(6,280)
```

```
      IF(IPLAN(J).EQ.3) WRITE(6,290)
  270 FORMAT(/25X,'(F) PLAN IMPLEMENTED--     RUNOFF')
  280 FORMAT(/25X,'(F) PLAN IMPLEMENTED--     RUNOFF AND IRRIGATION')
  290 FORMAT(/25X,'(F) PLAN IMPLEMENTED--     IRRIGATION')
      IF(RCYCLE(J).EQ.1) WRITE(6,300)
  300 FORMAT(/25X,'(G) CROP MANAGEMENT--     NO CROP ROTATION')
      IF(RCYCLE(J).GE.2) WRITE(6,310) NR
  310 FORMAT(/25X,'(G) CROP MANAGEMENT--     CROP ROTATION WITH ** ',I1,'
     1YEAR REPETITION')
      IF(DOUBLE(J).EQ.1) WRITE(6,325)
      IF(DOUBLE(J).EQ.2) WRITE(6,320)
  320 FORMAT(/25X,'(H) DOUBLE CROPPING MANAGEMENT WITH WINTER WHEAT BETW
     1EEN CROPS MENTIONED IN PART (B)')
      IF(DOUBLE(J).EQ.2.AND.IFALWT(J).EQ.1) WRITE(6,360)
      IF(DOUBLE(J).EQ.2.AND.IFALWT(J).EQ.2) WRITE(6,370)
  370 FORMAT(/25X,'(I) SEQUENCE OF DOUBLE-CROPPING : FALLOW--SUMMER CROP
     1--WINTER WHEAT--SUMMER CROP--AGAIN FALLOW')
  360 FORMAT(/25X,'(I) SEQUENCE OF DOUBLE-CROPPING ; WINTER WHEAT--SUMME
     1R CROP--FALLOW--SUMMER CROP--AGAIN WHEAT')
  325 FORMAT(/25X,'(H) SINGLE CROPPING MANAGEMENT')
      PAVLU=RPAVLU
  330 CONTINUE
  340 CONTINUE
      IF(NM.EQ.MSTART) WRITE(6,350)
  350 FORMAT('1',46X,'**** ANNUAL SUMMARY ****')
      RETURN
      END
      SUBROUTINE CROPCO (CROP,MGSB,DGSB,MGSE,DGSE,KCROP,NDIM,MMAT)
C***  SUBROUTINE CROPCO CALCULATES THE CROP COEFFICIENTS FOR USE IN
C***  THE MAIN PROGRAM.  THE CROP COEFFICIENTS ARE CALCULATED BY THE
C***  PRUCEDURES OUTLINED IN THECHNICAL RELEASE NO 21, IRRIGATION
C***  WATER REQUIREMENTS, UNITED STATES DEPARTMENT OF AGRICULTURE,
C***  SOIL CONSERVATION SERVICE, ENGINEERING DIVISION, APRIL 1967.
C***  SLIGHT MODIFICATIONS HAVE BEEN MADE FOR ADAPTAION TO THE MODEL.
C***  EQUATIONS FOR THE CROP GROWTH STAGE COEFFICIENT CURVES WERE
C***  DEVELOPED WHICH ELIMINATES THE NECESSITY OF READING THE VALUES
C***  FROM THE CURVES.  INPUTS TO THE SUBROUTINE INCLUDE THE CROP,
C***  MONTH AND DAY GROWING BEGINS AND ENDS, NUMBER OF DAYS IN EACH
C***  MONTH, AND THE MEAN MONTHLY AVERAGE TEMPERATURES IN FAHRENHEIT
C***  DEGREES.
      INTEGER CROP,DGSB,DGSE
      INTEGER NDIM(12),SHIFT
      REAL MID(12),DBMD(12),ACC(12),PCGS(12)
      REAL MMAT(12),KT(12),KCROP(7,12),PCGS1(12)
      DO 65 M=1,12
      MID(M)=0.0
      ACC(M)=0.0
      DBMD(M)=0.0
      PCGS(M)=0.0
   65 CONTINUE
C***  MGSB= MONTH GROWING SEASON BEGINS EXPRESSED NUMERICALLY IE 1-12
C***  DGSB= DAY GROWING SEASON BEGINS EXPRESSED NUMERICALLY
C***  MGSE= MONTH GROWING SEASON ENDS EXPRESSED NUMERICALLY IE 1-12
C***  DGSE= DAY GROWING SEASON ENDS EXPRESSED NUMERICALLY
C***  MID=MEDIAN DATES OF THE MONTHS IN THE GROWING SEASON
C***  DBMD= DAYS BETWEEN MID DATES
C***  ACC= ACCUMULATIVE DAYS IN GROWING SEASON
C***  PCGS= PERCENT OF GROWING SEASON REACHED AT MID DATES
C***  MMAT=MEAN MONTHLY AVERAGE TEMPERATURES
C***  MGSB1=TEMPORARY STORAGE FOR MGSB
```

```
      DO 30 K=1,MMM
C***  READ PLANTING AND HARVESTING DATES
      READ(5,20) NRCROP(J,K),MGSBP(J,K),DGSBP(J,K),MGSEP(J,K),DGSEP(J,K)
   20 FORMAT(2X,I1,4I2)
   30 CONTINUE
   40 CONTINUE
C***  CALCULATE CROP COEFFICIENTS
      IF(NY.GT.1.OR.NM.GT.MSTART) GO TO 90
      DO 80 K=1,NPLOTS
      MMM=RCYCLE(K)
      DO 70 J=1,MMM
      MGSB=MGSBP(K,J)
      DGSB=DGSBP(K,J)
      MGSE=MGSEP(K,J)
      DGSE=DGSEP(K,J)
      CROP=NRCROP(K,J)
      CALL CROPCO(CROP,MGSB,DGSB,MGSE,DGSE,KCROP,NDIM,MMAT)
   70 CONTINUE
   80 CONTINUE
   90 CONTINUE
C***  CALCULATE CROP COEFFICIENT FOR WHEAT OF DOUBLE CROPPING
C***  READ PLANTING AND HARVESTING DATES FOR WHEAT SHOULD BE READ
C***  ACCORDING TO THE PLAN OF DOUBLE CROPPING IF ANY.  I.E. IF TWO PLOTS
C***  CONSIDERED TO BE DOUBLE CROPPED, TWO CARDS OF SAME DATA SHOULD BE
C***  INPUT
      DO 100 IW=1,NPLOTS
      IF(DOUBLE(IW).NE.2) GO TO 100
      READ(5,35) MGSBW,DGSBW,MGSEW,DGSEW
   35 FORMAT(5X,4I2)
      MGSB=MGSBW
      DGSB=DGSBW
      MGSE=MGSEW
      DGSE=DGSEW
      CROP=1
      CALL CROPCO(CROP,MGSB,DGSB,MGSE,DGSE,KCROP,NDIM,MMAT)
  100 CONTINUE
  110 CONTINUE
C***
C*** ESTABLISH CROP ROTATION SYSTEM FOR MODEL TWO
C***
      DO 250 I=1,NPLOTS
      MMM=RCYCLE(I)
C***  SINGLE CROPPING EACH YEAR
      DO 240 J=1,MMM
      IF(NY.GE.MMM+1) GO TO 120
      ITEMP(I,MMM,NY)=NRCROP(I,NY)
      GO TO 130
  120 ITEMP(I,MMM,NY)=ITEMP(I,MMM,NY-MMM)
      GO TO 130
  130 IF(DOUBLE(I).NE.2) GO TO 230
C***  DOUBLE CROPPING
      NNN=IFALWT(I)
      GO TO (150,190),NNN
C***  BEGINNING WITH WHEAT
  150 IF(NY.EQ.1) GO TO 160
      IF(NY.EQ.2) GO TO 170
      IF (NY.GE.3) GO TO 180
  160 IWHT(I,NY)=1
      IWT(I,NY)=7
      GO TO 220
```

```
C***   MGSE1=TEMPORARY STORAGE FOR MGSE
C***   PCGS1=TEMPORARY STORAGE FOR PCGS
       MGSB1=MGSB
       MGSE1=MGSE
       IF(MGSB.GT.MGSE) GO TO 10
       GO TO 20
C***   WHEN MGSB IS GREATER THAN MGSE SUCH AS IN WINTER WHEAT THE
C***   SUBROUTINE "SHIFTS" OR ADDS 1 TO MGSB AND MGSE UNTIL MGSB = 13
C***   WHICH CORRESPONDS TO JANUARY.  THIS SHIFT WAS NECESSARY TO
C***   FACILITATE PROGRAM LOOPING.  AFTER CALCULATIONS ARE MADE THE
C***   CROP COEFFICIENTS ARE  "SHIFTED" BACK TO THEIR ORIGINAL MONTHS.
C**************************************************************************
C**************************************************************************
C**************************************************************************
C**************************************************************************
C***                                                                   ***
C***                                                                   ***
C***                                                                   ***
C***    *** CAUTION TO USE-  ***   THIS ROUTINE WILL NOT WORK IF THE    ***
C***   GROWING SEASON EXCEEDS ONE YEAR.                                ***
C***                                                                   ***
C***                                                                   ***
C***                                                                   ***
C***                                                                   ***
C***                                                                   ***
C**************************************************************************
C**************************************************************************
C**************************************************************************
   10 SHIFT=13-MGSB
      MGSE=MGSE+SHIFT
      MGSB=1
   20 NPLUS=MGSB+1
      NMINUS=MGSE-1
      MID(MGSB)=((NDIM(MGSB)-OGSB)/2.)+OGSB
      DO 30 N=NPLUS,NMINUS
   30 MID(N)=NDIM(N)/2.0
      MID(MGSE)=OGSE/2.0
      DBMD(MGSB)=MID(MGSB)-OGSB
      DO 40 N=NPLUS,NMINUS
   40 DBMD(N)=NDIM(N-1)-MID(N-1)+MID(N)
      DBMD(MGSE)=NDIM(MGSE-1)-MID(MGSE-1)+OGSE
      ACC(MGSB)=DBMD(MGSB)
      DO 50 N=NPLUS,MGSE
   50 ACC(N)=ACC(N-1)+DBMD(N)
      ACC(MGSE)=ACC(MGSE)-MID(MGSE)
      DO 60 N=MGSB,MGSE
   60 PCGS(N)=(ACC(N)*100.)/(ACC(MGSE)+MID(MGSE))
      IF(MGSB1.LE.MGSE1) GO TO 100
      DO 80 N=1,12
      NN=N-SHIFT
      IF(NN.LE.0) NN=NN+12
      IF(NN.GT.MGSE1.AND.NN.LT.MGSB1) GO TO 70
      PCGS1(NN)=PCGS(N)
      GO TO 80
   70 PCGS1(NN)=0.0
   80 CONTINUE
      DO 90 N=1,12
   90 PCGS(N)=PCGS1(N)
  100 MGSB=MGSB1
      MGSE=MGSE1
```

```
      IF(PCGS(J).LE.0.0) KCROP(5,J)=0.0                                  PASTURE
  170 CONTINUE
      GO TO 230
  180 KCROP(6,1)=0.63
      KCROP(6,2)=0.73                                                    ALFALFA
      KCROP(6,3)=0.86                                                    ALFALFA
      KCROP(6,4)=0.99                                                    ALFALFA
      KCROP(6,5)=1.08                                                    ALFALFA
      KCROP(6,6)=1.13                                                    ALFALFA
      KCROP(6,7)=1.11                                                    ALFALFA
      KCROP(6,8)=1.06                                                    ALFALFA
      KCROP(6,9)=0.99                                                    ALFALFA
      KCROP(6,10)=0.91                                                   ALFALFA
      KCROP(6,11)=0.78                                                   ALFALFA
      KCROP(6,12)=0.64                                                   ALFALFA
      DO 190 J=1,12
      KCROP(6,J)=KCROP(6,J)*KT(J)                                        ALFALFA
  190 IF(PCGS(J).LE.0.0) KCROP(6,J)=0.0
      GO TO 230
  200 XBAR=0.
      A=0.                                                                FALLOW
      B=0.                                                                FALLOW
      C=0.                                                                FALLOW
      D=0.                                                                FALLOW
      E=0.                                                                FALLOW
  210 DO 220 J=1,12
      Z=PCGS(J)-XBAR
      KCROP(CROP,J)=(A+B*Z+C*Z**2+D*Z**3+E*Z**4)*KT(J)
      IF (PCGS(J).LE.0.0) KCROP(CROP,J)=0.0
  220 CONTINUE
  230 CONTINUE
C***  SINCE THE MAIN PROGRAM APPLIES THE CROP COEFFICIENT (KCROP) TO
C***  THE ENTIRE MONTH, THE KCROP WAS PROPORTIONED ACCORDINGLY TO
C***  COMPENSATE FOR THIS.  THE NEXT TWO CARDS DO THIS.
      KCROP(CROP,MGSB)=KCROP(CROP,MGSB)*(NDIM(MGSB)-DGSB+1)/NDIM(MGSB)
      KCROP(CROP,MGSE)=KCROP(CROP,MGSE)*DGSE/NDIM(MGSE)
      RETURN
      END
      SUBROUTINE WTRMOD(PRECIP,MONTH,MODEL,WPCNT)
C
C***  SUBROUTINE WTRMOD ADJUSTS THE PRECIPITATION RESULTING FROM
C***  SEEDING CLOUDS
C
C***  MODEL=1:   NO PRECIPITATION MODIFICATION
C***  MODEL 2:   INCREASE PRECIPITATION DURING MARCH THROUGH SEPTEMBER BY
C***             THE FOLLOWING PERCENTAGES - 75% FOR RAINFALLS < 0.10 IN,
C***             30% FOR RAINFALLS < 0.50 IN, 10% FOR RAINFALLS < 1.0 IN,
C***             -10% FOR RAINFALLS > 1.0 IN
C***  MODEL 3:   INCREASE ALL RAINFALLS DURING EVERY MONTH BY A SPECIFIED
C***             PERCENTAGE, WPCENT
C***  MODEL 4:   INCREASE PRECIPITATION DURING MARCH THROUGH SEPTEMBER BY
C***             THE FOLLOWING PERCENTAGES - 75% FOR RAINFALLS < 0.10 IN,
C***             30% FOR RAINFALLS < 0.50 IN, 10% FOR RAINFALLS < 1.0 IN,
C***             NO ADJUSTMENT FOR RAINFALLS > 1.0 IN
C
      IF(MODEL.EQ.1) GO TO 40
      IF(MONTH.LT.3) GO TO 10
      IF(MONTH.GT.9) GO TO 10
      ADJ=1.75
      IF(PRECIP.GT.0.10) ADJ=1.30
```

```
      IF(PRECIP.GT.0.50) ADJ=1.10
      IF(MODEL.EQ.4) GO TO 20
      IF(PRECIP.GT.1.0) ADJ=0.90
      GO TO 30
   10 ADJ=1.0
      IF(MODEL.EQ.3) ADJ=WPCNT
      GO TO 30
   20 IF(PRECIP.GT.1.0) ADJ=1.0
   30 PRECIP=PRECIP*ADJ
   40 RETURN
      END
      SUBROUTINE SNOWRT(PRECIP,WATER,PACK,PET,TEMPAV,SNOVAP)
C
C     *** CALCULATION OF MOISTURE ADDED TO DISPOSAL AREA DUE TO
C                     SNOWMELT ON THE AREA ***
C
      REAL M,MA,MR
      M=0.0
      IF(PACK.GT.0.1) SNOVAP=PET
      PACK=PACK-SNOVAP
      IF(SNOVAP.GT.0.0) PET=0.0
      IF(TEMPAV-32.) 10,10,20
   10 IF(PRECIP) 70,70,30
   20 IF(PACK) 90,90,40
   30 PACK=PACK+PRECIP
      WATER=0.0
      GO TO 90
C***  MA IS SNOWMELT DUE TO ATMOSPHERIC CONDITIONS
   40 MA=0.05*(TEMPAV-34.)
      IF(MA.LT.0.0) MA=0.0
      IF(PACK-MA) 60,60,50
C***  MR IS SNOWMELT DUE TO RAIN
   50 MR=(PRECIP*(TEMPAV-32.))/144
      M=MR+MA
      IF(PACK-M) 60,70,70
   60 M=PACK
      PACK=0.0
      GO TO 80
   70 PACK=PACK-M
   80 WATER=M+PRECIP
   90 RETURN
      END
      SUBROUTINE DARCRT(PERC,FCU,SMUZ,FCL,SMLZ,FCGW,SMGWZ,DPERC,CONDUZ,C
     1ONDLZ,CONDGW,HUZ,HLZ,HGW,PWU,PWL,PWG)
      DIMENSION H(3),H1(3),SMD(3),WF(3),CCND(3),DEP(3),Q(2)
      DATA DEP,RCHGS,EXCESS,RCHGR/30.48,91.44,60.96,3*0.0/
C
C***  DISTRIBUTION OF WATER ADDED TO EACH PLOT
C
      EXCESS=0.0
      IF(PERC.LE.0.0) GO TO 10
      SMAVUZ=FCU-SMUZ
      IF(SMAVUZ.LT.0.0) SMAVUZ=0.0
      EXCESS=PERC-SMAVUZ
      IF(EXCESS.LT.0.0) EXCESS=0.0
      SMUZ=SMUZ+PERC-EXCESS
      SMAVLZ=FCL-SMLZ
      IF(SMAVLZ.LT.0.0) SMAVLZ=0.0
      EXTRA=EXCESS
      EXCESS=EXCESS-SMAVLZ
```

```
      DO 110 J=1,12
C***  KT IS A CLIMATIC COEFFICIENT APPLIED TO THE CROP GROWTH
C***  COEFFICIENT.  IT IS CALCULATED BY THE FOLLOWING EQUATION:
      KT(J)=.0173*MMAT(J)-.314
      IF(MMAT(J).LT.36.) KT(J)=.3
  110 CONTINUE
C***  CROP=1 FOR WHEAT
C***  CROP=2 FOR SORGHUM
C***  CROP=3 FOR CORN
C***  CROP=4 FOR SOYBEANS
C***  CROP=5 FOR PASTURE
C***  CROP=6 FOR ALFALFA
C***  CROP=7 FOR FALLOW
      GO TO (120,130,140,150,160,180,200),CROP
  120 XBAR=50.
      A=1.39093399                                                       WHEAT
      B=-0.00368378                                                      WHEAT
      C=-0.00004976                                                      WHEAT
      D=-0.00000233                                                      WHEAT
      E=-0.00000004                                                      WHEAT
      GO TO 210
  130 XBAR=50.
      A=1.05528355                                                     SORGHUM
      B=0.00198600                                                     SORGHUM
      C=-0.00051577                                                    SORGHUM
      D=0.00000045                                                     SORGHUM
      E=0.00000011                                                     SORGHUM
      GO TO 210
  140 XBAR=50.
      A=1.02805328                                                        CORN
      B=0.00880046                                                        CORN
      C=-0.00031919                                                       CORN
      D=-0.00000194                                                       CORN
      E=0.00000007                                                        CORN
      GO TO 210
  150 XBAR=50.
      A=0.74790430                                                    SOYBEANS
      B=0.01474796                                                    SOYBEANS
      C=-0.00013486                                                   SOYBEANS
      D=-0.00000443                                                   SOYBEANS
      E=0.                                                            SOYBEANS
      GO TO 210
C***  FOR PERENNIAL CROPS SUCH AS ALFALFA AND PASTURE, VALUES OF THE
C***  CROP COEFFICIENTS ARE BEST PLOTTED ON A MONTHLY BASIS THEREFORE
C***  EQUATIONS WERE NOT DEVELOPED.  MONTHLY VALUES WERE INTEGRATED
C***  WITHIN THE ROUTINE FOR PASTURE AND ALFALFA.
  160 KCROP(5,1)=0.49
      KCROP(5,2)=0.57                                                  PASTURE
      KCROP(5,3)=0.73                                                  PASTURE
      KCROP(5,4)=0.85                                                  PASTURE
      KCROP(5,5)=0.90                                                  PASTURE
      KCROP(5,6)=0.92                                                  PASTURE
      KCROP(5,7)=0.92                                                  PASTURE
      KCROP(5,8)=0.91                                                  PASTURE
      KCROP(5,9)=0.87                                                  PASTURE
      KCROP(5,10)=0.79                                                 PASTURE
      KCROP(5,11)=0.67                                                 PASTURE
      KCROP(5,12)=0.55                                                 PASTURE
      DO 170 J=1,12
      KCROP(5,J)=KCROP(5,J)*KT(J)                                      PASTURE
```

```
      IF(EXCESS.LT.0.0) EXCESS=0.0
      SMLZ=SMLZ+EXTRA-EXCESS
      SMAVGW=FCGW-SMGW
      IF(SMAVGW.LT.0.0) SMAVGW=0.0
      EXTRA=EXCESS
      EXCESS=EXCESS-SMAVGW
      IF(EXCESS.LT.0.0) EXCESS=0.0
      SMGWZ=SMGWZ+EXTRA-EXCESS
      RCHGR=EXTRA-EXCESS
      IF(RCHGR.LT.0.0) RCHGR=0.0
C
C***  MOISTURE REDISTRIBUTION USING THE ONE-DIMENSIONAL DARCY EQUATION
C***  FOR UNSATURATED FLOW
C
   10 LCOUNT=1
      DTIME=0.1667
      IF(PERC.LE.0.0) DTIME=1.0
      IF(PERC.LE.0.0) LCOUNT=6
      DPERC=EXCESS
      WF(1)=PWU/12.
      WF(2)=PWL/36.
      WF(3)=PWG/24.
      SMD(1)=SMUZ/12.
      SMD(2)=SMLZ/36.
      SMD(3)=SMGWZ/24.
      DO 20 K=1,3
   20 IF(SMD(K).GT.1.0) SMD(K)=1.
C
C***  CALCULATE SOIL MOISTURE TENSION IN CM
      H1(1)=SMD(1)-HUZ
      H1(2)=SMD(2)-HLZ
      H1(3)=SMD(3)-HGW
      DO 30 K=1,3
      H(K)=EXP(H1(K))
      IF(H(K).GT.1500.) H(K)=1500.
      IF(H(K).LT.0.0) H(K)=0.0
      XXX=SMD(K)-WF(K)
      IF(XXX.LT.0.01) SMD(K)=WF(K)+0.01
C
C***  CALCULATE UNSATURATED HYDRAULIC CONDUCTIVITY IN CM PER DAY
      IF(K.EQ.1) COND(K)=CONDUZ*(EXP(72.039*SMD(K)))/(SMD(K)-WF(K))
      IF(K.EQ.2) COND(K)=CONDLZ*(EXP(75.595*SMD(K)))/(SMD(K)-WF(K))
      IF(K.EQ.3) COND(K)=CONDGW*(EXP(70.598*SMD(K)))/(SMD(K)-WF(K))
      IF(COND(K).GT.10.0) COND(K)=10.0
   30 IF(COND(K).LT.1.0E-07) COND(K)=1.0E-07
C
C***  CALCULATE MOISTURE FLOW, IN INCHES
   40 DO 50 K=1,2
      Q(K)=(COND(K)+COND(K+1))/2*DTIME*(H(K+1)-H(K)+DEP(K))/DEP(K)
   50 Q(K)=Q(K)/2.54
      SMUZ=SMUZ-Q(1)
      SMLZ=SMLZ+Q(1)
      SMLZ=SMLZ-Q(2)
      SMGWZ=SMLZ+Q(2)
      RCHGS=RCHGS+Q(2)
      LCOUNT=LCOUNT+1
      IF(LCOUNT.LE.6) GO TO 40
      DPERC=DPERC+RCHGS+RCHGR
      RETURN
      END
```

```
      SUBROUTINE STORAG(P1,P2,P3,PRECIP,SNOW,FROZE,MONTH,GROW,DORM,RUNOF
     1F,WWINPT,RUNOFT)
C
C
C                 *** CALCULATION OF FEEDLOT RUNOFF ***
C
      IF(BYPASS.EQ.3) GO TO 60
C***  CALCULATE 3 DAY ANTECEDENT MOISTURE
      AM=P1+P2+P3
      P1=P2
      P2=P3
      P3=PRECIP
      IF (SNOW.GT.0.0.AND.FROZE.EQ.0) GO TO 10
      IF(PRECIP.LE.0.0) GO TO 50
      IF (FROZE.EQ.1) GO TO 40
      IF(AM.LE.0.5.AND.PRECIP.LE.0.5) GO TO 50
C***  CALCULATE FEEDLOT RUNOFF USING 3 DAY ANTECEDENT MOISTURE CONDITIONS
C***  MODIFICATION OF THE SCS METHOD
   10 AM1=AM+PRECIP
      PRESIP=PRECIP+SNOW
      RC=97.0
      IF(MONTH.LT.4.OR.MONTH.GT.10) GO TO 20
      IF(AM.LT.0.75) RC=91.0
      IF(AM1.GT.GROW.AND.PRECIP.GT.GROW) PRESIP=GROW
      GO TO 30
   20 IF(AM.LT.0.50) RC=91.0
      IF (SNOW.GT.0.0) RC=97.0
      IF(AM1.GT.DORM.AND.PRECIP.GT.DORM) PRESIP=DORM
   30 CS=1000.0/RC-10.0
      RUNOFF=(PRESIP-0.2*CS)**2/(PRESIP+0.8*CS)
      RUNOFF=RUNOFF+PRECIP-PRESIP+SNOW
      SNOW=0.0
      IF(RUNOFF.GT.0.06) RUNOFF=RUNOFF-0.06
      IF(PRESIP-0.2*CS.LT.0.0) GO TO 50
      GO TO 60
   40 SNOW=SNOW+PRECIP
   50 RUNOFF=0.0
      IF(BYPASS.EQ.2) GO TO 70
   60 RUNOFT=WWINPT/(3630*7.48)
   70 RETURN
      END
      SUBROUTINE MTEMP(TMAV,TAVG,NDAYS,NM)
C***********************************************************************
C***********************************************************************
C***
C***      THIS SUBPROGRAM CALULATES THE AVERAGE MONTHLY TEMPERATURE
C***      FOR LATER CALCULATIONS IN SUBPROGRAM YIELDS
C****
C***
C***********************************************************************
C***********************************************************************
      DIMENSION TMAV(12),TAVG(31)
      TSUM=0.0
      DO 5 ND=1,NDAYS
    5 TSUM=TSUM+TAVG(ND)
      TMAV(NM)=TSUM/NDAYS
      RETURN
      END
      SUBROUTINE IRROPT(MS,ND,NDAYS,NM,PRECIP,AREA,DSRATE,MCROP,
     X                 BYPASS,CISVOL,SMACCT)
```

```
C
C
C        THIS SUBROUTINE OPTIMIZES THE AMOUNT OF IRRIGATION WATER
C        APPLIED SINCE TOO MUCH WATER AT THE WRONG TIME OF THE
C        GROWING SEASON CAN REDUCE THE CROP YIELDS
C
C
C        MCWND=MONTH CROP WATER NEED FOR FOR MAXIMUM YIELD
C        XMCWND = MCWND
C        XND = NUMBER OF DAY IN MONTH
C        XNDAYS = NUMBER OF DAYS IN MONTH
C        CWND = CROP WATER NEED
C        AVWT = AVAILABLE WATER IN FIELD
C
C
C                RUSSELL W. LAFORCE       FEBRUARY 7 , 1980
C
C
      REAL MCWND
      DIMENSION SMACCT(13,9,9),AREA(9),DISVOL(9)
      DIMENSION XMCWND(12,7)
      IF(BYPASS.GT.1) GO TO 999
      DO 5 I=1,12
      DO 5 J=1,7
    5 XMCWND(I,J)=0.0
      XMCWND(5,1)=4.60
      XMCWND(6,1)=4.27
      XMCWND(6,2)=38.0
      XMCWND(7,2)=6.60
      XMCWND(8,2)=4.02
      XMCWND(9,2)=3.13
      XMCWND(6,3)=7.09
      XMCWND(7,3)=7.74
      XMCWND(8,3)=3.43
      XMCWND(7,4)=9.03
      XMCWND(8,4)=4.96
      XMCWND(9,4)=4.74
      XMCWND(3,6)=6.15
      XMCWND(4,6)=6.15
      XMCWND(6,6)=7.06
      XMCWND(7,6)=10.2
      XMCWND(8,6)=5.5
      XMCWND(9,6)=6.6
      MCWND =XMCWND(NM,MCROP)
      IF ( MCWND . LE . 0.0 ) GO TO 50
      XND =ND
      XNDAYS = NDAYS
      CAVWT=SMACCT(NM,2,MS)+SMACCT(NM,3,MS)+PRECIP+DSRATE
      CWND = MCWND * XND
      AVWT = CAVWT * XNDAYS
      IF ( CWND . LT . AVWT ) GO TO 50
      DISVOL(MS) = DSRATE * AREA(MS)
      GO TO 999
   50 DISVOL(MS)=0.0
  999 CONTINUE
      RETURN
      END
      SUBROUTINE SEEPGE(B2,PONVOL,DASEEP,DSEPRT)
      DASEEP=B2*DSEPRT/43560
      IF(DASEEP.GT.PONVOL) DASEEP=PONVOL
```

```
      PONVOL=PONVOL-DASEEP
      RETURN
      END
//GO.SYSIN DD *
                    COLBY, KANSAS        -          141699
 NO WEATHER MODIF
 NO MUNICIPAL INPUT
 &SEED MODEL=1,WPCNT=1.0,&END
 &ALPHA BRUNTA=0.79,BRUNTB=0.035,PAVLU=0.6,RCROP=0.23,E=0.75,DSRATE=1.50,
 DORM=1.0,GROW=1.25,PCVMAX=0.05,MOROT=2,EFFIRR=1,&END
 &BETA HMAX=14.,S=30.,L=65.,W=65.,MSTART=1,YSTART=1970,YEND=1978,DSEPRT=0.06,
 INOST=1699,STORM=4.5,DARCEQ=2,BYPASS=1,LTAREA=0.0,NPLOTS=2,ROTAYR=1,
 MPCFOM=1,&END
 168760616124258                                                   COLBY, KANSAS
 263790844125302                                                   COLBY, KANSAS
 366781111144365                                                   COLBY, KANSAS
 464781396141472                                                   COLBY, KANSAS
 566831591136581                                                   COLBY, KANSAS
 675791669129685                                                   COLBY, KANSAS
 778801629119756                                                   COLBY, KANSAS
 878821483115739                                                   COLBY, KANSAS
 977741228119646                                                   COLBY, KANSAS
1075750943116521                                                   COLBY, KANSAS
1170760685119375                                                   COLBY, KANSAS
1268760565113286                                                   COLBY, KANSAS
   1  1  2  3  3  140.0
   1  1  2  3  1  140.0
  3  410  920
  5  4011030
//GO.FT01F001 DD UNIT=TAPE6250,VOL=SER=9P86R8,LABEL=(1,SL,,IN),
// DISP=(OLD,KEEP),DSN=COLBY.KS20-78,
// DCB=(LRECL=320,BLKSIZE=3840,RECFM=FB,DEN=4)
/*
```

RELIABILITY OF SUPPLEMENTAL IRRIGATION SYSTEMS

by

Baxter Vieux

B.S., University of Kansas, 1978

AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of

the requirements for the degree

MASTER OF SCIENCE

Department of Civil Engineering

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1981

ABSTRACT

Reliability of a supplemental irrigation system in Riley County, Kansas is evaluated. A computer model continuously simulates the system using historic weather data. Irrigation application rates of 1.0 inch/day and 1.5 inch/day yield reliabilities of 58.6% and 55.2%, respectively. Computations using average annual yield and net irrigation requirements indicates a 49% reliability. Through management of irrigation application rates, the system's reliability is improved.