PART 594 - UNDERGROUND OUTLET - 620

KS594.00 General.

Design and layout will be according to guidelines in Chapters 3 and 8 of the Engineering Field Manual and the criteria listed in the Kansas Standard and Specifications for Underground Outlet - 620. If an underground outlet is to be a component of another practice (e.g. terrace, diversion, etc.), it shall also satisfy the applicable criteria of those standards and specifications.

KS594.01 Layout.

(a) A profile survey of the underground outlet shall be made and recorded on Forms SCS-ENG-28 and SCS-ENG-29.

(b) The survey shall contain the following information:

(1) Elevation and description of the bench mark. The bench mark is usually located near the outlet

(2) Station and elevation of the outlet and risers

(3) Elevation of natural ground above the outlet

(4) Station and elevation of significant breaks in slope between risers and/or outlet

(5) It is recommended that the distance between rod readings not exceed 200 feet.

KS594.02 Design.

(a) The design of an underground outlet should be recorded on LOTUS template STORTER.WK1, Form KS-ENG-17a or KS-ENG-17, Underground Outlet Terrace Design. This form may also be used for the riser and tile design of underground outlet diversions and water and sediment control basins.

(b) Refer to user instructions to complete Form KS-ENG-17.

(c) The first eight lines of Form KS-ENG-17 should be completed according to Part 591 of this manual.

(d) Record the following information on Form KS-ENG-17 as it pertains to underground outlet design:

(1) Based upon the design runoff and duration of flooding, calculate the minimum release rate. Refer to pages KS-8-1 and KS-8-2 of the EFM for release factors and other design guidance.

(2) Riser design.

(i) Refer to page KS-8-4 of the EFM and other approved design aids for riser design tables.

(ii) Select a riser diameter and the number and size of holes per foot.

(iii) Based upon item (ii) and the water depth at the riser, determine the riser capacity.

(iv) This capacity must equal or exceed the minimum riser release calculated in item (2).

(v) The following minimum dimensions are recommended: 1-inch diameter holes, 12 holes per foot, 3-foot long perforated section on riser.

(3) Orifice design.

(i) Orifice capacity must be greater than or equal to the minimum release rate.

(ii) Calculate orifice head. The orifice head is 0.7 times the water depth at the riser plus the distance from the channel elevation to the orifice.

(iii) Using the orifice head and the table on page 8-102 of the EFM, select an orifice diameter and determine orifice capacity.

(iv) It is recommended that orifices be designed in increments no smaller than 0.25 inch.

(4) Main conduit design.

(i) Determine the accumulated flow by summing the flow from the main conduit above the design point and the flow from the orifice at the design point.

(ii) Determine the trench depth at each riser, outlet, and other pertinent points.

(iii) Calculate the main conduit reach grades (slopes) using the trench bottom elevations and the distances between risers, outlet, and other pertinent points.

(iv) Select a main conduit material and diameter for each reach. Refer to the Standard for Underground Outlet page 620-2 for "n" values and EFM pages KS-3-1 through KS-3-4b for capacity charts.

(v) Determine main conduit capacity. The conduit capacity must equal or exceed the accumulated flow.

(vi) Check conduit for conformance to minimum and maximum fill-over-pipe criteria.

(vii) Repeat this process for each main conduit reach until all design criteria is satisfied.

KS594.03 Field Sheets and Plans.

(a) Use Form KS-ENG-19, Underground Outlet - 620, to record design information:

(1) Complete location map, owner, legal description, county, field, and utility blanks.

(2) Record dates and signatures of persons performing layout, design, and design check.

(3) Complete table of quantities, indicating all components and materials required to complete the job (see 594.06).

(4) List design dimensions of main conduit, risers, and orifices in blocks below the table of quantities (see 594.06).

(5) Record ground, channel, trench bottom, and outlet elevations on the reverse side of Form KS-ENG-19.

(6) Record stations, distances, and slopes of each main conduit reach.

(7) Record applicable cuts for channel and trench bottom.

(8) Record bench mark elevation and description.

(b) Complete additional plans and drawings as required to convey all pertinent details of the underground outlet design.

KS594.04 Checkout.

(a) Perform a profile survey on the underground outlet line.

(1) Record rod readings on the back of Form KS-ENG-19 in the checkout block.

(2) Rod readings will consist of shots of the following :

(i) Channel elevation at each riser location

(ii) Flow line elevation of main conduit at each riser location

(iii) Outlet elevation

(iv) Bench mark elevation

(v) Other pertinent points

(b) Measure the installed lengths of main conduit by chaining.

(c) Check and document type of riser and main conduit materials installed by recording markings on pipe, etc.

(d) Record installed quantities in the appropriate column of the table of quantities.

(e) Check the following details to insure the job conforms to the design:

(1) Riser - diameter, perforated length, size and number of holes per foot, and support posts and removable cap if required

(2) Orifice location and diameter

(3) Outlet protection and rodent guards

(4) As-built main conduit reach slopes

(5) As-built minimum and maximum heights of fill over main conduit

§KS594.05 Sample of Form KS-ENG-29 - Field Notes for Underground Outlet - Line A

2-30-85
O. Thudpucker π, HC
S. Spade ϕ, RC

Top of 1" x 2" stake, 20' east of outlet flag on creek bank

Outlet
Creek bank

Riser, T-3

Riser, T-2

Riser, T-1

Station	B.S.	H.I.	F.S. or grade rod	Elev. or planned elev.
B.M.	8.1	108.1		100.0
5+75			11.6	96.5
(300')			8.6	99.5
2+75			2.5	105.6
T.P. 1	10.4	117.3	1.2	106.9
(125')				
1+50			6.0	111.3
(150')				
0+00			1.7	115.6
B.M.			17.3	100.0

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§ KS594.06 Sample of Form KS-ENG-19

USDA
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FIELD SHEET: UNDERGROUND OUTLET - 620

KS-ENG-19
6/84

LOCATION MAP

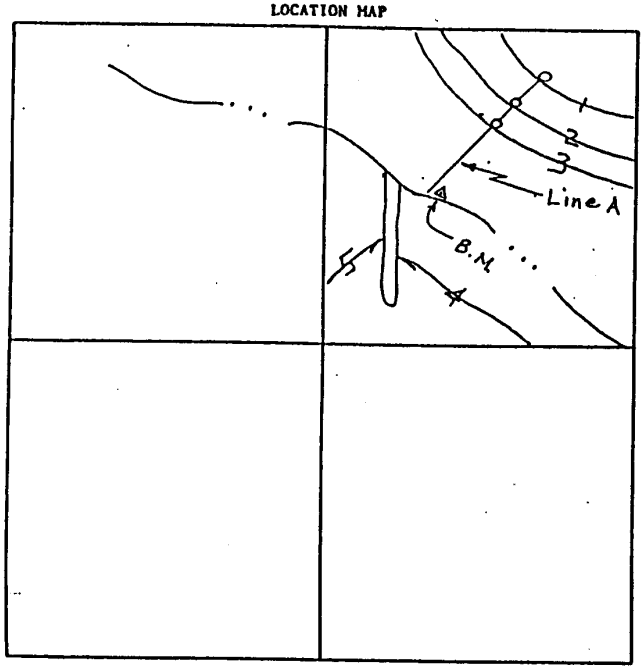


TABLE OF QUANTITIES -- OUTLET LINE A

ITEM	UNIT	PLANNED QUANTITY	INSTALLED QUANTITY
Main conduit, corrugated plastic pipe (PE), ASTM F405:			
5" dia.	Lin.Ft.	150	149
6" dia.	Lin.Ft.	125	125
8" dia.	Lin.Ft.	300	292
C.M. pipe, 10" dia., 16 ga. for outlet protection	Lin.Ft.	10	10
Rodent guard for 10" dia. C.M.P.	Each	1	1
Riser, 6" dia. smooth wall plastic	Each	3	3
Manually tamped backfill under terrace ridge:			
5" dia.	Lin.Ft.	50	
6" dia.	Lin.Ft.	50	
8" dia.	Lin.Ft.	50	

Location Map Scale 1" = 660'

Owner E. Z. Jones

Legal Desc. NW ¼ Sec. 35 T 17 R 3

County Saline Field No. _____

Buried Utility Yes _____ No X

D. Mann
Contractor

Orville Thudpucker 2-31-85
Design by Date

Snuffy Smiff 2-31-85
Design checked by Date

Orville Thudpucker 4-31-85
Checkout by Date

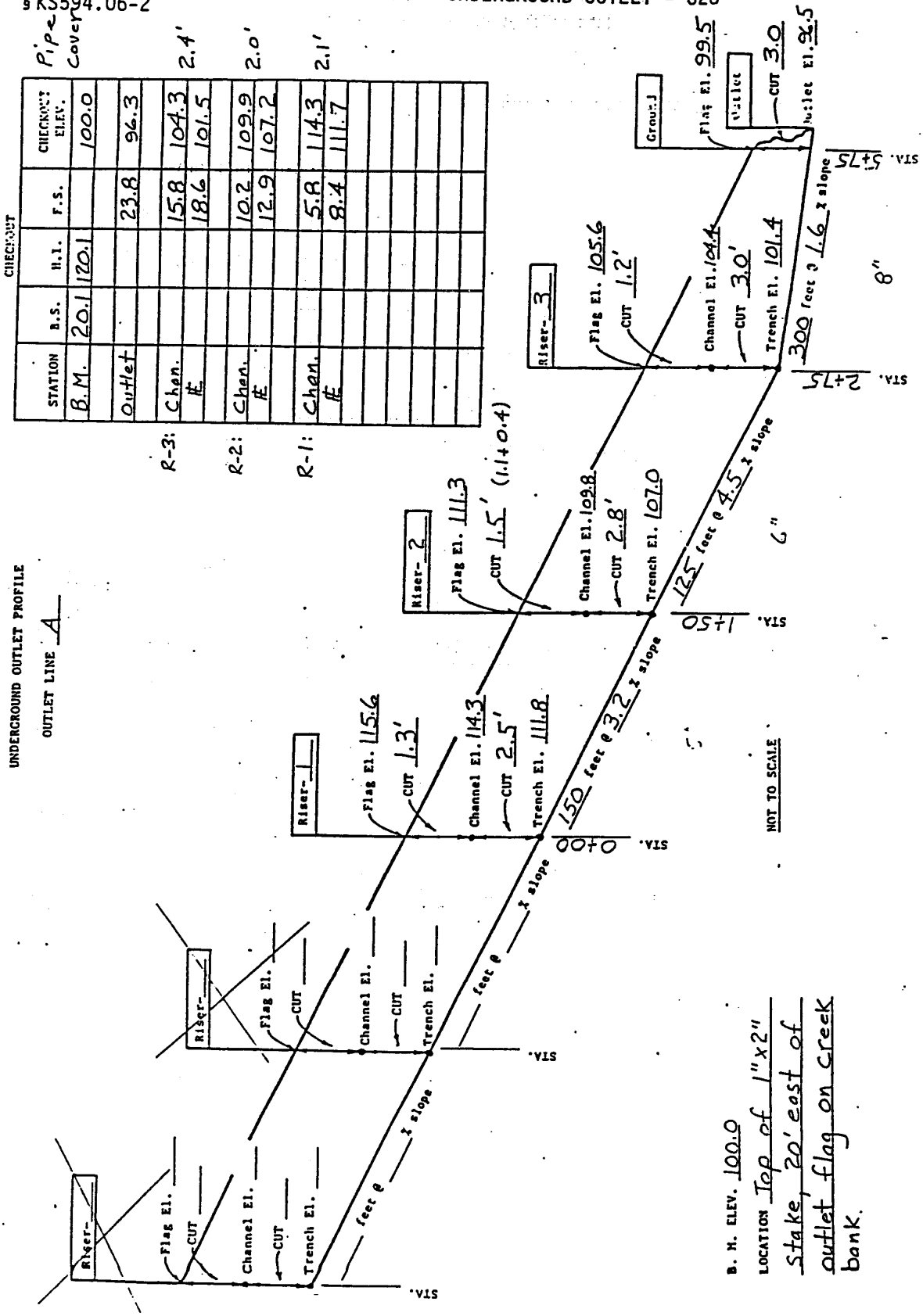
Orville Thudpucker 2-30-85
Layout by Date

MAIN CONDUIT				
Terrace Number or Station	Type: Corrugated	Type: Smooth Wall	Pipe Diameter Inch	Slope %
1				
2	X		5	3.2
3	X		6	4.5
Outlet	X		8	1.6

RISER								
Terrace Number	Cut at Riser Feet	Trench Depth Feet	Riser Diameter Inch	Type: Corrugated	Type: Smooth Wall	Holes per Foot No.	Holes per Foot Size	Length of Perforated Feet
1	1.3	3.8	6		X	24	1"	3.0
2	1.5	4.3	6		X	24	1"	3.0
3	1.2	4.2	6		X	24	1"	3.0

ORIFICE	
Distance Below Channel Inch	Diameter Inch
0	3.00
0	3.25
0	3.75

STATION	B.S.	H.I.	F.S.	CHECKOUT ELEV.	Pipe Cover
B.M.	20.1	120.1		100.0	
Outlet			23.8	96.3	
R-3: Chan.			15.8	104.3	2.4'
ft			18.6	101.5	
R-2: Chan.			10.2	109.9	2.0'
ft			12.9	107.2	
R-1: Chan.			5.8	114.3	2.1'
ft			8.4	111.7	



§KS594.07 Sample of Form KS-ENG-17a

UNDERGROUND OUTLET TERRACE DESIGN STORTER.WK1 VERSION 1.10 June 1, 1987 KS-ENG-17a

NAME:	E.Z. Jones	DRAINAGE AREA:	2.48	ACRES	RISER DIAMETER:	6	INCHES
LEGAL:	SE4-25-14-3	SOIL LOSS:	5	T/AC/YR	NO. OF HOLES/FT	30	NUMBER
COUNTY:	Blackdirt	CURVE NUMBER:	84		SIZE OF HOLES	1	INCHES
TERRACE:	T-2	10-YR RAINFALL	5.1	INCHES	ORIFICE BELOW GROU	0	FEET
BURRIED		FLOOD DURATION:	24	HOURS			
UTILITIES	No				RISER DISCHARGE	1.25	CFS
DATE:	01-Jun-87				MIN ORIFICE DIA	3.18	INCHES
		SOIL LOSS:	0.34	INCHES	DESIGN ORIFICE DIA	3.25	INCHES
		RUNOFF:	3.36	INCHES	PIPE FLOW ABOVE	0.31	CFS
		REQUIRED STORAGE:	2.45	INCHES	PIPE DIAMETER	6	INCHES
		STORAGE VOLUME:	22087	CU.FT.	PIPE GRADE	0.045	FT/FT
		RELEASE RATE:	0.35	CFS	PIPE MATERIAL	CPP	CPP OR SM
					PIPE DISCHARGE	1.03	CFS
					ACTUAL DISCHARGE	0.68	CFS

TERRACE CROSS SECTION

TOP WIDTH	4	MINIMUM HEIGHT:	1.3	CUT VOL:	25614	949	CU.YD.
CUT SLOPE	6	FREEBOARD:	0.3	FILL VOL:	18529	686	CU.YD.
FRONT SLOP	6	RISER STATION:	400	C/F RATIO:	1.38		
BACK SLOPE	6	OVERFILL AT RISER:	0.5	STORAGE VOL:	23615		
STAKE METH	2	H2O DEPTH @ RISER:	2.5	STORAGE RATIO:	1.07		

STATION	LANDSLOPE (%)	BOTTOM WIDTH	STAKE ROD	CHANNEL ROD	CUT (FT)	WATER DEPTH	RIDGE ROD	FILL (FT)	HEIGHT (FT)	CUT/FILL RATIO
0	5	12	6.0	6.7	0.7	0.5	5.4	0.6	1.3	2.90
100	5	12	6.4	7.1	0.7	0.9	5.8	0.6	1.3	2.90
200	5	12	6.7	7.5	0.8	1.3	5.9	0.8	1.6	2.21
300	5	12	7.2	8.0	0.8	1.8	5.9	1.3	2.1	1.04
400	5	12	7.9	8.7	0.8	2.5	5.4	2.5	3.3	0.34
500	5	12	7.0	8.0	1.0	1.8	5.9	1.1	2.1	1.74
600	5	12	6.5	7.5	1.0	1.3	5.9	0.6	1.6	4.27
700	5	12	6.2	7.0	0.8	0.8	5.7	0.5	1.3	4.26
800	5	12	5.5	6.5	1.0	0.3	5.2	0.3	1.3	10.14

DESIGNED BY [signature] 01-Jun-87 CHECKED BY [signature] UOC UD DATE 6-2-87

(KS210-KNKDM, June 1987)

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§594.08 Sample of Form KS-ENG-17

USDA

KS-ENG-17
Rev. 6/87

UNDERGROUND OUTLET TERRACE DESIGN

Owner E. Z. Jones ; Legal Description SE¼ 25-14-3

Design for Terrace No. T2

Designed by Orville Thudpusker Date 6-1-87 Design Checked by Snuffy Smiff Date 6-2-

Drainage Area = Terr. Lgth. 800 ft. x Terr. Spacing 135 ft. ÷ 43560 = 2.48 acre

Soil Loss = 5 tons/acre/year; Sediment Storage = 0.34 inches/10 yr.

Soil Cover Complex No., AMC II = 84 ; 10 yr. 24 hr. rainfall = 5.1 in.; Runoff = 3.36 in

Duration of flooding = 24 hrs.; Storage Factor = 0.63

Design Storage = Sed. Stor. 0.34 + (Runoff 3.36 " x Storage Factor 0.63) = 2.45 in

Storage Volume = Design Storage 2.45 " x Dr. Area 2.48 ac. x 3630 = 22,056 cu. ft

Min. Release Rate = .042 x Dr. Area 2.48 ac. x Runoff 3.36" x Release Factor 1.00 = 0.35 cf

Water depth at riser, d, = 2.5 ft.; Riser Dia. = 6 in.; holes/ft. = 30 ; Disch. = 1.25 cf

Orifice Head, h = 0 '+ .7d = 0 + .7 x 2.5 = 1.7'; 3.25" Diameter Orifice, Q = 0.36 cf

Accumulated Flow, $Q_{acc.} = Q_{above} + Q_{terrace}$ = 0.31 + 0.36 = 0.67 cf

n = 0.015 for CCP Pipe; 6 " Diameter on 0.045 Grade (Feet/Foot); Q = 1.03 cf

n = _____ for _____ Pipe; _____ " Diameter on _____ Grade (Feet/Foot); Q = _____ cf

Width 4 ; Back Slope Z_2 6 : 1; Front Slope Z_3 6 : 1; Channel Slope Z_4 6 :

TO 4 Chan. Width	Slope %	100' Slope STO 01	Sta.	Stake Rod	Ridge Rod	Ridge Fill F_1	Channel Rod	Channel Cut C_1	Depth D_1	Ridge Rod	Ridge Fill F_1	Channel Rod	Channel Cut C_1	Depth D_1	End Area	Volume Stored
12	5		0	6.0	5.4	0.6	6.7	0.7	0.5							
12	5		100	6.4	5.8	0.6	7.1	0.7	0.9							1158
12	5		200	6.7	5.9	0.8	7.5	0.8	1.3							2070
12	5		300	7.2	5.9	1.3	8.0	0.8	1.8							3339
12	5		400	7.9	5.4	2.5	8.7	0.8	2.5							5436
12	5		500	7.0	5.9	1.1	8.0	1.0	1.8							5436
12	5		600	6.5	5.9	0.6	7.5	1.0	1.3							3339
12	5		700	6.2	5.7	0.5	7.0	0.8	0.8							1959
12	5		800	5.5	5.2	0.3	6.5	1.0	0.3							879

From TI-59 Program

Cut 25,614 cu. ft. = 949 cu. yd.

Fill 18,529 cu. ft. = 686 cu. yd. = 1.38 Balance; Storage = 23616 cu. ft