PAUL GODLEY CO.
CONSULTING RADIO ENGINEERS
MONTCLAIR, N. J.

ENGINEERING PROPOSAL

COVERING INCREASE OF POWER

KOMA 1520 Kc 50 Kw

OKLAHOMA CITY, OKLAHOMA.

September 1945

PAUL GODLEY CO.
CONSULTING RADIO ENGINEERS
MONTCLAIR, N.J.

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OKLAHOMA CITY, OKLA.

SUMMARY:

KOMA, Oklahoma City, operates on 1520 Kc. with temporarily authorized 5000 watts, but subject to reduction of power to 500 watts at night lacking plans for night protection to co-channel stations.

This proposal contemplates increase of power to 50 Kw. day and night, change of site, and the use, at night, of a three element directive antenna designed to protect the secondary service areas of the Class I-B stations WKBW, Buffalo, N.Y. and TGW, Guatemala City.

The report includes (1) a discussion and mapping of the engineering and allocation factors involved, and (2) a mapping of areas and a tabulation of populations served by the present and proposed operations. It is shown in the report that, on the basis of FCC Standards, no interference will be caused to existing stations within their normally protected service areas.

Attached to, and a part of the report, are the following:

- Figure 1: Map of channel geography showing the allocation problem.
- 2: Horizontal plane radiation pattern - night.
- 3: Vertical plane radiation patterns.
- 4: Plat of proposed antenna and ground system.
- 5: Map showing computed present and proposed night coverage.
- 6: Map showing computed present and proposed daytime coverage.
- 7: Map showing so-called blanket areas, present and proposed - night time, - with airports and radio stations also indicated.
- 8: Map showing so-called blanket areas, present and proposed, - daytime.
- Appendix 1: Antenna design formulas and sample computation.

ALLOCATION PROBLEM:

There are two class I-B stations on the 1520 Kc. clear channel:

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WKBW, Buffalo, N.Y.	50 Kw. DA.	
TGW, Guatemala City	10 Kw. Non-DA. 710 mv/m effective field assumed.	

There are no other co-channel stations in North America.

Nearest adjacent channel station is KVWC, Vernon, Texas, 1490 Kc., 250 watts, Class IV, 132 miles from the proposed transmitting site. On the basis of desired to undesired, ground-wave signal ratio of 1:50, soil conductivities as shown on the FCC Map of Conductivity, and basic radiation data, no interference will be caused to either the existing or the proposed station. Power in excess of 50 Kw. is developed by the KOMA directive antenna in the direction of three adjacent channel stations:

KSTP, St.Paul, Minn.	1500 Kc.	Class I-B	50 Kw.
KGA, Spokane, Wash.	1510 Kc.	Class I-B	10 Kw.
KFBK, Sacramento, Cal.	1530 Kc.	Class I-B	10 Kw.

On the basis of desired to undesired signal ratio of 1:5 for 10 Kc. separation, and 1:25 for 20 Kc. separation, and the FCC second hour after sunset 10%-of-time sky-wave curves, no interference will be caused to any of these stations by KOMA, nor will KOMA suffer interference from any of these.

Bearings and distances from Oklahoma City to the normally protected service areas of the two co-channel stations are shown in Figure 1. Pertinent mileance field contours and service contours are also shown or indicated on the map. It is seen that no interference will be caused to the secondary service of WKBW within the boundaries of the United States, nor to the secondary service of TGW within the boundaries of Guatemala.

NIGHT LIMITATION - KOMA:

Sky-wave fields developed by TGW, Guatemala, (assuming 710 mv/m non-directive effective field) are such as to limit KOMA interference-free service to the 1.5 mv/m. Sky-wave fields of WKBW protect the 0.5 mv/m 50% sky-wave service area of KOMA.

DIRECTIVE ANTENNA SYSTEM:

The arrangement of the 3 element directive antenna system proposed for night operation is shown in Figure 2, with the horizontal plane radiation pattern. An enlarged detail of the computed minima and the expected tolerance of adjustment are also shown in Figure 2. Vertical plane patterns in the direction of the minima and the maximum are shown in Figure 3.

It is proposed to use the center one of the three towers by itself during the day, with a non-directional pattern of radiation.

Antenna design factors

Number of elements: 3 identical radiators.
Radiator type: Vertical guyed, uniform cross-section.
Overall height above grade level: 325 feet.
Height above insulators: approximately 320 feet.
Overall height above sea level: approximately 1600 feet.
Equivalent overall electrical height: 190°.
Orientation of towers: The 3 towers are in line bearing 113° true.
Tower spacing: 90° (162 feet)
Computed relative current and radiated field magnitudes:

Northwest tower	(1)	0.51
Center tower	(2)	1.0
Southeast tower	(3)	0.51

Relative current phasing:

#1	117.0°	lagging
2	2.5°	leading
3	117.0°	leading

Current distribution: Sinusoidal.
Ground system: Each radiator is to be supplied with 120 radial wires, each 0.4 wavelength long (259 feet) except where individual systems overlap. (See Figure 4). Wires are to be plowed into the soil to a depth of 4" to 6". Individual radiator ground systems are to be bonded to bus at points of intersection.
Effective field: Day and night - 1700 mv/m.

Towers #1 and #3 will be effectively disconnected during daytime operation. Operation of the proposed system in accordance with the above specifications will produce radiation patterns as shown in Figures 2 and 3. A plat of the arrangement of antenna towers and ground system is shown in Figure 4.

Radiation formulas used in the antenna design, together with sample calculations are appended to the report.

SERVICE CONTOURS:

The maps of Figures 5, 6, 7 and 8 show estimated day and night field intensity contours for both the authorized present and the proposed operation. Location of these contours is based on (1) the proposed basic pattern of radiation as shown in Figure 2, (2) conductivity of 15×10^{-14} emu, as shown in the FCC Map of Conductivity, and (3) non-directive effective fields as follows:

65

Present day	5 Kw.	435 mv/m eff. field
Present night	500 W.	135 mv/m eff. field
Proposed day	50 Kw.	1700 mv/m eff. field

Present night coverage is estimated on the basis of the FCC decision of September 5, 1945, covering the use of 500 watts at night. Night coverage prior to this time would be the same as shown for the present daytime operation.

The normally protected contour for the proposed class of station is 0.5 mv/m, day and night, and 2.5 mv/m for the present operation. The actual interference-free contour for the proposed operation is 1.5 mv/m. These contours are mapped in Figures 5 and 6.

TRANSMITTER SITE:

The site proposed for the transmitter is located about 9 miles south of Oklahoma City, in Moore Township, near US Highway 77. It is indicated on the attached maps at geographical coordinates approximately as follows:

North latitude: 35° 21' 40"
West longitude: 97° 30' 00"

The transmitting site has been selected in accordance with the Standards of Good Engineering Practice, and sufficient space has been made available to accommodate the required transmitting and radiating system as shown in Figure 4.

Distances from the proposed site to airports within 10 miles are listed as follows:

Wheatley Airport	3/4 mile southeast of site
Will Rogers Airport	7 miles northwest of site
Tinker Airport	7 miles northeast of site
Norman Field (Navy)	9 miles south of site

There are also emergency fields listed as follows:

South of site	4 miles
South of site	8 miles
Southeast of site	7.5 miles
Southeast of site	5 miles

The proposed site is not located within any regular airway marked on aeronautical charts; but it is located within the "Local Flying Area" associated with the Amber 4 Airway. Site is 3 miles south of the center line of Amber 4 airway to Tulsa, and 7 miles east of Amber 4 Airway to Fort Worth.

Radio stations and airports within 10 mile radius of the proposed site are indicated on the map of Figure 7.

980MA

1

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MONTCLAIR, N.J.

AREAS AND POPULATION:

The area covered, and population served within the various contours have been determined, and are tabulated below:

Day time operation

	Area (sq.mi.)		Population	
Contour	Present	Proposed	Present	Proposed
500 mv/m	2.12	23.75	115	1 153
250	7.06	72.4	534	3 131
25	266	1 194	224 200	260 793
5	1 523	4 900	287 950	422 458
2	3 280	10 520	357 000	610 125
0.5	10 950	32 350	554 400	1 092 672

Night time operation

500 mv/m	0.21	20.0	14	855
250	0.65	57.6	42	3 977
25	50.4	818	3 143	232 259
5	459	3 456	233 114	337 731
5				
2.5	960	-	246 416	-
2.0	1 195	7 500	255 840	429 959
1.5	1 592	9 790	264 965	470 211
0.5	-	22 870	-	682 784

Areas were computed where circular, or measured with the polar planimeter, and populations have been determined in accordance with FCC stipulations in Form 304, with reference to 1940 Census figures.

CONCLUSION:

It is believed that the proposal conforms with the requirements of good allocation; and that it involves an important gain in the efficiency of use of the 1520 Kc. channel in North America.

This report consists of 6 typewritten pages, 8 Figures and 1 appendix.

Paul F. Godley

Paul F. Godley
for PAUL GODLEY CO.
Consulting Radio Engineers
Montclair New Jersey

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PAUL GODLEY CO.
CONSULTING RADIO ENGINEERS
MONTCLAIR, N.J.

STATE OF NEW JERSEY:
COUNTY OF ESSEX: SS:

PAUL F. GODLEY, who is known to me, deposes and says: That he is a Consulting Radio Engineer; that he resides in Montclair, N.J.; that he is a member of the firm of Paul Godley Co.; that the foregoing report was prepared by him, or under his immediate supervision, and that the statements therein contained are true, to the best of his knowledge and belief.

Paul F. Godley

SUBSCRIBED and SWORN to before me this ___ day of September 1945

[signature]

My Commission expires Oct. 19, 1949.

PAUL GODLEY CO.
CONSULTING RADIO ENGINEERS
MONTCLAIR, N.J.

APPENDIX 1

Assuming equal height radiators, sinusoidal current distribution, and perfect ground reflection, and referring all current magnitudes and phases to the center tower (#2), the formula for the proposed three element array becomes:

$$e = k\,V \left[(1 + n_1 \cos A_1 + n_3 \cos A_3)^2 + (n_1 \sin A_1 + n_3 \sin A_3)^2 \right]^{1/2}$$

where

subscripts refer to tower numbers.

k = 1566 for an effective field of 1700 mv/m.

$V = \dfrac{\cos H - \cos(H \sin \theta)}{\cos\theta(\cos H - 1)}$

H = equivalent electrical height of antenna.

θ = vertical plane angle above the horizon.

n = (with subscript) current magnitude relative to center tower.

$A_1 = S_1 \cos(\phi - 180)\cos\theta + \psi_1$

$A_3 = S_3 \cos\phi \cos\theta + \psi_3$

S = (with subscript) spacing in degrees.

ϕ = azimuthal angle, measured counter-clockwise from line of towers.

ψ = (with subscript) current phase relative to center tower.

SAMPLE COMPUTATION:

Az = 168° ϕ = 55° θ = 20°

$A_1 = 90° \cos(55-180)\cos 20 + (-117 - 2.5) = -168.0°$

$A_3 = 90° \cos 55 \cos 20 + (117 - 2.5) = 163.0°$

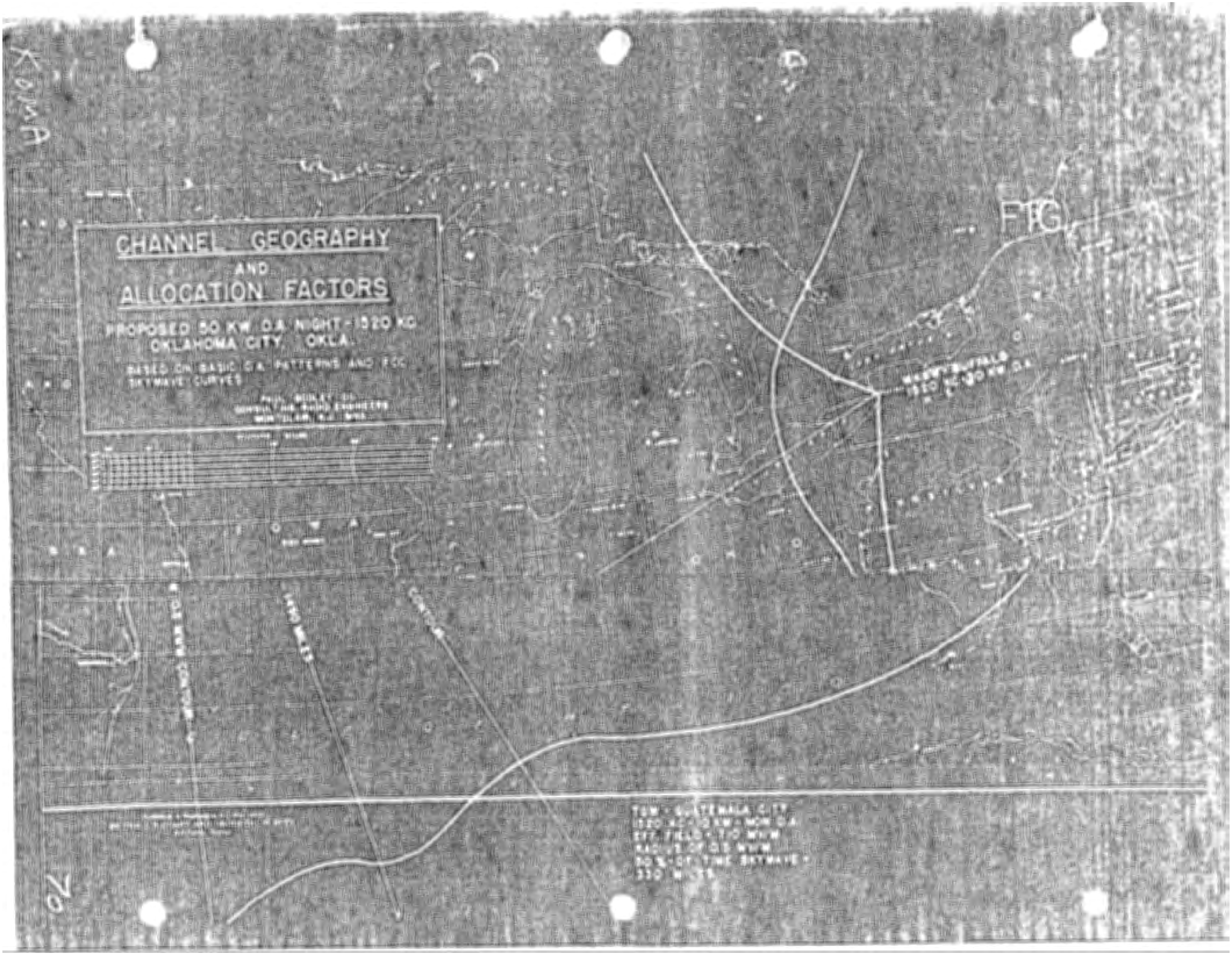
$n_1 \cos A_1 = -0.499$ $n_1 \sin A_1 = -.1060$

$n_3 \cos A_3 = -0.468$ $n_3 \sin A_3 = .1490$

$V = \dfrac{\cos 190 - \cos(190 \sin 20)}{\cos 20(\cos 190 - 1)} = 0.754$

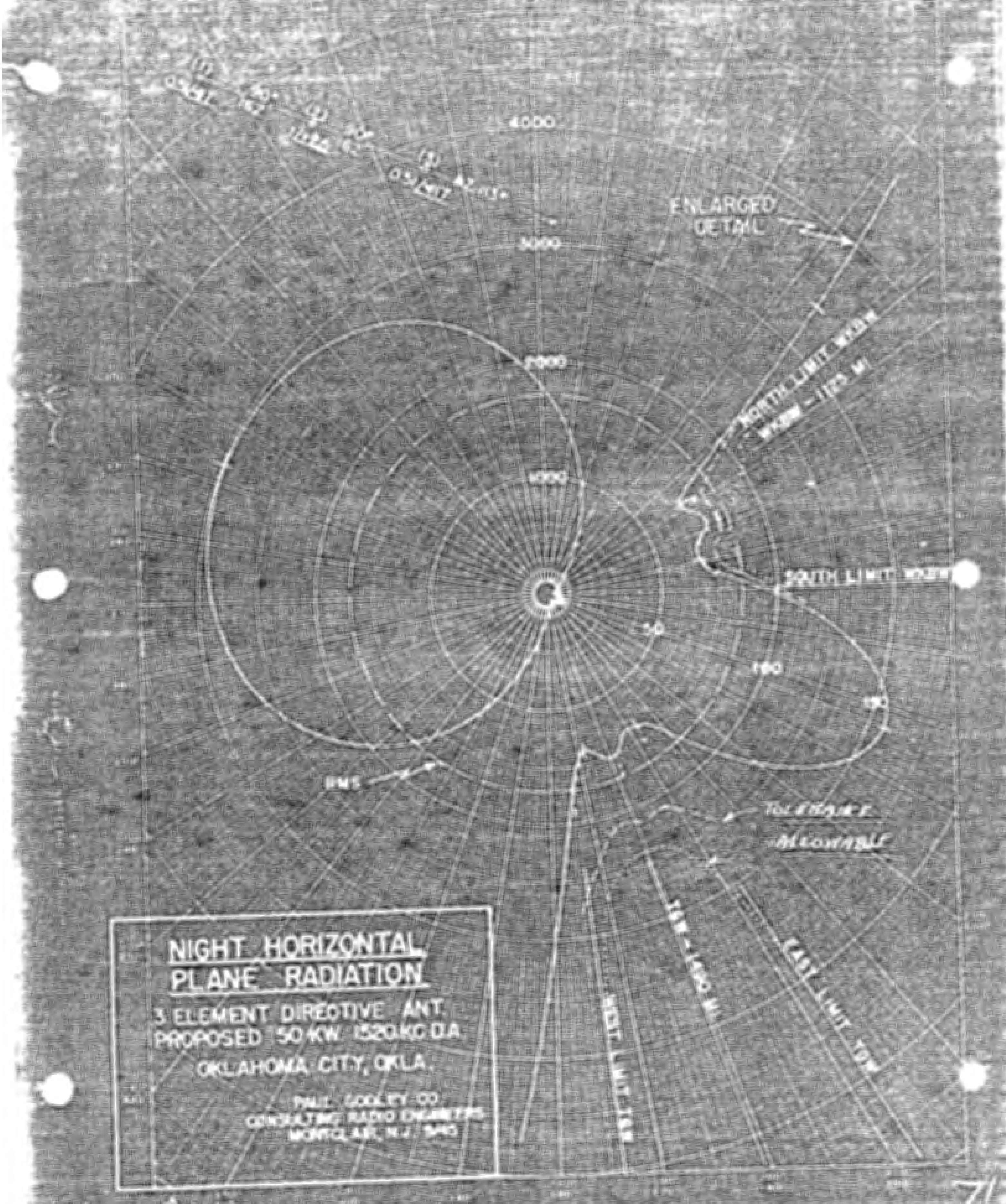
$e = 1566 \times 0.754 \left[(1 - .499 - .468)^2 + (.1490 - .1060)^2 \right]^{1/2}$

$= 53.1$ mv/m



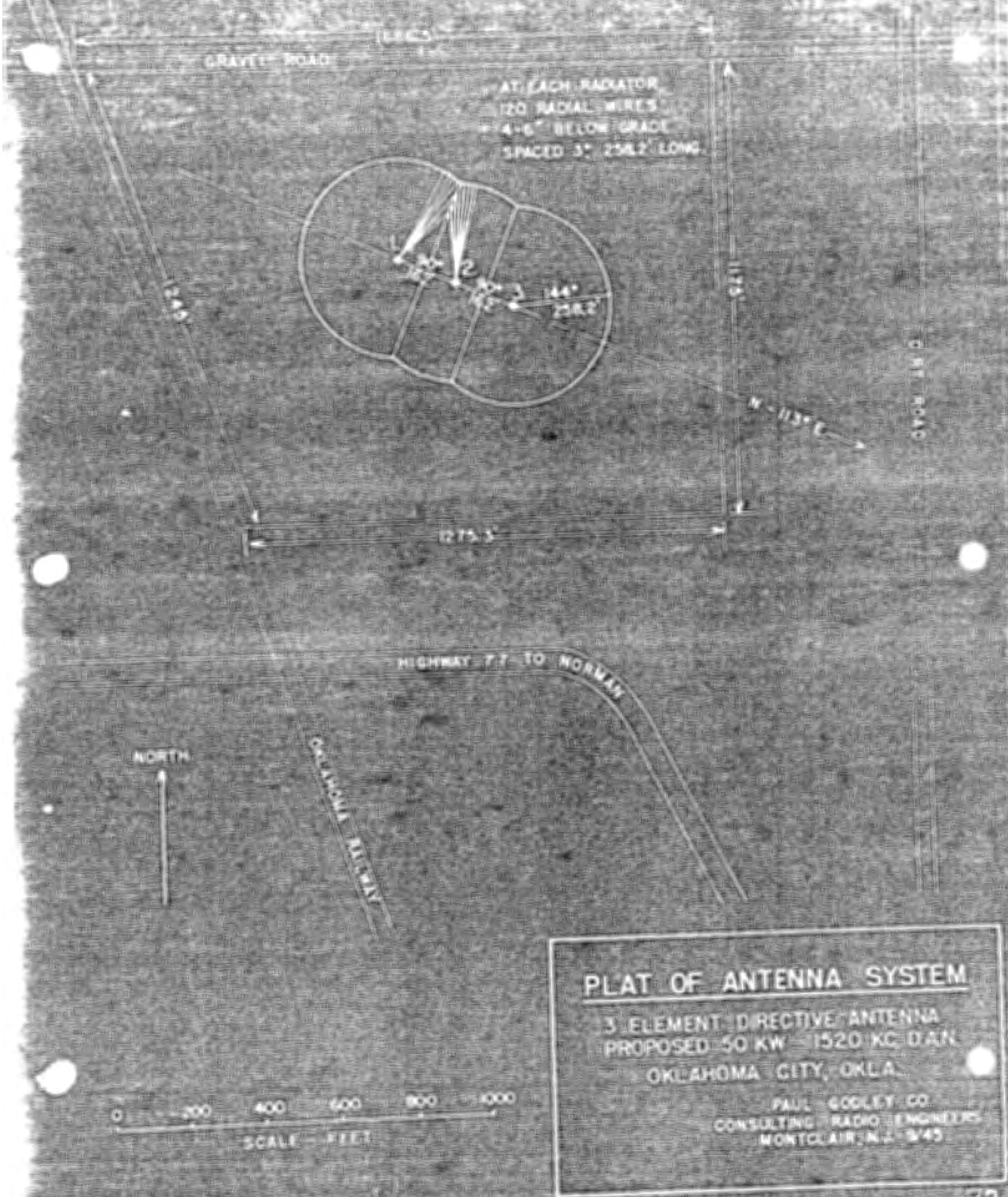
CHANNEL GEOGRAPHY
AND
ALLOCATION FACTORS
PROPOSED 50 KW DA NIGHT - 1520 KC
OKLAHOMA CITY, OKLA.
BASED ON BASIC DA PATTERNS AND FCC
SKYWAVE CURVES
FIG.
CONTOUR
KOMA
70

FIG. 2

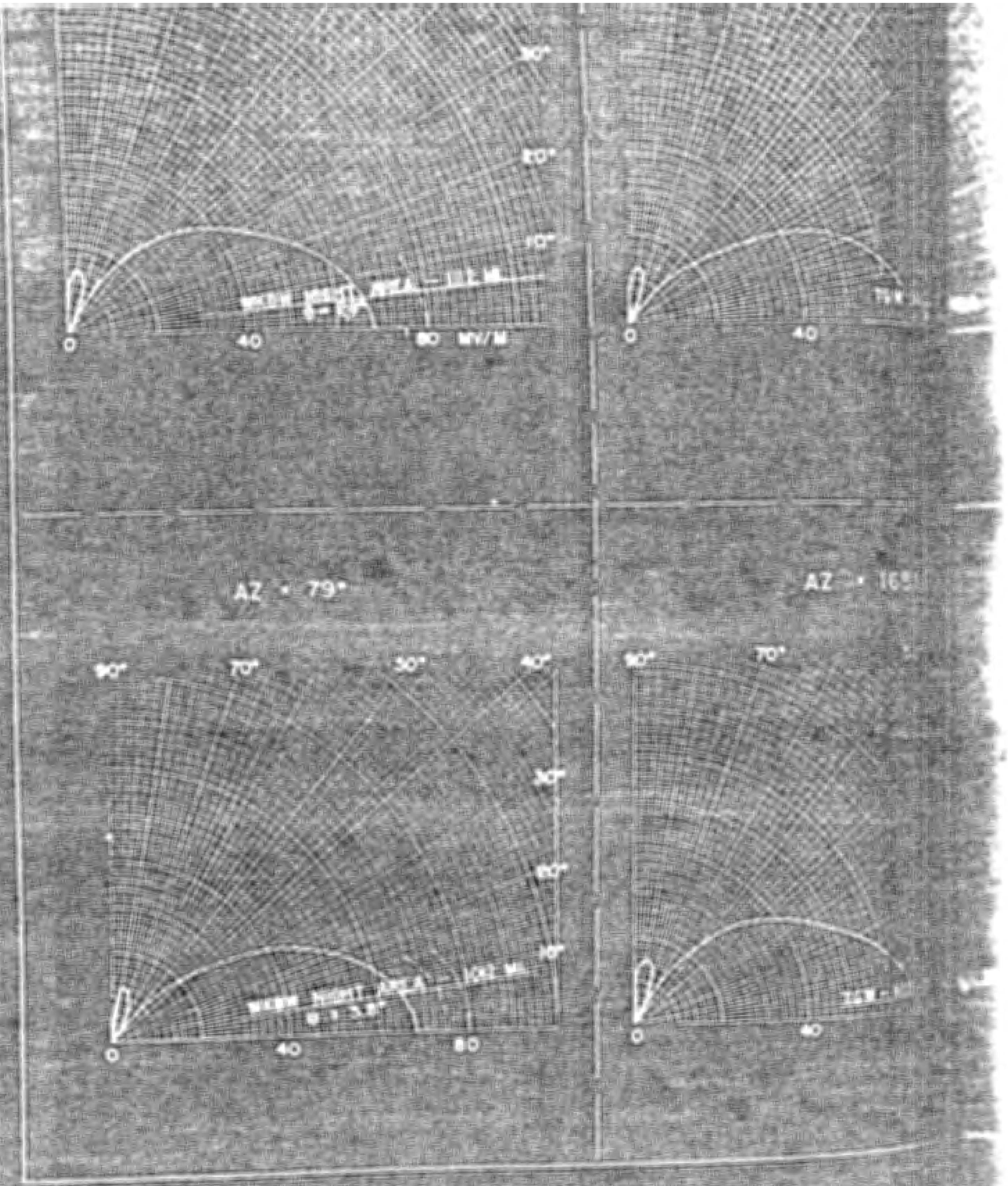

4000
3000
2000
1000
ENLARGED DETAIL
NORTH LIMIT WKBW
WKBW - 1125 MI
SOUTH LIMIT WKBW
50
100
150
RMS
EAST LIMIT
WEST LIMIT
NIGHT HORIZONTAL PLANE RADIATION
3 ELEMENT DIRECTIVE ANT.
PROPOSED 50 KW. 1520 KC D.A.
OKLAHOMA CITY, OKLA.
PAUL GODLEY CO.
CONSULTING RADIO ENGINEERS
MONTCLAIR, N.J.

KOMA

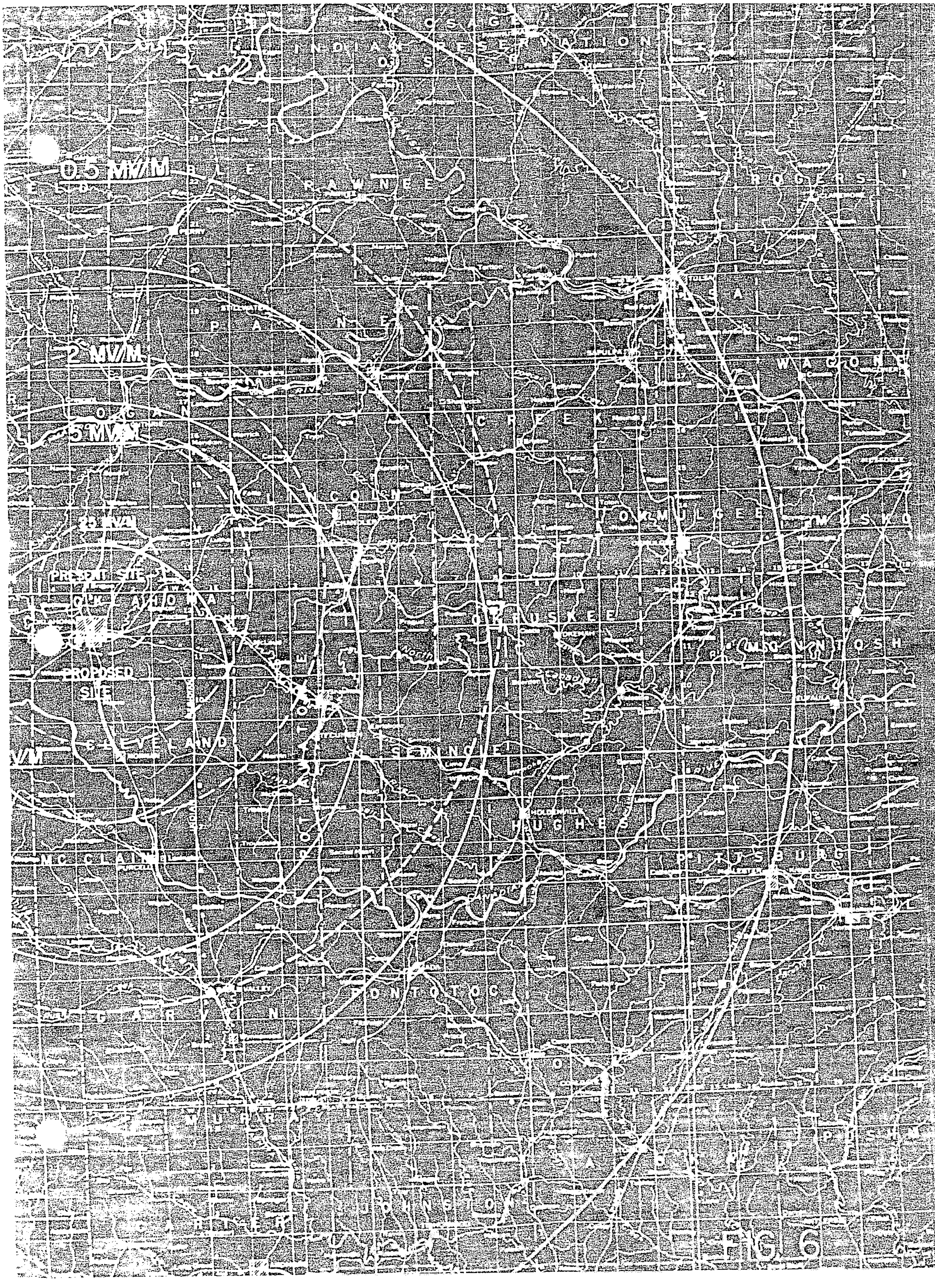
FIG 4



GRAVEL ROAD
AT EACH RADIATOR
120 RADIAL WIRES
4-6" BELOW GRADE
SPACED 3° 258.2' LONG
1
2
3
144°
258.2'
N-113°-E
1275.3'
HIGHWAY 77 TO NORMAN
OKLAHOMA RAILWAY
NORTH
0 200 400 600 800 1000
SCALE - FEET
PLAT OF ANTENNA SYSTEM
3 ELEMENT DIRECTIVE ANTENNA
PROPOSED 50 KW 1520 KC D.A.N.
OKLAHOMA CITY, OKLA.
PAUL GODLEY CO.
CONSULTING RADIO ENGINEERS
MONTCLAIR, N.J. 9/45



0
40
80 MV/M
AZ = 79°
90°
70°
0
40
80



INDIAN RESERVATION
0.5 MV/M
PAWNEE
ROGERS
2 MV/M
CREEK
5 MV/M
LINCOLN
OKMULGEE
25 MV/M
PRESENT SITE
OKLAHOMA
OKFUSKEE
McINTOSH
PROPOSED
SITE
CLEVELAND
SEMINOLE
HUGHES
McCLAIN
PITTSBURG
PONTOTOC
JOHNSTON

FIG. 6

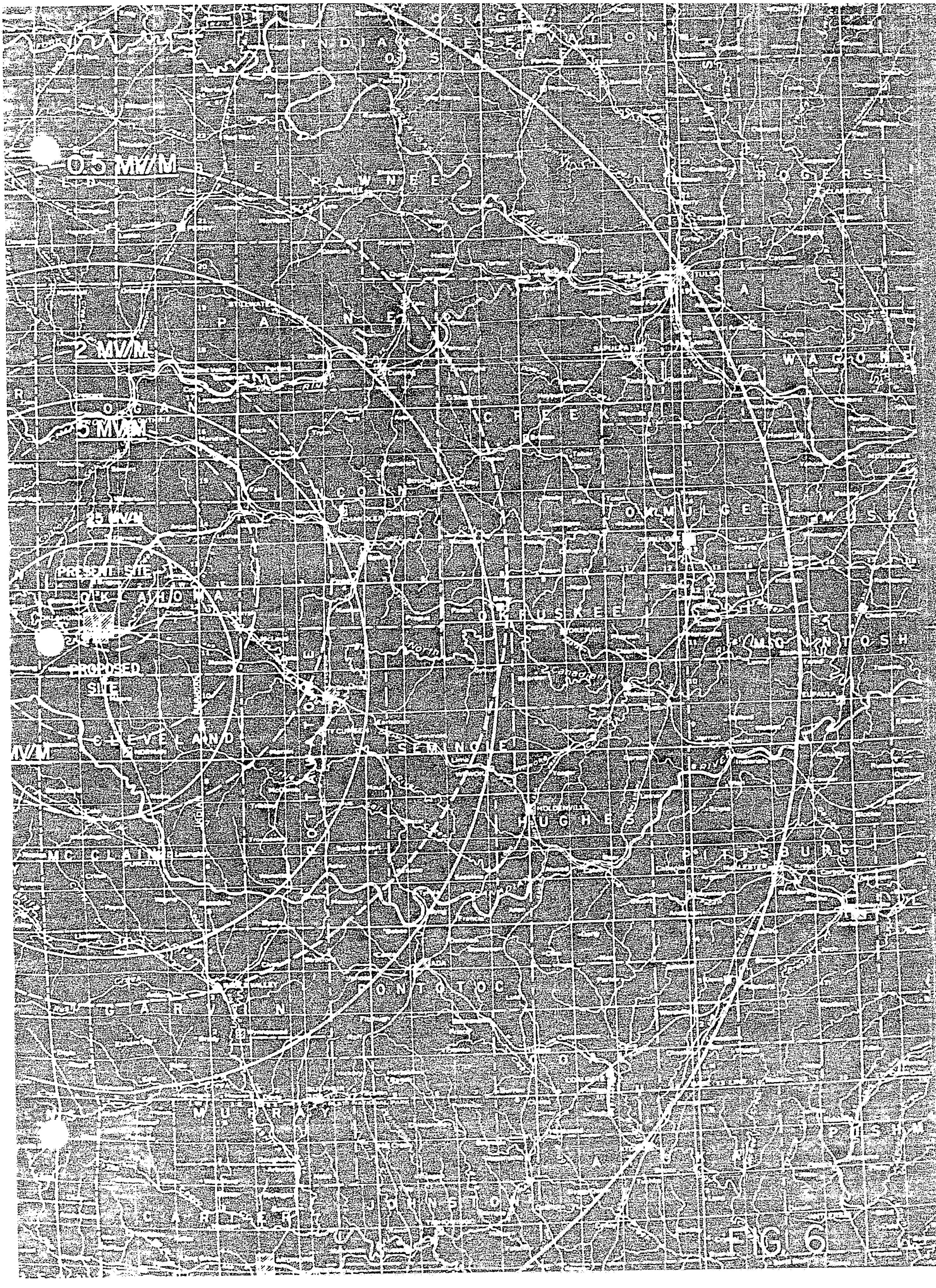
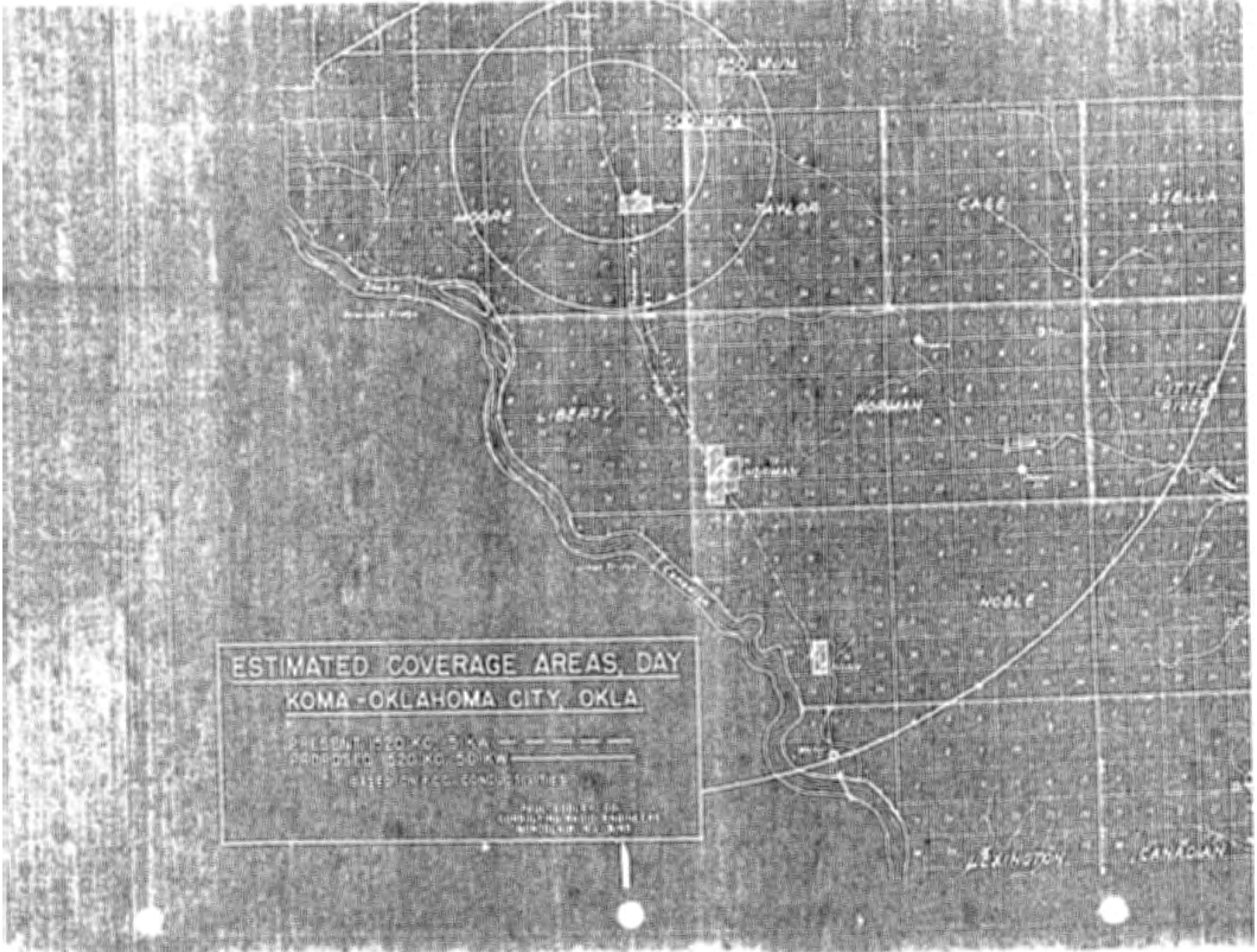

OSAGE
INDIAN RESERVATION
0.5 MV/M
PAWNEE
2 MV/M
CREEK
5 MV/M
25 MV/M
OKMULGEE
PRESENT SITE
OKLAHOMA
OKFUSKEE
McINTOSH
PROPOSED SITE
CLEVELAND
SEMINOLE
HUGHES
McCLAIN
PITTSBURG
PONTOTOC
GARVIN
JOHNSTON

FIG 6


ESTIMATED COVERAGE AREAS, DAY
KOMA - OKLAHOMA CITY, OKLA
PRESENT 1520 KC 5 KW
PROPOSED 1520 KC 50 KW
MOORE
TAYLOR
CALE
STELLA
LIBERTY
NORMAN
NOBLE
LEXINGTON

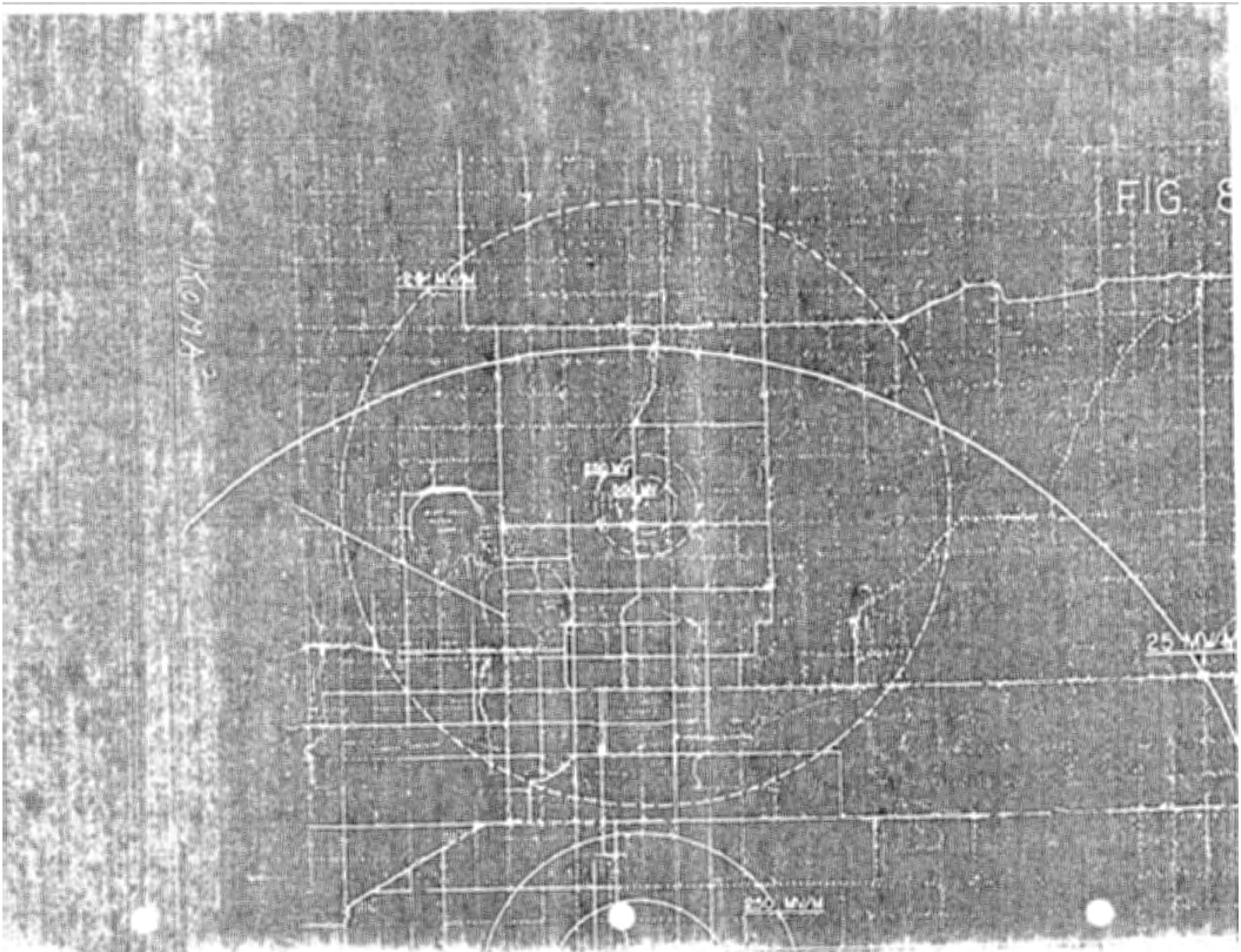
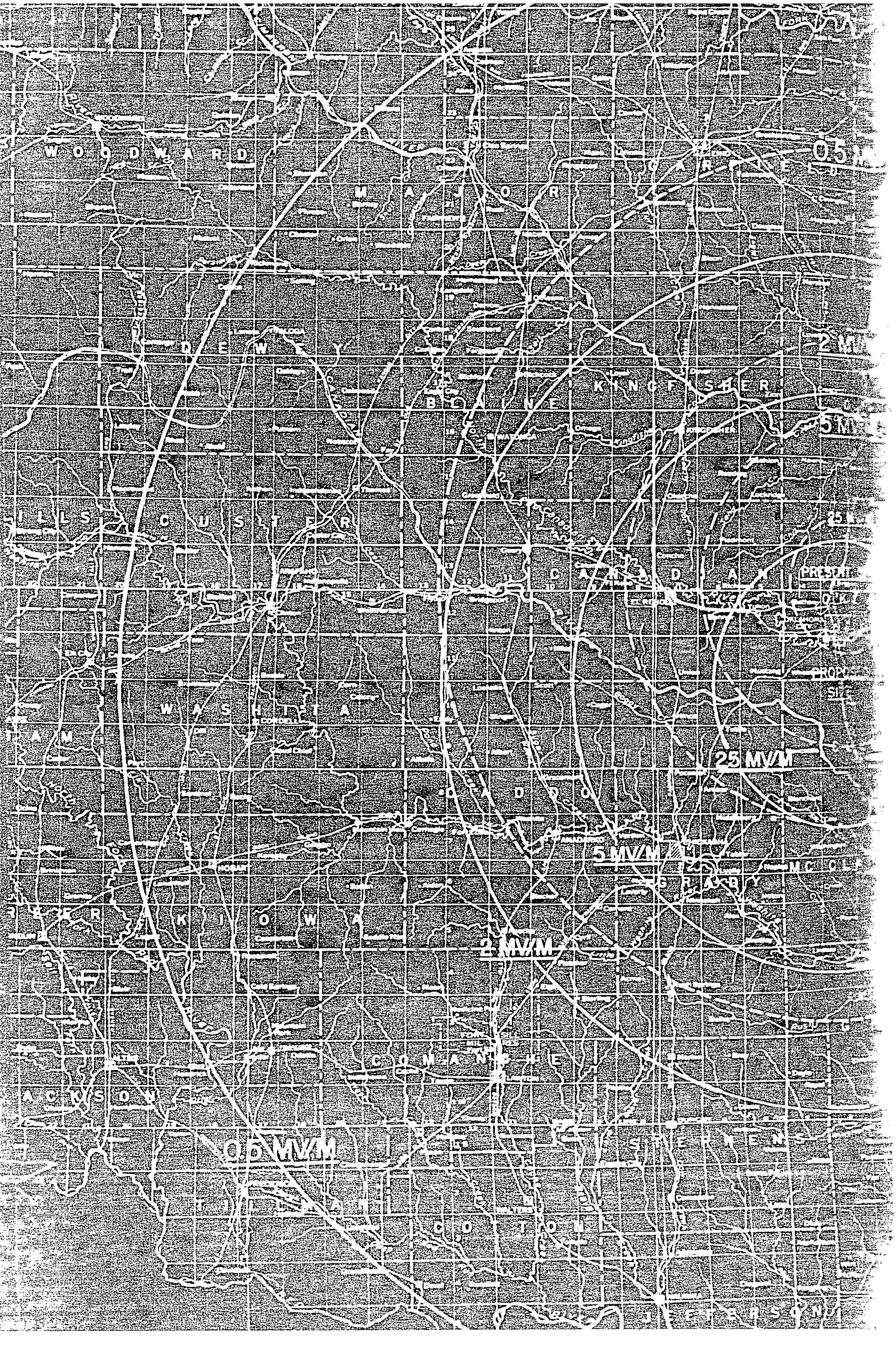
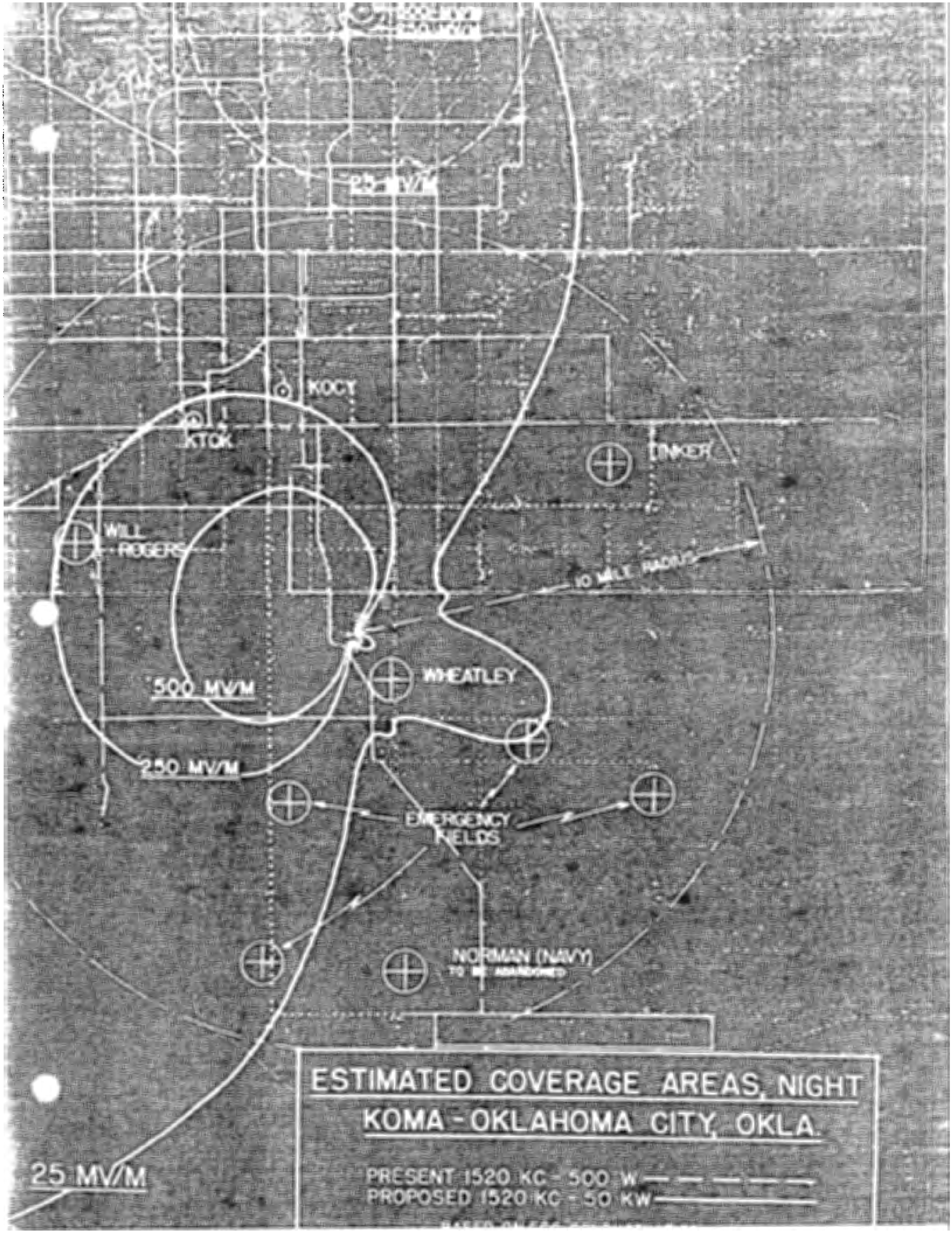
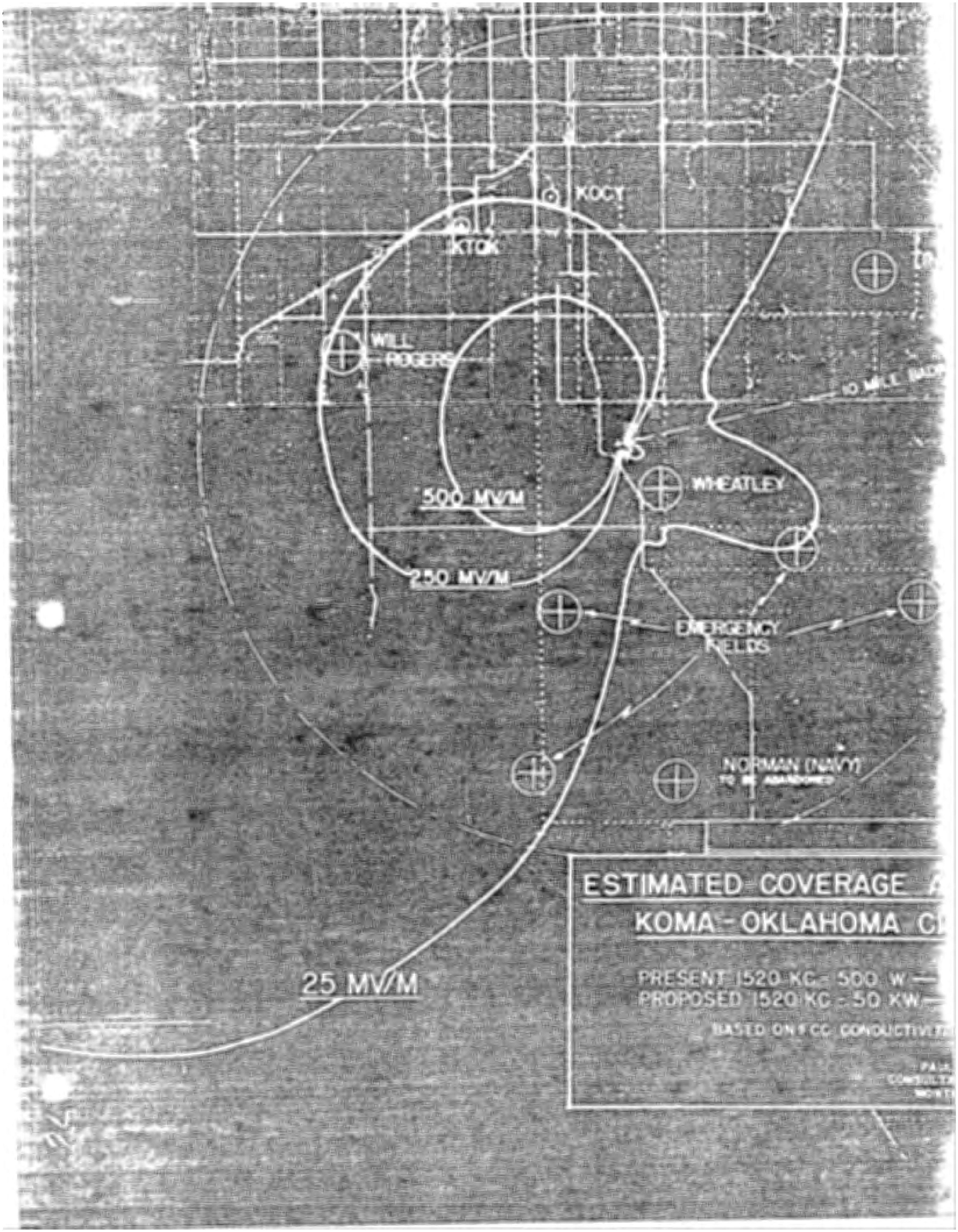


FIG. 8

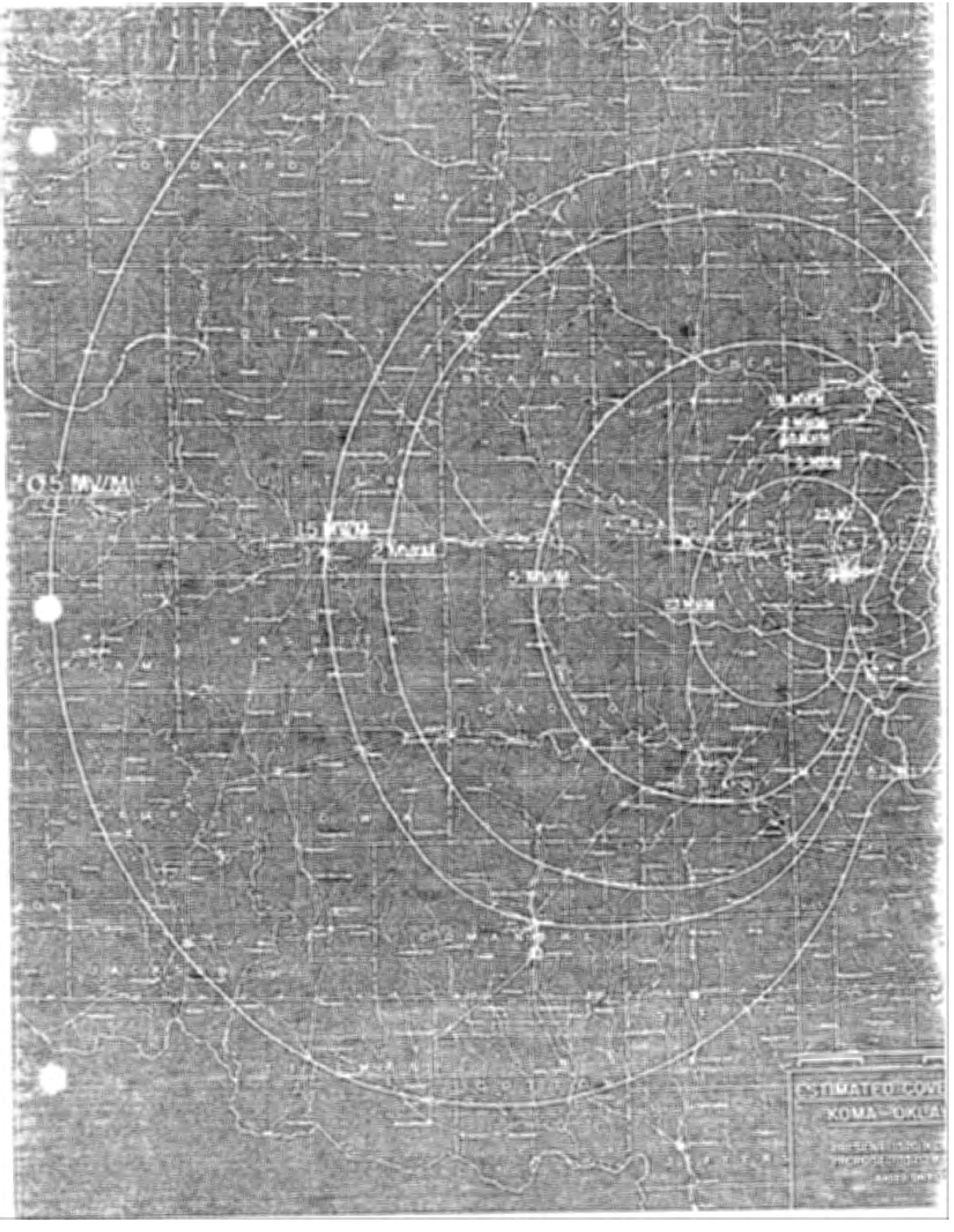


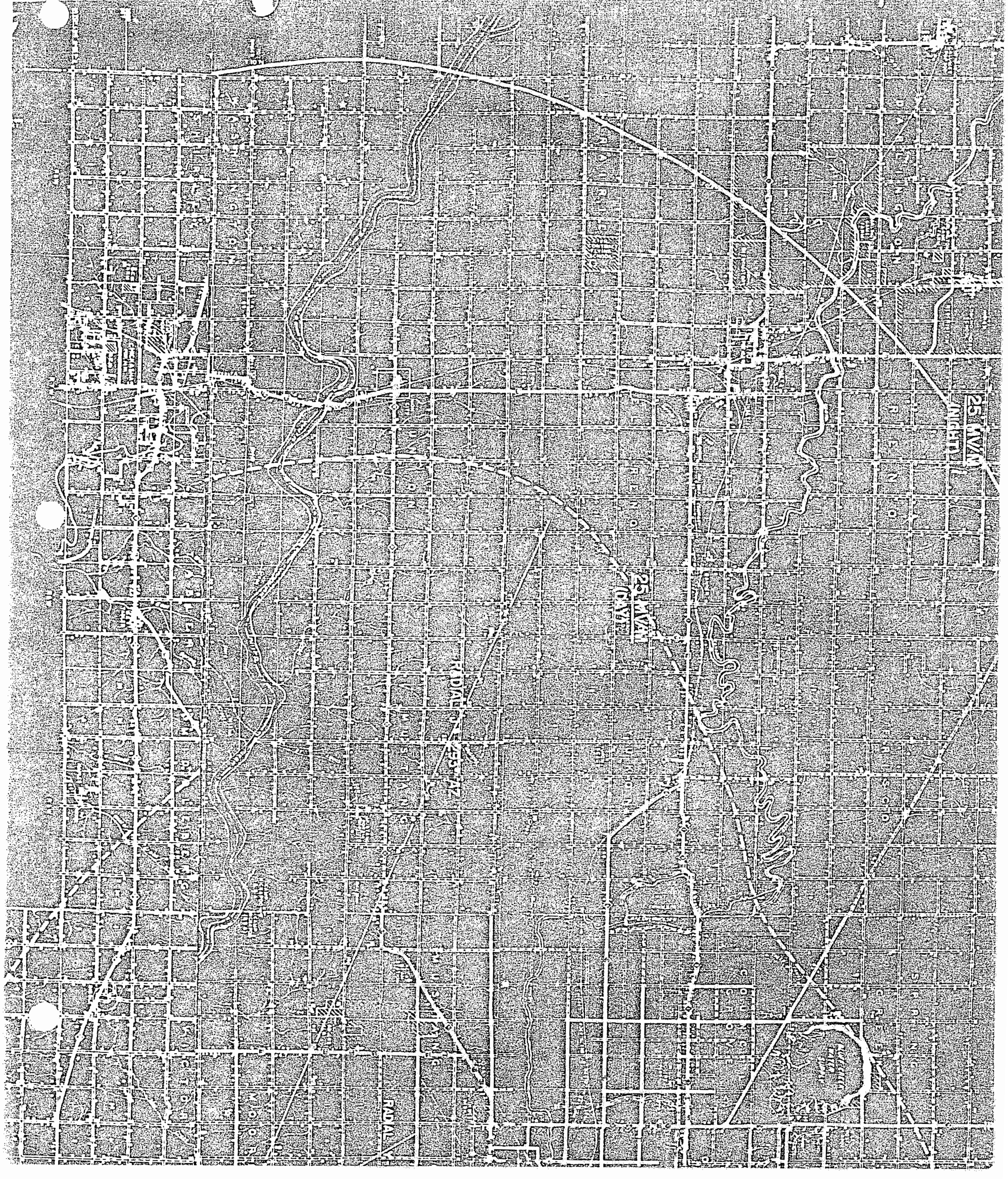
WOODWARD
MAJOR
DEWEY
BLAINE
KINGFISHER
CUSTER
CANADIAN
WASHITA
CADDO
KIOWA
COMANCHE
COTTON
25 MV/M
5 MV/M
2 MV/M
0.5 MV/M

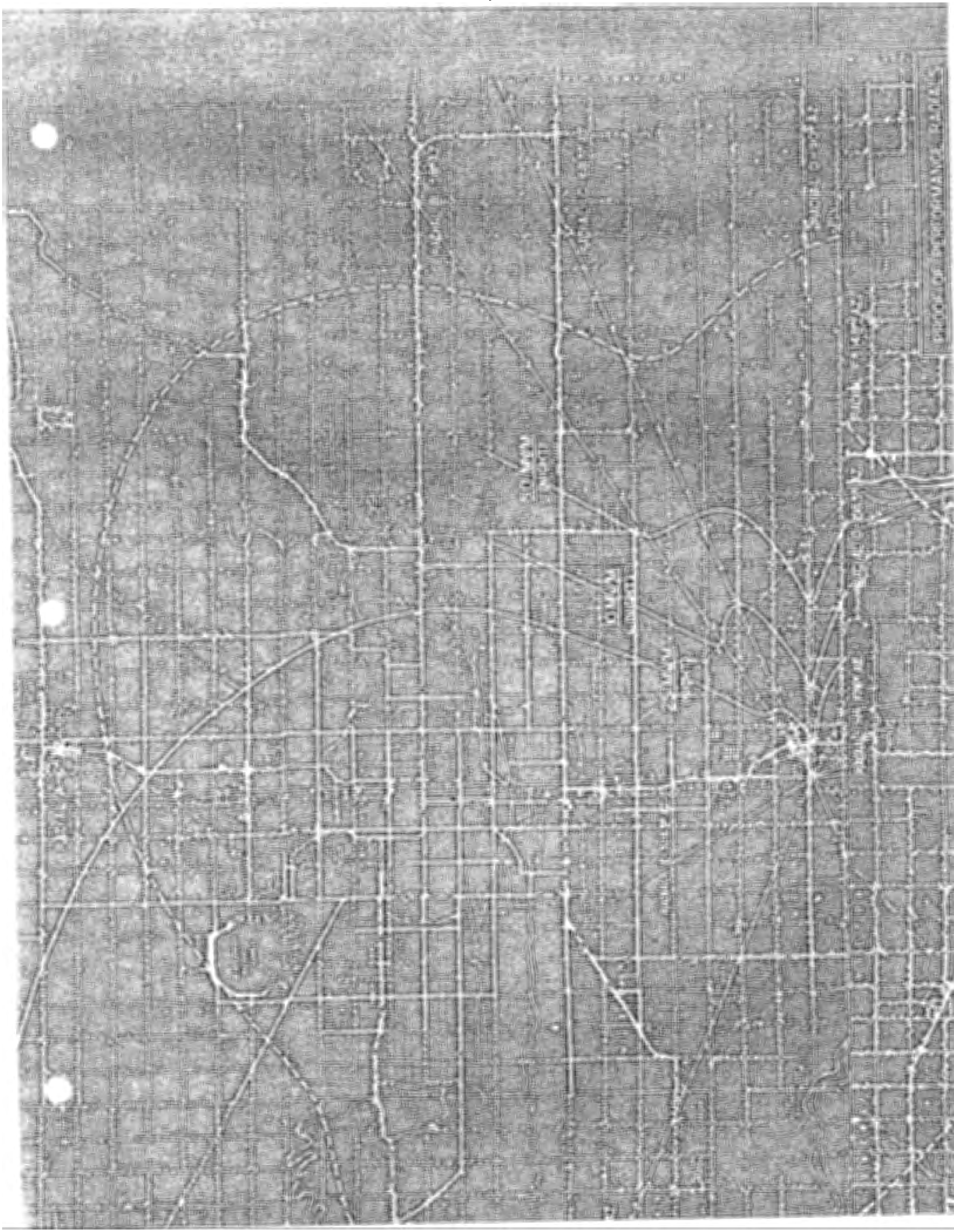

25 MV/M
KOCY
KTOK
WILL ROGERS
10 MILE RADIUS
WHEATLEY
500 MV/M
250 MV/M
EMERGENCY FIELDS
NORMAN (NAVY)
25 MV/M
ESTIMATED COVERAGE AREAS, NIGHT
KOMA - OKLAHOMA CITY, OKLA.
PRESENT 1520 KC - 500 W
PROPOSED 1520 KC - 50 KW

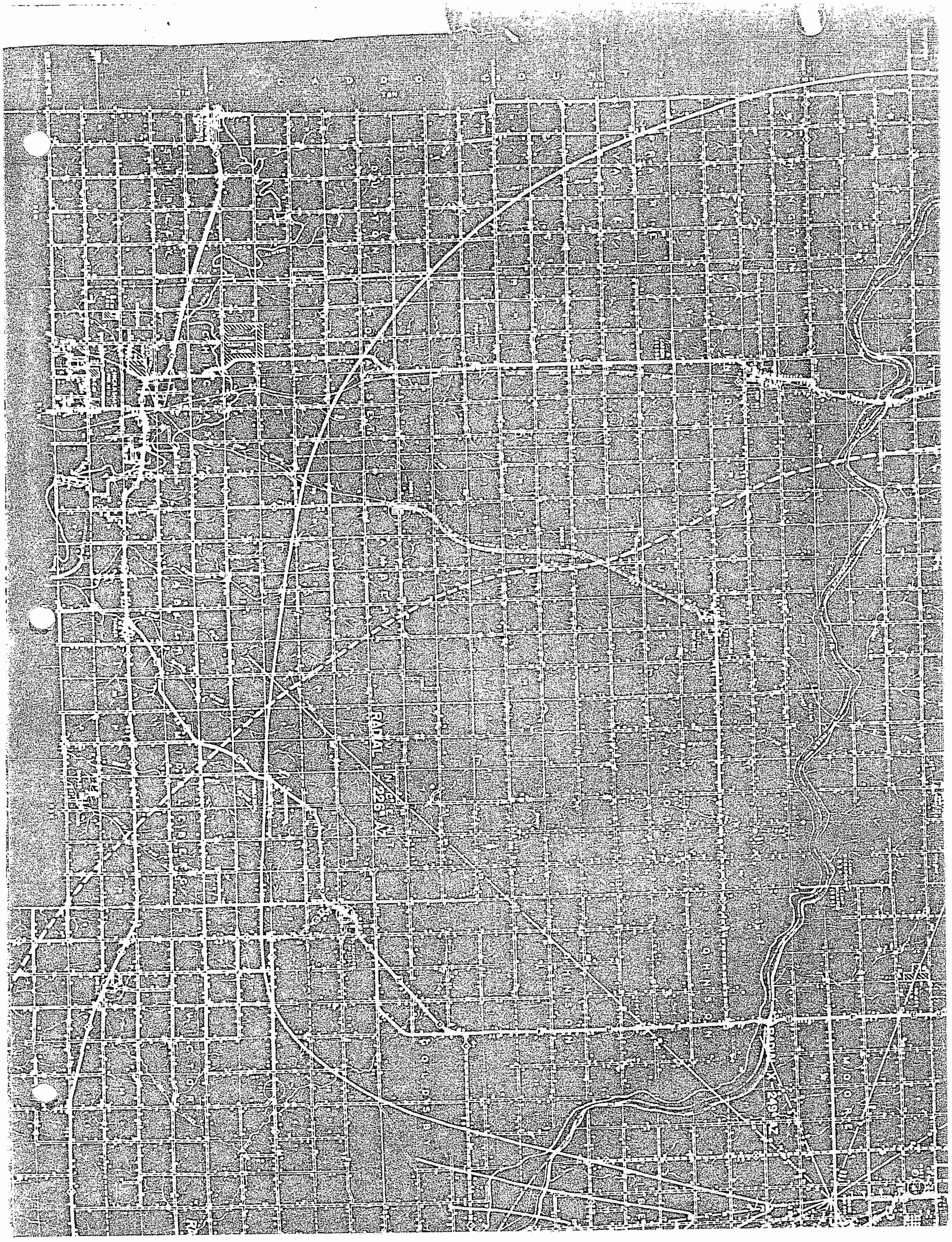


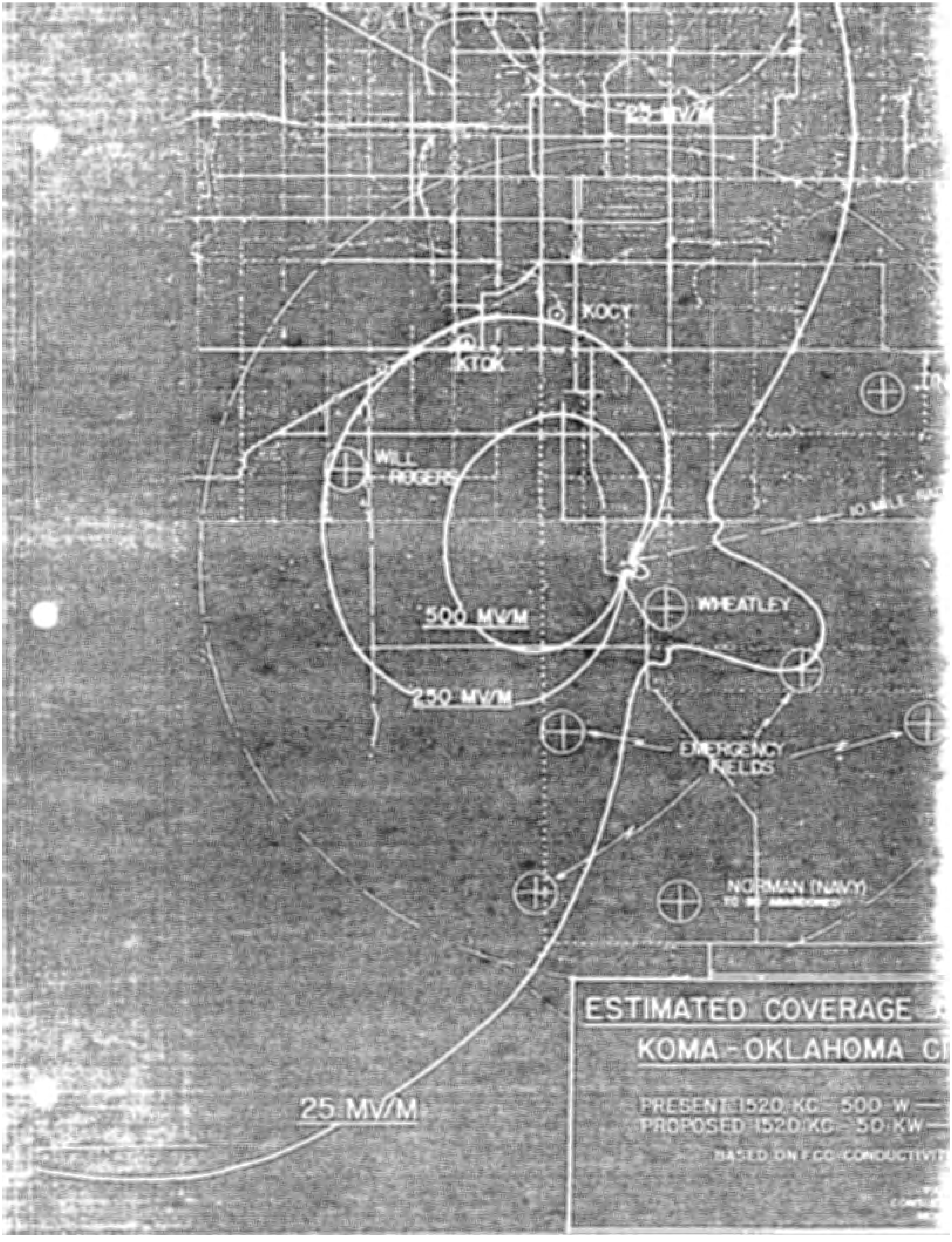
KOCY
KTOK
WILL ROGERS
WHEATLEY
500 MV/M
250 MV/M
EMERGENCY FIELDS
NORMAN (NAVY)
25 MV/M
ESTIMATED COVERAGE
KOMA - OKLAHOMA
PRESENT 1520 KC - 500 W
PROPOSED 1520 KC - 50 KW


0.5 MV/M

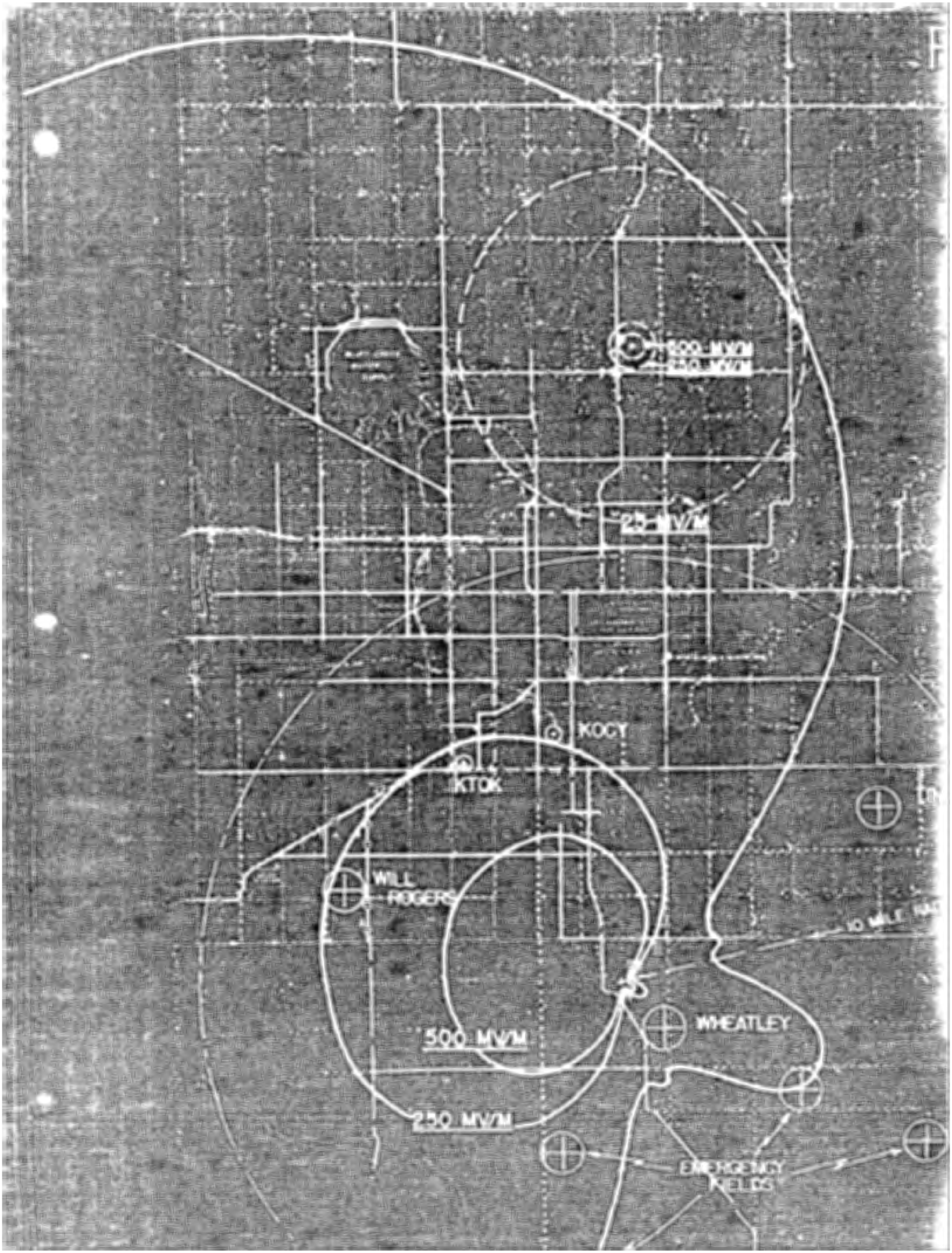

25 MVAR (NIGHT)
25 MVAR (DAY)



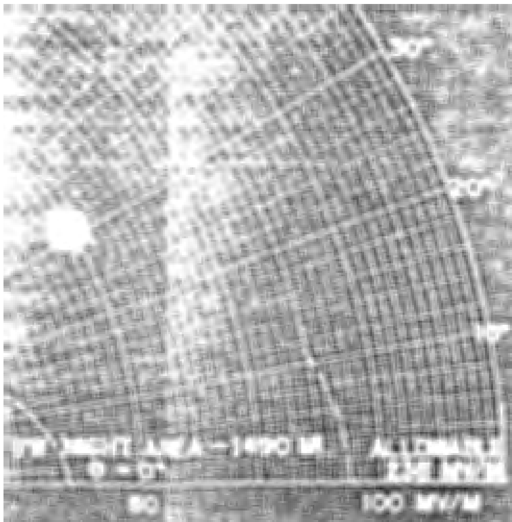


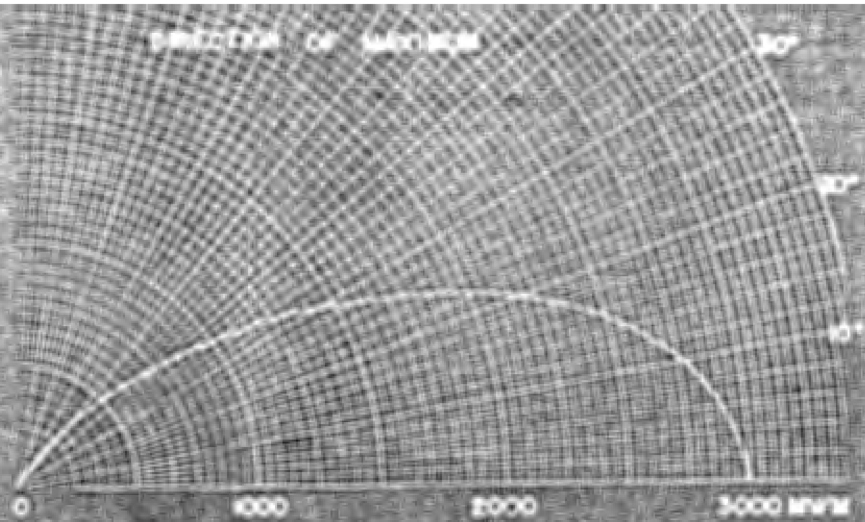


25 MV/M
KOCY
KTOK
WILL ROGERS
WHEATLEY
500 MV/M
250 MV/M
EMERGENCY FIELDS
NORMAN (NAVY)
25 MV/M
ESTIMATED COVERAGE
KOMA - OKLAHOMA
PRESENT 1520 KC 500 W
PROPOSED 1520 KC 50 KW

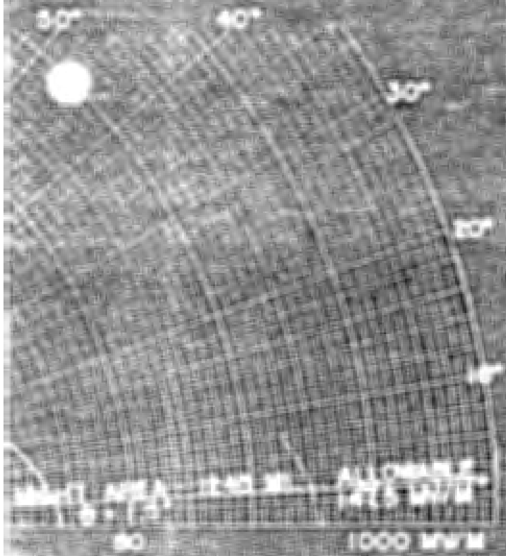


500 MV/M
250 MV/M
25 MV/M
KOCY
KTOK
WILL
ROGERS
10 MILE
WHEATLEY
500 MV/M
250 MV/M
EMERGENCY
FIELDS





68°



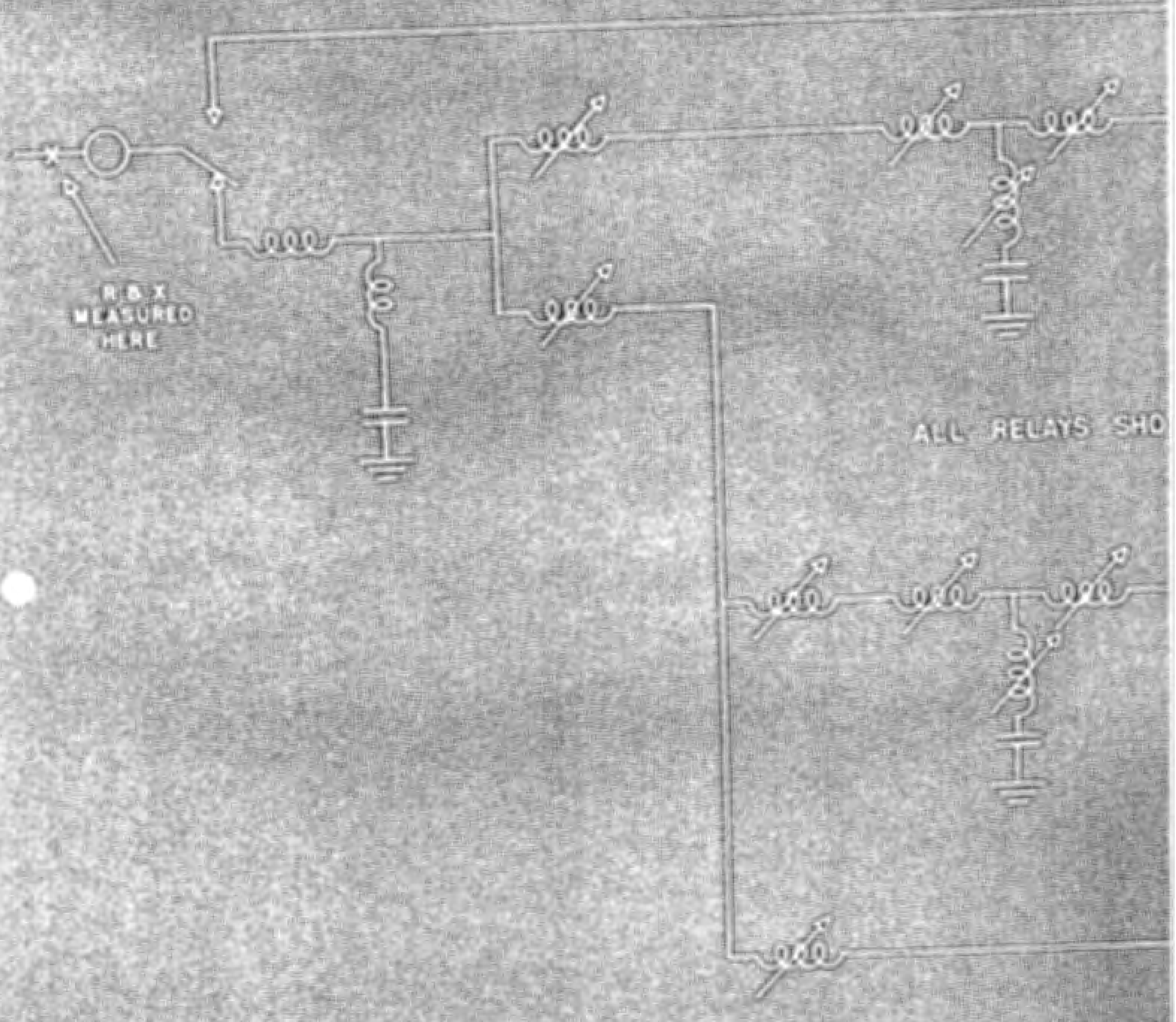
VERTICAL PLANE RADIATION

3 ELEMENT DIRECTIVE ANTENNA
PROPOSED 50 KW. 1520 KC. D.A.N.
OKLAHOMA CITY, OKLA.

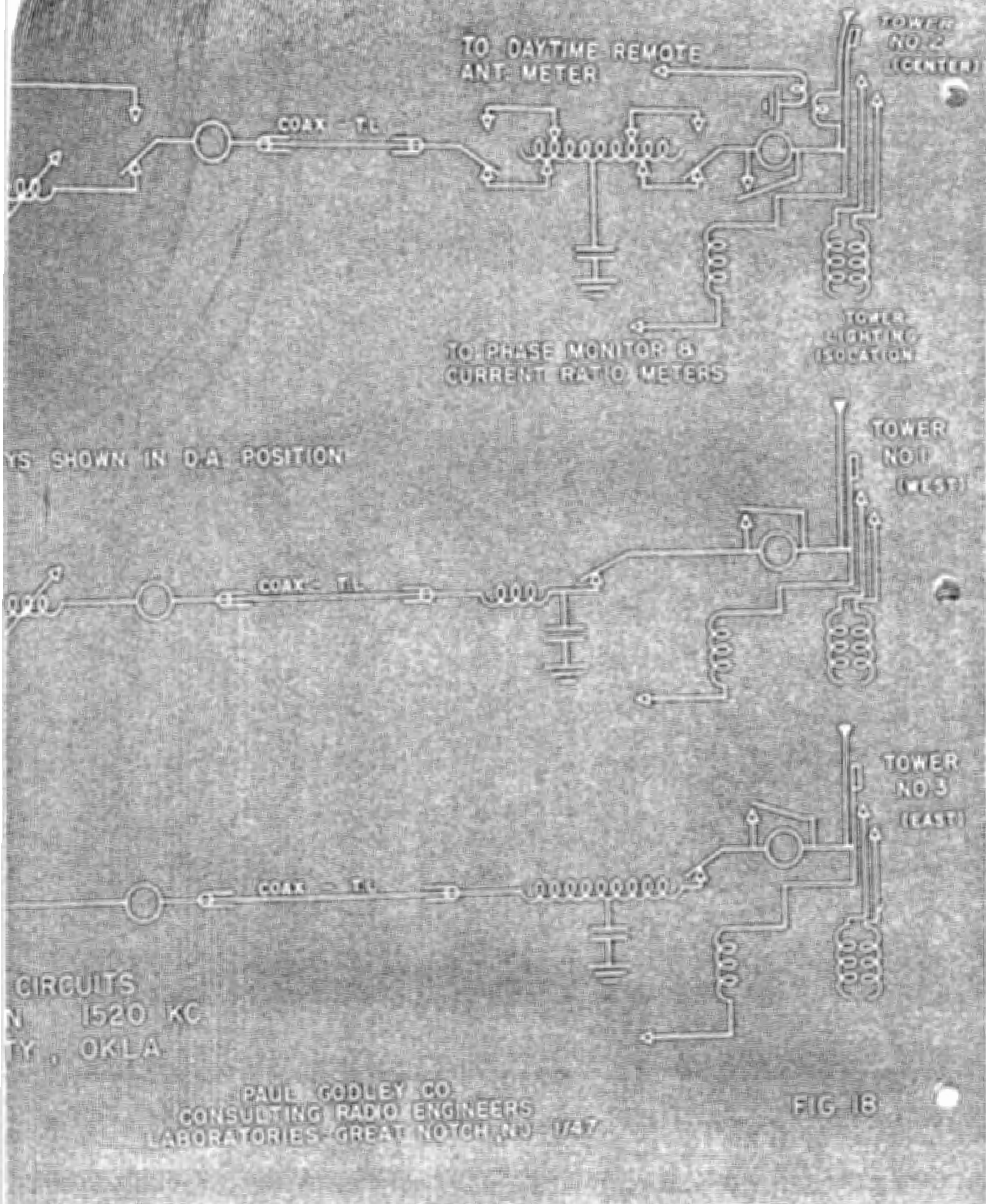
SHOWING ESTIMATED TOLERANCE
& MAXIMUM ALLOWABLE FIELD

PAUL GODLEY CO.
CONSULTING RADIO ENGINEERS
MONTCLAIR, N.J. 9/45

FIG. 3



SCHEMATIC CIRCU
KOMA 50KW DAN I
OKLAHOMA CITY, O


TO DAYTIME REMOTE
ANT. METER
TOWER
NO 2
(CENTER)
COAX - T.L.
TO PHASE MONITOR &
CURRENT RATIO METERS
TOWER
LIGHTING
ISOLATION
YS SHOWN IN D.A. POSITION
TOWER
NO 1
(WEST)
COAX - T.L.
TOWER
NO 3
(EAST)
COAX - T.L.
CIRCUITS
N 1520 KC
Y , OKLA.
PAUL GODLEY CO.
CONSULTING RADIO ENGINEERS
LABORATORIES-GREAT NOTCH, N.J. 1/47
FIG 18

May 18, 1950

Federal Communications Commission
P. O. Box 5238
Dallas 2, Texas

Attention: Mr. C. R. Williams

Dear Sir:

Reference to official notice dated April 22, 1950, regarding antenna currents in the elements not being maintained within 5% in compliance with Section 11 of Standards of Good Engineering Practice. We submit the attached data taken from field readings May 17th after final adjustments were made.

Sincerely,

H. W. Thomas
Chief Engineer

MWT/mh

Base Current	Amp.	Current Ratio	Current ratio Specified in License	% Deviation ~~Direction~~
I_1	15	1.22	1.2	plus 2%
I_2	12.3	1.0	1.0	0
I_3	1.74	1.414	1.36	plus 4%

Readings in MV/M at monitoring points

Point	MV/M	MV/M (License spec.)
1	32.0	33.0
2	3.5	15.0
3	3.2	10.0
4	13.0	23.0
5	7.2	7.2
6	6.6	14.0
7	7.7	10.

C.P. File No. ________ License File No. 469

LICENSE SPECS. FOR DIRECTIONAL OPERATION OF KOMA , Oklahoma City, Okla.

Freq. 1520 kc, Power 50 kw U DA-N , Date 10-20-50

No. and Type of Elements: Three uniform cross-section, guyed, series fed, vertical radiators

Height above Insulators: 326'

Overall Height: 327'

Spacing and Orientation: Spacing is 162'(90°) between adjacent towers on a line bearing 113° true.

Non-Directional Antenna: Center tower with end towers floating.

Ground system consists of 120 - 259' buried copper radials equally spaced about each tower.

Tower	Northwest (1)	Center (2)	Southeast (3)	
Theoretical Phasing:	-117°	2.5°	117°	
Phase Indication:*	-116°	0°	-246.5°	
Theoretical Field Ratio:	0.51	1.0	0.51	
Antenna Base Current Ratio:	1.185	1.0	0.136	
Phase Monitor Sample Current Ratio: ~~Remote Antenna Base~~	0.522	1.0	0.517	

* As indicated by W E 2A phase monitor.

Phase indications and antenna base currents shall be read and entered in the operating log at least once each hour. ~~Phase monitor sample~~ currents may be read and logged in lieu of base currents provided base currents are read and logged at least once daily (~~for each pattern~~).

The field intensity in mv/m (at night) of KOMA measured at the monitoring points described on the attached sheets is not to exceed the following values:

No. 1(58 °) 34.	No. 4(113 °) 23.	No. 7(174 °) 16.
No. 2(68.5 °) 45.	No. 5(148 °) 18.	No. 8(°)
No. 3(90 °) 10.	No. 6(158.5 °) 11.	No. 9(°)

(Special Requirements)

KOMA 1520 KC Projection of Contours by equivalent-distance method

Az	Eo*	0.5	Eo	0.5	Equal
0	1670	102	1910	107	5.5° and
30	✓	102	600	67	216°
60	"	102	67	26.6	
90	"	96	30	18.4	
120	"	90.5	120	34.3	
150	"	85	68	27	
180	"	104.5	110	33	
210	"	105	1280	94	
240	"	105.5	2620	124.5	
270	"	105.5	3330	135.5	
300	"	104	3580	138	
330	"	103	2910	122	
		15°	1270	92	
		45	170	39.5	
		140	61	25.5	
		158	95	31	
		173	45	22	
		195	530	64	

* Ht = 325'
6 = .5 λ
$\sqrt{50} \times 236$

KTOK - 212 510304 DBP

KOMA, 1520 KC, 50 KW, DA-N

Site 35° 20' 00" N h = 325'
97° 30' 02" W G = 0.5λ

F.C.C. Ground Conductivity Map

Az	Distance & Conductivity
0	15 (0-102 mi), 20 (102 -
30	15
60	15 (0-117 mi), 6 (117-140), 4 (140 →)
90	15 (0-77 mi), 6 (77-95 m), 4 (95 →
120	15 (0-63 mi), 6 (63-102)
150	15 (0-48 mi), 6 (48 →
180	15 (0-81 mi), 20 (81 →
210	15 (0-66 mi), 20 (66 →
240	15 (0-62 mi), 20 (62 →
270	15 (0-62 mi), 20 (62 →
300	15 (0-72 mi), 20 (72 →
330	15 (0-88 mi), 20 (88

Appendix V, attached hereto, is the Horizontal Plane Radiation Pattern of the KOMA Directional Antenna. This was obtained by plotting the results of Appendix III in graphic form.

Appendix VI-A and VI-B, attached, show the various Vertical Plane Radiation Patterns of the KOMA Directional Antenna. This was obtained by plotting the results of Appendix IV in graphic form.

Appendix VII, attached hereto, is a map of the United States, showing the Canadian border, on which have been drawn the estimated location of the 25 microvolt-per-meter 10% second-hour interference signal.

The North American Regional Broadcasting Agreement provides that in the use of 690 kc, in the United States, it is "permissible to increase the field intensity above 25 uv/m (10% skywave) west of ninety-[illegible] Canadian border." This agreement provides that (with the above exception) the United States station shall not deliver in excess of 25 uv/m across the Canadian border. Examination of Appendix VII shows that these conditions are met by the proposed operation of KOMA.

Appendix VIII, attached hereto, is a portion of an airways map showing the location of the proposed transmitter for KOMA, 50 kw, 690 kc operation, with relation to airways and airports. The nearest airport (Curtiss-Wright, 10 miles away) is not used by transport airlines.

Appendix IX, attached hereto, is a portion of a United States Topographic Map, showing the site of the proposed operation of KOMA, and also showing the estimated location of the 250 mv/m contours (day and night) resulting from the proposed operation.

Appendix X, attached hereto, is a map of Oklahoma City and surrounding area, showing the estimated location of the 25 and 5 mv/m contours. Signals in excess of 25 mv/m are provided over all the city of Oklahoma City.

The population within the various contours has been estimated by applying these contours to Census Bureau maps, and referring to the Report of the Fifteenth Census (1930). These estimates are as follows:

Contour	Day	Night
250 mv/m	4,114	1,154
25	315,204	297,904
5 mv/m	995,616	799,981

Affiant states that the foregoing is true of his own knowledge except as to such portions of the foregoing made on information and belief, and that he believes such portions to be true.

Joseph A. Chambers
Joseph A. Chambers

Sworn to before me this 9th day of December, 1940.

Grace L. [illegible]
Notary Public, D.C.

My Commission Expires ______________.

A P P E N D I X 1

DESCRIPTION OF DIRECTIONAL ANTENNA PROPOSED FOR

KOMA, OKLAHOMA CITY, OKLA., 50 KW., [illegible]

The proposed directional antenna is described as follows:

a. Number of elements: Three

b. Type of elements: Vertical radiators, insulated. The center element will be guyed, uniform cross-section. The two end elements will be self-supporting, tapered cross-section. Other details to be determined.

c. Top loading: None

d. Height above insulators: Center element: 750 feet, (0.[illegible] λ, 190°) Each end element: 200 feet (0.14 λ, 51°)

e. Overall height above ground level: Center element, approximately 755 feet; each end element, approximately 205 feet.

f. Overall height above mean sea level: Center element, approximately 1845 feet, each end element, approximately 1295 feet.

g. Orientation: Three towers on a line bearing 29° true. Towers spaced 110°, 436 feet apart on this line. The phase of the field from the north-east element is 74° ahead of the field of the center element, while the phase to the field of the south-west element lags to the field of the center element by 74°.

h. Ground system: A 40 x 40 foot ground screen will be placed under each tower. Not less than 120 buried radial ground wires will extend from each ground screen to a distance of 450 feet, except that where the ground systems of the separate towers would overlap they are joined.

i. Ratio of fields from elements: Relative units;
Center element = 2.04
Each end element = 1.0

j. The design includes the usual assumption that the current distribution in the elements is essentially sinusoidal. It is also assumed that the effective field in the horizontal plane from the center element alone (750 foot tower) is 240 mv/m/kw, or 1700 mv/m for 50 kw, and that the RMS value of the effective field from the array is 1500 mv/m for 50 kw.

APPENDIX II

FORMULAS FOR DETERMINATION OF PERFORMANCE

OF [illegible] DIRECTIONAL ANTENNA

The basic formula used for determination of performance of a three-element antenna, as here proposed is:

$$E = \frac{k}{\sin\theta}\sqrt{\begin{aligned}&\{f_1(\cos h_1 - \cos[h_1\cos\theta]) + f_2(\cos h_2 - \cos[h_2\cos\theta])\cos[S_2\cos(\phi_2-\phi)\sin\theta+\psi_2] + f_3(\cos h_3 - \cos[h_3\cos\theta])\\&\cos[S_3\cos(\phi_3-\phi)\sin\theta+\psi_3]\}^2 + \{f_2(\cos h_2 - \cos[h_2\cos\theta])\sin[S_2\cos(\phi_2-\phi)\sin\theta+\psi_2] + f_3(\cos h_3 - \cos[h_3\cos\theta])\\&\sin[S_3\cos(\phi_3-\phi)\sin\theta+\psi_3]\}^2\end{aligned}}$$

Where

f_1 = relative radiation from element No. 1

f_2 = relative radiation from element No. 2

f_3 = relative radiation from element No. 3

h_1 = height of element No. 1, degrees

h_2 = height of element No. 2, degrees

h_3 = height of element No. 3, degrees

ϕ = azimuth angle

ϕ_2 = bearing No. 2 element from No. 1 (used as reference)

ϕ_3 = bearing No. 3 element from No. 1

S_2 = spacing, degrees, No. 2 element from No. 1

S_3 = spacing, degrees, No. 3 element from No. 1

θ = zenith angle

ψ_2 = phasing No. 2 element referred to No. 1

ψ_3 = phasing No. 2 element referred to No. 1

k = pattern constant, including RMS value

For the array proposed, the No. 1 element has a height of

190°, and for the horizontal plane pattern, where $\Theta = 90°$,

$$f_1 (\cos h_1 - \cos [h_1 \cos \Theta]) = f_1 (-.985 - 1) = 1.985 f_1$$

Elements No. 2 and No. 3 each have a height of 51°, and for the horizontal plane pattern, where $\Theta = 90°$,

$$f_2 (\cos h_2 - \cos [h_2 \cos \Theta]) = f_2 (.629 - 1) = .371 f_2$$

The horizontal field of element No. 1 is 2.04 relative units. Therefore, $f_1 = \frac{2.04}{1.985} = 1.028$

The horizontal fields of elements No. 2 and No. 3 are each 1 relative unit. Therefore, f_2 and $f_3 = \frac{1.0}{.371} = 2.695$

Let f_2 and $f_3 = 1$, then $f_1 = .381$

Substituting these and other values for antenna proposed, and letting $\phi_2 = \phi_3 = 0$, the formula becomes:

$$E = \frac{1}{\sin \Theta} \Big\{ .381 (\cos 190 - \cos [190 \cos \Theta]) + (\cos 51 - \cos [51 \cos \Theta]) \cos [110 \cos \phi \sin \Theta + 74] + (\cos 51 - \cos [51 \cos \Theta]) \cos [110 \cos (120 - \phi) \sin \Theta + 74] \Big\} + [illegible] \Big\{ (\cos 51 - \cos [51 \cos \Theta]) \cos [110 \cos \phi \sin \Theta + 74] + (\cos 51 - \cos [51 \cos \Theta]) \cos [110 \cos (120 - \phi) \sin \Theta + 74] \Big\}$$

$$E = \frac{1}{\sin \Theta} \Big\{ .381 (\cos 190 - \cos [190 \cos \Theta]) + .742 \cos [110 \cos \phi \sin \Theta + 74] (\cos 51 - \cos [51 \cos \Theta]) \Big\}$$

For the horizontal plane pattern, $\Theta = 90°$,

$$E = \{ .381 (1.985) + .742 \cos [110 \cos \phi \sin \Theta + 74] \}$$

$$= \{ .7565 + .742 \cos [110 \cos \phi \sin \Theta + 74] \}$$

$$= .742 \{ 1.02 + \cos [110 \cos \phi \sin \Theta + 74] \}$$

APPENDIX III

[illegible] OF [illegible] PLANE RADIATION PATTERN

[illegible]

For determination of radiation pattern in the horizontal [illegible], where θ = 90°, the formula becomes:

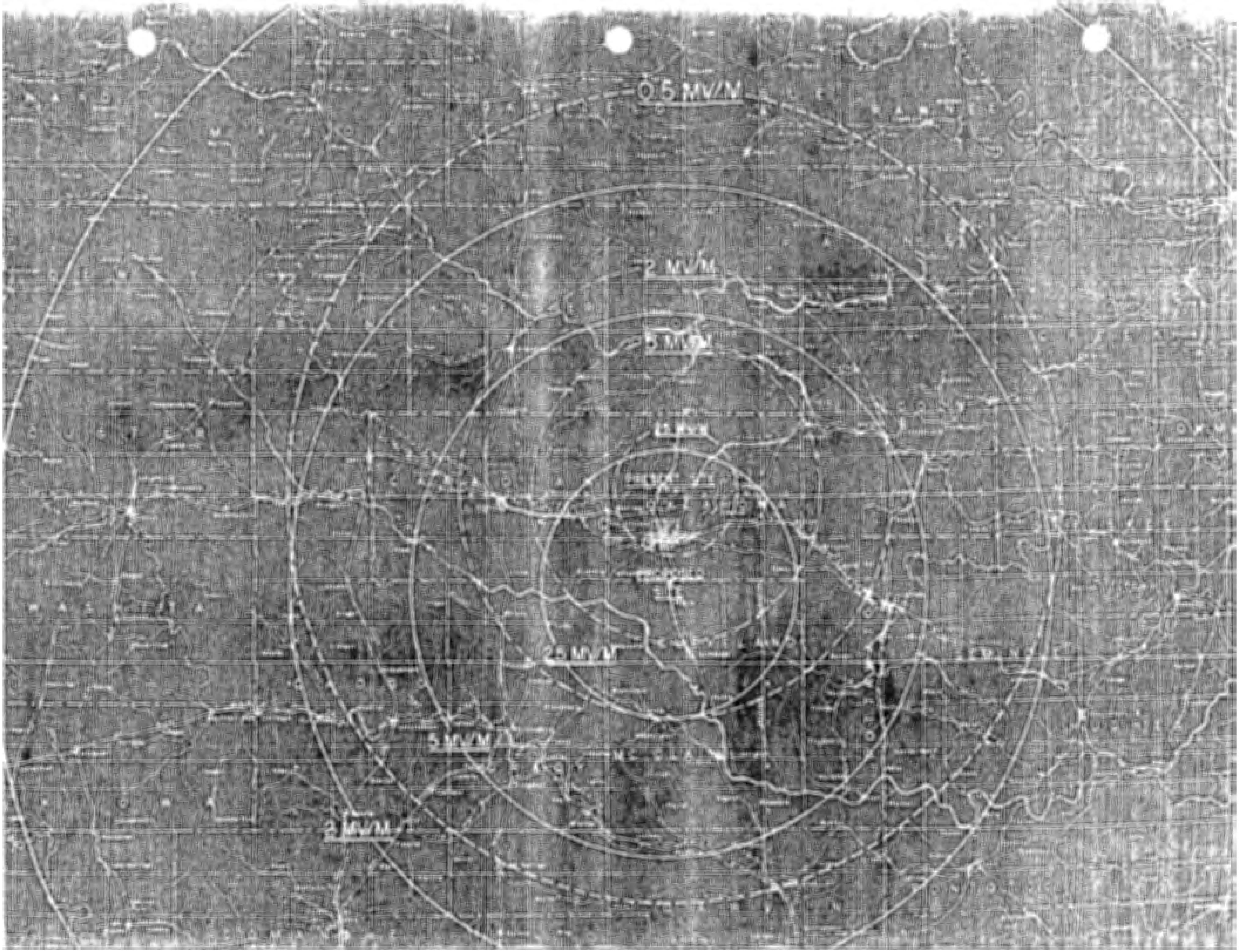
E_{ϕ} = K(1.02 + cos [110 cos ϕ + 74])

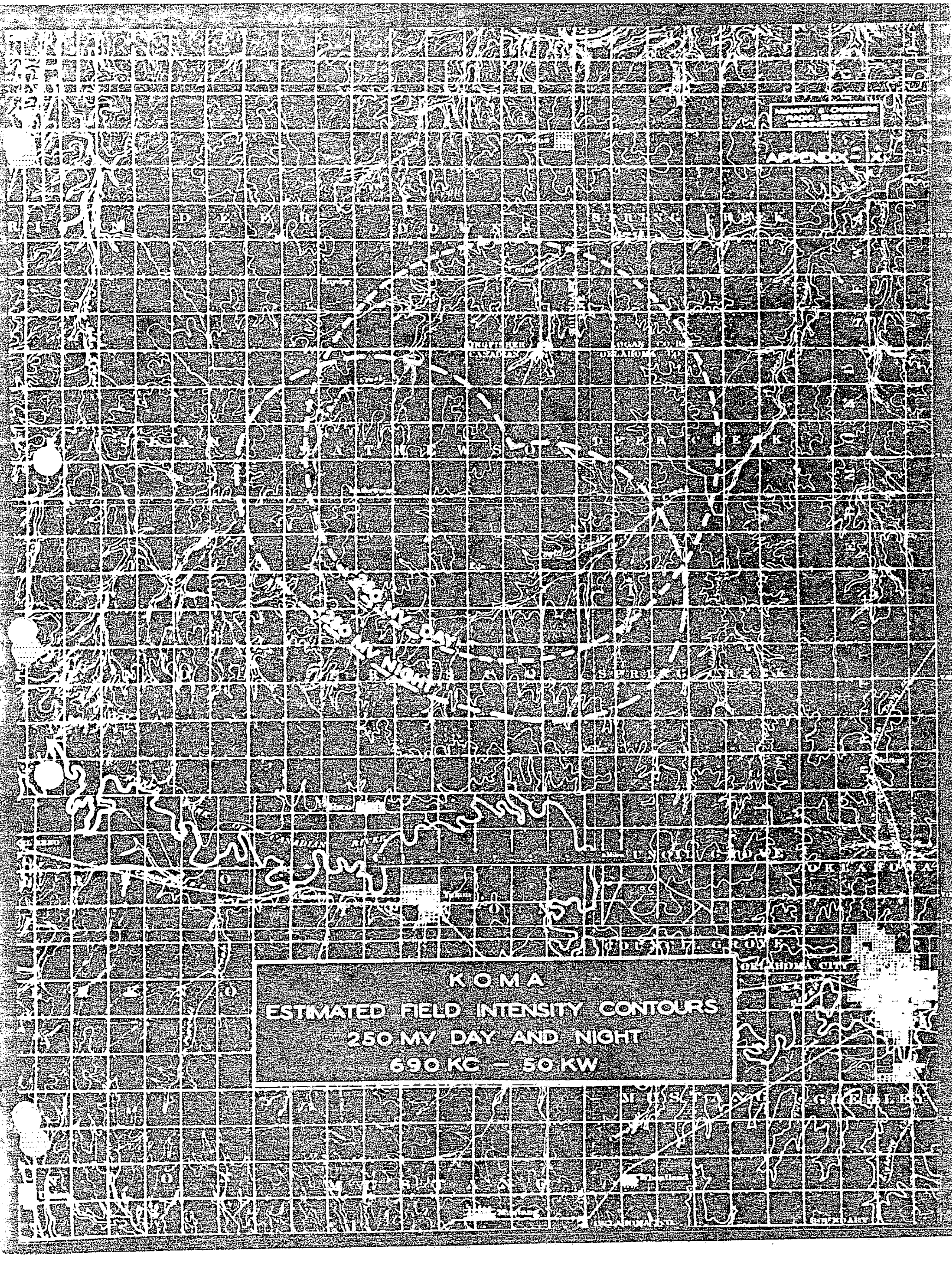
		A	B	C	D		E
Bearing	ϕ	110 cos ϕ	A + 74	cos B	C + 1.02	D^2	1100 × D
[illegible]	0	110.00	[illegible]	[illegible]	.021	.0005	24.[illegible]
[illegible]	5	109.55	[illegible]	[illegible]	.022		24.0
[illegible]	10	108.30	182.30	.999	.021	.0004	23.1
[illegible]	15	106.30	180.30	[illegible]	.020		22.0
[illegible]	20	103.[illegible]	[illegible]	[illegible]	.022	.0005	24.[illegible]
[illegible]	25	99.70	173.70	[illegible]	[illegible]		[illegible]
[illegible]	30	95.[illegible]	169.[illegible]	[illegible]	[illegible]	.0013	39.6
[illegible]	35	90.15	164.15	.963	.057		63.0
[illegible]	40	84.30	158.30	.930	.090	.0081	99.0
[illegible]	50	70.70	144.70	.816	.204	.0415	225.0
[illegible]	60	55.00	129.00	.630	.390	.1515	430.0
[illegible]	70	37.65	111.65	.372	.651	.4200	718.0
[illegible]	80	19.11	93.11	.054	.976	.9500	1075.0
[illegible]	90	[illegible]	74.00	.276	1.296	1.6800	1425.0
[illegible]	100	-19.11	[illegible]	.576	1.596	[illegible]	1760.0
[illegible]	110	[illegible]	[illegible]	.806	1.[illegible]	[illegible]	2020.0
[illegible]	120	-55.00	19.00	.946	1.966	3.8500	2150.0
[illegible]	130	-70.70	[illegible]	.999	2.019	4.0700	2220.0
[illegible]	140	-84.30	-10.30	.984	2.004	4.0000	2200.0
[illegible]	150	-95.[illegible]	[illegible]	.931	1.951	3.8000	2150.0
[illegible]	160	-103.35	[illegible]	.873	1.893	3.5700	20[illegible].0
[illegible]	170	-108.30	-34.30	.8[illegible]	1.848	3.4000	2030.0
[illegible]	180	-110.00	-36.00	.810	1.830	3.3100	2010.0

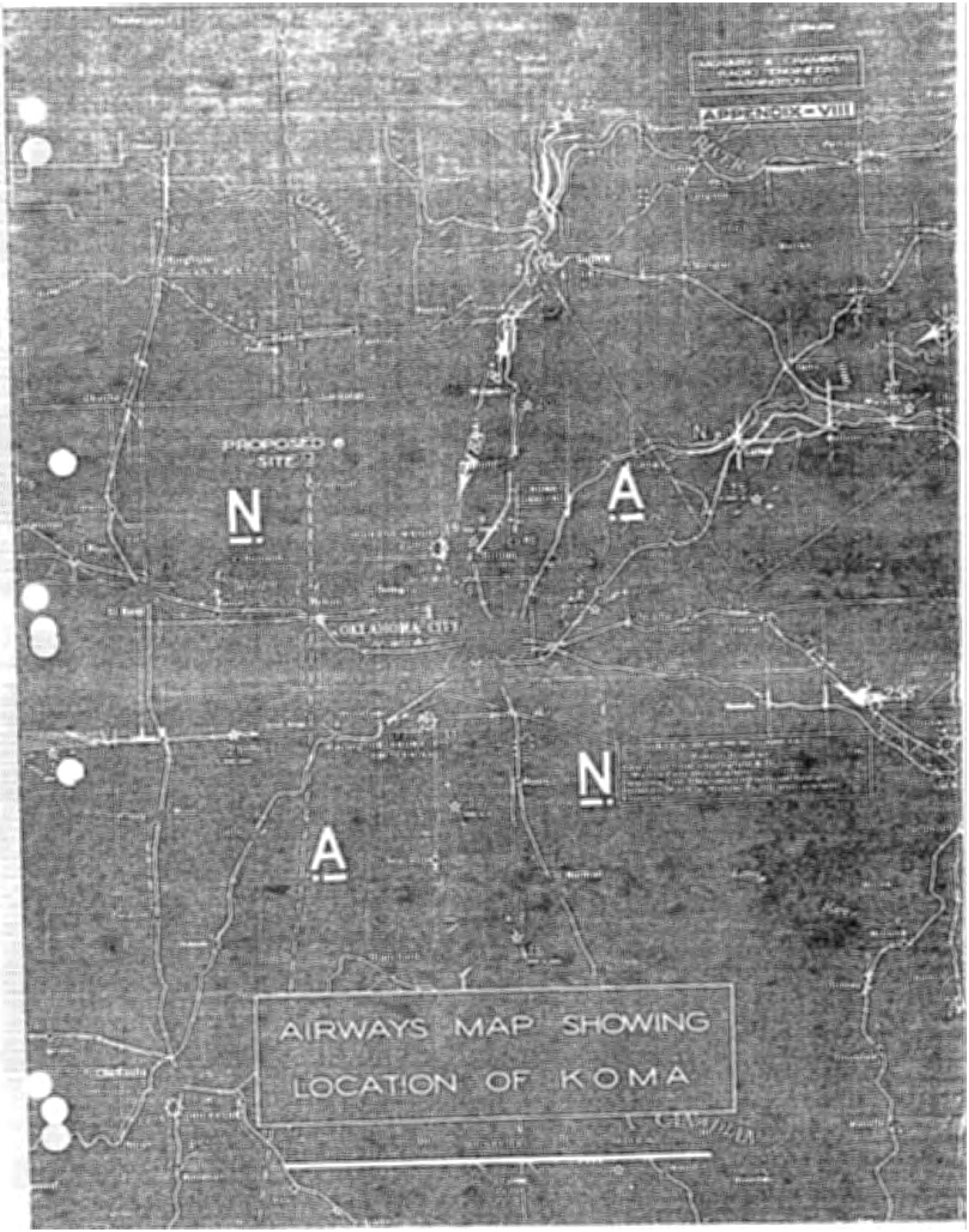
35.11
× 2
70.22
1.11
36) 66.[illegible]
1.857

$\sqrt{1.857}$ = 1.3[illegible]

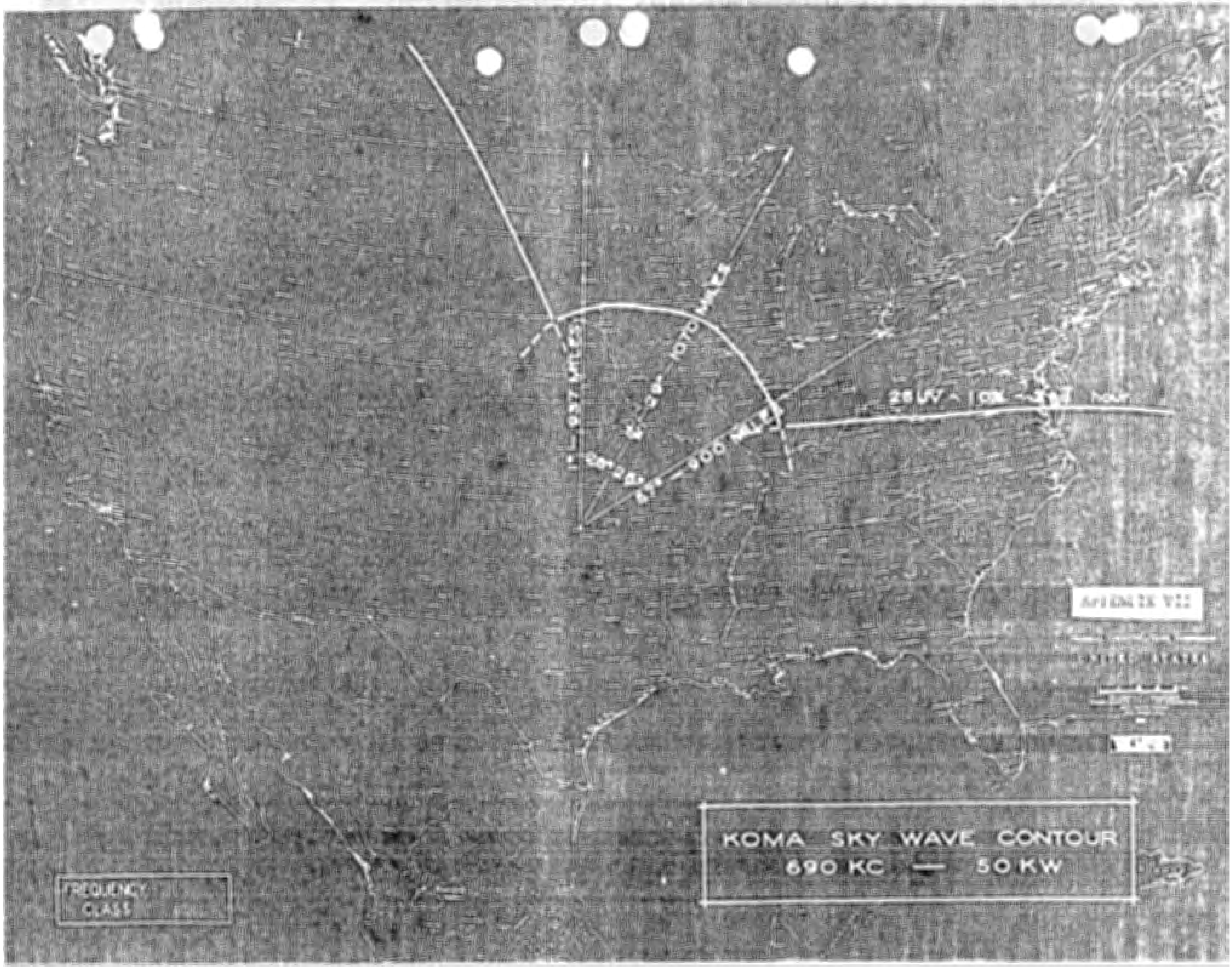
$\frac{1500}{1.3[illegible]}$ = 1100 = K


0.5 MV/M
2 MV/M
5 MV/M
25 MV/M
5 MV/M
2 MV/M


APPENDIX - X
KOMA
ESTIMATED FIELD INTENSITY CONTOURS
250 MV DAY AND NIGHT
690 KC — 50 KW
OKLAHOMA CITY



AIRWAYS MAP SHOWING LOCATION OF KOMA

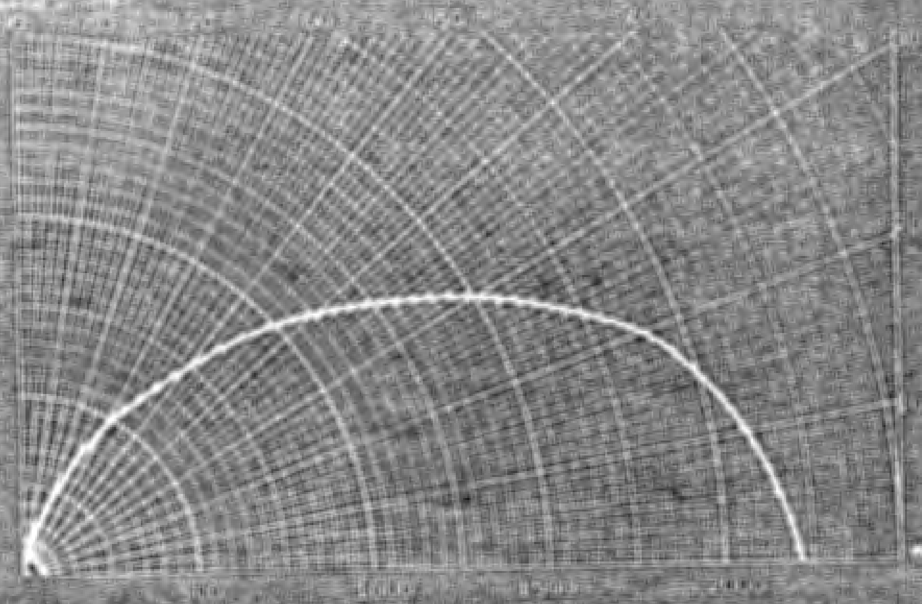


937 MILES
1070 MILES
900 MILES
KOMA SKY WAVE CONTOUR
690 KC — 50 KW
FREQUENCY
CLASS

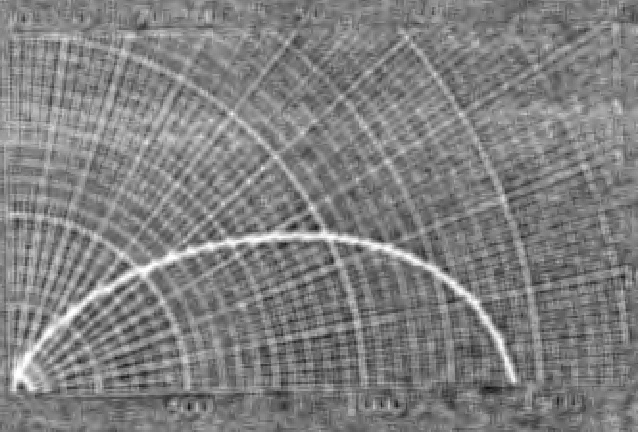
K·O·M·A

VERTICAL PLANE PATTERNS

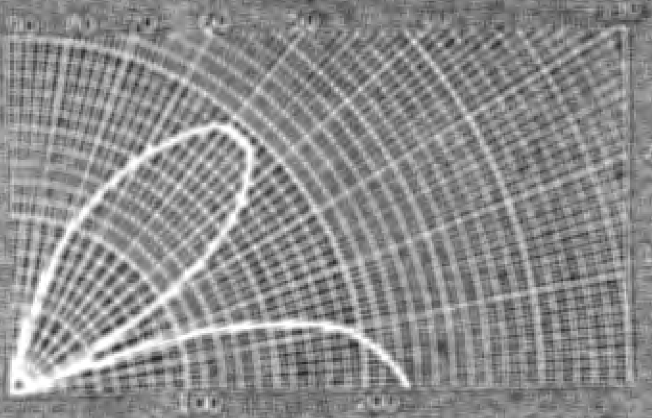
690 KC — 50 KW



Toward maximum [illegible]



Toward bearing [illegible]



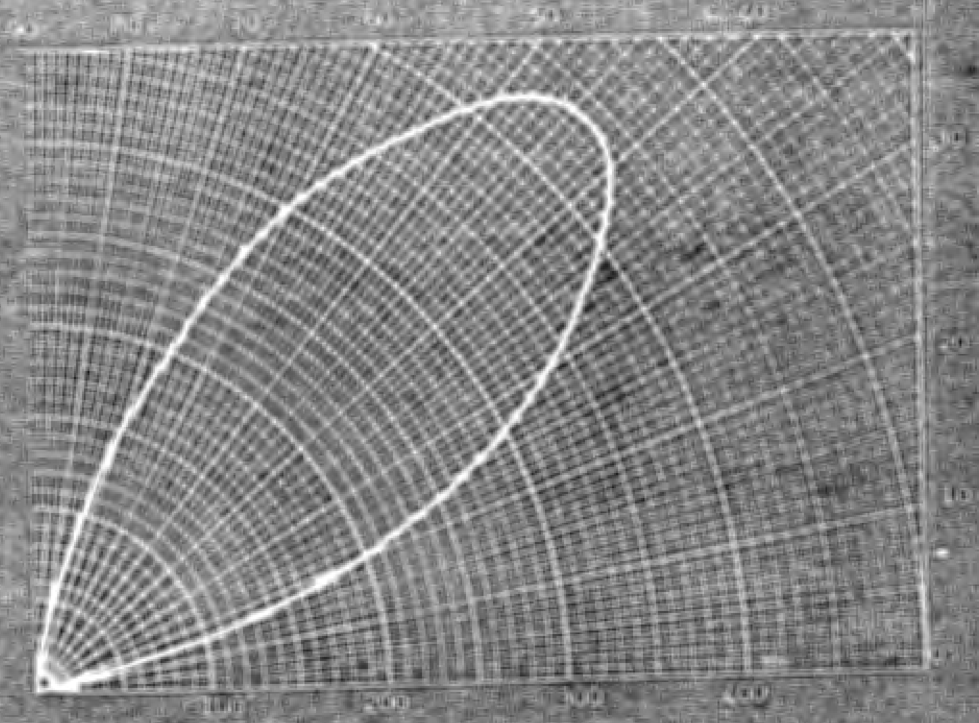
Toward bearing [illegible]

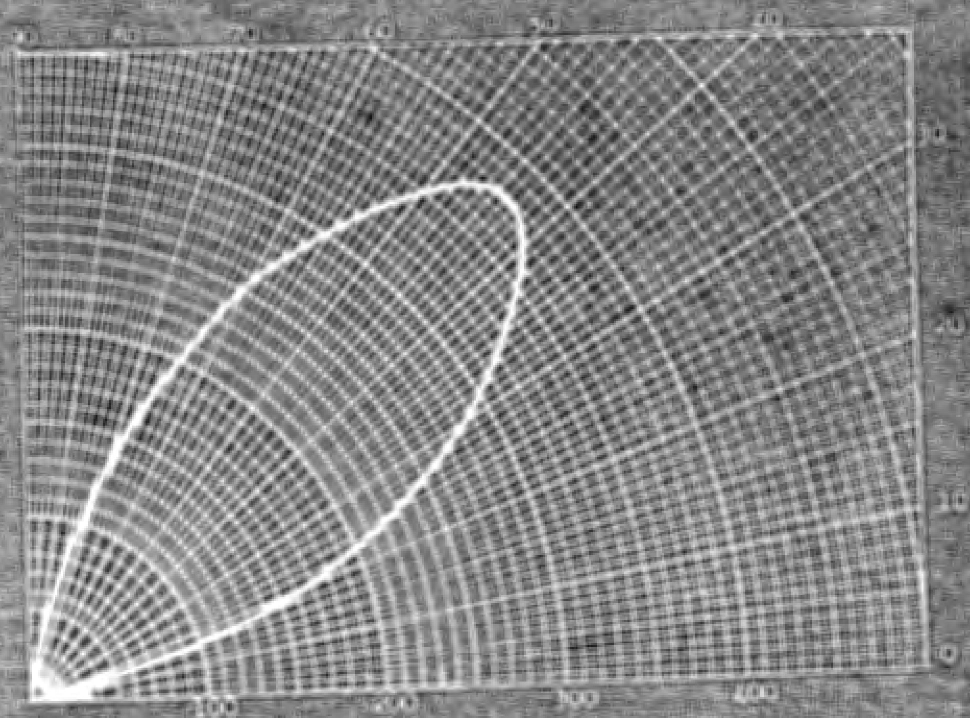
APPENDIX VI-B

— KOMA —

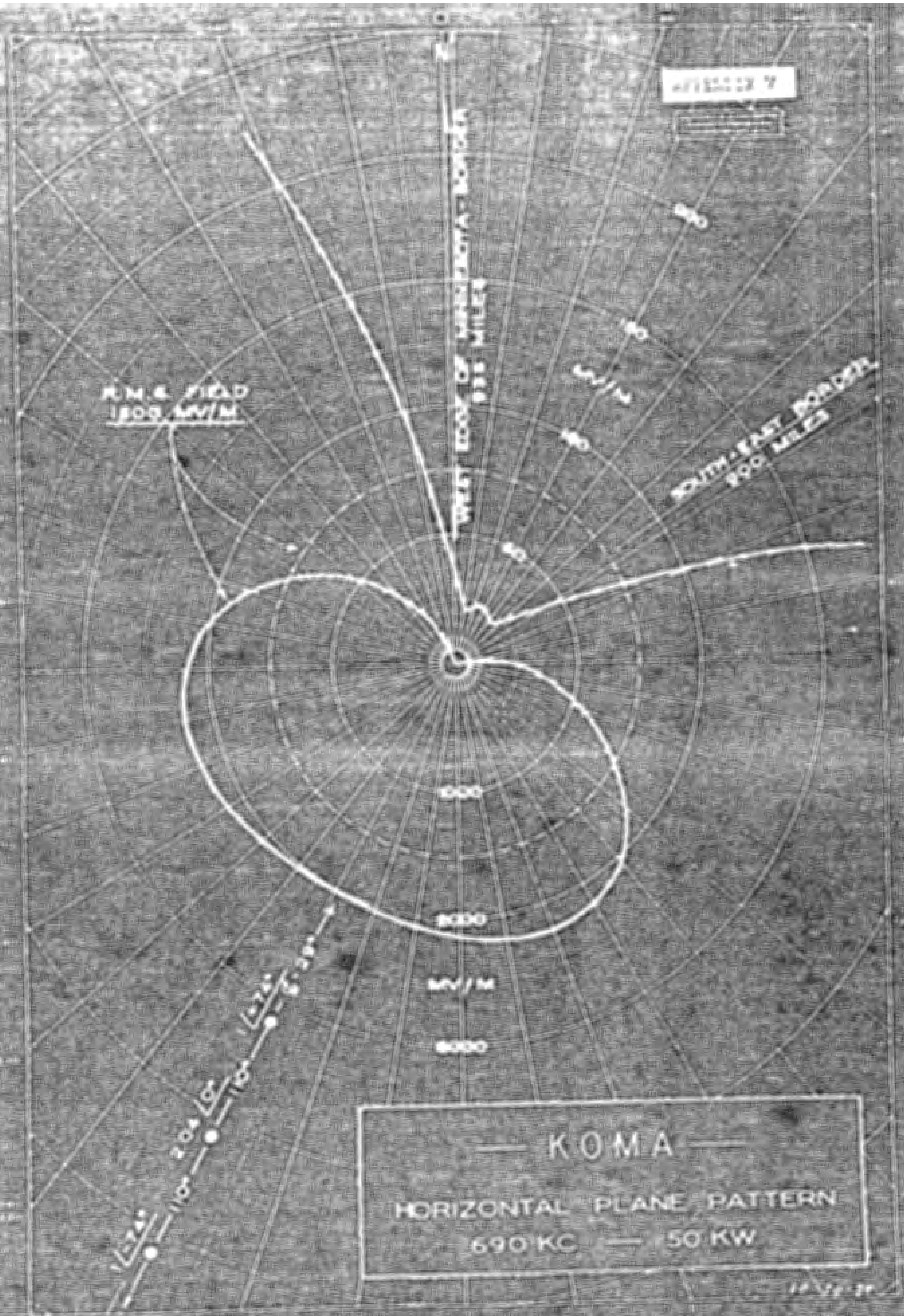
VERTICAL PLANE PATTERNS

690 KC — 50 KW





Toward Bearing 57°


N
SOUTH-EAST BORDER
900 MILES
MV/M
1000
2000
MV/M
KOMA
HORIZONTAL PLANE PATTERN
690 KC — 50 KW