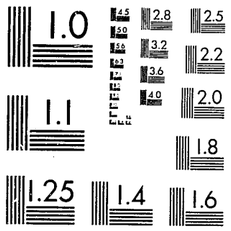
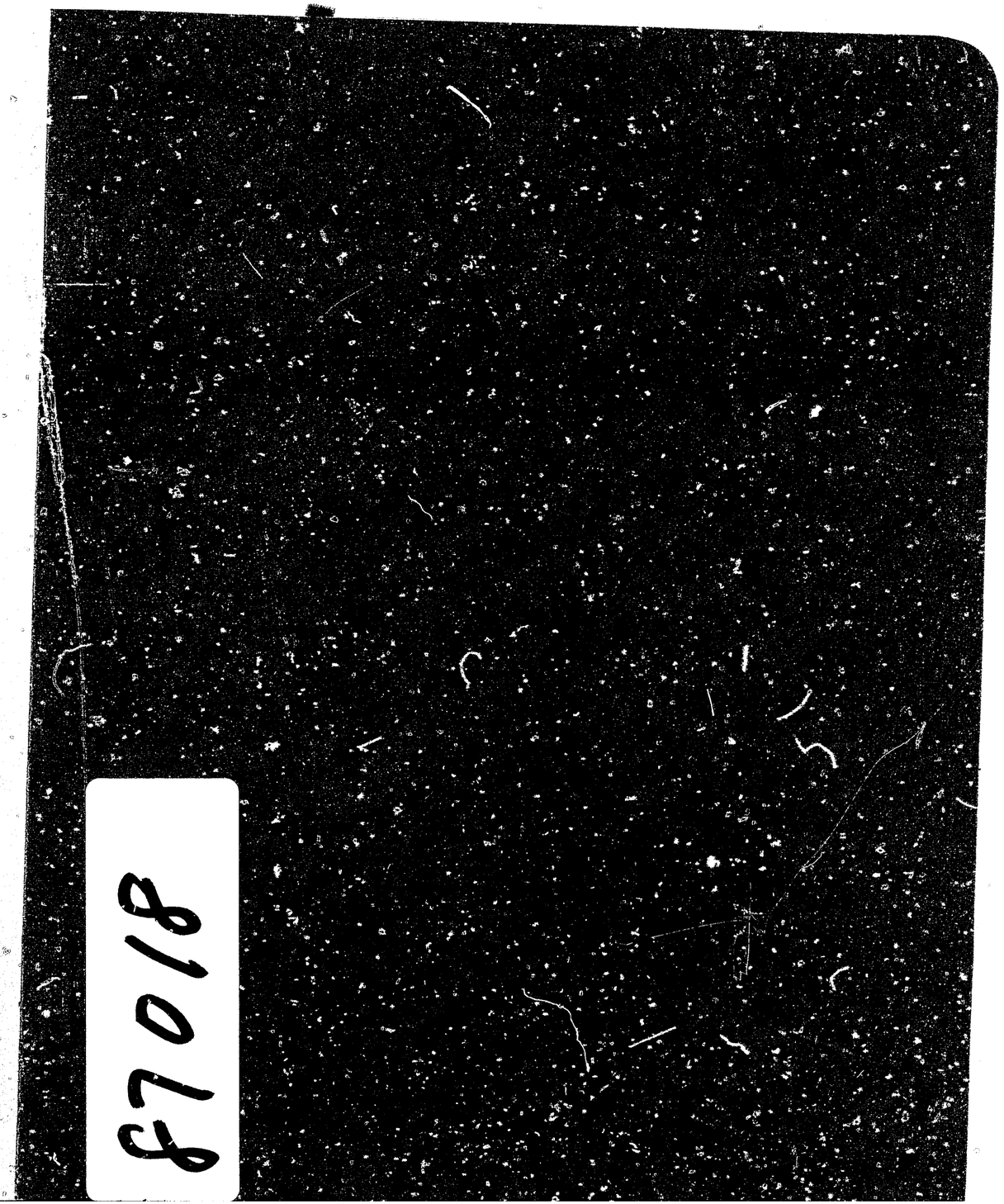




# ANALYSIS OF PUBLIC SAFETY COMMUNICATIONS OF DELAWARE COUNTY, PENNSYLVANIA



Task # 7801601

This report is based upon a study of the Public Safety Communications Facilities of Delaware County Pennsylvania conducted by James Barsuglia. The findings of this report reflect the technical opinions of the advisor and not necessarily of APCO, Inc. or the LEAA which funded this project.

James R. Barsuglia
June 26, 1979

## INTRODUCTION

The Delaware County Pennsylvania Criminal Justice Planning Unit (CJPU) is faced with the problem of appropriating funds for the establishment of an organized county wide public safety radio system. The impetus for this system is the need for Delaware County, not unlike others in Pennsylvania, to plan a 911 telephone system for the public to access the public safety resources in the county.

The CJPU does not perform the function of system planner in the county. The radio system has already been addressed by Mr. Thomas Shuler, a private consultant under contract. Mr. Shuler is working under the direction of Mr. Ed Truit, Director of Emergency Communications. Mr. Truit's responsibilities include the direction of the police, fire and EMS dispatching services performed by the county. Mr. Truit is also interested in and working on the establishment of a plan for the implementation of a 911 system.

The prime question of the CJPU at this point and reason for this technical assistance is, what changes must Delaware County make in order to establish a 911 system. How must the Police Communications Systems of the county be modified? How must the Fire and EMS Systems of the county be modified? What will happen to other local police dispatching now performed by many agencies in the county? These and other questions and problems will be discussed.

PROBLEM

The primary idea of a 911 public safety telephone system is to provide to the public a dependable, rapid and simple method of requesting public safety assistance. The ideal example of a 911 system is one in which the municipal boundaries coincide with the telephone system exchanges and where all public safety services in that area are centrally dispatched. Thus, a person dialing 911 is switched to the Public Safety Answering Point (PSAP),who in turn dispatches all of the necessary public safety units. Since all telephones in that telephone exchange are in the same municipality, there is no question as to where the call must go. However, in Delaware County as in most communities, the municipal and county boundaries do not coincide with telephone company exchange areas. It is the responsibility of the planners of a 911 system to resolve the problem in a way most suitable for the users. Delaware County is presently faced with this problem. In addition to numerous physical boundary problems in the county, there are fifteen different radio channels in operation. Twenty-seven of the police departments, plus various county agencies are dispatched by the county police radio dispatcher on five different radio channels. In addition to the County PSAP, there are nine other PSAP's using the remaining ten police radio channels assigned in the county.

As brought out in Mr. Shuler's report, in addition to the problem of public safety citizens access, there exists an even more serious problem. Police officers in one town cannot talk to police officers of neighboring towns. Compounded by the multiple dispatch center problem, a police officer for example in one town chasing a



car out of his normal working area would not have direct communications with other cars in his vicinity. This situation exists due to radio frequencies in various bands, making it impossible to establish a common county wide police radio channel. As an example, county dispatched units operate in both the 39 and 45 MHz band, while other dispatch centers in the county use all three bands: 39-45, 154-155 and 460-500 MHz. It is not uncommon for messages to be relayed from one dispatcher to several other dispatchers during situations requiring a several police department response. When time is of the essence and accuracy of information is vital, this method of communications is undesirable.

ANALYSIS

The two most significant problems of police radio in Delaware County are the unorganized assortment of radio frequencies in use and the establishment of a 911 telephone system. Centralized police dispatching is not necessarily a prerequisite to efficient organized police communications. However, a planned and coordinated police radio network is a necessity. As described in Mr. Shuler's report, the police in Delaware County are utilizing a radio system of multiple and incompatible frequencies. The increase in population of Delaware County has increased the demand for police services, and this caused an increase in radio traffic. The introduction recently of the CLEAN, NCIC and BVM systems has encouraged an officer on patrol to request more information from these computerized data bases. This again has increased radio traffic. Most police radio frequencies in Delaware County are currently overcrowded. The availability of additional "clear" radio channels is very low in the bands currently in use by the majority of the departments. The only possible place for large scale expansion is in the recently released "UHF TV" channels made available for public safety use. These frequencies in the 470 - 512 MHz band are available within a 50 mile radius of the major United States cities, Philadelphia being one of them. A recent check with the FCC indicates 120 available channels in this area. Although the FCC has restricted very closely the number of frequencies one may license, Delaware County is eligible for many more channels than currently in use.

The establishment in the 470 - 512 MHz of a county wide police radio system would be beneficial to the county in several ways.



This system would provide one common network throughout the county, such that a police car anywhere in the county would always be able to communicate directly with any other car in Delaware County. This new system would eliminate the present overcrowded radio channels, and outside interference that currently plagues the police radio systems of the county. This system would provide direct computer access to every patrol car or portable radio anywhere in the county without cluttering the primary working channel of any department. This system, as recommended by Mr. Shuler would establish a county wide organized police radio system. This system would <u>not</u> require total centralized dispatching.

Each and every police department could be equipped in such a way that local dispatching could be provided and still remain part of an organized county radio system. The implementation of a UHF radio system on the available channels would necessitate a complete change out of radio equipment in the county.

There are two basic methods of operating a 911 system. Both systems provide a sure and efficient means for the public to request public safety assistance.

In the first system a 911 center could be established somewhere in the county that would receive all 911 calls. This center would be staffed by a number of 911 operators. The primary function of these operators would be to answer and begin the initial processing of all requests for public safety assistance in the county. Using the most basic 911 system available, the 911 operator would have to determine the location of the caller solely through conversation with the person requesting assistance. Information such as location of caller or calling number would not be available to the operator.

It would be necessary for the operator to have the capability of transferring the incoming calls to the appropriate public safety dispatcher in the county. As an alternate, the operator could be provided an automated dispatch system "computer aided dispatching", in which the address and description of complaint could be entered. This would automatically display the required information to the appropriate dispatcher or dispatchers. These dispatchers could be part of a county wide dispatching service or could be a dispatcher in a municipality that performs their own dispatching. This would be a workable system. However, there are several drawbacks. The citizen requesting assistance would either be transferred to a dispatcher by the 911 operator, wasting valuable time, or would supply all of the necessary information to the 911 operator and never have direct contact with the person dispatching the call.

In Delaware County, the political influences are such that this is not an acceptable method. There are several towns that would not accept a dispatcher other than their own, speaking with citizens requesting assistance from them. This is a common problem in Delaware County. The establishment of a 911 center for the county would be expensive. Several operators would have to be on duty at anyone time to ensure that all incoming calls are answered promptly.

Delaware County would be plagued by the additional problem of identical addresses. Several municipalities in the county have streets with identical names and block numbers. It may be impossible for a 911 operator to determine the town in which the caller is located. The BASIC 911 system would not provide assistance for this type of problem.



The second type of 911 system that will be available in the near future for Delaware County is quite different. A system called Expanded 911 (E911) is much more advanced than the basic system. E911 is a term used to describe a 911 system that provides more features than simply providing the capability of routing an emergency call to a central location. E911 can include such features as : automatic number identification (ANI), selective routing (SR), and automatic number location (ANL). ANI is a system installed in the telephone company central office that recognizes the number from which the 911 call is being placed. This number is converted to a digital code and transmitted along with the call to the PSAP. At the PSAP, the digital information is decodedand the calling party's telephone number is displayed to the operator. This information provides a direct means of calling the requesting person back, and in most cases provides a means of informing the operator from which town the call is originating. Unless a detailed list of all telephone numbers in the county is maintained, the only real location information is the exchange from where the call is originating. In the county, since each exchange serves several towns, the operator still would not know in which town the caller is located. This system would still require a single PSAP in the county with a fair number of people dedicated solely to answer and transfer 911 calls. It would require all 911 calls in the county to be answered at one central location. The feature of SR is the real key to an improved 911 system. At one telephone company central office, a data base is established. This provides a cross reference between any telephone number, in service, in the county and the town in which it is located.

All 911 calls are routed automatically to this data base along with digital ANI information. The computerized data base recognizes the calling party's number and determines in which town that particular number has been assigned. Located throughout the county are a number of PSAP's. One PSAP for each police dispatching center in the county. After identification occurs, the call is then automatically transferred to the PSAP that dispatches for that town. This is all accomplished in a fraction of a second and without the intermediate step of having a 911 operator handle the call. A small town that dispatches for itself, for instance, would be a PSAP and would receive all of their emergency calls directly. In most cases in a small system PSAP, the person answering the call would also be the dispatcher. This feature of selective routing although more costly, primarily due to the necessary updating of the data base, is cost effective when compared with the financial obligation of maintaining a center staffed by 911 operators.

The third feature of E911 is Automatic Number Location (ANL). The data base installed at the selected central office would also contain the address to which all telephone numbers in the county are installed.

This feature would immediately provide to the PSAP the location of the caller. Additional information such as apartment numbers, floor numbers, and other important information that the PSAP operator might be able to use could be provided. The cost of ANL is the most expensive of all features of 911. Its value must carefully be weighed from a cost point of view.



Incorporated within the 911 system, an automatic call transfer feature could be provided. This would facilitate the transfer of EMS or fire calls to the proper dispatcher after being answered by a police department. This feature, in order to be fully automatic, must be operated in conjunction with ANI.

RECOMMENDATIONS

It is recommended Delaware County make the following system changes in order that public safety access and communications is provided effectively to its citizens. The recommendations cover two problem areas.

Delaware County should follow the recommendations found in Mr. Shuler's report, "Police Radio Communications Plan for Delaware County." When installed, this system will provide a unified radio system within the county. Zone channels are established for the primary dispatching of all police agencies in the county. Local dispatching can be provided as deemed necessary. In addition, county wide, data, and tactical channels are also provided. This system although requiring the purchase of all new equipment will serve the needs of police radio for many years to come.

An Expanded 911 (E911) telephone system should be made operational as soon as possible. The E911 system should provide automatic number identification (ANI) and selective routing (SR). Public Safety answering points should be established at the county central dispatching facility and at all polcie departments desiring todispatch for themselves. In addition, the system should have an automatic transfer capability such that any call for other than a police emergency may be transferred, by pressing one single key, to the appropriate dispatcher. Transfers would take place for calls requiring an EMS or fire response.



POLICE RADIO COMMUNICATIONS PLAN

PROPOSED FOR

THE COUNTY OF DELAWARE, PENNA.

BY

THOMAS H. SHULER
COMMUNICATIONS CONSULTANT
329 LAUREL DRIVE
TRAFFORD, PENNA. 15426

A NOTE TO THE READER:

This plan is currently in the draft stage, representing the thoughts and system concept conceived after a review of various parameters as they presently exist, a system study and plan done by others in 1976 and goals for future communications capabilities to provide a viable system with a long, useful life probability.

Some revisions, additions, deletions or other alterations will most likely be necessary before the plan is complete and ready for full acceptance and endorsement.

As you read this draft copy you are requested to note any questions or ideas concerning the various points of the plan and make them known to Mr. Truitt, preferably in writing, so they may be passed along to the consultant for consideration.

Your support and input will make the final version a product of the efforts of all interested members of the law enforcement community of Delaware County and a true county-wide plan representing the best interests of all.



PURPOSE

I. The purpose behind the development of this plan is the necessity to determine what measures are required to improve the police communications capabilities for the current users of the Delaware County Police Network. In addition to providing for the needs of the current users, the system design and size must be configured to accept and fill the needs of all the police agencies in Delaware County and provide a true County-wide police radio network.

PRESENT SYSTEM

I. The present system is comprised of the following componets:

A. A central communications control center located in the basement of the Delaware County Court House in Media, Pa.
1. This dispatch center employs the services of the Director of Emergency Communications, a deputy director, four shift supervisors, 27 full time and five part time dispatchers, and two secretaries.

2. The center provides facilities for receiving complaints, emergency assistance requests and other police related matters on 60 telephone lines which are answered by three complaint takers including a supervisor. Two radio dispatchers handle radio messages via a two-position console which controls the five police radio frequencies. Two C.L.E.A.N. computor terminals operated by individual dispatchers provide access to the state's auto license and operators information, files on wanted or missing persons, lost or stolen property, direct teletype communications with all the other centers in the state including the state police, and access to NCIC, LETS, and other services.

3. In addition to police communications the center also provides the necessary personnel and equipment to operate a communications service for fire and emergency medical agencies.

B. Base station equipment.
1. The base station radio equipment provides five low-band VHF FM police frequencies (39.50, 39.78, 39.82, 39.90 and 45.54 MHz) from transmitters located in the Court House, Lansdowne and Sharon Hill.

C. Participating departments.
1. There are currently 27 police departments, plus various County agencies such as the Sheriff, Detectives and others actively participating in the system.

2. These departments, according to data supplied in a recent survey of all the departments in the County, operate 107 mobile units and 110 portable units on the five frequencies.

D. Non-participating departments.
1. The police agencies in Delaware County, except for the State Police, not dispatched out of the County Center are dispatched out of facilities owned and maintained by the individual agency or are dispatched by such a neighboring agency.

2. Most of these police agencies use discrete and different radio frequencies not compatable with the County system or other independently operating departments.

3. Independent dispatch agencies using frequencies different than these utilized by the County are listed below.

| | |
|---|---|
| a. Chester City | 154.725 MHz |
| b. Haverford Twp. | 39.90 " |
| c. Norwood Borough | 45.22 " |
| d. Radnor Twp. | 45.50, 500.3375, 503.3375 MHz |
| e. Ridley Twp. | 39.42 MHz |
| f. Springfield Twp. | 45.56 " |
| g. Tinicum Twp. | 45.22, 45.74 MHz |
| h. Upper Darby | 154.950, 159.090 MHz |
| i. Yeadon Borough | 460.025, 465.025 MHz |

II. System problems

A. The present system suffers from several problems. The most serious problem causing the greatest concern is the inability of the various police agencies within the county to communicate with each other on common channels using common equipment.

1. There are currently five (5) county frequencies and 14 non-county frequencies employed in the overall police communications system in Delaware County.

2. These frequencies, because some system are simplex and others are duplex operation, afford a total of 15 police radio channels. (Simplex refers to a system where the mobile and base station transmitters and receivers use the same frequency and can only transmit or receive at any given time. Duplex refers to a system where base station transmitters use one frequency while the mobile transmitters use a different frequency. These systems can allow a mobile or base station to receive messages at the same time it is transmitting messages.

3. In mutual aid situations it is impossible to provide a common channel available to all units using their present radios.

B. A lack of back-up stations exist in the system. In most centers, when a base station fails there is no standby station to take its place. Communications on that channel are then reduced to the area covered by a mobile or portable unit or are out altogether until repairs have been made.

C. A third and growing problem is distant station or "skip" interference.

1. This is caused by atmospheric disturbances and sun spot activity. It is also caused to a lesser degree by new stations being licensed on the already crowded channels with minimum or less mileage seperation because of the lack of sufficient channels for all the users.

2. The sun spot activity will continue to increase into 1980 and requires, according to predictions, until 1983 to reduce to less harmful levels.

D. The coming of 9-1-1, the emergency telephone number, will require all agencies to receive calls from one or more central answering facilities capable of fully coordinating the response of the various agencies. This requires a county-wide coordinated radio system.

NEW SYSTEM PLAN

I. Basis



A. In order to formulate a system plan that would lead to a County-Wide police radio network responsive to the communications needs of today's police departments certain additional information had to be obtained.

1. Questions to be answered before a conclusion could be reached were-
   a. How many mobile and portable units will the system have to accomodate?
   b. How many radio channels will be required to effectively handle the predicted number of units?
   c. How many specialized channels will be required?
   d. Can the channel needs be justified to the F.C.C.?
   e. What consolidations can be made to meet F.C.C. conditions without harming the overall system operation?
   f. What type equipment will be needed to meet the requirements of the various agencies?
   g. How far can, or should, these units be able to transmit radio signals?
   h. What equipment configuration will provide maximum flexibility combined with ease of operation?
   i. Which municipalities can effectively share common channels?
   j. What changes or adjustments will have to be made in the current control center?
   k. Will the system be benificial and effective as a law enforcement tool?

B. In an effort to obtain the data necessary to answer all the preceeding questions, plus others that would arise concerning costs, alternatives, etc., a survey of the police agencies in Delaware County was undertaken during the period of January through March, 1978 and, through the efforts of the police chiefs' radio committee, updated in November, 1978.

1. The survey consisted of the questionaire addressing the following points:
   a. Number of mobile radios presently in operation.
   b. Number of portable radios presently in operation.
   c. Quantity of mobile radios projected in use five years hence.
   d. Quantity of portable radios projected in use five years hence.

2. The information obtained in the survey relating to questions a. and b. concerning equipment currently in use by each department is shown in the following chart.

CURRENT OPERATING EQUIPMENT

| MUNICIPALITY | MOBILES | PORTABLES |
|---|---|---|
| Alden | 2 | 3 |
| Aston Twp. | 7 | 3 |
| Bethel Twp. | 3 | 1 |
| Birmingham twp. | covered by P.S.P. | |
| Brookhaven | 6 | 5 |
| Chester City | 39 | 36 |
| Chester Heights | covered by P.S.P. | |
| Chester Twp. | 5 | 4 |
| Clifton Heights | 4 | 4 |
| Collingdale | 3 | 3 |
| Colwyn | 3 | 3 |
| Concord Twp. | covered by P.S.P. | |
| Darby boro | 4 | 6 |
| Darby Twp. | 4 | 4 |
| East Lansdowne | 3 | 6 |
| Eddystone | 3 | 4 |
| Edgemont Twp. | covered by P.S.P. | |

| | | |
|---|---|---|
| Folcroft | 4 | 2 |
| Glenolden | 3 | 5 |
| Haverford Twp. | 21 | 17 |
| Lansdowne | 5 | 13 |
| Lower Chichester Twp. | 3 | 3 |
| Marcus Hook | 4 | 3 |
| Marple Twp. | 11 | 9 |
| Media | 4 | 4 |
| Middletown Twp. | covered by P.S.P. | |
| Millbourne | 1 | 0 |
| Morton | 4 | 2 |
| Nether Providence Twp. | 8 | 4 |
| Newtown Twp. | 6 | 4 |
| Norwood | 4 | 4 |
| Parkside | 2 | 2 |
| Prospect Park | 3 | 2 |
| Radnor Twp. | 17 | 23 |
| Ridley Park | 3 | 4 |
| Ridley Twp. | 10 | 10 |
| Rose Valley | covered by P.S.P. | |
| Rutledge | covered by Norton Boro | |
| Sharon Hill | 2 | 2 |
| Springfield Twp. | 13 | 9 |
| Swathmore | 4 | 3 |
| Thornbury Twp. | covered by P.S.P. | |
| Tinicum Twp. | 4 | 9 |
| Trainer | 4 | 1 |
| Upland | 4 | 1 |
| Upper Chichester Twp. | 5 | 5 |
| Upper Darby | 34 | 33 |
| Upper Providence Twp. | 3 | 0 |
| Yeadon | 3 | 4 |
| County Units | 28 | 34 |
| Totals | 303 | 294 |

3. The information obtained from the same survey in response to questions c. and d. concerning the number of mobile and portable units projected in use within the next five years is shown as follows:

PROJECTED OPERATING EQUIPMENT WITHIN 5 YEARS

| MUNICIPALITY | MOBILES | PORTABLES |
|---|---|---|
| Aldan | 3 | 4 |
| Aston Twp. | 8 | 6 |
| Bethel Twp. | 3 | 2 |
| Birmingham Twp. | * | * |
| Brookhaven | 12 | 10 |
| Chester City | 40 | 38 |
| Chester Heights | * | * |
| Chester Twp. | 7 | 6 |
| Clifton Heights | 4 | 5 |
| Collingdale | 3 | 3 |
| Colwyn | 3 | 3 |
| Concord Twp. | * | * |
| Darby Boro | 4 | 6 |
| Darby Twp. | 4 | 4 |
| East Lansdowne | | 6 |
| Eddystone | 5 | 7 |
| Edgemont Twp. | * | * |
| Folcroft | 4 | 4 |
| Glenolden | 3 | 5 |
| Haverford Twp. | 21 | 17 |
| Lansdowne | 6 | 15 |
| Lower Chichester Twp. | 3 | 3 |
| Marcus Hook | 8 | 6 |
| Marple Twp. | 12 | 11 |
| Media | 4 | 4 |
| Middletown Twp. | * | * |
| Millbourne | 1 | 1 |
| Morton | 4 | 4 |
| Nether Providence | 8 | 6 |
| Newtown Twp. | 7 | 5 |
| Norwood | 5 | 8 |
| Parkside | 2 | 2 |
| Prospect Park | 3 | 3 |
| Radnor Twp. | 20 | 25 |
| Ridley Park | 3 | 4 |
| Ridley Twp. | 13 | 14 |
| Rose Valley | * | * |
| Rutledge | covered by Morton Boro | |
| Sharon Hill | 3 | 9 |
| Springfield Twp. | 14 | 12 |
| Swathmore | 4 | 5 |
| Thornbury Twp. | * | * |
| Tinicum Twp. | 5 | 9 |
| Trainer | 2 | 2 |
| Upland | 4 | 4 |
| Upper Chichester Twp. | 6 | 6 |
| Upper Darby | 39 | 53 |
| Upper Providence Twp. | 6 | 6 |
| Yeadon | 5 | 8 |
| Areas now covered by P.S.P. | *20 | *30 |
| County Units | 28 | 34 |
| Totals | 362 | 415 |

* It seems quite probable the areas presently served by the Pa. State Police will, within the 5-10 year period of immediate concern in this plan, establish local police departments. We have provided an estimated number of mobile and portable units to accomodate these departments.

C. From the information obtained and basing the plan on the premise that all the police agencies in the County will participate in the system, we are able to establish a basic, long range communications system plan.

1. We have determined that there are currently 303 mobile and 294 portable units in operation in Delaware County.

2. We have also determined the number of units which the departments expect to have in service within the next 5 years total 362 mobiles and 415 portables.

3. The Federal Communications Commission has established a channel load formula for system using the 500 Mhz channels. This criteria is based on 50 mobile units on a channel being considered a loaded channel. When one channel is loaded additional channels may be assigned so long as each meets the channel load requirements. The F.C.C. also consideres 2 hand held units to be equal to one mobile. Therefore, a loaded channel consists of 50 mobiles, 100 portables or a combination of both equalling 50 mobiles- (2 portables = 1 mobile = 1 channel laod unit).

4. The present combination of 303 mobile and 294 portable units constitute 450 channel load units.

5. The projected 5 year growth to 362 mobiles and 415 portables constitute 570 channel load units.

6. Comparing the channel load units indicates an expected growth rate of 26.6% over the next five years. This is equal to an average annual growth rate of 5.32% or approximately 24 channel load units per year. This is also equal to the addition of one portable each year by each of the 50 police agencies listed in our studies. The growth projection therefore appears quite realistic.

7. Based on the preceeding information and bearing in mind the useful life of equipment manufactured, purchased and placed in service today has a useful life span of approximately 10 years it would appear appropriate to structure any plan based on a 10 year period.

8. It is also probable the growth rate will not be as great over 10 years as over 5 years. We estimate the growth in years 6 through 10 will be one-half that of the preceeding 5 years. This projects to a system growth of 200 channel load units over the current 450; a total of 650.

9. Using the F.C.C. channel loat criteria of 50 our compatable channel requirements then equal 13 channels. These will be necessary to handle the command, control, dispatch and status change demands on a day to day basis.

10. Since one channel will be reserved to fill the needs of the system more than five years hence our immediate need for 12 channels will be the basis for additional supportive calculations. These calculations are based on the air time required by normal police activities.

11. Channels other than the 12 needed for routine traffic will be required and will be justified in following sections. These channels will be for data (voice), special tactical and operations, emergency preparedness services and municipal services such as highway maintenance, water and sewer and others.



D. Study of traffic, present system.

1. The number of specialized channels required can be determined through a study of radio traffic generated on the present system by only 107 mobile and 110 portable units equalling 162 channel-load units. The new system would be comprised of 570 channel-load units or 351% more than the present system.

2. A traffic study was made during the period from April 1 to June 30, 1978. The radio traffic information obtained is translated as follows:

| MONTH | DATA MSGS | OTHER MSGS | TOTAL MSGS |
|---|---|---|---|
| April | 2880 | 13998 | 16878 |
| May | 2960 | 13475 | 16435 |
| June | 3117 | 14867 | 17984 |
| Totals | 8957 | 42340 | 51297 |
| Averages | 2986 | 14113 | 17099 |

E. Projected Traffic Based On Present System Conditions.

1. To the above information, assuming the radio traffic will grow in proportion to the number of units, has been factored an additional 351% of activity. This brings the radio traffic estimate to 13,467 data messages per month and 63,650 other messages per month for a total average monthly radio message load of 77,117.

F. Calculation of channel traffic loads.

1. From actual experience it can be said that a busy channel is one that averages a 30% duty cycle. Said another way, a busy channel is one that has radio traffic in progress, equal to continuous transmissions at least 7 out of every 24 hours.

2. Since there are 24 hours in each day and an average of 30.4 days in each month, we can say there is an average of 729.6 hours in each month. Therefore, a channel with a 30% duty cycle will be handling radio messages 218.8 hours each month.

G. Justification for 12 zone channels based on radio traffic.

1. Previously established was a requirement for 12 dispatch and complaint channels to handle the 570 channel-load units comprised of 362 mobile and 415 hand held units. The actual total number of transceivers equals 777 (362 + 415).

2. Air time consumed by the total number of units divided by the previously determined number of hours a channel can be busy each month without harmful overload can also be used to calculate the approximate number of channels required for a public safety system.

3. During a normal eight hour shift an officer will have to advise of or update status several times-status is defined as a report of an officer's availability, non-availability, or location from which he can respond to answer a call. Normally these are: 1-start of shift, 2-off for meals, 3-back on street after meals, 4-off duty at end of shift. Additional updates will be required when an officer: 5-goes into court, 6-leaves court, 7-transports a prisoner (start and stop), 8-makes stops of

vehicles, 9-completes investigations at such stops, 10-assists motorists or others, 11-completes such assists. In addition, requests for tow trucks, dog enforcement officers, district justices, other personnel or directions will consume air time not calculated as part of any complaint call.

4. Each status change or request will consume approximately 15 seconds of air time, average. This includes both base and mobile or portable air time. Each unit will have an estimated average of six such transactions each shift. Total monthly air time for this purpose calculates as follows.

   777 units X 15 seconds X 6 messages X 3 shifts per day=209,790 seconds per day.
   209,790/3600 seconds per day=58.275 hours air time per day.
   58.275 X 30.4 days=1771.56 hours per month.

5. It has been projected 63,650 messages per month will be handled by radio. This is complaints only and does not include data messages. Data channel requirement calculations appear later.

6. Each complaint transmission plus additional air time required for follow up information, additional assistance and associated status changes not previously calculated, will consume approximately one minute.

   63,650 messages per month X 1 minute/60 minutes=1060 hours per month.

   1060 + 1771 = 2831 hours per month of air time. Since each channel can provide 218.8 hours of air time each month we are able to determine a need for at least 12 radio channels. (2831/218.8=12.93)

7. This also agrees with the channel calculations using the channel load by unit method.

H. Calculation and justification of additional data channels.
   1. Using the data message activity obtained in sections D and E and comparing this activity to the channel traffic loads derived from section F we are able to justify these requirements as follows.

   2. Each data request will be made by voice. Examples of such requests are license tag lookups, operators license data, information on lost, missing or wanted persons, messages for general rebroadcast, data needed concerning investigations of lost or stolen property.

   3. Each data request will require about 30 seconds air time from a mobile or portable unit, about 45 seconds of air time for response from the base station, plus approximately one minute of processing time or 2.25 minutes per request. This calculates to 27 message per hour. Multiplied by the 7 hour duty cycle we can determine each channel can handle 189 messages per day or 5746 messages each month.

   4. Dividing the projected average monthly data messages (13,467) by the 5746 figure we can determine that 2.3 channels are required now and a total of 3 will be adequate for the projected 10 year period.



I. Radio channel requirements based on zone and special channel considerations.

| | |
|---|---|
| Zone Channels, Immediate | 12 |
| Zone Channels, Expansion | 1 |
| County-wide | 1 |
| Data | 1 |
| Tactical | 3 |
| County Municipal (non-police) | 2 |
| Emergency Preparedness (C.D.) personnel | 1 |
| Total Channels | 1 |
| | 21 |

A. Justification for channels:

1. Zone Channels: These channels are sufficiently justified in the load and traffic calculation and in the zone breakdown in section J.

2. Expansion: One channel is provided for future additional zones as will be required to accomodate the normal growth of the departments and additional channel loading over the 10 year period.

3. County-wide: This channel shall be used for radio broadcasts, wide area chase or manhunt situations, etc., involving departments in more than one zone.

4. Date: These channels are required for handling the requests for information from CLEAN, NCIC, BVM, etc., concerning license information on drivers or vehicles, lost, missing or wanted persons, lost or stolen property, etc. The justification for these channels is made by the traffic analysis previously described.

5. Tactical: These two channels wil be used by the Criminal Investigative Division, police department detectives, and others as required for survailance and other investigative communications. They will also serve as the disaster, civil disobedience, etc., operations Channels

6. County Municipal: These channels will provide communications for the non-police, County agencies, that require radio facilities such as highway, civil defense, key governmental officials, etc. They are necessary to provide a communications media between highway and other selected municipal services, civil defense and key governmental personnel and direct links between them and police officials when the situation so demands.

J. Operational radio zone configuration.
   1. Based on the information and calculations described in the preceeding sections the 12 operational radio zones are proposed as follows.

| ZONE | DEPARTMENT | MOBILES | PORTABLES | LOAD |
|---|---|---|---|---|
| 1 | Newtown Twp. | 7 | 5 | 9.5 |
| | Radnor Twp. | 20 | 25 | 32.5 |

| | | | | |
|---|---|---|---|---|
| | Upper Providence Twp. | 6 | 6 | 9.0 |
| | | 33 | 36 | 51.0 |
| 2 | Haverford Twp. | 21 | 17 | 29.5 |
| | Marple Twp. | 12 | 11 | 17.5 |
| | | 33 | 28 | 47.0 |
| 3 & 4 | Upper Darby | 39 | 53 | 65.5 |
| | Millbourne | 1 | 1 | 1.5 |
| | Lansdowne | 6 | 15 | 13.5 |
| | E. Lansdowne | 3 | 6 | 6.0 |
| | Clifton Heights | 4 | 5 | 6.5 |
| | Aldan Boro | 3 | 4 | 5.0 |
| | | 56 | 84 | 98.0 |
| 5 | Yeadon | 5 | 8 | 9.0 |
| | Darby Boro | 4 | 6 | 7.0 |
| | Colwyn | 3 | 3 | 4.5 |
| | Collingdale | 3 | 3 | 4.5 |
| | Sharon Hill | 3 | 9 | 7.5 |
| | Glenolden | 3 | 5 | 5.5 |
| | Darby Twp. | 4 | 4 | 6.0 |
| | Folcroft | 4 | 4 | 6.0 |
| | | 29 | 42 | 50.0 |
| 6 | Ridley Twp. | 13 | 14 | 20.0 |
| | Ridley Park | 3 | 4 | 5.0 |
| | Prospect Park | 3 | 3 | 4.5 |
| | Norwood | 5 | 8 | 9.0 |
| | Tinicum Twp. | 5 | 9 | 9.5 |
| | | 29 | 38 | 48.0 |
| 7 | Springfield Twp. | 14 | 12 | 20.0 |
| | Nether Providence | 8 | 6 | 11.0 |
| | Media | 4 | 4 | 6.0 |
| | Swathmore | 4 | 5 | 6.5 |
| | Norton Boro | 4 | 4 | 6.0 |
| | | 34 | 31 | 49.5 |
| 8 & 9 | Eddystone | 5 | 7 | 8.5 |
| | Chester City | 40 | 38 | 59.0 |
| | Upland Boro | 4 | 4 | 6.0 |
| | Chester Twp. | 7 | 6 | 10.0 |
| | Trainer Boro | 2 | 2 | 3.0 |
| | Marcus Hook | 8 | 6 | 11.0 |
| | | 66 | 63 | 97.5 |
| 10 | L. Chichester | 3 | 3 | 4.5 |
| | Brookhaven | 12 | 10 | 17.0 |
| | Parkside | 2 | 2 | 3.0 |
| | Aston Twp. | 8 | 6 | 11.0 |
| | U. Chichester | 6 | 6 | 9.0 |
| | Bethel Twp. | 3 | 2 | 4.0 |
| | | 34 | 29 | 48.5 |



| | | | | |
|---|---|---|---|---|
| 11 | Areas Now P.S.P. | 20 | 30 | 35 |
| 12 | County Units | 28 | 34 | 45 |
| | Total Units | 362 | 415 | 569.5 |

K. Data Channel Assignment Plan

1. Data Channels provide the information in response to field inquires on license plates, operators information, lost or missing persons, wanted persons, etc. We have determined three channels are necessary to meet the system requirements. The channels shall be assigned for use by the various zones as follows.

   Data 1- Zones 1,2,7,12
   Data 2- Zones 3,4,10,11
   Data 3- Zones 5,6,8,9

II. System Operation

A. Having determined the number of necessary channels and the purpose each is to serve we may now describe how these channels would be used in primary and secondary functions to achieve the goal of coordinated redundant radio paths available to each participant.

B. Base station transmitters will be located in various areas throughout the county in such a manner as to provide two transmitters, one at each of two locations, for each zone channel. Additional transmitters as required will by located to ensure adequate coverage of the County-wide and data channels. Fixed receivers associated with each base transmitter will be located as necessary to provide adequate talk paths from a hand held unit to the control center. The sites proposed are described later in this plan.

C. Channel usage in each zone shall be typically as described herein. The field unit, mobile or portable, is seen as a four-channel radio with a scan capability. The scan operation and other features are described under Equipment Configuration.

1. Field Equipment-channel configuration

   a. Channel 1- The assigned zone channel. This channel will be a repeater type operation allowing all the vehicles and portables to be aware of the progress of all conversations on the channel. All dispatches and related transmissions including status will be handled on this channel. Provision is made for departments maintaining their own dispatch facilities to continue to do so by directly accessing the zone channel.

   b. Channel 2- County-wide channel. Common in all units. Used for broadcast of emergency messages or information of interest County-wide. Also used for coordination of chases or other incidents involving units of two or more zones. Normally not a repeater operation, it can be operated in the repeating mode under dispatcher control.

   c. Channel 3- Mobile to mobile channel. A direct (no base station) channel for the purpose of providing direct, short distance communications between units in the same zone or nearby units in adjacent zones.

d. Channel 4- Data channel. Used by field units to contact the data terminal operator for such information as license information, wanted or missing persons, stolen property, etc. Also is used for providing information for entry into files and or broadcast.

EQUIPMENT CONFIGURATION

I. Base Station Equipment

A. Base stations
1. Each base station shall be a single channel transmitter-receiver unit controlled over voice grade telephone lines from the communications center by tone commands.

2. Each station shall have the following features:
a. R.F. output power, 100 watts adjustable to as low as 30 watts by use of a single control.
b. Unit shall be a repeater station
(1) Repeat capability shall be controlled in an on-off manner by the dispatch center.
(2) Dispatcher shall have priority over mobile traffic.
c. Continuous tone coded squelch.
d. Receiver shall be equipped to operate in a receiver voting system.
e. Unit shall by powered by 117 volts A.C. During loss of A.C. power unit shall switch to and operate from a standby 12 volt D.C. system.
f. Unit shall be housed in a standard low cabinet.
g. Duplexers shall be built in.

B. Satellite Receivers
1. These receivers shall be of the same type and quality as the receivers in the base stations.

2. They shall be housed in standard 19" rack cabinets and meet the following criteria:
a. Continuous tone coded squelch
b. Single channel
c. Equipped to operate in a receiver voting system
d. Operate from 117 volts A.C. and revert to 12 volts D.C. standby power automatically during power failures.

C. Receiver Voting Systems
1. One system shall be provided for each channel.

2. Each system shall be comprised of electronic selecting and switching circuitry araanged so it will automatically and continously switch the best quality sound from the operating receivers to the dispatcher and, in the case of repeating conditions, to the selected transmitter for rebroadcast.

3. Each system shall be capable of automatically selecting the most appropriate transmitter on channels using more than one



transmitter location. Manual override switching shall enable the dispatcher to lock the transmitter site selection on to any one particular transmitter. This will compensate for local transmitter failure or other special operating condition

4. Each system will operate from 117 volts a.c. with automatic revert to standby 12 volts d.c. during power failures.

5. Each system shall have a minimum capacity of 4 receivers. All will be expandable to handle as many as 20 receivers. Transmitter selection capability shall be from 1 to 4 transmitters.

D. Control Consoles
1. Four units will be provided initally with design to permit expansion to as many as 15 operating consoles.

2. Consoles will be indentical and be capable of controlling all channels.

3. Space will be provided for future computer-aided dispatch equipment.

4. Telephone equipment will be built in.

5. Consoles will feature channel patching, simulcast and repeater control capabilities.

II. Field Equipment

A. Mobile Radios
1. Each radio shall be completely solid state and operate from 12 volts d.c.

2. R.F. power shall be 30-35 watts output into a 50 ohm load.

3. Radios shall be 4 channel sets providing access to one zone channel, the county-wide channel, mobile-to-mobile channel and one data channel.

4. Channel selection shall be made by a single knob or selection of one of four push buttons.

5. The channel selected shall be a priority channel in a scanning system.

6. The radio shall scan the selected and unselected channels and permit the operator to monitor the on-going communications on all the channels except the data channel. This channel will only be heard when it is selected as the priority channel Regardless of the activity on any other channel the radio will automatically switch to the priority channel whenever it is active.

7. The squelch control will be deleted from the control head and made an internal adjustment in the radio case.

8. The radio will be equipped to transmit its identifier number each time the microphone button is pushed. This number will be displayed at the console for immediate identification.

9. Tone coded squelch [illegible] used to reduce the possibility of interference and control the operation of the base repeaters.

10. A timer will be installed and adjusted to limit the air time of any one transmission to 30 seconds each time the microphone button is pushed. This protects the system from long term interference from jammed microphones, ets., and a tone alerts the operator when 30 seconds have passed and the timer has turned the transmitter off.

B. Portable Radios.

1. Each portable shall be a four channel unit operating on the same channels as a mobile radio in the same zone.

2. If available, the same scanning features as provided by the mobile radios will be provided. If not, an alternate scanning feature will be provided.

3. In any case channel selection shall be by operation of a single switch on the top of the set. Priority and non-priority channels shall be dictated by available equipment configurations.

4. Other features include:
   a. 1 watt r.f. power output
   b. 30 second timer
   c. externally mounted battery, snap on type
   d. usable with a vehicular charger
   e. insertion in a vehicular charger shall automatically connect the portable to an external antenna, microphone and speaker.
   f. belt clip and flexible antenna
   g. continuous tone coded squelch
   h. automatic unit identification and E.O.S. alarm features shall be included if available.

III. Special Tactical Channel Equipment

A. The equipment provided for use on each channel shall consist of a 20-25 watt r.f. power output, easily moved and stored, repeater station and at least 50, 1 watt, portable radios per channel.

B. This equipment shall be set up and placed in operation during emergencies such as disasters, riots, etc., where coordination and control of men and equipment is required on a frequency controlled by command post type operations.

C. Communications with the control center will also be available on those channels to designated officials.

D. Cross-channel communications with zone and other channels will be provided as required by the control center.



E. An additional number of two channel portables will be provided for command personnel to enable them to coordinate between channels in cases where both tactical channels are in operation at the same time.

IV. Emergency Preparedness (C.D.), Government Officials, Channel.

A. The field equipment on this channel shall consist of 1-watt portables radios and mating vehicular chargers.

B. The channel shall operate as a repeater channel.

C. The portables will be two channel units with one channel being repeater access and the other providing direct portable to portable communications without using the repeater.

D. During times of disaster or other such emergencies base facilities can provide a talk path between these non-police officials and police officials for the purpose of providing the necessary resources to meet the situation.

V. Highway Maintenance, Municipal Services Channel.

A. Only base station facilities will be provided by the county on this channel.

B. Field equipment shall be provided by the users in accord with county standards and requirements.

C. This channel will be used by the participants in their normal day to day operations and provide a means, through the control center, of coordination with police and government officials during emergency situations.

FIXED SITE REQUIREMENTS

I. How Determined.

A. The number of fixed sites necessary to provide reliable radio coverage throughout the county is directly related to the use of portable (hand held) transceivers as a major componet of the system.

B. Portable transceivers are, by nature of their physical size and stored power (battery) capacity, low powered radio units commonly using antenna systems which are inefficient radiators. The lack of efficiency of the portable antenna is the direct result of the need in the day to day field enviornment to provide a rugged, flexible, short antenna that is out of the way of the user and able to withstand physical abuse.

C. The result of the combined constraints is a hand-held radio of limited power with an antenna that does not transfer all the available radio frequency energy to the free air.

D. A study of the results of tests between one and four watt units conducted in actual operating systems by the New York City police

and others shows a one watt portable to be better suited to the daily needs of the foot patrolman. Some of the factors in this determination are-

1. The one watt unit is lighter in weight, therefore easier to handle and carr.
2. The battery life delivered by a four watt portable cannot meet the heavy traffic load encountered in the police service during a normal eight hour day. This means the officer would have to change batteries at least once during his shift to maintain full rated output over an eight hour period.
3. The additional initial cost of the high powered portable, plus the added maintenance expense of the high powered unit, make it a less cost effective system componet.
4. The incresed coverage provided by the four watt portable over the one watt unit is minimal and provides no great cost justification.

E. As a result of the considerations stated the one watt portable will be the basis of calculating the fixed site locations and configurations.

II. Coverage Predictions, Portable to Fixed Receiver.

A. The following criteria were observed in predicting the coverage area of a portable held in the normal transmitting position, approximately five feet off the ground.

| | |
|---|---|
| 1. Signal level at fixed receiver | 1.0 uV |
| 2. R.F. output power | 1.0 watts |
| 3. Antenna inefficiency, portable | -10 dB |
| 4. Receive antenna height above average terrain | 100 ft. |
| 5. Receive antenna system gain | 0 dB |
| 6. Feed line losses | 2.0 dB |
| 7. Cavity and filter losses | 2.0 dB |

B. The results of the calculations dtermined to provide 95% probability of coverage under normal operating conditions require that a single receiver be located within two miles of the hand held transceiver, two equally distant receivers each 2.75 miles away, 3 equally distant receivers each 3.25 miles swsy, or a combination of receiver distances that provide a calculated 95% probability of each message being received loud and clear at the dispatch site.

C. Based on the described requirements 14 receiver sites are proposed which will provide the needed coverage within the county and approximately 2.75 miles around the perimeter.

III Coverage Predicitions, base Transmitter To Portable.

A. Since base station transmitters can provide a radiated power from 25 to 1000 times that of the one watt portable the system will require considerably less transmitter sites to achieve satisfactory operation.

B. Site selection recommendations are based on the following criteria.



| | |
|---|---|
| 1. Signal at portable receiver antenna terminals | 1.0 uV/ |
| 2. Portable antenna inefficiency | -10 dB |
| 3. Portable carried on belt, antenna height | 3 ft. |
| 4. Transmitter antenna above average terrain | 100 ft. |
| 5. Transmitter antenna line and duplexer losses | -4 dB |
| 6. Area to be covered by transmitter, radius | 7 mi. |
| 7. Base transmitter r.f. power into duplexer | 50 W. |
| 8. Base transmitter antenna gain | +10 dB |
| 9. Probability of coverage | 95 % |

C. The radio horizion for an antenna located at an elevation 100 feet above average terrain (AAT) is approximately 14 miles. The required coverage is only seven miles. As a result, antennas having a pattern downtilt electrically built into their design will be used, where possible, to reduce the rediation beyond the desired coverage area to a minimum.

D. Where coverage areas are oddly shaped, antennas with special pattern or mounting arraggements providing the desired patterns will be used.

E. Transmitter power output and AAT will be adjusted where necessary to expand or reduce the overall coverage as each requirement is finalized.

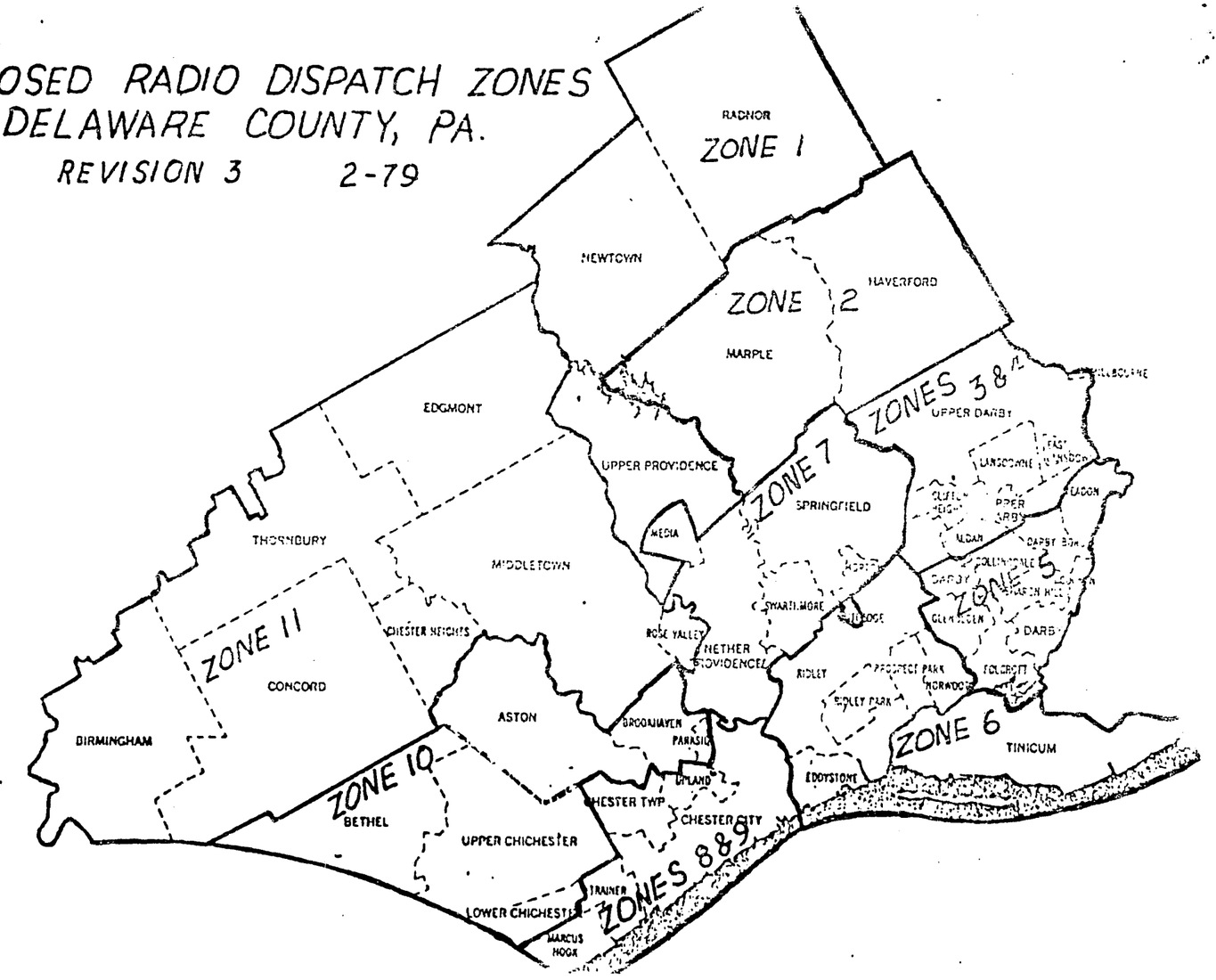
IV. Chart, receiver and transmitter locations per channel, per zone.

X- receiver only (X) - transmitter-receiver unit

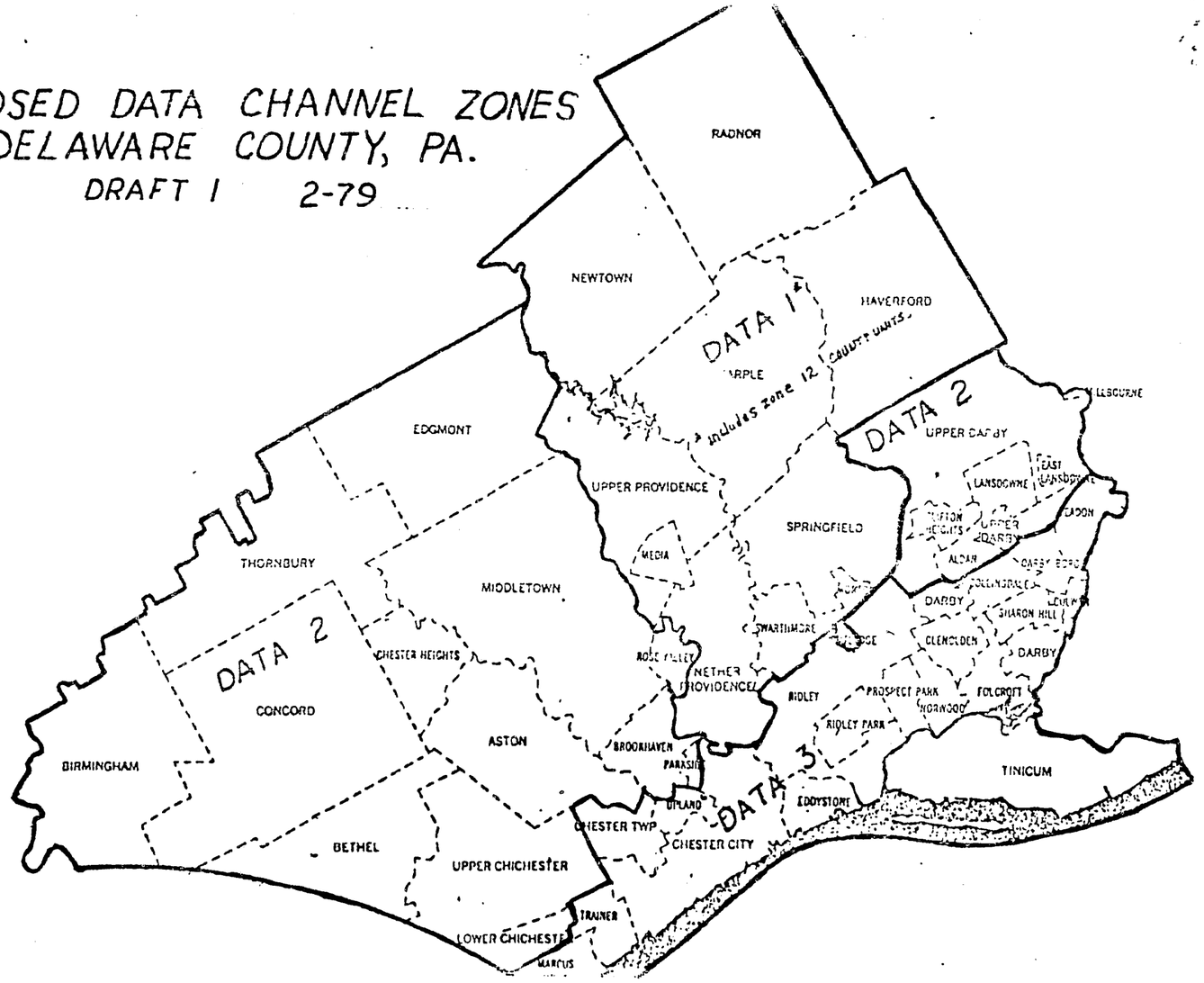
| SITE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ZONE | | | | | | | | | | | | | | |
| 1 | X | X | | | | | (X) | X | | | | | | |
| 2 | | (X) | X | | | X | X | X | | | | | | |
| 3 | | X | X | | X | (X) | | | | | | | | |
| 4 | | X | X | | X | (X) | | | | | | | | |
| 5 | | | X | X | (X) | X | | | | | | | | |
| 6 | | | X | X | (X) | X | | X | | | | | | |
| 7 | | | X | | (X) | X | | X | | | | | | |
| 8 | | | | | X | | | X | (X) | X | | | | |
| 9 | | | | | X | | | X | (X) | X | | | | |
| 10 | | | | | X | | | X | X | (X) | | | X | |
| 11 | | | | | | | X | X | | (X) | X | X | X | X |
| 12 | X | (X) | X | X | (X) | X | X | X | X | X | (X) | X | X | X |
| C.W. | X | (X) | X | X | (X) | X | X | X | X | X | (X) | X | X | X |
| D-1 | X | (X) | X | | X | X | X | X | | | | | | |
| D-2 | | X | X | | X | (X) | X | X | X | X | (X) | X | X | X |
| D-3 | | | X | X | (X) | X | | X | X | X | | | | |
| MUN | X | (X) | X | X | (X) | X | X | X | X | X | (X) | X | X | X |
| OEP | X | (X) | X | X | (X) | X | X | X | X | X | (X) | X | X | X |

C.W.= County Wide D-x= Data Channel MUN= Municipal
OEP= Office Emergency Preparedness (formerly C.D.)

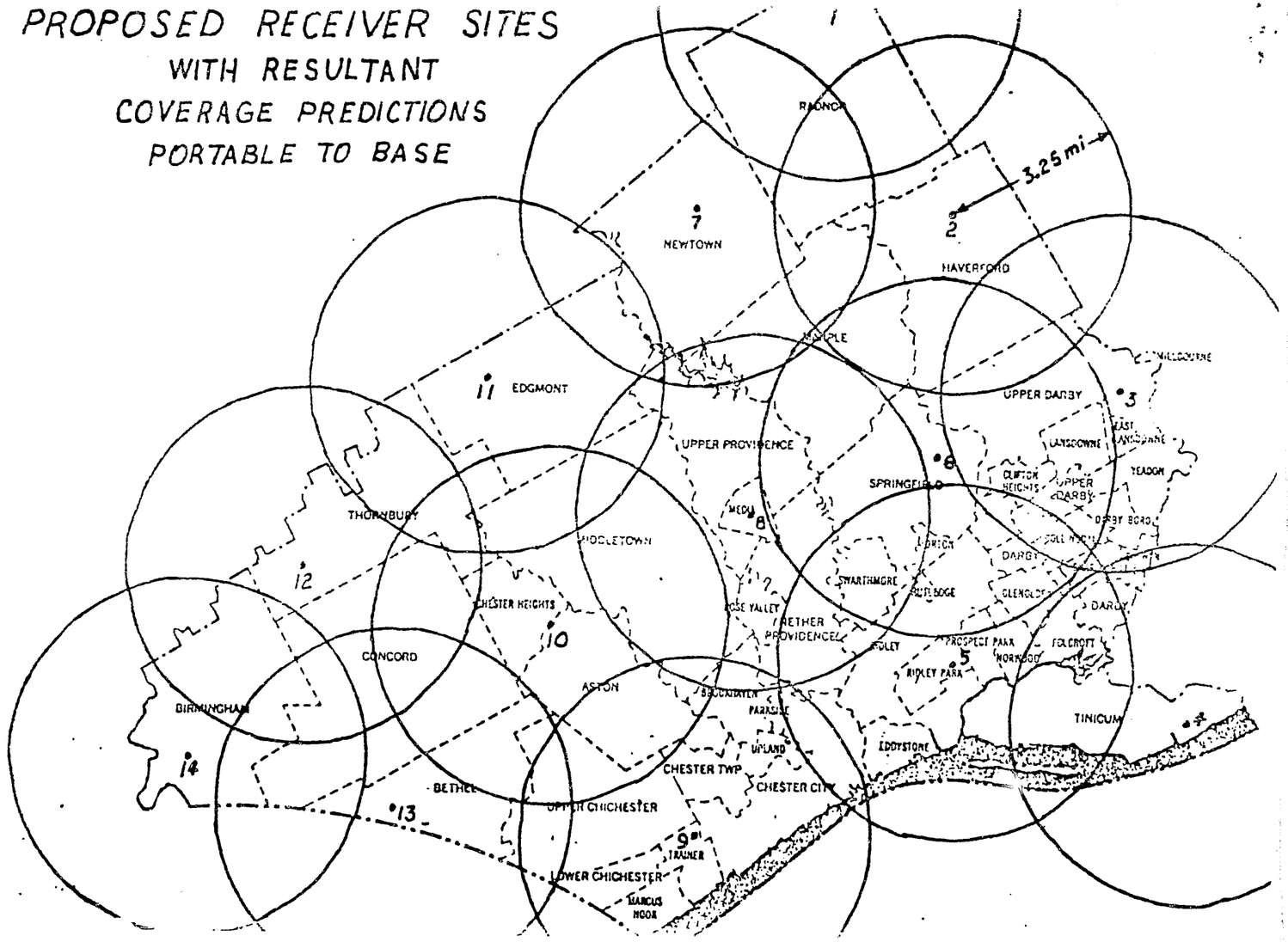
# PROPOSED RADIO DISPATCH ZONES
# DELAWARE COUNTY, PA.
REVISION 3 2-79



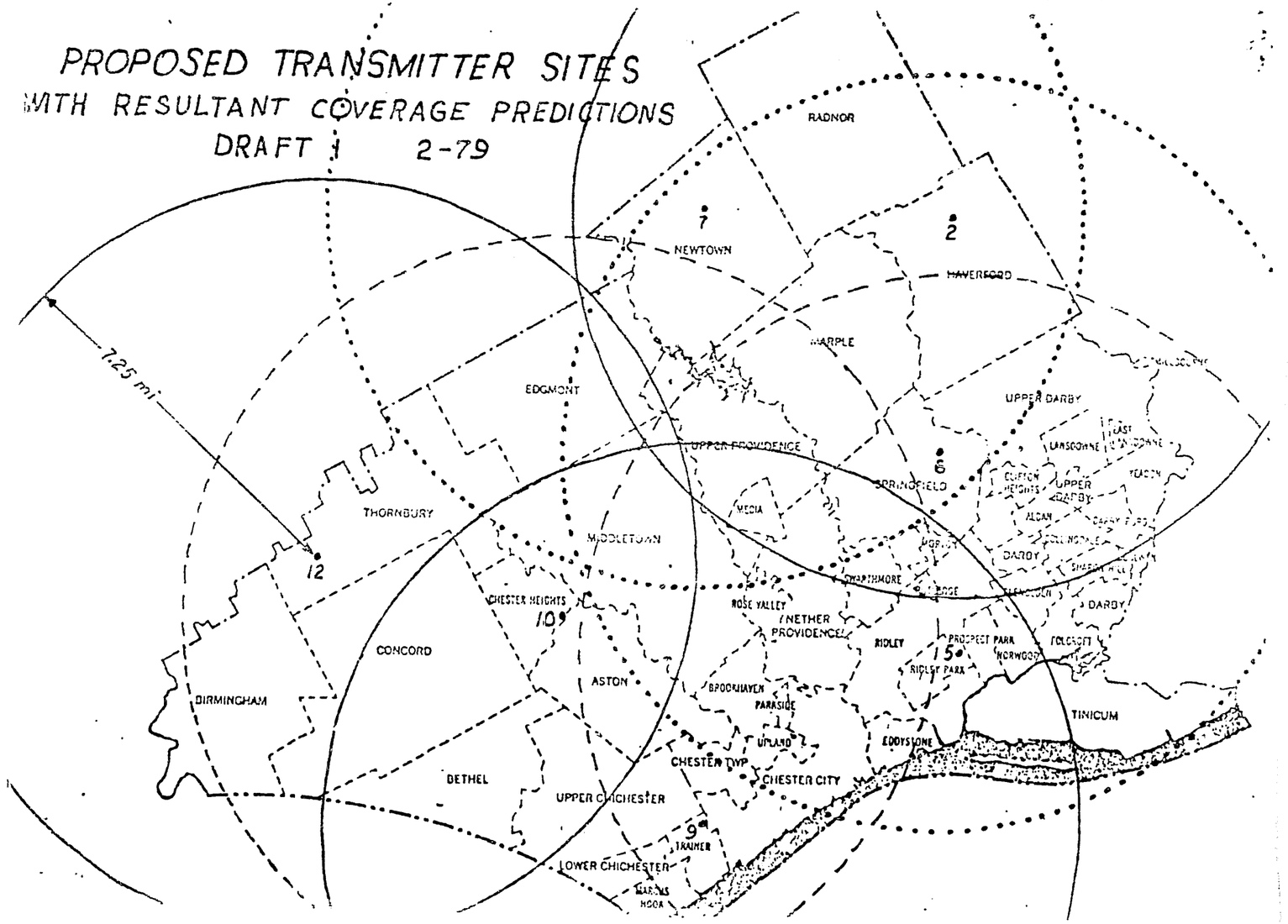
# PROPOSED DATA CHANNEL ZONES
# DELAWARE COUNTY, PA.
## DRAFT 1 2-79



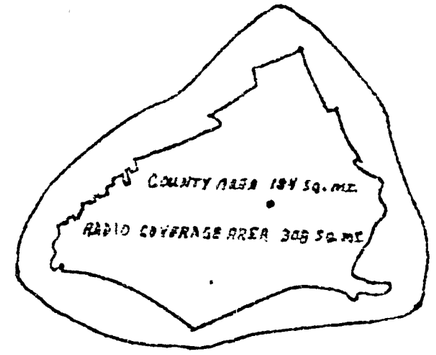
# PROPOSED RECEIVER SITES
## WITH RESULTANT
## COVERAGE PREDICTIONS
## PORTABLE TO BASE



# PROPOSED TRANSMITTER SITES
## WITH RESULTANT COVERAGE PREDICTIONS
## DRAFT 1 2-79



# OVERALL PREDICTED PORTABLE COVERAGE AREA




DELAWARE COUNTY, PA.

END