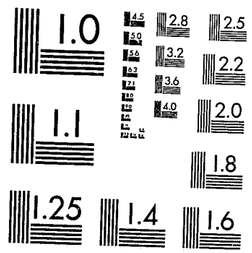


MF-1

LAW ENFORCEMENT ASSISTANCE ADMINISTRATION (LEAA)

POLICE TECHNICAL ASSISTANCE REPORT

SUBJECT: Communications System Review

REPORT NUMBER: 79-057-213

FOR: Department of Public Safety,
King County, Washington

Population 444,600
Police Strength (Sworn) 430
(Civilian) 144
Total 574

Square Mile Area 2,000

)R: Public Administration Service
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036

IT: R. James Evans

NUMBER: J-LEAA-002-76

August, 1979

I. INTRODUCTION

This report was prepared in response to a request from the King County, Washington, Department of Public Safety for technical assistance in reviewing the department's police communications system with particular attention to the planning process and the proposed upgrading of facilities.

To carry out this review, which had the major objectives of verifying current system design and operation and examining future system plans, a number of tasks are involved. These include observing Communications Center functions, reviewing system maintenance capabilities, verifying equipment replacement and upgrading of radio site plans, and inspecting all installations on-site.

The consultant assigned to this project was R. James Evans, PAS Senior Consultant; others involved in processing the request were:

Requesting Agency: Mr. Lawrence G. Waldt
Sheriff-Director
King County Department of Public Safety

Approving Agency: Mr. James G. Vetter
Chief, Police Section
Enforcement Division
Office of Criminal Justice Programs, LEAA

During the on-site phase of the assignment, July 23-31, 1979, the consultant interviewed the following key individuals in addition to talking to various other department staff members in the communications and dispatch area:

- Lawrence G. Waldt, Sheriff-Director, Department of Public Safety
- Major Jerry L. Burk, Commander Patrol Division, Department of Public Safety
- Harold B. Booth, Chief, Bureau of Staff Services, Department of Public Safety
- Barnard Winckoski, Executive Technical Administrator, Department of Public Safety
- Lt. R. W. Jenne, Commander, Communications Division, Department of Public Safety
- Sgt. Daniel J. Nolan, Administrative Assistant, Communications Division
- Sgt. Robert J. Schmitz, Administrative Assistant, Communications Division
- Frank L. Porter, Jr. Communications Supervisor-Engineer, Department of Public Safety
- Ms. Mary Ann McLaughlin, Research and Planning, Department of Public Safety
- John Murphy, Research and Planning, Department of Public Safety
- Frank Glaspy, Planning and Technical Assistance Manager, State of Washington, Law and Justice Division
- Don Linehan, Radio Technician, Department of Public Works

A. Background

King County, which surrounds the City of Seattle on three sides, has experienced a slow but consistent growth of population, from 411,000 in its unincorporated areas in 1972 to 444,600 in 1978. This growth has been accompanied by an increase in crime rates that has pointed up the need for improved communications for patrol officers. Annual increases in activity by the Communications Division support this need, as the following statistics demonstrate:

Table 1

COMMUNICATIONS DIVISION ACTIVITY, 1977-78

Activity	1978	1977
Total calls received	405,937	397,207
Office reports written	31,039	31,061
Incident cards made	243,042	233,348
Computer transactions - Radio	232,184	227,975
Computer transactions - Data	354,374	334,539
Teletypes handled	64,303	40,922
Warrants handled	64,413	53,700

Organization of the Communications Division is shown in Figure 1, which follows.

B. Tasks Performed

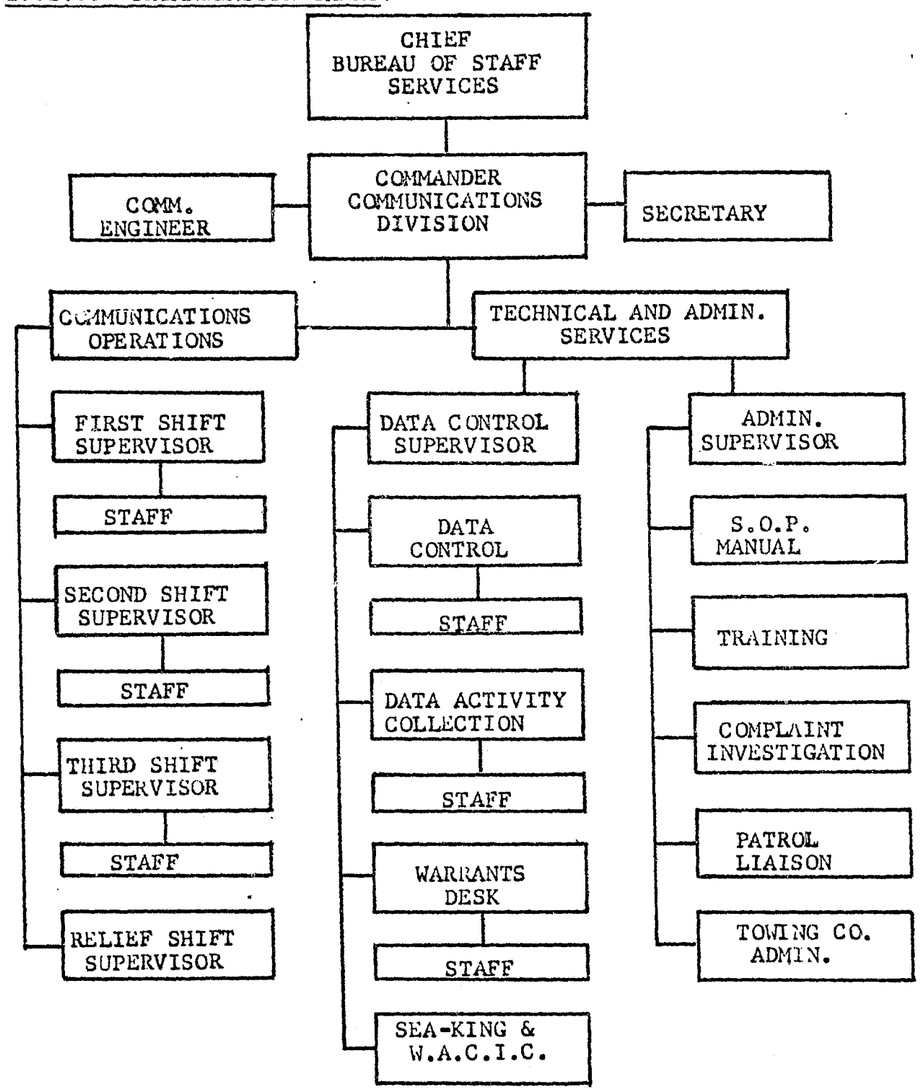
During his on-site visit, the consultant carried out the following tasks essential to fulfilling the objectives of the assignment:

KING COUNTY

Figure 1

SUBJECT: COMMUNICATIONS DIVISION	DATE: 10-01-78	INDEX: 4.0.
ORGANIZATION CHART	REVISED:	1.01.00

1.01.00 ORGANIZATION CHART.



1. Had discussions with and made on-site observations of call-taking and report-writing personnel. This task involved interviews with the division commander, his assistants, the staff supervisors, call-takers, and report writers. On-site monitoring of calls took place both during day and evening shifts.

2. On-site monitoring of the radio dispatching area to determine functional operations and workload.

3. Obtained workload statistics prepared by Planning and Research along with planning information for future automation of the call-taking and dispatch functions.

4. Reviewed the maintenance capability of radio equipment with the Chief of Staff Services, the Communications Engineer, and the Acting Supervisor of the radio maintenance section of the Department of Public Works. This task covered the financial aspect of maintenance, the engineering requirements, and the coordination of equipment installations and purchases.

5. Reviewed the budget documents for equipment replacement and additions for upgrading the system. This task required discussions with departmental personnel as to the final expectations in system design, system integration with other major systems, and future system flexibility.

6. Visited three remote locations in order to understand all phases of the system, particularly the complicated radio coverage designs required throughout the mountainous terrain.

7. Reviewed the alarm requirements, the satellite receiver requirements for the more populated areas, the cross-band in-car hardware requirements for mutual aid, and the microwave system expansion. Each of these technical areas were discussed in detail to determine their necessity, capability, and priority in the budget process.

8. Contacted the Sheriffs Association, the State Patrol, and the Fire and Emergency Services involved in the proposed countywide mutual-aid system. Time did not permit on-site discussions with these agencies; however the County mutual-aid system was thoroughly reviewed and a system proposed.

II. ANALYSIS OF THE PROBLEM

The analysis that follows includes verification of existing system components and design, a review of the existing call-taking and dispatch functions, and an evaluation of planned future needs of the Communications Center. This evaluation is based upon prior and proposed system design, the present implementation of systems, and the maintenance of those systems. Communications needs are assessed to determine if present operations are adequate of if staffing and workload data warrant further automation of the center.

A. Verification of Current System Design

This task involved a review of the following system parameters, configurations, and frequencies.

- Police Precinct, Southwest
- Police Precinct, Southeast
- Police Precinct, North
- Data Channel
- TAC I Channel
- TAC III Channel
- F1 Channel
- F2 Channel
- F3 Channel
- F4 Channel
- Satellite Receiver Channels

Figure 2 indicates the general locations of the base stations and microwave terminals throughout the County.1/

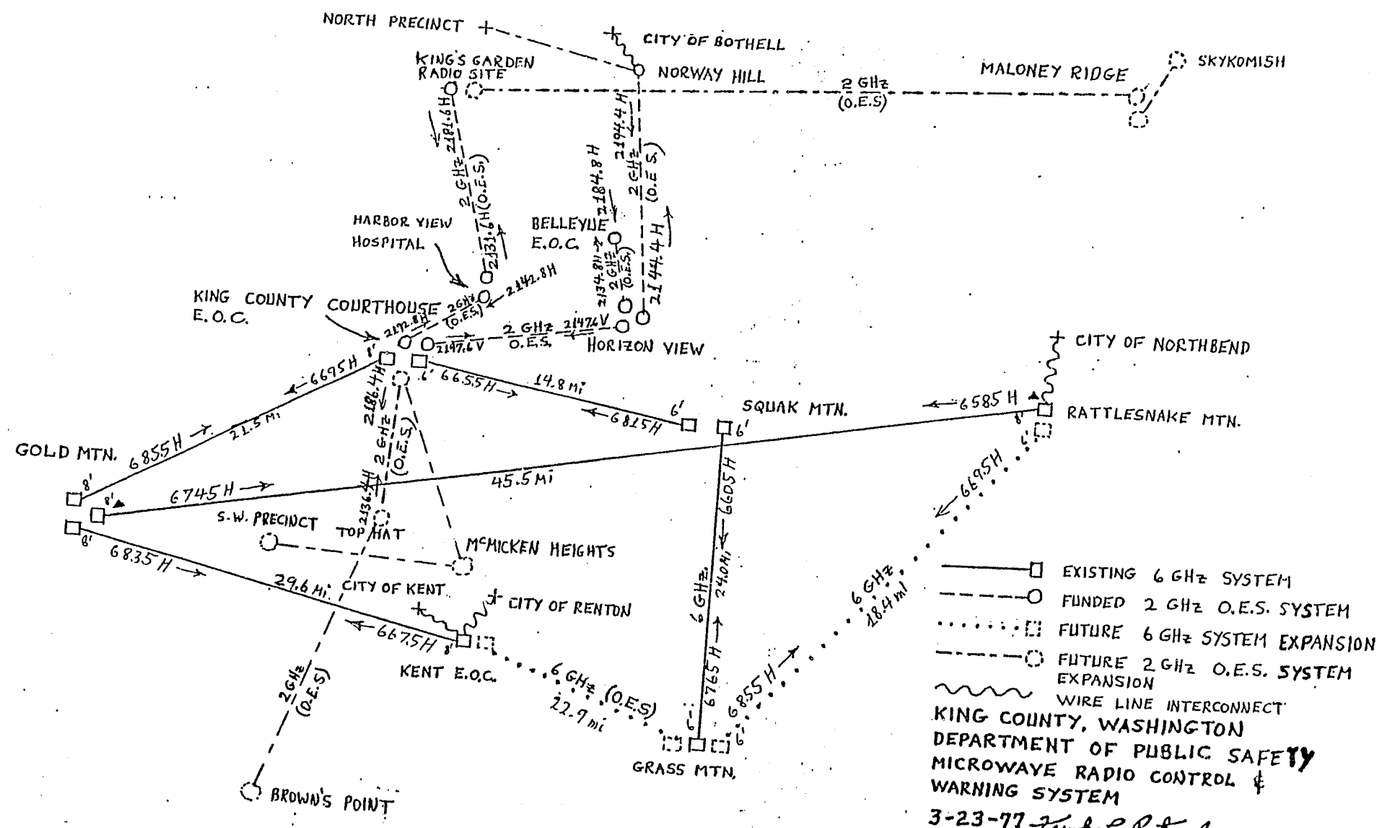
The following brief description is an attempt to simplify the explanation of a very complex system providing police radio coverage from a central office over rugged mountain terrain.

The Department of Public Safety utilizes a central dispatch radio concept whereby all citizens' calls for service are received at a central dispatch office in the County Courthouse in downtown Seattle. Calls requiring a police response are dispatched from this location to the appropriate patrol unit in one of three precincts. The dispatcher receives the call numbers of the patrol units on duty at the beginning of each shift. During the patrol shift, a continuous patrol update is provided by voice radio to the dispatcher.

1/ System location map provided by Frank L. Porter, Jr., Communications Supervisor and Engineer.

Figure 2

MAP OF BASE STATIONS AND MICROWAVE TERMINALS



The existing radio system was designed to provide positive radio contact with patrol units in all areas of the three precincts. Portable radio units now being used by officers when out of their vehicles do not always provide dependable communications to the dispatcher.

In order to adequately cover the large patrol areas in each precinct, the system is designed for simulcast operation. This means that two or more radio transmitters covering a precinct area broadcast the radio message simultaneously, thereby covering the entire service area.

Southwest Precinct patrol units receive their base station service from two existing locations--one on the top of Gold Mountain, west of Seattle, and one on Squak Mountain east and south of Seattle. The base stations transmit on a UHF frequency of 460.400 MHz, and receive the mobile and portable radio units on 465.400 MHz.

The Gold Mountain location is used to project the radio signal along the coastline on the east side of Puget Sound. Mobile operations are covered adequately; however the portable radio units need additional receiver capability.

The base stations are controlled from the central dispatch office over a 6-GHz microwave system.

The Southeast Precinct patrol units receive their service from three base stations, located on Squak Mountain, Grass Mountain, and adjacent to the City of Kent. These base stations transmit on the UHF frequency of 460.450 MHz and receive on 465.450 MHz. These three base stations are controlled from the Seattle dispatch point over a 6-GHz microwave system.

The North Precinct patrol units receive service from one base station located just north of the City of Seattle. Second and third base stations are located on Squak Mountain and Rattlesnake Mountain. The base transmits on 460.325 MHz and receives on 465.325 MHz. The present mode of control from the dispatch location is via a leased ratio telephone circuit and microwave.

The east portion of the North Precinct receives base station radio service from an in-band repeater station located on Maloney Ridge near Skykomish. This area is physically separated by a mountain range from the North Precinct base station. The radio frequency used at the east repeater is shared by Mason County and has occasional interference problems.

The "data" channel is used by all mobile units to request computer checks. The base stations are located at Gold Mountain and Squak Mountain. Each base station transmits on 460.275 MHz and receives the mobile unit on 465.275 MHz. These two base stations are controlled over a 6-GHz microwave system.

The County and TAC I are at the same tower locations. The base stations are located at Gold Mountain, Grass Mountain, Squak Mountain, and Rattlesnake Mountain. These four bases are controlled from the dispatch center over a 6 GHz microwave system. The county base station transmits on 460.200 MHz and receives mobile units on 465.200 MHz. The TAC I base station transmits on 460.500 MHz and receives on 465.500 MHz.

The county channel allows mobile units in one area to talk directly to mobile units in another area throughout most of the populated parts of the county. The TAC I channel provides a similar service to mobile units when necessary.

TAC II radio channel is presently inactive but is reserved for the countywide mutual-aid radio system.

The TAC III radio base station is located at Squak Mountain and is controlled from the dispatch center over a 6-GHz microwave system. The base station transmits on 453.350 MHz and receives on 458.350 MHz.

The VHF radio channels in use by the department are labelled F1, F2, and F3.

The F1 radio frequency has four base stations located as follows: one at Rattlesnake Mountain, one at Grass Mountain, one at Squak Mountain, and one at Gold Mountain. The base stations transmit on 155.190 MHz and receive on 154.650 MHz. They are controlled from the dispatch center over a 6-GHz microwave system. This channel is utilized by the department for communications while serving warrants and for conducting civil process, marine patrol, and administrative tasks. It also serves as a mutual-aid channel in the VHF range for units in the southern section of King County.

The F2 radio frequency has two base stations, one located at Rattlesnake Mountain and the other at Squak Mountain. These bases are controlled from the dispatch center over the 6-GHz microwave system. The base stations transmit on 154.965 MHz and receive on 153.995 MHz. This channel is used as a primary for marine patrol and search and rescue units.

The F3 radio frequency has three base stations, one located at Harbor View Hospital in downtown Seattle, one at Squak Mountain, and one at Rattlesnake Mountain. These bases transmit and receive on 153.775 MHz in a simplex mode. The base at Harbor View Hospital is controlled from the dispatch center by use of a leased telephone circuit. The two bases on the mountain tops are controlled over the 6-GHz microwave system. This channel is used for paging and by the Office of Emergency Services located in King County Court House.

The F4 radio frequency is a mobile-only channel used for rescue.

The satellite receiver program has recently been started and has one location at Norway Hill. This receiver operates on 465.325 MHz and connects

by wire line to the dispatch center. This satellite improves reception in the Bothell area on the North Precinct frequency.

The existing radio system design was reviewed through discussions with the King County Police Communications Engineer and by on-site field trips to several of the major base station and microwave locations.

The present use of radio frequencies, the base station sites, and control facilities were evaluated to determine if the basic plan was functional in operation and responsive to police needs.

B. Verification of Current Operations

This task involved the completion of a number of sub-tasks as follows:

- Review of incoming calls
- Future integration of a computer-assisted dispatch
- Report writing in the center
- Use of frequencies
- Staffing and workload
- Dispatch data collection
- Dispatching procedures

These sub-tasks involved numerous discussions with the division commander, the assistants to the commander, communications center shift commanders, dispatchers, and call-takers.

Workload observations were made by on-site monitoring of the call-taker and dispatcher positions during both day and evening shifts.

The personnel complement of the control center consists of eight call-taker positions (not all filled at present), three dispatch positions, and one shift supervisor. The call-taker and dispatch positions are manned by civilian personnel, while the shift supervisor is either a sergeant or lieutenant. Normally, there are three eight-hour shifts; however, there are two overlapping shifts for peak periods.

Adjacent to the dispatch center are a data operator who receives data check from field personnel by radio and enters and retrieves criminal justice information via a computer terminal, a warrant section, and a computer entry for incident card information.

The traffic flow through the center starts with the call-taker receiving the citizen's complaint which will be recorded on an incident card (see Figure 3). Some calls may require transfer or direct operator answer or may be transferred to a report writer. The incident card is pre-numbered and is stamped with the time the call is received. If the incident requires a patrol officers, the card is hand-carried to the dispatcher a few feet away.

Figure 3

SAMPLE INCIDENT CARD

1 A/C ☒ CONTACT ☐ CONTACT OPTIONAL ☐ CONTACT DECLINED ☐ IN PROGRESS

CLR APR DIS PRC

CASE X EVENT NO. 123456

ATION 516 THIRD AVE INTERSECTION SSC SDC2 APT. NO.

UNIT 1F19 BACK UP USED ☐ YES PATROL DIST. 59

PLAINTANT'S NAME DOE JOHN PHONE NUMBER 555-1212

GRID TRACT ARREST TYPE ☐ F ☐ M

PLAINTANT'S ADDRESS ☒ SAME AS LOCATION

SDCI SNM SSC SDC2 APT. NO.

OPER. 3 DISP. 3 EVENT CLASS 730 PRIORI 2

NESS NAME PHONE NUMBER

FINAL CLASSIFICATION 730 / D / 0

REMARKS:

FOLLOW UP NUMBER

LARY X RES BURG F/E

WHO WAS NOTIFIED

URBANCE

ENY SUSPECTS FLED LEAVING VEHICLE IN DRIVEWAY

DALISM

SEE BA X

GLOBE 338822-P KING COUNTY POLICE DISPATCH CARD KCDPS C-101 (REV. 3/76)

NO. OF SUSPECTS 7 LAST OBSERVED 10 MIN LOCATION SCENE HEADING ON: THIRD AVE ☒N ☐S ☐E ☐W ☒FOOT ☐VEHICLE

1	RACE	SEX	AGE	HGT	WGT	HAIR COLOR	EYE COLOR	COMP.	CLOTHING
	UNK	M	40	UNK	UNK	DARK	UNK	UNK	DARK

ADDITIONAL INFORMATION ALL SUSPECTS LOOKED SIMILAR

2	RACE	SEX	AGE	HGT	WGT.	HAIR COLOR	EYE COLOR	COMP.	CLOTHING

ADDITIONAL INFORMATION

VEHICLE INFORMATION: ☒ SUSPECT ☐ STOLEN ☐ RECOVERED ☒ IMPOUNDED DEPARTMENT IMPOUNDED AT: (ARRANGED TO WING)

LIC	LIS.	VIN.	VYR.	VMA	VMD	VST	VCO
AAA-111	WA	X111417D3	46	STUD	CHAMP	CONV	RUST

COMPUTER INFORMATION: ☒ENTERED ☐LOCATED ☐CLEARED ☐MODIFIED CCN NO. 1234567 WACIC NO. 79Y444444 NCIC NO.

REGISTERED OWNER DOE, BILL ADDRESS 1010 - FIFTH AVE HOME PHONE UNK BUSINESS PHONE UNK

NOTIFIED ☐ YES ☒ NO ☐ ATTEMPT TT SENT NO OPER. NO. 4 TOW COMPANY NO. XXXXXXX

REMARKS: HOLD FOR DETECTIVES

GLOBE 338822-P

If a patrol car is available and other higher priority calls are not waiting, the message will be dispatched immediately. If a car is not available, the card is "stacked." The stacking and assignment of priority of calls is the dispatcher's responsibility and requires continuous attention to assure that crimes in progress generate immedia police reaction.

Patrol car status for each precinct is a continuous dispatch function. When the message is dispatched, the operator stamps the time; stamping is also done for time of arrival at scene and patrol car clearing the scene.

If an incident is reported by an officer in the field, the dispatcher will fill out an incident card.

All telephone and radio calls are tape recorded in the control center.

1. Review of Incoming Calls

The call-taker is responsible for all incoming emergency calls and must make an immediate decision as to whether the call requires emergency dispatch or if the incident can be handled by a report-taker.

The incident calls average from 1.9 to 2.5 minutes in length, not including report writing. Time studies are underway in the department's Research and Planning Division in an effort to accurately predict the necessary staffing for the Communications Control Center.

The consultant reviewed the staffing formulas and proposed staffing requirements and concurs with the finding of the Research and Planning Staff in this regard.2/

The call-takers position requires a number of manual functions such as filling in the incident card, stamping the cards, and physically carrying the card to the dispatch console location, which reportedly takes 15 seconds on the average.

During the discussions with Control Center personnel it was learned that during busy periods some calls are never answered, an indication that additional personnel are required. In the course of on-site visits to the center it was observed that some

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2/ See Appendix A for July 30, 1979, letter to Lawrence Waldt, Sheriff-Director from Research and Planning, outlining call-receiver staffing requirements.

operators work very rapidly in answering citizens' calls, while others appear not to be busy.

2. Report Writing in the Center

Currently report writing in the Communications Center is done by a call-taker during his or her spare time. This is accomplished either by the call-taker recording the report immediately after receiving the first call or by taking the complainant's telephone number and calling him back during a slack period. One operator was observed trying to complete a report while switching back for emergency calls. This method of operation is very frustrating for the personnel involved.

The reports vary in length depending upon the type. For instance, a report on a stolen bicycle may be completed in five minutes, while a larceny involving many items may take 20 minutes.

Some relief in the report writing area will presumably be available through the new ICAP grant that provides for 11 report-takers.

There were some discussions relative to the physical placement of the report-writers, since space is at a premium in the existing center. This function could be located at a remote site in the building; however the following factors should be considered prior to a final decision on their placement:

a. There frequently is a need for the report-taker to discuss the case with the original call-taker (this could be accomplished by telephone).

b. The department would have to pay the cost of leased telephone circuits if moved out of the Center.

c. Supervision that is presently available in the Control Center might not be present in the alternate location.

3. Use of Frequencies

The use of frequencies to perform police functions appear to be well organized at this time. A separate UHF radio channel has been assigned to each of the three precincts, with a separate dispatcher for each precinct. A countywide channel allows any patrol unit to communicate with any other precinct unit, thus permitting interaction across precinct borders. A separate UHF radio channel is used for data checks from field officers. This channel is manned by a separate dispatcher at the Control Center.

There are two UHF tactical channels in use for countywide operation. One additional TAC channel will be used for mutual-aid on a countywide basis. In addition to the UHF channels, there are four VHF channels used for marine patrol, civil prepardness, and other functions.

Technically, the frequencies are well allocated for services throughout the department.

Each dispatcher has the capability of operating on any of the channels; however, the normal assignment is one precinct with monitoring of certain other channels. The shift supervisor has a control console with the capability of monitoring all frequencies.

Even though the present channels are adequate, the department should consider future expansion into the 800 MHz band. Since the range is shorter on these frequencies, it may be advisable to use the 800 band on a shared basis in the metro areas of the county. The FCC allocates these channels in blocks of five in order to permit trunking arrangements in metro areas.

4. Staffing and Workload

The staffing and workload of the Communications Center is a major consideration for the department because of increasing budget requests for personnel to satisfy an ever-increasing workload.

The Research and Planning Section is actively engaged in the collection of data and formulating staff requirements. The call-taker section of the center has been completed by Research and Planning employees through on-site data collection, use of time-proven formulas, and engineering calculations to produce a staffing guideline that relates to call answering speed. The results of this study were as follows.3/

Average Telephone Call Answering Speed	Call Receivers Required
5 seconds	30 persons
8 seconds	28 persons
10 seconds	27 persons

3/ Information from Research and Planning Memo, Appendix A.

The personnel listed are those necessary for a 24-hour, 7 day per week operation. Allowances are made for vacation sick leave and holidays, and relief dispatching that is necessary in the Control Center.

The staffing difference between the 5-second overall average answer criterion and the 10-second criterion is only three positions. However, loss of these three positions would significantly degrade the level of service to the public. The principal effects on service levels may be summarized as follows:

1. An increased number of delays in answering calls and longer overall delays for those calls not answered immediately.

2. An increased number of dropped calls, and

3. An inability to respond to temporary overload conditions.

The workload for the call-taker is increased by hand-carrying the incident card to the dispatcher, which is estimated to take an average of 15 seconds, unless discussions of the incident are necessary.

5. Dispatch Data Collection and Dispatching Procedures

The two sub-tasks of dispatch data collection and dispatching procedures were reviewed through on-site monitoring and discussions with dispatch and supervisory personnel. It was found that little data is collected at this time that is of value in staff justification.

The data useful in time allocation can be gathered by the use of a stop-watch method to time each manual function. Presently the supervisor has electronic counters at his location that provide transmission over the radio system for each of the three dispatch consoles. The Research and Planning Section will use this information as well as other data in the future to provide a more positive approach to staffing at the dispatch locations.

Dispatch procedures have been automated to the extent of workload equalization and computer entry; however, the present procedures require considerable manual activity in the handling, stamping, prioritizing, and stacking of incident cards. In addition to these duties, the dispatchers answer the telephone for overflow calls when a call-taker is not available. These are all in addition to the normal radio transmissions to and from officers in the field.

Analysis of this area indicates that further automation should be considered for dispatching functions.

The Communications Division has been active in upgrading the Control Center, and a few of the recent improvements are as follows:

- The addition of a data operator, control console on the data frequency, and a computer terminal for criminal justice queries from State and Federal files.
- The implementation of overlap shifts for easing peak load activity.
- The planned installation of call-director telephone instruments.
- Report-writers in the center through recent approval of ICAP program.
- The addition of the DADC (Dispatch Action Data Collection) system to provide management information from incident cards.

These and other minor operational improvements all tend to improve the efficiency of the call handling and overall operation of the center.

6. Future Integration of a CAD (Computer-Aided Dispatch) System

From the previous discussions of Control Center operations, it is apparent that most of the manual problems can be minimized by the addition of a CAD system.

The Research and Planning Section has been evaluating CAD systems and has considerable background and experience in this area of automation.

Justification for a CAD system in a Public Safety Department is generally based on one or more prime factors, such as the number of incidents handled, the size of the department in manpower and vehicles, the cost-effectiveness of one system vs. another, the need for more efficient handling of incident messages, etc.

The department could improve its functional operation of the Communications Center with the use of CAD, while also realizing a side benefit of improved car status and priorization of incidents.

Several questions arise when departments consider upgrading to computer-aided dispatch. First, how does the system change the present manual incident card system? The existing incident card information with minor changes would be programmed into the computer memory and would be available to the call-taker or dispatcher through pressing a key on the CRT terminal keyboard. As the call-taker questioned the citizen, he would type the answers to each question into the computer memory. The exact information being entered by the call-taker would appear immediately on the dispatcher's CRT screen to be dispatched to a police vehicle or stacked automatically if no vehicle were immediately available. The incident information is recorded by the computer memory and can later be printed in various forms for management information. There are many options available in system hardware and software that could enhance system capability in other ways.

Automatic car status, through the use of the CAD system, is an option that saves dispatcher time and on-the-air time. This option consists of a add-on device in the patrol car that allows the officer to select one of several pre-programmed messages and by pushing one control switch on his car unit, a data message is sent to the dispatchers status CRT. The message could read for example: car 123 back in service.

More advanced and costly are the in-car computer terminals that allow two-way data messages between the patrol officer, the dispatcher, other patrol units, and to the State and Federal Criminal Justice files.

Among the immediate improvements or benefits that become apparent when a CAD system is implemented are:

- Reduce or minimize movement of personnel in the Control Center.
- Reduce verbal conversations between call-taking and dispatching personnel.
- Improve the prioritization through automation of incidents to be dispatched.
- Improve "call stacking" of incidents while awaiting available patrol units, with less chance of error.
- Reduce manual workload of call-taker in handling incident cards, filling out information, stamping, and delivering cards to dispatcher.
- Reduce manual workload of the dispatcher in handling incident cards.
- Provide periodic management information from incident information in the computer.

- Eliminate the present DADC computer system used to record incident card information, thus saving personnel time and hardware cost.

- Provide report-writers terminal access to record all telephone reports that would be processed automatically in the Records Section with printer copies for other divisions such as Detectives, investigation, juvenile, etc. This reduces errors from handwritten reports and improves distribution.

- Reduce errors that occur in handwritten incident reports.

- Improve and automate the patrol car status at the dispatch positions.

- Provide automatic address verification of incidents.

- Provide automatic precinct identity for dispatch operation.

- Provide additional officer safety in the field when used with in-car status and/or terminal units.

- Provide immediate prior history of repeat incidents at an address.

These and other benefits may be realized with CAD and will depend upon the software sophistication and programming decisions of the department.

Expansion capabilities with the CAD system can include terminal switching modems for the use of one CRT terminal for accessing both local CAD files as well as the State and Federal Criminal Justice files, thus reducing the terminal hardware in the Communications Center. If a separate operation for mobile data checks is continued in the center, then the dual-use terminal improves the dispatchers' capability and optional flexibility to the system.

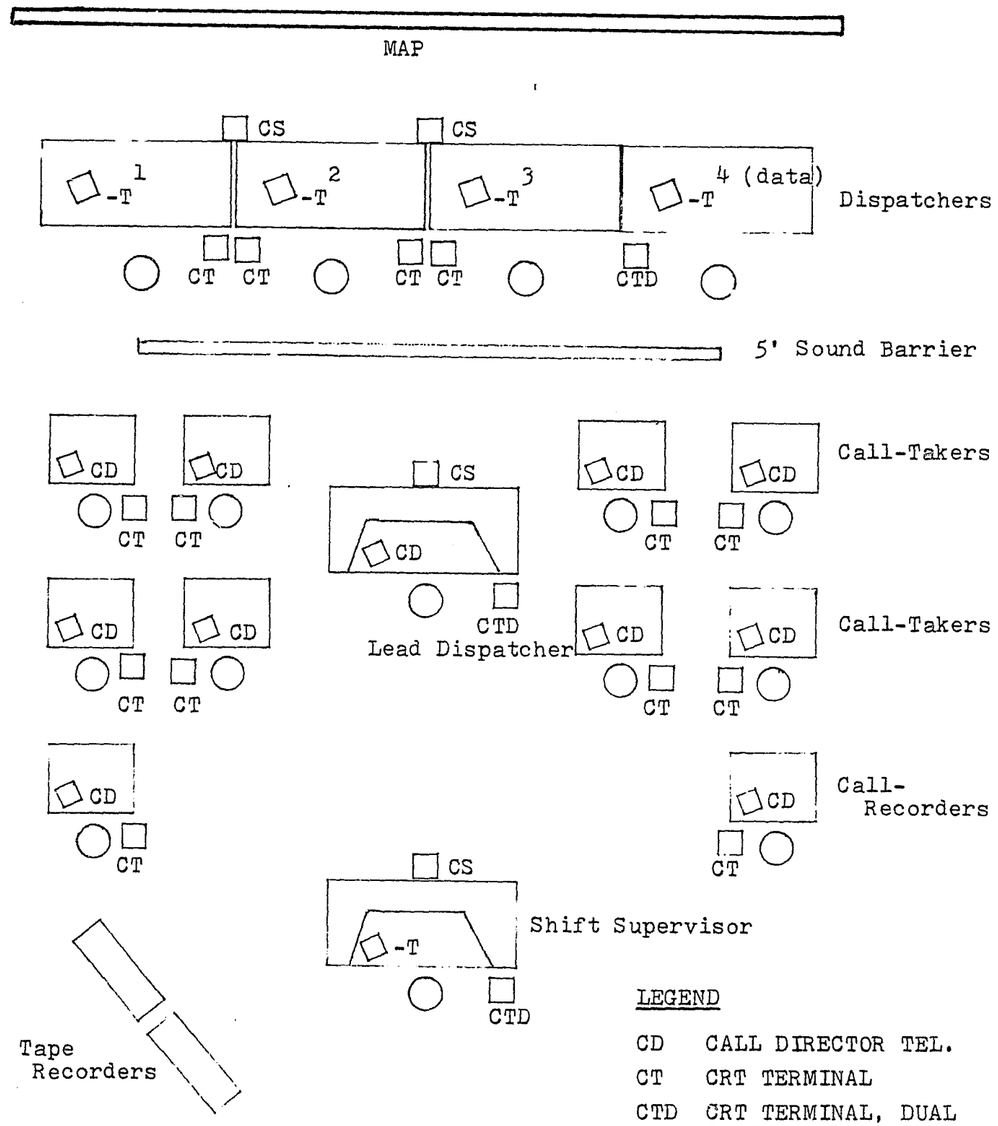
The integration of the CAD system into the existing center operation may require some physical changes along the lines suggested in Figure 4.

Discussions with Research and Planning personnel provided background for analyzing methods of implementing a CAD system in King County police operations. There appears to be at least three alternatives for implementation:

a. Use of the existing King County computer.

Figure 4

SUGGESTED CONTROL CENTER ARRANGEMENT
WITH COMPUTER-AIDED DISPATCH
(not to scale)



b. Use of the King County computer with mini-computers for real-time operations required by the police operation.

c. Possible dual use of the Seattle Police Department's CAD system.

Each alternative will require expert analysis to determine the programming and real-time storage of the police operation.

The police operation must have 24-hour uninterrupted service and a capability of expansion. The use of the Seattle CAD system would require that the King County Sheriff's Department use the same incident format and other criteria now programmed into the Seattle system. Expansion of the Seattle storage component may not prove capable of geo-coding all outlying areas required in the Sheriff's operation.

Many other factors must be analyzed prior to making final plans for CAD including number of terminals, printers, and one mini-computer or two; amount of storage and type required; physical location; computer programming; and source of maintenance personnel.

Prior to specification preparation the department should become familiar with CAD systems by:

- Discussions with computer personnel at the county level.
- Visit CAD installations throughout the country with similar requirements, such as size, number of vehicles, message, volume handled, etc.
- Determine minimum and maximum requirements that results in a cost-effective system within budget restraints.
- Plan multi-year expansion of original installation.

Operator Training

The call-takers and dispatch personnel in the control center should be provided with basic training when hired and in-service training every 6 to 12 months to keep uniformity in all operations.

This training will be extremely important if the computer-aided dispatch system is implemented.

C. Review of System Maintenance Capability

The first objective, verification of current system operation, has a sub-task that required the review of the system maintenance capability.

Background information for this task was obtained through discussions with the department chief of staff services, the communications engineer, and the acting supervisor of the Public Works radio maintenance shop. A brief memo, dated July 13, 1979, to the Sheriff-Director from the chief of staff services addresses the maintenance problem (see Appendix B).

1. The Problem

Several factors appear to influence the maintenance capability of the Sheriff's Department radio equipment, including:

- The Sheriff's Department has about 80% of all radio equipment requiring maintenance among county agencies.
- The Sheriff's Department radio equipment and systems are becoming more sophisticated in nature than some of the other agencies' equipment.
- Because the Sheriff's Department must operate on a 24-hour basis, 7 days per week, its equipment requires more maintenance than those systems operating on an 8-hour, 5-day basis.
- The emphasis on immediate service of the public safety equipment is lacking. Since human life is involved in many instances and the radio is the key tool used for notification, it would appear that the No. 1 priority would be Department of Public Safety equipment.
- The patrol car radio units must be brought into the central service garage in Seattle for maintenance, thus consumming personnel time.
- The Sheriff's Department has very little control over the activities of the radio maintenance shop, either in repair, installations, priority for repair.
- The cost of the existing maintenance has been a factor in these discussions.

  Base station and related equipment costs are $175,000 per year and parts cost $20,000 per year. Costs of Mobile units are not broken out of vehicle maintenance, but patrol car costs per month are $230 plus .14¢ per mile and administrative car costs are $68 and .11¢ per mile. These figures include vehicle maintenance, radio installation, and monthly radio service costs.

Each county department purchases its own radio equipment without prior consultation with the radio shop personnel, thus requiring the shop to purchase parts and test equipment and train personnel after the fact.

2. Options or Alternatives

Several alternatives are apparent in seeking a solution to the radio maintenance problem, including:

a. The King County Sheriff's Department could assume direct control of its own base station and related equipment and lease mobile maintenance from a private vendor.

b. King County Sheriff's Department could assume direct control of all county base station and mobile radio maintenance.

c. King County Sheriff's Department could assume control for its own base station and mobile equipment.

d. King County could remove the maintenance of radio equipment from an operating department and form a county radio division responsible for all electronic maintenance under the Department of Administration.

e. King County could contract with a private vendor for all radio maintenance.

f. King County could continue under Public Works as at present.

The first solution would appear to satisfy the major complaints, while the second would burden other departments with the same complaints that the Sheriff's Department has now. The third alternative has the disadvantage that space would have to be provided for mobile maintenance and a stock of parts, while the fourth would give all departments equal priority with no special priority to public safety. The fifth has the disadvantage of too high a maintenance cost in large systems and the loss of any priority to the Department of Public Safety, and the sixth does not solve any of the problems.

Each alternative should be evaluated on the basis of its ability to provide maximum service at a reasonable cost. Many large departments have their own maintenance section, while others find it cost-effective to have a central agency. However, if the central agency is to provide priority service to one or more agencies, then a department representative must have input to the central agency head to ensure satisfactory service.

D. Review of Future Planning

The second objective, the review of future planning, has a sub-task requiring the consultant to verify equipment replacement and upgrading of radio sites. In that regard, Appendix C contains a document that explains the future planning, the priorities, and the costs of upgrading the radio sites.

Future planning was discussed with Mr. Frank Porter, Jr., Communications Engineer, and on-site visits were made to three equipment locations.

The following list of needed improvements to the existing system is taken from Appendix C:

> Improvements are recommended for the DPS radio communications systems in order to adequately serve the purposes of this system (e.g., aid county law enforcement activities, provide for early warning and coordination of activities in response to a disaster, and provide some assistance to other agencies). The needs addressed by these improvements are prioritized, in descending order of priority, as follows:
>
> - Ensure minimum radio coverage in all areas of the county
> - Guarantee radio coverage in densely populated areas of the county
> - Provide an automated capability to prevent system failure in the densely populated area of the county
> - Provide radio reception coverage that will ensure the effective use of portable radio units in the densely populated areas of the county
> - Provide the capability for multi-jurisdictional radio communications (mutual-aid)

Because improvements to the radio communications system are relatively costly, it would not be feasible to fund all of the improvements during a one-year period. Scheduling of specific improvement projects is based on the above-listed priorities and the following considerations:

- requirements for meeting a contractual obligation;
- the urgency of a particular problem;
- the relationship of one improvement project to other projects;
- relationship of a project to the operations of other agencies (e.g., FCC); and,
- the amount of funding that can reasonably be provided by the county and other sources during the one year's time.

In order to verify the improvement areas and the equipment cost projections, each location, equipment complement, and cost was reviewed and discussed relative to the importance of system capability and upgrading. The locations reviewed and the associated costs are as follows: Maloney Ridge, $71,669; Kings Garden, $56,129; eliminate out-of-county interference, $17,217; Boulevard Park, $85,512; Brown's Point, $98,252; King County Courthouse, $73,482; closed microwave system loop, $45,000; alarm system $36,890; Harborview Hospital, $73,225; satellite receiver system, $385,117; mutual aid system, $285,000; Gold Mountain facility, $240,054; King County Courthouse security system, $53,227; Squak Mountain Facility, $297,920; alternate communications facility, $150,722. Total amount is $2,252,565.

Other hardware requirements in addition to these items that are deemed necessary are air conditioning at all microwave sites, dual battery chargers, and batteries at all sites. Prices were not available for these items at this time.

After detailed review of all items, their priorities, and the associated costs it appears that priorities may require changing on a yearly basis. For instance, the satellite receiver priority is number 3 for 1981; however, new portable radios are being purchased to be issued to the officers and positive communications to the control center cannot be guaranteed under the existing system. The satellite receivers would improve this requirement, but unless the microwave system is improved there is no economical method of relaying the satellite receiver information back to the control center.

The alarm system costs appeared low for a high-quality alarm system from all of the sites back to the headquarters. This item can be reviewed prior to the budget since it is a priority 2 item. The alarm system can either be installed on a partial basis with expansion capibility or it can be installed when all sites are completed.

The mutual-aid system was carefully reviewed and several methods discussed along with their advantages and disadvantages. Proposed systems are described below as Options 1 and 2. Option 1, the selected system could have a phased implementation to spread the cost over several annual budgets. The cost would include additional crystals for mobile and portable units (Sheriff's Department) through base stations at four locations, control consoles, microwave channels, and other associated equipment. Cost estimate for Option 1 is $420,000. The phased implementation plan provides new crystals for mobile and portables in the first year, second receivers and scanner units in the second, and a base station network in the third. Option 2 (not selected because the portable radios would not be effective in the system for inter-departmental communications) would purchase and install a countywide system with base stations and mobile units on the frequency of 155.370 MHz. Estimated cost of this system for entire county coverage and radios in all police cars would be $390,000.

It is the consultant's opinion after reviewing the future planning for the Department that each area of upgrading will enhance the total system design and provide a responsive and functional communications system. It will provide police officer safety improvement and greatly increase the probability of officers being able to reach the headquarters station with portable radios. The priorities should be reviewed periodically and changes made to assure sequential implementations toward the final system goal. The estimated costs will have to be adjusted each year during the multi-year program due to inflation and the rapidly rising costs of labor and equipment.

III. FINDINGS AND CONCLUSIONS

The findings and conclusions below represent the consultant's opinions formed during the on-site visit to the King County Department of Public Safety and refined during further analysis of facts relating to the problem's objectives.

FINDING: The method of handling the incoming telephone incidents involves too much manual work.

CONCLUSION: The physical handling of incident cards used for citizens' complaints is increasing rapidly and requires automation to reduce work load.

FINDING: The method of transferring the incident card from the call taker to the dispatcher requires too much staff time.

CONCLUSION: The movement of the call-takers and the verbal noise in the control center would be reduced by automation. This would decrease confusion and room noise and reduce response time.

FINDING: The work load of the call-takers is not evenly distributed.

CONCLUSION: The call-taking positions should be equipped with a telephone system that would equally distribute calls throughout the working area. This system is now being considered by the department.

FINDING: The control center should exercise closer supervision of the call-taking area.

CONCLUSION: The addition of a civilian lead or chief dispatcher could provide immediate supervision to the surrounding area.

FINDING: The dispatching operation of incident card handling, call prioritizing, call stacking, and car status requires too many manual functions and has the possibility of serious errors.

CONCLUSION: The dispatch operation should be automated to eliminate the need for manual time stamping of cards and the manual prioritizing, stacking and keeping status of field units.

FINDING: The department should give No. 1 priority to the implementation of a computer-aided dispatch system.

CONCLUSION: The workload of the call-takers and dispatchers requires automation to reduce fatigue, reduce room noise, improve accuracy, and reduce response time, now estimated at an average of 15 seconds for card transfer per call.

FINDING: The process of report writing within the Control Center can be improved by computer entry.

CONCLUSION: When a CAD system is implemented, the report writers may enter the complete report by keyboard to the Records Center, ready for microfilming or other processing without retyping, physical delivery of reports, or errors in handwriting.

FINDING: There is a requirement for a fourth dispatch console in the control center.

CONCLUSION: At peak periods there is a need for another operating position that can also double as the data center console. This should be considered when CAD is added.

FINDING: There is a need for operator training in the Center.

CONCLUSION: Operator training both call-takers and dispatchers was indicated while observing on-site operations. The basic training and in-service training will provide uniformity among all of the personnel. This is especially required when a CAD system is installed. A training program is now being considered by the Department for communications personnel.

FINDING: Automatic car status should be installed.

CONCLUSION: In order to reduce dispatcher workload and reduce on-the-air time, patrol cars should be equipped with a status transmission device. This device can be added at any time or as a part of a CAD system; it allows the patrol officer to automatically signal the dispatcher as to his present status (in service, out of service, call completed, etc.). This eliminates the need for verbal messages to and from the patrol car to the dispatcher. Officer safety is greatly improved through the emergency signal sent by data to the dispatcher for help.

FINDING: Call-taker staffing should be increased.

CONCLUSION: The normal staff for call-takers should be increased to 30 in order to provide an average 5-second call-answering response. This staff requirement is based upon calculations of the Research and Planning section and is designed to keep waiting time to a minimum even during busy periods.

FINDING: The system's maintenance problems require correction.

CONCLUSION: The Sheriff's Department should select one of the alternatives listed above that will be cost-effective and provide maximum and desirable maintenance. The first alternative appears most favorable from the Department's standpoint. It would give the Sheriff's Department control of all maintenance of base stations and related equipment but would have mobile units repaired by a private vendor. The fourth solution may be more desirable for County administrators who wish to centralize purchasing and standardize equipment.

FINDING: Verification of current system design in satisfactory.

CONCLUSION: The current system design is basically sound, since it provides an extensive metropolitan satellite receiver system to ensure officer safety and reduce response time to citizens problems. It provides base station capability on all of the usable frequencies throughout the county, connections to and from the dispatch office to all base station and receiver locations, a workable mutual aid system in the county, and several technical improvements.

FINDING: Radio channel acquisition is becoming acute in the Metro area.

CONCLUSION: Consideration should be given to the licensing of a block of (five) radio channels in the 800 MHz band for future mobile radio use in King County, possibly for data terminals in the vehicles or for car locator systems. Their use would probably be five years away.

FINDING: There is apparent cost duplication in the multi-year planning document.

CONCLUSION: Review of the radio communications system multi-year document indicated a cost duplication on satellite receiver equipment (Kings Garden location); however, this could not be verified since exact radio frequencies are not listed. Any discrepancy in this area should be corrected as future year budgets are prepared.

FINDING: Improvements in technical area are possible.

CONCLUSION: Two areas in the future system design should be reviewed. One, the proposed mutual-aid system appears low in estimated cost for equipment (this area should be coordinated with the Washington State Patrol to determine statewide plans to prevent future conflicts). The second area is the alarm system, whose cost vs. the functions and site locations should be reviewed to determine if the estimate is adequate.

The future budget should include some system refinements such as air-conditioning/heater units at all microwave sites (to prevent failures during extreme cold or heat) and dual fail-safe charging equipment with adequate battery supply at all major equipment sites (this improvement will keep the system functioning during power failures).

IV. RECOMMENDATIONS

The recommendations that follow are based upon the rationale that the Department of Public Safety plans to orient future planning in the communications area to reduce response time while striving for maximum utilization of staff time. The future system hardware and software projections will provide an expedient medium for fast and efficient message handling of incidents reported by the citizens of the county.

1. Recommend that the Department consider as its top priority in communications improvement a computer-aided dispatch system to improve the following areas:

   - The physical handling of incident cards by staff members.
   - Information transfer from call-taker to dispatcher, reducing confusion and noise in the control center
   - The present manual operation in dispatch area of call prioritization, call stacking, incident verification, and card stamping.
   - Car status, now manual by dispatcher, through data units installed in each patrol car.
   - Report writing through CAD terminal entry.
   - Response time in dispatch office for incident handling.

2. Recommend these control center changes in staffing and equipment.

   - Call-takers be staffed at 30 personnel for 5-second average call-answer time.
   - Use of a lead dispatcher for improved center control.
   - Add a fourth dispatch console and rearrange the control center for improved supervision and operation.
   - Allow space for report writers in center for incident coordination.

3. Recommend an improvement in system maintenance capability.

   - Use of the first alternative set out in Section II will provide the department with the immediate service required as the system becomes more complicated and sophisticated in design in the future.

4. Recommend continuance of the future planning program for communications, including:

   - Yearly review of priorities to ensure that the system relates directly to patrol activities and provides rapid dissemination of incident information.
   - Periodic review of future system costs as they relate to inflated labor and equipment prices.

5. Recommend the establishment of a mutual-aid radio system that will provide maximum portable and mobile usage for all departments in the county at a minimal cost.

   - The system design in the future planning document will allow the use of existing portable radio units throughout the county as well as car-to-car communications. This can be accomplished by the addition of the mutual-aid frequency to each radio and the installation of adequate base stations and associated accessories.

6. Recommend that the Sheriff's Department coordinate with the Washington State Patrol on future mutual-aid planning to ensure compatibility with adjacent areas outside of King County.

APPENDIX A

RESEARCH AND PLANNING MEMO ON COMMUNICATIONS

CENTER CALL-RECEIVER STAFFING REQUIREMENTS

KING COUNTY DEPARTMENT OF PUBLIC SAFETY

APPENDIX A

INTER-OFFICE MEMORANDUM

TO: SHERIFF-DIRECTOR, LAWRENCE G. WALDT

DATE: July 30, 1979

FROM: MARY ANN MCLAUGHLIN, RESEARCH & PLANNING

VIA: SERGEANT MURPHY

SUBJECT: COMMUNICATIONS CENTER CALL-RECEIVER STAFFING REQUIREMENTS

A study has been made to determine staffing requirements for the Department's Communications Center primary call-receiving positions. The study was based on:

1. Call handling times measured several years ago as part of the Wofac System revision.

2. Incoming call volumes for the first six months of 1979.

3. Workload -- staffing tables provided by Pacific Northwest Bell.

Report writing by the call-receivers was not included in the workload considerations because this task is interruptible and, within limits, does not materially affect the speed of answering the telephones. The relief dispatching function has been included, however, in the staffing requirements since it draws the equivalent of 4.5 fulltime call receivers.

The staffing tables provided by Pacific Northwest Bell are based on the principles used by Bell Telephone companies to staff their central offices. Several years ago when we obtained the tables from PNB, our service representative stated that they staffed to achieve a 5.6 second average answer speed for all calls. (This means that, on the average, we can expect an answer in 5.6 seconds when we dial "0".)

It is recommended that we staff our call-receiver positions to provide approximately the same level of service as Bell Telephone. This recommendation is based on the assumption that their service parameters have been arrived at through long experience, to provide an economical, yet satisfactory, level of service to the public in both emergency and non-emergency situations.

RESULTS

Primary call-receiver staffing requirements were calculated for three levels of service -- 5 seconds, 8 seconds and 10 seconds overall average answer speed. The minimum number of call receivers required for each case is given below:

Average Answer Speed	Call-Receivers
5 seconds	30
8 seconds	28
10 seconds	27

The above numbers of call-receivers allow for vacation, sick leave and holidays. The staffing is also based on seven hours per day of actual work time for each person.

The staffing difference between the 5 second overall average answer criterion and the 10 second criterion is only three positions. However, loss of these three positions would significantly degrade our level of service to the public. The principal effects on service levels may be summarized as follows:

1. An increased number of delays in answering calls and longer overall delays for those calls not answered immediately.

2. An increased number of dropped calls, and

3. An inability to respond to temporary overload conditions.

A 5 second overall average answer speed reflects average delays of 35-60 seconds for those calls which cannot be answered immediately. During a few early morning hours the average delay increases to 65-70 seconds. If we design our staffing to a 10 second overall answer speed, the average delays increase by 15-20 seconds during most hours of the week. There would be 46 hours during the week when delay times run 60 seconds or longer, versus only 14 hours under the 5 second criterion.

APPENDIX B

MEMO TO SHERIFF-DIRECTOR REQUESTING

NEW RADIO MAINTENANCE POSITIONS

APPENDIX B

KING COUNTY DEPARTMENT OF PUBLIC SAFETY

INTER-OFFICE MEMORANDUM

TO: LAWRENCE G. WALDT, SHERIFF-DIRECTOR DATE: July 13, 1979

FROM: H.W. BOOTH, CHIEF
BUREAU OF STAFF SERVICES VIA:

SUBJECT: NEW POSITIONS REQUESTED - 1980 PERSONNEL BUDGET
REQUEST FOR RADIO MAINTENANCE POSITIONS

PROBLEM

Currently the administration and operational control of the Department's radio maintenance resides with the Motor Pool radio shop, a division of the Department of Public Works which is a minor user of radio maintenance service. It is preferable from an organizational standpoint to place the maintenance function of Public Safety's communications system with this Department for the following reasons:

1. Over 80% of the radio shop's present workload is devoted to the Department of Public Safety's communications system. This percentage will increase in 1980 since equipment on hand is in the process of being installed and additional equipment ordered.

2. The Department of Public Works radio communications needs are not demanding. As a result, its communications system requirements are very simple. What maintenance is needed is very basic and can be acomplished at a leisurely pace. Thus the Department of Public Works administration does not understand nor place an emphesis on communications maintenance. This attitude is reflected by their radio shop.

   In contrast, the Department of Public Safety is almost totally dependent upon communications for its operation. The Department's communications system is thus very complex, requiring large amounts of very technical, high quality, and timely maintenance.

   The problem with the present radio maintenance arrangement is that the Public Works administration and radio maintenance shop reflect the degree of service required by the Public Works communications system. When this philosophy is applied to the complex Public Safety communications system (which demands a much higher quality of maintenance) the present radio maintenance arrangement falls way short and the the Public Safety system suffers.

3. The Department of Public Works, citing its radio maintenance responsibility, is attempting to control all radio purchases made by King County Departments by requesting that all such requests be routed through Win Mitchell, Fleet Administrator. A copy of this memo, dated January 18, 1979 is attached. When this request is viewed from the standpoint of the Public Works communications requirements outlined in item #2 above, it would appear that the Department of Public Safety communications needs would be secondary to radio shop requirements.

4. The Department of Public Safety has very little control over the activities of the radio shop and can only recommend changes or courses of action. In addition, the radio shop frequently takes unilaterial action in the placement and operational availability of the Department's radio equipment without the knowledge or permission of the Department. As a result, communications capability is not available when needed.

5. The cost of the radio maintenance service is very high when compared to available alternatives. This has been substantiated in the many memos written on this subject.

SOLUTION

The solution to the above problems is for the Department of Public Safety to establish its own radio maintenance positions. The following positions would be required:

Three (3) Radio Technician positions.

One (1) Lead/Foreman Radio Technician position.

One (1) Communications Manager position.

COST

The above required positions would NOT result in any increased cost the the Department of Public Safety since these charges would be offset by decreases from the Department's budget to support the Public Works operated radio shop (as requested by John Rose in his memo to you dated June 25, 1979).

APPENDIX C

RADIO COMMUNICATIONS SYSTEM

IMPROVEMENT PLAN

DEPARTMENT OF PUBLIC SAFETY

RADIO COMMUNICATIONS SYSTEM

The purpose of this report is to provide a plan for improvements to the Department of Public Safety's radio communication system over the next few years. The intent of this plan is to allow the County to allocate funds for these improvements in an orderly manner based on appropriate and complete information and to avoid unanticipated "emergency" expenditures for improvements to the communications system. Since the intent of this report is to provide necessary information to persons responsible for funding decisions an effort has been made to interpret technical information and present it in a manner that is readily understandable to persons not familiar with the radio communications field. For this reason the level of detail provided in this report is only that amount deemed necessary to understand the need for improvements to the system and the specific purpose of the various improvements which are recommended.

Existing System

The primary purpose of the Department of Public Safety's (DPS) communications system is to aid the law enforcement activities of the Department's operating units including the patrol, marine patrol, traffic, detectives, civil process (i.e. civil warrants), search and rescue, administrative and supervisory units. Most of this system was funded with L.E.A.A. grants. The secondary purpose of the system is to provide for early warning and coordination of activities in response to man-made or natural disasters which is the responsibility of the Department of Public Safety's Division of Emergency Services. The County has received 50% funding from the Federal Defense Civil Preparedness Agency (DCPA) for implementation of the early warning and emergency coordination system. Many of the communications system improvements funded as part of this system also serve DPS's law-enforcement activities. A tangential purpose of the system is to serve other agencies (the Seattle Police Department, the Seattle Fire Department and Emergency Medical Services) who install their own equipment at D.P.S. sites. The geographical area served by the DPS communications system is all of King County.

The DPS has several radio channels assigned for its use. These channels fall into three radio bands - VHF (150-160 MHz), UHF low (453-458 MHz) and UHF High (460-465 MHz). The frequencies an operating unit can access is determined by the band of the radio unit and the configuration of crystals in the radio unit. The ability of a unit to communicate with other units or one of the radio sites is determined by its geographical location and the configuration of equipment at the site or sites serving that geographical location. In terms of planning for improvements to the system most consideration must be given to the latter element, the configuration of equipment at the sites serving the system. A description of the existing system and needed improvements will be more understandable if the following terms are first explained.

Base Station: A type of equipment installed at a fixed location which provides the capability of receiving from and transmitting to mobile

units on a particular frequency. The base station consists of two separate components, the receiver and the transmitter, each serving a separate frequency. Thus a receiver and transmitter is required for each frequency served by a site. A receiver may be used alone to improve reception from low powered mobile units or hand held (portable) units; the signal thus received is relayed to another site which has both receiving and transmitting capabilities. A receiver used in this manner is called a satellite receiver.

Mobile Unit: A radio unit which is installed in a vehicle or a radio unit which can be hand held (portable). Portables are less powerful than the mobile units installed in vehicles. A radio unit is designed to operate on one band (a band is a range of frequencies.) DPS has radio units that operate on three different bands. Mobile units are equipped to receive and transmit on specific frequencies within the operable band by installation of a crystal for each frequency. Thus, the frequencies which can be accessed by a particular radio unit are determined by the band the unit operates on and the crystals installed in the unit.

Microwave Terminal: A type of equipment installed at a site which provides the capability of processing a radio signal, and transmitting it as an audio signal, thus relaying signals between two sites. A microwave terminal is required for each site thus served. For example, in order for the Gold Mountain site to relay signals to the King County Courthouse, Rattlesnake Mountain and Grass Mountain sites, three microwave terminals are required at Gold Mountain and a companion terminal at each of the other sites.

At less remote sites the relay function may be met by the use of phone lines. However, phone lines are less reliable than microwave equipment because they provide a lower quality, less consistent method of transmission, are subject to physical damage and, since monthly rental is paid on phone lines, use of microwave equipment is less costly over time.

Multiplex Channel: This auxiliary type of equipment is used in conjunction with the microwave terminal to superimpose a channel of audio information on the microwave channel. A multiplex channel is required for each frequency served by the microwave terminal.

Voting Comparitor: This type of equipment which selects the clearest audio signal among the signals received from different sites on one frequency.

Mutual Aid Channel: A system of radio frequencies which can be used for communication with other law enforcement agencies. Because the radio units used by law enforcement agencies in King County operate on three different bands, it was necessary for DPS to design a mutual aid system which uses three different channels, each is within the range of one of the three bands used by King County law enforcement agencies. Thus, a law enforcement agency would only need to install an additional crystal in its radio units in order to have access to a mutual aid channel. (If only one channel were used, most agencies would need to purchase

additional radio units in order to have access to the mutual aid channel). These three different channels will be electronically linked at the DPS communications center so that communications can occur between all units participating in the mutual aid system.

Antenna: This provides the physical link between a base station and the signal being received or transmitted. An antenna is required for each frequency served.

Site Facilities: Facilities include a building which meets all State and Federal requirements to securely house equipment, a tower to which antennae can be attached, and access to a power source. For certain radio sites it is essential to have, in addition to the regular power source, an emergency power source capable of providing power for two weeks beyond the anticipated amount of time a power outage would last. Emergency power is required at sites which have been partially funded by DCPA as it is anticipated that regular power sources would be inoperable in the event of a disaster. Emergency power is also essential at the remote sites which are often inaccessible for repairs during winter months so that regular DPS communications can continue if access to the regular power source is interrupted.

In order to understand how the DPS radio communications system works a description of the uses of the different radio frequencies is helpful. The frequencies assigned to the DPS are normally designated by channels. Each channel consists of one or two frequencies. The designated channels are used as follows:

County - This channel provides radio coverage for the majority of King County. The channel is used mainly by detective units and other units that operate on a County-wide basis. It is also used as a backup or secondary channel for the three precinct operational channels.

North - This channel provides radio coverage for the North Precinct area. It is presently a primary operating channel for the North Precinct patrol units. However, it does not cover the Skykomish - Stevens Pass area of this precinct because of the physical barrier created by mountainous terrain.

Southeast - This channel provides radio coverage of the Southeast Precinct area. It is presently the primary operating channel for the Southeast patrol units.

Southwest - This channel provides radio coverage of the Southwest Precinct area. It is presently the primary channel for the Southwest Precinct patrol units.

East - This channel provides radio coverage for the Skykomish - Stevens Pass area of King County. Since this channel is presently also used by Mason County, in order to avoid interference it is used to provide radio coverage of only that area and is the primary channel used by any of the Department's units operating within the Skykomish area. If the County were to meet the costs of moving Mason County to another frequency the "East" channel could be used throughout King County, thus accommodating increases in radio traffic.

Data - This channel was designed to provide radio coverage of the western third of King County, the area in which most radio traffic originates. This channel is presently used by all of the Department's units in the area to make data checks directly with the Communications Center Data Control unit. Thus, it provides the majority of the field units with better data service, reduces the need for operational dispatchers to make detailed data checks, and keeps other radio channels from becoming overloaded.

TAC 1 - This radio channel is designed to provide radio coverage of the majority of King County and to be used mainly for tactical situations. As an example, if a bank alarm sounds, all the units responding to this detail would switch to this channel. This not only gives the responding units a clear radio channel but also allows that precinct's regular operational channel to be kept open for routine details. This channel would also be used by any unit making an emergency call if that unit's normal operating channel was busy with other radio traffic. This channel is also used for security operations inside the King County Courthouse.

Also note that this same channel is used in Central Washington Law Enforcement Administrative Radio System (C.W. Learn). Using this channel and the proper transmitter tone, any of this Department's UHF equipped vehicles traveling in Central Washington would have communications with Benton County, Chelan County, Douglas County, Grant County, Kittitas County, Okanogan County and Yakima Sheriff's offices. This feature would be important for such activities as transporting prisoners to-and-from Eastern Washington.

TAC 2 - This radio channel is presently inoperative but will be used by DPS radio units in the UHF High band for access to the mutual aid system when this system is completed

TAC 3 - This radio channel is located in the UHF Low band and is designed to provide mutual aid coverage for the Lake Washington - Seattle area. It will provide access to the mutual aid system for Bellevue, Mercer Island, Clyde Hill, Kirkland, Redmond, Sea-Tac Airport, Bothell and the Port of Seattle Police Departments.

F_1 - This radio channel is located in the VHF band and provides coverage for the majority of King County. It is used by DPS warrants, civil process, marine patrol and administrative units. This channel is also designed to serve as a mutual aid channel for police departments equipped with VHF radio units, most of which are located in the South King County area. Renton, Tukwila, Kent, Auburn, Issaquah, Des Moines, Black Diamond, Carnation, Normandy Park and Lake Forest Park are equipped with radio units in the VHF band.

F_2 - This is the primary channel for the marine patrol and search and rescue units.

F_3 - This radio channel is designed to be used for the DPS paging system as well as the early warning and emergency coordination system. It is planned to expand this channel to cover all of King County.

As previously mentioned, the extent to which an operating unit has access to these various channels is determined largely by the configuration of equipment at the various DPS radio communication sites. The DPS system presently consists of 11 sites and one new site that is not yet operational (Boulevard Park); the attached map indicates the geographical location of these sites. The following list indicates the geographic area which is served by and the basic equipment which is installed and operable at each site. Map A, at the end of this section, indicates the location of each of these sites.

Squak Mountain: This is the primary site for central King County. The site has base stations for the following channels: "County", "Data", "North", "Southeast", "Southwest", "TAC-1", "TAC-3", "F_1", "F_2" and "F_3". The site also has two microwave terminals linking it to the communications center in the King County Courthouse and Grass Mountain. The physical facilities are old and deteriorating and are expected to require replacement in the near future. These facilities are shared with the Department of Public Works, County Parks Division and Emergency Medical Services.

King's Garden: This site is designed to provide radio coverage for the northwestern part of King County. The site is presently inoperable because the antenna was destroyed by lightning in 1978. It has one base station for the "North" channel.

Norway Hill: This site has one satellite receiver for the "North" channel which improves reception in the Bothell area.

Rattlesnake Mountain: This site provides radio coverage for the North Bend, Snoqualmie Falls and Snoqualmie Pass areas. The site has base stations for the "County", "North", "TAC-1" and "CW LEARN" channels. It also has one microwave terminal and auxiliary equipment which link this site with the Gold Mountain site. This site is shared with the Department of Public Works.

North City: This site serves as a control point for the Maloney Ridge repeater station for the "East" channel (see below) and serves to provide reception for the "East" channel in the Skykomish - Stevens Pass area. The site has one control station for the "East" channel. The function of the control station is to transmit signals which are received and automatically retransmitted by the Maloney Ridge repeater station to and from units in the Skykomish - Stevens Pass area.

Maloney Ridge: This site provides coverage for the northeastern section of King County (e.g. Skykomish - Steven's Pass). A repeater station for the "East" channel is located at this site. A new tower has been constructed and a new building is in the process of being constructed at this site. However, access to regular power has not been provided, therefore the site is not operable at this time.

Harborview: This site provides coverage for the King County Courthouse (e.g. for Courthouse security operations) and downtown Seattle. The only equipment presently installed at this site is a base station for the "F_3" channel.

King County Courthouse:This site serves as the communications center for DPS communications system. In addition to the radio consoles and other equipment used for the dispatching and call receiving functions this site has voting comparitors for every channel and three microwave terminals with auxiliary equipment to link the Courthouse to the Gold Mountain, Squak Mountain and Rattlesnake Mountain sites. The terminal which previously linked this site to Rattlesnake Mountain is over 20 years old, obsolete and therefore unusable.

Gold Mountain: This site provides coverage of Vashon Island and the extreme western area (i.e. bordering Puget Sound) of King County. The equipment at this site includes 3 microwave terminals providing links to the King County Courthouse, Rattlesnake Mountain and Kent (Southeast precinct) sites; base stations for the "TAC-1", "Southwest", "County", "Data", and "F_1" stations; and a satellite receiver for the "F_2" channel. This site is shared with Emergency Medical Services, the Seattle Police Department and Seattle Fire Department.

Grass Mountain: This site provides coverage to the southeastern portion of King County. The equipment at this site includes one microwave terminal and auxiliary equipment providing a link to the Squak Mountain site, base stations for the "TAC-1", "Southeast", "County" and "F_1" channels.

Precincts: The north and southwest precinct stations each have a UHF monitor receiver which allows monitoring of, but no communication on, the UHF frequencies. Thus, these sites do not provide any radio coverage. The Southeast (Kent) precinct has a UHF monitor receiver, one microwave terminal linking this site to the Gold Mountain site, one base station for the "Southeast" channel and six base stations which are used by the DPS Division of Emergency Services and are controlled only from this site (i.e. not from the King County Courthouse communications center). The Kent site provides coverage of the Kent-Auburn valley. This site is shared with the Kent Police Department and Kent Fire Department.

The facilities at all of these sites belong to the County. The land on which the site is located is County owned in some cases or is leased from another landowner such as the Department of Natural Resources or the U.S. Forest Service. In addition to the sites with County owned facilities DPS makes use of radio sites owned by other jurisdictions or commercial agencies. Similarly, the DPS radio sites are often shared by other agencies or jurisdictions such as the County Department of Public Works, Parks Department, Animal Control and Emergency Medical Services and the various public departments and fire districts. As a result of some of these arrangements for leasing land and sharing facilities the County has various contractual and less formal obligations relating to radio communications system improvements. The County also has certain contractual obligations to DCPA related to the implementation of the Early Warning and Emergency Coordination System. These obligations are described more specifically in the next section which identifies the improvements which are needed for the DPS communications system.

Improvements to Existing System

Improvements are recommended for the DPS radio communications systems in order to adequately serve the purposes of this system (i.e. aid County law enforcement activities, provide for early warning and coordination of activities in response to a disaster and provide some assistance to other agencies). The need addressed by these improvements are prioritized, in descending order of priority, as follows:

- ensure minimum radio coverage in all areas of the County
- guarantee radio coverage in densely populated areas of the County
- provide an automated capability to prevent system failure in the densely populated area of the County
- provide radio reception coverage that will ensure the effective use of portable radio units in the densely populated areas of the County.
- provide the capability for multi-jurisdictional radio communications (mutual-aid)

Because improvements to the radio communications system are relatively costly it would not be feasible to fund all of the improvement during a one year period. Scheduling of specific improvement projects is based on the above listed priorities and the following considerations:

- requirements for meeting a contractual obligation;
- the urgency of a particular problem;
- the relationship of one improvement project to other projects;
- relationship of a project to the operations of other agencies (e.g. FCC); and,
- the amount of funding that can reasonably be provided by the County and other sources during one year's time.

The types of improvements which are described in this plan generally fit into the following categories:

1) Install microwave equipment to eliminate dependance on phone lines. This improvement provides high quality and more consistent transmission, greater reliability for a particular communications link and, as it eliminates phone line rental, is less costly over time.

2) Install sufficient base stations to provide adequate coverage for all channels designated for use in the geographic area

served by each site. Coverage in an area may be inadequate because of the terrain creates "dead spots", spots where physical barriers prevent transmittal and reception from the primary site serving the area. These "dead spots" create significant problems only in areas where radio traffic is fairly heavy. In this case the installation of additional base stations at non-primary sites will eliminate the problem.

3) Install additional base stations or receivers to improve reception on the low powered portable radio units.

4) Improve physical facilities to meet State and Federal requirements, provide adequate security for equipment, provide regular and emergency power and usable tower.

5) Install equipment, including microwave, base stations and additional radio crystals to make the mutual aid system operational.

6) Install equipment to extend the geographic area served by a channel. The use of additional channels in some areas would help to handle an increased volume of radio traffic.

7) Purchase and install equipment to provide an alternate communications center to serve the County in case of disaster which incapacitates the King County Courthouse facility.

The improvement projects planned for the DPS communications for the next several years are described below. The first eight projects have been prioritized and the planned date of implementation is indicated in the left hand column. The remaining projects are lower priority projects for which an appropriate implementation date has not yet been determined. All project costs are given in 1979 dollars except for priority I projects which are estimated in 1980 dollars. Most of the improvements described are eligible for 50% reimbursement from DCPA. However, the exact amount which would be reimbursed to the County is dependant on the amount of funds available to DCPA in a given time period. Thus, this amount cannot be predicted for future years, but reimbursement will be requested. The improvements which are not eligible for DCPA reimbursement are the construction projects and these are marked by an *(asterisk).

PRIORITY 1 (1979)

I. Maloney Ridge: The purpose of this project is to improve coverage in the area of King County from Everett to east of Stevens Pass. Presently, this site only provides coverage for the "East" channel. The improvements proposed for this site are:

A. Provide regular power to this site. The construction costs for this site were funded with 50% reimbursement from DCPA. This improvement is required to make this site operational thus meeting DCPA requirements and the needs of DPS.

B. Purchase and install a microwave terminal and auxiliary equipment to link this site with the King County Courthouse communications center. This improvement would eliminate the potential dependence on phone lines, which at present are not available at this remote location. It would also, in conjunction with the existing repeater station for the "East" channel, allow Maloney ridge to serve as a base station for the "East" channel,

C. Purchase and install receivers for the "F_1", "F_2", "TAC-1", "County" and "Data" channels to improve reception in this area which is now either poor or non-existant (for these channels).

The budget for this project is provided below:

Two (2) Microwave RF Units 2 @ $9,850.00 each	$ 19,700.00
One (1) Microwave Frequency Selection Plan	550.00
One (1) Station Receiver Unit	10,500.00
One (1) UHF Repeater Unit	5,500.00
Two (2) RF Cavities 2 @ $175.00 each	350.00
Five (5) Microwave Multiplex Units 5 @ $1,600 each	8,000.00
One (1) Baseband Order Wire Unit	1,800.00
Misc. Transmission Line and Hardware	200.00
Commercial power service installation	15,000.00
	$ 61,600.00
Contingency	6,160.00
	$ 67,760.00
5.4% State Sales Tax	3,659.04
Estimated Shipping Charges	250.00
Total Project Cost	$ 71,669.04

II. King's Garden: As previously indicated, this site is now inoperable because the antenna was damaged by lighting. The improvements proposed for this project are:

A. Install an existing antenna to replace the damaged one.

B. Install an existing microwave terminal and purchase and install a microwave terminal and auxiliary microwave equipment to provide a link with the King County Courthouse communications center thus eliminating dependance on phone lines.

C. The above improvement will make operable an existing base station for the "North" channel. This would make King's Garden, instead of Rattlesnake Mountain, the primary transmitting site for the "North" channel thus providing better reception for radio units in the North precinct.

D. Install and purchase satellite receivers for "County", "Data", "TAC-1", "TAC-3", and "F-3" channels, thus enabling these channels to be received in the North area of the County.

The budget for this project is provided below:

One (1) 24 Volt D.C. Power Panel and Charger Unit	$ 4,775.00
One (1) D.C. Converter Unit	560.00
One (1) Battery Power Supply	9,276.00
One (1) Station Receiver Unit	10,500.00
One (1) Communications Antenna with Mount	350.00
One (1) Antenna Multicoupler	1,400.00
Two (2) R.F. Cavities 2 @ $175.00 each	350.00
Three (3) Microwave Multiplex Units 3 @ $1,600 each	4,800.00
One (1) Baseband Order Wire Unit	1,800.00
Transmission Line Mounting Hardware	125.00
One (1) Antenna Feed Assembly	260.00
Antenna and Transmission Line Installation	14,000.00
	$48,196.00
Contingency	4,820.00
	$53,016.00
5.4% State Sales Tax	2,862.86
Estimated Shipping Charges	250.00
Total Project Cost	$56,128.86

III. Eliminate Radio Channel Interference: As previously indicated, the "East" channel assigned to DPS is presently used only in the northeastern portion of King County because the same channel is also assigned to Mason County. Thus, use of this channel in any portion of King County (other than the eastern portion) would create interference problems to Mason County. Since DPS does not presently use the "East" channel in other parts of King County this situation does not create any problems for Mason County. However, due to the proximity of Mason County to King County, any time a Mason County mobile unit or dispatcher transmits, their signal "captures" the channel and the DPS dispatcher is unable to hear DPS units' transmissions, nor can the DPS dispatcher hear any of the Mason County transmissions. At times this problem makes the "East" channel almost unusable for DPS units regardless of their location.

Since almost all DPS UHF mobile and portable radio units are presently equipped to handle the "East" channel, this channel could be used to accommodate increased volumes of radio traffic throughout King County if the interference problem is eliminated.

There are two alternatives for eliminating this interference problem: 1) obtain from the FCC assignment of a new channel to DPS and equip DPS radio units to handle the new channel or 2) assist Mason County to obtain a new channel and equip their radio units accordingly (This would have to be done at King County expense because Mason County does not have a need to make these changes). Because of the number of radio channels which are already assigned in the King County area it would be difficult to obtain an unused channel, thus the first solution is impractical. Also, because the DPS has many more radio units than the Mason County police conversion of DPS radio units would be more costly. Therefore, the second solution is the more practical and cost effective.

A second radio interference problem exists on the "F_1" radio channel because this channel is also assigned to Kittitas County. The solution recommended for the "East" channel interference problem would also be the best solution for the "F_1" channel interference problem.

If King County purchases the new crystals required to make Mason County and Kittitas County radio units usable on new frequencies, the old crystals from these radio units would be turned over to King County for use in King County radio units. This exchange will somewhat reduce the cost of this project.

The cost of the necessary parts and labor to make the channel changes, inclusive of State sales tax, is as follows:

Replacement channel elements, crystals, transmitter, and band change kits	$ 9,800.00
Replacement of frequency sensitive antennas, duplexers and antenna multicouplers	2,850.00
Contract labor and travel costs	2,200.00
	$14,850.00
Contingency	1,485.00
	$16,335.00
5.4% State Sales Tax	882.09
Total Project Costs	$17,217.09

PRIORITY 2 (1980)

IV. Boulevard Park: Boulevard Park (also called Top Hat) is a new site located in the Burien area. The building, tower and regular power access for the site have been completed. The following improvements are proposed for this site.

A. Purchase and install equipment to provide emergency power. This improvement is required for two reasons. Firstly, it will meet the County's contractual obligation to Teleprompter. Secondly, the provision of emergency power will meet DCPA requirements, thus qualifying the County for 50% reimbursement for part of the costs of this project.

B. Purchase and install a receiver for the "F-3" (Division of Emergency Services) channel. This would provide coverage of this channel in the Southwest area. This improvement will also help qualify the County for reimbursement from DCPA.

C. Purchase and install a microwave terminal and auxiliary equipment to link this site with the King County Courthouse communications center. This improvement would eliminate the need to use phone lines.

D. Purchase and install a base station (transmit and receive) for the "Southwest" channel. This would make Boulevard Park, instead of Squak Mountain, the primary site for the Southwest "channel" thus providing better reception for the low powered portables that are frequently used in this densely populated area.

E. Purchase and install receivers for the "TAC-1", "Southeast", "Data" and "County" channels. This would improve reception on the portable radio units; Squak Mountain would remain the primary transmitting site for these channels.

The budget for this project is provided below:

One (1)	30 KW Diesel Generator	$ 11,255.00
One (1)	Battery Power Supply	9,275.00
One (1)	24 Volt D.C. Power Panel and Charger Unit	4,775.00
Two (2)	Microwave R.F. Units 2 @ $9,850.00 each	19,700.00
One (1)	Microwave Frequency Selection Plan	550.00
One (1)	Station Receiver Unit with OES F-3	10,500.00
One (1)	Antenna Multicoupler Unit	1,400.00
Two (2)	RF Cavities 2 @ $175.00 each	350.00
Four (4)	Microwave Multiplex Units 4 @ $1,600. each	6,400.00
One (1)	Baseband Order Wire Unit	1,800.00
	Transmission Line and Mounting Hardware	1,750.00
	30 KW Generator Installation	1,500.00
	Antenna and Transmission Line Installation	4,500.00
		$ 73,755.00
	Contingency	7,376.00
		$ 81,131.00
	5.4% State Sales Tax on Above Equipment and Installation	4,381.07
	Equipment and Installation Costs	$ 85,512.07

In addition to the costs for these new improvements there are $2,000 (plus State sales tax) of outstanding costs from the already completed construction phase of the Boulevard Park project. These outstanding costs are for unanticipated charges. Thus, the total cost of completing the Boulevard Park project is $87,623.24.

V. Brown's Point: Reception on the "Southeast" channel is now either non-existant or very poor in the Federal Way area (which is part of the Southeast precinct). In order to improve reception and transmission in this area a base station, microwave terminal, antenna and auxiliary equipment for the "Southeast" channel would be purchased and installed at the Brown's Point site. This site is a commercial radio site at which DPS could rent space. The budget for this project is provided below:

Construction (antenna and transmission line)	$ 25,000.00
Equipment	60,000.00
Contingency	8,500.00
	$ 93,500.00
5.4% State Sales Tax	4,752.00
Total Project Cost	$ 98,252.00

VI. King County Courthouse: The improvements proposed for this site are:

A. Install existing microwave terminals to provide communications links with Harborview Hospital, Boulevard Park and Horizon View thus eliminating use of phone lines. The link with Horizon View, which is a City of Bellevue site, will be used for early warning and emergency coordination, EMS communications and, in the future, for the mutual aid system. The purchase of these microwave terminals was funded in part with reimbursement from DCPA. The purpose of these microwave links is primarily to serve the early warning and emergency coordination function. Thus, installation of the terminals is required to meet County obligations to DCPA.

B. Purchase and install auxiliary microwave equipment to make the terminals operable.

C. Install receivers for "County", "TAC-1", "TAC-3", "F_1" channels and auxiliary equipment to improve reception in and around the Courthouse, particularly for portable radio units which are used for Courthouse security operations.

D. Purchase and install equipment in the communications center equipment room to control and monitor the Department's radio equipment.

The budget for this project is provided below:

Two (2)	Control Stations	$ 8,500.00
Two (2)	24 Volt DC Power Panel and Charger Units	9,550.00
Two (2)	DC Converter Units	1,200.00
One (1)	Battery Power Supply	9,500.00
One (1)	Station Receiver Unit	10,500.00
Three (3)	Communications Antennae with Mounts	2,000.00
Two (2)	Antenna Multicouplers 2 @ $1,400.00 each	2,800.00
Two (2)	RF Cavities 2 @ $175.00 each	350.00
	Receiver Voting Comparitor Modules	2,800.00
One (1)	Baseband Order Wire Unit	1,800.00
Two (2)	Antennae Transmission Lines	5,800.00
One (1)	Antenna Feed Assembly	360.00
	Antenna and Transmission Line Installation and Misc. Hardware	8,000.00
		$ 63,160.00
	Contingency	6,320.00

	$ 69,480.00
5.4% State Sales Tax	3,751.92
Estimated Shipping Charges	250.00
Total Project Cost	$ 73,481.92

VII. Close Microwave System Loop: All of the DPS major remote radio sites are controlled by the microwave system. Thus, any microwave terminal breakdown results in the total failure of those radio sites it controls. The purpose of closing the loop is to provide alternate microwave paths so that each radio site has a microwave link in two directions. Thus, should any one link in the system fail, the information would automatically be routed via the other link. Map B illustrates the microwave loop system.

Closure of the loop could be accomplished by purchasing and installing "companion" microwave terminals at the Grass Mountain and Rattlesnake Mountain sites. The Department is presently licensed for the Grass - Rattlesnake Mountain microwave path. However, if this microwave circuit is not made operational in early 1980 the FCC license for this portion of the system would be forfeited. Recent revision to FCC rules make the re-licensing of this microwave circuit extremely difficult and much more expensive. And, since all of the appropriate microwave frequencies in this area are used up, it would not be possible to obtain another one.

The total cost of this project is $45,000.

VIII. Alarm System for Remote Sites: All of the Department's major remote radio sites are controlled by the microwave system. Thus, any microwave failure results in the total failure of those radio sites it controls. Alarm equipment would signal the Communications Center whenever unauthorized persons enter one of the buildings. The alarm system would also indicate commercial power failure, whether the emergency power generator is operating, battery charger failure, microwave failure and so forth. This equipment status information would allow DPS to take corrective measures before there is an entire system failure. Also, in the case of microwave failure, the alarm system would indicate the radio site where the problem was occurring. This is an advantage over the present trial and error system where several sites might be checked before the cause of the problem is discovered. The cost of installing an alarm system is $36,890 (inclusive of State sales tax).

IX. Harborview Hospital: The improvements proposed for this site are:

A. Install an existing microwave terminal to link this site with the King County Courthouse communications center, thus eliminating the use of phone lines. This microwave equipment is also needed by Emergency Medical Services.

B. Purchase and install auxiliary microwave equipment (e.g. multiplex channels) to make the microwave terminal fully operable.

C. Install existing base stations to provide adequate coverage in Seattle and surrounding areas for the "County", "TAC-1", "TAC-3", "F_1", "F_3" channels. Since the existing base station sites for these channels are some distance from Seattle, coverage in the Seattle area (particularly in the King County Courthouse) is now extremely limited.

D. Purchase and install antenna and auxiliary equipment to make base stations operable.

E. Purchase and install satellite receivers for "Scuthwest", "Southeast", "North" and "F_2" channels to improve reception in the Seattle area, particularly for low powered portable radio units.

The budget for this project is provided below:

One (1) 24 Volt DC Power Panel and Charger Unit	$ 4,775.00
One (1) DC Converter Unit	560.00
One (1) Battery Power Supply	9,276.00
One (1) Station Receiver Unit	10,500.00
One (1) Communications Antenna with Mount	350.00
One (1) Antenna Multicoupler	1,400.00
Two (2) R.F. Cavities 2 @ $175.00 each	350.00
Three (3) Microwave Multiplex Units 3 @ $1,600. each	4,800.00
One (1) Baseband Order Wire Unit	1,800.00
Transmission Line and Mounting Hardware	125.00
One (1) Antenna "Flag Pole Type" Tower	18,000.00
Antenna, Tower, and Transmission Line Installation	8,000.00
	$ 62,936.00
Contingency	6,300.00
	$ 69,236.00
5.4% State Sales Tax	3,738.74
Estimated Shipping Charges	250.00
Total Project Cost	$ 73,224.74

PRIORITY 3 (1981)

X. Satellite Receiver System: The purpose of this project is to expand the Department's radio receiving capability so that the existing portable radio units can be used effectively.

The Department's present UHF radio system was originally designed to receive signals from 100 watt mobile radio units. Since that time, the Department has implemented the use of low power (4 or 5 watt) UHF portable radio units. While the portables have no problem receiving the base stations, their low powered transmitters are not always received by base stations. Thus, in order to improve reception, satellite receivers are installed in areas of poor signal reception. Radio information is then relayed to the Communications Center via microwave or leased telephone lines.

In order for this system to be usable, it is necessary to install satellite receiver units in those areas where the majority of the portable units operate. While it would be advantageous to provide this type of coverage over the entire County, the cost would be prohibitive. Thus, only the more densely populated areas of unincorporated King County are planned for coverage.

The improvements for this project would be made at the following sites: the Southwest precinct station, North City site and McMickin Heights site (a commercial radio site located in the Southwest area).

The costs for this project are broken down by the precinct served.

Precinct #2 (North)

Two (2) satellite multiple receiver units, each with antenna multicoupler and antenna. One will be installed at the Norway Hill, the second at the Kings Garden radio site. 2 @ $20,000 ea. =	$ 40,000
One (1) satellite multiple receiver unit with antenna multicoupler, antennas, and microwave equipment installed at the North City Communications Facility. See attached North City Communications Facility C.I.P. Project No. 002023	85,120

Precinct #3 (Southeast)

One (1) satellite multiple receiver unit with antenna multicoupler, antenna, and microwave multiplex installed at the Precint #3 office.	25,000
One (1) satellite multiple receiver unit with antenna multicoupler, antennas, and microwave equipment installed at existing radio site at Harborview Hospital.	30,000

Precinct #4 (Southwest)

One (1) satellite multiple receiver unit with antenna multicoupler, antenna, antenna pole, and microwave equipment installed at the Precinct #4 office	75,361
One (1) satellite multiple receiver unit with antenna multicoupler antenna, antenna pole and microwave equipment installed at the McMicken Heights Communications Facility.	84,636
One (1) satellite multiple receiver unit with antenna multicoupler, antenna, and microwave multiplex installed on the water tower on the hill north of Des Moines	$ 25,000
	$365,117
Contingency	20,000
Total Project Cost	$385,117

PRIORITY 4 (1982)

XI. Mutual aid system: A radio communications system which allows communications between all police agencies in King County would permit coordination of operations involving more than one agency and would be useful in emergency situations (e.g. when assistance is needed or when information needs to be disseminated rapidly). A mutual aid system would perform the following funcions:

1. Any police unit in King County would be able to communicate directly (without a dispatcher relay) with any other police unit in King County.

2. Any police unit in King County would be able to communicate directly with the King County Department of Public Safety Communications Center.

3. Any police dispatch center would be able to communicate directly with the King County Department of Public Safety Communications Center.

In the past, police agencies in a given area usually shared a common radio frequency. However, as the years passed, departments grew and radio traffic increased. As a result, most police agencies changed their radio systems to operate on separate, unshared frequencies. This occurred in King County. At the present time almost all police agencies in King County utilize operational radio frequencies which fall into three categories or radio bands. These are as follows:

A. 150 MHz radio band (VHF)

Washington State Patrol, Lake Forest Park, Issaquah, Renton, Auburn, Des Moines, Normandy Park, Black Diamond, Pacific, Algona, Carnation, Skykomish, Enumclaw, Kent, Tukwila and Boeing Field.

B. 453/458 MHz radio band (low UHF)

Bothell, Kirkland, Redmond, Bellevue, Clyde Hill, Mercer Island, and Port of Seattle.

C. 460/465 MHz radio band (high UHF)

King County, Seattle, and University of Washington

The most cost effective method of meeting the requirements of a mutual aid system is to establish a mutual aid channel in each of the three radio bands now used by police agencies in King County. This way, each police agency in King County who wished to participate in the mutual aid radio system would add the appropriate mutual aid radio channel to their mobile and portable radio units. In addition, they would also install a mutual aid system fixed station at their dispatch center. In the case of the mobile and portable radio units, only the installation of channel crystals would be required as most agencies have been purchasing units which have the capability of additional channels.

The mutual aid channel an agency selects depends on the radio band the present equipment operates on. These are as follows:

A. 150 MHz radio band (high band)

The statewide VHF mutual aid radio channel (adopted by the State Sheriff's and Chief's of Police Association) would be designated as the mutual aid radio channel for those police agencies who operate in the 150 MHz band. Units using theis channel would transmit and receive on 155.370 MHz. This particular channel is important since all Washington State Patrol cars are being equipped with it for mutual aid communications with other police agencies.

Base stations satellite receivers, microwave multiplex, a voting comparitor and control equipment are required to make this channel operational using existing radio sites.

B. 453/458 MHz radio band (low UHF)

The King County Department of Public Safety's TAC-3 radio channel would be designated as the mutual aid radio channel for those police agencies who operate in the 453/458 MHz UHF low band. Units using this channel would transmit on 458.350 MHz and receive on 453.350 MHz.

This channel is presently operational but only covers the portion of King County extending from Issaquah to Seattle. Additional base stations, satellite receivers, microwave multiplex, and control equipment are required in order to provide more coverage.

C. 450/465 MHz radio band (high UHF)

The King County Department of Public Safety's TAC-2 radio channel would be designated as the mutual aid radio channel for those police agencies who operate in the 460/465 MHz UHF high band. Mobile units using this channel would transmit on 465.550 MHz and receive on 460.550 MHz.

This channel is not presently operational. Base stations, satellite receivers, microwave multiplex, a voting comparitor, control equipment and crystals for this Department's mobile and hand held radio units is required to make this channel

operational using existing radio sites.

The cost of purchasing and installing the equipment required for these improvements is approximately $285,000 (in 1979 dollars). The possibility of receiving L.E.A.A. funds for part of this project will explored.

PRIORITY 5 (1983)

XII. Gold Mountain Facility: The purpose of this project is to construct a Gold Mountain communications facility. The present facility, rented from the State of Washington Division of Natural Resources, is inadequate for the Department's present needs. The building has deteriorated and the equipment installed in it is subjected to vandalism. Secondly, the building is much too small, and as a result, both the equipment room and generator room are filled above capacity with equipment, thus violating state and national electrical codes. Also there is no separate space for required microwave storage batteries. Thirdly, the existing emergency power generator has only the capacity to power one half of the equipment when the regular commercial power fails. Lastly, the existing radio tower is overloaded with the antennas. This results in interference and reduces radio performance.

This site is an important part of the King County Department of Public Safety's communications system. Its primary function is to serve both as a major relay station and to provide a communications system for a highly populated portion of King County. The necessary equipment installed here requires a secure, solid building to provide protection from weather and an adequate radio tower to insure operational capability.

The budget for this project is provided below:

Design	$ 10,000.00
Construction	
A. Building	120,000.00
B. Tower	80,000.00
Equipment	30,000.00
Contingency	24,000.00
	$264,000.00
1% Art Fund	2,640.00
5.4% State Sales Tax	14,398.56
Total Project Cost	$281,038,56*

Since the Gold Mountain site is also an important site for the Seattle Police Department it is possible that some of the costs of this project may be assumed by Seattle. Possible arrangements for sharing costs would be for the City to pay some of the construction costs in exchange for use of equipment or to charge rent to the City for use of the facility. If the timing of such arrangements requires it, this project may receive higher priority and be recommended for funding earlier than 1983.

The remaining projects are scheduled for implementation in the five

**Costs are not eligible for 50% DCPA reimbursement.*

year period from 1984 through 1988. Since the variables affecting the priority assigned to these projects are not all known at this time, most of the projects have not been prioritzed. One project, Grass Mountain Facility, has received first priority for this time period because of the urgency of the problem related to this site.

PRIORITY 6 (1984-1988)

Grass Mountain Communications Facility: The purpose of this project is to construct a Grass Mountain Communications facility. The present facility, rented from the State of Washington Division of Natural Resources, is inadequate for the Department's present needs. The building had deteriorated and the equipment installed in it is subjected to vandalism. Secondly, the building is much too small, and as a result, both the equipment room and generator room are filled to over capacity with equipment, thus violating state and national electric codes. Also there is no separate space for required microwave storage batteries. Thirdly, the existing emergency power generator has only the capacity to power one half of the equipment when the regular commercial power fails. Lastly, the existing radio tower is overloaded with the antennas crowded. This results in interference and reduces radio performance.

This site is an important part of the King County Department of Public Safety's communications system. Its primary function is to serve both as a mjor relay station and to provide a communications system for a highly populated portion of King County, The necessary equipment installed here requires a secure, solid building to provide protection from weather and an adequate radio tower to insure operational capability.

The budget for this project is provided below:

Design	$ 10,000.00
Construction	
A. Building	100,000.00
B. Tower	65,000.00
Equipment	30,000.00
Contingency	20,500.00
	$225,500.00
1% Art Fund	2,255.00
5.4% State Sales Tax	12,298.77
Total Project Cost	$240,053.77

King County Courthouse Security System: The purpose of this project is to upgrade the security of the King County Courthouse by providing improved radio communications inside the entire building and installing a closed circuit television system (C.C.T.V.). The radio communications system would include the purchase and installation of a satellite receiver unit, the necessary antenna receiver unit, the necessary antenna multicoupler, transmission line, antenna, miscellaneous modules and hardware. The C.C.T.V. system would include the purchase and installation of a monitor console in the communications Center and remote TV cameras in the following locations:

1. First floor lobby
2. Entrance to the Fourth Avenue pedestrian tunnel

going to the Administration Building
3. Back entrance to the Communications Center
4. Basement entrance to the O.E.S. classroom
5. One spare camera

The budget for this project is provided below:

1. Communications System	
Equipment	$ 15,000.00
Installation	3,000.00
Contingency	2,000.00
	$ 20,000.00
5.4% State Sales Tax	1,080.00
Total Cost	$ 21,080.00
2. Closed Circuit Television (C.C.T.V.) System	
Equipment	$ 25,000.00
Installation	2,500.00
Contingency	3,000.00
	$ 30,500.00
5.4% State Sales Tax	1,647.00
Total Cost	$ 32,147.00
TOTAL PROJECT COST	$ 53,227.00

Squak Mountain Communications Facility - (C.I.P. PROJECT NO. 002026)
The purpose of this project is to replace the Squak Mountain Communications facility which is over 25 years old and inadequate for the Department's present needs. The present building has deteriorated and the equipment installed in it is exposed to the elements. Secondly, the building is much too small, and as a result, both the equipment room and generator room are filled to over capacity with equipment. Also there is no separate space for required microwave storage batteries. Thirdly, the existing emergency power generator has only the capacity to power one half of the equipment when the regular commercial power fails. Lastly, the existing radio tower is overloaded with the antennas. This results in interference and reduces radio performance.

This site is an important part of the King County Department of Public Safety's communications system. Its primary function is to serve both as a major relay stations and to provide a communications system for a highly populated portion of King County. The necessary equipment installed here requires a secure, solid building to provide protection from weather and insure operational capability.

The budget for this project is provided below:

Design	$ 10,000.00
Construction	
A. Building	100,000.00

B. Tower	
Equipment	$100,000.00
Contingency	50,000.00
	20,000.00
	$280,000.00
1% Art Fund	2,800.00
5.4% State Sales Tax	15,120.00
Total Project Cost	$297,920.00*

Alternate Communications Center: The entire communications system is dependent upon the operation of the Courthouse Communications Center. Should this center be disabled due to technical failure or destructive forces, the entire communications system would be inoperative (including all car to car transmissions except those using the short range DIRECT capability).

This item would provide the Kent Emergency Operations Center (Kent Precinct) with a minimum dispatch capability which could be manned in an emergency. The base station, receiver unit and microwave would also be used on a regular basis to complement the communications system.

The budget for this project follows:

Two (2) 6 GHz microwave terminals		
2 @ $20,000. ea.	=	$ 40,000.00
Two (2) 6 GHz antenna systems		
2 @ $3,000. ea.	=	6,000.00
Fifteen (15) multiplex channels		
15 @ $2,000. ea.	=	30,000.00
24 volt D.C. power panel & charger unit		
1 @ $5,000. ea.	=	5,000.00
Battery power supply		
1 @ $10,000 ea.	=	10,000.00
Two (2) antenna multicouplers		
2 @ $1,500. ea.	=	3,000.00
Two (2) remote control dispatch consoles		
2 @ $4,000. ea.	=	8,000.00
Two (2) voting comparitor units		
2 @ $3,000. ea.	=	6,000.00
One (1) UHF base station		
1 @ $10,000 ea.	=	10,000.00
One (1) station receiver unit		
1 @ $12,000. ea.	=	12,000.00
		$130,000.00
Contingency		13,000.00
5.4% State Sales Tax		7,722.00
Total Project Cost		$150,722.00

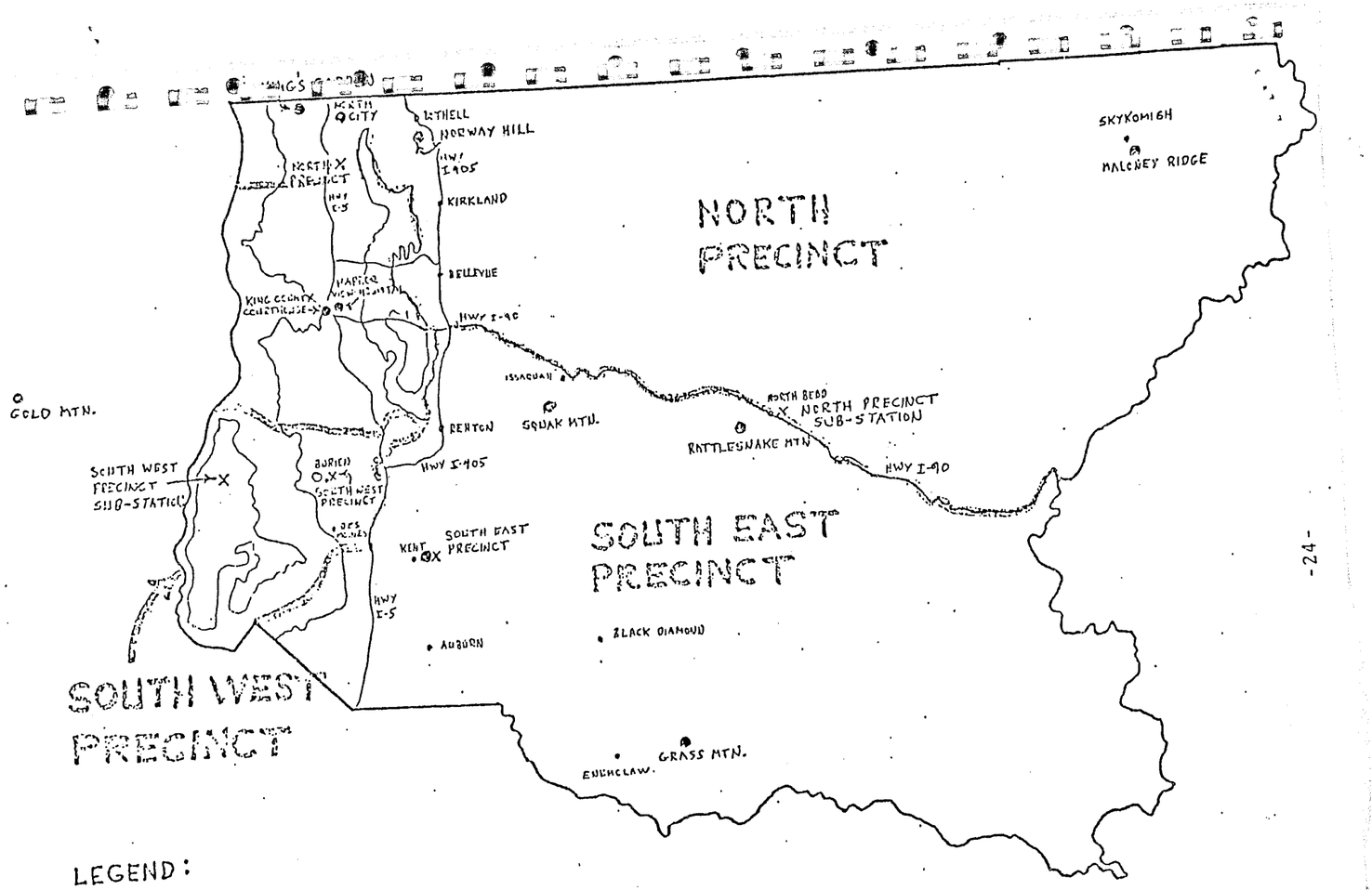
Costs are not eligible for 50% DCPA riembursement.

Summary:

The capital projects recommended in this plan including associated costs (in 1979 dollars) are listed below. The potential sources of funding for these projects include DCPA reimbursement, LEAA grants and County CIP funds. The total cost of the projects which are eligible for DCPA reimbursement is $1,433,552.89, thus the County could receive up to $716,776.44 in DCPA funds. Also, the Mutual Aid System ($285,000) is a potential candidate for an LEAA gratn. The costs of the construction projects which are not eligible for DCPA reimbursement, may be shared with other agencies that presently use or will need future use of the sites. For example, Seattle uses the Gold Mountain site and some arrangements, such as levying user charges or sharing construction costs could be made to defray the costs of improving this facility.

Priority 1 (1979)		
Maloney Ridge	$ 71,669.04	
King's Garden	56,128.86	
Eliminate Radio Channel Interference	17,217.09*	
		$ 145,014.99
Priority 2 (1980)		
Boulevard Park (Top Hat)	$ 87,623.24	
Brown's Point	98,252.00	
King County Courthouse	73,481.92	
Close Microwave System Loop	45,000.00*	
Alarm System for Remote Sites	36,890.00*	
Harborview Hospital	73,224.74	
		$ 414,471.90
Priority 3 (1981)		
Satellite Receiver System		$ 385,117.00
Priority 4 (1982)		
Mutual Aid System		$ 285,000.00
Priority 5 (1983)		
Gold Mountain Facility		$ 281,038.56**
Priority 6 (1984-88)		
Grass Mountain Facility	$ 240,053.77**	
King County Courthouse Security Sys.	53,227.00	
Squak Mountain Facility	297,920.00**	
Alternate Communications Center	150,722.00	
		$ 741,922.77
TEN YEAR PLAN TOTAL		$2,252,565.22

**Potential candidates for DPS operating budget*
***Not eligible for 50% DCPA reimbursement*



LEGEND:

X = PRECINCT OFFICES

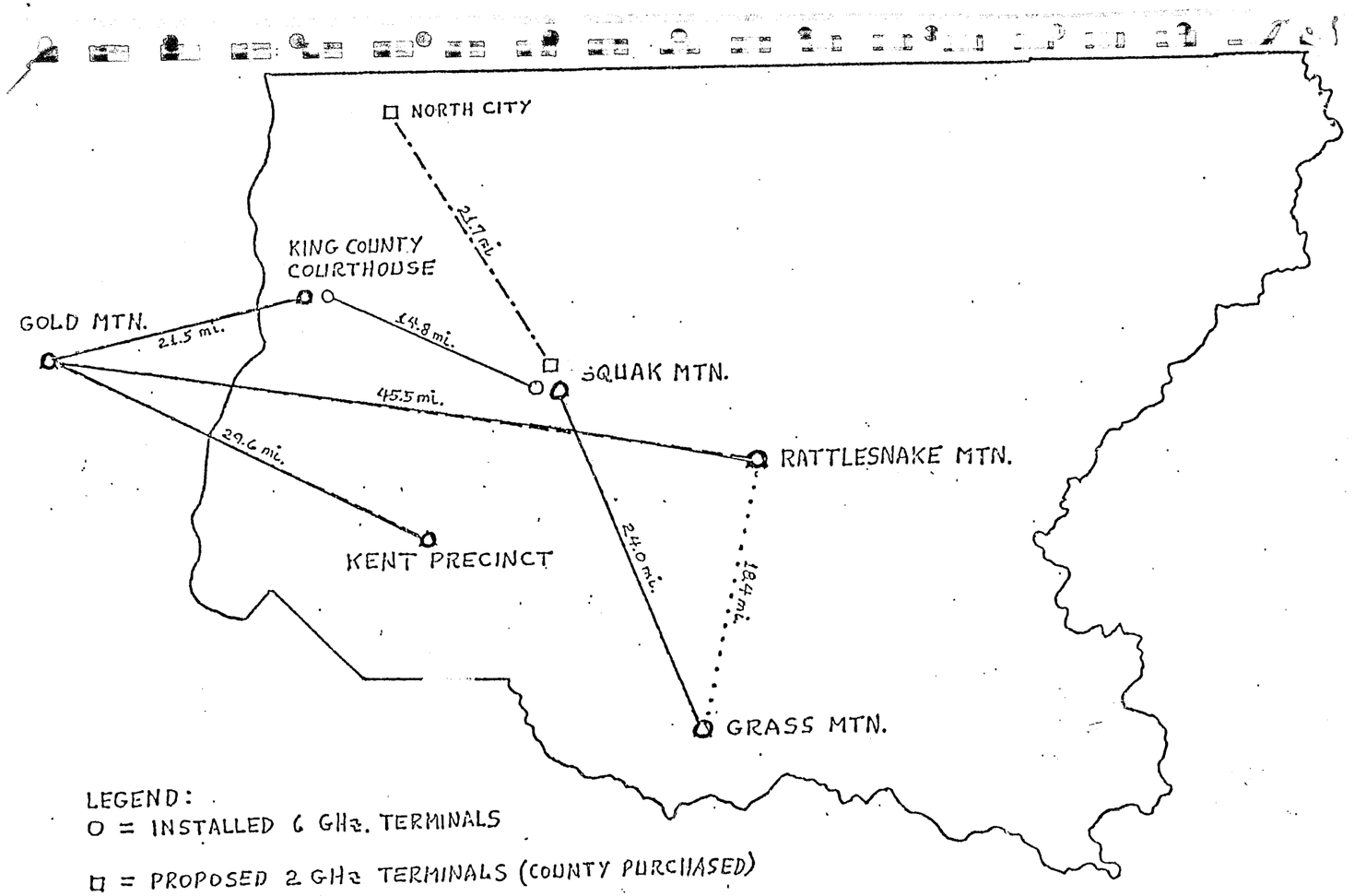
⊙ = RADIO STATION SITES

MAP A

KING COUNTY DEPT. OF PUBLIC SAFETY

PRECINCT BOUNDARY MAP

4-1-75 J. J. Porter, Jr. Updated 7/4/79



LEGEND:
O = INSTALLED 6 GHz. TERMINALS

□ = PROPOSED 2 GHz TERMINALS (COUNTY PURCHASED)

STATE PATROL 6 GHz SYSTEM

——— = 6 GHz MICROWAVE PATHS (EXISTING)

· · · · · = 6 GHz MICROWAVE PATHS (PROPOSED)

— · — · — = 2 GHz MICROWAVE PATHS (PROPOSED)

MAP B

KING COUNTY DEPT. OF PUBLIC SAFETY

MICROWAVE SYSTEM DIAGRAM

4/1/75

Updated 6/4/79

END