THE INTERIM CONCEPT PLAN LAND USE INVENTORY

by

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ABSTRACT

One element of the Interim Concept Plan developed by the City of Tucson Planning Division was a computerized land use and zoning inventory system. This intership report is a critical review of the development of that system, the procedures utilized to gather and tabulate the data, and the results produced by that inventory.

The intent was to develop the procedures and techniques necessary to computerize land use and zoning data in a system which allowed periodic updating and rapid retrieval in a variety of land use sizes. The land use and zoning data would first be used to complete the ICP. Afterwards, further refinement of the procedures and techniques would perfect a system to aid planners in making both long and short range land use and related decisions. This intership report provides an insight into some of the problems involved in the development and production of the inventory and offers recommendations to be considered in the development of similar inventories in the future.

The conclusion of this critique is that the techniques and methodology used to complete the inventory would better meet the original intent with certain modifications.

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FORWARD

From early January until early June of 1973, I was employed by the City of Tucson Planning Division in the preparation of the Interim Concept Plan. During the term of my employment, I was fortunate to participate in almost every phase of the development and production of this plan. Due to the time constraints imposed upon the planning staff by the Planning and Zoning Commission, many people had to work extremely long, hard hours in researching and analyzing data, preparing graphic elements, and developing the policies and concepts necessary to complete the plan. In many instances, accuracy may have been sacrificed for expediency.

It is not the intent of this report to be unduly critical of any member of the planning staff involved in the production of this plan, but rather to identify what I consider to be a problem, expose its causation, consider its influence, and finally, to propose recommendations.

I wish to thank those members of the planning staff and others for their assistance in the preparation of this report.

I. INTRODUCTION

A. The Purpose of the Interim Concept Plan

At a meeting on November 21, 1972, the City of Tucson Planning and Zoning Commission directed the Planning Division to produce by April 30, 1973, a plan to be utilized as the guiding instrument for the Commission's decisions pending the completion of the Comprehensive Planning Process (CPP) due in late 1974. At a subsequent meeting on December 12, 1972, the planning staff outlined to the Commission the purpose, scope, and function of what was to be called the Interim Concept Plan.(ICP). The purpose of the plan was to serve as a reference document for making planning and zoning decisions until the completion and adoption of the Comprehensive Plan currently being produced. To meet this purpose, the framework for the plan had the following basic characteristics:

1. It would consist primarily of policy statements illustrated where possible and necessary with concept schemes, sketch maps and graphics.

2. It would recognize the diverse physical and social communities in Tucson, and would relate their separate needs to the overall planning and development of the City. and region.

3. It would address itself to the issues and problems of Tucson identified in previous studies, and by citizens of the community during the Comprehensive Planning Process and other programs.

4. It would focus on problems and recommend policies, where possible, in a variety of study areas ranging from the 14 planning districts to the Tucson region.

5. It would not abrogate the Comprehensive Planning Process, and shall be subject to ongoing revision.

6. It would coordinate all policy formulation at the regional level with the appropriate governmental agencies.

B. The Function of the Interim Concept Plan

The functions of the Interim Concept Plan included the collection of land use and other data in order to determine the current status of the urban area, the outlining of the major planning problems existing in the community, and the recommendation of policies and plans to guide the development of the urban area until the Comprehensive Plan had been completed and adopted.[1]

C. The Objectives of the Interim Concept Plan

Finally, the objectives of the Interim Concept Plan were resolved and listed as follows:

1. To respond to the pressing planning problems of Tucson by setting forth interim policies for orderly growth and development.

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1. Interim Concept Plan Tucson, Planning Division Department of Community Development, City of Tucson, July 1973, Volume I, page 1-1.

2. To improve and facilitate decision making in zoning and related land regulation matters in the Tucson area.

3. To provide information and recommendations for the improvement of environmental standards.

4. To establish planning priorities and policies to assist in shaping the Tucson area until the Comprehensive Planning Process is completed.

5. To analyze and identify sources of data or potential hazards which may aid or hinder effictive planning in the Tucson area.[2]

D. Purpose of this Intern Report

Inherent to the achievement of objectives number two and five is the necessity of an accurate and timely land use survey. It is necessary that the land use data generated for the Interim Concept Plan be accurate, so that the policies and concepts derived from, or influenced by the use of this data would also be accurate. If the land use data was inaccurate, the subsequent policies, concepts, and decisions made with the utilization of the data would likewise be inaccurate. The purpose of this intern report is to investigate the accuracy of the land use survey completed for the Interim Concept Plan. Specifically, I shall check and analyze the methodology used for the identification of the land use, the measurement of that land use, and the computations required to compile and display the land use data.

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2. Ibid; page 1-1 and 1-2.

II. ANALYSIS OF THE LAND USE DATA

A. Methods Employed to Generate the Land Use Data

The production of the land use and zoning data for the Interim Concept Plan was a joint effort of the Planning Division and a private consultant firm, Resource Consultants, Inc. (hereinafter referred to as RCI), which specializes in computer programs and related software. The planning staff was to identify the land use and measure the land area. RCI was to keypunch, sort, compile, and printout the land use data in several different formats utilizing computers and programs of its design to achieve the objective.

RCI was not a novice in the area of computerized filing systems. RCI had developed a computerized Geographic Base File (GBF) based on the Census divisions of Tucson's Urbanized Areas. Essentially, this was a system by which demographic and economic information was stored for rapid retrieval and analysis. The basic unit of measurement and indexing was the census block. The Planning division felt that coupling this type of information with a computerized land use file offered an invaluable tool for future planning. The need to develop some type of land use element for the ICP offered the convenient opportunity to try to set up a land use file based on the census divisions. Hopefully, the land

use could be quickly identified, measured, compiled, and printed out for use in the ICP. After the ICP was completed, the staff could go back to the land use materials and further refine them for utilization in the Comprehensive Planning Process.

B. Elements of the Methodology

1. The Study Area

The study area to be considered in the ICP consisted of the incorporated limits of the City of Tucson plus the three mile fringe area surrounding the city. Map #1 on the next page illustrates the ICP study area as well as the Urbanized Area for Tucson as defined in the 1970 US Census. The approximate size of the study area is expressed in Table #1.

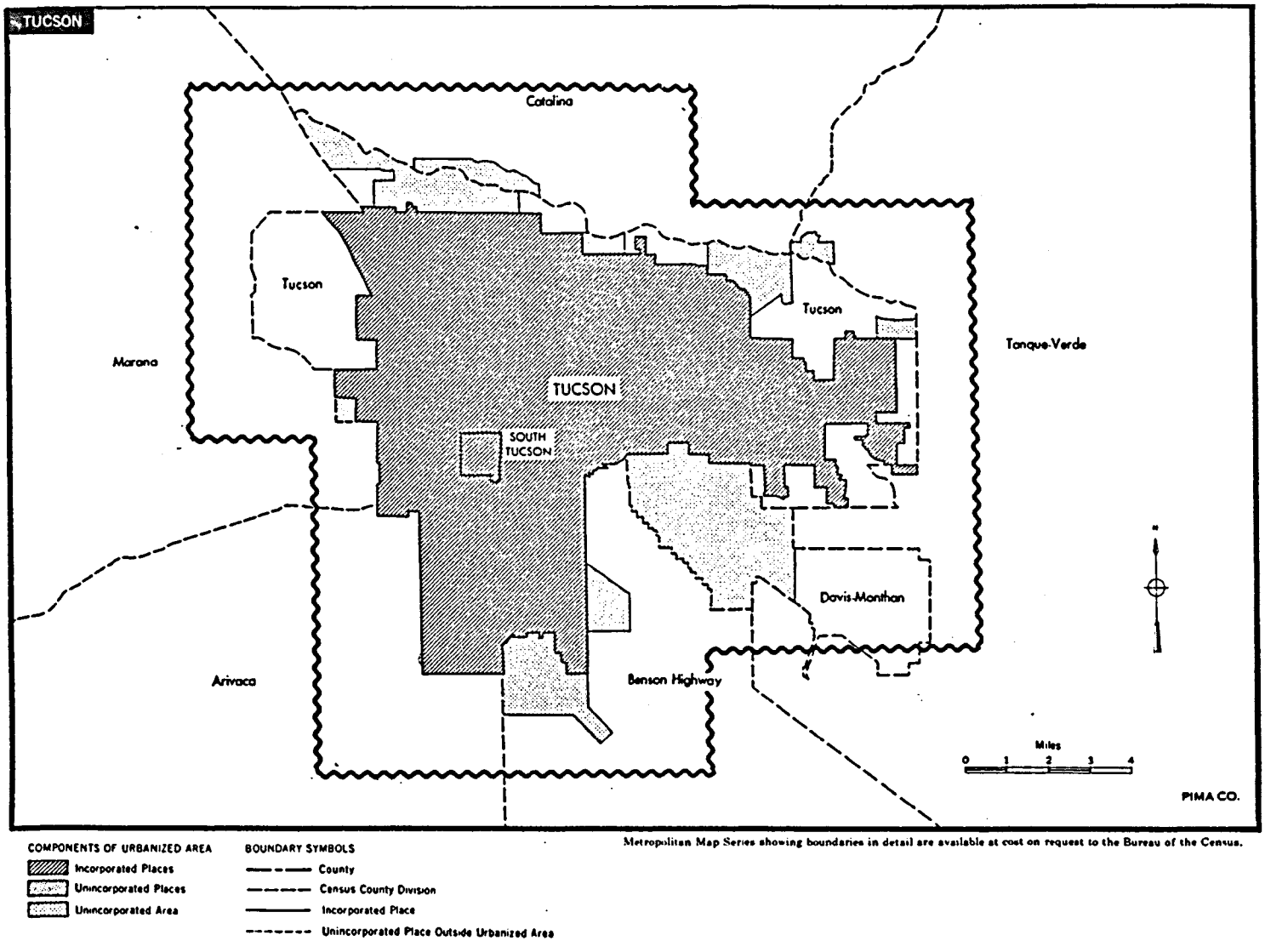
TABLE #1

AREA	SQUARE MILES
City of Tucson	84
3 mile periphery	190
Total Area	274

Source : Interim Concept Plan Tucson, Planning Division, Department of Community Development, City of Tucson, July 1973, Volume I, page 1-2.

MAP #1.

Interim Concept Plan Study Area



~~~~ Boundary of Interim Concept Plan Study Area

Source: Bureau of the Census.
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The study area for the ICP extended beyond the area encompassed by the Urbanized Area. Since the GBF developed by RCI was based on the census divisions included in the Urbanized Area, RCI's computer program would not cover the entire study area of the ICP. For those areas outside of the Urbanized Area which did not have census identification numbers other than tract numbers, the calculations had to be added manually by the planning staff to the totals produced by the computer.

2. The Land Use Categories

For the purposes of the Interim Concept Plan, the land use was categorized into seven general uses:

1. Single Family Residential
2. Multiple Family Residential
3. Commercial
4. Industrial
5. Public and Semi-Public
6. Vacant Land
7. Streets

A more definitive outline of the exact uses included within each of these seven categories can be found in Appendix A. Each of the seven land uses was recorded as a color on base maps for measurement.

3. The Land Use Codes

The land uses were colored with the traditional land use colors on the base maps. The seven land uses and their respective color indicators are given in Table #2.

TABLE #2

LAND USE	COLOR CODE
1. Single Family Residential	Lemon Yellow 915
2. Multiple Family Residential	Orange 918
3. Commercial	Red 924
4. Industrial	Grey 967
5. Public and Semi-Public	Ultramarine 902
6. Vacant Land	Apple Green 912
7. Streets R/W	White (left blank)

Prismacolor pencils were used to color totally each lot and/or parcel with its respective land use. Within the city limits, every lot or parcel was colored completely. As the coloring progressed outward toward the county fringes of the study area, the total coloring was replaced with only marking a single line of the respective color in each lot or parcel.

4. The Base Maps

Each of the land uses was recorded as a color on the base maps for measurement. Each map was of the Scale of 1:400 (one inch on the map equals four hundred feet on the ground). There were approximately 86 maps in the series which covered the ICP study area. Each map covered about 4.4 square miles or 2800 acres.

Illustrated on each base map were lot and/or parcel lines, easements boundaries, street right-of-way, the zoning applicable to the area, etc. Appendix B contains a portion of one of these base maps.

When the census blocks to be measured extended over two, three, or even four maps, the maps had to be taped together at

the margins before the measurements could be completed.

In some cases, there were duplicate maps which covered the same area. On one map, the zoning within the city limits was shown while on the second map, the county zoning. This only occurred on those maps which contained some portion of the city limits.

5. Land Use Identification

The primary source used to identify the land use was aerial photographs. The land use was identified from the photos and then the proper color code for that land use colored onto the base map. Any use that could not be readily identified was to remain uncolored pending a decision by the planning staff or perhaps a field check to determine the correct land use.

Only as a last resort, did the planning staff utilize field checks to identify land uses not discernable from the aerial photographs. One objective of the planning staff was to minimize field checks. Accordingly, the land uses identified and coded in the office, no matter how identified, were not checked in the field for accuracy.

6. Land Use and Zoning Measurements

After the land use had been identified by the color coding, the land area for each land use and zone in each census block was measured and recorded on tabulation sheets. An example

of this form is attached as Appendix C. For example, if a census block contained all single family residential land use, but had two different types of zoning, say R-1 and R-3, the land area would be measured and recorded as so much single family R-1 and so much single family R-3. Appendix D illustrates some typical entries. Usually two people worked as a team taking the measurements and recording the results. One person made the measurements while the other wrote them onto the tabulation sheets. This system seemed to work very well.

The land area was measured utilizing a triangular engineer's scale. The width and then the depth of each lot or parcel was measured and recorded. The nonrectangular shaped blocks were reduced to their rectangular or triangular elements for easier measuring. The intent at first was to measure the streets and alleys, but this was soon abandoned as being too difficult and time consuming. A method to estimate the area of streets and alleys was devised by RCI and will be discussed later in this report.

In addition to the engineer's scale, a rotary wheel and polar planimeter were used at times to measure peculiar shaped blocks.

7. Measurements Tabulations for Computer Card Entry

After the land use and land zoning data had been entered onto the tabulation sheets, the land uses and zones were consolidated prior to entry onto computer cards for keypunching. The process of calculating the area by hand was supposed to be eliminated by a program designed by RCI. By entering both the width and depth of the land area, the computer could be utilized to make the multiplications and divisions necessary to reduce these dimensions to acres.

The process of consolidation consisted of combining area of similar land use and zoning within a block to a single total for ease of entry onto computer cards.

8. Computer Card Coding

RCI designed a system by which the computer cards could be prepunched with block identification information yet leaving room to enter the land use and zoning data. Each data entry covered nine card columns. A parcel of land measuring 150 feet by 300 feet occupied by a single family house in a R-1 zone was entered as:

SR1015030

The first column was the land use type code. The next two columns were the code for the zoning. A complete breakdown of the entry codes for both land use and zoning is given in Appendix E. The width and depth of each land area were each entered as a three

column field. The last zero of each measurement was dropped prior to entry. Dimensions containing over four digits had to be reduced to meet the three column constraint. Similarly, the measurements made by the planimeter (square inches) or rotary wheel (linear inches) had to be converted into two dimensions before being entered onto the computer cards.

A large rubber stamp marked the data entry positions on the front of each card. From the tabulation sheets, the clerks transferred the data onto the computer cards.

The coding from the tabulation sheets to the computer cards was not checked for errors before the cards were keypunched. There is no record of the punched cards being validated prior to loading the data onto magnetic tape for processing by the computer.

9. Indexing

The land use and land zoning information measured and compiled for each census block was indexed into several categories for compilation and printout by the computer. Each block was categorized by:

1. City or County location
2. Planning District
3. Neighborhood Number
4. Traffic Analysis Zone (TAZ)
5. Census Tract

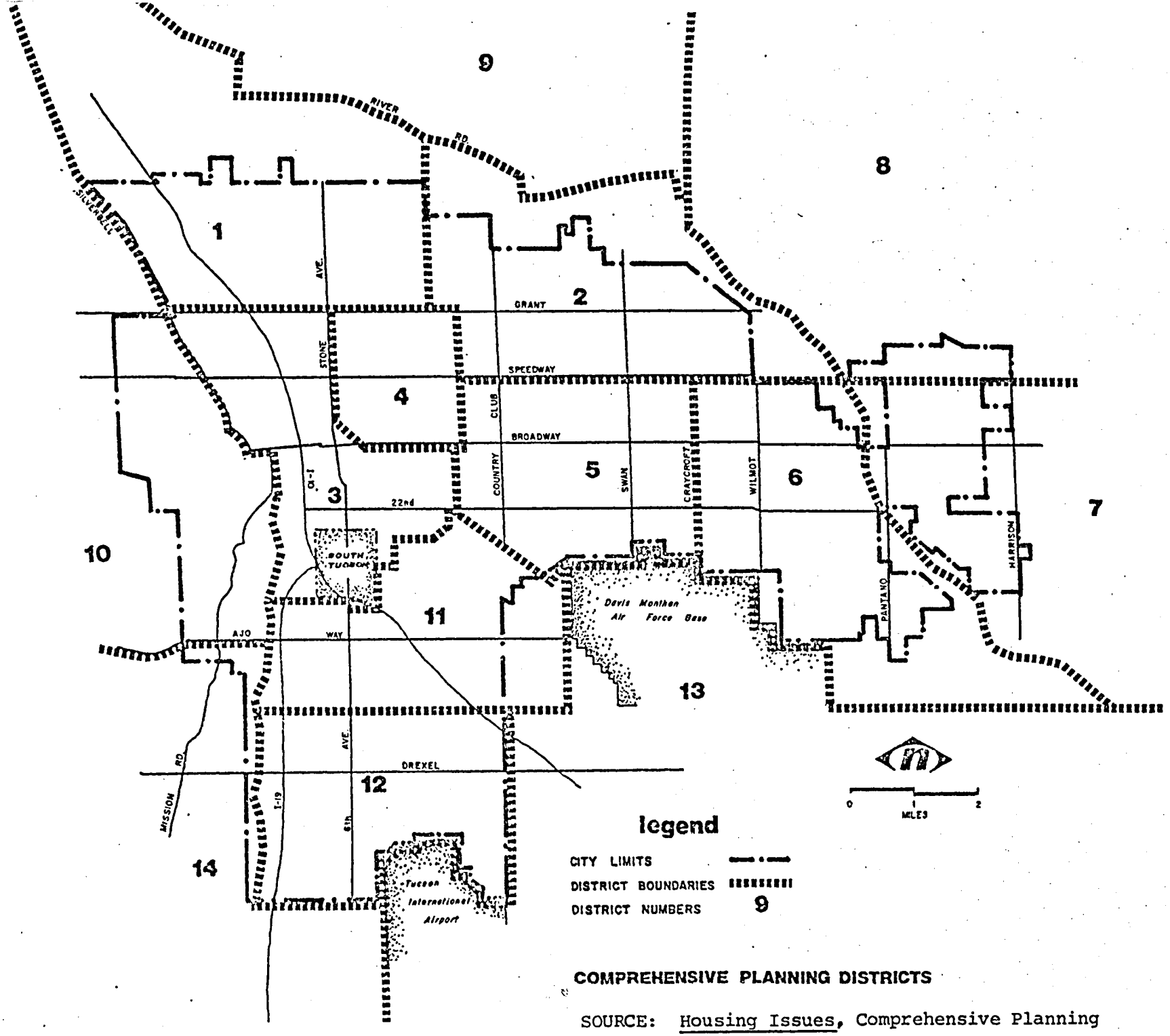
The intent behind this extensive categorization was to compile and printout the land use and zoning inventory in several different land area sizes ranging from the smallest individual census

block to the entire Tucson metropolitan region in order to facilitate land use decision-making. The planning staff envisioned an on-line computer program with periodic updating and printout capabilities which could be used not only for the ICP but also for the CPP, rezoning considerations, etc. The two most important subdivisions by which the data could be displayed are the planning district and the neighborhood.

The Tucson region consists of the urbanized area of Eastern Pima County. For the purposes of the Comprehensive Planning Process, this area has been divided into 14 planning districts. Map #2 shows the district boundaries. For the purposes of this report, these boundaries can be considered as terminating at the boundary of the ICP study area shown earlier in Map #1. The planning districts contain similar socioeconomic and physical characteristics and are being used as a basic land use planning unit for the CPP.

The City of Tucson has been divided into approximately one hundred and fifteen neighborhoods. These neighborhoods are used as planning units by the planning staff. Each neighborhood is about one mile square and contains approximately 640 acres within its boundaries. Map #3 depicts the city neighborhoods and gives their respective numbers.

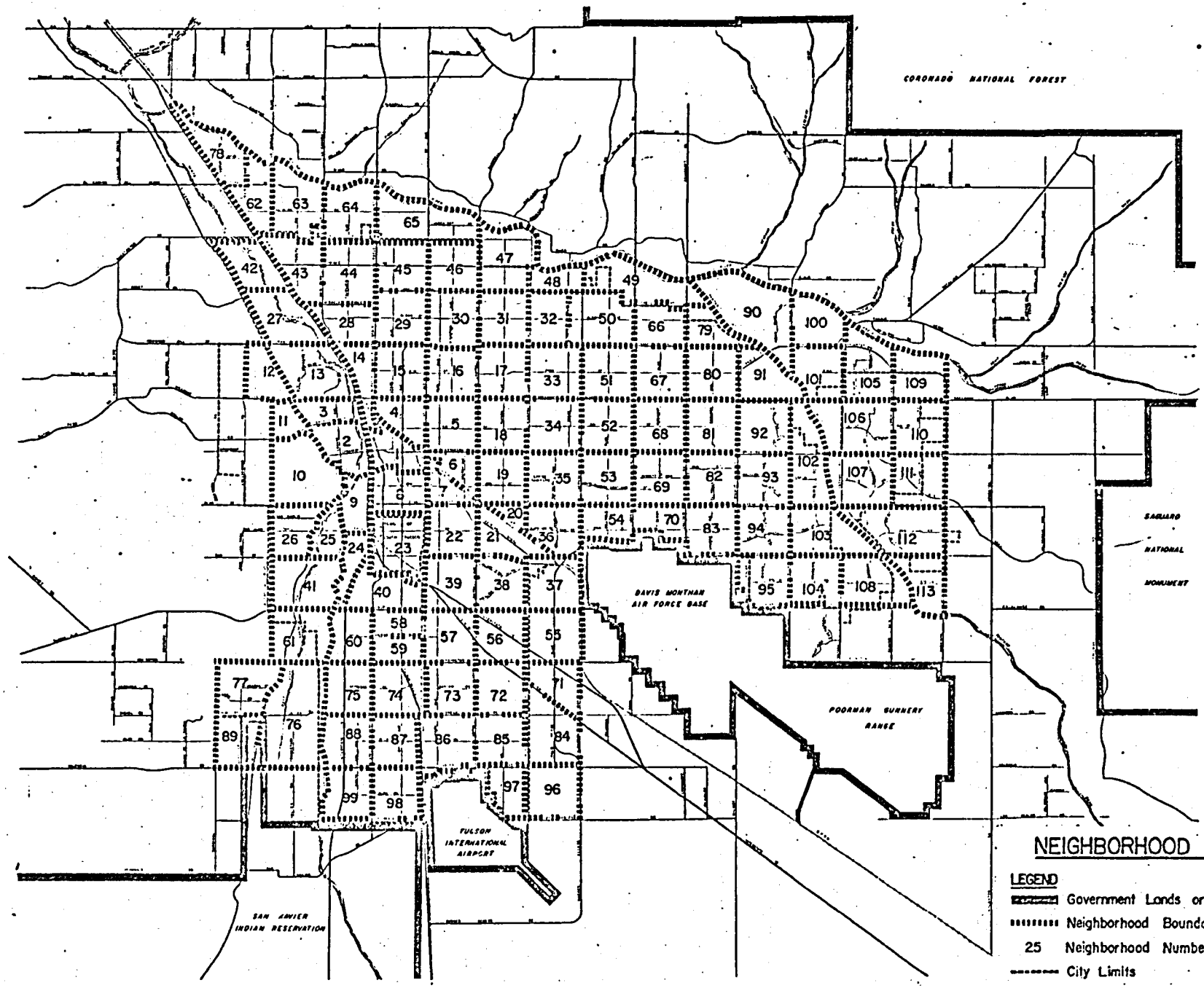
The land area which fell outside of the city limits in the county and extended to the ICP study area boundary was divided into twenty-two "neighborhoods" for the purposes of the ICP. Map #4 illustrates these areas.



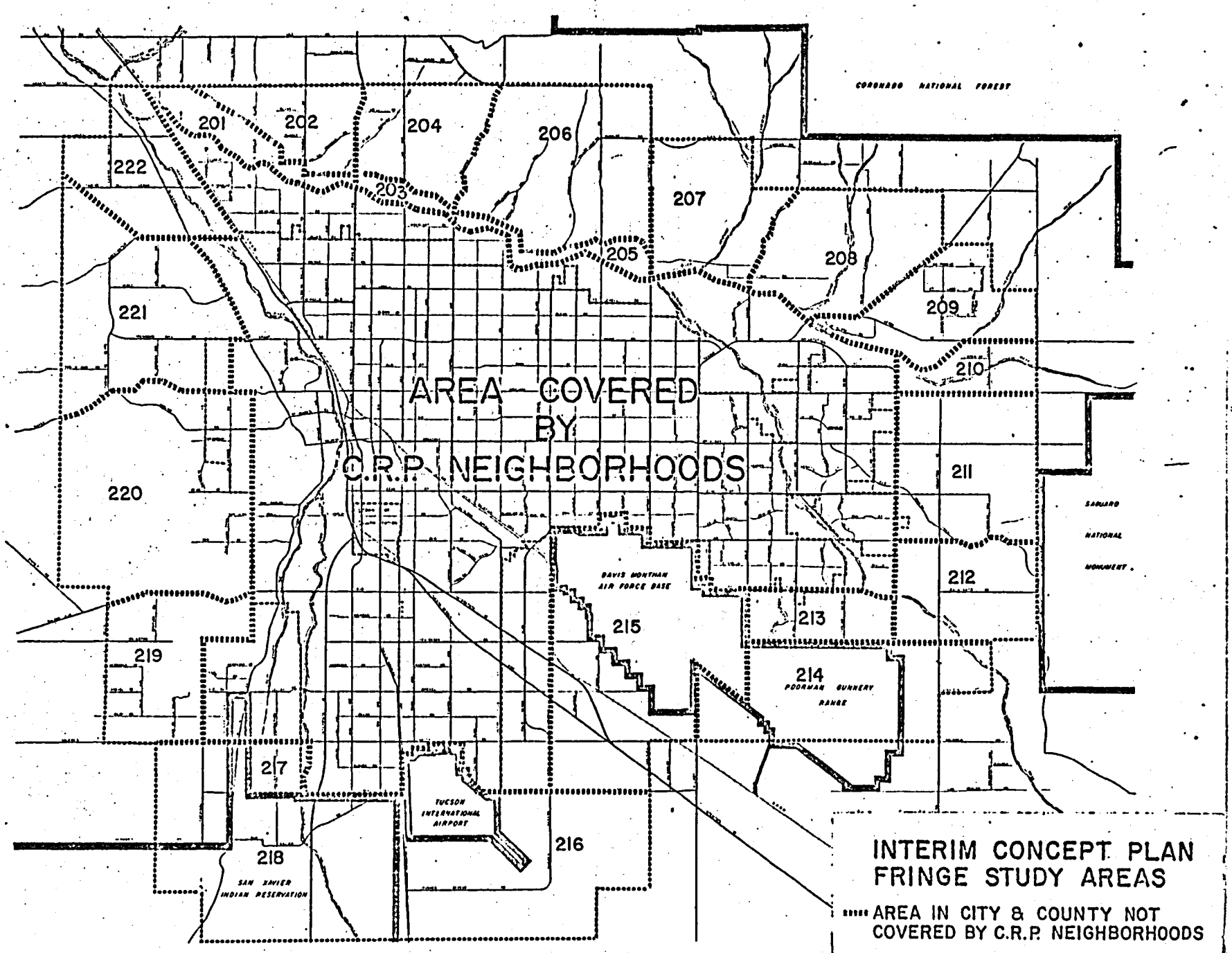
COMPREHENSIVE PLANNING DISTRICTS

SOURCE: Housing Issues, Comprehensive Planning Report No. 4, pages 5 and 25.

MAP #2.


CORONADO NATIONAL FOREST
DAVIS MONTHAN AIR FORCE BASE
POORMAN GUNNERY RANGE
SAGUARO NATIONAL MONUMENT
TUCSON INTERNATIONAL AIRPORT
SAN XAVIER INDIAN RESERVATION
NEIGHBORHOOD INDEX
LEGEND
Government Lands or Airport Boundary
Neighborhood Boundary
25 Neighborhood Number
City Limits

MAP #3.


AREA COVERED BY C.R.P. NEIGHBORHOODS
CORONADO NATIONAL FOREST
201
202
204
206
222
203
207
205
208
221
209
210
220
211
SAGUARO NATIONAL MONUMENT
DAVIS MONTHAN AIR FORCE BASE
212
213
215
219
214
FOORMAN GUNNERY RANGE
217
TUCSON INTERNATIONAL AIRPORT
216
218
SAN XAVIER INDIAN RESERVATION
INTERIM CONCEPT PLAN
FRINGE STUDY AREAS
AREA IN CITY & COUNTY NOT COVERED BY C.R.P. NEIGHBORHOODS

MAP #4

RCI indexed each block by each of the five subdivisions listed above. This information was fed into the computer to sort, compile, and printout the land use and zoning data by each of the five subdivisions.

Independently, the planning staff utilized the eleven map Metropolitan Map Series for 1970 produced by the Bureau of the Census to categorize each block. Superimposed upon these Census maps were the current boundaries of the city, the planning districts, the neighborhoods, and the TAZ's. As each block was measured, it was identified on the tabulation sheets by codes signifying the respective subdivisions in which it was located.

For those blocks which straddled boundaries of any of the subdivisions, the planning staff decided that the block should be assigned into the subdivision in which a majority of the land area was located. For example, block 906 in census tract 40.03 on the eastside of the city lies both in the city and in the county. This block was assigned as a county block since a majority of the land area in this block is outside of the city limits.

10. Checks on Accuracy

Because of the time constraints, a complete system of checks at each step of the process was never developed nor used. Most checking done was the result of errors discovered

after the first computer printouts were received by the planning staff. RCI developed a program for checking the area measurements made by the planning staff against measurements RCI had previously made in order to gauge the accuracy of the planning staff's measurements. RCI had measured the total land area for each of the approximately 5000 census blocks in the Tucson Urbanized Area as a requirement for the development of the GBF. These measurements were the gross area for each block, that is to say, all of the land area was measured with no distinction drawn between land uses or zoning. The set of maps from which RCI measured were of the same scale (1:400) as the base maps used by the planning staff, but of a different type. Rather than illustrate property lines, street rights-of-way, etc., the maps RCI used were enlargements of the eleven unit Metropolitan Map Series for 1970 produced by the Bureau of the Census which only illustrated census tracts and blocks. The method RCI utilized to measure the area is not known, but was thought to be a polar planimeter.

Since the planning staff was not measuring streets and alleys, the two different measurements could not be compared until either RCI's gross total was reduced or the planning staff's total was increased. RCI decided to multiply the perimeter distance of each of its blocks by thirty feet with the resultant square footage subtracted from the gross area total. RCI figured that thirty feet was one-half of the street right-of-way surrounding each block and the reduction in RCI's

gross total adequately compensated for the streets and alleys the planning staff had not measured. The two acreage totals for each block could now be compared. If one measurement differed from the other by twenty-five percent of the total area or more, RCI considered this an error and printed out a listing of such blocks. If the error was twenty-four percent of less, the block was not flagged. Even before the over twenty-five percent errors could be corrected, RCI ran the total program for the first time and presented the results to the planning staff.

As a result of RCI's "check" program, the first printouts sent to the planning staff had total acreages which were not realistic within the professional judgements of the planners. At this time, the twenty-five percent criterion developed by RCI came under scrunity. The planning staff initiated the correction of the greatest errors (those over twenty-five percent) and ran the program again. The data was needed to complete the ICP so not all errors were corrected. Those parts of the ICP which were dependent upon the land use data had been held in abeyance pending the results of the land use inventory.

Again the results were unacceptable to the planning staff. Starting with the largest errors and proceeding toward the smallest (both in percentage and absolute area), the planning staff attempted to rectify as many errors as time allowed. Alterations were made to the data entries until the final

printout of the metropolitan totals at least fell within the expected ranges as delineated by the planning staff. The intent being to correct the metropolitan total first as this information was needed to complete the ICP. The totals for the smaller subdivisions, such as planning districts and neighborhoods could be rectified later.

Many of the totals compiled in the smaller subdivisions still had gross errors as of the data of this report. Corrections, such as block assignments which would have involved program changes by RCI, could have easily been made but were not made. The exact percent of error existing in the final printouts has not been ascertained.

III. CRITIQUE

The single most critical problem evident in this job was the lack of coordination between the planning staff and RCI in the planning and completion of the land use inventory. The lack of a system of checks permitted the errors to compound upon other errors with the magnitude not apparent until the first printouts had been produced. By that time, it was too late to go back and change things since the data were needed to complete the ICP.

Briefly, each element of the land use inventory procedure discussed in Section II shall be analyzed and critiqued separately. General criticism shall be reserved until the end of this section.

1. The Study Area

The land area measurements for those areas within the ICP study area but outside of the Urbanized Area where RCI did not have census block numbers had to be manually added to the computer printouts for each of the subdivisions. The Census numbering system could have been expanded so the land use and zoning data from those areas could have been fed into the computer for tabulation and printout.

2. The Land Use Categories

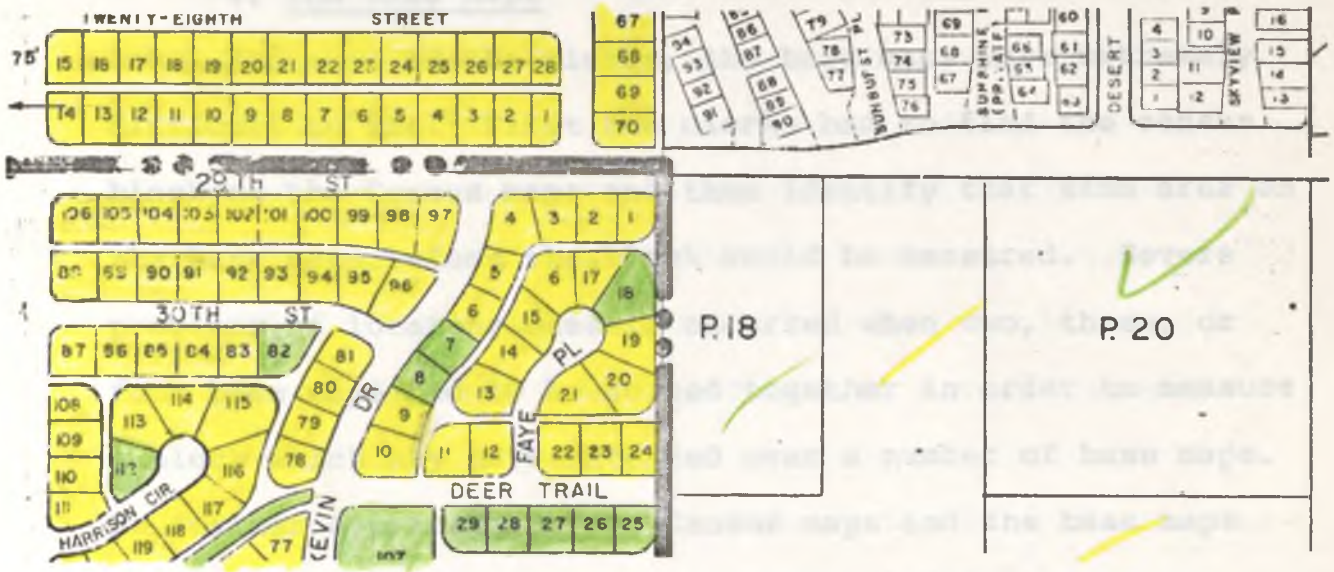
The objective of utilizing just seven land use categories was simplicity. The more simple the categories, the less the chance for error, ceteris paribus. RCI developed land use categories independently of those used by the planning staff. One category in particular caused major problems. RCI had developed new census blocks and numbers for the major washes and river bottoms, as well as for street medians. These areas were measured separately and entered as a separate land use category RCI called "medians-washes". The planning staff was not aware of this additional land use category and did not allow for it in the measurements and tabulations made by the clerks.

Additionally, RCI constructed new block configurations for some of the CBD, yet failed to inform the planning staff of these changes. As a result, the computer continually rejected the data entries of the planning staff as "erroneous".

3. The Land Use Coding

While there was not much of a problem with the color coding of the land uses within the city limits where the lot or parcel was colored completely, there was a serious problem in the fringe area where a single mark of color was used to identify the land use. An example of the technique used is shown in Figure #1.

FIGURE #1.



As the colors aged, it became difficult and some times impossible to differentiate between the yellow used to signify single family residential and the apple green used to indicate vacant land. By the time the fringe areas were measured, much of the vacant and single family land had to be rechecked and recoded with the respective color or some other form of identification.

In some of the low density residential areas where a single house may occupy only a small portion of the lot or parcel, some of the staff would code part of the parcel as single family and code the remainder as vacant. Other members of the staff colored the entire lot or parcel single family. No clear directive from staff was received on this problem.

4. The Base Maps

For some of the clerks, the base maps were extremely difficult to use. First the clerks had to find the census block on the Census maps and then identify that same area on the base maps before the block could be measured. Severe problems of locating oneself occurred when two, three, or four base maps had to be joined together in order to measure a block which may have extended over a number of base maps. As further aggravation, the Census maps and the base maps were of different scales (Census maps, 1:800, base maps, 1:400).

The numerous subdivisions in which the metropolitan area was divided tended to confuse the clerks as they attempted to orientate themselves on the base maps.

The space requirements posed by the size of the 86 base maps, the aerial photographs, necessary working area, etc., were never adequately considered nor met by the planning staff.

5. Land Use Identification

The aerial photographs utilized as the primary source of land use identification were secured from numerous sources and reproduced in various scales. The only complete set covering the entire study area was available in the planning division. While these photographs were of identical scale

to the base maps (1:400), they were two years old (1971). Some of the photographs from other sources were newer but were usually of limited range and/or of a different scale. The resulting potpourri of available photos were extremely difficult to work with as the scales differed continously. As a result, the majority of the land use was interpreted from the two-year old set of photographs having the same scale as the base maps.

The personnel hired to determine the land use and perform the measurements received no briefing or training in methods and techniques of aerial photo interpretation. Experience in aerial photo interpretation was not a prerequisite for working on this job. Any use that could not be readily identified was to remain uncolored pending a decision by planning staff or perhaps a field check to determine the correct land use. Rather than admit to an inability to identify some of the uses from the aerial photographs, some clerks made a "guess" as to the use and colored in the lot or parcel accordingly. At times, speed was emphasized over accuracy. Many times personal knowledge or recollection about the land use in a questionable area sufficed as justification for the coloring in of a particular use.

In lieu of more current aerial photographs, more field survey work could have been done. Only in extreme cases were lots or parcels upon which the land use could not be identified

by any other manner field checked. Very limited field checking was done in those parts of the city and county experiencing rapid development. Less than one percent of the total survey area was field checked. The trade offs between old photographs and field checking should have been investigated more thoroughly in the initial planning stages for this job.

6. Land Use and Zoning Measurements

The measuring techniques worked well for areas of a square or rectangular shape. Originally, a triangular engineer's scale was used to measure the width and depth of each lot or parcel. The constant shifting of the large scale from width to depth encumbered both the speed and accuracy of each measurement. Some errors were encountered when the wrong side of the scale was utilized as each of the engineer's scales had six different scales inscribed on it. As an innovation, a piece of clear plastic acetate with the proper scale inscribed in a right angel configuration upon it was pressed into service. The width and depth of the parcel could be measured simultaneously without moving this scale, The clerk had the added advantage of being able to see the actual land area being measured through the clear plastic. This technique seemed to speed the measurement process and completely eliminated the problem of using the wrong scale.

The measuring techniques employed worked well for areas consisting of small rectangular shaped blocks, but many lots or parcels to be measured were of shapes other than rectangular. Man-made as well as natural influences designed the shape of the lots and parcels. Curvilinear subdivision design, the meandering paths of natural drainage ways, off-set street alinements, etc., all contributed to the varied designs faced by the clerks. Whenever possible, there nonrectangular areas were reduced to rectangular and/or triangular elements for easier measurement. While this increased the ease of measurement, it also increased the chance of error. Some shapes which did not lend themselves to this reduction, such as the long blocks in curvilinear residential subdivisions were measured by a rotary wheel. The length of the block was measured by the wheel and then that distance multiplied by the average depth of that block. A separate conversion was necessitated by the use of this wheel as it recorded distances in inches which in turn had to be converted into linear feet.

To a limited extent, a polar planimeter was used for large irregular shaped areas. This technique was difficult to apply when the block extended over two or more maps. As with the rotary wheel, a conversion was necessary to change the square inches recorded by the planimeter into two dimensions for entry onto the computer cards.

In conjunction with the problem of disorientation mentioned earlier, there was the danger of either measuring too much land area or not enough, especially when two or more base maps had to be joined together along their margins.

7. Measurement Tabulations

One of the more serious examples of the lack of coordination between RCI and the planning staff can be found in the whole area of tabulation sheets and computer card coding. The tabulation forms used to record the measurements were outdated and did not lend themselves to the requirements of this job. The intent was for the codes and measurements to be keypunched directly from the tabulation sheets onto computer cards. This intention was never realized. The format of the tabulation sheet as well as the codes and measurements, were wrong for direct keypunching. A new tabulation sheet should have been designed so that keypunching could have been done off this sheet thus eliminating one step and another chance for error. More coordination would have prevented the need to code by hand the data entries onto the computer cards.

8. Computer Card Coding

RCI designed a system which lacked flexibility to cover the wide range of dimensions generated by the land area measurements. The measurement procedure used necessitated an unlimited number of cards being available for each census

block. While RCI was independently developing the format for entering the data onto the computer cards, the planning staff was measuring and recording the land use data in a manner which prevented that data being keypunched directly from the tabulation sheets. RCI's prepunching of cards for the census blocks which severly limited the width of the data field as well as the number of cards available was inexcusable. RCI could have easily programed for extra cards in the data set.

The use by the planning staff of several different instruments to measure the land area caused problems because numerous different computations were necessary to get the measurements into the two dimensional format before card entry. When the polar planimeter was used, the area was registered in square inches which in turn had to be reduced to the equivalent measurement of width and depth.

One additional source of error in card coding was the necessity of dropping the last zero when entering the measurements onto the computer cards. Many times, more than three digit entries were needed. RCI only provided for three digit entries. As a partial solution, RCI informed the planning staff that the final zero could be dropped during data entry. The computer would be programed to add this zero back onto the measurements before calculating the area. Some times, the clerks failed to make this adjustment. This was one more change which may have caused error to creep into the results.

The coding system used to write the zoning codes onto the cards was somewhat confusing. Rather than using the actual zoning codes as entry data, the clerks were forced to translate the zoning codes as they wrote them onto the computer cards. RCI should have utilized the computer's capabilities to translate the codes in an attempt to reduce error, not compund it.

9. Indexing

It is obvious that little or no time was spent in the preparation of an indexing system for storing the tabulation sheets and ensuring that all of the census blocks were measured. An early attempt by the staff to index the blocks by a section system using the townships and ranges was abandoned due to the complexities involved with the five subdivision boundaries.

Again the independent action of both RCI and the planning staff only served to complicate the problems in this area. RCI had assigned each census block by the five subdivisions while the planning staff was also assigning each block. The only hitch was that the assignments were not identical. Nor were the assignments compared until the initial computer printouts were received and the errors in assignments noted. Even after the planning staff had furnished RCI with a list of the corrections to be made in the assignments, the final printouts still had errors in the assignments of census blocks.

10. Checks on Accuracy

The most severe criticism of the total project can be leveled in this area. Neither RCI nor the planning staff appeared interested in the development and application of a comprehensive system of checks to be performed at various stages of the process. The prime reason being the necessity to complete the job quickly to complete the ICP coupled with the intent to go back later and make corrections.

The land uses indentified by the clerks from the aerial photographs were not subject to any type of verification. The limited field checking that was done was to make identifications which could not be made in the office from the photos, not to verify identifications already made.

The planning staff was severely remiss in allowing RCI to develop the only check program to be applied to the data. Staff should have developed some type of checks to ensure some degree of accuracy in the measurements it was making. With the numerous steps and chances for error in the process, a rigorous system of checks should have been developed and applied. As a direct result of this lack of checks, the planning staff spent nearly as much time on rectifying the errors as it did on measuring the land area the first time.

After the printouts were received, no attempts were made to determine the accuracy or inaccuracy of the results obtained.

11. General Critique

Most of the errors and problems encountered in the preparation of the land use element of the ICP can be attributed either directly or indirectly to the lack of coordination and planning between the planning staff and the private consultant. RCI continually developed procedures independent of the planning staff. Many times it appeared that RCI was using procedures which served RCI's interests rather than meeting the needs of the planning division. Closer supervision of the consultant may have eliminated some of the problems before they had a chance to develop.

The planning staff who worked on this project, and especially the provisional clerks hired just for this job, should have received briefings and training on some of the procedures and techniques used, certainly aerial photograph interpretation and land area measurement.

A land use inventory is a necessary element of any comprehensive plan. Yet, there had been no comprehensive systematic inventory of land use in the Tucson urban area in the past ten years prior to the ICP project. The Comprehensive Planning Process which has been ongoing for approximately two years has not (as of the date of this report) completed a land use inventory as one element of that plan. Neither has any attempt been made to evaluate the validity of the land use inventory done for the ICP.

IV. RECOMMENDATIONS

The recommendations in this chapter are by no means extensive or complete. Nor are they offered as the only procedures or methods by which to complete such a task. Rather, they are offered as points of departure for consideration in the development and planning of future land use inventories. The current needs of planners dictate that a new, accurate land use inventory be conducted immediately.

1. The Base Maps

There should be a set of base maps upon which to indicate the land use, land zoning, and from which to take measurements of these uses and zones. If the census block system is to be used as the basic unit, then probably the census tract and block boundaries should be printed on the base maps. These boundaries could be drawn in a different color, different style of line, or some other method yet to be determined. Putting the census boundaries on the base maps should eliminate the problems caused by using two different types and scales of maps by which to di-entify census block areas on the base maps.

The boundaries of the base maps should be modified so that the previous necessity to join two or more maps together in order to measure a census block is eliminated or reduced to a minimum.

Consideration should be given to coordinating the scales of the base maps with the aerial photographs if such photos are used for land use identification. The relationships between different base map scales and the techniques and tools used to measure the land area should also be investigated.

2. Land Use Coding

Probably some type of color coding for land use should be used which will not fade in time. If Prismacolors are used again, a greater deviation between colors should be considered so if there is fading with time, the differences in colors, i.e. land uses, could be distinguished.

In addition, all lots or parcels should be colored completely with the applicable color. A decision should be made for those lots which appear to be under utilized, and then consistently applied throughout the inventory.

3. Land Use Identification

Obviously a new set of aerial photographs of the same scale as the base maps should be used as one source of land use identification. Some experience in aerial photo interpretation may be a prerequisite for working on this aspect of the job. In lieu of

such experience, some training in the basic elements and techniques of aerial photo interpretation should be given to potential land use indentifiers.

The use of field checks should be investigated, both as a means to check the accuracy of determinations made in the office as well as a means to check land uses not discerible from the aerial photographs. It may be more accurate to field check certain areas of dense, mixed land use while relying upon the aerial photos for the identification of less dense, more homogeneous areas.

4. Land Use Measuring

From the results of the ICP inventory, it is clear that other tools and methods to measure the land use should be considered. One method should be used to measure all the land uses. Probably the planimeter offers the most suitable means to do this as the planimeter is more adaptable to irregular shaped areas than the scalar method used in the ICP. The measurements could be recorded as square inches and fed into the computer for multiplication and aggregation.

In lieu of measuring the streets and alleys or using the method developed by RCI to "estimate" the area in streets or alleys, some other methods should be considered. One may be a subtraction method involving the gross area of the block and subtracting the net area of land uses other than streets and alleys. Other methods may prove more efficient and accurate.

5. Index system

An assignment list for all the subdivisions should be carefully developed early in the development stages of the inventory. Each census block should be identified by the subdivisions into which it falls. When this information is fed into the computer, the segregation and aggregation of subdivisions can be quickly and accurately accomplished.

Some consideration should be given to retaining the neighborhood as a basic index. A check list of all the census blocks in the neighborhood should be marked as each block is completed.

6. Measurement Tabulations

A new tabulation sheet should be designed so that the measurements can be recorded on this sheet and then keypunched directly onto the computer cards. Careful attention must be given to the ranges involved with the land use and zoning codes as well as the size of the measurements to be taken. Flexibility should be designed into the tabulation and coding formats with the computer's capacity for aggregation used to its greatest potential rather than using clerks to manually aggregate the data.

7. Checks

A comprehensive system of checks to be preformed at various stages of the process should be developed before the process is initiated. Checks on land use identification as well as land area

measurments should be a part of such a system. Some type of check should be developed for application at the individual census block level. If each of the blocks are accurate, the aggregation of the blocks should also be accurate. A bench mark could be developed against which to compare the measurements as they are made at the block level. Correction if necessary, could be made prior to keypunching.

Probably the check system for measurements should be multi-staged with the main emphasis made at the individual block level and the neighborhood level.

V. CONCLUSION

The techniques and methodology considered to complete the Interim Concept Plan land use and zoning inventory merit retention with certain modifications. Given the basic intent to develop a computer based land use and zoning inventory file, the census block offers an excellent vehicle to achieve this goal. The data available from the Bureau of the Census offers a multitude of possibilities for the correlation of socioeconmic data with land use data. Once an accurate and timely land use inventory has been compiled, it should be periodically updated to keep the land use and zoning information current.

The Planning Department presently has the necessary personnel with the required expertise to develop such a land use and zoning file without relying on outside consultants. The major problem of the lack of coordination between the private consultant and the Planning Department staff should be eliminated by the use of inhouse personnel. The people developing the new land use inventory system will be doing so with the best interest of the Planning Department in mind.

Hopefully, any feelings that a similar project should not be considered for the future because of what happened to the ICP land use survey are negated by the pressing need for such data.

APPENDICES

APPENDIX A

Land Use Categories

LAND USE PROPOSAL - INTERIM PLAN

I. Single-Family Residential

A. 1/F Individual Lots

1. Tract Developments

2. Other 1/F Housing

3. Mobile Homes, 7,000 sq. ft. lot

B. Other 1/F Types (14 ft. separation between units)

1. Court Apartments (1/F houses, lot area per 1/F 6,000 sq. ft. plus)

2. Two 1/F houses per lot, lot area per 1/F 6,000 sq. ft. plus

3. 1/F House and Mobile Home per lot, lot area per unit, 6,000 sq. ft. plus

4. 2, 3 or 4 Mobile Homes per lot, lot area per unit, 6,000 sq. ft. plus

II. Multi-Family Residential

A. Apartment Complexes (5 units per complex plus, not classifiable as Court Apt.)

B. Mobile Home Parks

1. Parks 5 MH plus

2. Other MH units

C. Other M/F Types

1. 2/F, 3/F, 4/F, individual lots

2. Rooming, Frat., or Sorority House

3. Nursing Homes

4. Residential Hotels (including YMCA, YWCA)

III. Commercial

A. Shopping Center, 5 plus stores with own parking area

B. Retail Stores (other)

1. Department, large discount stores

2. Grocery, liquor, drug, variety stores

3. Clothing, shoe, gift, jewelry, book, florist, photography, stationary, art supplies, etc., shops and stores

4. Restaurants, bars

C. Heavy Commercial Types (mainly bulk items)

1. Building materials, furniture, hardware, office equipment, sporting goods, radio-TV, appliance, paint, lumber yards auto accessories (tires), etc.

2. Auto dealers (new, used), boats, mobile home sales, farm equipment, feed and grain, fuel, etc.

D. Commercial Services

1. Personal: cleaners, laundry, barber and beauty shops, shoe repair, funeral parlor

2. Business: advertising, credit unions, blueprint, photocopy, auto rental, travel agency, employment agency, photo studio

3. Repair: appliance, radio-TV, upholstery

4. Recreation: movie theatre (indoor, outdoor), race track, bowling alley, skating rink, miniature golf, golf driving range, amusement, campgrounds, travel trailer park, riding stables

5. Motels, hotels, resorts

6. Auto: gas stations, garage auto repair, auto wash

7. Other: Art, music, dancing schools in commercial setting

E. Commercial Offices

1. Medical: doctors, dentists, laboratory

2. Professional: legal, accounting, tax, engineering, architect, construction

3. Financial: banks, real estate, insurance, brokerage and investment

4. Transportation, communication, utility offices

5. Major company (mining, etc.)

F. Parking garages, lots

IV. Industrial

A. Industrial Parks, 5 plus establishments with employee parking, etc.

B. Wholesale - Warehouses

1. All wholesale dealers, large establishment, clearly advertised as such

2. Warehouse, storage yards, large establishments, large scale trucking involved, etc.

3. Feedlockers

C. Manufacturing Establishments

1. Food processing, bakery, ice plant, bottling works

2. Apparel plants

3. Millwork, furniture

4. Printing and publishing

5. Soap, chemical, paint, petroleum refining

6. Cement mfg., building materials

7. Fabricated metal products, machinery, electronics

8. Optical instruments

D. Transportation and Communication Facilities

1. Railroads: R/W, Yards, freight and passenger stations

2. Airports: runways, hangars and storage, terminals, taxiways

3. Motor vehicle: bus terminals, major truck terminals, bus or truck storage, repair yards

4. Communication: telephone exchange and microwave stations, radio-TV broadcasting stations

E. Utilities

1. Water treatment plants, well sites

2. Sewage treatment plant, composting plants, sanitary land fill

3. Gas and electric: R/W, substations, generating plants

F. Other Industrial Types

1. Oil storage yards

2. Stock yards

3. Sand and gravel extraction

4. Mining, other

V. Public and Semi-Public

A. Government Offices and Services

1. City Hall, County Court House, Post Office, other city, county state or federal offices

2. Fire stations

3. Law enforcement

4. Libraries, auditoriums, museums, etc.

B. Schools (public and private)

1. Nursery, pre-school, kindergarten

2. Elementary

3. Junior High

4. Senior High

5. College, university, includes dormitories adjacent to college

6. Business or trade

C. Parks and Recreation

1. Neighborhood parks, swimming pools

2. District and Regional Parks, zoo, amphitheatre, picnic grounds

3. Golf course (public, private)

4. Stadium, fairgrounds, rodeo grounds

5. Historic sites

D. Institutional Uses

1. Churches, includes quarters and educational - recreational facilities on-site or adjacent

2. Clubs, fraternal organizations, civic associations, labor union halls, welfare and charitable offices

3. Hospital

E. Cemeteries

VI. Street R/W

A. Freeways

B. Major Streets

1. Major arterial

2. Scenic routes

3. Routes with landscaped medians, etc.

C. Commercial and Service Streets

D. Residential and Minor Streets

VII. Vacant Land

A. Developable Land

1. Residential

2. Commercial

3. Industrial

4. Public sites

B. Undevelopable Land

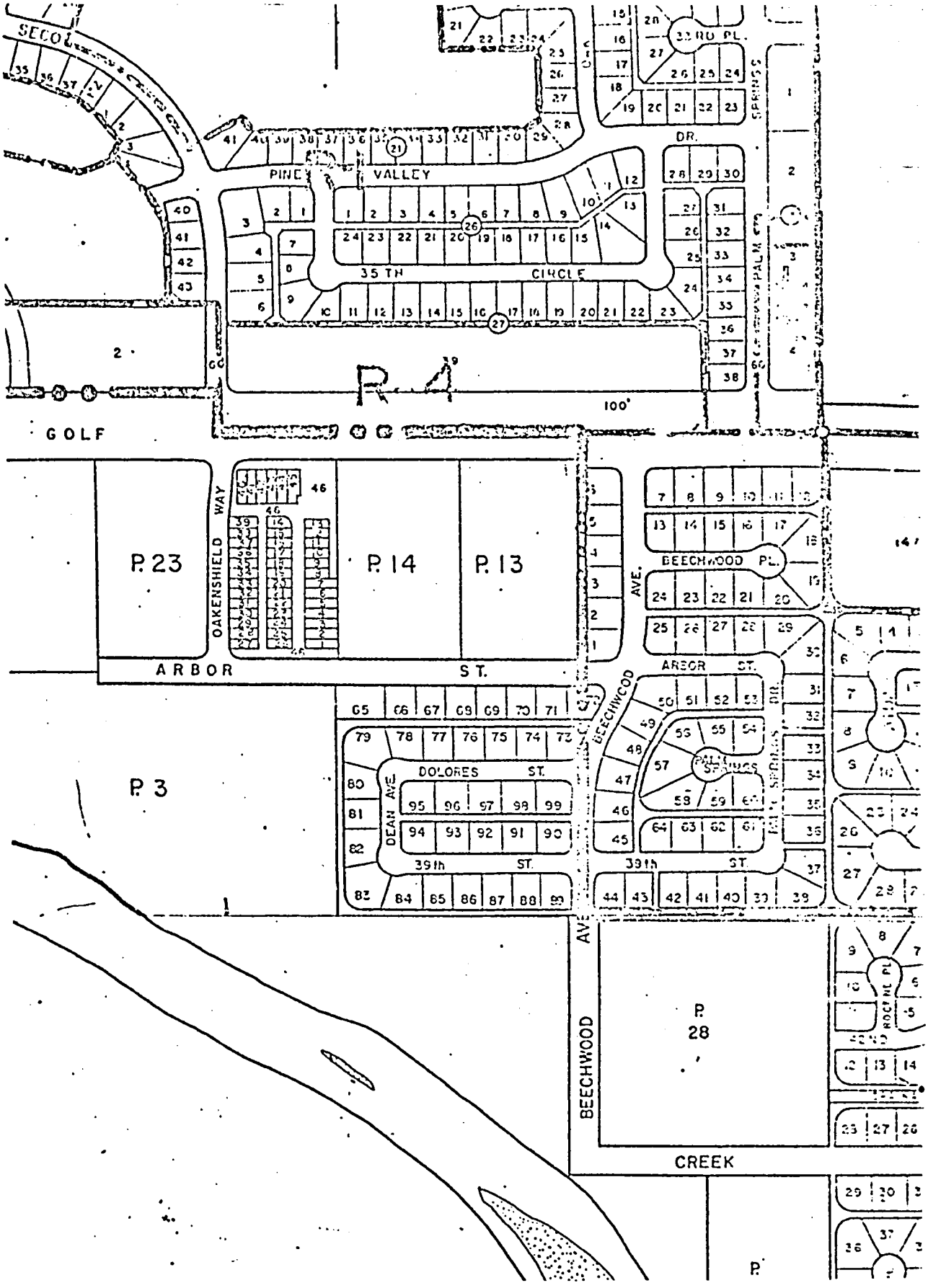
1. Flood plain

2. Rough terrain, poor soil, etc.

3. Other

APPENDIX B

Example of Base Maps


PINE VALLEY
35 TH CIRCLE
GOLF
P. 23
OAKENSHIELD WAY
P. 14
P. 13
ARBOR ST.
BEECHWOOD PL.
BEECHWOOD AVE.
DOLORES ST.
DEAN AVE.
39th ST.
P. 3
P. 28
BEECHWOOD AVE.
CREEK
100'

APPENDIX C

Tabulation Sheet

NBRHD # _____ DIST. # _____ TAZ _____ _____

_____ 19____ Calculator _____ MAP # _____ Section ____; T-__-S, R-__-E

BLOCK IDENTIFICATION	BLOCK AREA	ZONE AREAS PER BLOCK	DIMENSIONS OF INCREMENT per LAND USE	ZONING SYMBOL	LAND USE NO.	AREA OF INCREMENT PER LAND USE

APPENDIX D

Typical Data Entries

NBRHD # 102 DIST. # _____ TAZ 205 _____

_____ 19 ____ Calculator JZ MAP # 53 Section ____; T-__-S, R-__-E

BLOCK IDENTIFICATION	BLOCK AREA	ZONE AREAS PER BLOCK	DIMENSIONS OF INCREMENT PER LAND USE	ZONING SYMBOL	LAND USE NO.	AREA OF INCREMENT PER LAND USE
47.01 –			100 X 500	R1	SF	
101			100 X 600	R2	MF	
			300 X 600	B2A	CO	
			150 X 600	B2A	VA	
102			100 X 600	R1	SF	
			100 X 200	R1	VA	
103			100 X 600	R1	SF	
			100 X 80	R2	SF	

APENDIX E

Entry Codes for Land Use and Zoning Data

INTERIM CONCEPT PLAN

MEMORANDUM 73-140-2

FROM: A. M. BROWN
RESOURCE CONSULTANTS, INC.

TO: CITY OF TUCSON
PLANNING DEPARTMENT STAFF

DATE: February 13, 1973; Revised February 27, 1973

SUBJECT: DATA ENTRY CODES FOR LAND USE AND ZONING CATEGORIES, INTERIM PLAN PROJECT

On the afternoon of February 13, 1973, the following coding system was established for encoding block level data on keypunch cards. This revision of February 27, 1973, was made to include the seventh land use code "X" and show the zone groupings to be used in the reports.

1. No problem is seen in assuming a 1970 Census Block as totally within or totally outside of the city for data summarization purposes.

2. A total of twenty-six zones were decided upon for data entry purposes. The two character abbreviation and the City/County zones are as follows:

DATA ENTRY CODE	TABLE POSITION	CITY ZONE	COUNTY ZONE
A. RURAL GROUP			
SR	1		SR
UR	2	UR	GR
SH	7		SH
B. SINGLE FAMILY RESIDENTIAL GROUP			
X1	3	RX-1	CR-1
X2	4	RX-2	CR-2
R1	5	R-1	CR-3
CR	6		PR-3
MH	8	MH	CMH-1

DATA ENTRY CODE	TABLE POSITION	CITY ZONE	COUNTY ZONE
C. MULTI FAMILY RESIDENTIAL GROUP			
MP	9	MHP	CMH-2
R2	10	R-2	CR-4
R3	11	R-3	CR-5
R4	12	R-4	TR
R5	13	R-5	
PR	14	PR	
D. COMMERCIAL GROUP			
RV	15	RV	TH
VC	16		RVC
B1	17	B-1	CB-1
BA	18	B-2A	CB-2
B2	19	B-2	
BH	20	B-2H	
B3	21	B-3	
MU	22		MU
E. INDUSTRIAL GROUP			
PK	23	P-1	
C1	24	I-1	C1-1
C2	25	I-2	C1-2
C3	26		C1-3

3. The seven land use codes to be used for data entry are as follows:

S	Single family
M	Multiple family
C	Commercial
I	Industrial
P	Public & Semi-public
V	Vacant
X	Washes & Medians