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AN ANALYSIS OF FIVE KALISPELL RURAL SCHOOL
DISTRICT BOUNDARIES AND
POTENTIAL MIDDLE SCHOOL LOCATION

By

Janice K. Calm

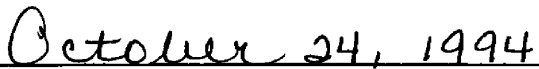
B.A. Fort Lewis College, 1977

Presented in partial fulfillment of the requirements
for the degree of
Master of Arts
October 1994

Approved by


Chairman, Board of Examiners


Dean, Graduate School


Date

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An Analysis of Five Kalispell Rural School District
Boundaries and Potential Middle School Location [110pp].

Director: Paul B. Wilson *PW*

The objectives of this study focused on the locational problems facing rural school administrators in Montana. These objectives were specifically to determine the distribution of students within five rural Kalispell school districts, investigate the efficiency of the school district boundaries based on student's residence distances, determine the optimal site for a potential new middle school based on these distances, and provide study results with recommendations useful to a review of facilities by school administrators or planners.

The first methodology for the study estimated Flathead County's future population growth and graphically displayed the recent population growth of the study schools. The second methodology evaluated the efficiency of the study schools' district boundaries by the development and comparison of two different ranking systems--the first ranked the distances from each student's residence to each school, while the second system ranked the study schools in relation to each student's residence. Finally, a gravity model and descriptive statistics were used to determine the optimal site for a new potential middle school based on the distribution of student's residences.

ACKNOWLEDGEMENTS

For writes and rewrites, thank you Paul,
And to Sara Jane who punctuated it all,
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And Dr. Luckowski for the educator's view,
To the administrators and clerks for all of the maps,
Nancy and her humor during deadline mishaps,
To Barbara and Alex with wheels to spare,
And my folks who reminded me there is still life out there,
To Jim and Rita for caring, Bill on the net,
And my musical cohorts who helped me forget,
To all friends and family who helped more than they knew
This is it! I am leaving! I FINALLY AM THROUGH !!

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CHAPTER I

INTRODUCTION

"The quality and level of U.S. economic growth to a very large degree lies with the public choices made by the thousands of local school districts across the country".¹

The planning of school districts and school site locations has become an increasing concern for school administrators. Decisions regarding school district boundaries, overcrowded classroom conditions, and school consolidations are complicated, requiring extensive time, energy and expense. Student distribution evaluation methodologies are complex, many requiring intricate computer and mathematical backgrounds, while analytical techniques frequently extend beyond the specific expertise of the decision makers. The development of various alternatives and long-range options is often not financially feasible, with the resulting emphasis being placed on the urgent instead of the important.

Rural schools have supplementary problems to consider. Student residences are often spatially isolated, rural schools are small and school budgets already stretched

¹ Brady Deaton and Kevin McNamara, Education in a Changing Environment: Impact of Population and Economic Change on the Demand and Cost of Public Education in Rural America (February 1984):6, quoted in Daryl Hobbs, "Rural School Improvement: Bigger or Better?", The Journal of State Government 61 (January/February 1988):22.

beyond their limit. Consolidation and redistricting issues continue to cause controversy, as do concerns over minimum and maximum enrollment guidelines. Rural school boards today require a wide foundation of information to make decisions; first, to make appropriate decisions regarding school concerns; and second, to provide justification of their decisions to the communities they serve. This information foundation includes a wide spectrum of topics, including details regarding the distribution of students' residences and the efficiency of district boundaries.

School district and student's residence locational analysis is of concern to researchers in multiple disciplines, including geographers, educators, computer scientists, and statisticians. Problems incurred in the study require an understanding of spatial relationships, descriptive statistics, and iterative algorithms, as well as a thorough perception of community and educational impacts of change. Controversial issues regarding consolidation and desegregation demand extensive knowledge regarding the many facets of the problem, thus requiring practical and accessible solution processes.

Purpose of Study

This study is focused on the locational problems facing rural school administrators in western Montana. Its specific purpose is to determine the distribution of students within five rural Kalispell school districts,

investigate the efficiency of the school district boundaries based on student's residence distances, determine the optimal site for a potential new middle school based on these distances, and provide study results with recommendations useful to a review of facilities by school administrators or planners. This information will be provided to the school administrators of the study schools to allow it to be combined with other relevant information in considering the issue of middle schools in the Flathead Valley. It is an additional goal of this study to provide information for school administrators regarding the procedures involved for student distribution analysis. Backgrounds and explanations of methodologies have been provided for future studies of rural school student district analysis.

The results of this study are intended to provide a supplementary report to the one initiated by the Flathead Valley Cooperative Planning Coalition,² discussed more at length later in this thesis. The researcher is aware of the many considerations necessary in the determination of a school site, but has opted to concentrate on locational details and student distribution in order to provide more

² *"The Cooperative Planning Coalition is a group of concerned citizens, businesses, organizations, agencies and local officials dedicated to promoting quality land use planning specifically designed to address the Flathead's unique needs and resources."*

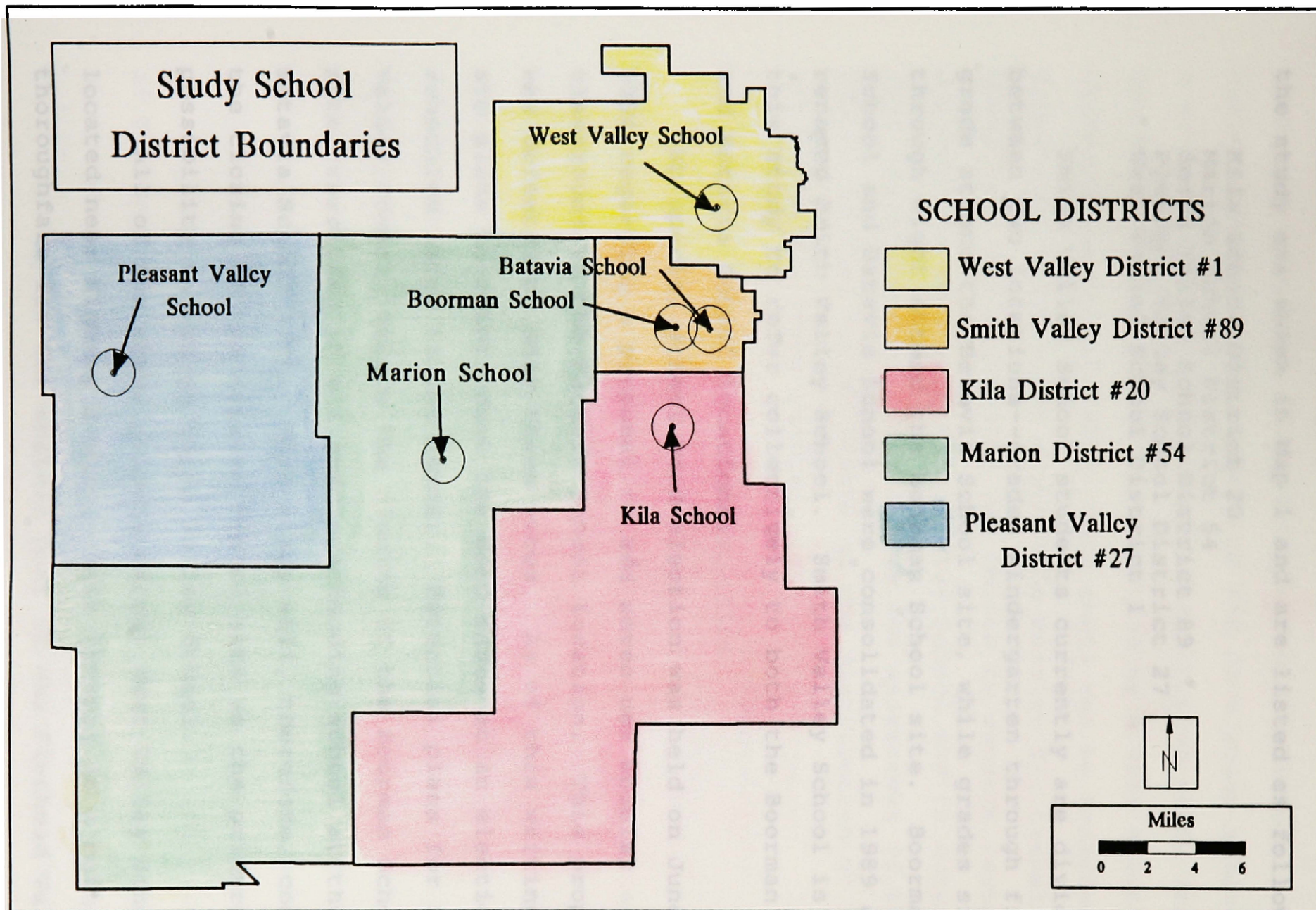
in-depth information. A list of additional factors to be considered in future studies is provided for reference within the study.

Limitations of the study prevent the locational analysis of home-schooled students and students attending private schools outside of the study area. The information regarding the distribution of home-schooled and private-schooled students within the study area was not available, although the total number of these students within Flathead County has been included for reference in Appendix A.

Description of Study Area

The rural school districts constituting the study area are located in Flathead County, Montana. The five districts are specifically located to the west of the town of Kalispell. Each school is contained within its own district and is comprised of kindergarten through the eighth grade. Each district is governed by its own elected school board, representing the highest local authority. After completion of the eighth grade, students attend school in Kalispell High School District V for completion of the ninth through twelfth grades.³ The specific school districts involved in

³The specific school the students attend is Flathead High School, the largest high school in the state.



Map 1

the study are shown in Map 1 and are listed as follows:

Kila School District 20
Marion School District 54
Smith Valley School District 89
Pleasant Valley School District 27
West Valley School District 1

Smith Valley School students currently are divided between two locations--grades kindergarten through fifth grade attend the Batavia School site, while grades six through eight attend the Boorman School site. Boorman School and Batavia School were consolidated in 1989 and renamed Smith Valley School. Smith Valley School is used in this study to refer collectively to both the Boorman School and Batavia School locations.

An special school bond election was held on June 7, 1994 regarding a proposal to add seven new modular classrooms at the Batavia School location. This proposal was defeated by only three votes. As of this writing, there are plans to reintroduce the bond issue at an election to be scheduled later in the summer. Potential plans for Smith Valley School include the closing of the Boorman School site, resulting in all grades attending school at the Batavia School site. This study will, therefore, consider the closing of the Boorman School site as the primary possibility regarding Smith Valley School.

All of the study schools except West Valley School are located near Highway 2 West. This highway is a main thoroughfare for the western part of the Flathead Valley

with many potential sites for a new middle school. West Valley School is the largest of the five study schools with a strong impact on the student distribution study results. However, access to Highway 2 West is by a very steep hill, called Sheepherder's Hill. This route can be treacherous in winter and constitutes a possible barrier for travel. Therefore, the researcher has chosen to conduct certain analyses to data with West Valley School and to data without West Valley School. This allows for assessment of the impact of West Valley School on the distribution of student's residence points.

Methodologies

The problems facing the researcher required a basic understanding of practical applications of spatial analysis techniques. A thorough literature study and review expanded the researcher's proficiency and allowed specific methodologies to be developed. Knowledge concerning the use of certain computer software was additionally required to complete the study.

The first methodology for the study concerned the estimation of Flathead County's future population growth, as well as a graphical display of the recent population growth of the study schools. This required data on the population of Flathead County and enrollment statistics for each of the study schools. In pursuit of this goal, population data for Flathead County was acquired from 1970 through 1992,

(the most current available) and school enrollment records were obtained from 1970 through 1993.⁴

The evaluation of the efficiency of the study schools' district boundaries was achieved by the development of a comparison technique and required specific information on the road distances from the student's residences to each of the study schools. Two different ranking systems were established to accomplish this. The first system ranked the distances from each student's residence to each school. The second system reversed this process and ranked the study schools in relation to each student's residence.⁵ The location of student's residences were obtained from each study school, and the applicable road distances were measured within a specialized computer system.⁶

The technique for determining the optimal site for a potential new middle school was also based on the measured road distances from student's residences to the study schools. A gravity model was designed to measure each school site's population potential in relation to the distribution of student's residences.

⁴Population analysis is addressed in Chapter III. Specific population figures for Flathead County and enrollment totals for the study schools are included for reference in Appendix A.

⁵The ranking procedures are explained in Chapter IV.

⁶The acquisition of data is specifically discussed in Chapter III. Spatial analysis techniques are discussed in depth in Chapter IV.

The discernment of possible changes in student's residence distribution patterns was accomplished by calculating the average position (the arithmetic mean center) for each grade level. The arithmetic mean centers were graphically compared, allowing an evaluation of changes in the student distribution from year to year⁷.

Sources of Data

The information and statistics essential for this study were acquired by researching multiple sources, including the following: (1) Dorothy Laird, the Flathead County Superintendent of Schools; (2) the principals of the schools in the study, specifically Linda Kittle, Mike Welling, Wayne Strong, Cindy Williams, and Frank de Kort; (3) the Flathead County Plat Map Division; (4) the Flathead County Library; (5) the 1990 Department of Commerce, Bureau of the Census; and (6) the Bureau of Business and Economic Research at the University of Montana. In addition, a literature review was accomplished at the Mansfield Library at the University of Montana in Missoula, including extensive use of the Interlibrary Loan Service.

⁷Gravity models and arithmetic mean centers are discussed in Chapter IV.

CHAPTER II

BACKGROUND STUDY

The field of planning has specific relevance to contemporary society. Complex land usages and population surges have mandated a need to visualize the future, involving the need to examine various alternatives and directions. Controversial issues and concerns must be anticipated and included within the planning mechanism, requiring clear and effective communication procedures. The following ten steps illustrate the continuous flows and feedbacks of the planning process:

1. Problem Identification
2. Goal Setting (statement of objectives and establishment of a work program to prepare appropriate plans)
3. Data Collection and Analysis
4. Refinement of Goals
5. Development of alternative plans and/or policies (designed to achieve goals)
6. Evaluation of alternatives (determine probable effects, both good and bad, and the ease or difficulty of implementation)
7. Adoption of preferred plans and/or policies
8. Implementation of plans and/or policies
9. Monitoring and evaluation of results (alerts to progress toward goals and/or danger signs calling for course correction)
10. Feedback (recycle the planning cycle necessary to meet emerging circumstances)⁸

⁸ Preston P. LeBreton and Dale A. Henning, The Practice of State and Regional Planning, (Englewood Cliffs, NJ: Prentice-Hall, 1961), 7.

The planning involved in the location of schools and school district boundaries comprises numerous variables and considerations. School facility planning should include the entire community, considering both societal expectations and educational needs. The selection of appropriate factors will facilitate the determination of the optimal school sites for both the future students and the community the school serves. It is essential to have a knowledge of the distribution of students, the physical characteristics of the area and an understanding of future population growth. Long-range and concrete plans of potential action are the safest and the most economical as problems anticipated in advance can be met with well-planned solutions and actions.

Western Kalispell Narrative

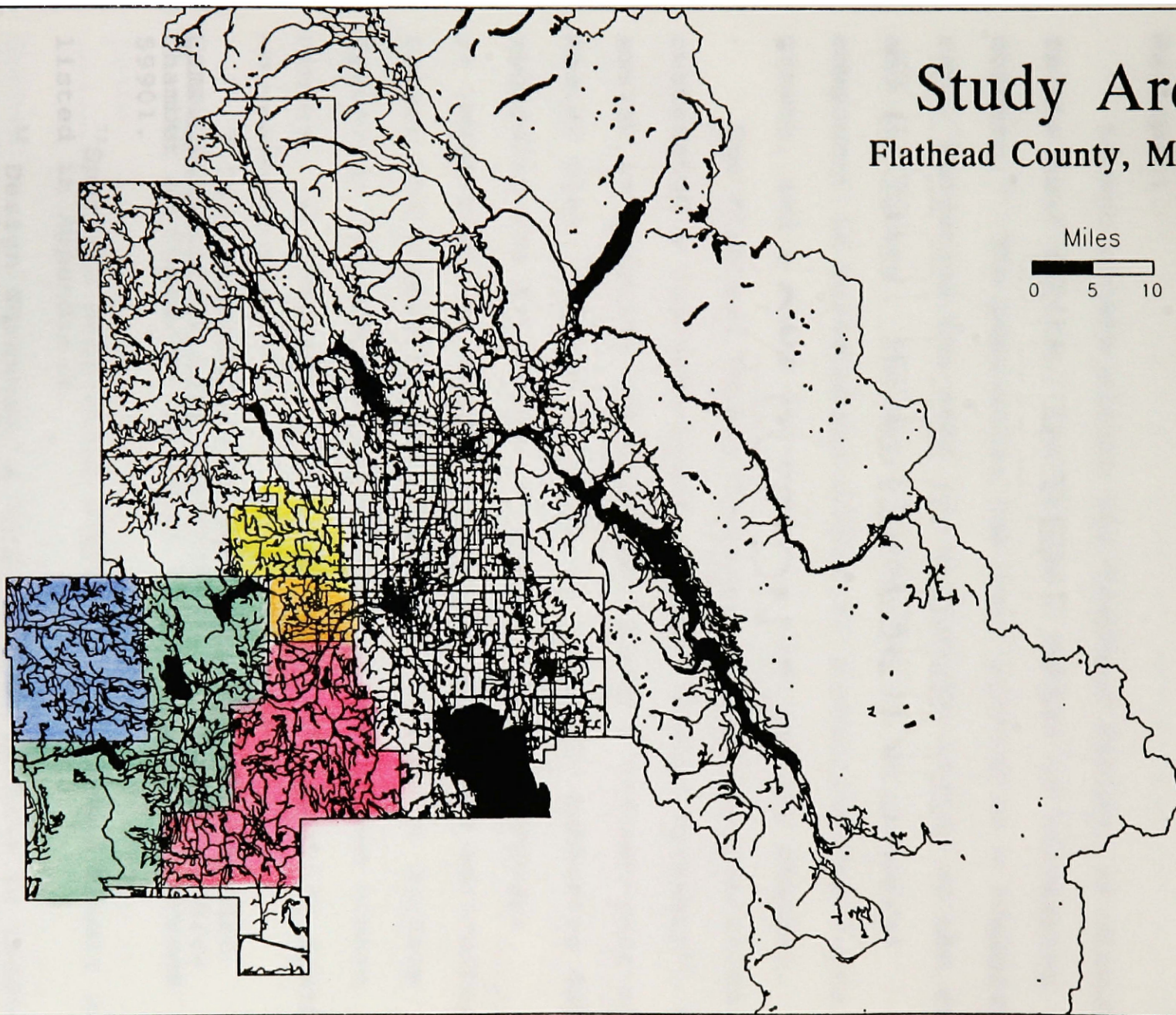
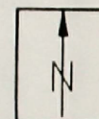
Kalispell, Montana is located in the Flathead Valley in the Rocky Mountains of northwest Montana. It is the county seat of Flathead County, as shown on Map 2, with 23,600 residents in the greater Kalispell area.⁹ The economy is based primarily on wood products (35.87%) and metal refining (21.17%), but the region has great attraction for visitors as non-resident travel provides 10.19% of the economic base. The remaining 19% is based on the railroad industry (7.63%),

⁹ The greater Kalispell area is defined by the Kalispell Chamber of Commerce as a 16 square mile planning area surrounding and including the 4 square miles of Kalispell.

Study Area

Flathead County, Montana

Miles
0 5 10



Map 2

miscellaneous manufacturing (7%), and agriculture (4.75%).¹⁰ Flathead Lake, Big Mountain Ski Area, and Glacier National Park are all located within a short distance of downtown Kalispell.

Recent growth within the Flathead Valley, as discussed in the next section, has become a matter of increasing concern.¹¹ The population has been growing at a tremendous rate, mandating the need for a thorough review of the area and its future. The use of planning is an essential component in structuring effective directions for rapid growth, and a means for assuring high quality changes.

The Flathead Valley Cooperative Planning Coalition has contracted a Colorado-based company, Design Workshop¹², to assist in updating the Flathead Valley's fifteen-year-old master plan. Design Workshop is currently gathering data regarding the following: 1) Topography; 2) Geology; 3) Vegetation; 4) Resource Mapping (including agriculture, timber and minerals, and visual resources); 5) Surface Hydrology (including wetlands, floodplains, and scenic rivers); 6) Community Infra-structure; 7) Wildlife Habitat;

¹⁰ This information is described in the pamphlet Community Profile 1991 produced by the Kalispell Area Chamber of Commerce, 15 Depot Loop, Kalispell, Montana 59901.

¹¹ Specific population figures for Flathead County are listed in Appendix A.

¹² Design Workshop, a company specializing in land-use planning, is based in Aspen, Colorado, with additional offices in Denver and Phoenix.

8) Land use, Transportation, and Housing; 9) Economics
10) Current Zoning and Subdivision Regulations; 11) Growth
Data 12) Citizen's Comments, and 13) Goals and Objectives.¹³
The data and analysis provided by Design Workshop will be
available to the public and includes basic information
necessary for important decisions regarding the future of
the Flathead Valley. Pertinent information concerning the
economics, growth, and physical characteristics of an area
can be directly applied by planners and school adminis-
trators to the selection of potential school sites.

Kalispell Area Schools

Kalispell schools are currently located within one
urban school district and eight rural school districts.
The urban district is comprised of five elementary schools
(grades kindergarten through sixth), one middle school
(grade seven only), one junior high school (grades eight
and nine), and one high school (grades ten to twelve).
There are additionally ten private schools in Flathead
County.

The area directly west of Kalispell is one of the
rapidly growing parts of the county and has attracted a
diverse population. The area has a reputation for lower
taxes, land values, and rental costs, consequently drawing

¹³ This listing constitutes the first step of Data
Gathering as indicated by Design Workshop in their planning
summary entitled the *Flathead Solution: Planning Our Future
Together*.

many young families and transient inhabitants. Discussions with rural school administrators in this region have indicated a need to review the current school district boundaries to accommodate the recent changes in population.

The possibility of adding a new middle school has become an issue of increasing concern to residents, both as to the location and the grades to be included. It is important to determine where current students live in relation to the present rural schools and their school district boundaries. These schools and their districts need to be analyzed to determine whether existing boundaries and facilities are appropriate or if new schools or district boundary changes would be more advantageous. In addition, studies of the region's population history and future population trends should be examined to determine their impact on this matter.

The Consolidation Debate

The issue of school consolidation is not specifically addressed within the objectives of this study, but a short discussion is included here as background to recognize the importance of the topic. The establishment and reorganization of school districts has been a critical subject of debate for the Montana legislature since 1899, not only because of financial considerations, but also as a result of the issue of local authority.

The number of school districts in Montana has varied from a high of 2439 in 1930 to the present total of 503, as indicated in a special report on Montana school districts by Ted Schwinden and Lynda Brannon of Project SEEDS. This study was designed to "develop reorganization alternatives and recommendations for their consideration and subsequent submission to the legislature".¹⁴ This in-depth 76-page study discusses the continuing importance of the issue, as reflected from a 1972 quote in a report from the Montana Business Quarterly; "School district reorganization is one of the singularly most important concerns confronting Montana education today".¹⁵ The hotly debated and emotionally charged topic continues to be of importance today. The researcher supports the recommendation in the study that "the impact of school reorganization on communities must be considered in any decision to substantially alter, or close, a local school".¹⁶

The issue of consolidation has recently been considered by administrators and school board members within the Flathead Valley. Although the issue is not included within

¹⁴Ted Schwinden and Lynda Brannon, "School Reorganization in Montana: A Time for Decision, a Report Prepared for the Montana School Board Association" (Project SEEDS, 1993), 5.

¹⁵Ibid., 11, citing State School Superintendent Dolores Colberg, "A Case for Changing School District Organization", Montana Business Quarterly, Summer, 1970, 8.

¹⁶Ibid., 43.

this study, the researcher considers locational studies to be an essential element in making effective decisions regarding consolidation. The understanding of student distributions and spatial relationships provides valuable and fundamental insights towards understanding complicated consolidation issues.

CHAPTER III

DATA ACQUISITION

The first step in the analysis of the study area was to examine the student enrollment history of the study schools, then construct a simple population projection of the region as a general backdrop against which to examine it. The next phase involved the determination of the exact location of the student's residences for each of the five study schools and the transformation of the data into a format suitable for the computer. The student's residence location distribution was examined in detail, followed by the measuring of road distances between each of the student's residence locations and the study schools. This chapter discusses each step of the data acquisition process.

Population Projection of Study Area

A population projection is an examination of future population levels and represents potential changes. A population projection differs from a population forecast in that a forecast involves a judgmental prediction of the future, while a projection is a hypothetical application based on the assumption that population trends will continue in basically the same manner.

The population projection technique of mathematical trend analysis estimates an unknown variable based on one or more related known variables. The specific technique

employed by the researcher used a regression analysis statistical function in Microsoft EXCEL for Windows,¹⁷ an electronic spreadsheet software,¹⁸ to examine future population possibilities for Flathead County. School enrollment totals for a twenty-four year period were manually entered into an EXCEL spreadsheet, then graphed to provide comprehension of the historical enrollment trend. The resulting graph is displayed in Figure 1.

The graph of the study schools indicates an enrollment increase for four of the five study schools, with the exception of Pleasant Valley School.¹⁹ West Valley School is the largest of the study schools and shows the greatest enrollment increase, with Kila School showing the second greatest growth. Smith Valley School has a greater enrollment than Kila School, but the overall growth is not as great. Marion School shows a varying enrollment rate, but the current enrollment trend is at a high level.

Flathead County population data for a twenty-two year period was then entered into an EXCEL spreadsheet, graphed, and projected with the software's exponential regression

¹⁷Microsoft EXCEL for Windows, Ver 4.0, (Seattle, WA: Microsoft Corporation).

¹⁸Microsoft EXCEL is an integrated software that combines three specific applications--spreadsheet, graphics and database, and is specifically designed for the analyzing and processing of numerical data.

¹⁹The specific enrollment totals for the study schools are provided in Appendix A.

Growth of Study Schools

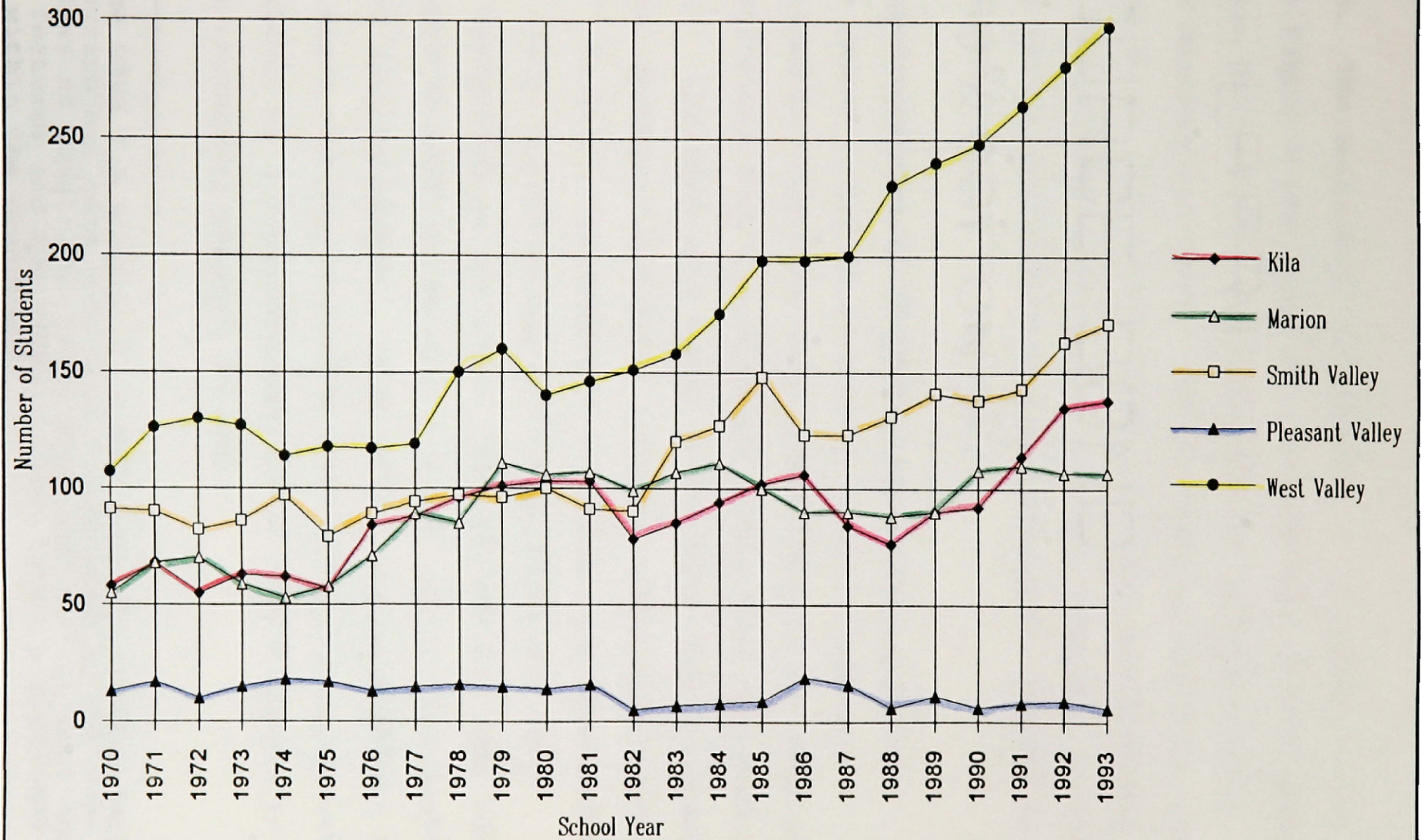


Figure 1

function. The population projection for Flathead County is shown in Figure 2 and shows an increased population growth curve that follows the census population totals closely along an exponential curve. The projected population growth will come as no surprise to those familiar with Flathead County, as indications of growth are very apparent in the Flathead Valley and have become an increasing concern to school administrators in the region.

Determination of Student's Residence Locations

The actual location of student's residences was accomplished by acquiring large-scale maps of the five rural school districts from the Flathead County Plat Division in Kalispell. The maps were based on the USGS (United States Geological Survey) 7.5 minute, 1:24,000 scale quadrangle series.²⁰ Accurate latitude and longitude reference points, current roads, subdivisions, and rural addresses were already designated on the maps. The appropriate maps were distributed to each of the five schools, along with eight different colored markers. Each school was responsible for marking where the students live, with different grade levels distinguished by a predetermined, color-coding system to maintain uniformity between schools.

²⁰The USGS 7.5 minute, 1:24,000 scale quadrangle series are topographical maps that span 7.5 minutes of latitude and 7.5 minutes of longitude. These maps include cultural and natural features and are usually named after a prominent feature within the quadrangle.

Projected Flathead County Population Growth

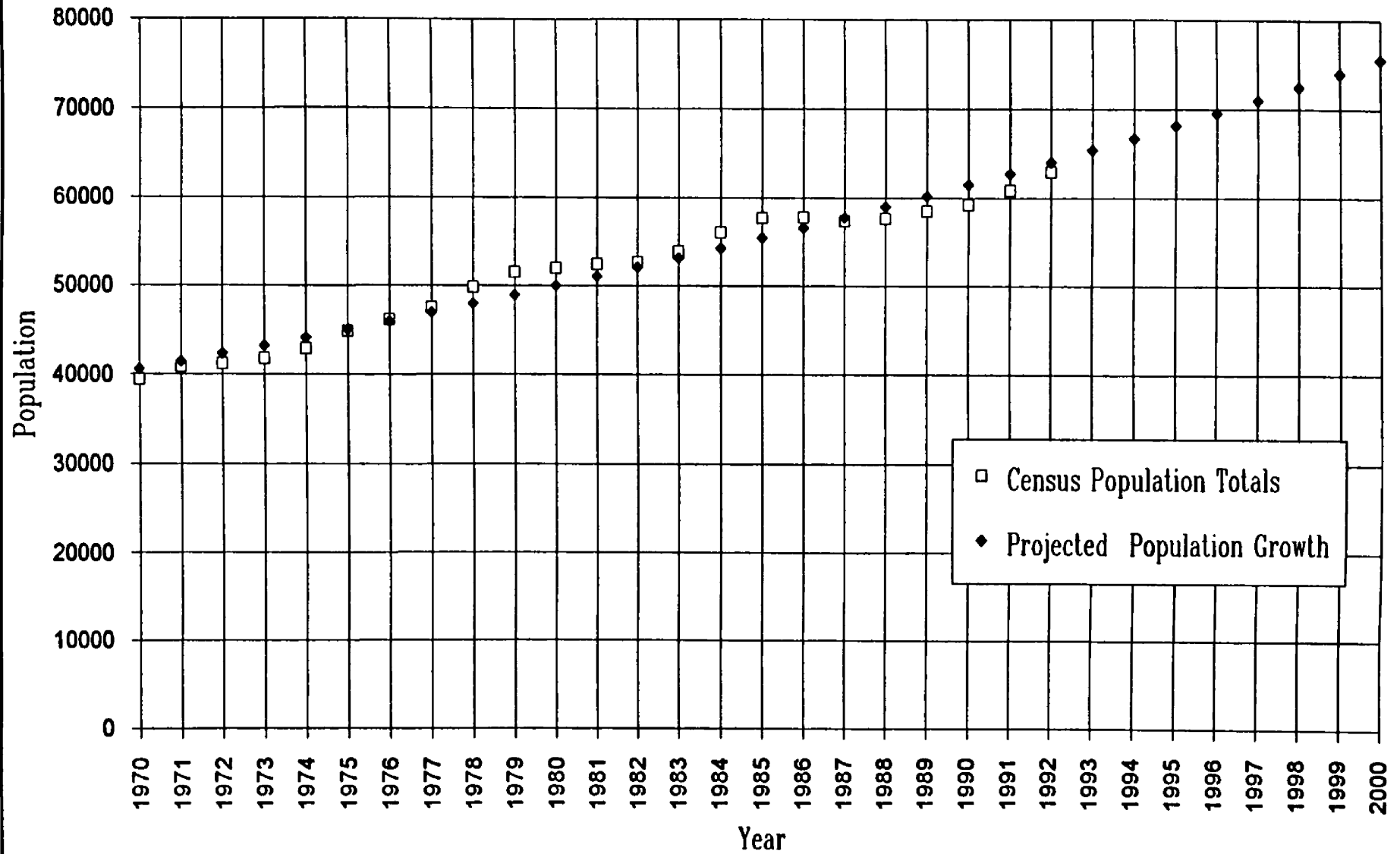


Figure 2

The completed maps were then assembled by the researcher. The total number of student residence points are recorded in Table 1.

Table 1.-- Total Number of Student's Residence Points in Study Area

Grade	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley	Total
K	17	-	12	12	23	2	66
1	12	-	15	9	34	1	71
2	22	-	15	10	33	1	81
3	20	-	11	17	31	1	80
4	14	-	21	11	27	0	73
5	16	-	15	8	36	0	75
6	-	22	12	11	37	0	82
7	-	13	19	15	30	0	77
8	-	23	16	11	36	0	86
T	101	58	136	104	287	5	691

Data Input Techniques

The next step was to transform the location of the student residence points marked on the maps into a form readable by the computer. Each point indicating a student's residence was transferred to the computer by means of the ROOTS²¹ digitizing program.²² The latitude and longitude

²¹ROOTS Program for Map Digitizing, Editing and Verifying, Ver. 1.0, created by Jonathan Corson-Rikert, Dennis White, Kelly Chan (Cambridge, MA: Harvard College).

²²A digitizing program utilizes a computerized table and pointing device to convert analog information into digital representations. Exact latitude and longitude coordinates for specified positions can be determined based

coordinates of the four corners of each map provided reference points for the ROOTS program to calculate the coordinates for each individual student's residence. The researcher assigned each student's residence a unique identifier to distinguish the exact longitude and latitude coordinates associated with the specific point. The composition of the unique identifier, designed to provide a means to verify data, was planned prior to digitizing and included the grade of the student as well as a number to reference the map from which the point was digitized. Residences containing more than one student were considered separate residences at the same location.

The resulting coordinate-referenced data was imported into ATLAS*GIS,²³ a geographical information system (GIS). Stan Aronoff describes a GIS as follows:

A GIS is a computer-based system that provides the following four sets of capabilities to handle georeferenced data: 1. input; 2. data management (data storage and retrieval); 3. manipulation and analysis; and 4. output.²⁴

Numerous systems of this type have been designed to display data in a thematic manner and to allow comparison between different variables. A GIS employs a method of layering

on their relationship to coordinate control points.

²³ATLAS*GIS, Ver 2.1, (San Jose, CA: Strategic Mapping, Inc.).

²⁴Stan Aronoff, Geographical Information Systems: A Management Perspective (Ottawa: WDL Publications, 1993), 39.

wherein each layer consists of different information. These layers can be overlaid and combined with each other, resulting in in-depth analysis capabilities and cartographic display. An essential concept of geographical information systems is topology. This is "the mathematical method used to define spatial relationships"²⁵ and is an explicit relationship between spatial data and its nonspatial characteristics. This relationship allows graphical map features to be linked with an attribute database.

ATLAS*GIS has the capability to utilize the U.S. Census Bureau TIGER (Topologically Integrated Geographic Encoding and Referencing) files. These files comprise a system of digital maps and geographic databases for the entire United States and were specifically designed to support the censuses and surveys of the Census Bureau. TIGER/Line files contain latitude and longitude coordinates for numerous geographic features within the file region, as well as an associated geographical data base. The database is topologically consistent with roads, highways, hydrological features, and political and statistical areas, and it allows

²⁵Ibid., 174.

for the inclusion of additional topologically integrated map features.²⁶

The data on the location of student's residences was merged with the TIGER/Line file in ATLAS*GIS. This allowed for the student's residence points to be displayed with the appropriate roads.

Description of Student's Residence Point Distributions

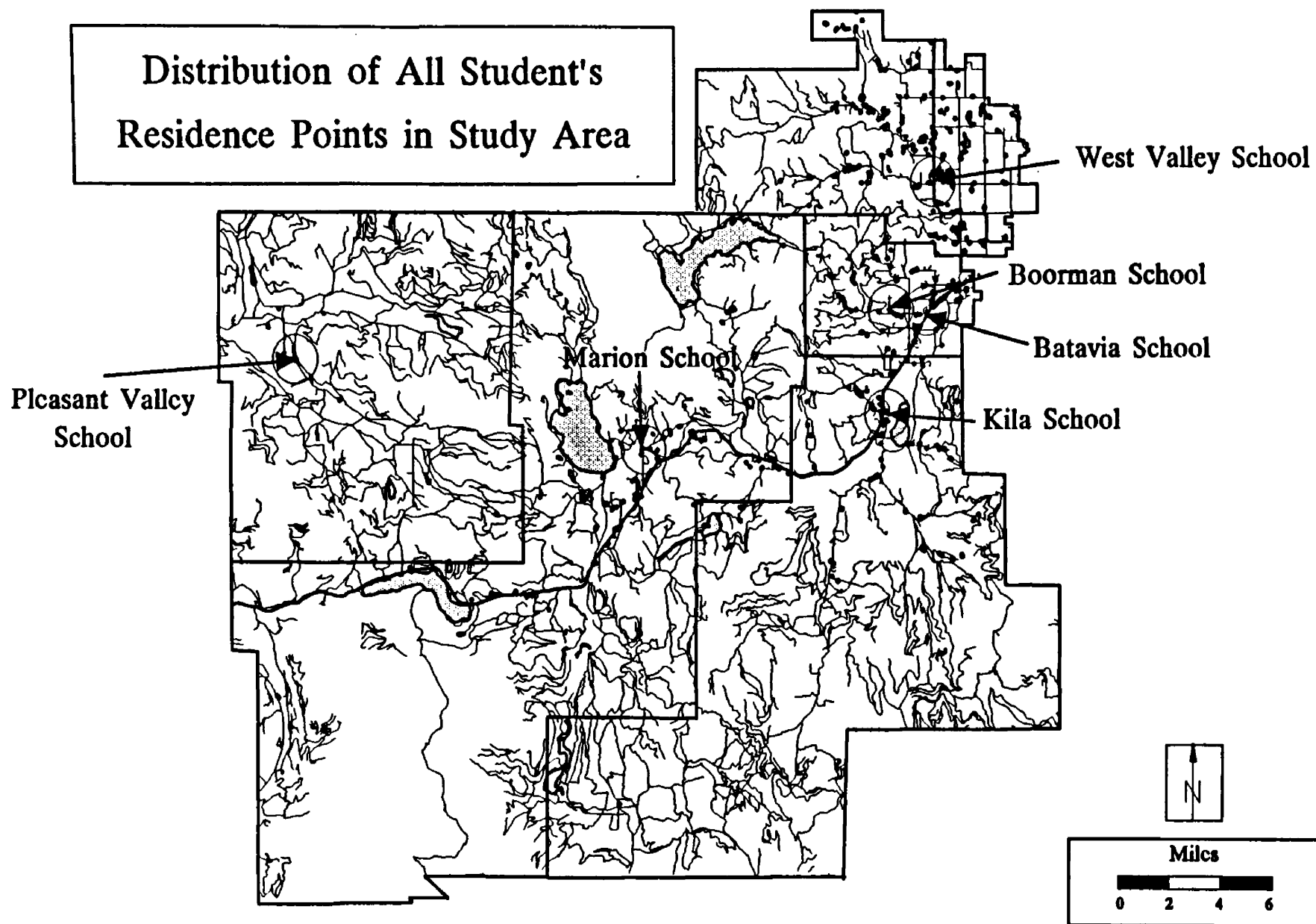
The entire distribution of student's residence points is shown in Map 3 (with no differentiation of grade levels) where linear patterns following main roads can be observed. Significant clusterings, isolated or out of district student's residence points are also worth noting and are discussed in the following paragraphs. Reference maps indicating significant road names are located in Appendix C.

The main clustering of student's residence points occurs in the West Valley District (the largest district in the study area), where the points form linear patterns along Farm-to-Market Road, McMannamy Draw, Rhodes Draw, Mountain Meadow Road, Pleasant Hill Drive, the Coclet Lane Area, and Bald Rock Road. Student's residence points in the West Valley District are shown on Map 4.

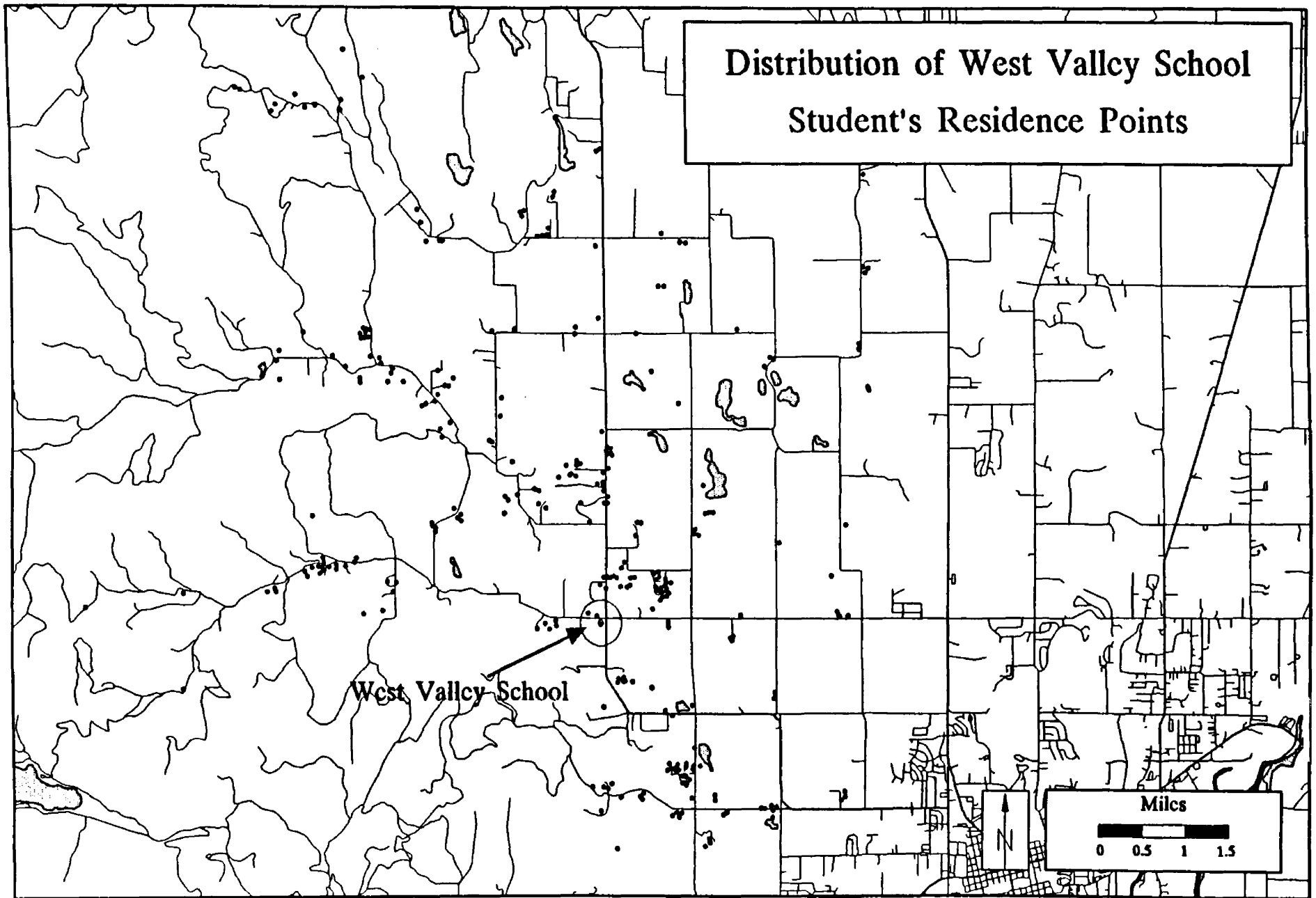
The distribution of student's residence points then extends down West Valley Drive to Highway 2 West into the

²⁶U.S. Department of Commerce, Bureau of the Census, TIGER: The Coast-to-Coast Digital Map Data Base, (Prepared within the Data User Services Division, November 1990), 5.

**Distribution of All Student's
Residence Points in Study Area**



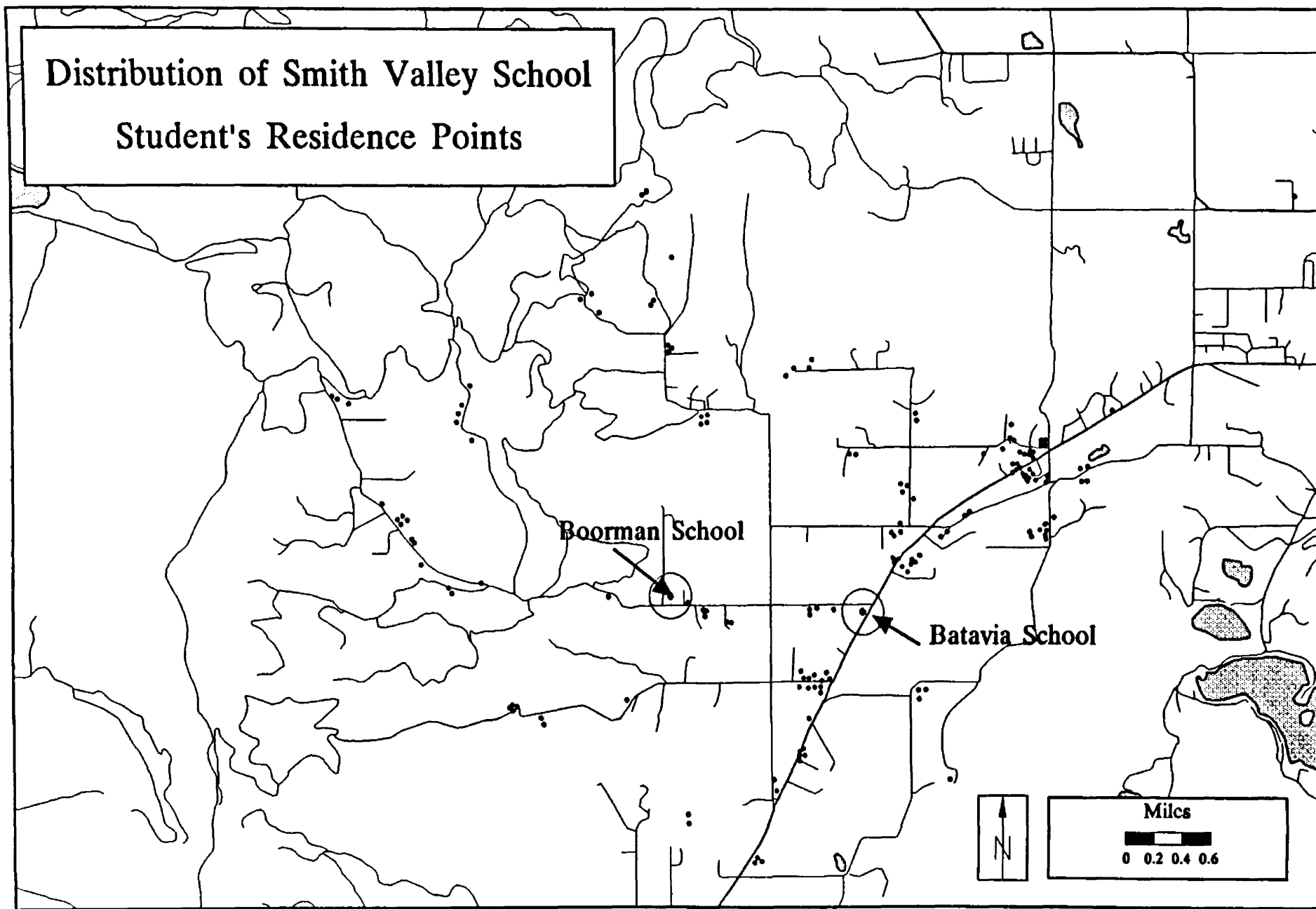
Map 3



Map 4

Smith Valley School District. Student's residence points are mainly in linear patterns along Highway 2 West and the adjoining roads--Morning View Drive, Whalebone Drive, Marquardt Lane, Batavia Lane, and Danielson Road. A number of student's residence points are also along Kienas Road, North Hill Road, and Sherman Road. Batavia Lane extends west in this area and turns into Ashley Lake Road, where there are additional student's residence points. It is interesting to note that a school district boundary line divides Ashley Lake Road--the eastern segment is included in the Smith Valley School District, while the western segment is in the Marion School District. There are student's residence points in the Smith Valley School distribution located on both segments of Ashley Lake Road. The Smith Valley School District's distribution of student's residence points is shown on Map 5.

Student's residence points continue along Highway 2 West into the Kila School District where they again form linear patterns. The main linear patterns are on Hoffman Draw, Dower Draw, and Spring Hill Road, while point clusters are observable on Truman Creek Road, Emmons Creek Road, Haywire Gulch, and Brown's Meadow Road. There is also a strong clustering on Kila Hill and Kila Road. Student's residence points continue along Highway 2 West where there are seven points outside of the Kila School District border. Rogers Lake Road is also bisected by a school district

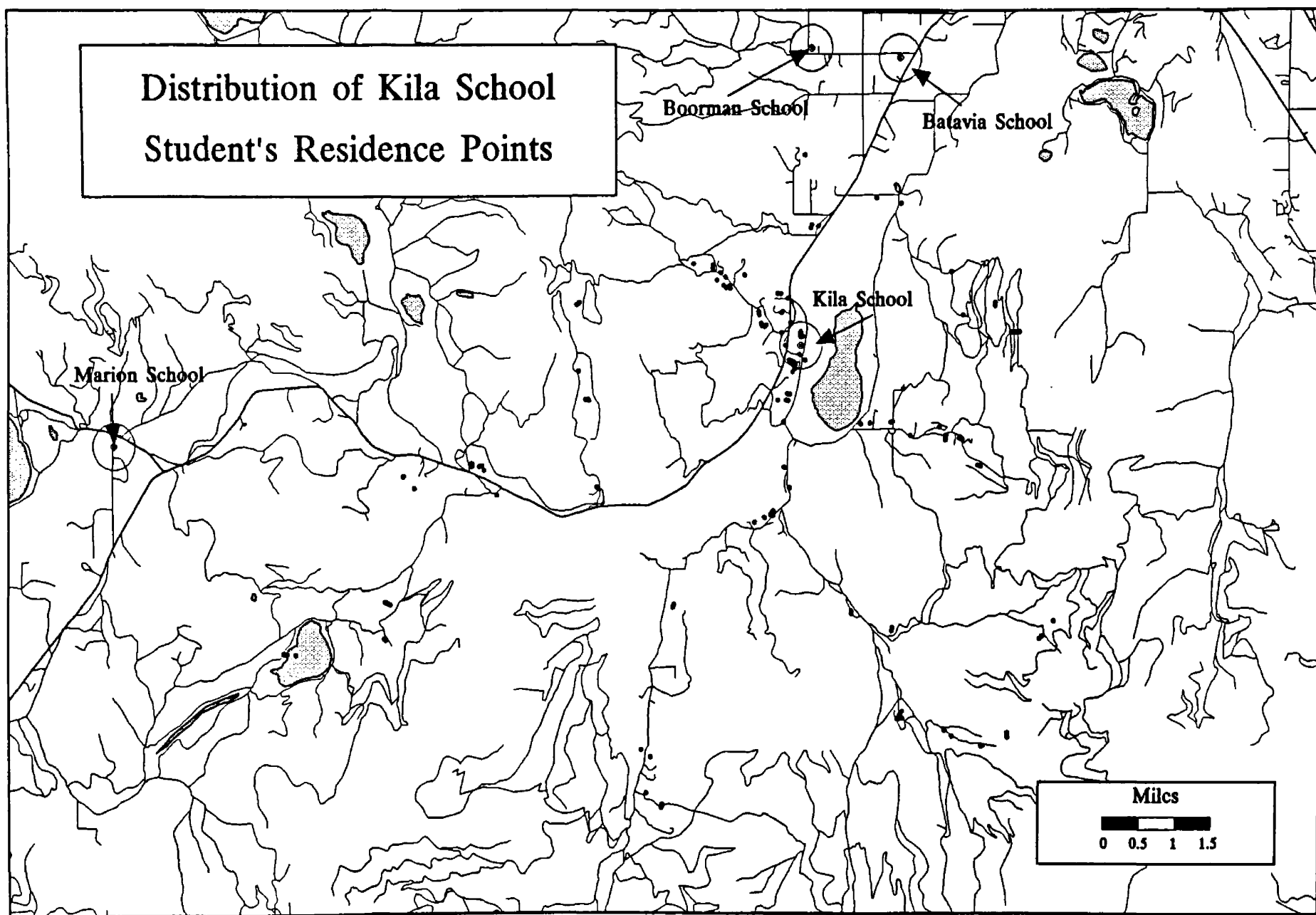


Map 5

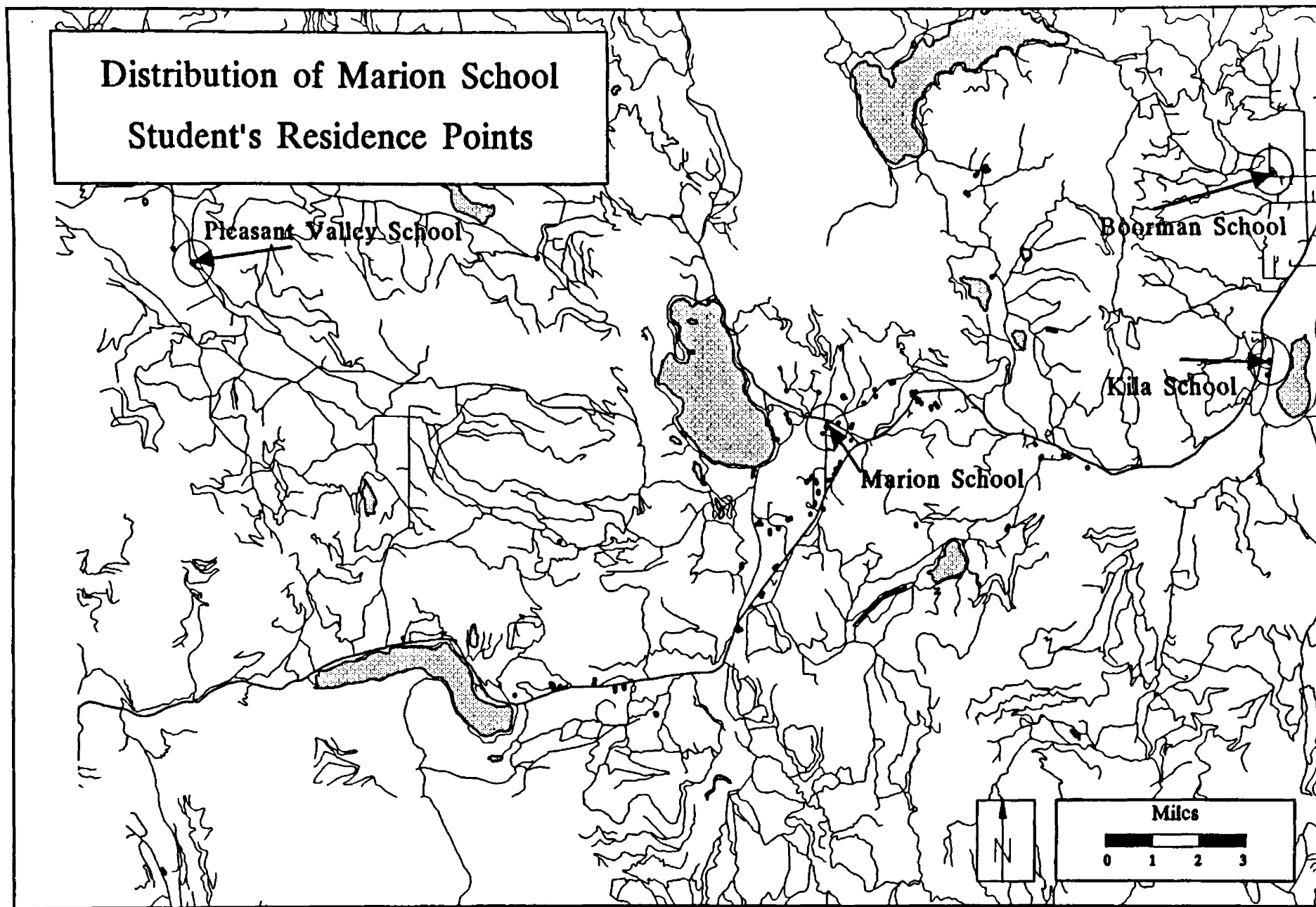
border--the southern segment is in the Kila School District (where there are seven student's residence points), while the northern segment is in the Marion School District. The distribution of student's residence points for Kila School District is indicated on Map 6.

The main linear pattern in the Marion School District follows along Highway 2 West as it continues from the Kila School District. There are also strong linear patterns in the Marion town area along Pleasant Valley Road, Idaho Hill Road, Bitterroot Drive, Wildebeest Lane, and the western segment of Ashley Lake Road. Two student's residence points are significantly isolated on Thompson River Road. Another student's residence point is on Hubbart Dam Road (in the Kila School District). There are three clusterings of student's residence points on Rogers Lake Road--two clusters within the Marion School District and one cluster in the Kila School District. Two student's residence points are within the Pleasant Valley School District. Map 7 shows the distribution of student's residence points in the Marion School District.

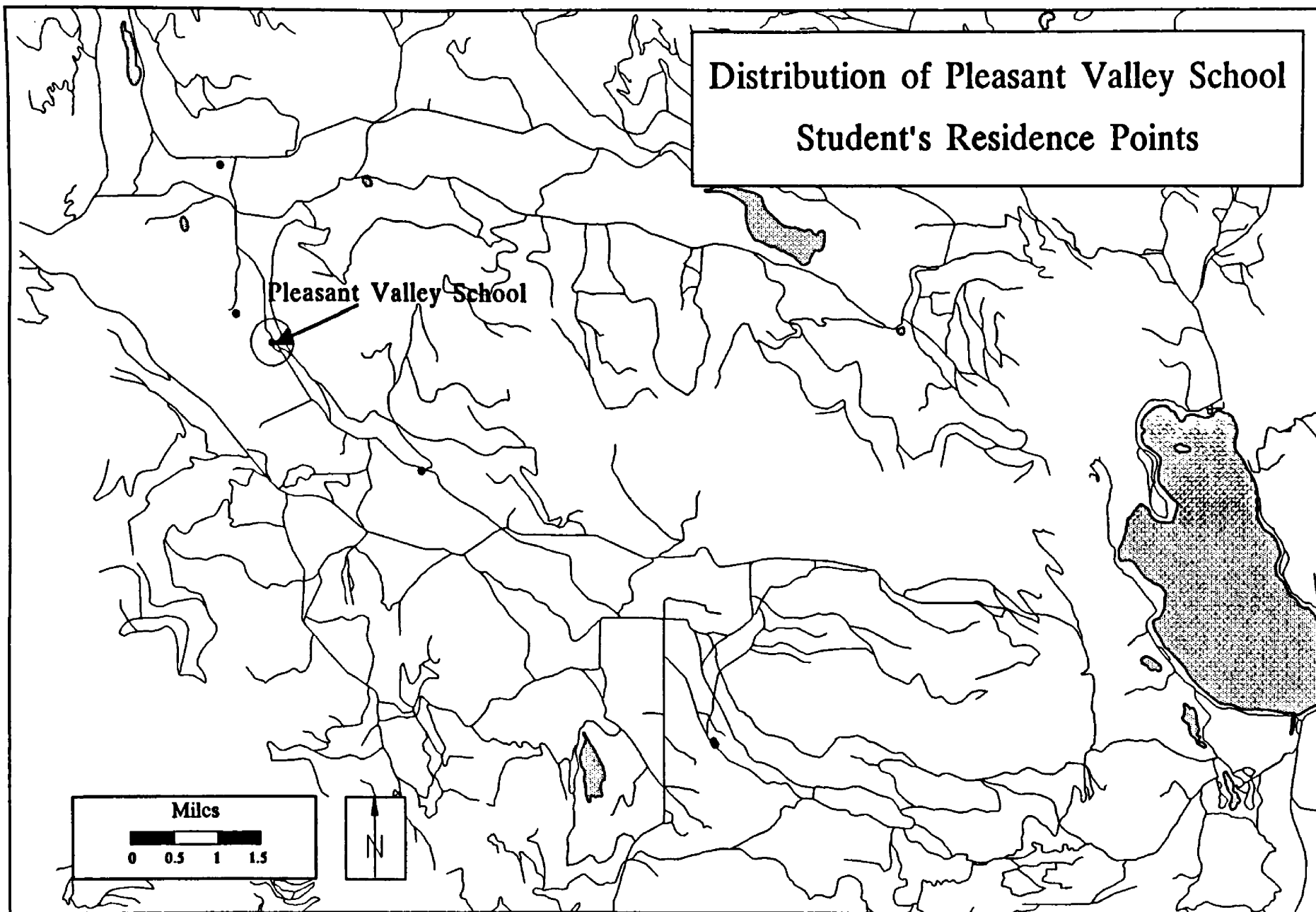
Finally, the distribution of the Pleasant Valley School student's residence points is indicated on Map 8. There are only five students considered within the study, all located along Lost Prairie Road and Island Lake Road.



Map 6



Map 7



Map 8

Construction of Measured Road Distance Database

The actual road distance of each student's residence point to each of the six school sites was measured by an analyzer tool within ATLAS*GIS. Every attempt was made by the researcher to achieve the best balance between the closest route, the best-maintained route, and the most commonly used route. This decision was based in part on road information acquired from the reference maps and part on the researcher's personal knowledge of the area. Specific distances were recorded in the ATLAS*GIS database for further reference.

The database created in ATLAS*GIS was exported to EXCEL, which was used as an external database management system and expanded the database analysis capabilities of ATLAS*GIS. The database included individual school data files, as well as a master file consisting of all student's residence point data. The master database file allowed the simultaneous comparison of all student's residence point locations, while individual school database files permitted analysis within the school district itself. Statistical analysis and data manipulations performed in EXCEL were then imported back into ATLAS*GIS, with each point's unique topology still protected.

CHAPTER IV

SPATIAL ANALYSIS OF STUDENT DISTRIBUTION

The next step in the examination of the student population distribution was the analysis of the computer-measured road distances from the 691 student's residence points to each of the six school sites in the study area. Two ranking procedures were used to analyze the distribution of the student's residence points in relation to the schools--first, the ranking of distances from all of the student's residence point locations to each of the six school sites (one school at a time) and second, the ranking of the distance from the study schools to each of the student's residence points (one student at a time). The results of the two ranking systems will be compared in Chapter V to provide an understanding of the distribution of the student's residence points, and specifically show how they relate to the present and future location of schools and school district boundaries.

This chapter will provide an in-depth explanation of the two ranking procedures as well as a procedure for determining the maximum student quota for enrollment (MSQ). Both ranking procedures will be used to create map polygons from the student's residence points and will be accompanied by corresponding maps and detailed descriptions. The second ranking procedure will additionally involve the creation of isoline maps and ranked numerical summaries.

Ranking of Student's Residence Point Locations

This procedure ranked the distances from the student's residence points to each of the six school sites. First, the computer-measured road distances from each student's residence point to Batavia School were placed in ascending order. Each student's residence point was assigned a unique number from 1 to 691 that directly reflected the rank of the distance from the student's residence point to Batavia School. This resulted in the closest student's residence point being assigned the rank of 1 and the farthest student's residence point being assigned the rank of 691. The same procedure was followed to assign unique numbers reflecting the rank of each student's residence point to Boorman School, Kila School, Marion School, West Valley School, and Pleasant Valley School. The final result was each student's residence point held a unique numerical rank between 1 and 691 for each of the six school sites.²⁷

Maximum Student Quotas. The calculation of the maximum student quota (MSQ) of enrollment for each school was the next step necessary in the analysis of the student's

²⁷An example of this ranking is provided for a specific student's residence point in the Smith Valley School District. The point holds a rank of 1 for Batavia School, meaning it is the closest student's residence point to the school. The point also holds a rank of 11 for Boorman School, indicating it is the eleventh closest point to Boorman School. The remaining ranks are as follows: Kila School rank- 107; Marion School rank- 236; West Valley School rank- 344; Pleasant Valley School rank- 243.

residence points. The calculation was based in part on the Montana school accreditation standards and part on recent school enrollment figures. The Montana school accreditation standards set the following restrictions on elementary classroom sizes:

RULE 10.55.712 CLASS SIZE: ELEMENTARY

- (1) In single-grade rooms the maximum size shall be:
 - (a) No more than 20 students in kindergarten and grades 1 through 2;
 - (b) No more than 28 students in grades 3 and 4;
 - (c) No more than 30 students in grades 5 through 8.
- (2) In multigrade classrooms, the maximum size shall be:
 - (a) No more than 20 students in grades K, 1, 2, and 3;
 - (b) No more than 24 students in 4, 5, and 6;
 - (c) No more than 26 students in grades 7 and 8.
- (3) Multigrade classrooms that cross grade-level boundaries (e.g., 3-4, 6-7) shall use the maximum of the lower grade.
- (4) In one-teacher schools, the maximum class size shall be 18 students.²⁸

Marion School, Smith Valley School, and West Valley School budget seventh and eighth grades based on high school accreditation standards (Kila School is in the process of requesting approval to use the same standards). High school accreditation standards have the following enrollment restriction: "Individual class size shall not exceed 30 students."²⁹

²⁸Montana Accreditation and Procedures Manual, (Board of Public Education, Helena, MT, July 1992), 9.

²⁹Ibid., 24.

The figures determined from the Montana accreditation standards were averaged with school enrollment totals for the last four years. The resulting figures were then rounded slightly higher or lower for convenience and are shown in Table 2. The figures are for comparison purposes within this study only and are not intended to reflect official limits.

Table 2: Maximum Student Quota Totals

School	Kila	Marion	Pleasant Valley	Smith Valley	West Valley
MSQ	120	110	24	165	285

Construction of Maximum Student Quota Areas (MSOA). The next step was to determine which student's residence points should be included within the MSQ for each school. For the purposes of this study, the researcher selected the nearest student's residence points to each school until the calculated MSQ (Table 2) for the school was reached.³⁰ This procedure was completed independently for each of the five study schools, thus allowing for some student's residence points to be included within the MSQ for more than one school.³¹

³⁰The researcher chose to use the nearest students in order to best evaluate the district boundaries. The closer the students are to the school, the less money is required for transportation of students and the more optimal the school site.

The student's residence points assigned to each school were displayed in ATLAS*GIS. Lines were drawn between the student's residence points on the outside edges of the point distribution to form closed map polygons. These map polygons, shown in Map 9, will subsequently be referred to in this study as maximum student quota areas (MSQA). The map polygons created for each of the five study schools are discussed in-depth in the next section.

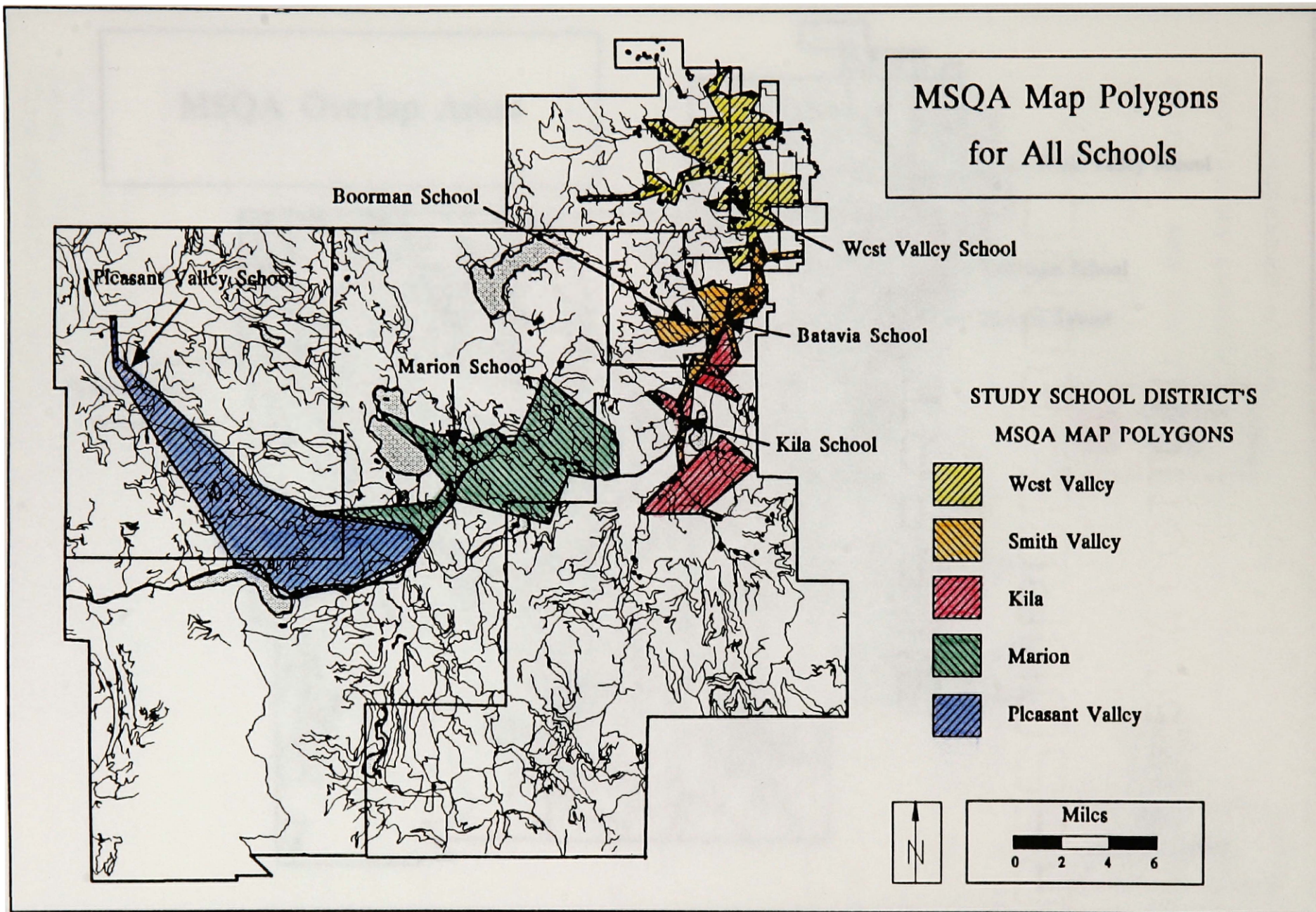
The MSQA map polygons created for each of the schools were combined to determine overlap areas.³² Overlap areas are a result of student's residence points being assigned to more than one school and are shown in Map 10. These areas require further evaluation, as they could indicate inefficient district boundaries or schools that are located too close together.

Student's residence points not included within an MSQA were designated as detached student's residence points and

³¹An example of this is the student's residence point cited in footnote 27, a point within the Smith Valley School District. The point's rank of 1 includes it with the 165 points assigned to Smith Valley School (MSQ of 165). However, the point's rank of 107 in relation to Kila School also allows it to be within Kila School's MSQ of 120.

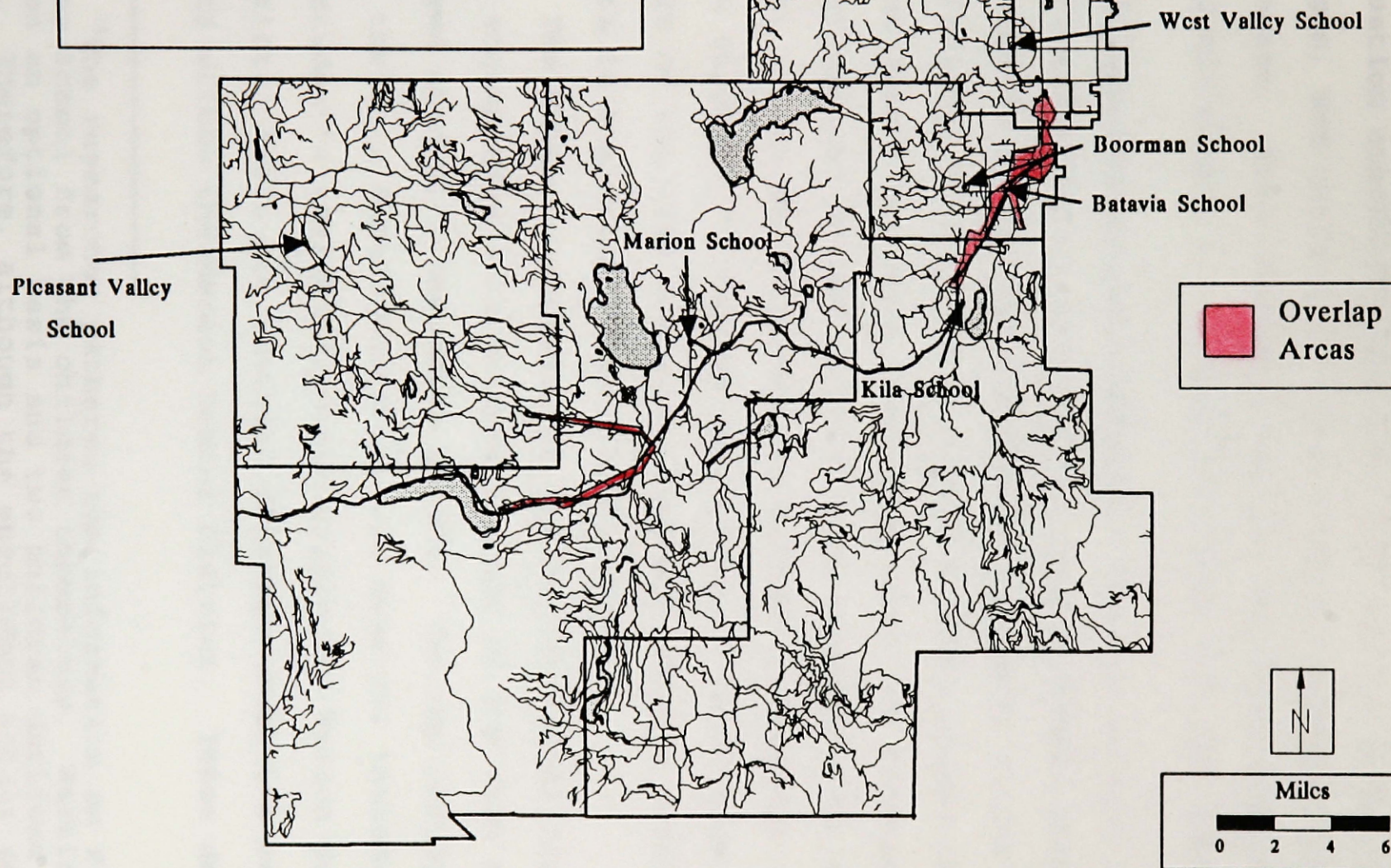
The areas where points are assigned to more than one school will be specifically discussed later in this chapter.

³²The combining of map polygons is accomplished by an overlay operation. This allows the intersection of two map polygons to be mathematically calculated.



Map 9

MSQA Overlap Areas



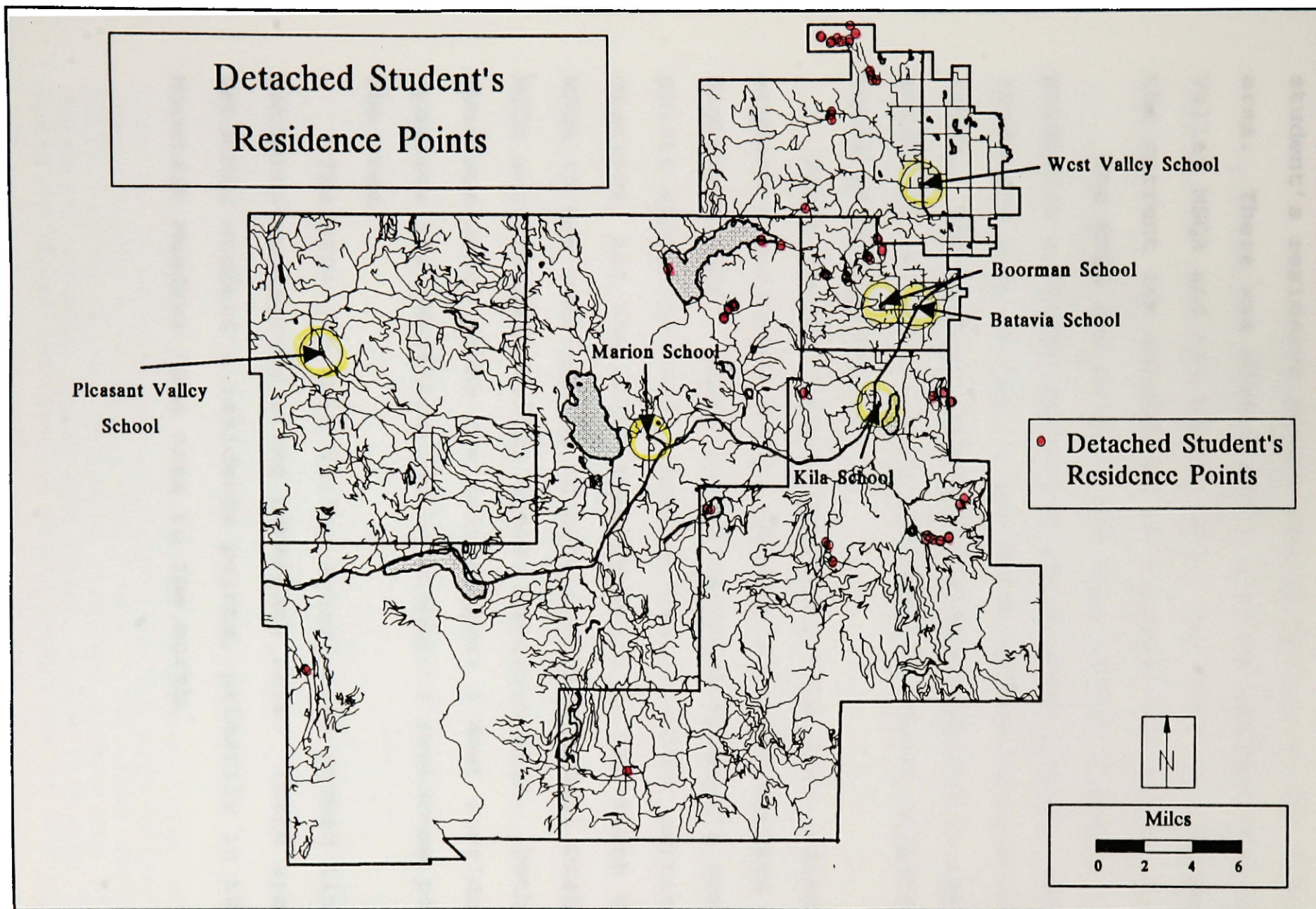
Map 10

are indicated on Map 11. These points also need further evaluation concerning why they were not included within a polygon, and could be an indication of schools located too far apart. Both overlap areas and detached student's residence points are discussed within the next section.

Map 9 MSQA Polygon Descriptions. The map polygon formed by the Pleasant Valley MSQA started with a linear pattern that encompassed the current student's residence points within the Pleasant Valley School District, then spread east to the Marion School District. The MSQA limit for Pleasant Valley School was set at the maximum level allowable for a one-room school, which far exceeded the current attendance level of seven students.³³ The map polygon has a large area as a result of the wide distance between student's residence points in the western part of the county.

The MSQA map polygon for the Marion School District also encompasses a large area because of the wide distance between student's residence points. The map polygon extends into the Kila School District, but does not include all of the student's residence points within the Marion School District. There are fourteen detached student's residence points within the Marion School District. These detached

³³The researcher gathered the information on Pleasant Valley School from the children themselves. Participation was on an optional basis and two children declined to take part. Therefore, although the enrollment totals seven, only five student's residence points are shown.



Map 11

student's residence points are primarily in the Ashley Lake area. There was also a small overlap between the Pleasant Valley MSQA and the Marion MSQA, but this is only because of the current low enrollment at Pleasant Valley School.

The MSQA map polygon for Kila School District reflects primarily a linear pattern along Highway 2 West, but also shows the many student's residence points located on rural roads. The largest number of detached student's residence points in one district is in the Kila School District--a total of 35 points.

Smith Valley School District's MSQA also reflects many student's residence points forming a linear pattern along Highway 2 West. There are 14 detached student's residence points along the rural roads in the northwest portion of the district, but the major consideration in the Smith Valley MSQA is the overlapping of both the Kila School District MSQA and the West Valley School District MSQA. Both overlaps occur along the main Highway 2 West corridor and indicate the concentration of student's residence points in the area.

The MSQA for West Valley School also showed linear patterns--primarily along McMannamy Draw. There are 23 detached student's residence points, primarily in the Mountain Meadows Road area to the north.

Ranking of the Study Schools

The second ranking procedure ranked the five study schools in relation to the student's residence points, a reversal of the first ranking procedure. The five study schools were placed in ascending order in relation to each student's residence point based on their measured road distance to that point.

A weighted ranking system was devised that assigned a weighted rank of one to the closest school to each student's residence point and ranged to the furthestmost school receiving a weighted rank of five.³⁴ The procedure was weighted to allow a numerical weighted rank total to be made for each school, which subsequently could be compared with the weighted rank totals for the other study schools. The weighted rank totals indicate the importance of each school location--the lower the weighted rank total, the more central the school location.³⁵ The weighted rank totals

³⁴The student's residence point referred to in the previous examples is closest to Smith Valley School, resulting in Smith Valley School being assigned a weighted rank of one. Kila School was the second closest school to the student's residence point and was assigned a weighted rank of two. West Valley School was the third closest school and was assigned a weighted rank of three. Marion School was the fourth closest school and was assigned a weighted rank of four. Finally, Pleasant Valley School was the farthest school with an assigned weighted rank of five.

³⁵ Pleasant Valley School has a ranked total of 3,354 when all student's residence points are considered, while Smith Valley School only has 1,329. The lower score of Smith Valley School reflects a larger proportion of lower weighted rankings (ones and twos), while Pleasant Valley School's total reflects a high proportion of the weighted

and averages for all schools are shown in Table 3. As mentioned earlier in this study³⁶, the researcher has opted to provide results for certain techniques without the impact of West Valley School. The weighted rank totals and averages without West Valley School are shown in Table 4.

Table 3.-- Weighted Ranking Totals

	Smith Valley	Kila	Marion	West Valley	Pleasant Valley
Sum	1329.00	1619.00	2396.00	1635.00	3354.00
Average	2.01	2.34	3.47	2.37	4.85

Table 4.--Weighted Rank Totals without West Valley School

	Smith Valley	Kila	Marion	Pleasant Valley
Sum	795.00	705.00	979.00	1561.00
Average	1.97	1.75	2.42	3.86

Isoline Maps of Weighted Ranking Results. Isoline maps with intervals of one were created to illustrate the weighted rankings assigned to the five study schools. This was accomplished by the following process: the student's residence points for which a weighted rank of one was assigned to Smith Valley School were displayed in ATLAS*GIS

rank of five. Many more student's residence points are closer to Smith Valley School than to Pleasant Valley School, thus indicating the central location of the Smith Valley School site.

³⁶Please refer to the bottom of page 6.

and an isoline was drawn around them. The student's residence points for which a weighted rank of two was assigned to Smith Valley School were then displayed and another isoline drawn around these points. This process was continued until isolines reflecting the weighted rankings assigned to Smith Valley School for all points were drawn. The isolines were then adjusted to reflect the interpolated position between each weighted rank value. The entire procedure was subsequently completed for Kila School, Marion School, West Valley School, and Pleasant Valley School.

The isoline maps graphically represent the relation of the student's residence points to each of the study schools and are labeled with the corresponding weighted rank. A line labeled with a '1' indicates the school has been assigned the weighted rank of one for all of the student's residence points between the isoline and the school. These student's residence points are closer to that school than any other. An isoline labeled with a '2' indicates the school has been assigned the weighted rank of 2 for all of the student's residence points between that isoline and the isoline labeled '1'. The school, therefore, is the second closest school to the student's residents points in this area. The school holds the rank of third closest school for all of the student's residence points between the isolines labeled with a '3' and '2' and is the fourth closest school (or second farthest) for all of the student's residence

points between the isolines labeled '3' and '4'. The school has been ranked the farthest for the student's residence points between the isoline labeled '4' and the edge of the map. Isoline maps with the absence of isolines for '4' and '5' weighted rankings indicates these rankings are not applicable for the school.³⁷

The higher the total number of student's residence points that are within the isolines reflecting the weighted ranks of one and two, the greater the convenience of the school site for a potential middle school. Schools assigned a large number of high value weighted rankings (fours or fives) indicate the remoteness of the school site. A numerical summary of the weighted rankings for each school is provided in Table 5 to assist with isoline map interpretation.³⁸ Although isoline maps that exclude West

³⁷The absence of the isoline for '4' weighted rankings indicates the school was assigned the weighted rankings 1-3 only. The school has not been ranked as the farthest or second farthest school for any of the student's residence points.

The absence of '5' weighted rankings means the school was only assigned the weighted rankings for 1-4 only. The school has not been ranked as the farthest school for any of the student's residence points.

³⁸An example of the use of Table 5 is as follows: Smith Valley School was assigned the weighted rank of five for 173 student's residence points, a weighted rank of four for 391 student's residence points, a weighted rank of three for 101 student's residence points and a weighted rank of two for 26 student's residence points. Smith Valley School was not ranked as the farthest school for any of the student's residence points, so the weighted rank of 1 was not assigned.

Valley School were not created,³⁹ Table 6 provides a numeric summary of the weighted ranking of the study schools without West Valley student's residence points. Detailed descriptions of the isoline maps for each school are provided in the following paragraphs.

Table 5:--Numerical Summary of Weighted Rankings

	Closest				Farthest
School	Rank = 1	Rank = 2	Rank = 3	Rank = 4	Rank = 5
Smith Valley	173	391	101	26	0
Kila	123	208	359	0	0
Marion	106	21	10	555	0
West Valley	280	60	215	90	46
Pleasant Valley	9	11	6	20	645

Table 6:--Numerical Summary of Weighted Rankings without West Valley School

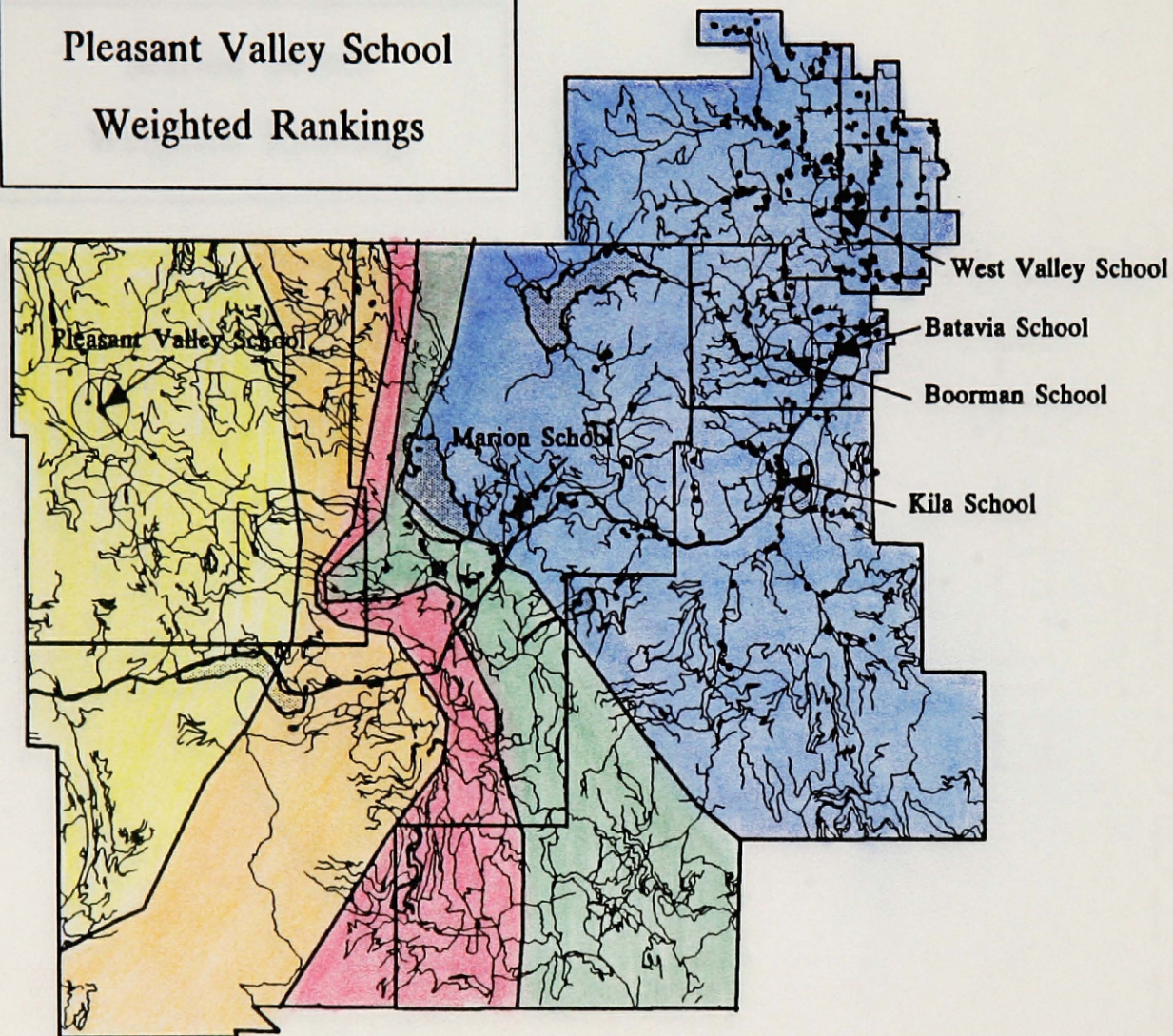
	Closest			Farthest
School	Rank = 1	Rank = 2	Rank = 3	Rank = 4
Smith Valley	165	112	101	26
Kila	123	261	20	0
Marion	106	21	277	0
Pleasant Valley	9	11	6	378

³⁹Please refer to page 6 for the reasons to provide additional analysis results that exclude West Valley School.

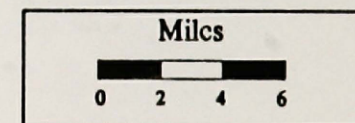
The weighted rank isolines for Pleasant Valley School are shown in Map 12. Pleasant Valley School was assigned the most high-value weighted rankings of all the study schools (Pleasant Valley was assigned a weighted rank of five for 645 student's residence points). This supports the expected result that the Pleasant Valley School site is too isolated for serious consideration in the middle school issue. Pleasant Valley School serves its intended purpose, however, in providing a school for students living in remote areas in the western part of Flathead County.

Marion School's weighted rank isolines are shown on Map 13. Marion School was not ranked as the farthest school for any of the student's residence points, but was the second farthest school for 555 of the student's residence points. The Ashley Lake region is unique in the study area as Ashley Lake Road spans both Marion and Smith Valley school districts. The student's residence points on the eastern edge of Ashley Lake are closer to Smith Valley School, while the student's residence points on the western edge are closer to Marion School. The student's residence points on Rogers Lake Road are almost equal distance between Marion School and Kila School, resulting in the close proximity of the isolines representing the closest and second closest school weighted rankings ('1' and '2'). Marion School was not assigned many third closest school weighted rankings

Pleasant Valley School Weighted Rankings

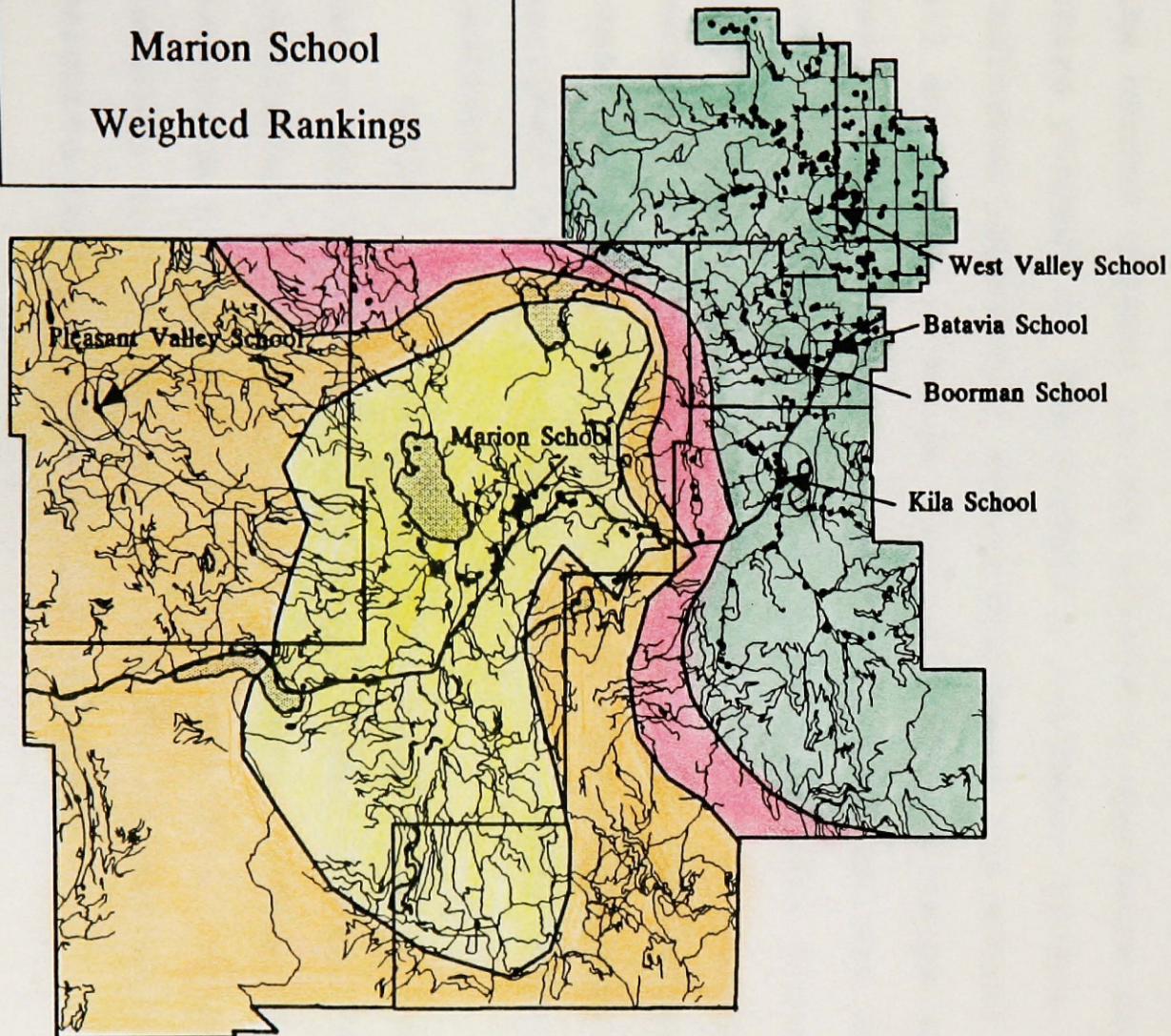


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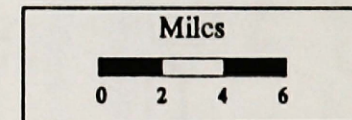
Map 12

Marion School Weighted Rankings



LEGEND

- Weighted Rank = 1
- Weighted Rank = 2
- Weighted Rank = 3
- Weighted Rank = 4



Map 13

(10 student's residence points) or second closest school weighted rankings (21 student's residence points).

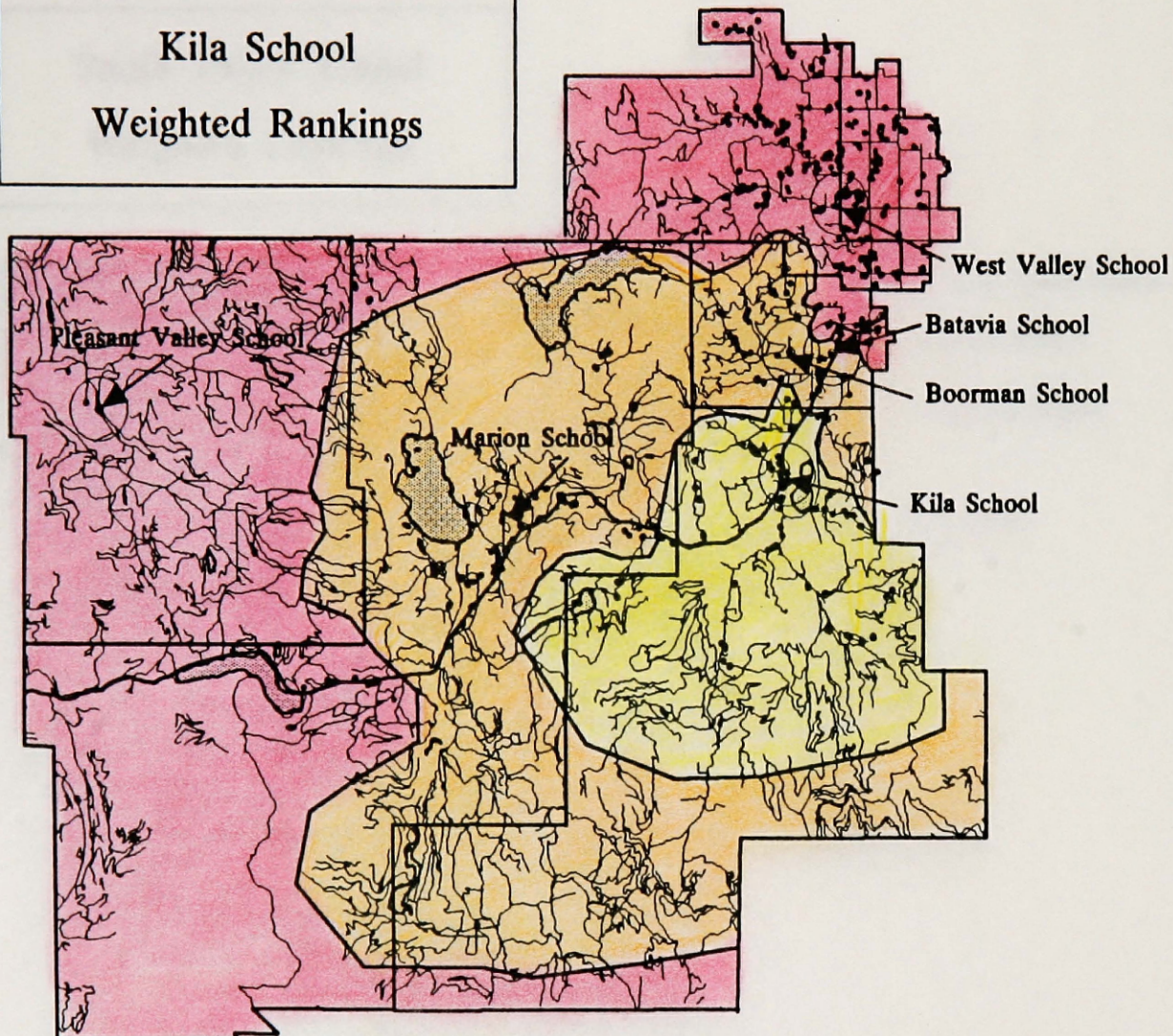
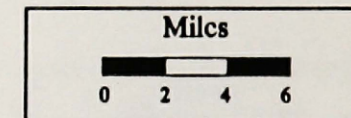
Weighted rank isolines for Kila School, as indicated on Map 14, reflect its central position in relation to the study's student population. Kila School was assigned one of the three highest weighted ranks (one, two or three) for all student's residence points; specifically, it is the closest school to 123 student's residence points, the second closest to 208 student's residence points and third closest to 359 student's residence points. This indicates reasonable accessibility of the school site for all students, although there are still a large number of West Valley students for which Kila School was assigned only the third closest rank. The numeric results without West Valley School (as shown in Table 6) show that Kila School received more assignments in the first two categories combined than Smith Valley School (although Smith Valley was assigned the most number of closest-school weighted rankings).

Smith Valley School has the most central location when the student's residence points for all schools are considered, as it received the highest number of student's residence points for the closest and second closest weighted rankings (173 points and 391 points respectively). School weighted rank isolines are shown on Map 15.

Kila School Weighted Rankings

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- Weighted Rank = 1
- Weighted Rank = 2
- Weighted Rank = 3

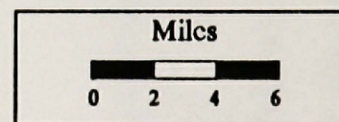
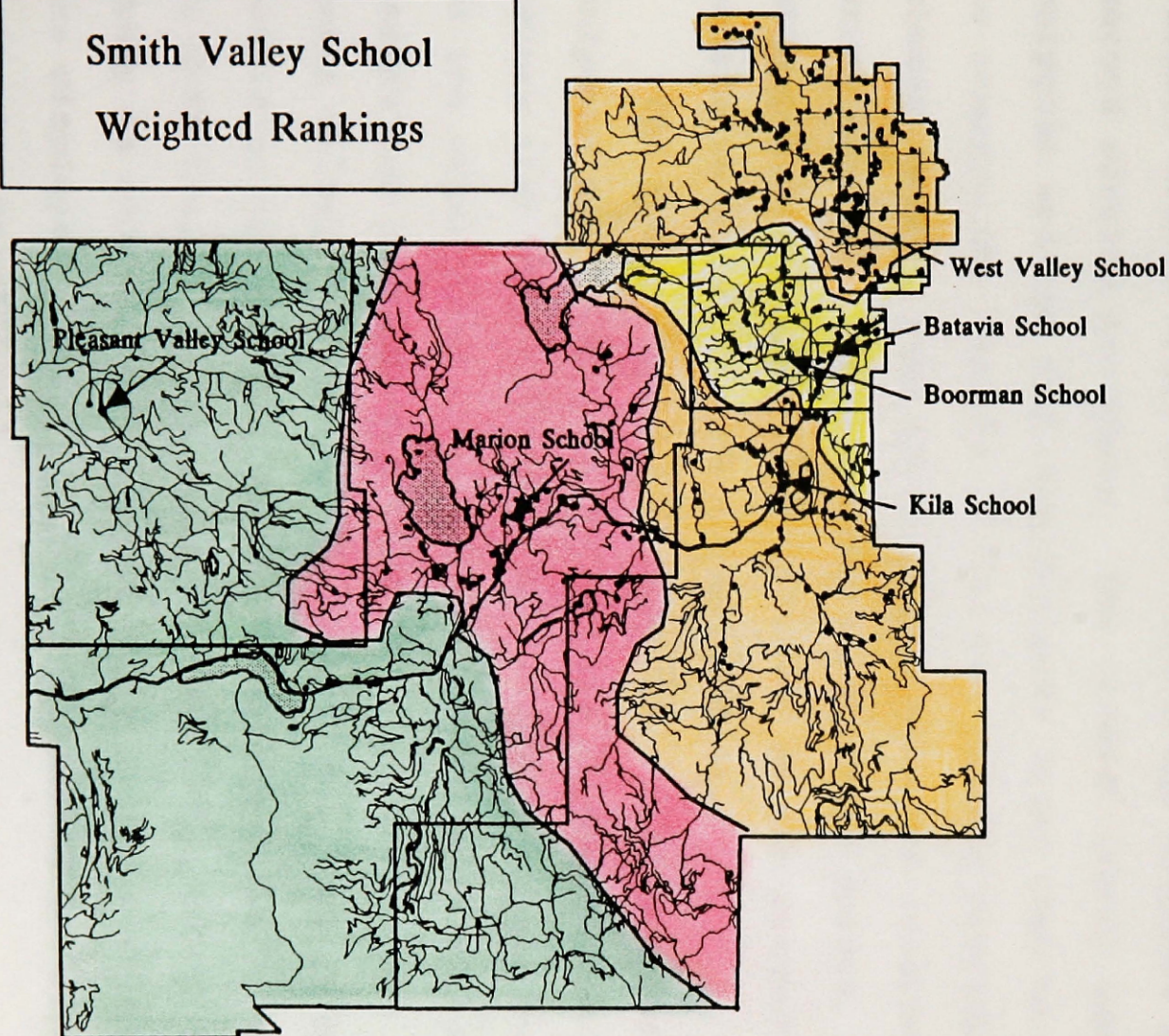


Map 14

Smith Valley School Weighted Rankings

LEGEND

- Weighted Rank = 1
- Weighted Rank = 2
- Weighted Rank = 3
- Weighted Rank = 4



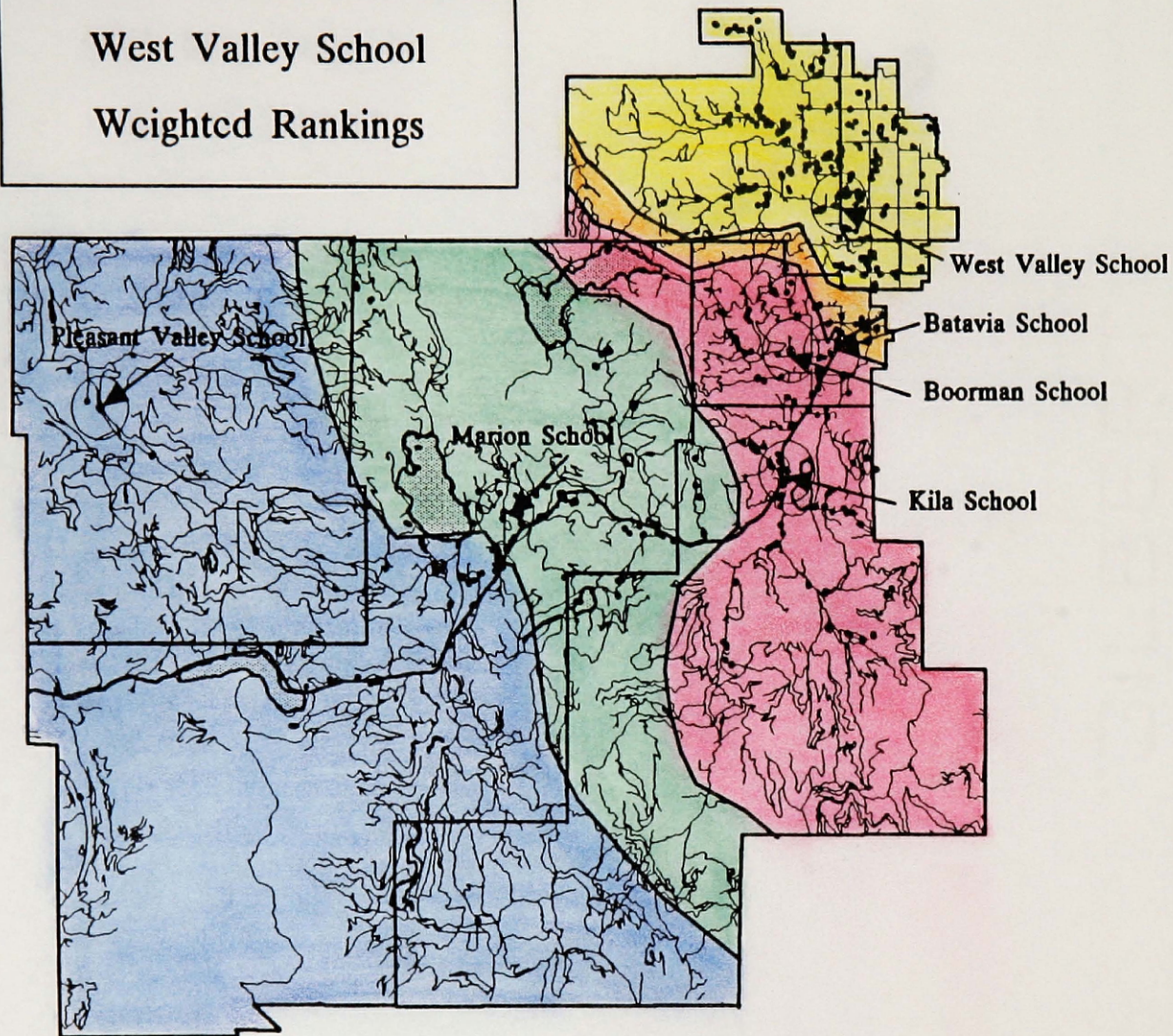
Map 15

Finally, weighted rank isolines for West Valley School are shown on Map 16. West Valley School received the highest number of student's residence point ranking's for the closest school (280 points), but also received many designations as only the third and fourth closest school (90 and 46 points, respectively).

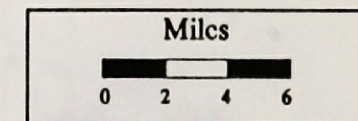
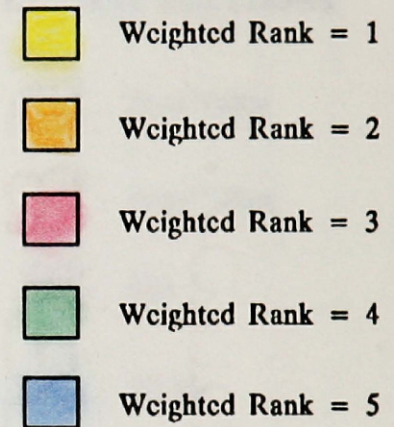
Closest School Areas (CSA). The purpose of establishing closest school areas was to create map polygons based on the second ranking procedure. The closest school area map polygons and the MSQA map polygons could then be contrasted to compare the results of the two ranking procedures. (The closest school area map polygons show the relation of the study schools to the student's residence points, while the MSQA polygons reflect the relation of the student's residence points to the study schools.)

The first step in creating the closest school area map polygons was to display all of the student's residence points that were closer to Smith Valley School than to any of the other study schools. (These student's residence points had already been identified as the points for which Smith Valley School had been assigned a rank of one.) The points on the outside edges of the distribution were joined to form closed map polygons and are referred to in this study as closest school areas (CSA). The resulting polygons are displayed on Map 17 and are discussed in detail in the following paragraphs.

West Valley School Weighted Rankings

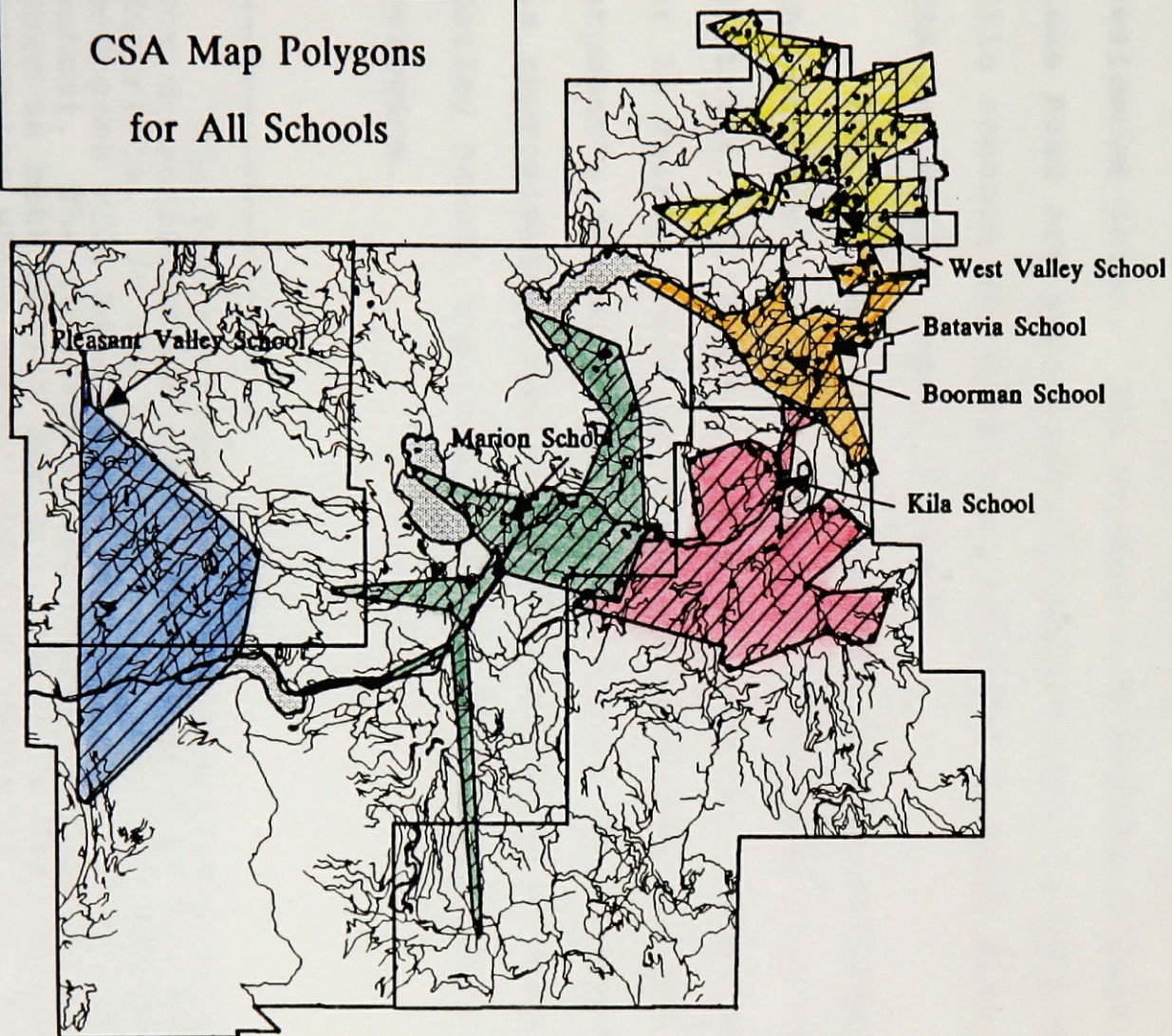


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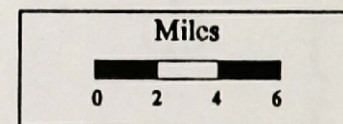
Map 16

CSA Map Polygons
for All Schools



STUDY SCHOOL DISTRICT'S
CSA MAP POLYGONS

-  West Valley
-  Smith Valley
-  Kila
-  Marion
-  Pleasant Valley



Map 17

Pleasant Valley School's CSA map polygon has a very large area but few student's residence points. The CSA map polygon (as with the MSQA polygon) is clearly defined and separate from the map polygons for the other schools.

The CSA map polygon for Marion School extends out to include isolated student's residence points and includes the west portion of Ashley Lake Road. The map polygon expands down into the Kila School District for a single student's residence point. The student's residence points on Rogers Lake Road are approximately equidistant to both Marion and Kila schools and have been included in both Kila School's CSA and Marion School's CSA.⁴⁰

The CSA map polygon for Kila School includes most of the student's residence points within the Kila School district. Although the map polygon has linear extensions, it is fairly solid in shape and does not include any extreme student's residence point locations. The Haywire Gulch area is approximately equidistant from both Kila School and Smith Valley School and is also included in both school's CSA polygons.

⁴⁰The final purpose of the CSA polygons is as a tool for determining the efficiency of each of the school districts. In the final chapter, the CSA and MSQA map polygons will be compared and discussed separately for each school. The researcher has chosen to display Rogers Lake Road in both Marion and Kila School's CSA polygons so as to determine which school district would be most suited for its inclusion.

Smith Valley School's CSA extends west to the Ashley Lake Road area, thus distorting its shape. As mentioned previously, the map polygon reaches down into the Kila School District to include points in the Haywire Gulch area.

Finally, the CSA polygon for West Valley School includes most of the student's residence points within the West Valley School District. The map polygon's shape is fairly solid with the main linear pattern following McMannamy Draw.

Comparison of Polygons. The next step in analyzing the efficiency of the school districts was to compare the results of the two ranking systems. This involved viewing the CSA and MSQA map polygons simultaneously, as the student's residence points included within the MSQA (maximum allowable attendance area) map polygon for a school did not necessarily include all of the student's residence points within the school's CSA (closest school area) map polygon.

The MSQA map polygons and CSA map polygons were displayed together to determine their spatial relationship to each other. The ideal situation in an efficient school district is for the student's residence points to also be included in the MSQA for the school to which they are closest. Therefore, the greater the intersection of the CSA and MSQA map polygons, the greater the appraised efficiency of the school district. The CSA and MSQA map polygons are compared and discussed in detail in Chapter V.

Descriptive Statistical Techniques

The CSA and MSQA ranking procedures provide a graphic means of evaluating the efficiency of the school districts. However, the researcher opted to support the procedure results with a method to mathematically compare the existing school sites (relative to the student's residence points). This was accomplished by the use of descriptive statistics. Descriptive statistics are used to interpret data quantitatively, to analyze changes occurring over time, and to determine patterns of spatial distributions.

Techniques utilizing descriptive statistics employ the concepts of central tendency and dispersion to interpret the characteristics of data. Central tendency can initially be measured by calculating the average of the data, while basic dispersion analysis techniques employ measures of deviation. More complex analyses of central tendency and dispersion result when linear statistics are applied to areal data.

Two procedures that measured central tendency were used in this study--a procedure that measured the potential of the population for the school site and a procedure that measured the average position of the student's residence points in relation to the school. Supplementary statistics concerning the average, standard deviation and range of the measured road distances from each student's residence point to each of the study schools are provided in Appendix D.

Population Potential. The first central tendency procedure calculated which of the six school sites was the peak center of the study--the school site with the highest demand. The resulting figures indicate the most optimal site for a potential new middle school in relation to the distribution of student's residence points.

This procedure was accomplished by applying the law of gravity to areal data. The law can be translated into a geographical gravity model by measuring the theoretical potential or "pressure" of population. The higher the resulting number, the greater the potential (or "pressure") of the school in relation to the distribution of students. The population potential is determined by using the following formula:

$$\sum_{x=1}^P (1/r_{jx}) \quad \text{where } P = \begin{array}{l} \text{the total number} \\ \text{in the population} \end{array}$$

$$r_{jx} = \begin{array}{l} \text{the distance from} \\ j \text{ to } x \end{array}$$

The principle of population potential was applied to the study area where each student's residence point was considered to have a population of one ($P = 1$). The population potential formula was first applied to the eighth grade student's residence point data to determine the site with the peak potential for the oldest students. Next, the

⁴¹Neft, Statistical Analysis for Areal Distributions, 35.

formula was applied separately to student's residence point data for the lower grade levels. The resulting values reflect the number of people per linear mile (plm) and indicate the change in the peak center of the student's residence point distribution from year to year. The results of the population potential analysis for all study area schools are shown in Table 7, while the results from Smith Valley, Kila, Marion, and Pleasant Valley Schools are shown in Table 8. These results are specifically discussed in Chapter V.

Arithmetic Mean Centers. The distribution of discrete points of an area can be summarized by the arithmetic mean center. Although this measure is highly influenced by extreme data positions, its sensitivity to change can successfully be used to compare distribution of data over time. Analysis based on the arithmetic mean center alone is limited as it does not consider other critical variables, including land values, traffic patterns, and actual road distances.

The concept of arithmetic mean centers was applied to the distribution of different grade levels in this study. The center was calculated for the entire distribution of students, then calculated separately for each grade level. The arithmetic mean center indicates the average areal position of the student's residence point distribution and

Table 7.--Population Potential PLM (People per Linear Mile)
Totals for All Schools by Grade Levels.

Grade	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley
K	.1076	.0941	.0942	.0585	.0893	.0264
1	.1141	.0976	.0969	.0531	.1065	.0248
2	.1279	.1094	.1042	.0564	.1076	.0255
3	.1098	.0959	.0930	.0588	.0935	.0261
4	.1279	.1082	.1126	.0600	.1037	.0260
5	.1357	.1152	.1088	.0561	.1202	.0251
6	.1334	.1142	.1050	.0557	.1194	.0251
7	.1114	.0965	.1008	.0612	.0934	.0265
8	.1383	.1193	.1093	.0570	.1157	.0255
All	.1223	.1052	.1025	.0573	.1048	.0257

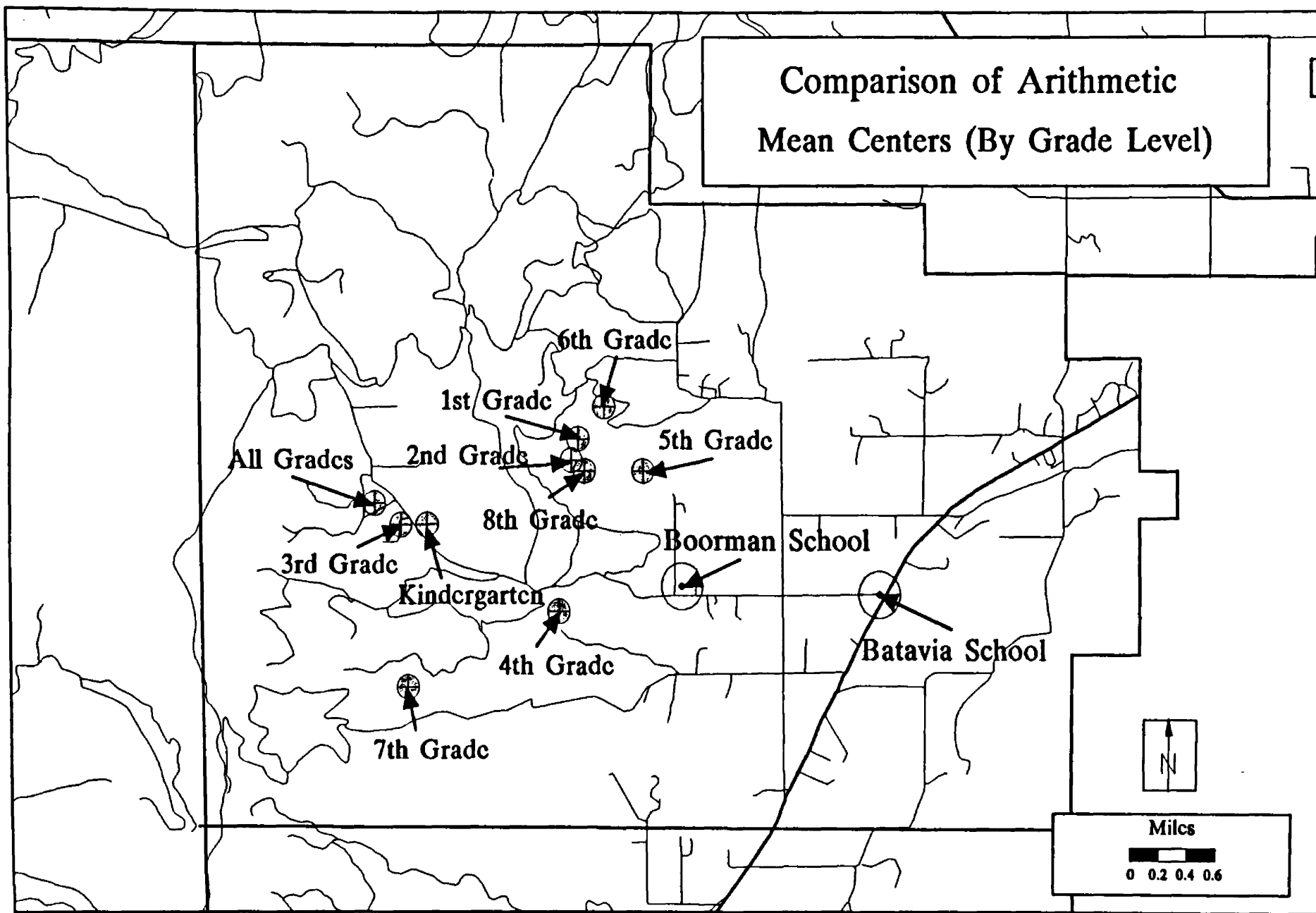
Table 8.--Population Potential PLM (People per Linear Mile)
Totals by Grade Levels Without West Valley School.

Grade	Batavia	Boorman	Kila	Marion	Pleasant Valley
K	.1035	.0916	.1063	.0758	.0302
1	.1130	.0968	.1265	.0729	.0292
2	.1275	.1104	.1267	.0728	.0289
3	.1033	.0918	.1036	.0794	.0301
4	.1310	.1108	.1469	.0803	.0294
5	.1321	.1147	.1406	.0760	.0288
6	.1390	.1207	.1357	.0751	.0288
7	.1027	.0904	.1171	.0853	.0306
8	.1417	.1255	.1378	.0742	.0288
All	.1197	.1045	.1249	.0768	.0294

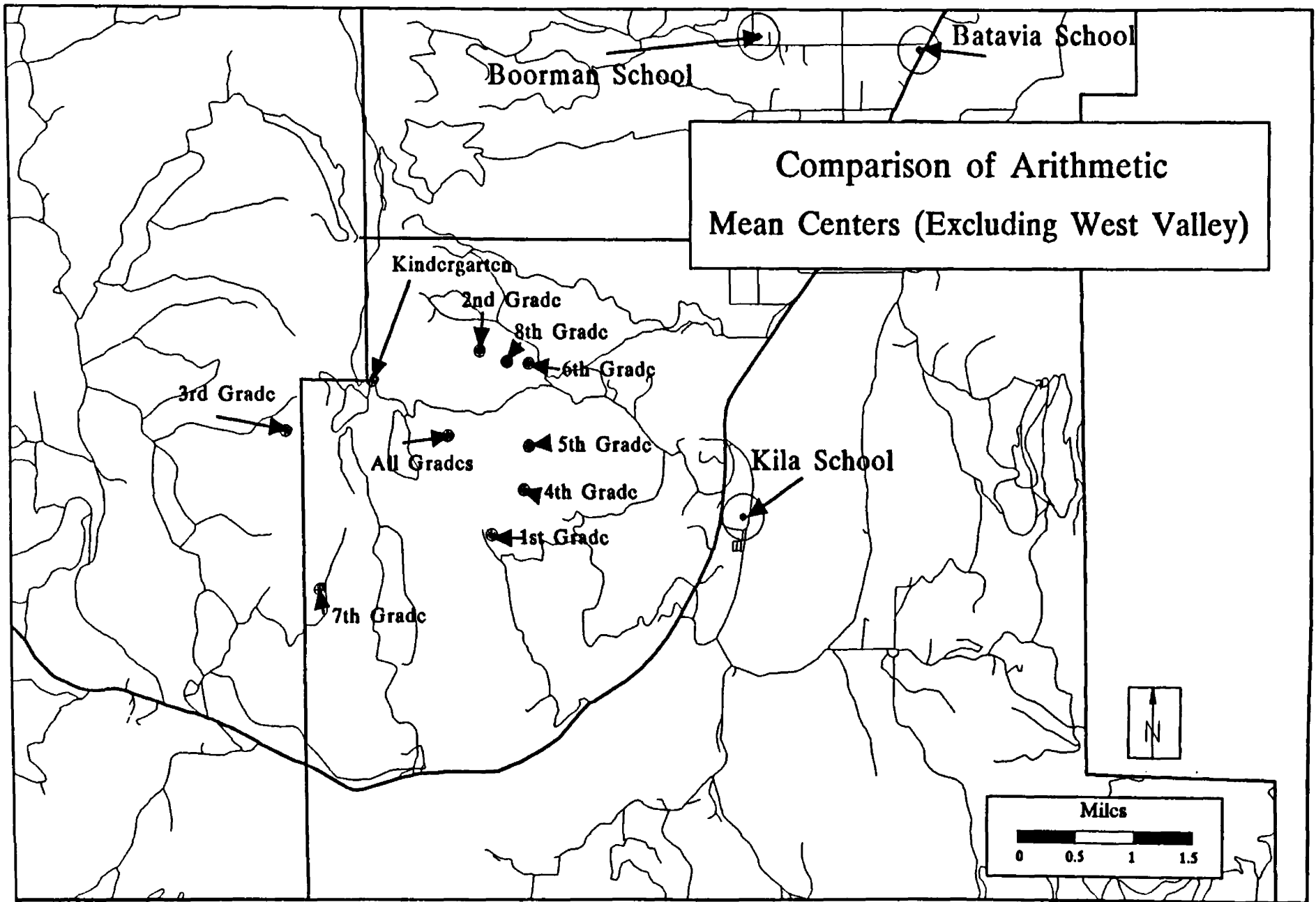
indicates the central site for a potential middle school. The comparison of the arithmetic mean centers for each grade reveals changes in the average position of the student's residence distribution from year to year.

Map 18 shows the arithmetic mean centers for the combined study population by grade levels. The resulting arithmetic mean centers converge to the west and north of Smith Valley School and are all located within the Smith Valley School District.

The arithmetic mean centers were then calculated for Smith Valley, Kila, Marion and Pleasant Valley schools to determine the average positions of the study population without West Valley School. The resulting arithmetic mean centers by grade level are shown on Map 19. The arithmetic mean centers have shifted to the south and slightly west of those shown on Map 18 and are all located within the Kila School District. Map 20 compares both sets of arithmetic mean centers. Further interpretation of the arithmetic mean centers is provided in the next chapter.

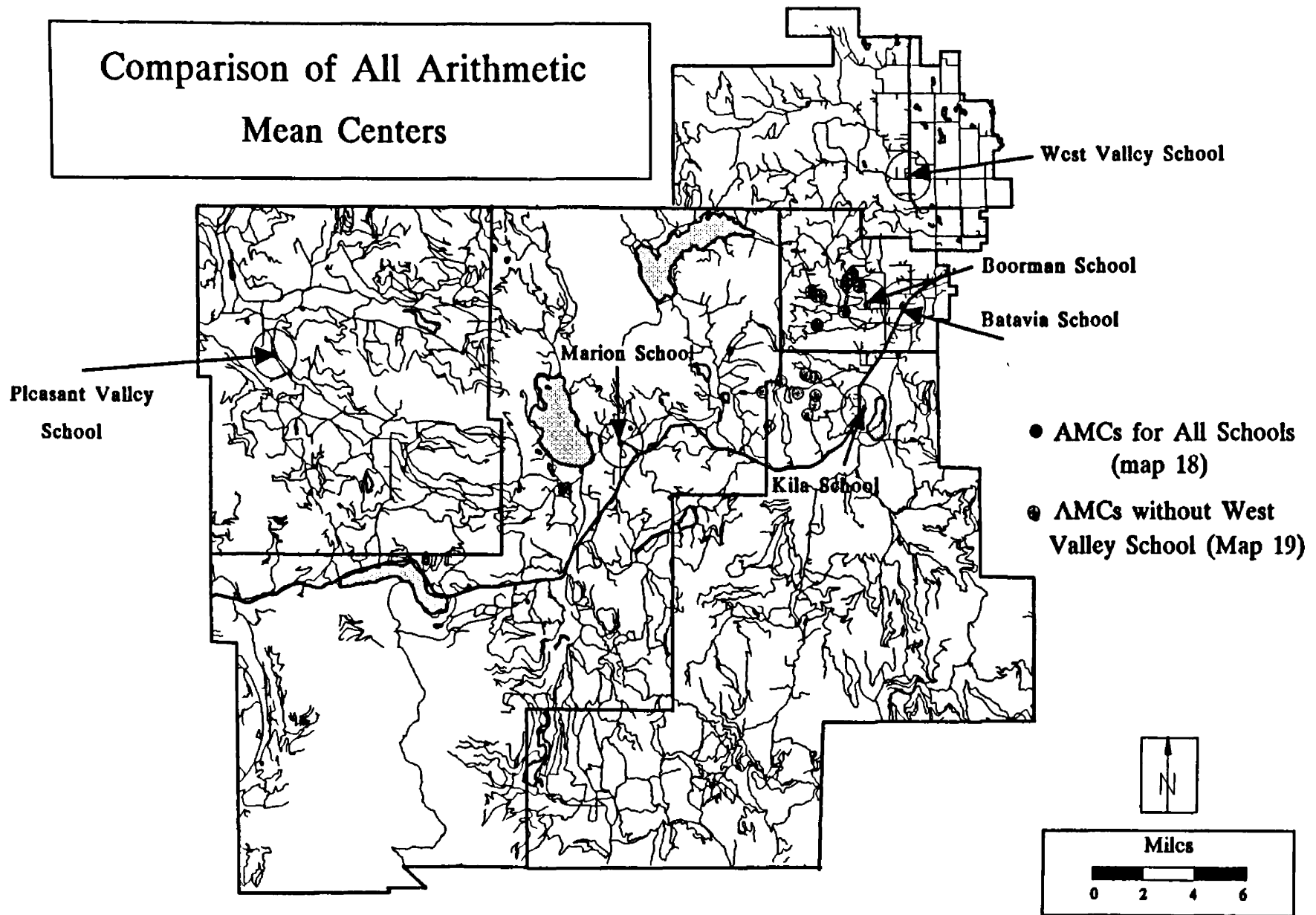


Map 18



Map 19

Comparison of All Arithmetic Mean Centers



Map 20

CHAPTER V

GENERAL OBSERVATIONS AND RESULTS

The methodologies used within this study were designed to focus on two basic issues--first, the determination of the most optimal site for a potential middle school within the study area and second, the rating of the efficiency of the school district boundaries. This chapter will summarize the results of the study methodologies and apply them to the two above-mentioned issues, while Chapter VI will provide recommendations based on the results.

Potential Middleschool Site Determination

The determination of the most optimal location for a potential middle school in the study area was best addressed by the population potential analysis. The specific results for all schools were shown in Table 7 (page 65) with Batavia School consistently receiving the highest population potential value. West Valley School, Kila School, and Boorman School alternated for the second highest value, while Marion School and Pleasant Valley School consistently remained in fifth and sixth positions, respectively. The population potential values without West Valley School balanced between Kila School and Smith Valley Schools as the optimal location for a middle school.

The arithmetic mean center determination also dealt with the potential middle school location by indicating the

central tendency of the student's residence point distribution. The arithmetic mean centers on Map 18 (page 67) were closest to the Boorman School site when all student's residence points were considered, with the Batavia School site a close second. This illustrates the central position of Smith Valley School. The arithmetic mean centers calculated without West Valley School (as shown on Map 19, page 68) converged in the northwestern part of Kila School District, with one center slightly into the Marion School District. This result indicated the central site is the Kila School location.

The isoline maps also revealed the central position for both Smith Valley School and Kila School. As cited in the previous chapter, Kila School was not assigned weighted ranks of four or five, indicating it is the first, second, or third closest school for all of the student's residence points. Smith Valley School was assigned a small amount of the weighted rank of four, but it was a result of isolated student's residence points in the western Marion and Pleasant Valley school districts. Although the isoline map technique is disadvantaged in that the boundary between rank values is interpolated and not clearly defined, it is still indicative of the general central tendency trend.

The overlap areas from the MSQA polygons as shown on Map 10 (page 42) fell primarily along the Smith Valley-Kila Highway 2 corridor. This indicates the concentration of

student's residence points and the importance of the area. The overlap between Smith Valley School and West Valley School was also significant, but it is important to consider that the overlap occurred on Sheepherder's Hill.⁴² The overlap area is subject to other considerations besides actual road distance.

The most optimal site for a new middle school (based on the analysis of the student's residence point distribution) is at either Kila School or Smith Valley School. Smith Valley School is the most optimal site when all the student's residence points are evaluated, while Kila School is more central when West Valley student's residence points are excluded. Additional factors must be considered in the final decision as well--Kila School is located off of busy (and dangerous) Highway 2 West, but Smith Valley School is closer to Kalispell (where many parents work). The Highway 2 West corridor connecting the two schools is an area of concentrated growth and shares in their central tendency positioning. Additional sites along this corridor that meet other location criteria are also potential middle school locations.⁴³

⁴²Please see pages 6-7 for comments concerning Sheepherder's Hill.

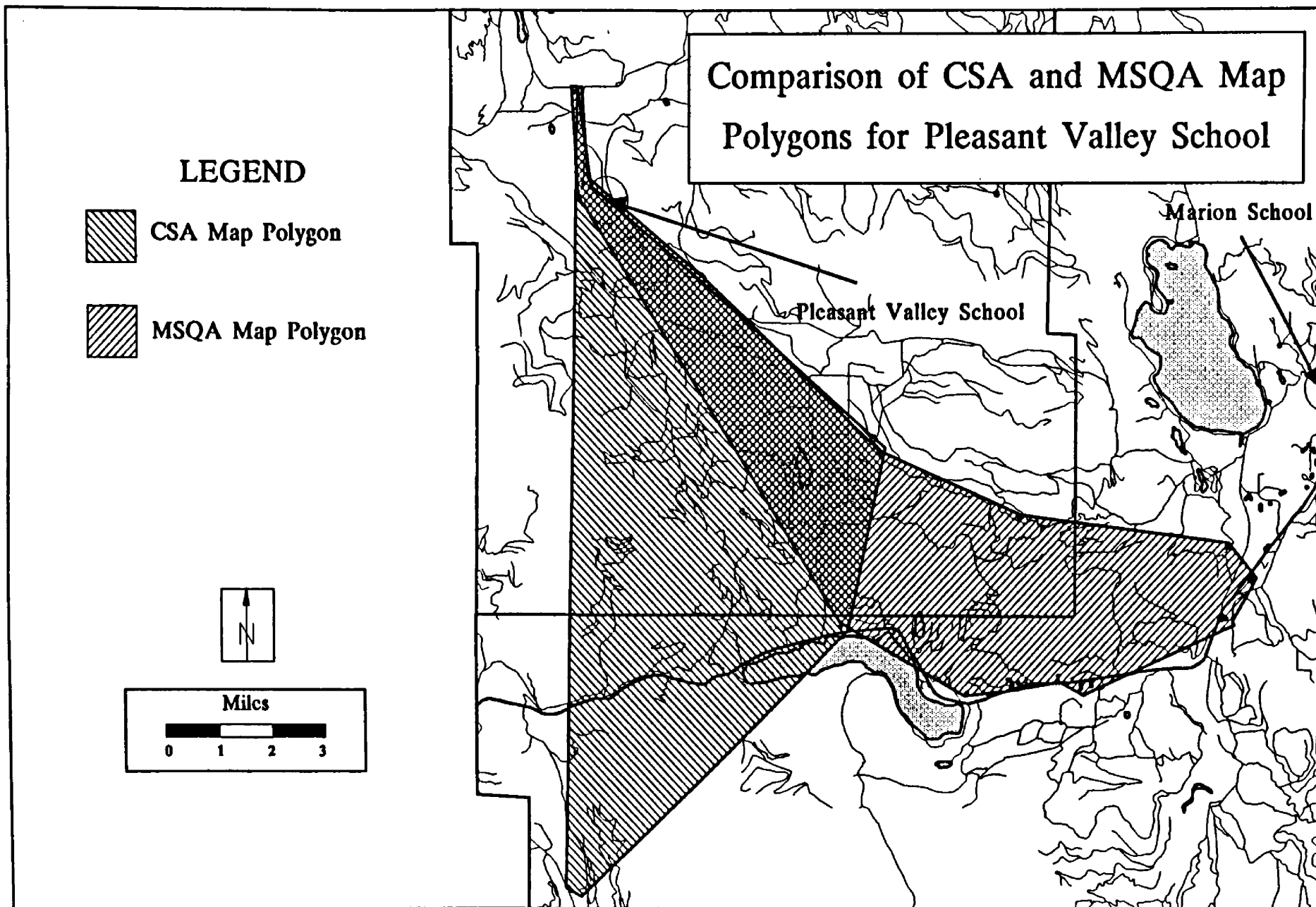
⁴³Please refer to Appendix B for additional criteria in determining a potential school site.

Evaluation of Efficiency of School Districts

The comparison of the CSA and MSQA map polygons confronts the issue of the efficiency of district boundaries by contrasting the two ranking procedures. As discussed in the previous chapter,⁴⁴ the more efficient the school district boundary is, the greater the number of student's residence points contained in both the CSA map polygon and the MSQA map polygon. The CSA map polygon indicates the school that is the closest to the student's residence points. Parents and students both prefer the school that is the closest, as it represents convenience and minimum travel time on rural roads. The MSQA map polygon displays the student's residence points that represent the minimum travel costs for the school--the closer the student is to the school, the less busing is required for the school system. Therefore, the greater the intersection of the two map polygons, the greater the efficiency of the district for both students and school administrators. Map polygons comparisons for each of the five study schools are specifically discussed in the following sections.

Pleasant Valley District Polygon Comparison. The map polygons for the Pleasant Valley School District, as shown on Map 21, are both large in area because of isolated student's residence points. The CSA map polygon contains

⁴⁴Please refer to page 61.



Map 21

most of the student's residence points for Pleasant Valley School, with the exception of the Lower Lost Prairie student's residence point. The CSA map polygon also extends south to include the isolated two student's residence points on Thompson River Road (in the Marion District). There is a student's residence point on McGregor Lake that is closer to Pleasant Valley School; however, it is much more convenient to travel Highway 2 West to Marion School.

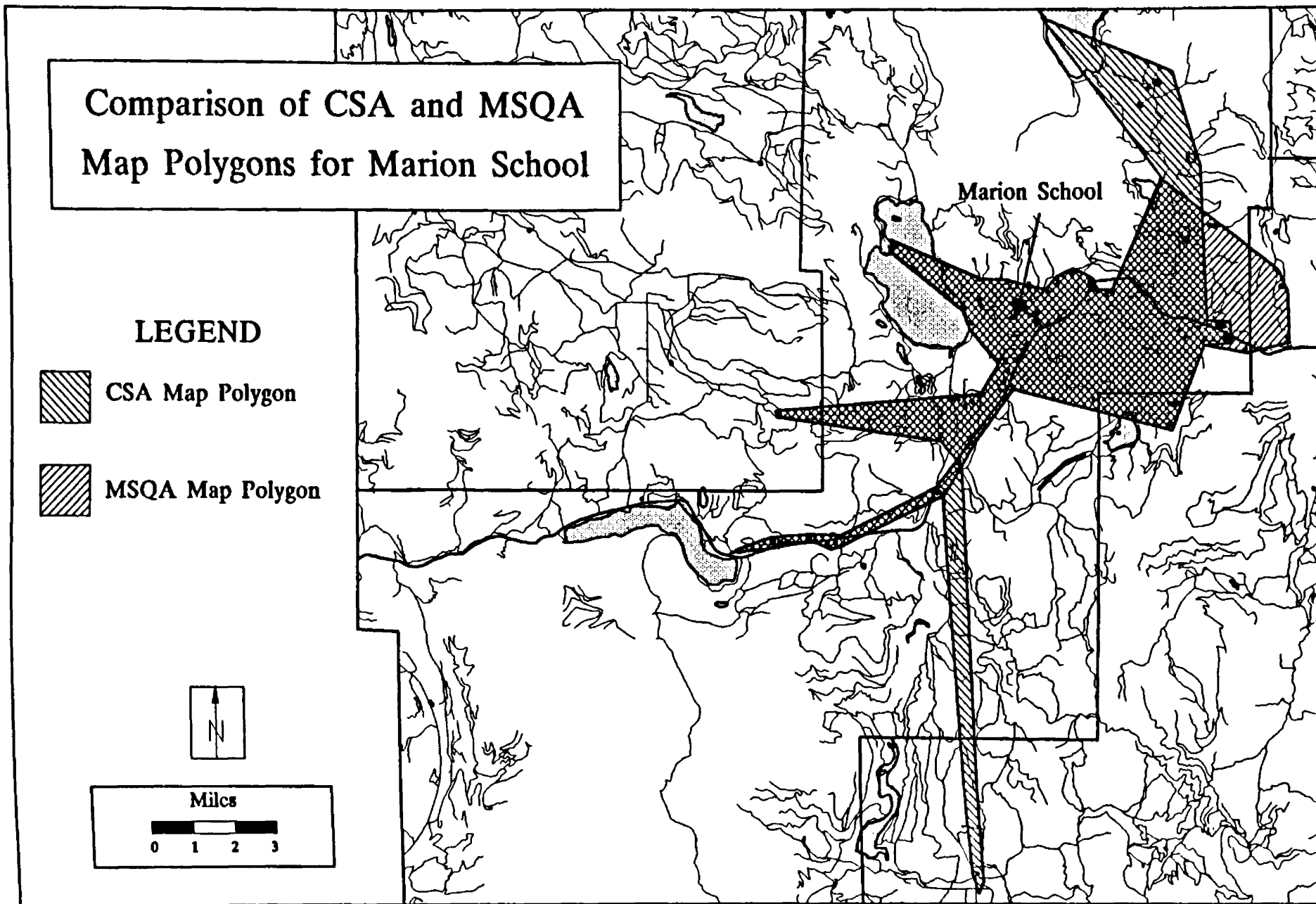
The MSQA map polygon reaches beyond the school district line, as discussed earlier in the study. The intersection of the CSA and MSQA Polygons contains all the points in the CSA, except the student's residence points on Thompson River Road. The student's residence point on Lower Lost Prairie falls within the Pleasant Valley District, but is closer to Marion School. (The student, in fact, does attend Marion School.)

The remainder of the student's residence points in the MSQA polygon are located along Highway 2 West. Marion School is much more accessible for this area than Pleasant Valley School, so these students would be best remaining in the Marion School District.

The efficiency of the Pleasant Valley District boundary is difficult to assess with so few data points. Also, the rural roads in this area are in varying conditions and boundary evaluations cannot be made on road distance alone.

Marion School District Polygon Comparison. The intersection of the Marion School District's MSQA and CSA map polygons is shown on Map 22. The map polygons are very similar in shape with the following two primary exceptions: the isolated student's residence point on Hubbart Dam Road stretches the CSA map polygon to the south into the Kila School District, while the Ashley Lake Road student's residence points extend the CSA map polygon to the north. Both map polygons reach west to include the student's residence point on Lower Lost Prairie Road and extend east to encompass the student's residence points on Rogers Lake Road. (The student's residence points on the north part of the road are in the Marion School District while those on the south part are in the Kila School District.) The MSQA map polygon also includes student's residence points on Dower Draw in the Kila School District; however, these points are closer to Kila School and should remain in the Kila District.

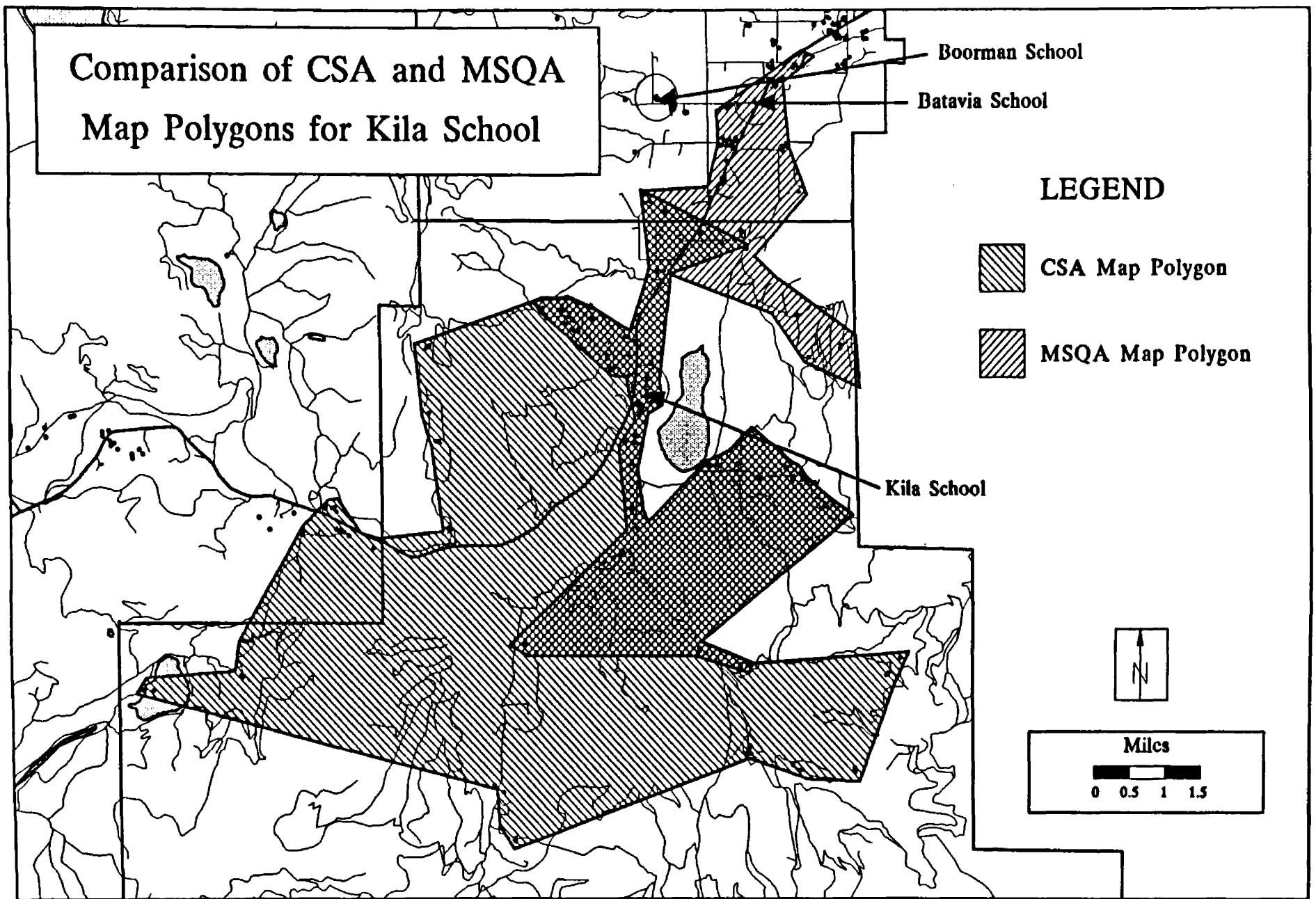
The question of the Ashley Lake Area requires further attention. The entire Ashley Lake area is in the Marion District, yet the students on the southeastern shore are closer to Batavia School. There are plans for new housing developments in this area as well as along Ashley Lake Road to Batavia Lane. The importance of this district border will continue to increase, mandating the need for school administrators to determine the best district boundary structure.



Map 22

Kila School District Polygon Comparisons. The comparison of map polygons for Kila School is shown on Map 23. The CSA map polygon for Kila School includes most of the student's residence points within the Kila School District. Significant exceptions are the student's residence points on Haywire Gulch and the isolated student's residence point on Thompson River Road. The CSA map polygon also includes the student's residence points along Rogers Lake Road, as mentioned in the previous section.

The MSQA map polygon tends toward a linear shape and extends up Highway 2 West into the Smith Valley School District. The Highway 2 West corridor between Kila and Batavia Schools is one of the most populated sections in the study area and generates some concern. One problem in the area is the northern end of Von der Heide Lane is in the Smith Valley District, yet access to Smith Valley School is through the Kila School District. Another concern is the Haywire Gulch student's residence points are approximately equidistant between Kila and Smith Valley schools, as are the student's residence points nearest the school district border on Highway 2 West. Haywire Gulch also extends to the east over the district boundary line separating Kila School District with Kalispell District V. Students living on Haywire Gulch who fall within Kalispell District V must travel through Kila School District, then continue all the way to Kalispell for school.

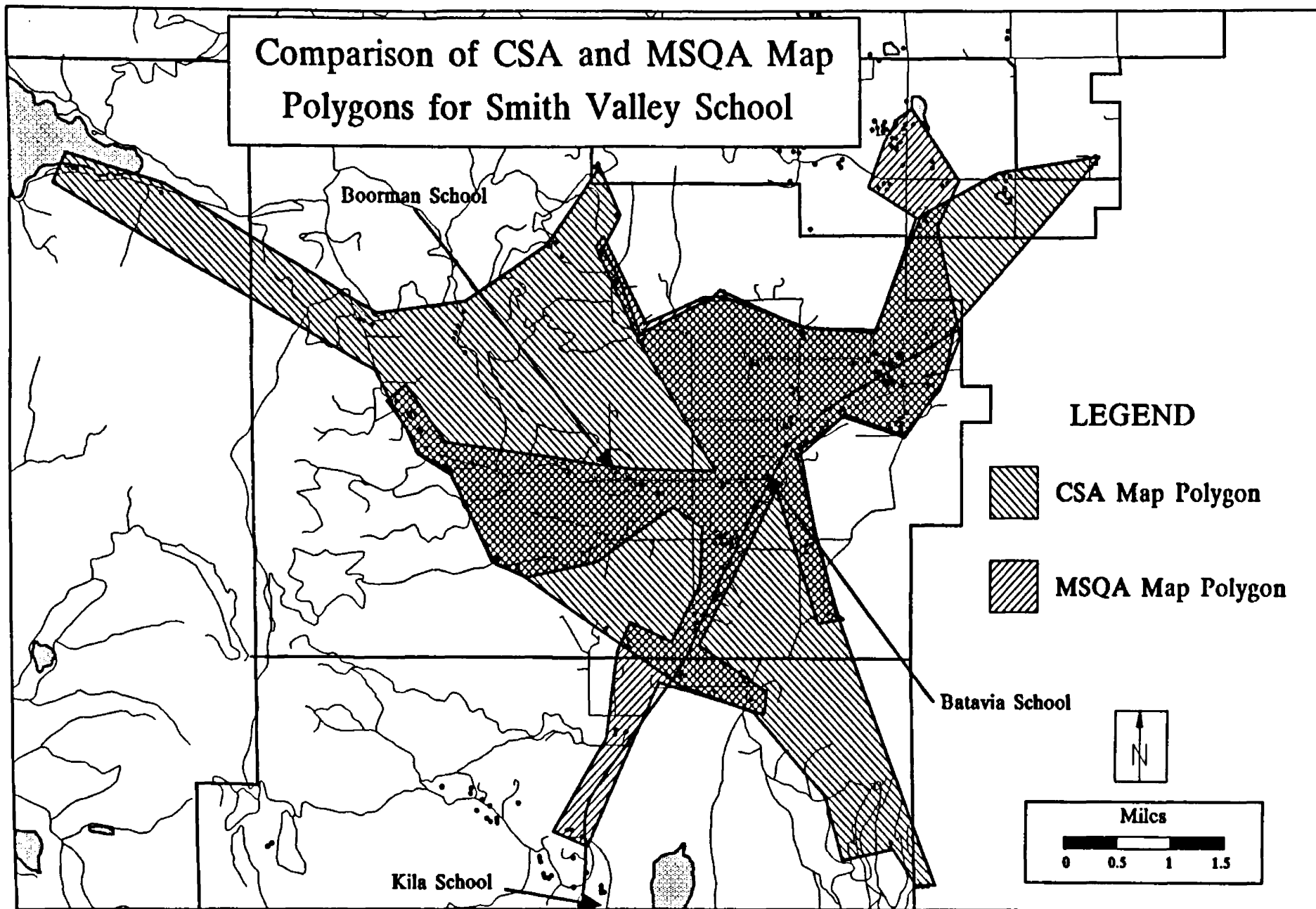


Map 23

The southern part of the Kila School District also causes considerable concern.⁴⁵ Students living on the southern portion of Brown's Meadow Road attend school in Hot Springs in Sanders County, with Kila School District paying a required stipend for each student. The situation does not have any immediate alternatives as the Flathead County line prevents restructuring the district boundary to the south, while the creation of a new rural school district is not financially feasible.

Smith Valley School District Polygon Comparison. The CSA and MSQA map polygons for Smith Valley School, as shown on Map 24, are of very different shapes, although the majority of student's residence points are contained in both map polygons. The MSQA map polygon is concentrated in the populated part of the school district, primarily along Highway 2 West. The CSA map polygon reaches west to include the Ashley Lake Area. Smith Valley School, as discussed earlier, is more convenient to this area--both in distance and the condition of roads traveled. Ashley Lake Road is very hard to travel on in winter due to snowpack, so a minimum amount of travel time is preferable. The MSQA map also extends down into the Kila School District to include

⁴⁵The actual residence locations of these students was not provided to the researcher--therefore, actual distances and specifics cannot be cited.



Map 24

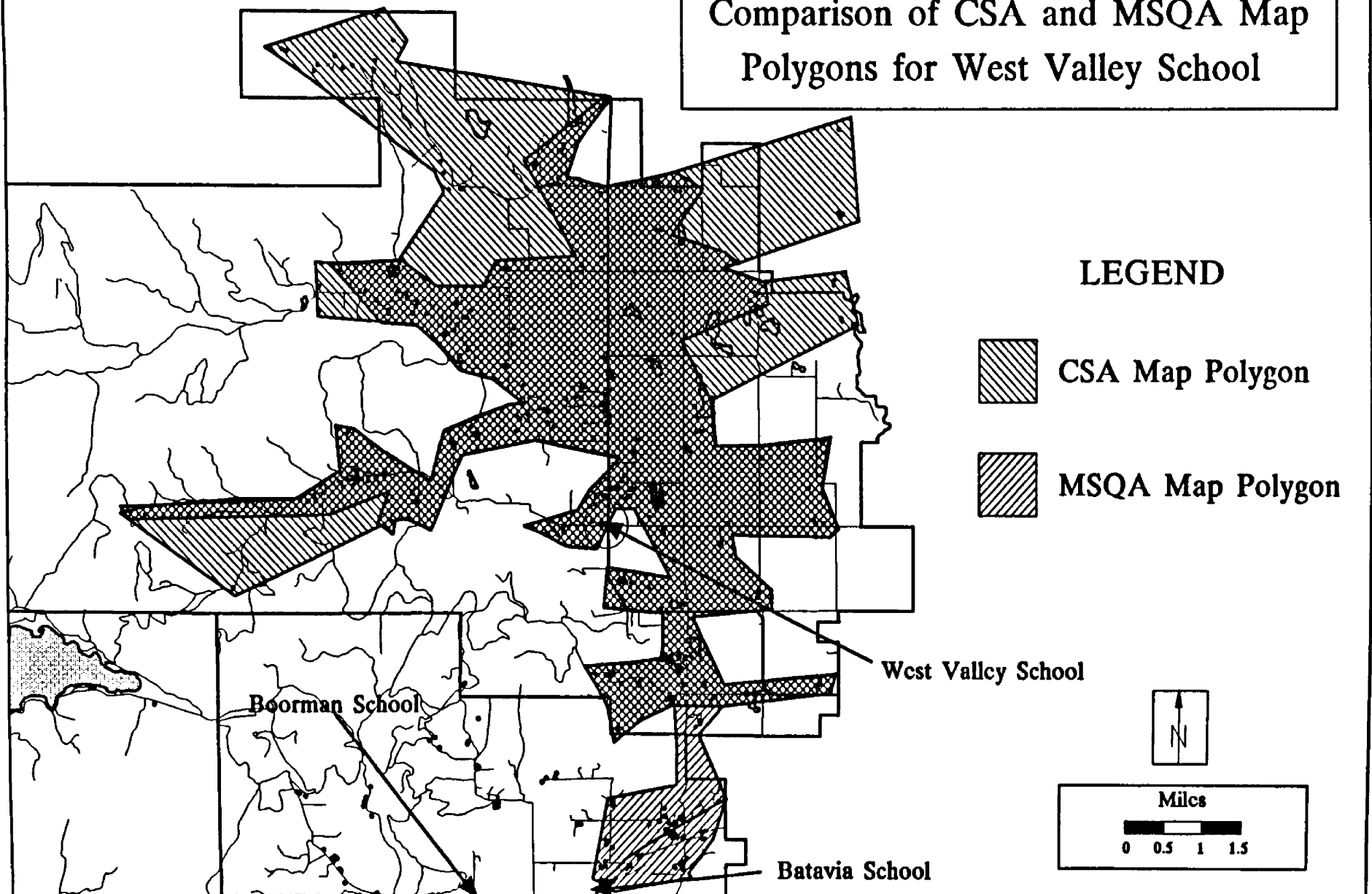
part of Haywire Gulch, as well as points along Highway 2 West to Kila School.

Both the MSQA and CSA polygons extend up into West Valley School District. Although the distance is convenient, the actual road travel is not, as access is by Sheepherder's Hill. There are also three student's residence points on upper Kienas Road that are in the West Valley School District; but as access is through Smith Valley District, school attendance is at Smith Valley School.

West Valley District Polygon Comparison. The MSQA and CSA map polygons for West Valley on Map 25 are basically the same shape--the difference being the CSA map polygon extends farther out to envelop extreme student's residence points, and the MSQA polygon reaches down into Smith Valley School District. As discussed earlier, Sheepherder's Hill acts as a barrier to students attending Smith Valley School. These student's residence points could be removed from the MSQA, thus allowing the student's residence points in more extreme locations to be included. The West Valley School District student's residence points would then all be included in both the CSA and the MSQA map polygons.

The comparison of CSA and MSQA map polygons provides a means of graphically comparing the student's residence point distribution for each of the study schools. Although the technique is affected by extreme student's residence point

Comparison of CSA and MSQA Map Polygons for West Valley School



Map 25

locations, the procedure still allows the evaluator to visualize the characteristics of the distribution of student's residence points. The effectiveness of the CSA and MSQA map polygon technique will be further discussed in the next chapter.

CHAPTER VI

CONCLUSIONS

The final stages in the study include the formation of recommendations from the study result interpretations and the evaluation of the study techniques. This chapter will discuss these conclusive steps, as well as provide suggestions for application of the study techniques by school administrators. It is important to recognize, however, that the recommendations in this chapter are only based on a locational study of the distribution of students, and do not consider many essential variables, including tax bases and school budgets. The following recommendations are not intended to be implemented without consideration of other important school site locational factors.

Study Recommendations. These recommendations are based on the discussion of results in Chapter V. Specific recommendations are as follows:

1. Potential Middle School Location
The most optimal location for a new potential middle school to accommodate students in the Kila, Marion, Smith Valley and Pleasant Valley districts is on Highway 2 West between and including the Kila School and Smith Valley school sites. West Valley District middle school students would be best served by the current West Valley School location.

2. Pleasant Valley School District Recommendations
 - a) The district is primarily adequate "as is" as it fulfills the intended purpose--to provide a school for students living in isolated locations in western Flathead County, with the following exception:
 - b) The eastern portion of Lower Lost Prairie Road should be evaluated for possible inclusion into the Marion School District.
3. Marion School District Recommendations
 - a) The entire Rogers Lake Road should be included into the Marion School District.
 - b) All of the Hubbart Dam Road should be included into the Marion School District.⁴⁶
4. Kila School District Recommendations
 - a) The entire Haywire Gulch area should be included into the Kila School District.
 - b) Von der Heide Lane should be entirely within the Kila School District.
5. Smith Valley School District Recommendations
 - a) The eastern portion of Ashley Lake Road should be included in the Smith Valley School District.
 - b) Upper Kienas Road should be included in the Smith Valley School District.
6. West Valley School District Recommendations
 - a) No specific recommendations except as indicated under Smith Valley School District.⁴⁷

The researcher additionally recommends school administrators concerned with the study area continue to plan for increased growth in the Highway 2 West corridor

⁴⁶The researcher made this recommendation based on a decision the entire road should be contained within one school district for convenience and cost-effectiveness in busing. The student's residence points are approximately the same distance to both Kila School and Marion School, however, Kila School is under more strain to include growth areas to the east of the school. Marion School could best accommodate these students.

⁴⁷West Valley District recommendations could not be made in-depth as most of the surrounding school districts were not considered within this study.

between Smith Valley and Kila schools, as well as along the adjoining roads. The Ashley Lake region should also be of concern--specifically the eastern portion, as the closest school is within another school district.

Evaluation of Techniques

Source Materials and Data Acquisition. The maps provided by the county plat office were ideal for this study. The maps were on a large enough scale to be seen clearly, yet were convenient to use. The location and accuracy of rural roads and addresses on the maps were essential for determining student residence locations. The color-coding system was effective, but a uniform point mark for all student's residence location should have been assigned. (The location notations easiest to read were small circles.) In addition, a simple tabulation of the total number of points by map would have saved the researcher time in verifying all points on each map were found (a total of 32 maps were used). A uniform method for designating residences with more than one student should also have been established prior to distributing the maps.

The digitizing process was very time-consuming, but critical to the success of the project. The use of EXCEL as an external database proved very useful to analysis. The

ROOTS files were easily imported into EXCEL, then saved as .XLS files for importing into ATLAS*GIS.⁴⁸

The TIGER/Line files were very easy to work with, although there was some confusion regarding rural roads. Highways were clearly designated, but all other levels of roads appeared the same. It was necessary to compare the TIGER/Line roads with the topographical maps to determine the main roads likely to be traveled (as opposed to logging and other minor roads). There were errors in the school district boundaries in the TIGER/Line files that needed to be revised for accurate results. Hydrographic features, however, were accurate and very convenient in locating other features.

ATLAS*GIS was an excellent program for making the final maps. The cartographical capabilities of the program balanced out the limited database analysis capabilities. The maps and titles printed up clearly and accurately and served as an excellent communication medium.

The use of computers was essential in this study, but many decisions also required personal knowledge of the area. The measuring of road distances, rather than straight line distances, was also necessary as many student's residences were isolated on long, curvy roads. Straight line distance measurements would not have provided as accurate results.

⁴⁸ATLAS*GIS allowed for the import of EXCEL 3.0 files, but is not equipped to import EXCEL 4.0 files.

Ranking Procedure and Polygon Comparison Evaluation. The two ranking systems and polygon comparison procedure provided a graphic illustration of the student's residence point distributions. The CSA and MSQA map polygons were subject to distortion by isolated points, but this also assured that these points would be noticed. Rural school student residence distribution analysis needs to equally consider all student's residence points--not only those in high growth areas.

The comparison of the CSA and MSQA map polygons allowed both student's and administrator's views to be considered in the distribution analysis. It also allowed the researcher to focus on problem areas by observing overlap areas and detached student's residence points. Student's residence points that were included in both CSA and MSQA polygons were appraised to be in a satisfactory condition and did not cause additional concern.

The isoline and map polygon maps provide a visual aid that can be used for presentations by school administrators. This can be a very effective support to mathematical and statistical summaries. Community residents are then able to understand the relation of specific areas to the whole situation.

The ranking and comparison techniques have the advantage of not requiring advance mathematical and computer proficiency, as do many alternate techniques. Complicated

computer algorithms and programming techniques are often out of the expertise of school administrators. This fulfills the researcher's goal to provide techniques that can be directly applied to actual circumstances.

Descriptive Statistical Techniques. The descriptive technique of population potential analysis was needed to provide mathematical verification of the polygon comparison technique. Population potential analysis has already been applied to a variety of distribution analyses and served as a more conventional backup technique. However, it was effective in this application and provided mathematical confirmation of the results.

The technique did not consider all possible sites, but the acquisition of additional land for a new school is currently not financially feasible. The choice for a potential middle school was determined to be made only among existing sites.

The arithmetic mean centers were primarily effective as a graphic illustration. The technique was disadvantaged in that it was affected by extreme student's residence points. It additionally did not consider road distances, only average latitude and longitudinal coordinates.

Application of Study for School Administrators

The processes used by the researcher for acquiring and recording information, as well as digitally measuring road distances, can easily be performed by school administrators and staff. The measurement of distances was extremely time-consuming, but the process could have been greatly simplified by the use of a survey form sent to each student. The distance from the student residence to each of the study schools could have been calculated by student's parents or guardians. This technique would have both advantages and disadvantages over the technique used by the researcher. Advantages include the measured distance reflecting the actual road used from the student residence to the school, time saved in the determination of distances and double-checking the measured results, hard-copy documentation of data and the encouragement of community involvement in the school districting problem. Disadvantages include the expense of printing and distributing the surveys, unwillingness of parents to participate, intentional or accidental mistakes in recording of road distance, and possible inconveniences on the part of school administrators in obtaining the return of the surveys.

The availability of a GIS and trained GIS operator to most rural school districts is very limited. It is more likely the school district will need to employ the services

of a consultant in analyzing the information. It is, therefore, to the school district's financial advantage to have data in the necessary computer format before employing the consultant and to work with the consultant in cost-saving measures during the analytical process. The acquisition and formation of data into an accurate and usable format contributes greatly to the cost incurred in GIS data analysis. The actual file format needed is dependent on the type of GIS used. School district personnel should obtain an exact description of the necessary format and should adhere strictly to the dimensions.

Although the acquisition of a GIS is very costly, external database management systems (such as EXCEL) are often within reach of most school budgets. This type of software is also very useful in many other school district accounting and management needs and may already be in use in many school district offices. Data input and manipulations can be completed by school district personnel or temporary employees, thus saving expensive consulting fees. It is essential for the school district personnel to be in clear communication with GIS consultants concerning this issue.

APPENDIX A
SUMMARY TABLES

Appendix Table 1.--Average Distances for Student's Residence
Points to Study Schools (Miles)

Grade	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley
K	9.29	10.62	10.62	17.08	11.19	37.82
1	8.76	10.25	10.33	18.83	9.39	40.25
2	7.82	9.14	9.60	17.72	9.29	39.19
3	9.11	10.42	10.76	16.99	10.70	38.30
4	7.82	9.24	8.88	16.68	9.64	38.51
5	7.37	8.68	9.19	17.83	8.32	39.80
6	7.50	8.76	9.53	17.96	8.38	39.77
7	8.98	10.36	9.92	16.32	10.70	37.79
8	7.23	8.38	9.15	17.55	8.65	39.28
All	8.17	9.50	9.75	17.44	9.55	38.98
Excluding West Valley	8.35	9.57	8.01	13.02	-	38.98

Appendix Table 2: Population Totals for Flathead County
(1970-1992)

Year	Population	Year	Population
1970	39,460	1982	52,658
1971	40,900	1983	53,859
1972	41,200	1984	56,059
1973	41,800	1985	57,649
1974	42,900	1986	57,755
1975	44,900	1987	57,324
1976	46,200	1988	57,600
1977	47,500	1989	58,432
1978	49,800	1990	59,218
1979	51,500	1991	60,848
1980	51,966	1992	62,908
1981	52,404	-	

Source: The Bureau of Business and Economic Research, University of Montana (based on data from the U.S. Bureau of the Census)

**Appendix Table 3:--Enrollment Totals for All
Flathead County Schools**

Year	All Schools	Rural Schools	Private Schools	Ungraded Students	Home- Schooled Students
1970	7536	1183	328	69	-
1971	7571	1198	317	34	-
1972	7445	1175	338	73	-
1973	7378	1168	326	95	-
1974	7472	1147	360	68	-
1975	7277	1154	380	57	-
1976	7547	1233	406	51	-
1977	7839	1316	460	92	-
1978	7881	1386	471	75	-
1979	7769	1392	523	49	-
1980	7911	1345	669	-	-
1981	7930	1312	693	-	-
1982	8186	1257	935	-	-
1983	8700	1301	1089	-	-
1984	9032	1401	994	73	-
1985	9014	1492	1094	62	-
1986	9121	1487	1110	53	-
1987	8799	1493	825	50	85
1988	9177	1561	839	82	112
1989	9328	1619	860	108	119
1990	9653	1637	954	45	130
1991	9879	1726	983	33	176
1992	10238	1816	1004	54	236
1993	10381	1879	1107	22	268

Appendix Table 4:--Enrollment Totals for Study Schools

Year	Smith Valley	Kila	Marion	Pleasant Valley	West Valley
1970	91	58	55	13	107
1971	90	68	68	17	126
1972	82	55	70	10	130
1973	86	63	59	15	127
1974	97	62	53	18	114
1975	79	57	58	17	118
1976	89	84	71	13	117
1977	94	88	89	15	119
1978	97	96	85	16	150
1979	96	101	111	15	160
1980	100	103	106	14	140
1981	91	103	107	16	146
1982	90	78	99	5	151
1983	120	85	107	7	158
1984	127	94	111	8	175
1985	148	102	100	9	198
1986	123	106	90	19	198
1987	123	84	90	16	200
1988	131	76	88	6	230
1989	141	90	90	11	240
1990	138	92	108	6	248
1991	143	114	110	8	264
1992	163	135	107	9	281
1993	171	138	107	6	298

APPENDIX B

ADDITIONAL VARIABLES APPLICABLE TO SCHOOL LOCATION PROBLEMS

The limitations of the study have already been defined and the following variables mentioned as important to the choice of a school location. In the interest of the school administrators and school boards involved with the complete decision, these variables have been included for reference. This list is provided for reference only, and school administrators and personnel may have their own variables to add.

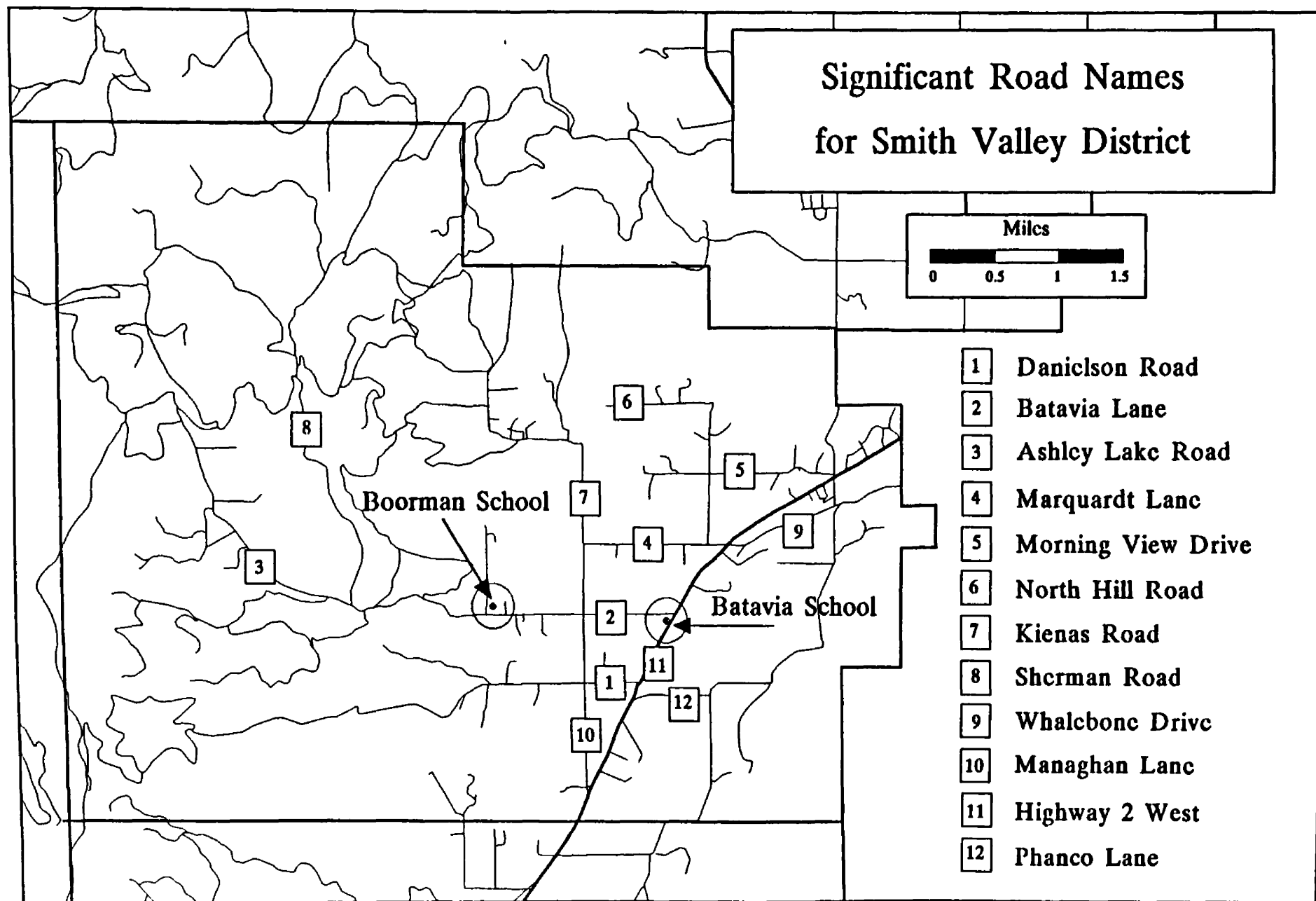
Major Site Location Factors

- 1) School and Site Details
 - a) size, physical condition, and age of school
 - b) special student or school usage needs
 - c) priority between a large site or central site
 - d) future expansion needs
 - e) space needed for playing fields, pools, theaters, agriculture sites, play grounds, bands, physical education, vocational, bus maintenance shop
 - f) choice of available sites
- 2) Water Supply and Sanitation
 - a) adequacy of existing water supply
 - b) future plans involving the water supply that could affect the school
 - c) current use of septic tanks and sewer systems
 - d) existing sanitation facility regulations and restrictions
 - e) planned development for future facilities
- 3) Economics Factors
 - a) proximity of district or school to employment areas
 - b) economic support of area
 - c) financial groupings and strengths of the area
 - d) existing tax rates and tax base
 - e) current land values
 - f) ownership of land

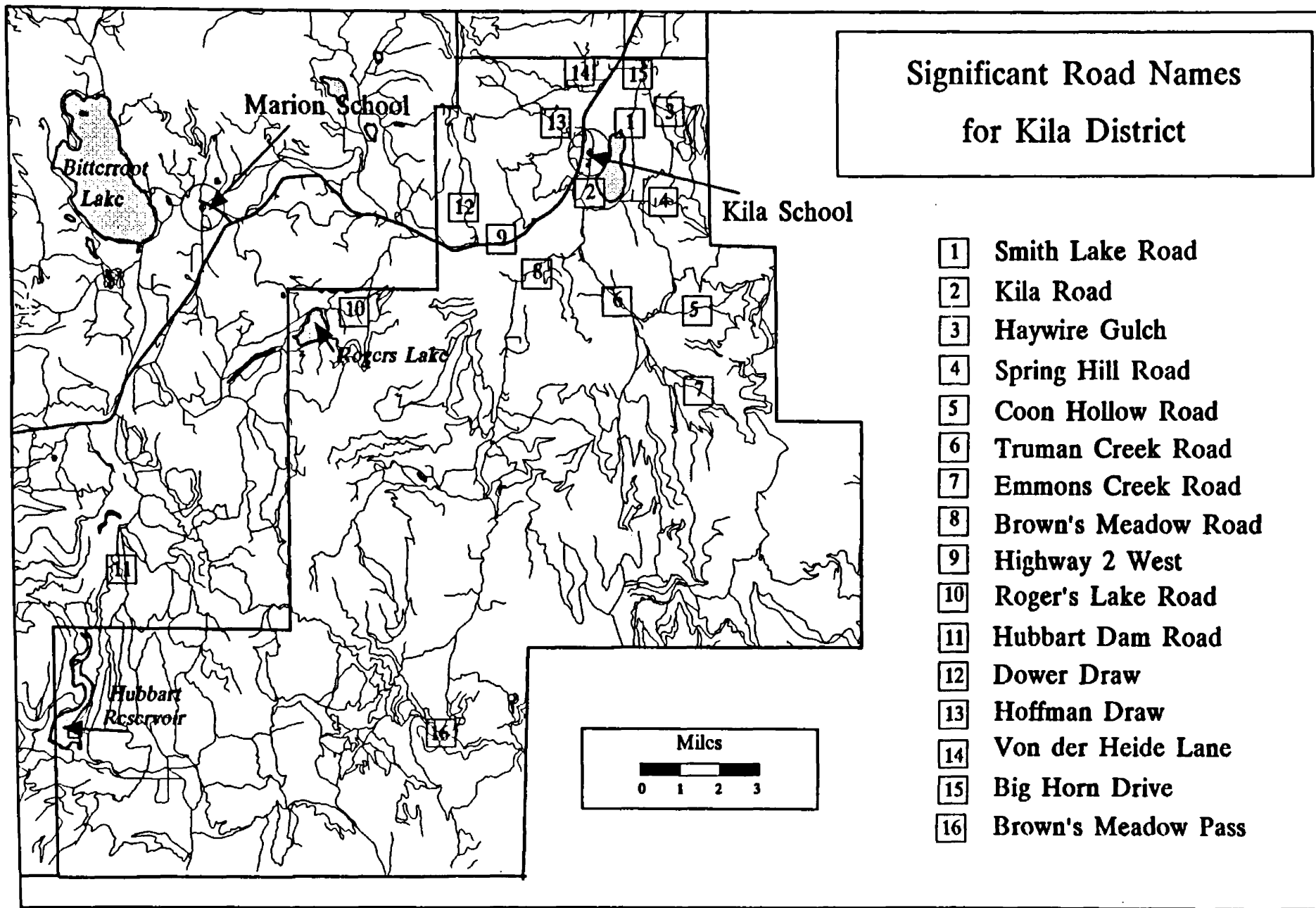
- 4) Residential Housing
 - a) existing home improvement types, sizes, values
 - b) zoning requirements and regulations
 - c) influence on sections for population density
 - d) type of structure (apartments, single-home)
- 5) Physical Characteristics of Area
 - a) shape and topography of the area
 - b) orientation of sun for the area
 - c) soil and drainage evaluation
- 6) Hazards
 - a) existing and future traffic hazards
 - b) existing noise hazards in the area
 - c) potential or existing odor sources
- 7) Transportation and Accessibility of Area
- 8) Regulations
 - a) current health and building codes
 - b) state's suggestion attendance divisions
 - c) state-mandated regulations for boundaries
- 9) Community
 - a) community expectations
 - b) possibilities for combining school facilities with public facilities, specifically: recreational, theatrical and library facilities, preventative health service center, adult education facilities
- 10) Future of Area
 - a) existing patterns and trends of growth and development for businesses, homes and industries
 - b) locations for new housing permits
 - c) transient nature of area
 - d) anticipated community growth
 - e) existing and expected population trends

APPENDIX C

SIGNIFICANT ROAD NAMES FOR STUDY SCHOOL DISTRICTS



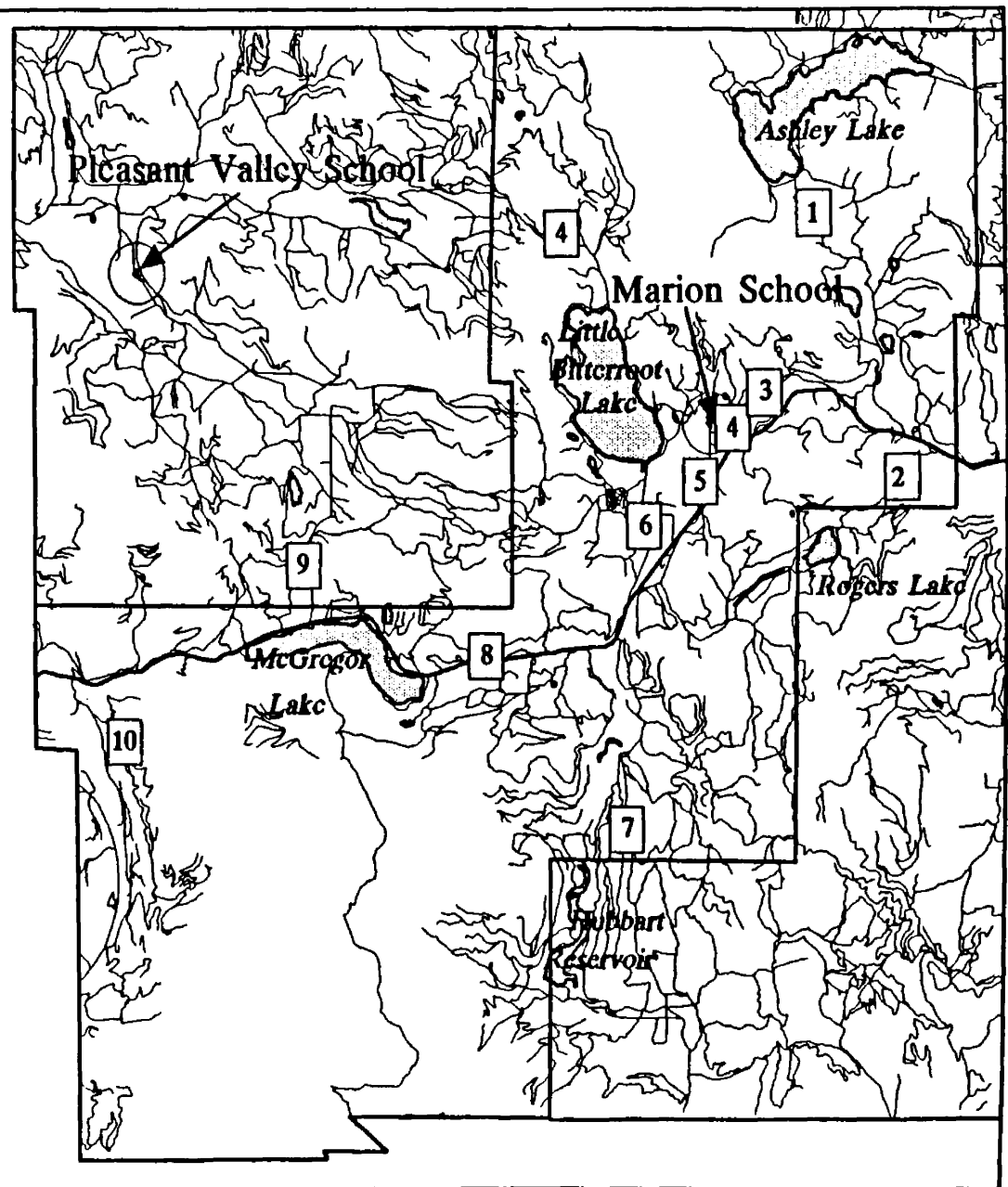
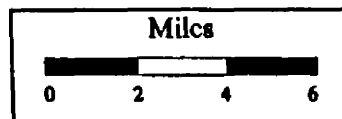
Appendix Map 1



Appendix Map 2

Significant Roads for Marion District

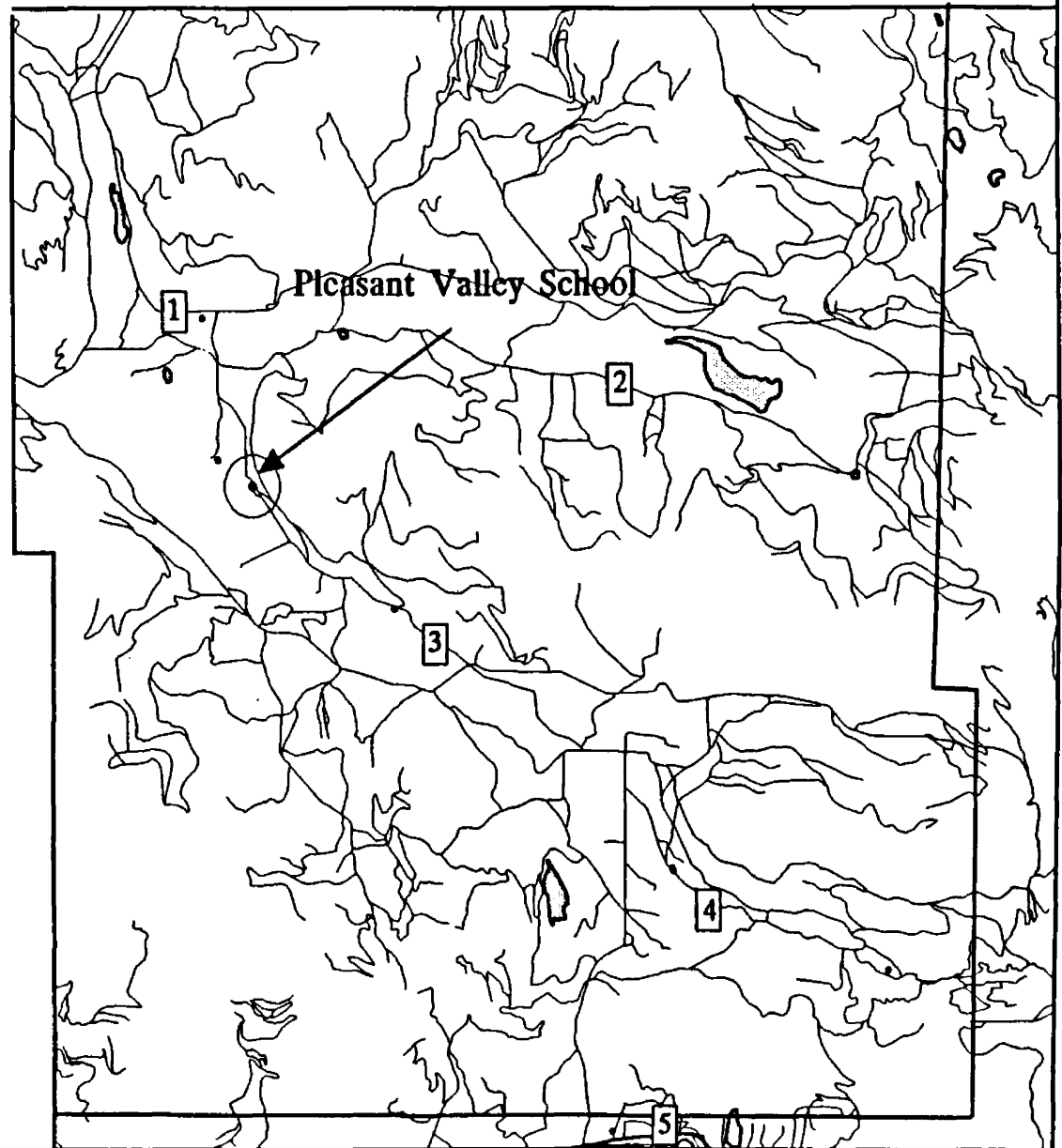
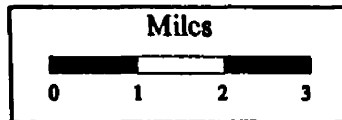
- 1 Ashley Lake Road
- 2 Rogers Lake Road
- 3 Idaho Lake Road
- 4 Pleasant Valley Road
- 5 Gopher Lane
- 6 Bitterroot Drive
- 7 Hubbart Dam Road
- 8 Highway 2 West
- 9 Lost Prairie Road
- 10 Thompson River Road



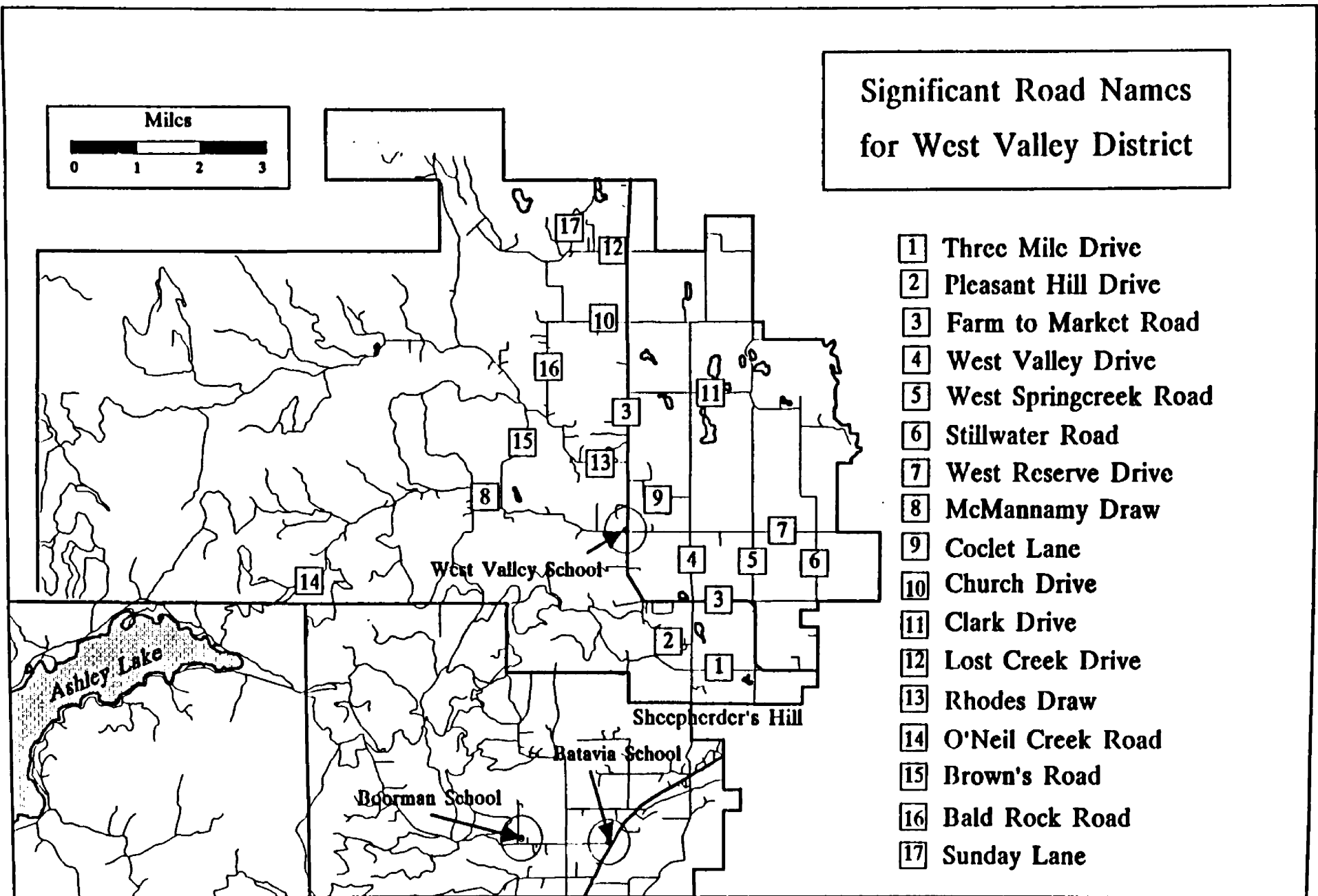
Appendix Map 3

Significant Road Names for Pleasant Valley District

- 1 Island Lake Road
- 2 Pleasant Valley Road
- 3 Lost Prairie Road
- 4 Lower Lost Prairie Road
- 5 Highway 2 West



Appendix Map 4



Appendix Map 5

APPENDIX D
DISTANCE STATISTICS

Appendix Table 5.--Kindergarten (all schools)

	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley
Average Distance to School	9.29	10.62	10.62	17.08	11.19	37.82
Standard Deviation of Distance	7.70	7.85	6.59	7.49	9.67	10.23

Appendix Table 6.--First Grade (all Schools)

	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley
Average Distance to School	8.76	10.25	10.33	18.83	9.39	40.25
Standard Deviation of Distance	5.93	5.93	5.58	7.04	8.03	9.14

Appendix Table 7.--Second Grade (all Schools)

	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley
Average Distance	7.82	9.14	9.60	17.72	9.29	39.19
Standard Deviation of Distance	6.32	6.41	5.60	6.74	8.25	8.59

Appendix Table 8.--Third Grade (all Schools)

	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley
Average Distance to School	9.11	10.42	10.76	16.99	10.7	38.30
Standard Deviation of Distance	6.93	7.16	5.57	7.74	9.32	9.35

Appendix Table 9.--Fourth Grade (all Schools)

	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley
Average Distance to School	7.82	9.24	8.88	16.68	9.64	38.51
Standard Deviation of Distance	5.02	5.10	5.10	7.24	7.25	8.34

Appendix Table 10.--Fifth Grade (all Schools)

	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley
Average Distance to School	7.37	8.68	9.19	17.83	8.32	39.80
Standard Deviation of Distance	4.89	5.12	4.48	7.17	7.46	

Appendix Table 11.--Sixth Grade (all Schools)

	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley
Average Distance to School	7.50	8.76	9.53	17.96	8.38	39.77
Standard Deviation of Distance	5.26	5.45	4.90	7.01	7.18	8.24

Appendix Table 12.--Seventh Grade (all Schools)

	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley
Average Distance	8.98	10.36	9.92	16.32	10.70	37.79
Standard Deviation of Distance	6.84	6.94	6.13	7.61	9.25	8.74

Appendix Table 13.--Eighth Grade (all Schools)

	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley
Average Distance to School	7.23	8.38	9.15	17.55	8.65	39.28
Standard Deviation of Distance	5.66	5.93	5.17	6.96	7.49	8.22

Appendix Table 14.--All Grades (all Schools)

	Batavia	Boorman	Kila	Marion	West Valley	Pleasant Valley
Average Distance to School	8.17	9.50	9.75	17.44	9.55	38.98
Standard Deviation of Distance	6.12	6.27	5.47	7.14	8.22	8.69

Appendix Table 15.--All Grades
(Excluding West Valley School Student Data)

	Batavia	Boorman	Kila	Marion	Pleasant Valley
Average Distance to School	8.35	9.57	8.01	13.02	33.98
Standard Deviation of Distance	7.65	7.87	6.20	5.89	7.97

SELECTED BIBLIOGRAPHY

BOOKS

- Caudill, William W. Your Schools, An Approach to Long-Range Planning of School Buildings. A. & M. College of Texas, 1950.
- Cyr, Frank W. and Henry H. Linn. Planning Rural community School Buildings. New York: Bureau of Publications. Teacher's College, Columbia University, 1949.
- Greenberg, Michael R., Donald A. Krueckeberg and Connie O. Michaelson with assistance from Richard Mautner and Nancy Newman. Local Population and Employment Technique. New Brunswick, NJ: Center for Urban Policy Research, 1978.
- Hammond, Robert and Patrick McCullagh. Quantitative Techniques in Geography. Oxford: Clarendon Press, 1978.
- Haring, L. Lloyd, John F. Lounsbury and John W. Frazier. Introduction to Scientific Geographic Research. Dubuque, IA: Wm. C. Brown Publishers, 1992.
- Herrick, John H. Ralph D. McLeary, Wilfred F. Clapp and Walter F. Bogner, A Discussion of Problems Planning School Buildings. New York: Henry Holt and Company, 1956.
- Holy, Russell A., Ph.D. The Relationship of City Planning to School Plant Planning. New York City: Bureau of Publications, Teacher's College, Columbia University, 1935.
- Kowalski, Theodore J. Planning and Managing School Facilities. New York: Praeger Publishers, 1989.
- Lewis, James Jr. Long-Range and Short-Range Planning for Educational Administrators. Boston: Allyn and Bacon, Inc., 1983.
- MacConnell, James E. and Jon S. Peters. Trends in School Planning. Stanford: Stanford University Press, 1955.
- MacKenzie, Donald G. Planning Educational Facilities. Lanham, MD: University Press of America, 1989.
- McClurkin, W.D. School Building Planning. New York: The MacMillan Company, 1964.
- Morphet, Edgar L., Ph.D. Measurement and Interpretation of School Building Utilization. New York City: Bureau of Publications, Teachers College, Columbia University, 1927.

Stautz, Carl H. Planning Your School Building Dollar. Philadelphia: Chilton Company- Book Division, 1960.

Stoddard, Robert H. Field Techniques and Research Methods in Geography. Fairfax, VA: TechBooks, 1982.

Turabian, Kate L. A Manual for Writers of Term Papers, Theses, and Dissertations. 5th ed. Chicago: The University of Chicago Press, 1987.

Thrasher, James M. Effective Planning for Better School Buildings. Midland, MI: Pendell Publishing Company, 1973.

Tomlin, C. Dana. Geographic Information Systems and Cartographic Modeling. Englewood Cliffs, N.J.: Prentice Hall, Inc., 1990.

Turner, Claude C. and James M. Thrasher. School Size Does Make a Difference. San Diego: The Institute for Educational Management, 1970.

PERIODICALS

Hobbs, Daryl, "Rural School Improvement: Bigger or Better?," The Journal of State Government 61 (January/February 1988):22-28.

Maxfield, Donald W., "Spatial Planning of School Districts," Annals of the Association of American Geographers 62, no.4 (December 1972): 582-590.

Meyer, John, W. Richard Scott and David Strang, "Centralization, Fragmentation, and School District Complexity," Administrative Science Quarterly 32, no. 2 (June 1987): 186-201.

Taylor, H.W., W.R. Code, and M.F. Goodchild, "A Housing Stock Model For School Population Forecasting and Planning," The Professional Geographer 38, no. 3, (August 1986): 279-286.

Yeates, Maurice, "Hinterland Delimitation: A Distance Minimizing Approach," The Professional Geographer 15, no.6 (November 1963): 7-10.

OTHER

Hefty, Eric Paul B. Wilson and Darshan Kang. "Facilities Study and Demographic Study of Missoula School District #1." Missoula, Montana, 1986.

Schwinden, Ted and Lynda Brannon. "School Reorganization in Montana: A Time for Decision, a Report Prepared for the Montana School Board Association." (Project Seeds, 1993).