

SECTION 6
SITE SELECTION

Site selection is the comparative evaluation of alternative airport sites for their suitability to provide the calculated facility requirements. In addition, each site is evaluated for its ability to satisfy the overall aviation needs of the Hopi Tribe, consistent with community plans and the opportunity for co-located economic development projects. The analysis culminates in a recommended site based on the evaluation criteria stated.

The findings and recommendations of the site selection are presented first, followed by the technical analyses of the evaluation process. This process is a three phase analysis; first Polacca Airport is evaluated; second, alternatives are identified; and third, the various alternatives are comparatively evaluated.

6.1 FINDINGS AND RECOMMENDATIONS

The objective of the site selection study has been to determine the most desirable location for a new airport to meet the forecast aeronautical needs of the Hopi Indian Reservation. Airport planning criteria utilized for the site selection were developed in the forecasts of future needs and determination of facility requirements prepared as a part of this planning study. The airport required is one with a single runway 7,000 feet long and related taxiways, aprons, buildings, roads, and utilities. An area of 300 acres will accommodate these needs.

Preliminary alternative evaluations were made of seven candidate sites including existing Polacca Airport. The sites were primarily in the lower desert area below Highway 264. However, sites at Second Mesa

and Keams Canyon above the highway were also studied. From this analysis it was determined that potential airport locations in the lower desert area along Highway 87 and along the Leupp-Oraibi Road should be considered in a final analysis, as well as retaining Polacca Airport. Above Highway 264, only the Second Mesa site remained as a viable candidate.

6.1.1 Conclusions

The alternative evaluation of the four candidate sites included the following considerations: Comparative Costs, Airspace and Aviation Factors, Accessibility, Environmental Concerns, Engineering and Economic Factors. An evaluation matrix depicting the results of this analysis is shown in the following Exhibit 6-1. Detailed review of the matrix and the supporting text indicate the following:

- Comparative Costs - The total comparative costs including construction of the facility and cost to the user indicates that the site receiving the highest evaluation is existing Polacca. The next most likely candidate site is New Oraibi. However, only New Oraibi meets the airport siting criteria and on this basis would be considered as the preferred site.
- Accessibility - Accessibility to existing and proposed centers of demand in the Hopi Indian Reservation indicate that the Polacca Airport has the highest evaluation, but that New Oraibi is the preferred candidate because it meets airport design criteria.
- Airspace and Aviation - The freedom of the Second Mesa site from surrounding strong topographical features, as mesas, and its excellent visibility from the air identified this

EXHIBIT 6-1
HOPI INDIAN RESERVATION
AIRPORT SITE SELECTION STUDY
EVALUATION MATRIX

<u>ALTERNATIVES</u>	<u>SITE 2 HIGHWAY #87</u>	<u>SITE 4 SECOND MESA</u>	<u>SITE 5 NEW ORAIBI</u>	<u>POLACCA AIRPORT (Do Nothing)</u>
<u>EVALUATION CRITERIA</u>				
<u>COMPARATIVE COSTS</u>				
<u>Cost of Development</u>				
Land	0	0	0	0
Landside Improvements	223,500	163,500	163,500	238,500
Airside Improvements	2,229,250	2,316,105	1,774,250	546,000
Navigational Aids	23,000	23,000	23,000	23,000
Buildings	<u>506,500</u>	<u>506,500</u>	<u>506,500</u>	<u>506,500</u>
20 Year Total	2,982,250	3,009,105	2,467,250	1,314,000
<u>Cost to User</u>				
Travel Mileage	1,114,000	1,450,000	1,054,000	1,044,000
Travel Time	<u>534,000</u>	<u>652,000</u>	<u>504,000</u>	<u>494,000</u>
20 Year Total	1,648,000	2,102,000	1,558,000	1,538,000
<u>Total Comparative Cost</u>	<u>4,630,250</u>	<u>5,111,105</u>	<u>4,025,250</u>	<u>2,852,000</u>
<u>ACCESSIBILITY</u>				
Travel Distance - Weighted Average (mi.)	14.9	19.4	14.1	9.6
Travel Time - Weighted Average (min.)	18	22	17	12
Population Within 30 Minutes Time to Tribal Headquarters (min.)	95%	95%	95%	100%
Time to Cultural Center (min.)	22	20	6	20
Time to Keams Hospital (min.)	15	13	14	12
	32	40	40	19
<u>AIRSPACE AND AVIATION</u>				
Field Elevation (ft. MSL)	5,420	6,160	5,540	5,570
Runway Length Required	7,000	8,000	7,000	4,000
Obstructions to Air Navigation				
Within 5 NM (≥500 ft.AGL)	Yes	No	Yes	Yes
Within 3 NM (≥200 ft.AGL)	Yes	No	Yes	Yes
Part 77 Penetration	No	No	No	Yes

(Continued)

EXHIBIT 6-1

(Cont.)

<u>ALTERNATIVES</u>	<u>SITE 2 HIGHWAY #87</u>	<u>SITE 4 SECOND MESA</u>	<u>SITE 5 NEW ORAIBI</u>	<u>POLACCA AIRPORT (Do Nothing)</u>
Field Visibility	Fair	Good	Poor	Poor
Expected HAT Runway SW	540	520	720	590
Air Turbulence Expected	None	Moderate	None	Light
<u>ENGINEERING</u>				
Topography	Good	Poor	Good	Good
Soils and Excavation	Fair	Poor	Good	Fair
Site Flooding	Poor	Good	Fair	Poor
Availability of Materials	Good	Fair	Good	Good
Availability of Utilities	Fair	Poor	Good	Fair
<u>ENVIRONMENTAL</u>				
<u>Not Applicable to Any Site</u>				
Existence of any Rare or Unique Flora/Fauna				
Impacts on Historical or Archeological Sites				
Effects on Underground or Surface Water				
Threat of Air Pollution				
Relocation of Residents				
				(All sites were visited and evaluated by representatives of the Hopi Tribal council, but these factors were found to be of little or no concern.)
<u>Applicable Factors</u>				
Proximity to Parks, Wildlife and Recreation Areas	No	Yes Wildlife	No	No
Effects on Prime Agricultural Soils and Grazing Areas	Moderate	Light	Moderate	None
Area Utilized for Sacred or Religious Ceremonies	Yes	No	No	No
Threat of Noise Pollution	Light	No	Moderate	Light
Visual Impact of Airport	Light	No	Strong	Light
<u>ECONOMIC</u>				
Revenue Development Potential	Good	Fair	Good	Poor
Opportunity for Related (Induced) Development	Good	Poor	Poor	Fair

area as the preferred airport location. The Highway 87 site is not rated as highly, although it would be satisfactory from an airspace and aviation standpoint.

- Engineering and Construction - Due to the closer availability of materials of construction and utilities, plus ease of construction based on better soils and foundation condition, there is some advantage to the New Oraibi site over the others. The Highway 87 location is rated as second to the above.
- Environmental - This area of concern was considered the most important in the evaluation process and resulted in the Second Mesa site as being the most desirable from this standpoint. The location of Highway 87 was considered the next most suitable, although it is used as a source for snakes used in religious ceremonies.
- Economic - The location having the best opportunity for airport related development was considered to be Highway 87. In the future, as the Leupp-Oraibi Road is completed, the New Oraibi site could be considered as having an equal potential.

6.1.2 Recommendation. While cost, access, engineering, and construction concerns are important, the most critical evaluation factors for siting an airport include airspace and aviation requirements, and especially environmental impacts related to aircraft operations. On the basis of the foregoing matrix evaluation, the location at New Oraibi should be preferred. But the environmental concerns, especially the visual impact of the development from Old Oraibi and the aircraft approach just east

of New Oraibi, completely rule out this location. An almost comparable location at Highway 87 could be considered as the most suitable candidate site, but airspace and aviation factors related to poor airport visibility, engineering and construction problems related to a wet sub-grade condition with a potential for site loading, and an environmental impact related to use of the site to obtain snakes used in religious ceremonies would tend to devalue this location. It is the recommendation of this study that the airport location on Second Mesa be selected for further detailed evaluation because of its suitability from aviation and environmental standpoints. It is believed that these issues are the most important to consider in the evaluation of where a new airport should be planned to serve the existing and future development of the Hopi Indian Reservation.

6.2 POLACCA AIRPORT EVALUATION

Polacca Airport has a paved runway 4,000 feet long by 40 feet wide, a paved aircraft parking apron, and a graded (unpaved) entrance road and auto parking area. The airport is located in an open grazing area below the mesas. Immediately off each runway end is a major natural drainage channel. Off the northeast runway end is Polacca Wash, which collects runoff from a tributary area greater than 100 square miles. Wepo Wash off the southwest runway end serves a primary tributary area of about 55 square miles.

Section 5, entitled Airport Requirements, identified the requirement for a 7,000 foot long by 75 foot wide runway to satisfy the long-range aviation needs of the Hopi Tribe. In order to lengthen Polacca's runway by 3,000 feet, one of the above-mentioned washes would have to be placed in a structure under the runway or realigned. Because of the volume of water to be accommodated, the cost of a structure or realignment would be prohibitive. For example, the walls of the realigned wash would

require protection to prevent erosion toward the runway. Sizeable revetments will be required for each wash to overcome the hydrological problems associated with flash flood conditions.

The washes were inspected onsite, by aerial overflight and using photographs, and by study of topographic maps. Preliminary analysis revealed that undertaking any of the improvements to the washes cited above will cost considerably more than replacement of the existing investment in Polacca Airport. Additionally, if those improvements were undertaken, they would result in substantial siltation problems and associated adverse environmental impacts, including scarring of the landscape.

Various alternative development schemes for the existing airport site were explored, but none were capable of accommodating the calculated facility requirements. Therefore, any further development of Polacca Airport was determined to be undesirable and identification of alternatives was initiated.

6.3 IDENTIFICATION OF ALTERNATIVES

Alternative airport sites are identified in conjunction with an analysis of the overall airport system requirements of the Mesa area. The system analysis is necessary to avoid selecting a new airport site, perhaps with a central location, when in the future it may be necessary to provide two airports, one on either end of the Mesa area, for example.

As described in Section 4 entitled Aviation Demand Forecasts, there are three major political or economic units located in the Mesa area. These units are found at Oraibi, Second Mesa, and Keams Canyon. Located at Oraibi is the Hopi Tribal Headquarters or government center, at Second

Mesa is the Cultural Center or tourist center, and at Keams Canyon is the Bureau of Indian Affairs and the U.S. Public Health Service hospital. If these units were to remain in their existing locations without change in the future, each would be equally weighted with respect to an evaluation of airport system requirements. However, the role of the BIA is expected to diminish and eventually be phased out. In addition, the Hopi Tribe is hopeful of constructing a new hospital on top of Second Mesa, more centrally located with respect to the population. Therefore, in evaluating airport system requirements, the Keams Canyon unit can be equally weighted with the Oraibi and Second Mesa units only for the short-range, and for the long-range, its weight should be downgraded.

Prior to identifying search areas, a thorough investigation of existing, planned, and proposed development was undertaken. This investigation included an evaluation of telephone communications and accessibility to electrical power, the existing water system, the location of planned fire stations and proposed civic centers, and an evaluation of existing and proposed subdivisions or other development. Following this investigation, search areas were identified in the general areas south of Oraibi, south and north of Second Mesa, and south of Keams Canyon.

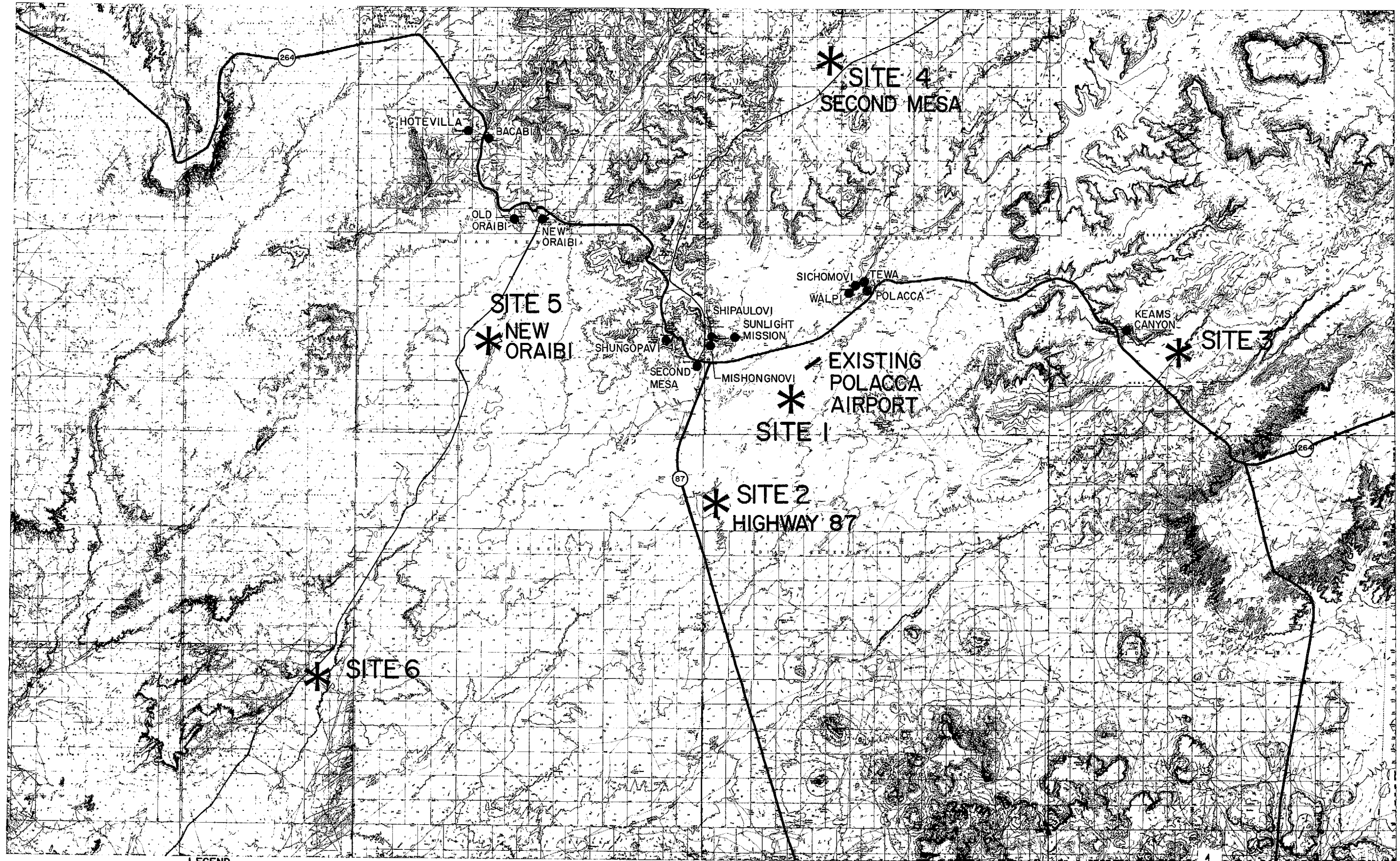
Specific sites were located within each of the search areas, and airport system alternatives were then identified. These alternatives were then coordinated with Hopi Tribe planners and community specialists, and there was the opportunity for public input. As a result of coordination and further analysis, seven system alternatives were formulated. These alternatives are as follows:

- I. Develop a new airport adjacent to Polacca Airport (Site 1); and close Polacca Airport.
- II. Develop a new airport along Highway 87 (Site 2); and close Polacca Airport.

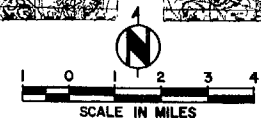
- III. Develop a new airport near Keams Canyon (Site 3); and close Polacca Airport.
- IV. Develop a new airport on top of Second Mesa (Site 4); and maintain Polacca Airport over the short-range, but close the airport in the long-range.
- V. Develop a new airport near New Oraibi (Site 5); and maintain Polacca Airport for the short-range, but close the airport over the long-range.
- VI. Develop a new airport along Leupp Road in the Joint-Use area (Site 6); and maintain Polacca Airport for the short-range but close the airport over the long-range.
- VII. Develop no new airports, do-nothing, and maintain Polacca Airport in its present state.

As can be seen, Alternatives IV, V, and VI, include maintaining Polacca Airport for the short-range. The purpose of maintaining Polacca Airport is to assure that there is an airport within about a 30-minute drive of the hospital at Keams Canyon. This requirement can be dropped over the long-range at that point in time when a new hospital is constructed on top of Second Mesa. Notice also, that Alternative III does not include maintaining Polacca Airport. This is because although the Keams Canyon airport would be greater than thirty minutes driving time from Oraibi. The Hopi airport requirements cannot be met by Polacca Airport, and therefore, there is no benefit in maintaining this facility. In all seven system alternatives, the long-range system is a one airport system serving the Mesa area.

The six new airport sites that were identified during the systems analysis are graphically illustrated in Exhibit 6-2. An on-site inspection was performed for each site, followed by a detailed inventory undertaken by Hopi Tribe planners and community specialists. Preliminary analysis of data resulted in the elimination of three potential sites. Site 1 was eliminated for financial and economic feasibility reasons. Although



LEGEND
 - - - - - RESERVATION BOUNDARY
 = = = = = PAVED ROADS
 ——— UNPAVED ROADS



No.	Revision	By	Appr.	Date

Approved
 By _____
 Date _____

R. DIXON SPEAS ASSOCIATES

Designed M.F.R.
 Drawn J.R.H.
 Checked R.O.K.
 Date JULY 1977

**HOPI TRIBE
 ORAIBI, ARIZONA**

**SITE SELECTION STUDY
 ALTERNATE AIRPORT SITES**

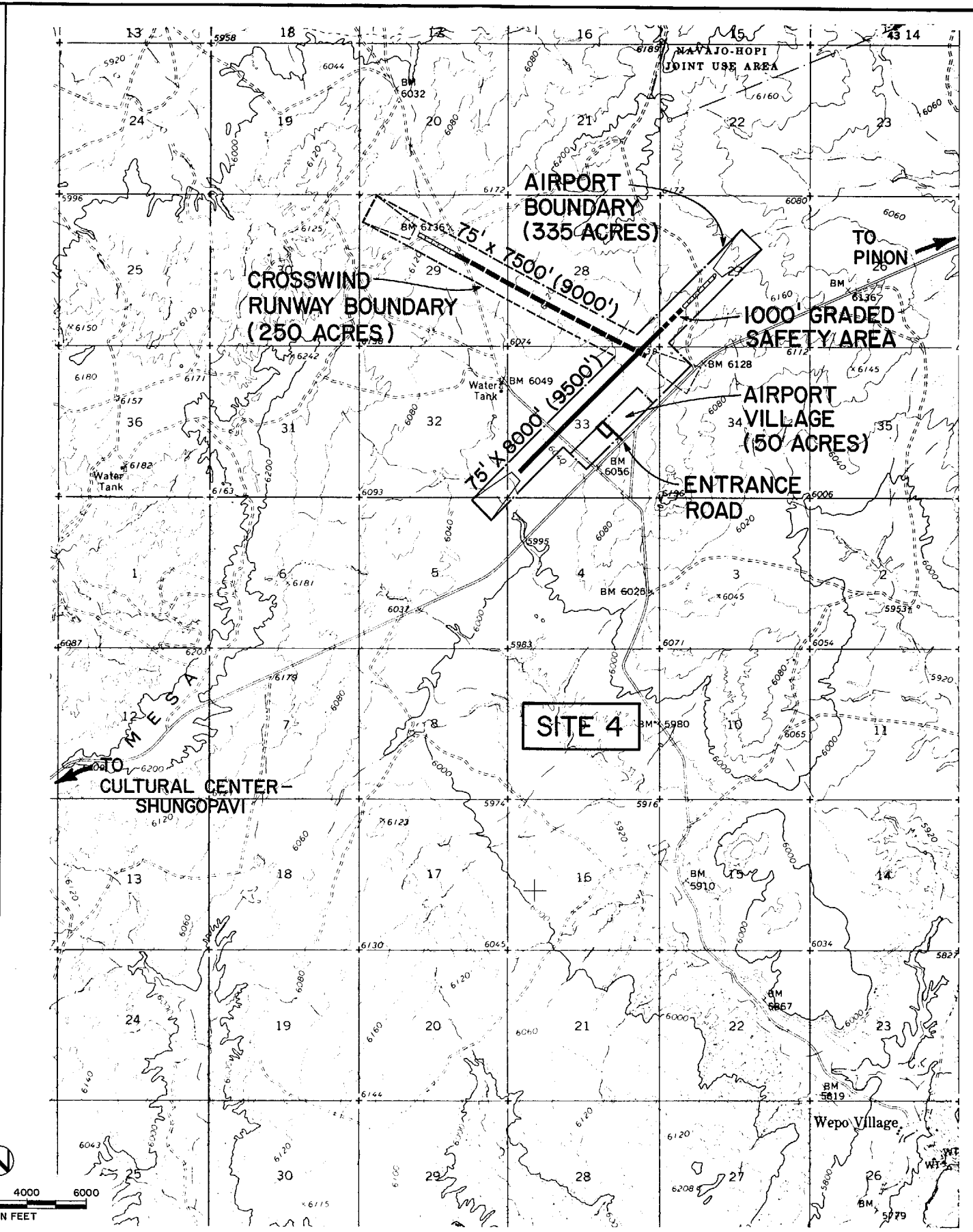
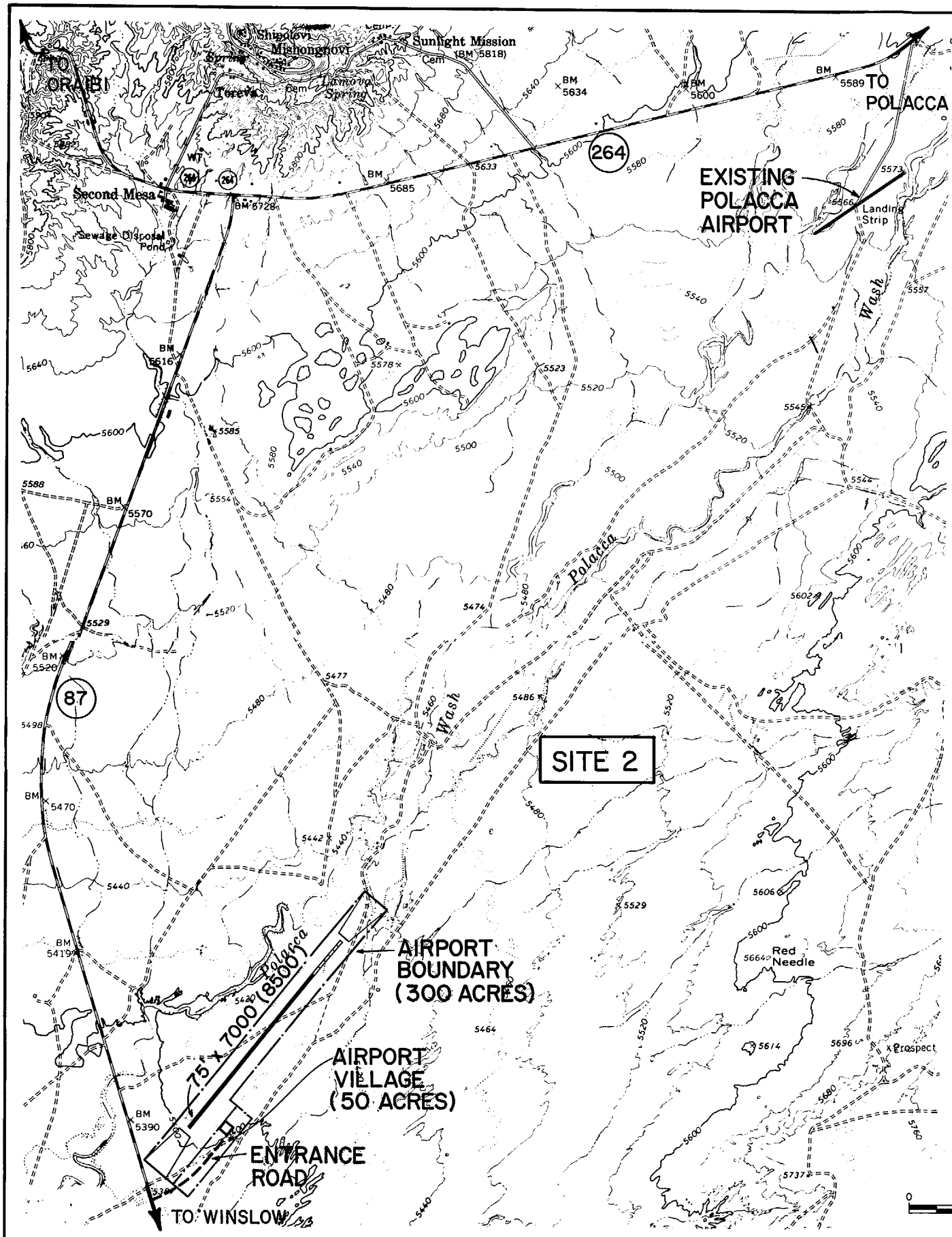
Site 1 is essentially the same as Site 2, the latter provides for frontage on a main highway, whereas Site 1 is three miles from the nearest highway. Because of its relatively remote location, it would be unlikely that Site 1 would draw a reasonable volume of patrons for the trading post, gas station, restaurant, or motel that will be needed to help support the airport. Sites 3 and 6 were also eliminated, because each is too distant a drive to Oraibi and Keams Canyon, respectively. In addition, each is greater than 30 minutes driving time to the Cultural Center, and only 60 percent of the Mesa area Hopi population is within a thirty-minute drive of Site 3. Only 40 percent is within a thirty-minute drive of Site 6.

As a result of the preceding analysis, four alternative airport sites remain for comparative evaluation to determine which best satisfies the Hopi Tribe's long-range airport needs, these are:

<u>ALTERNATIVE SITES</u>	<u>EXHIBIT</u>
o Site 2 - Highway 87	6-3
o Site 4 - Second Mesa	6-3
o Site 5 - New Oraibi	6-4
o Polacca Airport - Do-nothing Alternative	6-4

6.4 COMPARATIVE EVALUATION OF ALTERNATIVES

Identifying which alternative site will best satisfy the long-range aviation needs of the Hopi Tribe requires that each of the alternative sites be comparatively evaluated against the others. Six categories of consideration are utilized for the comparative evaluation, these are as follows:



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R. DIXON SPEAS ASSOCIATES

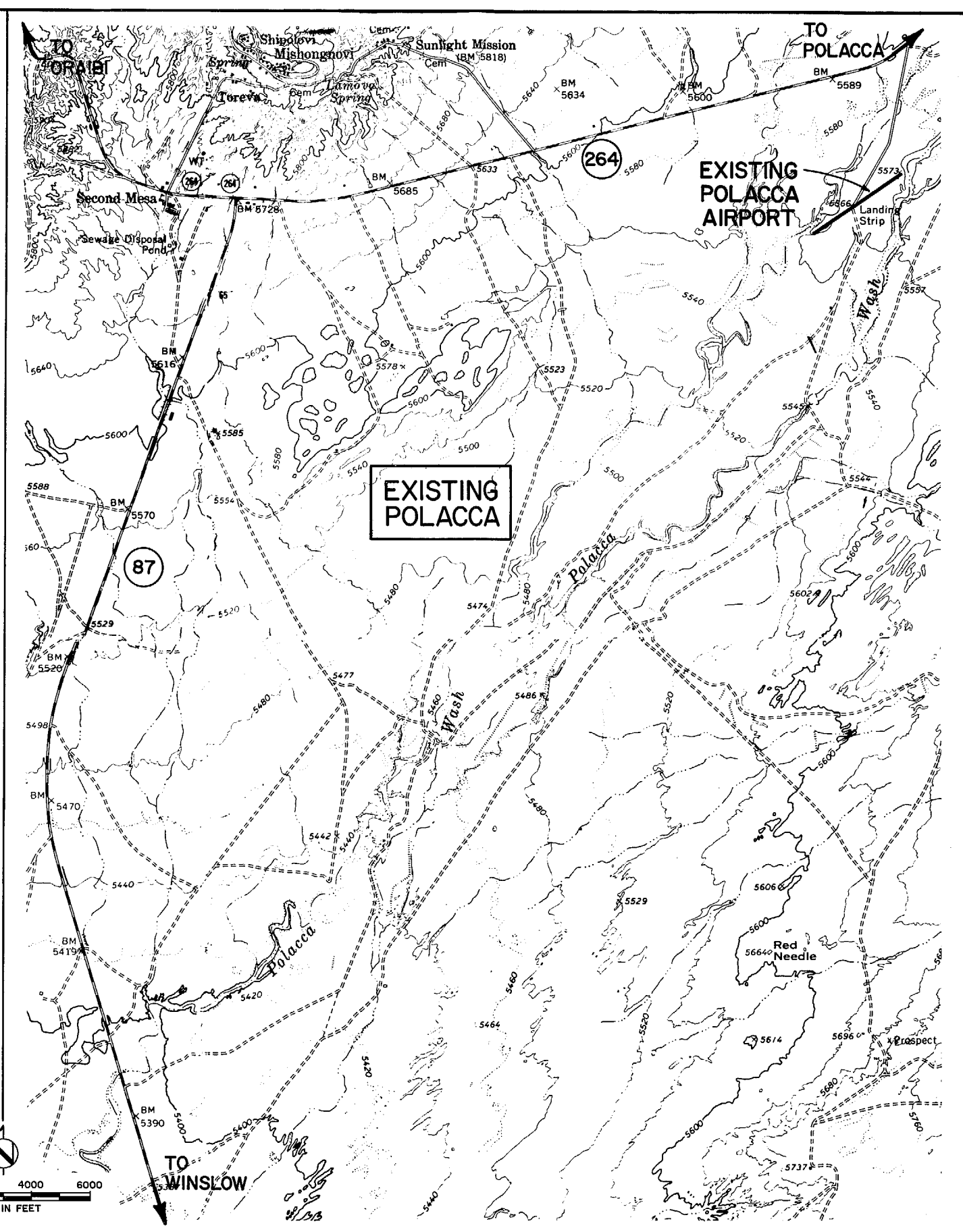
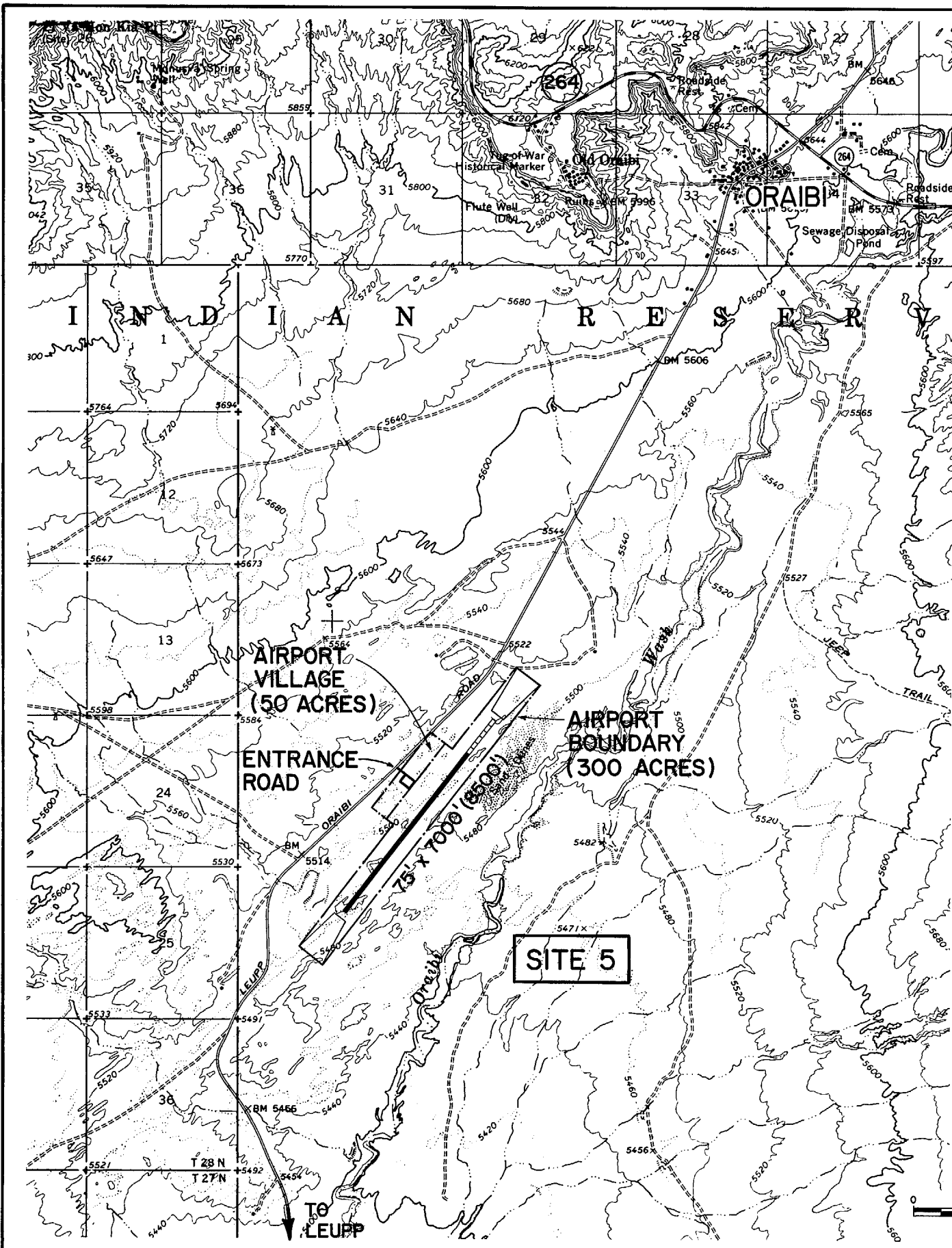
Designed R.O.K.
Checked M.F.R.
Date JULY 1977

Drawn J.R.H.

**HOPi TRIBE
ORAIBI, ARIZONA**

**SITE SELECTION STUDY
SITES 2 AND 4**

EXHIBIT
6-3



No.	Revision	By	Appr.	Date

Approved
By _____
Date _____

R. DIXON SPEAS ASSOCIATES

Designed R.O.K.
Checked M.F.R.
Drawn J.R.H.
Date JULY 1977

**HOPi TRIBE
ORAIBI, ARIZONA**

**SITE SELECTION STUDY
SITE 5 AND EXISTING POLACCA**

EXHIBIT
6-4

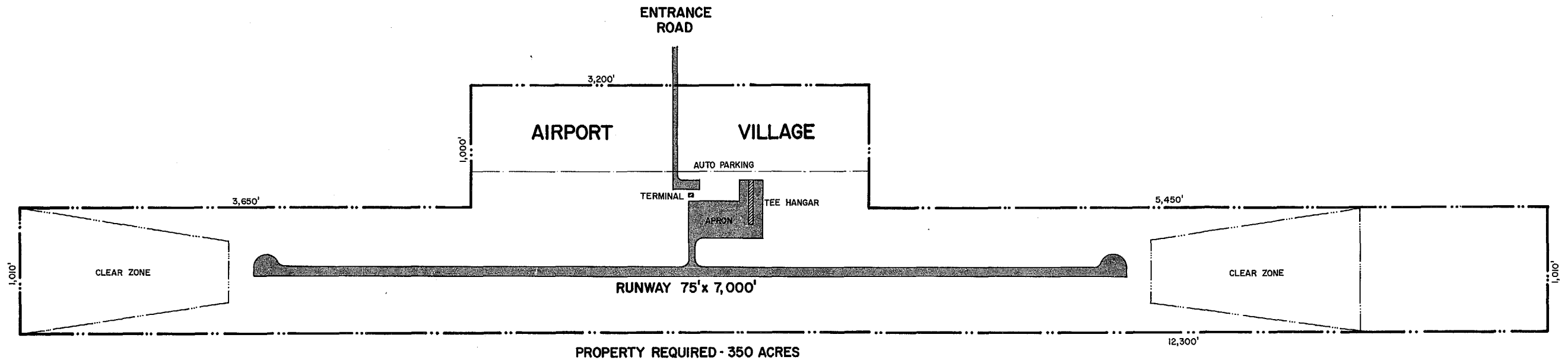
- Cost Considerations
- Accessibility Considerations
- Airspace and Aviation Considerations
- Economic Considerations
- Engineering Considerations
- Environmental Considerations

The subsequent paragraphs discuss the comparative evaluation of sites with regard to these considerations. Exhibit 6-1 in the Summary and Recommendations (6.1) presents a matrix summarizing the evaluations by site and category of consideration.

6.4.1 Cost Considerations

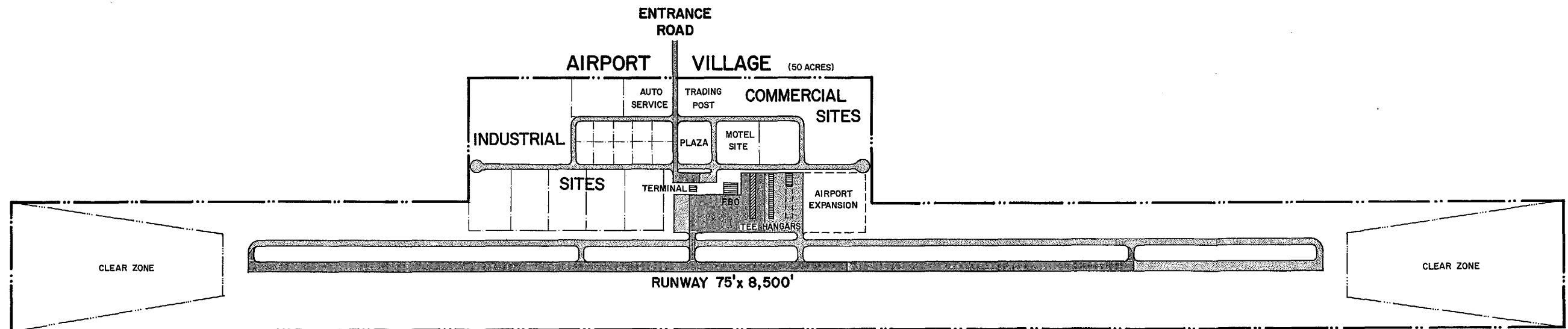
Cost considerations are based on developing an FAA general utility category airport. The basic design criteria for siting the new airport were determined in the facilities requirements analysis of the airport site selection study. This resulted in a need for an airport, as shown on the following exhibit 6-5 entitled Airport Development Concepts. A single runway 7,000 feet in length with taxiways, aprons and related support areas is the principal feature of the development. The airport area required is about 300 acres, not including 50 acres for the creation of an airport village. The facility requirements for Ultimate Development, as shown on the exhibit, were utilized in locating all potential sites in the lower desert area, and consequently the basic construction costs are the same except for variations in site characteristics. However, the Second Mesa location, being at a higher elevation and in steeper topography, will require a basic runway length of 8,000 feet, together with support facilities.

The basic construction costs for the Ultimate Development concept are tabulated as follows:



PROPERTY REQUIRED - 350 ACRES

INITIAL DEVELOPMENT



AIRPORT DEVELOPMENT
(300 ACRES)

ULTIMATE DEVELOPMENT

400 0 400 800 1200
SCALE IN FEET

Approved		By _____		Date _____	
No.	Revision	By	Appr.	Date	

R. DIXON SPEAS ASSOCIATES

Designed
ROK

Checked
ROK

Drawn
TMS

Date

HOPi TRIBE
ORAIBI, ARIZONA

AIRPORT DEVELOPMENT
CONCEPTS

EXHIBIT
6-5

Land - 350 acres	No cost
Landside Improvements	\$163,500
Access Road	
Auto Parking	
Utilities	
Fencing	
Airside Improvements	\$1,452,250
Site Preparation, including grading	
Itinerant and Hangar Aprons	
Runway	
Taxiways	
Lighting and marking	
Navigation Aids	\$23,000
Buildings	\$506,500
Terminal Building	
Tee Hangars	
Maintenance Hangar	
TOTAL CONSTRUCTION COST	\$2,145,250
Engineering and Administration (15%)	<u>\$322,000</u>
TOTAL AIRPORT DEVELOPMENT COST (Ultimate Development)	\$2,467,250

A discussion of the variations in construction cost at each of the final candidate sites with their estimated total costs is as follows:

- Site 2 - Highway 87

Adapting the previously described basic airport to this site will require considerable site grading to elevate the paved airfield areas above the flood plain. A subsurface drainage system will be required because of the saturated native soil conditions. The entrance road from Highway 87

is 4,000 feet in length. These additions will increase the development cost at this site to an estimated total of \$2,982,250 or \$515,000 above the basic airport cost.

- Site 4 - Second Mesa

As mentioned previously, the Second Mesa site is at an elevation 500 feet above the lower desert and the estimated gradient of the runway is considerably steeper than at the lower desert sites. This will require the lengthening of the basic runway by 1,000 feet to 8,000 feet, incurring added costs. Also, since the topography in this area is quite irregular, grading costs will increase over those at other locations. The total cost of airport development at this site is \$3,009,105 or \$541,855 above the basic airport cost.

- Site 5 - New Oraibi

The development of this site will have the least amount of grading, drainage and other construction problems. It is therefore considered to have an estimated construction cost equal to that for the basic airport development, or \$2,467,250.

- Polacca Airport

The cost estimate for the existing airport includes the addition of taxiways, aprons, improved entrance roads, buildings and utilities comparable to the other sites. However, the runway was retained at 4,000 feet in length. The resultant costs are estimated to total \$1,314,000 to add these improvements at the present airport.

Summary. The least expensive airport improvement is to retain airport operations at Polacca Airport, accepting the inadequacy of the 4,000 foot runway. The most expensive site to develop will be at Second Mesa. A comparison of estimated construction costs is noted in Exhibit 6-1, Evaluation Matrix, found in Section 6.1 herein.

6.4.2 Accessibility Considerations

Accessibility is evaluated to estimate which alternative the airport area will prefer, and which site best satisfies the Hopi Tribe's needs, from the standpoint of surface transportation. Exhibit 6-2 illustrates the individual alternative sites, the road system, and the Hopi Villages. All the roads shown are existing or planned two lane roads of generally equal grade. There are no existing or planned railroads, waterways, or transit systems providing supplementary surface transportation. A significant impact to the existing and planned road system will not result from developing any of the alternative sites.

Six criteria are used to comparatively evaluate accessibility. These are: a weighted average travel time and distance, Hopi population within 30-minutes driving time, and the driving time to the Tribal Headquarters, the Cultural Center, and the Keams Canyon Hospital. Travel times shown in Exhibit 6-4 were calculated assuming a 45 mph driving speed within one mile of a Village, 30 mph on the airport entrance road, and 55 mph elsewhere. The weighted average travel time and distance was calculated by weighting the time and distance by the Hopi population of the Villages located in the Mesa Area. These populations are presented in Exhibit 4-4, Section 4, and entitled Aviation Demand Forecasts. Since the Hopi population is concentrated in the area between Oraibi and Polacca, the weighted figures de-emphasize Keams Canyon and are therefore more representative of the Hopi Tribe's long-range needs.

- Site 2 - Highway 87

The Highway 87 site has a weighted average travel time and distance slightly greater than average for the four alternatives. Roughly 95 percent of the Mesa area Hopi population is within a 30-minute driving time from this site. The driving time from this site to the Tribal Headquarters and Cultural Center is about the same as from the Second Mesa site and Polacca Airport. Additionally, the driving time to the Keams Hospital only slightly exceeds 30 minutes.

- Site 4 - Second Mesa

The weighted average travel time and distance for this site is the greatest of all four alternatives. The greater weighted average is partially due to the population centered at the Villages of Polacca, Sichomovi, Tewa, and Walpi. Furthermore, the driving time to the Keams Hospital is estimated to be 40 minutes.

- Site 5 - New Oraibi

The New Oraibi site is the closest to the Tribal Headquarters, but also a 40-minute drive from Keams Canyon where the existing hospital is located. As with the preceding two alternative sites, approximately 95 percent of the Mesa area Hopi population is within a 30-minute drive. Overall, the weighted average travel time and distance is slightly below average.

- Polacca Airport

The existing airport site displays the minimum weighted average travel time and distance for all four alternative sites. One hundred percent of the Mesa area Hopi population is within a

30-minute drive. This is the only site which has a driving time to the hospital less than 30 minutes. In addition, this site is the closest to the Cultural Center.

Summary. From the standpoint of accessibility alone, it would appear that Alternative IV, Do-nothing Polacca Airport, is the most desirable alternative. However, consideration must be given to all airport users, including those using larger and high performance aircraft which cannot be accommodated at Polacca Airport. For these uses, the comparative analysis is not representative of accessibility since they will have to drive to Winslow's airport approximately 70 miles from Polacca. Therefore, from the standpoint of accessibility alone, Site 5 just south of New Oraibi is the most desirable. The remaining two sites are about equal with respect to accessibility.

6.4.3 Airspace and Aviation Considerations

Airspace and aviation considerations are assessed to determine which site best provides for the safe and efficient accommodation of aircraft flight. The airfield capacity, that is, the number of landings and takeoffs that can be accommodated, will be essentially the same for each site since each has a single runway and no airspace interaction with surrounding airports. With respect to the type of aircraft and time of day that activity can be accommodated, however, Polacca Airport is inferior to the three new sites. This is because Polacca Airport's short runway (4,000 feet) will not accommodate the larger aircraft, nor permit most aircraft to operate during summer mid-day periods.

There are five airspace and aviation evaluation criteria shown in Exhibit 6-4. Field elevation is shown because aircraft performance is to a large extent dependent on air density, and air density decreases with altitude increases. The runway length shown was calculated based

on field elevation, normal maximum temperatures, and the runway gradient that is expected at each site. Obstructions to air navigation are terrain or obstacles exceeding a specified height within a prescribed normal aircraft operating area around the airport. Obstructions in and by themselves are not a hazard; however, when combined with a high elevation or in specific locations, their presence is highly undesirable. The expected Height Above Touchdown (HAT) is the lowest altitude to which an aircraft can descent without the pilot having visual reference to the ground. This altitude is determined by the height of obstructions to air navigation in the final and intermediate approach areas, assuming installation of a VOR (an electronic approach aid) and availability of a final approach fix. The minimum HAT that can be expected is 300 feet; normally the HAT is expected to fall in a range between 400 and 600 feet, and a HAT greater than 800 feet is clearly undesirable. Because of unusual wind current encountered in areas of precipitous terrain, the expectation of air turbulence has been subjectively evaluated.

- Site 2 - Highway 87

Site 2 has the lowest field elevation of the four alternative sites. It appears that a runway having an insignificant amount of gradient can be developed, and therefore the runway length requirement is only 7,000 feet. There is terrain to the north near Shungopavi and Shipaulovi (see Exhibit 6-1) which is greater than 500 feet above the airport elevation and within 5 nautical miles (1 nm = 6,076 feet; 1 U.S. mile = 5,280 feet). Further, terrain to the southeast

within 3 nautical miles rises more than 200 feet above the airport. There is no identifiable penetration of the Part 77 civil airport imaginary surfaces. This site is located in a generally open area of sufficient distance from the mesas that air turbulence is not expected to be a safety factor, but light turbulence might be encountered during the early stages of the intermediate approach segment for a southwest instrument approach. Airfield visibility for the pilot is considered fair, as Highway 87 will assist in locating the facility.

- Site 4 - Second Mesa

The Second Mesa site is located at the highest elevation of all four sites, approximately 6,160 feet. Because of the high elevation and the expected steeper runway gradient, the required runway length for this site is 8,000 feet. One advantage to being located on top of Second Mesa is that the general area is without strong topographic features, and as a result there are no obstructions to air navigation. Furthermore, this type of terrain results in the lowest expected HAT. An area of major concern with this site is the possibility of air turbulence. A review of Exhibit 6-2 shows that there are many valleys leading up to the Second Mesa from different directions. These topographical features indicate that there is a high potential for slight to moderate air turbulence throughout most of the year at the airport. Airfield visibility for the pilot is

considered good since the location is on top of a mesa and in an area of some vegetation which will be cleared for the runway development.

- Site 5 - New Oraibi

The New Oraibi site is located at a relatively low elevation and would require a 7,000 foot runway. It would be difficult for a pilot to locate the airport in the lower desert area, except for its location adjacent to the Leupp-Oraibi Road and the Oraibi Wash. Terrain to the northwest, north, and northeast rises to elevations above 6,000 feet within 5 nm of the site. The expected HAT is 720 feet, considerably higher than the expected HAT for the other sites. Although no turbulence is expected, aircraft approaching to the southwest could experience strong updrafts.

- Polacca Airport

The existing Polacca Airport has an elevation of 5,573 feet, and requires a 7,000 foot runway length. However, because of the washes off each runway end, the airport site can provide only the existing runway length of 4,000 feet. Terrain surrounding the airport is more than 500 feet and 200 feet above the airport within a 5 nm and 3 nm radius, respectively, to the west, north, and southeast. Furthermore, terrain at Walpi penetrates the Part 77 Conical Surface. Although no air turbulence is expected at the airport site, light air turbulence is expected for the approach and maneuvering areas to the north between Sunlight Mission and Walpi and northeast between Polacca and Keams

Canyon. Airfield visibility is considered poor for the pilot because of the larger expanse of desert area in which the airport seems to merge. With respect to an aircraft conducting an instrument approach landing to the southwest, moderate turbulence could be encountered at low altitudes in the intermediate approach segment.

Summary. Although the Second Mesa site will require a larger runway, it is preferable to the other sites from the standpoint of airspace and aviation. This conclusion is drawn primarily on the basis of the spatial relationship of the other sites at the mesas. The mesas present potential hazardous conditions to aircraft approaching during low visibility or taking off during hot periods.

6.4.4 Engineering Considerations

Engineering considerations, including construction feasibility, involve a review of each site to determine its suitability for development of an airport. Each site will vary in its desirability for airport development because of the nature of the topography, suitability of the soils for construction, the amount of excavation required to meet design standards, and whether the site is subject to flooding. For construction, the capability of the soils on the site for pavement foundation is important. The location and availability of imported materials such as crushed rock and asphalt for concrete or soil treatment can be evaluated. Sources for primary utilities such as water, power, and telephone are important in comparing the differences between candidate airport sites.

A comparative site evaluation for the principal engineering and construction factors includes the availability of uniform topography, suitability of the soils for construction, volumes and ease of excavation, threat of site flooding, availability of materials, and location

of utilities. An engineering evaluation of each of the final sites is as follows:

- Site 2 - Highway 87

Topography. Because of its location in the lower desert areas, the topography of this site is very uniform and without strong topographic features, being similar to the existing Polacca airport site. The site is slightly crowned -- with the runway in the center between Polacca Wash and a lesser tributary to the southeast. The centerline gradient is 0.24%, as compared to the almost level site at New Oraibi and the much steeper gradient of 1.6% at the Second Mesa location.

Soils and Excavation. Soils at this location are alluvial clay, approximately 60 feet in depth, reportedly saturated below the surface, but suitable for excavation and grading. This is also the case at the existing Polacca airport, and may be less desirable than the sandy soil at New Oraibi and the shallow soils at Second Mesa where there is also evidence of the need for rock excavation. The amount of excavation required to prepare the Highway 87 site is increased considerably by the need to elevate the runway above the surrounding area because of wet sub-grade conditions and the sheet flooding which occurs in the area every few years.

Site Flooding. There is a possibility that sheet flooding will occur at this site, similar to the situation at the existing Polacca airport, and to a lesser extent at New Oraibi. However, the Second Mesa site would not have this problem.

Availability of Materials. The natural soils are suitable for subgrade development, but crushed rock base materials would have to be obtained at a distance of 10 miles. Crushed rock is available to all sites, but it appears that the Second Mesa site would have the longest haul (20 miles) for this material. Asphaltic concrete could be developed on the site, which is typical for all locations being considered.

Utilities. Water supply would be developed on the site by drilling a well. The water may tend to be saline in this location, whereas at the other locations water quality is expected to be good. Power and telephone sources are located about six miles from this site, compared to five miles at Second Mesa.

- Site 4 - Second Mesa

Topography. The topography of the Second Mesa site is irregular, forming several drainage tributary areas and channels. These drainage channels, along with the topography dictate the positioning of the runways. This would indicate that the location is not as well suited to airport development as those in the lower desert areas. Where the runway is shown at right angles to the contours (paralleling the road to Pinon), the runway center line gradient is 1.6% -- approaching the maximum of 2% for this category of airport. However, the crosswind runway shown would roughly parallel the contours and have a reasonable gradient of 0.5%. The 1.6% gradient is considerably greater than that of the other airports being evaluated and requires additional runway length to meet criteria.

Soils and Excavation. Surface soils at the location are not of great depth and there is some evidence of rock outcropping. While the soils would be suitable for foundations, the excavation required for airport construction would far exceed that required for the sites in the lower desert area. Excavation costs will probably be higher because of the potential rock.

Site Flooding. The proposed airport site is in a low valley area on the top of the mesa. There are numerous drainage channels collecting runoff from a number of small tributary areas. The airport runways have been positioned to avoid the drainage as much as possible, except for two channels, each draining 300 acres, which would cross the northwest/southeast runway alignment. This is not considered an insurmountable problem. Flooding is not likely to occur at this site as the numerous channels will quickly remove the water from the area. In this respect this site is to be preferred to those in the lower desert areas, which drain large tributary areas and which are closer to major washes subject to flooding during storms of high volume and short duration.

Availability of Materials. It is assumed that native soils will be suitable for subgrade preparation. Rock base material can be obtained at a source about twenty miles from the site, a distance which exceeds that of other sites. Asphaltic concrete can be developed on site or obtained at a location about ten miles from the site.

Utilities. A water tank located in the center of this area indicates that a water supply can be developed at this location. Power and telephones are located at a source near the Community

Center, about 10 miles distant, which exceeds the other sites being evaluated.

- Site 5 - New Oraibi

Topography. This site between Leupp-Oraibi Road and Oraibi Wash is relatively level. Sand dunes have accumulated due to wind and water erosion along the wash, but there are no other strong topographic features. This site appears to be easily capable of airport development, comparing favorably to other lower desert sites, as along Highway 87 and at the existing Polacca airport.

Soils and Excavation. Surface soils appear to be sandy in nature, but the basic soil is clay, reported to be up to 100 feet in depth. There are no rocks evident on the site. Excavation for this site to create the runway system would be minimal -- perhaps the least of any of the final sites under consideration.

Site Flooding. Hillside drainage from areas northwest of Leupp-Oraibi Road would traverse the site in one location. This drainage is from an area of 600 acres. It would have to be carried in a structure under the runway or diverted to clear the airfield area. Because of the level nature of the site, more local drainage channel work would be necessary to insure airfield drainage than that required at the Highway 87 or existing Polacca airport sites.

Availability of Materials. As in the other sites being considered, native soils are considered suitable for airport foundations. Rock base material is available at the site.

Asphaltic concrete would have to be developed on the site or transported from a local plant.

Utilities. Good water can be easily developed at this location by drilling a well. Telephone and power sources are very close (5 miles) at the town of New Oraibi. From the standpoint of utilities, this site is to be preferred to those near Polacca and on Second Mesa.

- Polacca Airport

Topography. The existing airport is located on a relatively level site between Polacca Wash and a major channel northwest of the airport. The major topographic features are the drainage washes which are located at each end of the paved landing strip. The channels make this site the least desirable from the topographic standpoint.

Soils and Excavation. Soils are a saturated clay existing to a reported depth of about 100 feet, similar to the Highway 87 site. Excavation at this location could be accomplished with ease, except for the major construction that would be required to realign the washes to permit a 3,000 foot runway extension. This excavation program is deemed unfeasible due to cost, engineering, and environmental problems.

Site Flooding. The major channels located at each runway end are in drainage ravines created by erosion due to past storms. These deep ravines will tend to keep all storm waters confined during normal rainfall periods. Flooding would only be likely during a 50 to 100 year storm period. In some respects, this

site is less likely to be flooded than the Highway 87 or possibly the New Oraibi locations because of the depth of the washes.

Availability of Materials. Because this is an existing facility, availability of materials is not a major factor.

Utilities. There is a good water well already at the location, and power and telephone are available along Highway 264, one mile to the north or at the town of Polacca four miles east. Utility availability at this location compares favorably to that of the New Oraibi site.

Summary. The foregoing review of engineering and construction considerations indicate that in general the sites in the lower desert area are to be preferred. The two most likely candidate sites are at the Highway 87 location and the New Oraibi site on the Leupp-Oraibi Road. Of these two, which are almost comparable, there is some advantage to the New Oraibi location due to the closer availability of raw materials and utilities, and better soil and foundation conditions.

6.4.5 Environmental Considerations

An on-site review of each of the candidate airport locations was made to study environmental concerns. This work was accomplished by the staff of the Hopi Tribal Council and questions were guided by the requirements for site selection delineated by the Federal Aviation Administration Airport Master Plan Program. This program (a DOT order) lists a number of potential effects which, if produced by a

proposed action, would be likely to result in a significant impact on the environment. These effects include:

- A noticeable change in the sound level for a substantial number of people.
- The displacement of significant numbers of people.
- The division or disruption of an established community.
- Adverse aesthetic or visual effects.
- Adverse effects on areas of unique interest or scenic beauty.
- Alteration of the behavior of species of wildlife or interference with important breeding, nesting or feeding grounds.
- An increase of air or water pollution levels, or an adverse effect on the water table or water supply of an area.
- Disruption of the ecological balance of a land or water area.

The environmental setting of Hopiland has been described as follows:

Topography:

The Hopiland is a high desert area located on the Little Colorado Plateau. The terrain is characterized in the northern portion by a long fingerlike extension of Black Mesa, while the southern portion generally exhibits a more rolling topography. Large, intermittently spaced buttes and rock formations, uniquely designed and colored by nature, enhance the environmental qualities and beauty of the southern portions of the Hopi Reservation. Whereas the northern portion of the reservation is characterized by many mesas, the southern portion is generally rolling desert. The reservation has a low of 4,900 feet in the southwest to a high of 7,000 feet in the northeast.

Flora and Fauna:

Vegetation and woodland species are limited which is characteristic of this high desert environment. The basic vegetation of the area would include: the primitive forest stand of Juniper and Cedar trees, small areas of cottonwood stands, mesquite bushes, a variety of species of cacti and a fragile floor covering of wild grass. Indigenous fauna includes prairie dogs, kangaroo rats, ground squirrels, mice, rock squirrels, chipmunks, wood rats, pocket gophers, some coyotes and bobcats. Dove, jackrabbits and cottontail habitats are fairly populated within the Reservation and in many cases used as a basic source of food supply by the Hopi people.

Climate:

Climatic records show a relatively mild temperature variation, ranging from a low of 16°F in January, to a high of 89°F in July, and averaging about 51°F. On the average there is 10 inches of annual rainfall, with about 3 inches occurring during July and August. Most of the water resource needs are derived from wells and the few springs in the area. Winds prevail from the southwest.

General. A summary matrix showing environmental information for each of the final candidate sites is found in Section 6.1 of this study. Review of this material will show that environmental concerns are not major issues in the site selection process. The factors which are not applicable because there is no environmental impact associated with any of the candidate sites include existence of any rare or unique flora/fauna, impacts on historical or archaeological sites, effects on underground or surface water, threat of air pollution, and relocation of residents.

The environmental factors which do enter into the evaluation process include the following:

Proximity to parks, wildlife and recreation areas. No parks or recreation areas would be affected by any site development. However, the Second Mesa site is reportedly an area where wildlife exists and could be an important bird habitat. In this respect, then, this site is less favorable than the other candidate areas in the lower desert where wildlife is not significant.

Effects on prime agricultural soils and grazing areas. Prime agricultural soils do not exist in the candidate airport locations. In some respects, all of the candidate sites may be used for grazing, even in the areas around existing Polacca airport. The latter airport, because it is developed now, could be considered as having the least impact on grazing lands. The Second Mesa location is less suitable for agriculture or grazing than those at the Highway 87 and New Oraibi locations.

Area utilized for sacred or religious ceremonies. The Highway 87 site is considered important with regard to this environmental concern since it is the source area for snakes used in the ceremonies. Therefore, it would have to be devaluated when compared to the other locations which do not have this problem.

Threat of noise pollution. The Second Mesa location would avoid this concern almost entirely; the sites at Highway 87 and the existing Polacca airport could create some noise impact problems if approach and local traffic patterns were not controlled to avoid the community of Polacca and nearby subdivisions. The New Oraibi site has the greatest potential

for creating a noise problem due to an approach path from the north which would be just east of the community, generally following the wash line. The New Oraibi site should receive the greatest devaluation in this respect.

Visual impact of airport. The least desirable airport location from a visual standpoint is New Oraibi. It should be devaluated due to the fact that it would be quite apparent as viewed from the Old Oraibi site. Both existing Polacca airport and the Highway 87 sites would be seen from developed community areas along Highway 264. The site creating the least visual impact would be Second Mesa. This location could only be seen from the roadway to Pinon, but no communities would look down on the airport location.

Summary. Any airport constructed in the scenic Hopi Reservation will be incongruous from an environmental standpoint. Of the sites being considered, the Second Mesa location will be the least objectionable.

6.4.6 Economic Considerations

Economic considerations are concerned with the suitability of the airport for support of aviation related commercial or industrial activities or other uses which may become feasible due to the construction of the airport, access roadways, and utility systems. For example, user traffic to an airport, together with adjacent highway traffic, may make a commercial venture feasible. The development of a water supply could encourage agriculture or the introduction of power may facilitate industry.

An analysis of the candidate sites with respect to their economic potential is as follows:

- Site 2 - Highway 87

The proposed airport location adjacent to the main highway to Winslow and the development of utilities suggests this location may be feasible for commercial or industrial activities related to the highway and on the airport. Probably these activities would be concentrated more toward the highway than the airport, as the airport terminal would be 4,000 feet from Highway 87.

- Site 4 - Second Mesa

This site is remote from high volume highway traffic which could help support airport development. Also, airport destined traffic by itself is not expected to be at a level sufficient to support commerce and industry. Adjacent lands are not suitable for intensive development or agriculture. Therefore, the prospects for the Second Mesa location as an economic generator are low.

- Site 5 - New Oraibi

The airport is located adjacent to the Leupp-Oraibi Road, anticipated to be the future main highway to the Reservation from Flagstaff. An airport village concept could be developed adjacent to the highway and as part of the airport, thus maximizing the potential activity exposure. This location is rated as having a good economic potential for commerce and industry.

- Polacca Airport

Polacca airport is a mile from highway 264 and must compete with the nearby Polacca community for commercial or industrial activity. This location is the least desirable from the standpoint of generating economic activity related to airport development.

Summary. The airport having the best opportunity for airport related development was considered to be Highway 87, although in the future the New Oraibi site could be considered as having an equal potential.