<Introduction>

The most complex occupation of Cedar Mesa was during the Pueblo period. Not only do we find ceramics from two different traditions, which are usually assigned to the differing Mesa Verde and Kayenta branches of the Anasazi tradition, and the occurrence of the intensive use of the canyons, but it is also the only period which can be subdivided so that changes within the period can be examined. The additional complications, compared to the earlier occupations, are partially offset by the lack of the site classification complexity found in the Grand Gulch phase, as the Pueblo period has, in the main, the Mossbacks pattern of habitation sites and limited activity field stations. Even with this simple site function structure, in many situations, the number of sites belonging to any single class of interest becomes too low to do anything of statistical significance. This is one law of data analysis, the Alfred Law, that states no matter how large your initial sample is, by the time you have controlled for every variable of interest, your working sample is too small to do anything of statistical significance. Another, opposite law of data analysis, is that no matter how small and well controlled your initial sample is, there are
Matson, Lipe and Haase (Jun. 90) XI-2 always too many errors or ambiguities in the data to do anything of statistical significance. Both of these problems appear a number of times in this chapter.

Given the greater complexity in this period, this chapter differs in a number of ways from the two preceding ones. While the initial quadrat analysis, complete with hypervolume summary, is similar, the on site data analysis section is different. This portion is based largely on Haase (1983a) and is where some of the ideas used earlier are most fully discussed and justified. Most of this section is based on the remains recovered from Hardscrabble, Bullet, and North Road, with the Upper Grand Gulch and West Johns drainages not being used. The following section examining the distribution of Pueblo sites and the population estimates is similar to the earlier comparable sections. Changes within the Pueblo occupation are examined and different interpretations about the nature of the Cedar Mesa occupation are evaluated. Finally, the basic findings of Pueblo settlement patterns are recaptured and integrated.

<Quadrat Analysis>

<Elevation>

Our basic operating assumption for this period, as for earlier periods, is that the Pueblo Anasazi were farmers. If climatic conditions were similar to those of today,
Matson, Lipe and Haase (Jun. 90) XI-3 successful rainfall farming could take place only at the higher elevations on Cedar Mesa and only those higher elevation with deep-soils. If rainfall farming was the main subsistence activity (Lipe and Matson 1971a), we would expect habitation sites to be located in respect to these arable soils. Further, given the dispersed settlement pattern found on Cedar Mesa, we would expect habitations to be located immediately adjacent to arable soils. Therefore, quadrats with Pueblo habitation sites present should be higher in elevation and be covered with higher percentages of dense pinyon-juniper than expected.

The elevations of Pueblo habitation quadrats (n of 35), Pueblo limited activity quadrats (n of 42), and all 76 quadrats are plotted in Figure XI-1. It is obvious from this figure that Pueblo habitation quadrats are significantly higher than expected, with nearly three-fourths of them having higher elevations than the overall median. None of the highest four quadrats, however, have habitation sites, which may suggest a high altitude truncation, like that found for the Grand Gulch Phase. We will return to that question later. Only two quadrats with elevations lower than 1830m (6000 ft) have Pueblo habitation sites; none of the 13 lowest quadrats do. If we look at the "residuals", that is, the first quartile of the distribution of habitation quadrats that do not fit the high elevation hypothesis, we find most of them
Matson, Lipe and Haase (Jun. 90) XI-4 either are effectively more mesic than their elevation above sea level indicates, or have other characteristics that indicate the presence of arable soil. The three lowest are all from North Road and have effective or equivalent elevation much higher than their measured ones. The next quadrat, Bullet 17, has two cliff dwellings and is close to the only substantial canyon bottom alluvium in the five drainages, in lower Bullet Canyon. Bullet 17 is also close to one low elevation deep-soil divide areas, such as found on the adjacent quadrat, Bullet 14, which is also found in the first quarter of the elevation range. Hardscrabble 3 has the only possible Pueblo habitation site in the Hardscrabble drainage quadrats (and one that is a member of the dubious habitation class). Hardscrabble 3 is the highest quadrat in this drainage and is located in a deep soil divide area. West Johns 17-1 is another member of the dubious habitation site class and has features that may be the results of a series of cists rather than a dwelling. This quadrat is located close to the mesa rim, and does not have any obvious agricultural potential nearby. It may be remembered that this quadrat also had a dubious Grand Gulch Phase habitation site. Bullet 5 is near Bullet 14 and in a similar environment, close to the deep soil Sheiks-Bullet divide. These two quadrats are in apparently good agricultural locations, except for their slightly low elevations. Neither one is very far from the
Matson, Lipe and Haase (Jun. 90) XI-5
lower Bullet Canyon bottom soils.

Examination of the elevation residuals, then, indicates that these quadrats are found at effectively higher elevations (North Road), have dubious habitation sites (Hardscrabble 3, West Johns 17), are cliff dwellings (Bullet 17) with access to canyon bottom deep soils, or are located on deep soils at only slightly lower elevations with access to canyon bottom soils (Bullet 5 and 14) (Figure XI-2). What is striking is that no quadrat in Hardscrabble or West Johns at an elevation below 1885 m (6200 ft) has a clear, unequivocal habitation site. This suggests that 1885 m is the lower limit for successful rainfall agriculture. Twenty-five of the 35 habitation quadrats are located between 1926 m (6320 ft) and 2045 m (6710 ft), a range of only 125 m (410 ft).

The concentration of Pueblo habitation quadrats into a relatively, narrow, high elevation band is similar to the preceeding Mossbacks Phase, for which we have suggested a similar adaptation (Lipe and Matson 1971a). The Mossbacks appears to have had an even narrower, and higher elevation pattern. If we use the Wilcoxon test to compare the habitation quadrats of the two time periods, counting many quadrats twice (those that have habitation sites of both periods) we do not find a significant difference (this unit normal deviate 1.1208, .14 probability deviate 1.08, .13 deviate, 1.126). If we recast the test to compare those
Matson, Lipe and Haase (Jun. 90) XI-6 quadrats that have Basketmaker III habitation sites with those that have Pueblo, but no Basketmaker III habitations, eliminating counting quadrats twice, we find a significant difference (sample sizes of 15 and 23, this rank sum is 228.5, .05 probability rank sum is 236, .025, 226). The Mossbacks adaptation, then, is located at higher elevations than the general Pueblo one.

Given that two major limitations on agriculture are moisture and temperature, the differences in distributions is consistent with the climate being dryer or warmer during the Mossbacks times. Since the Basketmaker III occupation lasted no more than half the length of the Pueblo, we might expect that conditions were more marginal in the earlier period. If the growing season is critical, we would expect lower elevations; if precipitation is critical, then, higher. If both are critical, then, we expect sites to be at higher elevations that is also truncated at the top like the Grand Gulch Phase. Since the Mossbacks distribution is higher than later, it appears that moisture was the most critical limitation for agriculture on Cedar Mesa at that time. Differences in crops and maize races, used as well as temporal trends within the Pueblo period may make this explanation too facile.

While the Pueblo habitation quadrats are higher than expected and lower than the Mossbacks, how do they compare with the Grand Gulch Phase? On general grounds we might
Matson, Lipe and Haase (Jun. 90) XI-7
expect them to be higher. For maize to be successfully
grown on the Colorado Plateau, it must, above all, develop
two traits over its original Mexican domestication:
tolerance to drought and the ability to mature in short,
cold seasons. Most Mexican maize is planted after the
beginning of the monsoon season, as is low elevation Pima
and Papago maize. The Plateau pattern of initiating growth
on winter moisture and maturing growth on the monsoon
precipitation is practiced by a only a few northern groups
such as some Tarahummar (Pennington 1963). Drought
resistant maize is necessary for this planting strategy.
In addition the crop needs to be brought to maturity in a
short season with long days, requiring further genetic
modification. The first change, drought resistance, must
have occurred for the Grand Gulch adaptation to be
successful. The second development would allow increasing
use of the higher, better watered areas, where the drought
resistance factor would become less important. Thus, we
would expect increasingly high elevation (or more
northerly) maize use through time, everything else being
equal.

We can test to see if this expected difference occurs
simply by comparing the elevations of the habitation
quadrats using the Wilcoxon test. In this comparison many
quadrats are counted twice, as many had habitation sites of
both periods present. The trend is as expected and is
significant at the .10 level (this unit normal deviate 1.356, prob .09 unit normal deviate 1.341, .08 is 1.405). Given the large number of quadrats in both classes, we can recast the test to compare those quadrats with Grand Gulch habitation sites and no Pueblo habitation sites with those that have Pueblo habitation sites and no Grand Gulch habitation sites. This procedure reduces the sample sizes to 11 and 15, but a more "significant" results occurs (this rank sum 108.5, .025 rank sum is 110, .01 rank sum is 103). On the average, then, Pueblo habitation sites are lower than those of the Mossbacks Phase and higher than those of the Grand Gulch Phase.

The Pueblo period, shows a distribution in between the other two periods with elements similar to both. While the median elevation is situated exactly halfway between the medians of the two earlier periods, the Pueblo dispersion is much closer to the Grand Gulch Phase than the Mossbacks Phase (Pueblo interquartile range is 96m, compare to 110m and 59m.) A distinctive difference between the two earlier phases is the high elevation truncation occurring during the Grand Gulch Phase. This we argued to be indicative of temperature limitations on agriculture. While this truncation is not as evident in the Pueblo sites, it is of interest that none of the four highest elevation quadrats have Pueblo habitation sites.

If this truncation occurs, it stands to reason that
Matson, Lipe and Haase (Jun. 90) XI-9
the highest habitation sites will be smaller than ones less marginal. We can contrast those quadrats in the third quartile of the Pueblo habitation range with those in the fourth. We will run this test two ways. First we will use all quadrats, including those without sites. This version will include the four empty quadrats with the highest elevations and include the proportion of empty quadrats in the two quartiles. The second test will compare only habitation quadrats. As a measure of "size" we will use the number of Pueblo catalogue entries, or artifacts. This number will include limited activity sites, although as per our earlier analyses, the great majority of Pueblo material is found on habitation sites.

The first version of the tests finds that the third quarter quadrats do have more material, but not to a significant extent (this rank sum 179, .10 rank sum is 154). Comparing only the quadrats with habitation sites results in a reverse trend, with the higher elevation sites being larger, but not to a significant amount (sample sizes of 9 and 10, this rank sum 84, .10 rank sum is 73). Note that the Alfred Law is coming into effect, as our sample sizes are becoming very small. From these two tests, we can conclude that there is not good evidence of a truncation in elevation, and that there probably are Pueblo habitation sites at the highest Cedar Mesa elevations. In this respect, then, the Pueblo pattern appears to be
Matson, Lipe and Haase (Jun. 90) XI-10
similar to the Mossbacks adaptation.

<Elevation, Pueblo Limited Activity Sites>

Our original proposition that the general Pueblo and
Mossbacks settlement patterns were essentially the same has
been supported in terms of elevation ranges for habitation
sites. If this identity is true for non-habitation sites,
Pueblo limited activity sites should, in the main, be field
stations, sites immediately adjacent to agricultural
fields. Since the Pueblo habitation sites are located in
high elevation areas that appear to have a high
agricultural potential, we expect little difference in
overall distribution between habitation and limited
activity sites, with a few exceptions. The expected
exceptions would be canyon bottom locations suitable for
flood water farming, sand dune agriculture, as well as
limited activity sites that were not field stations, such
as storage facilities of graineries and cists, but are
agriculturally related. Non-agricultural pursuits of
hunting and lithic reduction sites ought to have very
different distributions, as well as being identifiable by
their contents. Sites in each of these categories were
identified in Chapter VII, but the lithic reduction class
is the only one of any size. The great majority of the
limited activity sites, though, ought to be field stations.
Storage and hunting campsites were not found with in the
Matson, Lipe and Haase (Jun. 90) XI-11
small sample of Mossbacks limited activity sites. Because
of the drainage canyon survey we would also expect more
canyon related sites in the Pueblo period than in the
Mossbacks Phase.

Figure XI-1 also illustrates the elevational
distribution of all quadrats with limited activity sites.
The three parameters of first quarter, median and third
quarter are virtually identical with that of the habitation
quadrats, with the maximum deviation being no more than six
meters (20 ft) in elevation. This is convincing evidence
that the great majority of both site classes do have a
similar distribution, that is, in the elevations of
concentrated arable soil.

The close association of habitation and limited
activity sites can be measured in other ways as well.
Twenty six of the 35 quadrats with habitation sites also
have Pueblo limited activity sites. Of the total of 77
limited activity sites, 50 are found in quadrats that have
Pueblo habitation sites. Of the 27 sites that are not,
seven are lithic reduction sites and three are hunting
campsites, leaving only 17 possible farming limited
activity sites, that is, both storage and field station
sites. Whether one looks at elevation or at associated
sites within quadrats, the Pueblo pattern is mainly that of
a single mode, like that of the Mossbacks and differs
greatly from that seen for the Grand Gulch Phase.
In spite of this great overall similarity in elevation, there are differences in the tails, particularly the lower tail. This "residual" should have a disproportionately high percentage of sites that do not fit into the field station class, as briefly described above.

The lowest elevation Pueblo limited activity quadrat, West Johns 15, includes four sites, all with Grand Gulch components, that we previously classified as hunting campsites on the basis of the existence of some site facilities, numerous projectile points and fragments, the lack of groundstone, and the absence of any potential of arable soil. In addition, petrographs with animal images are present. Two of these four sites had Pueblo components and these were identified in Chapter VII as hunting-staging campsites. Hardscrabble 13-1 is a site that is very similar to these last two. At least one hearth is present, as are ceramics, large Grand Gulch Points, small Pueblo Points, bifaces, but an absence of groundstone. This small two-component site is not located in an area with any deep soils present today. This low elevation small site is best interpreted as a hunting campsite. So the two lowest quadrats are hunting related.

The next two quadrats, Hardscrabble 4 and 5(Figure XI-2), had been referred to previously in discussions of Grand Gulch and Mossbacks Phases. These two kitty-corner quadrats contain the lowest elevation possible Basketmaker
Matson, Lipe and Haase (Jun. 90) XI-13
II habitation site, the lowest Mossbacks site of any kind
and lowest possible Pueblo agricultural site. Some of the
largest sand dunes on Cedar Mesa pass through these two
quadrats. Our dilemma in suggesting possible uses of this
area has previously floundered on the fact that, in
general, these low elevation sandy areas have Indian rice
grass as well as dunes and this one was particularly noted
as having abundant Indian rice grass. Further, for dunes
need to be located on some sort of impervious surface that
forces the water to discharge for successful extreme water
storage agriculture. Inspection of these two quadrats in
July 1982 showed that these dunes were sitting on slickrock
which would serve this function. Further, the dune area
that has the three sites surrounding it, does not have
particularly abundant Indian rice grass, although other
less active dune areas within several hundred meters did
have abundant Indian rice grass. These observation s
indicate that this area could be used for extreme water
storage agriculture, the only such obvious area within the
quadrat survey. Hardscrabble 4-1 with Grand Gulch,
Mossbacks and Pueblo components probably results from such
intermittent use over a long period of time.

The next quadrat in elevation, North Road 8, has two
limited activity sites, neither of which is likely to be
involved with agriculture. North Road 8-3 is by far the
most substantial and has previously been classified as a
Matson, Lipe and Haase (Jun. 90) XI-14 lithic reduction site. The other site, North Road 8-2 is simply the remains of a single Mancos style water jar, possibly dropped in transit, as a good spring is adjacent to this quadrat.

North Road 5 is across the canyon from the heavily occupied quadrats 10 and 11. Perhaps it was not as heavily utilized because of its general southward exposure compared to the generally northeastern and, therefore, effectively more mesic environment of North Road 10 and 11. The only Pueblo site, North Road 5-8, is a three component site and located in a deep soil area. This Pueblo component is probably most likely a field station for rainfall farming, as we previously argued for the Mossbacks component. North Road 10 and 11 have substantial habitations and were discussed in the previous section dealing with habitation sites.

The next to the last member of the first quartile, Hardscrabble 14, has been discussed as an exception both in the Mossbacks and Grand Gulch Phases(Figure XI-2). There is a single Pueblo component present in 14-1 and either two or three present in 14-2. One Mossbacks component is also present in 14-2 as is one or two Grand Gulch components. This particular spot seems to have been utilized a number of times over the years like Hardscrabble 4 and 5, but like the lower area, usually not for habitation. As we have discussed before, this area is sandy and has deep soil, but
Matson, Lipe and Haase (Jun. 90) XI-15 does not really have extensive sand dunes. The farming strategy may represent a compromise between sand dune agriculture and rainfall agriculture. Another possibility has to do with flood water farming, for two drainages occur here today which are not cut out and might be suitable for flood water farming.

The last first quarter quadrat is North Road 2 which is located on a deep soil divide between the two main branches of the North Road Canyon. This is a location that appears to be suitable for agriculture and the site itself, might be a field station. Only two quadrats in the first quartile, then, fit the various criteria for rainfall farming field stations. The other quadrats have either hunting campsites (2), extreme water storage (2), Lithic reduction and pot drop (1) and the ever anomalous Hardscrabble 14.

Another way to examine the relationship of limited activity sites and elevation is to look at those quadrats which have only limited activity sites, also plotted in Figure XI-1. These 16 quadrats represent 27 sites. Eleven of these 27 sites are the seven lithic reduction sites and the three hunting campsites and one is the pot drop (North Road 8-3). Thus, at a maximum, only 16 can represent field stations. Of these 16, the site in Hardscrabble 4 is apparently one of extreme water storage, and the two in Hardscrabble 14 also differ from the
Matson, Lipe and Haase (Jun. 90) XI-16 expected high elevation deep-soil divide field stations. Of the 27 sites found in the quadrats with only limited activity sites, only 13 can be the expected field stations, compared to 57 out of 77 total Pueblo limited activity sites being possible field stations. So limited activity sites which are found in quadrats without habitation sites are twice as likely to have functions other than field stations than those found in quadrats with habitations.

The two highest elevation limited activity quadrats, Upper Grand Gulch 9 and 1 have only lithic reduction sites present. Six of the eight Pueblo lithic reduction sites are found in quadrats without habitation sites. This is not unexpected. First, one might bring the material to one habitation site if it is nearby, and second, one would not expect good lithic sources to be located in the same areas as arable land as pointed in the introductory settlement pattern chapter. Somewhat surprisingly, all five storage sites are located in quadrats with habitation sites. This is likely to be the result of the smallness of the "true" sample of storage sites, two quadrats, and the fact that graineries are located in canyons which were not well sampled by the quadrats.

<Deep Soil Pinyon-Juniper>

<Pueblo Habitation sites>

While elevation is a good indirect measure of
Matson, Lipe and Haase (Jun. 90) XI-17 precipitation, it does not take into account that other important prerequisite of agriculture, deep soil. The percentage of each quadrat that is covered in dense pinyon-juniper is an indicator of both precipitation and the presence of at least moderately deep soil. Figure XI-3 illustrates the distribution of the quadrats with Pueblo habitation sites. If amount of dense pinyon-juniper is directly related to amount of soil which is arable under rainfall farming, we would expect a one tailed distribution, with most habitation quadrats concentrated against the high percentage end. This is exactly what occurs, with the fourth quartile having less range than the third, which in turn has a smaller range than the second. Note that fully half of the habitation quadrats have 80% or more of their area covered by dense pinyon-juniper. This is considerably greater than the 72.5% median of the Grand Gulch Phase and the 61.5% median of all 76 quadrats. The 80% median, however, is identical with that of the Mossbacks habitation quadrats, and the Pueblo third quartile of 93% is one percent lower than that of the Mossbacks. The lower quarter of the Mossbacks ends at 61% compared to 54% of the Pueblo period. So, similar to the situation in elevation, the Pueblo distribution appears to lie between the Basketmaker II and III ranges, with the upper portions being very similar to the Mossbacks, but the lower portion being more spread out like that of the
Matson, Lipe and Haase (Jun. 90) XI-18 earlier Grand Gulch Phase. Before attempting to test the significance of these distributions, let us examine the residuals of the lower quarter with respect to agricultural potential.

The quadrat with the least amount of dense pinyon-juniper is that of Bullet 17, a quadrat with two cliff dwellings, situated on the side of lower Bullet Canyon, directly above the alluvial soil in the canyon bottom, although no good access to the canyon is obvious today (Figure XI-2). Deep soil divide areas of relatively low elevation are also present directly to the north. West Johns 17 has a questionable habitation site and is located on the extreme western edge of the mesa top, close to some cliff dwellings. No soil is present in the adjacent canyons, nor, if dense pinyon-juniper is any indication, are there any large amounts of arable soil within two kilometers. This site is itself an anomaly and its setting difficult to understand.

Like the previous two quadrats, Bullet 18 has been described before, and is located on a very deep soil divide between Bullet and Sheiks. While sagebrush (73%) is the dominant cover, abundant deep-soil pinyon-juniper is present immediately to the west. Some parts of this quadrat has small sand dunes and are reminiscent of Hardscrabble 14. Upper Grand Gulch 6 is surrounded by high elevation, deep-soil pinyon-juniper. A slight shift in the
Matson, Lipe and Haase (Jun. 90) XI-19 placement of the quadrat would give a very different value for dense pinyon-juniper coverage. Hardscrabble 3 is located just to the west of an extensive deep-soil pinyon-juniper area in an ecotone where the pinyon-juniper gives way to sagebrush on soils of moderate depth. The habitation site located here is also one of the dubious ones.

West Johns 9 is located on a ridge running between two sagebrush flats at a respectively high elevation. There is no question about the deep soil here, although there are questions about the arableness of sagebrush flats that we will examine later. A slight shift in quadrad boundaries would change the percent covered by dense pinyon-juniper. North Road 4, as described in the Mossbacks analysis, is located on the highest deep soil divide area between North Road and Bullet, with one side of the quadrat falling over a rocky rim. The last quadrat in the first quarter, West Johns 6, is located in a high elevation deep-soil pinyon-juniper area, with part of the quadrat extending into a canyon head.

In our examination of the residuals, those quadrats without a high percentage of dense pinyon-juniper, only two serious anomalies were found, the easily explained (as a cliff dwelling) of Bullet 17 and the twice anomalous West Johns 17. Almost all Pueblo habitation quadrats are located on, or adjacent to, large amounts of arable
deep-soil.

Turning to the comparison with the Mossbacks and Grand Gulch Phases, we will first use the Wilcoxon test to see if the differences are significant. Comparing the 32 Grand Gulch habitation quadrats with the 35 Pueblo ones, (with some quadrats counted twice), we find a unit normal deviate of .778, not significant (unit normal deviate of .772 has a probability of .22). This test appears to run counter with the judgmental evaluation of a significant difference. If we divide the sample so that we compare the 15 quadrats that have Pueblo habitation sites but not Grand Gulch habitation sites against all quadrats with Grand Gulch habitation sites (n of 32) a smaller unit normal deviate of .593 results. We can not demonstrate that the Pueblo habitation quadrats are associated with significant more dense pinyon-juniper than those of Grand Gulch.

If we compare the Mossbacks habitation quadrats (n of 23) with Pueblo habitation quadrats, we find an insignificant unit normal deviate of .183 (unit normal deviate of .176 has a probability of .43). Our basic hypothesis of similarity predicts this, in spite of apparent differences in the lowest quartile. If we eliminate the overlapping quadrats (samples of 16 and 23), a non significant rank sum of 302 is calculated (probability of .10 is a rank sum of 274). These tests confirm the visual impression that the Pueblo distribution
Matson, Lipe and Haase (Jun. 90) XI-21 lies in between the significantly differently distributed
Grand Gulch and Mossbacks Phases.

<Dense Pinyon-Juniper Coverage, Limited Activity Sites>

Limited activity quadrats should have a distribution similar to that of habitation quadrats as both are oriented to environments suitable for rainfall farming. The low percentage tail, however, should be longer and include a high percentage of non-agricultural activities and non-direct rainfall agricultural sites, as found in the elevation inspection. Figure XI-3 also shows the limited activity site quadrats plotted for percent of deep soil pinyon-juniper. Notice how similar the habitation and limited activity quadrat first quarters and medians are, neither varying more than a half of a percent. The upper quarter, however, is six percent lower for the limited activity sites. This might be expected on the basis that habitation sites would be located in respect to a number of plots of arable land, and thus be more concentrated in areas with large patches of dense pinyon-juniper, while a single field station might be located in respect to a single arable plot of a few hectares.

As predicted, the limited activity lower tail is longer. Inspecting the "residuals" we find that many are clearly not rainfall farming field stations of the usual sort. The two quadrats with zero percent of dense
Matson, Lipe and Haase (Jun. 90) XI-22
pinyon-juniper are the hunting campsite quadrats of
Hardscrabble 13 and West Johns 15. Next is the extreme
water storage quadrat of Hardscrabble 4, followed by the
cliff dwelling quadrat, Bullet 17. This is in turn
followed by the halfway Hardscrabble 14, neither a typical
location for rainfall farming, but without the extensive
sand dunes found in Hardscrabble 4. Upper Grand Gulch 6
has been discussed before and is on the edge of a large
high elevation deep-soil pinyon-juniper area, as is North
Road 4. Upper Grand Gulch 9 has nothing in it but lithic
reduction sites. Bullet 9 is located adjacent to Bullet 22
in the only area of Upper Bullet Canyon that has any arable
soils. The limited activity sites in Bullet 22 and 9 most
likely represent canyon bottom farming, and the four
"storage" sites (three graineries and a cist) are probably
related. West Johns 6 was previously discussed under
habitation sites and is located at the edge of a deep-soil
pinyon-juniper area, but also includes the head of a
canyon.

The limited activity sites show the pattern as
expected, with the residuals of both the elevation and
dense pinyon-juniper cover having an abundance of sites
which could not be rainfall farming field stations. The
only unexpected feature was the slightly lower fourth
quartile of the pinyon-juniper coverage, which might be
explained on the grounds that a field station would be more
Matson, Lipe and Haase (Jun. 90) XI-23
apt to be located on a small patch of dense pinyon-juniper
than a habitation sites which one would expect to be
located in the midst of a series of potential farm plots.

<Distance to Canyon Rim>

Another variable of interest both in the Grand Gulch
Phase and the Pueblo period is that of distance to canyons.

In the Grand Gulch Phase, the question was the
relationship as postulated in 1971, and partially confirmed
in 1975 and 1978 (Lipe and Matson 1971a, Matson and Lipe
1975, Matson and Lipe 1978) and rejected here. For the
Pueblo period the question revolves around the use of
canyons seen in the highly visible cliff dwellings. The
question of changes within the Pueblo period will be
examined later in this chapter. Here, we will look at the
overall pattern, which we would expect to be mainly like
the Mossbacks pattern, but because of the terminal canyon
emphasis, slightly closer to canyon rims.

The distance of habitation quadrats to canyon rims, as
defined before, of habitation quadrats is shown for all
three occupations in Table XI-1. Here, the habitation
quadrats of the Grand Gulch Phase are closer to the canyon
rims than those of the Mossbacks Phase. The Pueblo period
habitations quadrats are plotted in an intermediate
position, slightly closer to the canyon rims than the
Mossbacks Phase. Note that none of the differences are
significant according to the Wilcoxon test, although the Grand Gulch—Mossbacks comparison is close and many quadrats are found in all three groups.

If we rerun these tests dropping out those quadrats that have both kinds of habitation sites under consideration, we reduce the sample sizes, but the differences between occupations become larger. If we compare Mossbacks and Grand Gulch habitation quadrats, our sample sizes reduce to 12 and 21, and our rank sum is 175.5, just over the .10 probability (rank sum of 169). Comparing Pueblo and Grand Gulch occupations results in a sample size of 12 and 15, and again a rank sum (146.5) slightly greater than the .10 level (141). A final comparison between Pueblo period habitation quadrats and Mossbacks period quadrats does result in a significant rank sum (23.5, sample size of four and 16, probability of rank sum of 24 is .05). This suggests the equivocal possibility that the distribution in the middle, the Pueblo, is more different from one of the ends, than the ends are from each other! The figures actually tested, however, are those of quadrats with only one kind of habitation site, ignoring the ones with both kinds present. Obviously, many of the Mossbacks sites are located in quadrats of moderate distance from the rims, which also have Pueblo habitation sites. When these are eliminated, the remaining Pueblo and Mossbacks sites show differences in distances to canyon
Matson, Lipe and Haase (Jun. 90) XI-25
rim. If we recall that distance to rim is positively
correlated with elevation, and that Mossbacks habitation
quadrats are located significantly higher than Pueblo ones,
this distance to canyon rims is not necessarily new
information. The general pattern, though, is clear: the
Pueblo habitation quadrats lie in between those of the
Grand Gulch and Mossbacks, and at least some of the
observed differences are significant.

<Hypervolume>
The reconstructed niche space should reflect the same
pattern discovered above, but one with composed of a lesser
number of compounded independent variables. Figure XI-4
illustrates the first two dimensions of the reconstructed
hypervolume with the habitation quadrats designated. The
expected concentration in the high elevation deep-soil
pinyon-juniper occurs, with lesser numbers found in the
sagebrush divide area to the left and in more rocky
situations. This pattern is generally similar to that
demonstrated by Grand Gulch Habitation quadrats in Figure
IX-4. During both periods habitations are concentrated in
the deep-soil pinyon-juniper, but extended to more open
divide areas and to the rocky shallow soil divides, not
occupied during the Mossbacks Phase. A difference is the
presence of the high elevation truncation which is not
apparent on Figure IX-4.
sites and high elevation, deep-soil divide areas would be located on the descending lower right 'leg' of the horseshoe. These turn out to be the same exceptions, in general, as noted before. Bullet 17, the lowest one, is the cliffside quadrat, complete with cliff dwellings. West Johns 17 appears again, as a complete anomaly. Upper Grand Gulch 6 is surrounded by deep-soil pinyon-juniper, as is West Johns 6. North Road 4 is located half on the deep soil, high elevation divide between the Bullet and North Road drainages, and half on a rocky rim. Bullet 22 stands astride a canyon in upper Bullet which has deep soil and includes at least one canyon bottom habitation site and a minimum of three graineries. Upper Grand Gulch 7 is located on a point of deep-soil pinyon-juniper that protrudes into Kane Gulch. Except for West Johns 17 and possibly Upper Grand Gulch 7, these "exceptions" turn out to be either expected "exceptions" such as cliff dwellings or the result of an artifact of measuring coverage. The concentration of habitation sites in areas of deep-soil pinyon-juniper is further confirmed by the first two dimensions of the hypervolume.

Figure XI-5 is the habitation quadrats plotted on the next two dimensions of the reconstructed niche. Remembering that quadrats both low and to the left on this figure are from lower, hotter areas, the habitations would
Matson, Lipe and Haase (Jun. 90) XI-27 be expected to be concentrated in the middle, and this pattern is what is observed. The two exceptions are the ever anomalous West Johns 17 and Upper Grand Gulch 6. Both quadrats have been discussed before; only West Johns 17 is not high elevation and not close to deep soil pinyon-juniper. It remains anomalous. Even the two quadrats with "cliff dwellings", Bullet 17 and 22, are in the middle, although toward the rocky end of the continuum in the upper right. This pattern is strikingly similar to that found for Grand Gulch habitation quadrats (Figure IX-5) where the only exception to the clustering in the center was, again, West Johns 17.

Figure XI-6 shows the Pueblo limited activity quadrats plotted on the first two dimensions of the hypervolume. We expect a pattern similar to that of the habitation quadrats. Limited activity sites should be concentrated in quadrats with arable land as indicated by deep-soil pinyon-juniper, but with outliers populated by sites that are not deep-soil divide field stations. And such a pattern is found in Figure XI-6.

One of the striking features about Figure XI-6 is the concentration of sites in the deep-soil pinyon-juniper cluster from Bullet 19 to Upper Grand Gulch 5. Some 36 quadrats are found between these two, and 30 of them have Pueblo limited activity sites present. Fully 56 out of the total of 77 limited activity sites are found between Bullet
Matson, Lipe and Haase (Jun. 90) XI-28
9 and Upper Grand Gulch 6 and of the 21 limited activity
sites found outside, 14 are either storage, or lithic
reduction limited activity sites, or hunting campsites. Of
the seven remaining limited activity sites, one is the sand
dune site in Hardscrabble 4 at the bottom of the figure,
and two are the sites in Hardscrabble 14, at the opposite
end of the Horseshoe. Only four standard "field stations"
are found outside the main cluster.

The hunting campsites are found in the lower right
hand leg of the horseshoe in quadrats West Johns 15 and
Hardscrabble 13. Nearby is the previously mentioned
Hardscrabble 4 and the cliff dwelling quadrat, Bullet 17.
Next is the lithic reduction quadrat, Upper Grand Gulch 9.
The next little group has been discussed with the exception
of Bullet 9. This quadrat, it may be remembered, is
immediately adjacent to Bullet 22 and includes a limited
activity site on the deep-soil found in the canyon.

The concentration of Pueblo limited activity sites in
deep-soil pinyon-juniper quadrats shown Figure XI-6
confirms our main interpretation of them as being mainly
field stations. It also neatly shows the outliers to be
other kinds of sites, already described on artifactual
grounds as not being field stations.

Figure XI-7 shows the Pueblo limited activity sites
plotted on the next two dimensions. We would expect the
great majority of the sites to be located in the center,
Matson, Lipe and Haase (Jun. 90) XI-29
with the outlying quadrats having sites previously
classified as not being high elevation deep-soil divide
field stations. The two most extreme outliers are West
Johns 15 and Hardscrabble 13, both having hunting
campsites. Hardscrabble 4 appears here again as an
outlier, as does Upper Grand Gulch 6. North Road 4 and
Bullet 9 occur at the top side of this figure and away from
the center cluster. Both of these quadrats have been
previously discussed as exceptions. There are no surprises
on this plot, the Pueblo limited activity sites are
concentrated in high elevation deep soil areas and those
that are not, usually have artifactual or architectural
attributes indicative of other functions.

<Special Purpose Limited Activity Sites>

During the analysis of Pueblo limited activity sites,
we have developed a residual class of sites which are not
rainfall agricultural field stations, but Special Purpose
limited activity sites. We will briefly examine two
aspects of the four kinds of sites in this class, how they
were defined and what their environmental parameters are.

For proper settlement hypothesis testing, we have
stressed that it is important to define classes of sites
independent of their environmental location. If this is
not done, one introduces circularity into the hypothesis
testing since one is using the same information to test a
Matson, Lipe and Haase (Jun. 90) XI-30 pattern as to define it. This stricture does not mean that the environmental information cannot be used to define a site class, but that this step cannot be taken prior to testing hypotheses about environmental position. For example, one might define a single site class on the basis of artifactual remains, and on inspection find that it occurs in two very different environmental situations, with the result that the inferred functions of the two geographical groups would be different. One would want to call these two groups, at least tentatively, two separate kinds of sites. One could not, however, then go back to them and demonstrate that two distinct classes existed by showing that at a high probability level they were located in different environments! One could, on the other hand, on the basis of environmental locations, test for differences in artifactual remains.

Among the Pueblo limited activity sites, we have defined 20 special purpose sites, as listed in Table XI-2. The eight (or nine, if one includes the "pot drop" of North Road 8-2 as being associated with North Road 8-3) lithic reduction sites were all defined independently of location on the basis of the quantitative cluster and scaling analyses in Chapter VII. So these sites would be appropriate to use in settlement pattern hypothesis testing, but the five quadrats in which they are found is too small a number to demonstrate significance in all
Matson, Lipe and Haase (Jun. 90) XI-31 but the most gross situations (the Alfred Law of data analysis again).

The storage class of five sites (and North Road 8-2 could be equally included here) were also defined independent of location, in this case by architectural remains, but, again, these sites are found in only two or three quadrats.

In contrast to the first two classes, the next class of three hunting campsites are not totally free of locational interpretations. While West Johns 15 was interpreted as a "campsite" on the basis of architectural and artifactual remains in the original Basketmaker II analysis, the other components in that quadrat were also considered to be campsites on the basis of archaeological similarities and their presence in the same unique setting. So the two Pueblo components in West Johns 15 were not defined totally independently of the environmental information. The third member of this class, Hardscrabble 13-1, like the other two, a multicomponent Basketmaker II-Pueblo site, was brought to our attention by its environmental location. Thus it cannot really be formally tested in terms of environmental location.

The last group of special purpose sites, the sand dune agricultural sites, were defined largely by their location. Hardscrabble 4-1 is the only definite Pueblo member, with the situation in Hardscrabble 14 more ambiguous. It needs
Matson, Lipe and Haase (Jun. 90) XI-32 to be reiterated that the use of environmental information to define a class does not weaken the class, merely limits the uses of the class in hypotheses about environmental location.

It is clear from this review that no separate function of the special purpose sites are found in enough quadrats to be useful in the tests used so far. Further, the inclusion of several different purposes with different environmental locations and at least several sites being included on the basis of their environmental locations makes treating all 12 quadrats as a single class, dubious. Let us instead, inspect the locations of these sites in a more judgmental fashion.

Figure XI-1 shows the 12 quadrats coded as to function and elevation. The lithic reduction sites are found well spread out, occurring in the two highest quadrats with Pueblo material (Upper Grand Gulch 9 and 1), as well as in three lower quadrats. As we stated earlier, lithic raw material is most accessible in two areas on Cedar Mesa, on the upper end of the mesa, where material has washed down from the higher geological layers on Elk Ridge, and from the south end of the mesa were quartzites are exposed in the lower layers of the Cedar Mesa sandstone. In addition, most canyons show some exposures of materials in limestone beds. In view of the northward emphasis of Pueblo occupation on Cedar Mesa, it is not
surprising that we do not show evidence of special purpose sites using the southern material. The Upper Grand Gulch sites fit the expectation for use of material coming from higher elevations and the North Road for use related to canyon sources.

Since Upper Grand Gulch has a dense Pueblo occupation, one might wonder why separate lithic reduction occur there at all. Indeed, one may well expect local inhabitants to bring the material back to habitation sites. One can offer an idea, though, why people from other areas of Cedar Mesa would produce lithic reduction sites. For instance, people from the Bullet drainage would be in a different situation. They could not "inbed" obtaining lithic raw material in their daily activities. They could either obtain material in trade or collect it themselves, possibly while engaged in trips with other functions. In this latter situation, one might expect lithic reduction campsites to develop in spite of the close proximity of Pueblo habitation sites in Upper Grand Gulch and North Road, for that matter. Here, or at source locations, material would be tested or reduced for the nontrivial task of lugging it back to distant habitations. This is a possible explanation for the surprisingly large amount of features on the Upper Grand Gulch lithic reduction sites, which would be very difficult to explain in terms of day camp use by Upper Grand Gulch inhabitants.
The lack of mid-elevation range lithic reduction sites may also be explained by the combination of this possibility and the distribution of raw resources. Such minor resources that exist in the center of the mesa would be utilized on a day to day basis, invisible to this level of analysis. Special trips would only be made to the concentrated resources, either in canyons, the south end of the mesa or the north end.

Storage sites, on the other hand, would be expected near fields. Since fields are concentrated, at high elevations one would expect relatively high elevations, and that is what is seen in Figure XI-1. Since these sites are all "preserved" in rock shelters, one needs rock which increases at low elevations. Further, some farm plots are expected in canyon bottoms at low elevations (including Bullet 17) and in low elevation sand dune areas. The latter has two examples, Hardscrabble 4, a good one, and Hardscrabble 14, only a possible one.

The final class, hunting campsites, might be expected to occur both in elevations much higher than habitation sites and in elevations much lower. Since the Cedar Mesa quadrat sample does not appear to even reach the high end of the habitation elevation, although there are some indications it is nearing it, it is not surprising that the only two examples, West Johns 15 and Hardscrabble 13 are low elevation. What may be significant is that these are
also the lowest quadrats with any Pueblo use.

Examining Figure XI-1, one notes the close similarity between the 16 quadrats which have only Pueblo limited activity sites and these 12. In fact, seven of the quadrats are the same in these two groups. Since special purpose sites would tend to be located distant from habitations as opposed to field stations, one would expect them to occur more often in quadrats without habitations than field stations, and this is the case as illustrated here. Overall, only 16 of the 42 quadrats with Pueblo limited activity sites do not have habitation sites, while only five of the 12 special quadrats have habitation sites present.

Turning to Figure XI-3, special purpose limited activity sites are seen to be more broadly dispersed in terms of dense pinyon-juniper coverage. Again, the lithic reduction sites are well spread out, but in the higher ranges. This is what would be expected, given that three of the five quadrats are from the Upper Grand Gulch drainage. The two storage quadrats have intermediate values. While on the elevation plot, both were within the habitation interquartile range; only one is here on the coverage figure, perhaps indicative of the rock cliffs where these two are found. The sand dune sites are found to have very low percentages of dense pinyon-juniper coverage, and the two hunting campsites, none.
While in the elevation figure, the special purpose upper quartile was approximately the same as that of the habitation and limited activity quadrats, on the coverage figure it is lower than the other two medians. This is a demonstration of how the other two classes select for concentrations of deep-soil pinyon-juniper and the special purpose limited activity sites do not. Seven of the first quarter (10) of the overall limited activity quadrats are also special purpose limited activity quadrats, which again indicates the nature of the activity taking place, definitely not ridgetop rainfall dry farming.

<Sagebrush Flats as Arable Land>

It will be recalled that initially we expected that high elevation sagebrush flats would be prime arable soil. Yet, at this point, we have failed to show any such relationship, and, in fact, it will be recalled that the Mossbacks pattern appeared to be one of avoidance of sagebrush flats. This was true in spite of the fact that Mossbacks sites were concentrated in the higher elevation area where the sagebrush flats thought to be arable were concentrated. Quadrats with limited activity sites, in fact, had less sagebrush present than habitation quadrats, although neither class had much. We will briefly examine the Pueblo evidence and summarize the evidence for agriculture on high elevation sagebrush flats on Cedar
Matson, Lipe and Haase (Jun. 90) XI-37
Mesa.

If we compare the 10 quadrats that have field stations and no habitation sites with the 35 habitation quadrats, we find, unlike the Mossbacks situation, sagebrush appears to be slightly more common on the field station quadrats having a median of 5.5% cover. When we compare the two groups, using the Wilcoxon test, the difference is not significant, with a unit normal deviate of only .683. Neither class, however, has much sagebrush present. Four of the ten field station quadrats have none, one has 2% and 3 of the 4 quadrats with substantial amounts are located below the zone of most dense pinyon-juniper, at or below 1920m (6300 ft) (Hardscrabble 8, 14 and West Johns 13). These three quadrats then, to not have the high elevation, 1980m (6500 ft) or higher, sagebrush flats we originally thought would be selected. Fully 18 of the 35 habitation quadrats have no sagebrush recorded as cover, and another eight have less than 10% covered with sagebrush. Only nine have more than 10% (Hardscrabble 3, West Johns 7, 9,11, Bullet 1,11,12,18, and 19). Overall, fully 20 of the 76 quadrats have 10% or more sagebrush as cover. Nine of the 40 quadrats in North Road, Bullet and Upper Grand Gulch have 10% or more sagebrush cover. The limited activity field stations appear to avoid the high elevation sagebrush flats, and the habitation quadrats do not indicate any selection for sagebrush areas, even if they do not show the
Matson, Lipe and Haase (Jun. 90) XI-38

apparent avoidance found in the Pueblo field stations and Mossbacks habitation quadrats.

While almost all sites are located in the pinyon-juniper, one can suggest reasons local to the site for this. Shade, protection and firewood are all present and not in the sagebrush areas. Still, if sagebrush areas were being heavily utilized, one would expect the sites to be located on the edge of the pinyon-juniper next to the flats and this is simply not found. As we argued earlier the boundary between sagebrush and pinyon-juniper is stable, particularly in the higher elevation where it is dependent on edaphic factors.

In conclusion, while sagebrush areas may have been farmed, they were not a primary focus. During all occupations, the deep-soil pinyon-juniper high elevation areas were the primary focus, with secondary foci in the canyon bottom and sand dune areas, with the canyons apparently being used more in the Grand Gulch and terminal Pueblo occupations. If sagebrush areas were farmed, they were likely those adjacent to pinyon-juniper areas, in sand dune and blow out environments at lower elevations. The only obvious potential drawback to farming sagebrush areas, is the possibility of cold sink inversion layers. The lack of large scale use of sagebrush flats may be indicative of a critically short growing season on Cedar Mesa.
Matson, Lipe and Haase (Jun. 90) XI-39
<Location of Largest Pueblo Sites>

One of the trends seen through time in Cedar Mesa is a reduction in site types and an increase in variation in size within a site type, at least for habitation sites. Thus, with one exception, all Basketmaker II habitation sites, as defined in the field, had no more than one dwelling present, yet in Pueblo times, habitation sites range from one small jacal house to several dozen structures with perhaps a dozen or so being habitation rooms. Because of this variation in site size it is worthwhile to investigate whether the larger sites in this class are located in different situations than the smaller ones.

As a measure of site size we might take number of artifacts. Further, if we use quadrats as our unit we can test the significance of the difference with some reliability. Our test is thus to compare the habitation quadrats containing the most Pueblo artifacts with those that have less. The obvious environmental variable is that of elevation with the larger habitation sites being expected to be at the higher elevations.

Figure XI-8 plots the elevations of the two classes. The quadrats with more material do appear to be located at higher elevations. Note that the two lowest are not typical. North Road 11, once again, appears to be unique and Bullet 22 is essentially a canyon bottom site with
Matson, Lipe and Haase (Jun. 90) XI-40 adjacent arable soil, although at a higher elevation than most. The other eight habitation quadrats are all over 1950m (6400 ft) compared to only 14 of the remaining 25. If we use the Wilcoxon test to compare these two samples we find a rank sum of 130 results, significant at the .05 level (rank sum of 134). The habitation quadrats with the most abundant material are indeed found at the higher elevations.

Haase (1983a) found that the habitation sites with the most structures within his sample were found at elevations above 1980m (6500 ft). These he termed "homestead units". We will return to the possible interpretations later; at this point we only wish to point out that Haase's measurement of site size is completely independent of the one used here, but gave equivalent results. In sum, whether measured by artifacts per quadrat or apparent number of contemporaneous structures, the larger Pueblo sites are limited to the higher elevations within the habitation site range. This finding is additional support to the previous conclusion that the Pueblo adaptation was not fully contained within the elevation range of our quadrat sample.

<On Site Variables>

<Introduction>

In turning to examine questions that can be evaluated
Matson, Lipe and Haase (Jun. 90) XI-41 by on site variables, we also turn to the results of a study carried out by Haase (1983a). This investigation was carried out while chapters 3 through 7 were being researched and written, and before the settlement pattern work reported in the previous chapters was done. Haase's investigation focussed on the Pueblo settlement pattern in the Bullet, Hardscrabble and North Road drainages, the three contiguous drainages which held 23 of the 35 Pueblo habitation quadrats and about 70% of the possible or probable habitation sites as defined here.

We will first compare the procedures used by Haase with those used previously and evaluate whether the central transect can be used as representative of all the mesa. A number of ideas will be evaluated by looking at the variables of landform, exposure, distance to nearest water source, distance to nearest water course, and watershed divide. The question of investment in facilities at limited activity sites, as raised by Haase (1983a, 1983b) finishes this section.

<Comparison of Transect and Overall studies>

While the transect study did include the majority of the Pueblo material found in the quadrat survey it did not include the material found in West Johns or Upper Grand Gulch. For the approach used by Haase a contiguous, continuous sample area was preferred, and since Hardscrabble, Bullet and North Road were contiguous and
Matson, Lipe and Haase (Jun. 90) XI-42 sampled at the same rate they could be joined together and treated as a simple random sample giving a transect across the middle of the mesa from west to east. Haase was interested in a contiguous sample because he chose to use the archaeological sites as the sample and contrast these with an equal number of random points. Environmental characteristics then could be used to characterize the transect sample as a whole, without the problem of having really five discontinuous samples.

The reliability of the transect sample as being representative of all five drainages for the Pueblo period is attested to by the similarity of results between portions of Haase's study and the results presented here on the elevation of habitation sites, limited activity sites and their environmental locations. For these characters the results based on this large transect using 3 of the 5 drainages are also true for the 5 drainages. While the on site variables have not been checked in every case it would be difficult to argue that they would somehow turn out to be different for the complete quadrat sample.

As one might expect, there were also differences in methodology. In addition to the differences in sampling approach, Haase compared his on site information with random points rather than quadrats and used these to calculate nominal probability levels. We will repeat this, in part, here. The treatment of sites and their
Matson, Lipe and Haase (Jun. 90) XI-43 classification also differs slightly from the classification used previously, as Haase began his study before Chapter VII was complete. Haase used 78 Pueblo components in the three drainages after eliminating a few confused or extremely sparse sites for various reasons. Thirty-two of these he defines as habitation components on the basis of surface features and the presence of groundstone tools. Five sites, which were large in area, he divided into separable components (B3-7, B12-1, B16-1, H 14-2 and B14-1) by plotting out locations of Pueblo sherds and features, such as discussed in the Mossbacks chapter. In some cases, such as Bullet 12-1 and Hardscrabble 14-2, the different components are given the same functions. In others, different spatial components are assigned different functions, in some cases on the basis of spatial separation and, in at least one, on the basis of spatial and apparent temporal differences. The splitting procedures gives slightly large numbers of components that we have considered up to this time for the Pueblo period.

In spite of using a different procedure to classify sites and in defining components, there is a good agreement between Haase's classification and the one previously used for the Pueblo period in this volume. Haase found 32 habitation components and all of these are habitation sites, or part of them, as previously defined here. Haase found 46 limited activity sites, 12 of which are field
Matson, Lipe and Haase (Jun. 90) XI-44 stations with cists and/or jacal (Haase 1983a:44) and it is this latter subclass that they only real difference occurs.

This group includes components that we previously called limited activity sites and some we classified as habitation sites. Five are considered limited activity sites in both classifications; two are portions of sites which we called habitations and which Haase has also classified portions as habitations. So for these seven sites there are no serious disagreements. Two more sites (North Road 11-12 and Hardscrabblle 3-1) are sites we previously called questionable habitations which should be considered roughly equivalent to this in between category of field stations with cists or jacal. The final 3 sites, however, are a different matter, as all three were previously considered habitations in this study.

Of these three, only Bullet 3-4 has architecture of any account, the most important measure that Haase used. The other two, Bullet 21-10, and North Road 11-1 have a few features which Haase (1983a:40) interpreted as slab lined hearths, cists and ash hearths; however, they contain substantial artifactual collections. Bullet 21-10 has a total of 169 sherds, 134 lithics, including 5 manos and 1 metate, while North Road 11-1 has 171 sherds and 124 lithics which also included a single piece of groundstone. It is easy to see why these two were considered habitations in our artifact analysis, but not by Haase, since they had
substantial artifactual remains and few identifiable architectural ones. The interpretation of Bullet 3-4 focusses on the meaning of a collapsed masonry heap, which obviously differed between the two studies. In summary the intermediate category of 12 sites has three members that were classified differently, one because of the interpretation and meaning of a feature, and two because of differential weighting of artifactual analysis. The net result is that Haase's definition of habitation is slightly more restrictive than the one used previous in this volume. The final group of 34 limited activity sites show fewer disagreements between the two classifications. One component is a spatial portion of a site previously treated as a habitation. Both Haase and the previous work in this volume agree that habitation occurs at the site as a whole. Bullet 1-6 is treated as a separate limited activity site by Haase, but it may be remembered that in Chapter VII we combined it with Bullet 1-5 and Bullet 1-5A, a habitation site, from which it is separated by an arroyo.

In sum there is very good agreement between the two classifications. If the spatial separations by Haase are put aside, only 3 serious disagreements occur, all of the previous classified habitation sites being placed in the field station with jacal/cist class. In general, by creating a more substantial "middle" category, Haase is able to make the ends more precise, and we will show,
Matson, Lipe and Haase (Jun. 90) XI-46 demonstrate some very interesting features about this middle category. Because of the relative similarity of the classifications and off site variables analyses it is relatively safe to treat Haase's analysis of the transect as being representative of the Pueblo occupation of the entire mesa.

<Landform as a Factor in Site Location>

Landforms or terrain features are an important aspect in analysis of Pueblo settlement patterns in that arable soil is found on certain ones. On Cedar Mesa, landform type is determined by the structural characteristics of underlying bedrock and unconsolidated sediments deposited by wind, water or other erosional factors. Landforms found on Cedar Mesa can be divided into Drainage Bottom, Rocky Break, Watershed Divide, Sagebrush Flat, Sandstone Cliff, and Canyon Bottom Alluvial Terrace.

A short definition of those not previously discussed is necessary. "Drainage bottoms" are simply the channels of stream courses; all are linear and very narrow in form. "Rocky breaks" are escarpments and talus slopes consisting of sandstone boulders and patches of colluvium. The last two landforms are usually found only within canyons. "Sandstone cliffs" are very steep and nearly devoid of vegetation and occur as canyon walls and the steeper escarpments. "Canyon bottom alluvial terraces" are found
Matson, Lipe and Haase (Jun. 90) XI-47
only in the widest portions of entrenched canyons. Most
terraces have been removed by arroyo cutting over the past
century.

Landforms considered most suitable for farming include
watershed divides and canyon bottom alluvial terraces. The
latter, however, is very poorly represented in the transect
study area. Floodwater farming may have occurred along
drainage bottoms and sagebrush flats. Both are at slightly
lower elevations than surrounding terrain, and as a
consequence are also cold air drainages. Least suitable
for farming are rocky breaks and sandstone cliffs.

We expect that all kinds of sites occur in greater
proportions on landforms having arable qualities, and will
be under represented on other landforms. Table XI-3 shows
that this hypothesis is strongly supported only by
distributions of field stations. While differences are
apparent between habitation sites and the random model,
they are not large enough to produce a nominal significant
chi square. Although this result was not expected, with
this sample size only large differences would be
significant, and the differences that do occur are those
that are expected.

Differences between sites and random points are most
apparent for field stations. While 54 percent of random
points are located on watershed divides and sagebrush
flats--landforms having arable qualities--79 percent of
Matson, Lipe and Haase (Jun. 90) XI-48
field stations occupy these landforms. Rocky breaks and
cliffside associations--both unsuited for farming--contain
31 percent of the random points but only 4 percent of field
stations, a difference nominally significant according to
binomial confidence intervals. This relationship is
further support to the idea that field stations were
agricultural in function.

When examining habitations and corresponding random
points, 69 percent of the former and 62 percent of the
latter were located on arable terrain. There is no nominal
significant difference between the two, suggesting that
other criteria were important in locating residential
sites. These other criteria include avoidance of sandstone
cliffs and drainage bottoms--both have discrepancies from
the random model nominally significant at the .05 level
according to binomial confidence intervals. The lack of on
site arable land at residences, combined with the previous
section on quadrat variables, gives the picture of
habitation sites being located in an area with abundant
arable land, but not on arable land.

Although no habitations were located in drainage
bottoms, field stations are located along these. The
reasons for this are not clear, but it may be that
differences in site facilities played a role in locational
decisions. Habitations frequently had pitstructures, and
these may not be possible to build in areas such as
Matson, Lipe and Haase (Jun. 90) XI-49 drainage bottoms where soil is relatively shallow and rocky outcrops common. Also, there was danger of flooding in these areas. On the other hand, the presence of field stations in these areas suggests that deep soil may not have been the only criterion for agriculture. The same floodwaters that would have destroyed habitation sites would bring nutrients, soil and moisture to fields located within or alongside drainages. We will return to this idea later.

<Aspect or Exposure as a Factor in Site Location>

This section examines the aspect, or compass angle at which Pueblo sites were oriented in terms of exposure. While we have used this basic idea in previous chapters, it is here that the full development is given, at it is most relevant for the Pueblo period. Both sites and random points were considered oriented in either magnetic cardinal (N,E,S,W) or subcardinal (NE,SE,SW,NW) octants having 45 degree exposures.

When discussing the sun’s influence on the form of modern Hopi habitations, Fewkes (1906:88) speculated as part of his "heliotrophic hypothesis" that:

The arrangement and orientation of houses in Hopi pueblos are largely due to an attempt to secure sunny exposures for entrances and terraces and consequent protection from cold and wind...this form...has been evolved from a preexisted condition in which the sedentary people of the Southwest were more scattered, the habitation partaking more of the nature of isolated rancherias...
Matson, Lipe and Haase (Jun. 90) XI-50

The settlement pattern at Cedar Mesa is clearly that of "isolated rancherias" and so we would expect that southern exposures would be sought when establishing habitations, while northern exposures were avoided.

Exposures of fields are also mentioned in the literature. When discussing results of the Wetherill Mesa survey, Erdman et. al. (1969:58) write:

The distribution of farming terraces was studied to determine whether the use of slopes and mesa rims that harbor more favorable moisture regimes was intentional....The pattern indicates that the more mesic canyon and mesa slopes <were selected> for agricultural purposes. Of the terrace systems on talus slopes, about 75 percent of the sites surveyed have a northeastern exposure and about 25 percent of the sites have a southwestern exposure....Farming sites along the mesa-top rims are also predominately on northeastern exposures...Sixty percent of those surveyed face approximately northeast, while forty percent have a southwestern exposure. The northeast-facing sites receive less insolation, and late-lying snow beds improve moisture conditions in the soil.

An additional suspected reason for this phenomenon was:

...that while the southwest slope receives more solar radiation at noon, the actual maximum radiation occurs in late morning at the northeast exposure....We believe that the southern exposure receives more solar radiation on a yearly basis, but the northeast slope probably receives more during the growing season (1969:48).

From these quotations come two hypotheses about exposures for Pueblo habitation and field station sites on Cedar Mesa. Due to year-round heliotrophic needs, and especially those of winter, habitations will have
Matson, Lipe and Haase (Jun. 90) XI-51 predominately magnetic southerly exposures (true southwest). Field stations, because of the need for late spring soil moisture and to maximize the insolation will have mainly a magnetic north (true northeast), with a secondary magnetic south (true southwest) exposure.

Results are illustrated by Rose diagrams (Figure XI-9) where random points are compared with habitation and field station sites. As is seen 50 percent of the habitation sites have magnetic southern exposures, and when southeast and southwest oriented sites are added to this group, the figure becomes 70 percent. This is contrasted with the 40 percent found in these three octants and only 18 percent in the south direction among random points. This pattern supports Fewkes’ (1906) speculation that isolated prehistoric habitations were oriented towards sunny exposures, a pattern we have traced further back in time in the preceding two chapters. It should be remembered that magnetic south is true ssw, so that the actual fit is very good, with half the habitation having the sunniest possible exposure.

The Rose diagram for field stations indicates that the most used octants were the northern or southern magnetic ones. If the other six octants are ignored, the proportions are very close to those reported by Erdman, et al. (1969) reported for the top of Wetherill Mesa. One difference though, is that on Cedar Mesa fields were not
Matson, Lipe and Haase (Jun. 90) XI-52 defined by stone check dams or terraces. Instead, we are analysing field stations which are assumed to be located either within or at the borders of the fields, similar to modern-day Navajo field shelters. This may explain some of the scatter of the exposures outside the two main octants. If we look at the two main octants and the two octants on either side of these, we find only five sites found in the remaining two octants, when we would expect 11.5 by chance or 8.8 according to the random points.

Erdman, et al. (1969) suggest the reason for northern/northeastern exposures is to grow crops in more mesic conditions and to have greater sunlight, but this may not be a complete explanation for the duality of field locations. While increased soil moisture in the spring was desired, fields with northern exposures may have been susceptible to late spring or early autumn frosts. The duality of location, then, may represent a strategy designed to minimize cumulative effects of drought or frosts on Anasazi crops. It may also reflect, as earlier presented, field stations located on opposite slopes to field plots to produce a good view of the field.

<Distance to Nearest Probable Water Source>

Distances to nearest known water sources were calculated as before, but to sites rather than to centers of quadrats. It is to be remembered that because of
Matson, Lipe and Haase (Jun. 90) XI-53 probable changes in springs and uncertain coverage along the edges of the drainages, that this measure has more uncertainty than many of the others we have used. Although limited by methodological constraints, we can test the hypothesis that Pueblo sites of all kinds will be closer to water sources than will random points.

Results of nominal Wilcoxon rank-sum tests, based on the data summarized on Figure XI-10 indicate that acceptance of this idea is mixed, depending on a site's function.

For random points versus field stations, the rank sum indicated a discrepancy that was insignificant in the opposite direction of the hypothesis (this unit normal deviate 1.20, probability of about .12 one-sided test, .24, two-sided test). Field stations were farther from water sources than were random points, a finding similar to that reported on above for earlier occupations. The median distance to water for random points is 700m, while for field stations it is 875m. There is only a 50m difference between the two groups at the lower hinge or quartile, but again, random points are closer to water than field stations. The greatest different is apparent at 1000m--the upper quartile of the random point distribution. While 25 percent of the random points were at greater distances, 37 percent of field stations were found beyond 1000 meters of any known water source.
Since arable land tends to be located away from the canyons, where most water occurs, this relationship should not be surprising. If the duration of use of the field stations is limited, the access to water would not be important, as this data, and that reviewed in earlier chapters, indicates. The relationship between random points and habitations is more complex. When comparing all Pueblo habitations to random points, the Wilcoxon test indicated no nominal significant difference between sites and random points. (This unit normal deviate is 0.044, approximate one-sided probability is 0.48). We will show later, that if one controls for time within the Pueblo period, that significant differences and changes do occur. The habitation furthest from water, Bullet 1-1, may not be as far from water as indicated. It is fairly close to a large mesa top escarpment, and as noted earlier, this zone was not systematically examined for seeps or springs, although they did occur here occasionally.

In summary, field stations appear to avoid water sources, suggesting that other environmental factors were of greater importance in determining site location. Since deep-soil divide areas were the apparent prime Pueblo farming areas, as we will demonstrate shortly, this "avoidance " of water is to be expected. Pueblo habitation sites, on the other hand, neither avoid water or select for it. Given the general location of arable soil
Matson, Lipe and Haase (Jun. 90) XI-55 away from water sources, as demonstrated by the field stations, this is, in fact, evidence of selection for locations that are both close to arable soil and water sources. Notice that more than three-fourths of the habitation sites are located within a kilometer of known water sources, while the figure for field stations is some 500 meters further.

<Distance to Nearest Water Course>

In the section of this chapter dealing with landforms, it was noted that no habitations were located along bottoms of stream courses. Reasons for this were not explored in depth, but we did note that stream courses are cold air drainages and that it was unlikely habitations would be established in areas of frequent flooding. Instead, the vast majority of habitations were found on landforms termed "watershed divides."

Although the majority of field stations were also found on watershed divides, analysis of landform data suggests that the Pueblo Anasazi were not adverse to locating <some> field stations along drainage bottoms. Reasons for this latter choice of field station location are perhaps found in an analogy with modern Navajo. Hill (1938:20) describes field locations selected by the Navajo:
The prime essential was the possibility of getting water on the land. This was accomplished by...locating either where a perennial or intermittent stream could be conducted by ditches to the field, or where the natural flood would inundate the land. Hence, fields were distributed along courses of perennial or intermittent streams, on the gentler slopes below escarpments, on the flood plains of ephemeral streams, and on alluvial fans at the mouths of streams.

While this statement hints at the use of man-made diversion systems, Russell (1978a:40) notes that only 10 percent of the Navajo sites he investigated in the Klethla Valley of Arizona had evidence of soil or water control features. The Pueblo inhabitants on Cedar Mesa appear likely to have followed a similar strategy of flood water farming when utilizing drainages, because at the most, only three or four check dams have been observed on the plateau, and only two possible ones located during the survey, with West Johns 6-4 being the only likely one.

The objective of this section is to further examine these settlement trends. Rather than just note the presence or absence of sites along drainages, the question is asked: How close or how far are archaeological sites from stream courses?

A few comments about the means to develop this test are necessary. The vegetation/landform map was used to assess drainage rank and measure distances from sites and random points to stream courses. However, not all drainages appeared on the map; short, ephemeral drainages were apparent only from contour lines and not from stream
markings drawn by U.S.G.S. personnel charged with making topographical maps. To correct this, Haase drew additional drainages on the map. Criteria used to locate additional drainages were both simple and consistent: when three or more adjacent contour lines interlocked to form a set of "v’s" pointing towards higher elevations, this was considered evidence of a drainage channel. Most first order and many second order streams were delimited in this fashion.

The two key expectations about the relationship of sites to nearest water courses are that we expect habitation to be located away from water courses and field stations to be located similar to random points. The first occurs because of the desire to avoid flooding and cold air drainage. The distribution of field stations will be similar to random points because some sites of this type will be located in drainages and some on deep-soil divides. A comment on the second hypothesis is needed. Although it is assumed that distributions of field stations will resemble random points, this does not mean that field stations were randomly distributed with respect to distance from the nearest drainage. What it does suggest is that this is an inappropriate test for field stations. Because of the dichotomous locational nature of these sites, a "middle ground" will be observed, rather than discrete groupings of sites along drainages or on deep-soil divides.
The test that follows this one is more appropriate in illustrating locations of field stations within the settlement system.

When comparing distance of habitation and random points to nearest drainage, the Wilcoxon test resulted in differences nominally significant at the .01 level (This unit normal deviate 2.43, approximate probability level of .008). This difference is illustrated on Figure XI-11. Differences between the locations of field stations and random points, as expected, were not nominally significant (This unit normal deviate .65, approximate probability of .75).

While 25 percent of field stations and 35 percent of random points are within 30m of a drainage, no habitations are closer to water courses than this. Only 30 percent of habitations are within 50 m of a water course, although this is the median distance of field stations to these topographical features. A complementary trend occurs at the distant end. Beyond the median distance for habitations, located 100m from the nearest drainage, lie only 33 percent of field stations. In sum, data strongly support the first hypothesis.

The second idea is also supported, because the distribution of field stations do indeed resemble the distributions of random points, at least more closely than they resemble distributions of habitations. Median values
of both are 50m from the nearest drainage. Also, as we reported above, there is no nominal significant difference between random points and field stations according to the Wilcoxon test.

Drainage rank was mentioned briefly at the introduction of this section. When comparing drainage ranks there was no apparent significant difference between random points and habitation or field station sites, or between the two site classes, either by inspection or by chi square goodness-of-fit test. In all cases, the nearest drainage for sites and random points were small first order mesa top streams.

<Watershed Divide as a Factor in Site Location>

The polar opposite of a drainage is watershed divide. Divides are boundaries of rainfall catchment areas for streams. On Cedar Mesa, the major divides are generally elevated topographical features covered with eolian soils and dense pinyon-juniper forest. Even in the more xeric desert shrub blackbrush community, divides typically have pinyon-juniper and sagebrush present. The few exceptions are divides composed of long, linear bands of exposed Cedar Mesa sandstone and colluvium, but even along these deep soil is found in the immediate proximity.

Like other variables examined in this chapter, watershed divide is a proxy measure. Divides are important
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because this is where concentrations of deep, eolian deposited loess are found. There is headward removal of loess starting at canyon rims, escarpment rims and along mesa top drainages. Because watershed divides are generally the points farthest from these three topographic features, erosion is more limited. Divides are also more level than the areas adjacent to escarpments and canyons. In sum, we have argued throughout that watershed divides would be the preferred locations for habitations, and for field stations as well (although the latter may be also positioned along drainages for floodwater farming).

Position and location of watershed divides were determined in the same fashion as stream drainages. When three or more contour lines formed sets of interlocking "v's"--always in the opposite direction from "v's" forming drainages--a line denoting the divide was drawn on a base map of the study area transects. Watershed divide rank was defined in a similar fashion as stream rank. In general, a first order ranked stream was bounded by a pair of first order divides, second order streams were bounded by second order divides, and so on. Exceptions exist, however, especially at the outer boundaries of the study area. These divides were classed as fifth order because entrenched drainages central to the study area are fifth order streams. Yet drainages whose boundaries were actually formed by fifth order divides were primarily first
order in rank.

Two factors of settlement location are examined in this section: 1) distance to nearest watershed divide, and 2) rank of nearest watershed divide. Each will be discussed individually below.

Distance to nearest watershed divide.

Earlier, it was noted that roughly 70 percent of all Pueblo transect sites were located on or very near watershed divides. The apparent reasons for selecting this landform include the presence of arable soils and the avoidance of floodwaters and cold air drainage. Based on these insights, we can expect that both habitations and field stations, due both to residential and agricultural needs, are located closer to watershed divides than are random points.

This hypothesis is supported by results of the Wilcoxon test. Field stations are much closer to watershed divides than are random points, nominally significant at any level (This unit normal deviate 3.40, approximately probability .0004). Habitations are also closer to divides than are random points, with the discrepancy significant at the .005 level (This unit normal deviate 2.61, approximate probability .0045). The distribution of all three point classes are illustrated on Figure XI-12.

For both field stations and habitations the first
quartiles are the same as the low end of the range, and both are 0m distance from the nearest watershed divide. In fact, 41 percent of field stations and 37 percent of habitations are located directly atop watershed divides, while 67 percent and 72 percent, respectively, are located within 30m of these terrain features. Only 15 percent of the random points are located directly atop divides, while 36 percent of the points are within 30m of these features.

Only two "residual" sites are present in distributions shown on Figure XI-12. A habitation (Bullet 22-2), as noted before is located along the south fork of Bullet canyon, close to the main wash, which is surrounded by steep sandstone walls, although the canyon bottom does still have abundant soil today. It is one of two Pueblo habitations located in the canyon plant community in the transect, and the arable canyon bottom soils are found in the immediate vicinity of the site. The second outlier is a field station (Bullet 19-2), that is located within a large mesa top sagebrush park between two forks of Bullet Canyon. This site is one of the most ephemeral in the transect, containing 49 artifacts, only two of which are flaked lithic tools and no flaked lithic tools, facilities or features.

At first glance, the fact that a majority of field stations are located atop watershed divides, which would appear to be in opposition to the idea that field stations
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were close to drainages to take advantage of floodwaters rushing over fields; that is, floodwater farming. What was postulated, however, was a duality in locations for field stations. Some of these sites would be located within drainages, while others appear to have taken advantage of divide areas having deep, arable soils. The latter is the dry-farming method dependent solely upon direct rainfall.

The present day Navajo follow field strategies very similar to these approaches. Russell (1978:20) writes about Black Mesa Navajo:

Three agricultural field types exist among the seventeen fields examined. Nine are dry fields, six are floodwater fields, and two are irrigated from water stored behind a spreader dam...Dry fields receive their moisture from precipitation that falls directly on the field. Floodwater fields in contrast, are located in a position such that during the summer where rainfall occurs, floodwaters, from a normally small catchment area, move into field areas.

As argued before, the first two "Navajo" procedures may have been used on much of Cedar Mesa, and we do have evidence of field stations being located in situations to take advantage of both. By using two types of fields, the calamity of a drought killing crops solely dependent upon rainfall, or an excessive downpour washing away floodwater fields is mitigated.

Median rank of nearest watershed divide.

A final factor in Pueblo site location is the rank of
the nearest watershed divide. There are hundreds of divides within the transect area, but most are neither long nor wide, and separate only first order drainages from one another. Far fewer divides have second order ranks, and even fewer are considered third order or greater. The approach used here is primarily exploratory, so no hypothesis has been generated. However, median rank values and chi square goodness-of-fit tests (Table XI-4) are used to evaluate differences in divide rank between prehistoric sites and random points.

Results indicate that median divide rank for both random points and field stations is first order, while the median divide rank for habitations is second order. Far fewer of the latter exist within the study area. When conducting chi square tests of nearest divide rank, an evaluation of random points versus field stations elicited no difference of nominal significance. However, a similar test between random points and habitations indicated differences between the two groups were significant at the nominal .05 level.

A final way to evaluate relationships between sites and watershed divides is to examine proportions of each group having nearest divides ranked second order or greater. For habitations, 62 percent of the closest divides were second order or greater. This figure was only 47 percent for field stations and 46 percent for random
points. This suggests that for habitations, there may have been a conscious selection for divides having greater ranks than would be expected, given the random model. It is unlikely that the Pueblo Anasazi were aware of divide rank, but with deeper soil and denser pinyon-juniper forest, second order or higher watershed divides were the preferred locations for year-round settlement. Higher ranked divides were the likely locations of the best arable farm lands. They had abundant building timber and fuel, and the deep unconsolidated sediments made pitstructure construction feasible. Conversely, field stations, although located mostly atop divides, appeared to have been positioned without regard for watershed divide rank. Instead, this group of sites fits almost exactly the distribution expected from randomly located points.

<Investment in Facilities at Field Stations.>

<Introduction>

Although, as a whole Pueblo field stations differ greatly in number of features from habitation sites, there was actually considerable variability in the number of facility types present at these sites. A group of eight field stations in the transect had no facilities, being nothing more than sherd and lithic scatters, while another group of four field stations had a number of facilities including hearths, slab-lined cists, burned jacal and
millingstones, and some of these latter were classified in Chapter VII as habitation sites. As indicated in Table XI-5, most Pueblo transect field stations fell between these extremes.

This section illustrates how a general analogy with the Navajo can lead to creation of a hypothesis that attempts to explain patterns of site facilities found at field stations. Review of the literature suggests the Navajo have a specific strategy when placing facilities at temporary camps. Jett and Spencer (1981:38) write that "...lightly constructed shelters are most commonly for use near fields <distant> from the main camp" (emphasis added). In another article Russell (1978:38) states that storage pits at Navajo fields or field houses were visited during the winter to restock corn and squash supplies at the winter habitations. Although Russell did not mention distance from storage pits to habitations, if there were close to the main camp, a visit would not worth a mention.

<The Idea and the Test>

Haase argues (1983a, 1983b) that these ethnographic observations could be applied to many types of site facilities, and that increasing or decreasing distances from habitations may be related to diversity in site facilities at field stations on Cedar Mesa. He formulated as a hypothesis that as distance from contemporary habitations increases, the diversity of site facility types
at field stations will also increase.

Diversity of facility types, rather than total number of facilities found at field stations, was chosen as the relevant dependent variable because a number of types suggest more residential functions at a site, or duration of use, while numbers may just indicate length of use. The data shown on Table XI-6, are the information source used to test this hypothesis. The term "contemporary" refers to habitations and field stations falling into the same ceramic assemblage, and assignable to one of the four Pueblo occupational phases. Sites with mixed components or those not assignable to a phase were excluded from this analysis.

Field stations were placed into one of four classes, depending on diversity of facility types found at these sites. These are: 1) sites with no facilities; 2) sites with one facility type; 3) sites with two facility types; and 4) sites with either 3 or 4 facility types. Because of the "Alfred Law" examination by individual facility type (e.g. cists vs. hearths) would split the data into categories too small to interpret statistically.

Use of the Kruskal and Wallis test indicates that differences between the four classes in distances to nearest contemporary habitation sites, significant at a nominal level of .05 (H = 9.14, 3 degrees of freedom, approximately distributed as chi square, where the .05
critical value is 7.815). Figure XI-13 graphically illustrates these trends. The median distance to nearest contemporary habitation for field stations having no site facilities was 250m and with the exception of one site located 940m from the nearest habitation, all were found within 300m of known residential sites. Field stations with one facility were generally located farther from habitations, having a median distance of 690m and a maximum distance of 3.06 km. Sixty-one percent of sites within this category were less than 1 km from nearest contemporary known habitation. Field stations containing two facilities were located at even greater distances from known habitations, with a median distance of 950m and a maximum distance of 4.62 km. Fifty-two percent of these sites were found within 1 km of contemporary habitations. The real break occurs with sites having 3 or 4 facility types. Median distance to nearest habitation was 4.06 km, while maximum distance was 7.25 km. Only two sites from this category were located closer than 2.75 km from the nearest contemporary habitation. While 75 percent of sites with 3 or 4 facility types were located greater than 2.75 km from habitations, 84 percent of field stations with two or less facility types were closer than this distance to contemporary residential bases.

In sum, the hypothesis that diversity of site facilities at field stations increase with distance from
habitations is supported by the data. But why did this occur? Plog and Hill's (1971:12) assertion that "Sites were located so as to minimize the cost of resource information flow between sites..." offers some insight. It can be inferred that "resource information flow" means a number of things, including time expended walking between sites. This is important, because the more time spent traversing between field stations and habitations, the less time could be spent tilling and protecting distant fields. The time element would be especially critical during harvest or planting when maximum labor at the field was necessary.

While travel time was not a factor when farming plots of land located a few hundred meters from habitations, a daily trip could consume considerable amounts of time, especially if fields were located several kilometers from the residential base. This distance factor may explain why nearly 60 percent of field stations are found within 1 km of contemporary habitations. Lack of facilities at a site may indicate farmers tending the fields returned to habitations on a daily basis, while field stations containing facilities limited to hearths and millstones suggest food processing and preparation occurred, perhaps necessitated by occasional overnight stays at the field.

At distances greater than 2.5 or 3 km from habitations the Pueblo on Cedar Mesa appear to have spent
proportionately greater amounts of time at field stations. Bradfield (1971) argues that prior to draft animals that 4 miles (6.4 km) from the village was the maximum distance that any amount of land could be farmed for the Hopi, which fits in with this pattern. With the exception of just a few sites, field stations at these distances had hearths, millingstones, slab-lined cists and burned jacal. Remnants of burned jacal suggest the presence of substantial structures, far more extensive than a wind break or ramada, while cists may indicate that harvested food was stored at these sites in anticipation of retrieval later in the year.

Cists may also have been used to store seed for the next growing season. As transporting the crop is one of the most labor intensive tasks, cists would enable this task to be spread out over time. These sites may have been occupied for much of the growing season in some years, serving similar functions as the residential base, or even, at times, as residences when fields close to the main habitation failed.

As noted on Figure XI-13, there are two sites having either three or four facility types that do not fit the overall trend; they are within 300m of the nearest contemporary habitation. This may be the result of 1) weak chronological controls, or 2) the possibility that these residuals are in fact small habitation sites. In neither site classification, however, were these sites categorized
as habitation sites. Contemporary sites are those occupied during a single phase which may have had a duration of 50 years. There is no way individual field stations can be associated with a particular habitation; thus the two sites may not be located within 300m of a parent habitation, and instead, may be associated with habitations at greater distances not accounted for in the archaeological survey. Haase used the presence of pitstructures, surface rooms or structured trash disposal, to classify a site as habitation. According to field notes, these two sites lacked all three of these feature types, and lacked the numbers and diversity of artifacts to suggest habitations on that basis as well.

Given that Haase has demonstrated a relationship between the diversity of utilities and distance from nearest known contemporary habitation site can we use this information to gain further enlightenment about our questionable habitation class defined in Chapter VII? Remembering that Haase's class of eight "field stations with abundant facilities" includes two members of this questionable class, we might inspect this class as a whole to see if the "questionable habitation" class appears to be similar to the "field station with abundant facilities".

Of the seven sites in the questionable habitation class one (North Road 3-2) (?) cannot be securely dated and so we cannot use it to see how close it is to the nearest
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contemporary habitation. It is notable that of the six remaining, only one (North Road 11-4) is found within a quadrat with a contemporary habitation site. The median distance to the nearest known contemporary habitation site is 2.83 km and the mean is 3.37 km. Of the classes used by Haase, it is most similar to the 3-4 facility class but falls well short of the median distance of 4.06 km recorded there.

We can conclude, then, that the questionable habitation sites in terms of distance to the nearest known contemporary habitation site are not like the usual field station site. This was known already, because of the overlap in classification. However, if we can calculate distances between "good" known contemporary habitation sites, we will have an addition baseline to evaluate this group of sites.

Distances between nearest contemporary habitations appear to differ considerably between Pueblo phases and drainages. One might expect the shortest distances to be found in the most common phase in the most densely occupied drainage, Bullet. Nine Windgate habitation sites are found in Bullet and they have a median intersite distance of 1.10 km and a mean of 1.12 km. A less abundant phase in a less densely occupied drainage would be expected to give us larger distances and the Mossbacks Phase in West Johns does. The three sites here have a median distance of 2.80
km and a mean of 3.62 km, almost the same as that of our group of six questionable habitation sites. The problem here is the very small sample size -- three. A little reflection will indicate that sites distant from each other are always going to be sparse resulting in small sample sizes. The eight Windgate Phase sites in West Johns, on the other hand, have a median intersite distance of only .20 km and a mean of .64 km.

What these three measures of intersite distances indicate is that the questionable sites are at the outside limit for habitation sites and are similar to the distances for field stations with abundant facilities. While still ambiguous this observation does suggest that it is quite likely that some and, perhaps most, of the questionable habitation sites are better thought of as Haase's new type of "field stations with facility". While this conclusion may not appear to be very satisfactory at this point, it is likely to be a true reflection of the intermediate nature of these sites. Let us examine the concepts of habitation and field station further.

<Relationship between Field Stations and Habitations>

A habitation site is usually thought of as the site where the family resides year around. "Field stations" as developed by Haase (and used throughout this volume) appear to be day camps, sites that are frequently utilized
on a day time basis. Yet it is to be expected that at times of harvesting and predation that around the clock use of these sites would occur, at least, by some individuals. If we are correct in suggesting that agricultural activities involved women much more prior to the proto-historic Pueblo aggregation than after, such site use may well have involved more of the family than one would expect from the ethnographies. For such periods of intensive use, the field station would be the residence and the habitation site "seasonally abandoned". Such considerations, however true, do not negate the general assignment of the main habitation as "habitation" or "residential" and the field station as "limited activity". The next step, though is a bit different.

Given field station sites located some distance from the main habitation, we would expect less desire to commute on a daily basis during the growing season. As Haase (1983a, 1983b) has demonstrated and we have confirmed here, such field station sites have a greater number of facilities, indicating a more residential nature. These may approach, or even surpass, what is usually thought of as a field house. Remembering that the entire family is apt to be more involved than the Pueblo ethnographies indicate, we can see a situation where a distance field station regularly is the family residence for several contiguous weeks each year during harvest, as well as
possibly other periods during the growing season. While one would expect most fields to be close to the main habitation site, and to mature at a similar rate, a more distance plot could be planted to ensure a crop if the main ones failed and so would likely not conflict in seasonality of the most labor intense periods with the "main" ones. In such a situation if the primary ones failed early, would not one move to the distance field and work hard to ensure its success? And might one winter there as well? In such a situation the distinction between habitation and field station may depend on which year one is considering.

A further consideration is a choice for a new habitation. This might evolve as suggested by the sequence above or perhaps an explicit decision. In such a case using a known reliable field some distance from other habitations as a base and putting in more fields from that base may will be an effective choice. Such a trial may fail for agricultural or social reasons and the site revert to a "simple" field station. Thus we can expect that sites will occur that will have a fuzzy location in the middle of this "habitation"--"field station" dichotomy, and have characteristics of both field stations and habitations as defined by Haase. Such sites should not only have facilities and artifacts of an intermediate nature, but also be located, as Haase has demonstrated, more distant from contemporary habitations than most field stations,
and, as also demonstrated here, most contemporaneous habitations are from each other.

<Changes Within the Pueblo Period>

<Introduction>

The fundamental change within the Pueblo occupation of Cedar Mesa was the development of the cliff dwelling adaptation in the terminal phase, tree ring dated to AD 1240 to AD 1267. In this section we examine the mesa-top occupation to see if we can discover changes that correspond, and also if we can find evidence of other developments within the Pueblo occupation. We will refer, not only to the quadrat data from all five drainages, but also to the analysis carried out by Haase (1983a) on the central transect and various drainage canyon data.

-The Terminal Redhouse Phase-

It will be recalled that in the seriation, most of the sites collected from the drainage canyons and from the canyon architectural survey dated to the end of the Cedar Mesa Pueblo occupation. Of the 22 drainage canyon sites classified according to discriminant analysis, 16 were placed in the terminal Redhouse Phase, four in the Woodenshoe Phase, and with only a maximum of two sites in the earlier two phases. If we include Upper Grand Gulch C14-1, which was used in the original seriation, 21 of the
23 sites collected during the drainage canyon survey and collection belonged to the last two phases, and 17 of those, to the terminal Redhouse Phase. This dramatic, and highly visible, occupation is not as obvious in the quadrat survey, as the canyon environment is not well represented in that sample.

Five of the quadrat sites are in canyon, or cliffside, environments and the sherds recovered fit the pattern found during the drainage canyon work. Both Bullet 17 habitation sites are classified into the Woodenshoe Phase; all three sites found in Bullet 17 and West Johns 6-4 belong to the Redhouse Phase. This last site appears to be as recent as any according to the final re-seriation (Figure VII-12), including the drainage canyon sites, and it is found in a "cliff" situation with the only probable water control feature found during the survey.

It will be recalled, that, as a group, the drainage canyon Redhouse material appeared to be more recent, according to the ceramic seriation, than the mesa-top Redhouse material. In fact, none of the drainage sites with enough ceramics to seriate directly (rather than using multivariate discriminate analysis) appeared to be other than Redhouse Phase components. These results are shown graphically in Figure VII-12 in the seriation section. According to this figure, of the 28 most recent Pueblo sites, only nine are mesa-top sites.
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The terminal placement of the canyon occupation according to ceramics is supported by the existing tree-ring dates. Table XI-7 gives some of the later dendrodates for the drainage canyon sites. It will be noted that sites with good dendrodates do not necessarily have good ceramics. There may well be a problem with selective surface collection, particularly on the best preserved cliff dwellings, exactly the ones with the best dendrodates!

Another problem is the different natures of dates based on tree rings and those on ceramics. Few bark dates exist, and when they do, they are usually the most recent dates. Thus these can often be interpreted as dating the latest building or remodelling episode. Many of these sites also incorporate numerous logs with dates in the middle of the 12th century testifying to reuse of previous construction peak, a pattern also found elsewhere (Harrill and Breternitz 1976). While the interpretation of such a series may well be, say, construction of existing structure in early AD 1250’s with final remodelling in 1259 and the reuse of wood from unknown construction in the 1150’s, the ceramic date may be quite different. Since few sites show significant earlier ceramics, the earlier construction may well have been limited to storage. On the other had, a mixture of the ceramics from two periods is apt to give a ceramic date in between, representative of neither. The
usual situation appears to be that the ceramics represent only the last building episode, probably dating in the AD 1230's, 40's and 50's and lasting no later than the 60's.

Table XI-7 appears to fit this pattern with three of the dated sites having tree ring data that can be interpreted as indicating final construction in this time range and ceramics of the Redhouse phase. The canyon architectural and tree ring survey sites typically showed a similar pattern, with the final occupation in AD 1230's, 1240's, and 1250's but with evidence of earlier canyon use from apparently reused beams dating to the mid twelfth century. Only a few sites in this survey, such as Grand Gulch Canyon 3-1, have ceramics which correspond to the earlier tree ring dated construction period. So, both the drainage canyon work, and the partially analyzed architectural and tree ring survey produced equivalent patterns.

In summary, there is little doubt that the terminal occupation of Cedar Mesa was in the canyons. We have three separate lines of evidence for this. First, and the only really good comparative data, is the seriation where the drainage canyon bottom sites date consistently to the last part of the Pueblo occupation with a concentration on the terminal Redhouse Phase. The canyon Redhouse ceramics as a whole appear to be later than those found on the mesa-top, particularly when the "mesa-top" cliff dwellings
(i.e. sites found in the quadrat survey, although located in canyon situations) are taken into account. Second, the dendrodates from the drainage canyons are the most recent and post date by some three decades any mesa-top dendrodate, although the sample size of the latter is very small. Finally, the canyon bottom tree-ring architectural survey confirms the late date of Cedar Mesa cliff dwellings. The ceramics of the last, picked over, and meager as they are, appear to fit the pattern expected on the basis of the seriation.

Given the late Pueblo III concentration in the canyons, two questions arise. Does contemporaneous habitation continue on the mesa-top and do locational shifts precede or accompany the shift into the canyon? The first is not possible to answer at this time. While the mesa-top terminal sites appear as a whole to date earlier on the basis of ceramics, they could have been occupied simultaneously at the end. The apparently earlier ceramic date of the Mesa-top sites could be the result of their earlier initial establishment. Extensive tree-ring dates would seem to be the only way to decide this argument conclusively. The nature of the cliff dwellings, however, suggests that simultaneous use, at least for much of the time, may be the case. Cedar Mesa cliff dwellings have abundant storage facilities and defensive arrangements, along with often plentiful kivas (Lipe 1987). They are
usually notably short on habitation rooms. This suggests that some members of a cliff dwelling "community" usually lived elsewhere. The absence of arable land near many of these cliff dwellings also suggests members spent substantial durations of time elsewhere, for farming purposes at least. The ever anomalous West Johns 17-1 might be the result of some compromise habitation, close to cliff dwelling and not too far from arable land, and therefore contain less than usual site facilities for a habitation.

With respect to the second question about other locational changes co-occurring or preceding this shift, we can look for trends in mesa-top quadrat sites by contrasting the various phases. On inspection of the data one trend is immediately apparent, the absence of any Redhouse or Woodenshoe habitation in the Upper Grand Gulch drainage. The distribution of habitation sites according to period and drainage is seen in Table XI-8. The Redhouse or Woodenshoe presence in Upper Grand Gulch is limited to three limited activity sites, and one of those is a lithic reduction site. The apparent large number of facilities on the Upper Grand Gulch lithic reduction sites may be explained by the absence of contemporaneous habitation sites during the Redhouse Phase. These sites would then become something similar to Grand Gulch Phase campsites in terms of facilities, occupational duration and
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positioning with respect to contemporaneous habitation sites.

The absence of Redhouse habitation sites in Upper Grand Gulch is supported in Table XI-8 by the higher proportion of the last phases in the southern portions of the Pueblo occupation on Cedar Mesa, Bullet, West Johns and Hardscrabble drainages. Twenty-two of the 41 habitation sites found in these three drainages are classified in the last two phases, while only two of the 13 habitation sites found in Upper Grand Gulch or North Road are. Fully 13 of the 14 Redhouse quadrat habitation sites are found in the southern three drainages while the only remaining one is found in the northern two drainages.

On first glance this distribution suggests a decrease in elevation for later Pueblo sites, and an abandonment of northern environment. We know, however, that this abandonment is not true, at least for the wider area. Some 30 km northwest of Cedar Mesa, Brooks (1974) describes a late Pueblo III occupation on a plateau more than 2030m (7000 ft) in elevation at Horse Flats (Figure XI-14). This occupation not only includes the late high elevation Pueblo occupation of Mesa Verde ceramic tradition, but also involves numerous water control devices, also lacking on Cedar Mesa. The Horse Flats investigation demonstrates that higher elevations were used elsewhere, but that does not mean that on Cedar Mesa the higher elevations were not
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abandoned. So the absence of Redhouse Pueblo habitation sites in Upper Grand Gulch cannot be easily ascribed to some broadscale, general trend of abandonment of all higher elevation areas.

If, along with the decreased use of the northern portions of the mesa, there was a move to or a greater reliance on the canyons during the terminal Pueblo occupation, this ought to be evident in additional ways on mesa-top quadrat sites. We would expect Redhouse Phase habitation sites to be located closer to canyons than earlier Pueblo habitation sites. Since canyons are found more abundantly at lower elevations, we would expect quadrats with Redhouse habitation sites to have lower elevations than other Pueblo habitation sites.

If we test this hypothesis by using the Wilcoxon test to compare Redhouse habitation quadrats with all other Pueblo habitation quadrats, we find that the trend is in the expected direction, but the amount is insignificant (Sample sizes of 12 and 23, this rank sum 202.5, .10 probability rank sum is 183). A more direct test might be to take the same two samples and the distance to canyons of 49m (160 ft) or more as devised for the Grand Gulch settlement pattern testing. If we do this, we find that quadrats with Redhouse habitation sites tend to be <further> from canyons than other Pueblo habitation quadrats, although not to a significant extent (this rank
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sum is 195). The gross positioning of Redhouse quadrats with respect to other Pueblo Phase sites and canyons is unclear at this point.

Haase, however, was able to show a trend towards known water sources through time among Pueblo habitation site for the transect (Haase 1983a). Figure XI-15 illustrates that the last two phases do show a much tighter relationship with known water sources than the first two. Differences between late Pueblo habitation (Redhouse and Woodenshoe Phases) and random points in the transect have a nominal probability of .025 according to the Wilcoxon test (This unit normal deviate is 2.007). This pattern contrasts with the insignificant difference found for Pueblo transect habitations sites as a whole(?). In fact the combined Windgate and Clay Hill Phases in the transect have the same first quartile, median and upper quartile as the random points--400m, 700m and 900m respectively. While 50 percent of the random points are further than 700m from water, only 8 percent of the Woodenshoe/Redhouse habitation sites are located beyond this distance. Although 50 percent of the habitations from the last two Pueblo phases are located within 400m of water, only 31 percent of random points were this close. The only "residual", is Bullet 1-1, which was discussed before, when dealing with the Pueblo period as a whole. This site is close to a large mesa-top escarpment, and this zone was not systematically examined for seeps or
springs, although they did occur in this situation. None of the other Redhouse/Woodenshoe habitation sites were 800m away from a known water source.

From this analysis it appears that nearness to canyons were not being selected for during the last part of the Pueblo occupation, but water sources are. As this is a very important point, it is important to confirm that this pattern extends outside of the transect. Limiting ourselves to the Redhouse Phase, we can relatively easily confirm this pattern for the remaining habitation sites. Since the Upper Grand Gulch drainage does not contain any Redhouse habitation sites all we have to do is inspect those in the West Johns drainage to see if this trend toward water of mesa-top terminal occupation continues outside the transect.

Two of the three Redhouse habitation sites in West Johns have already been discussed; the cliff dwelling West Johns 6-4, adjacent to two water sources and the forever anomalous West Johns 17-1. West Johns 17 is located right at the western edge of the mesa, at the head of a side canyon (Figure XI-2). While the main branch head, some 1000 meters away does have a spring, the side branch was never searched, so the presence or absence of a spring in this setting although common to many springs, is unknown. In any event, water is not far, and may be quite close, as are at least two cliff dwellings.
The final West Johns Redhouse habitation site, 2-1, is also located near the head of a canyon, although in a place with soil that is much more likely to be arable than West Johns 17. A spring is present in this canyon head, about 450 meters away. So all three West Johns Redhouse Phase habitation sites support the pattern reported by Haase for the central transect. There is a clear trend for the last occupied mesa-top sites to be located closer to known water sources than earlier. Matson (1978:10) also found this to be true when analyzing with sites from Hardscrabble and Bullet.

In contrast, the Anasazi the Windgate/Clay Hills Pueblo demonstrated that the proximity of water was not the only factor involved when choosing habitation locations. In this instance, the habitations closely resemble the random model on the transect. It is only the last two phases that show this trend, the shift in the importance of domestic water sources. Perhaps this is indicative of a gradual drying trend at this time. We will return to possible causes later.
Earlier we also demonstrated that Pueblo field stations, as a whole, are found further from known water sources than expected. This finding can be thought of as supporting our earlier statements that arable land is located away from water, that is, in deep-soil divide areas usually relatively distant from canyons and canyon heads where springs are abundant. The observation that the terminal occupation is one that places closeness to domestic water at a high premium suggest that our basic assumption about habitation sites being located adjacent to arable land may be in doubt for the Redhouse Phase.

Our best measure of arable land has been dense pinyon-juniper cover. Dividing the 35 Pueblo habitation quadrats into two groups depending on the presence of Redhouse habitation sites results in Figure XI-16. Note how half of the earlier habitation quadrats have coverage of dense pinyon-juniper of 86% or greater while only two Redhouse habitation quadrats do. Note too, that the quadrats belonging to the earlier three phases and having low percentages of dense pinyon-juniper cover tend to have "excuses"; Bullet 17 has two Woodenshoe cliff dwellings, Bullet 18 is located on a deep-soil divide and both Upper Grand Gulch 6 and North Road 4 are located adjacent to high elevation deep-soil pinyon-juniper areas. The remaining member of the low tail, West Johns 9 is located in a setting similar to that of Bullet 18. So, one way or
another, the first three phases are almost always located in areas of concentrated arable soil.

If we use the Wilcoxon test to compare the two distributions as seen in Figure XI-16 where quadrats with Redhouse and other Pueblo Phase habitation sites are placed in the Redhouse group, we do not find a significant difference. (This rank sum 188.5, .10 probability rank sum is 178). However, if we recast the test to compare those quadrats with only Redhouse habitation sites against all other Pueblo habitation quadrats, we do find a significant difference. (Sample size of 7 and 28, this unit normal deviate is 2.144, .02 probability deviate is 2.054). We can conclude that this difference is significant and that the terminal mesa-top Pueblo occupation is not as oriented toward mesa-top arable soils as are earlier phases.

The meaning of this change is not altogether clear. Given that we are uncertain whether the mesa-top Redhouse sites were occupied along with the canyon bottom sites and together form a unit, or whether the mesa-top sites represent a step on the way to the canyons, many features will continue to be unclear. What is certain is that domestic water begins to become more important, and regardless of whether or not the mesa-top sites were abandoned before the canyons, access to domestic water becomes more important than access to arable land, which
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has, up until this time, been the primary consideration.

The intermediate state of the Pueblo occupation
(between the Grand Gulch and Mossbacks Phases) on many
variables, such as elevation and pinyon-juniper coverage,
can now be clarified. The basic Pueblo occupation, as seen
in the first two Pueblo phases, and probably in the third,
is an adaptation basically the same as that seen hundreds
of years earlier in the Mossbacks Phase. The apparently
intermediate situation is the result of the move to the
canyons, clearly present in the Redhouse Phase, and
probably partly underway during the Woodenshoe Phase. This
is the basic hypothesis presented by Lipe (Lipe and Matson
1971a) and is well supported here, although the actual
expression observed in the terminal mesa-top Redhouse Phase
was not predicted. Several of the features found in the
mesa-top Redhouse Phase are seen in a more extreme form in
the canyon Redhouse occupation.

Preliminary analysis of the canyon material confirms
our earlier statements (Lipe and Matson 1975) to the effect
that while the amount of arable land in the canyons does
have an effect on the number and sizes of sites found
there, it is only a minor effect. The presence of numerous
cliff dwellings in canyons such as North Road and Slickhorn
which have no remnants of arable land in the canyon bottom
indicates that the occupation of the canyons was dependent
on other factors. The two obvious additional factors are
domestic water and defense, a factor much less easy to
demonstrate.

While the full explication of the canyon occupation on
Cedar Mesa, as elsewhere in the Southwest, is yet to come, we will offer a few additional words later. When the
analysis of the canyon material is complete we hope to be
able to add further substantive information.

In addition to the changes associated with the
terminal Pueblo occupation, one other change within the
Pueblo occupation is notable, that of the close
relationship between the Windgate phase sites and the
Basketmaker III occupation of Cedar Mesa. Of the
twenty-nine Mossbacks sites that have a Pueblo component, 15 have a least a probable Windgate component present. Of
the 14 Pueblo components which are not Windgate, six could
not be classified to any phase. So there is a close
correspondance between Windgate Pueblo components and
Mossbacks ones. This association was close enough so that
it caused us to seriously underestimate the number of
Mossbacks components earlier (Matson and Lipe 1978) since
we assumed that the early appearing gray wares naturally
occurred in our earlier Pueblo sites! Further work showed
the presence of diagnostic Basketmaker III sherds and
usually some sort of spatial difference between the Pueblo
and Mossbacks ceramics, as related in Chapter VI.
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The exact reasons for what appears to be an intentional selection of Basketmaker III site locations by Windgate Phase farmers will probably never be known for certain, but reasonable speculations are possible. The three of us have developed the following scenario.

When Windgate peoples first entered Cedar Mesa, they were pioneers settling a virgin landscape. The region may have been suited for hunting or gathering, but within these farmers' lifetimes, no one had attempted to test its agricultural potential. During the 300 plus years Cedar Mesa remained unoccupied by permanent residents, Basketmaker fields and clearings were completely reforested. Basketmaker III ruins with pithouse depressions and sherd scatters, however, were probably quite evident in the pinyon-juniper; they certainly are to the archaeologist today.

Upon finding these remains, the Windgate farmers likely concluded that the Basketmakers had been farmers as well, following similar lifeways. Certainly the Basketmaker III sites were located in areas of deep arable soil and had sunny exposures—necessary requirements for any farmer. The forest had returned, providing fuel wood, and possibly slash and burn farming opportunities as well as building supplies. Perhaps the returning Anasazi liked what they saw in the immediate proximity of Basketmaker III sites, and because the region had yet to be thoroughly assessed
for its agricultural potential, they simply settled atop these sites with the assumption that if the vicinity had been productive previously, it would maintain farming settlements, or at least farm plots and field stations again.

Occupants of later Pueblo phases, however, did not intentionally select site locations containing Mossbacks components. Later Pueblo occupations also did not appear to settle in exactly the same vicinity as Windgate Phase Anasazi. This difference is illustrated on Figure XI-17, which shows placement of sites by period along a west/east axis running through the Hardscrabble, Bullet and North Road Drainages as prepared by Haase. While there is some overlap between all periods, post-Windgate Phase occupations are concentrated farther to the west, suggesting that factors other than proximity to Basketmaker III sites became important in determining settlement location. Using the Wilcoxon rank sum test to examine differences in west/east locations between periods along the transect, no significant differences were observed between Basketmaker III and Windgate sites (this unit normal deviate 0.023), while the discrepancy between Windgate and later Pueblo Phases has a nominal probability of about .015 with a unit normal deviate of 2.233.

The exact reasons for westward movement through time
are not clear, but previous findings suggest that placement of resources within the environment may have played a role in shifting settlement locations. During the Windgate Phase, it is likely that Cedar Mesa was thoroughly explored and through a series of trials and errors, the region's agricultural potential determined. It is the well watered areas containing the deepest soils that were settled by later Pueblo occupations. With the exception of a few field stations, and the terminal canyon occupation, the westward trend ceased at the edge of the blackbrush community.

The reason for the initial eastern bias is very obvious, for that is the direction the Windgate settlers came from. During the 300 plus years hiatus, the nearest large Pueblo population was to the east and one might expect a wave type immigration pattern, with the first habitation sites in an area being formerly distant field stations. The eastern orientation of the Mossbacks occupation is not so obvious, but likely the result of the same process. The Mossbacks occupation of Cedar Mesa is short, and the source was undoubtedly to the east, thus the eastern orientation seen in Figure XI-17.

<Pueblo Population>

<Introduction>

For the earlier two occupations of Cedar Mesa some
argument was necessary to demonstrate the existence of population aggregations larger than a single family. In the Pueblo occupation there are several sites which have too many structures for a single family making such an argument unnecessary. Clearly at some residential sites the social unit was larger than a nuclear family. On the other hand, the "typical" situation appears to be more in accord with that of a nuclear family residing in a separate structure. In this section we will examine the distribution of habitations large and small, and with each other before developing any population estimates. First we will see if sites tend to be isolated or occur in groups, a question that can be investigated in more detail for the Pueblo occupation than for the earlier ones because of the subdivision into shorter ceramic phases.

Associations of Habitation sites>

The distribution of habitation sites per quadrat is shown in Table XI-9a and Figure XI-18 and the total number of sites found in each quadrat class in Table XI-9b and Figure XI-19. As before, most habitation sites are found in quadrats with other habitation sites; in this case about 63 percent. While previously we had no way to test the contemporaneity of the sites within a cluster, for this time we have defined four phases and we can use these to
get a better estimate. In addition to multiple habitation sites within quadrats we have three cases where sites occur in adjacent quadrats: Bullet 3 and 6, Bullet 8,10,21, and Upper Grand Gulch 2 and 4. Rather than using multiple habitations in a quadrat as our units, we can use "clusters" of sites within single quadrats or in adjacent quadrats and we find the distribution of site clusters seen in Table XI-10 and Figure XI-20. This results in 14 clusters of sites which must be inspected in regards to ceramic phase.

Of the eight clusters of size two, four are made up of one phase. Of the four other clusters, three are of phases of adjacent age and one one is of further separated phases.

While our phases probably average durations of fifty years, the average duration of a Pueblo site is undoubtedly less than that. The most straightforward interpretation of the clusters of size two, would be that while some of them were occupied contemporaneously, most were not. Of the four clusters of three sites, only two have two sites belonging to the same phase, suggesting that most of these sites were not occupied contemporaneously. Both of the two largest clusters have three sites belonging to the same phase, indicating that some of these sites were contemporaneous.

Even allowing for some misclassification of sites, so that contemporaneous sites were placed into different
phases, the number of contemporaneous sites in these clusters is not more than half of the sites observed. While 38 of the 55 total separate habitation sites are found in clusters, this suggests that at any given time two-thirds of the sites would be found in quadrats by themselves, a reversal of the aggregated data. Since we do have sites that are too large for a single nuclear family we are still certain that at least some sites were occupied by larger social groups, even if most sites were isolated.

<Pueblo Habitation Distribution>

One way of social aggregation is of isolated dwellings located not too far from other dwellings. We can examine the data for this sort of clustering as before using goodness-of-fit with discrete probability distributions. Table XI-11 shows the fit of the habitation-per-quadrat distribution with the Poisson distribution. Notice, that once again, the variance is greater than the mean (lambda) indicating a clustered distribution. In fact, the fit with the Poisson is not a good one and can be rejected at the 10% level, in spite of the previously mentioned tendency of chi square to overestimate goodness-of-fit in this situation.

Table XI-12 in contrast gives the fit with the negative binomial fit using the moment estimator of k. By
inspection, and by chi square, this fit is far superior. Reference to the figure on p. 133 of Johnson and Kotz (1969) indicates the efficiency of the moment estimator of k in this situation is only about 90 percent. If we use method 2, k is reduced to 1.6328 and a fit that gives a chi square of only .185 and a nominal probability of about .67. Method 2, though, is also only about 90 percent efficient with this data set. In any event, the habitation sites do appear to be clustered and have a distribution similar to that given by the negative binomial.

As pointed out above, if we control for phase, the clustering is reduced. If we control for phase, however, our sample size becomes too small for this sort of analysis, as the Alfred Law strikes again. While the pattern is for Pueblo habitation sites to be clustered in space, but without much of the cluster being inhabited at any one time. Areas on Cedar Mesa were reoccupied during the Pueblo period rather than used once and then abandoned. Dispersed aggregation of sites that are contemporaneous can neither be rejected by discrete propability distributions, nor can it be considered to be well supported. It is clearly possible, not necessarily probable.

<Multi-family Sites>

While the situation for dispersed settlements is
ambiguous there are single sites which were occupied by multi-family groups. Some of the most obvious sites too large for a single nuclear family are the cliff dwellings in the canyons. They are the terminal occupation of Cedar Mesa and can not be assumed to be typical of the situation on the mesa-top. If these cliff dwellings are the Cedar Mesa version of the Pueblo III aggregation, the usual mesa-top sites must be smaller. The usual large mesa-top sites are the Cedar Mesa version of Prudden unit type Pueblo, with an above ground structure, a pithouse depression and a trash or midden area. All three features usually were aligned from northwest to southeast. We assume that the pithouse is a kiva, and from what information we have (such as the test excavations at Upper Grand Gulch 4-3 and Bullet 3-10a) this is probably so. The aspect that is often different from what one expects in a unit type Pueblo is the above ground structures which are usually slab based jacal structures, more the size of storage features than habitation rooms. The actual nature of these sites would take extensive excavation to determine. From the experience of the Black Mesa project (Hantman 1980, for example) one would expect that substantial jacal structures would be recovered in addition to what we observed on the surface. Casual comparison of the unit type sites on both mesas does indicate a number of
similarities which suggests that the Black Mesa experience may be appropriate. Even if little more than was usually recorded was discovered, the typical Prudden unit would be too large for a small nuclear family, but not necessarily for two large families.

In our tabulations of 55 separate habitations (Tables VII-23, 26 and 32), 10 possible or probable Prudden unit type sites are found. In addition, there are a number of other sites that have too many structures present to be the result of a single contemporaneous nuclear family occupation. Bullet 12-1, is a large disorganized Windgate Phase site built around a low mesa. Some 29 separate features were recorded, nine of which were interpreted as habitation structures. No obvious kiva was present. Bullet 17-1 is a cliff dwelling poorly preserved on several ledges, with five structures interpreted as habitation, with a total area of 67 square metres. On the same quadrat was another devolved cliff dwelling with a possible floor area of 40 square meters. No other "large" Pueblo site was found in the quadrat survey that did not appear to be a possible or probable Prudden unit. Thus 12 or 13 of the 55 separable sites appear to be too large for a single nuclear family.

At the same time some of those 55 sites are dubious habitation sites, as discussed earlier. If we eliminate all seven habitation sites that we earlier considered
questionable (and later suggested are probably intensely utilized field stations located some distance from the area of concentrated residences) we end up with 48 sites. Thirty-five or 36 of these were probably occupied by a single nuclear family. This figure suggests that most residential sites on Cedar Mesa were occupied by single families. If we allow five people per family we can develop population estimates by using this figure for the small sites and developing some other estimate for the larger sites. One way would be simply suggest an average of three families per large site. Using five people per family would give 15 people per large site.

Two possible checks on this figure exist. One is to calculate an average of habitation rooms per site and use the previously discussed figure of Hill's (1970c) 2.8 people per room. If we do this, and do not count kivas as rooms, we find an average 4.67 rooms per site and 13.07 people. Since in many sites a certain number of rooms are very evident, and others probably exist, as denoted as a "plus" in Table VII-7, this would appear to be a conservative estimate, and one in close agreement with the initial three family estimate. Another alternative population estimate is to use the total structural area and follow the Cook and Heizer (1968) formula, as before. The mean structure area is 60.8, which results in an estimate
of 11.05 people, considerably lower than the previous two estimates. This figure was derived by lumping all structural area in a site together and treating it as if it was a single giant pithouse, which is clearly not the case.

In the Cook and Heizer formula, the first six people occur in 13.9 m² and each additional individual uses 9.29 m². Since the usual site consists of a number of small rooms, this procedure results in an under estimate. If we calculate the mean room size, it is 13.02, very close to the 13.9 square meter initial figure. We might consider five people per habitation room, we end up with an average of 23.4 people per site, considerably over the first two estimates and twice the size of our first use of the Cook and Heizer formula. Averaging the two Cook and Heizer estimates results in 17 people per site, very close to the previous two procedures. These various methods altogether suggest an average population size of some 10-20 persons per large site, with the most likely figure in the middle of that range, leaving us with the first, crudest estimates of three families and five people per family being as reasonable as any.

<Population Estimates>

Once we derive population estimates for each size of habitation site, we need only to estimate the average uselife of a habitation site and the duration of the Pueblo
occupation to calculate the instantaneous population estimate. We will give two different types of estimates, which imply two different types of social systems. We will start with the simplest, the one that assumes the duration of occupation is the same on large and small habitation sites.

If we have 12 large sites averaging 15 people, we have a total of 180 people living in the large sites found in the quadrat survey. If we ignore the seven dubious small habitation sites, there are 36 small habitation sites, each occupied by 5 people for another 180 people. These two figures give a total of 360 people living in the Pueblo quadrat sites. If we assume that both kinds of sites are occupied for the same period of time, then half of the population is living in multi-family sites, and half in single nuclear family dwellings (although many of them may be living only a few hundred meters from other families.

If we assume, as we have done before, that our sample has recovered two percent of the habitation sites on Cedar Mesa, we would expect a total of 600 large and 1800 small Pueblo habitation sites to exist in total. To develop an instantaneous population estimate, all we need is estimates of duration for the Pueblo occupation and habitation site use.

We have a very good idea of the termination of Pueblo
occupation on Cedar Mesa, thanks to the terminal cliff dwellings and the resulting tree ring dates. The latest date is AD 1268. It is likely that this dates remodelling of one of the last sites occupied in the Cedar Mesa area (Moon House) and so probably is from a time after most Pueblo inhabitants had left this area. The beginning dates for the Pueblo occupation are much less precise. We think it predates AD 1080, but possibly not AD 1060. These two figures suggest 200 years would be a fair estimate for the Pueblo occupation. Given a few years for initial build up and for the abandonment (and ignoring the possibility of a hiatus), 180 years might be a fair value for the period of substantial Pueblo habitation.

Assuming equal uselife for small and large sites results in the population line seen in Figure XI-21. Remembering that with this assumption half the population is living in small sites and half in large sites, a five year average appears to be too low, making a population of 500 a subminimal estimate. While some of the smaller sites may have been occupied for less than five years, it is hard to imagine the larger sites with kivas being used, on the average, for less than 10 years. Therefore a population on the order of a thousand appears to be the most reasonable.

Taken into account the assumed longer duration of the larger sites, we can develop another population (and social) model. If we assume that the larger sites are
used, on the average, for twice the duration of the smaller sites, we end up with Figure XI-22. If we assume that the larger sites were occupied for a mean length of 10 years, and the smaller ones for five years, a population of 750 results. Surely a mean estimate for the larger sites of 10 years is not too high, and five years for the smaller suggest, that half would be occupied for less if the distribution was symmetrical, which is hardly excessive. On the upper end, if the larger sites were occupied for 30 or more years we would regularly expect ceramic profiles that indicated overlapping phases. While some of the larger sites such as Bullet 3-10, 3-7 and Upper Grand Gulch 4-3, do show this trend, most do not. This indicates an expected duration of less than that of an average phase length of 50 years. From the cliff dwellings we have evidence of reuse and modification in the 15 to 20 year range, although it is difficult to know how these data apply to mesa-top sites. Once again a population estimate of 750 to 1500, or about 1000, if a point has to be picked, appears to be in accord with our information.

This second population model results in a different social model than the first. Because the larger sites are assumed to be occupied twice as long as smaller sites, two small sites will be "used up" for everyone of the larger sites. This implies that at any point in time, twice as
many people were living in the larger sites as in the smaller sites. In other words, two-thirds of the population were living in multi-family sites while one-third is living in single family sites.

Once again, duration of occupation of habitation sites is the least known variable. The second weakest variable is probably the population estimate for the larger sites. Figures XI-23 and XI-24 repeat the last two, but only allowing 10 people or two families on the average large site. The first figure shows only a slight decrease, with perhaps the most likely point estimate being between 750 and 1000 population total. Reasonable outside limits on this line in the second figure appear to be populations of 600 and 1500, suggesting once again that a population of around 1000 is probably most likely.

It would be interesting to attempt to analyze population trends during the Pueblo II/III occupation, but unfortunately the Alfred Law intervenes again, as the sample sizes become too small to be useful. We might also note, that once again, we have used a conservative estimate for sampling rate, and we deleted the dubious habitation sites from our analysis. If anything, the population estimates given above are apt to be low rather than high.

While there are more variables involved in the Pueblo period than in the earlier two periods because of the greater differences in site size, the end result is
probably a better population estimate. More precise information on duration of occupation length is available and the sample is slightly large and better preserved. The end results are population estimates only slightly larger than those obtained for the two earlier periods. Of the two different models used, the second is (where large sites are occupied longer than small ones) to be preferred, as it is more realistic (if more complicated). It also results in social organization aspects closer to those that are traditionally expected.

－The Nature of the Pueblo Occupation－

－Introduction－

Cedar Mesa was occupied three different times during the Basketmaker II, Basketmaker III and Pueblo II/III periods. During the first occupation, Cedar Mesa was occupied as densely as any area yet reported for that period and clearly was the residential center for a substantial population. The second occupation was more concentrated in space and less impressive, considering our knowledge of other occupations during this period. If we combine our information with that recovered by the Utah 95 salvage work (Wilson 1974, Dalley 1973) there is little doubt that Cedar Mesa was the focus of substantial Basketmaker III residential activity, although only for a
short period of time. In contrast to the first two occupations, the Pueblo is sparse in terms of large sites compared to areas directly east of Cedar Mesa. While there is little question about the nature of the year-round habitation during the first two occupations, questions can be raised about the nature of the last. We will review a number of aspects which affect the interpretation of the Pueblo occupation, and return to the notion of "field houses" and the effects of distance on settlement patterns of horticulturalists.

<Large and small sites on Cedar Mesa>

There is no doubt that Cedar Mesa was not a locus of intense Pueblloid occupation, in spite of the population estimates produced. Compared to areas in Upper Comb Wash, or in Cottonwood Wash, to the east, Cedar Mesa lacks large sites. Mesa-top sites with masonry rooms in the dozens, to say nothing of the hundreds, are completely, or almost totally, lacking. Vast sites occur frequently between Cedar Mesa and Mesa Verde on the southern edges of modern agricultural area on the sage plains. Even on Mesa Verde, which except for the last cliff dwelling period, tends not to have large sites, the sites are larger and much more concentrated than on Cedar Mesa.

The lack of large sites on Cedar Mesa can be viewed by two very different alternative ideas. The first would
follow Jennings' (1963) idea and have Cedar Mesa be a typical Pueblo II/III mesa-top occupation, that of "rancherias." The second view would be that Cedar Mesa sites are not habitations, but instead summertime field houses used seasonally by sections of the large populations to the east. We have followed the first view throughout our discussions and here we wish to martial the evidence, pro and con, of these ideas to justify our use of the first.

First we will examine if all the Pueblo habitation sites could be field houses on the basis of their physical makeup. At a minimum, many of the sites in the canyons could not be field houses. These sites have kivas, habitation rooms, storage facilities, and, sometimes, defensive structures. Some of these sites, it is true, have only a few good habitation rooms while having the other features. It would still be very difficult to argue that these "cliff dwellings" are seasonal field houses in the usual sense. The canyon occupation is, in the main, late and so might possibly be considered the result of a terminal migration from elsewhere, rather than people from the adjacent parts of Cedar Mesa. This perspective would ignore the poorly preserved circa AD 1140 building episode pointed out by Harrill and Breternitz (1976:384) for Johnson Canyon which shows up at White Canyon, just to the northwest of Cedar Mesa (Hobler and Hobler 1978:63) as well.
as at Cedar Mesa. Our preliminary information, though, suggests that this earlier canyon manifestation may not have had as residential emphasis as the later one. One could also postulate that this earlier building episode was also a separate migration from far to the east. Some of the cliff dwellings (such as Bullet 17-1 and 17-2) also appear to be occupied well before the last Pueblo Phase, which would also contradict this idea. In any event, it appears that the canyon sites, at least the best preserved, latest building period, could not be seasonal field sites, but exceptions could be made for these sites and the basic argument still followed for other Cedar Mesa sites.

Except for the canyon sites and a few of the largest mesa-top sites, one could argue that the rest of the sites do not have physical characteristics of large size or architectural features, such as definite kivas, that clearly indicate that they are winter habitations rather than field houses. So, with exceptions, one can still argue on the basis of physical size (smallness) that most habitations are still field houses. If the typical small mesa-top habitation site is really a field house, some nearby population concentration must exist that is the winter "homeland." While we have the impression that the largest Pueblo sites are in Cottonwood Wash some 30 km from the nearest Cedar Mesa quadrat, a substantial population of large Pueblo sites does exist closer at hand in the upper
Comb Wash drainage. Further, a substantial Pueblo I occupation also exists in Comb Wash, and a more ephemeral one in the adjacent highland area on Milk Range Point, which may represent related seasonal agricultural sites (Green and DeBloois 1978). The upper Comb Wash not only has a dense population concentration (at least relative to Cedar Mesa) but also shows a possible precedent for seasonal field house occupation.

This concentration of population to the east begs the question of the Kayenta ceramics using Clay Hills occupation on Cedar Mesa. If the Pueblooid occupation on Cedar Mesa consisted primarily of seasonal field houses from the east, one would expect them to bring their pots with them. And their pots would be of the Mesa Verde ceramic tradition, as the amount of Tusayan and Tsegi wares falls off quickly to the east. On the other hand, if one believes that Kayenta pottery means the Kayenta culture, which appears to fit the Cedar Mesa situation, then one has to eliminate all Clay Hills Phase sites from the field house explanation as well. This conclusion follows from the observation that Cedar Mesa has some of the largest known concentrations of Kayenta ceramics north of the San Juan, and thus would act as the home for dispersed field houses. Let us ignore the Clay Hills Phase material for now, recognizing that it raises some problems, but by itself
does not falsify the field house model.

<Distance between Home and Field.

Let us inspect the distances between the supposed population concentrations and Cedar Mesa quadrats to see if the habitation sites could be summertime field houses. We will first review the information as it is traditionally done and then inspect with more care the pre-draft animal situation following Bradfield (1971). While the lower end of the North Road Drainage is only 10 km from Comb Wash, very little Pueblo occupation is present that far down the Comb Wash valley. If we use the junction of Arch Canyon and Comb Wash, further up the valley as a supposed center of the concentrated Pueblo occupation, we find it is some 15 km from the closest Cedar Mesa quadrat. At the other extreme, the furthest quadrats in West Johns and Hardscrabble are about 42 km in a straight line from our hypothetical population center.

For comparison, the modern example frequently used as an extreme is Moenkopi which is said to have started out as a summertime agricultural area. Moenkopi is about 45 km from the closest parts of Third Mesa. This is clearly an extreme example, as the Hopi are much more aggregated than any prehistoric Anasazi group, arable land in Hopi territory is far less continuously distributed than at Cedar Mesa, and, Moenkopi has become a permanent
settlement. On the other hand, the central portions of Milk Ranch Point are 12 km from our hypothetical center and the tip is only 9 km. Milk Ranch Point then could be a Pueblo I seasonal agricultural area.

At this point one might argue that the northeast portion of Cedar Mesa is close enough to be used for agricultural plots by people from Upper Comb, but that other parts are too distant. Since we have recorded "habitation" sites nearly as distant from our hypothetical center on Comb Wash as Moenkopi is from Third Mesa. These distant sites would appear to be most unlikely field houses on the basis of distance alone, given our current state of knowledge about intervening arable land and a much lesser degree of aggregation existing in Upper Comb Wash than at the Hopi Mesas.

This "traditional" view of Moenkopi and field houses according to Bradfield (1971) is a distorted picture. Bradfield reports that Moenkopi was founded by people from Oraibi on the site of an earlier village in the 1870's and in the 1880's was used by a few families from Oraibi during the farming season (Mindeleff 1891:77), and by the 1890's was joined permanently by members from Oraibi (Bradfield 1971:41). Members still returned to Oraibi for important ceremonies. The picture of a permanent summer colony is clearly falsified by this information, although the actual
nature and length of use as a "summer colony" is unclear. Was it a permanent village from the 1870's and during the 1880's had a large summer influx who became permanent residences in the 1890's or were the initial occupiers also summer residents?

Of greater importance is Bradfield's revelation that this occurred only after the integration of draft animals into the Hopi way of life (1971:41). Thus the use of Moenkopi as an example, even an extreme example is contradicted for the precontact case as draft animals drastically changed the situation. Moenkopi's position as a long term summer farming village appears to be more legendary than factual in this account, and one possible only after the introduction of draft animals, no matter how much returning to Third Mesa for important ceremonies occurred.

Bradfield examines in some detail the limits on field-dwelling distance and these are worth reviewing as they have some implications, not only to the current argument, but also towards our understanding in general of prehistoric Anasazi settlement patterns. He concludes (1971:22) that the physical labor of carrying corn on the cob precludes having substantial acreage further than 4 miles (6.4 km) from the village in the Hopi situation. Maize ceases ripening at the first frost, which usually occurs late in September at Hopi. (Slightly earlier at
Cedar Mesa?). The Hopi usually left the corn on the plant for a week or two to dry before being collected and transported. The cobs (1971:22) could be safely left on the plant or laid out to dry in October, but would need to be gathered in by early November because of the occurrence of rains which would ruin the crop. So some six weeks exist for transporting the crop, and this limits the bulk of the acreage to be within four miles of the village (1971:22).

The figures Bradfield uses are some ten acres of land per family and some three tons of corn on the cob (1971:39). If a man can carry 56 lbs (one bushel) of corn on the cob at a trip and does two trips a day and if his wife or son carries one half that amount, it will take the six weeks to bring in the crop (1971:39). Bradfield calculates that a field four miles away will consume four hours a trip by one hour out, one hour to foot of mesa, one hour to climb the mesa, with the rest of unloading, loading taking another hour (1971:39).

Some differences exist for the Cedar Mesa situation. The climb to the mesa does not usually exist except for canyon bottom farming. The time between frost and rains may also be different. The obvious alternative of storing the corn at the field to extend the transportation period could also be carried out and connects up the ideas that
Haase presented about distance from habitation and number of site facilities on field stations.

The implication, though, of Bradfield's careful examination are clear. Distant field houses do not make economic sense for predraft animal economies. If one used the storage alternative, one could extend the distance and the time spent transporting the corn back. A little thought will show that one very quickly reaches a point where all the winter is spent carrying the corn back, and then it is time to return to the field to plant the crop! This might occur at distances no more than 15 km from the main habitation. Smaller fields, with different seasonality appear to be a more viable option, but large, main fields need to be relatively close to the main habitations (Woodbury 1961:43).

The Pueblo II/III occupations to the west of Cedar Mesa which share some attributes with Cedar Mesa, but are even more dispersed, must likewise not be summer field sites. Not only are there occupations to the west of Grand Gulch but also even in the Red Rock Plateau west of the Clay Hills (Lipe 1966, 1970). It is difficult to see a continuous distribution of similar sites consisting of field houses "close" to Comb Wash and "permanent" habitation further west as the sites themselves become smaller and more sparsely distributed. If these sites are to be considered field houses, then the only possible place
for permanent settlement is Cedar Mesa. The dispersed mesa-top occupation such as found on Cedar Mesa and to the northwest of Cedar Mesa by Hobler and Hobler (1978) cannot be considered invariably as summer field houses.

The larger mesa-top habitation sites on Cedar Mesa sites appear to be comparable to other such dispersed sites found in other highland areas. In a number of such cases, such sites cannot themselves be considered summertime sites because of the lack of nearby concentrated population. An example are some of the sites seen on Black Mesa. The larger Toreva Phase sites (those with kivas) appear to be comparable with our larger Clay Hills Phase sites of the same ceramic tradition and larger sites of other traditions. Clearly, these sites are not seasonally utilized field houses.

Given that the larger sites are not seasonal occupations, the situation, if some of the small "habitation" sites were field houses, would be of field houses intermixed with permanent habitations, but with the field house occupants coming and going from the distant large Pueblos. This would be an inherently unlikely situation.

If we move away from these factors of distance and size, there is little that would suggest that the habitation sites are field houses. Our measures of
exposure suggests that habitation sites are oriented to the south or southwest while most of the limited activity site field stations have northern or eastern exposures. We would expect if the habitation sites were occupied only in the summer, they would have have a northern or eastern exposure as well. We would also predict that if some of the habitation sites were really field stations and others really habitation, that artifactual differences would exist. It will be recalled that no such differences were found. It is interesting to note that the recent analysis by Lightfoot and Jewett (1984) of a somewhat different situation used similar ideas to come to the same conclusion for the function of small "habitation" sites.

From Bradfield's economic analysis based on location, to the comparison of artifact profiles, all the evidence points the same direction. In order to interpret most of the Cedar Mesa Pueblooid occupation as summertime field houses, one has to argue for a string of unlikely events, and to ignore our current understanding of primitive agriculture and to exclude a large part of habitation sites from consideration. There is good support during most of the Cedar Mesa occupation for the existance of habitation sites. In comparison, with the two earlier occupations, there appears to be more, not less, residential activity on Cedar Mesa during the Pueblo period.

Lipe (1970:119-122) has a similar argument about the
nature of the Red Rock Plateau occupation in Pueblo III times. The situation on Cedar Mesa is probably more or less typical of dispersed mesa-top occupations. Field houses appear to occur where there is a very aggregated population and not enough local farmland. An example is the modern Hopi and possibly the Pueblo I situations in Comb Wash reported by D. Green and E. DeBloois (1978).

With the possible exception of the terminal Pueblo occupation, the Cedar Mesa occupation during all times was dispersed and unencumbered. It is difficult to see how the first two occupations could be seasonal variants of some other population, and there is little reason to believe the Pueblo occupation was an exception.

The origin of the Pueblo occupation very likely occurred initially as a seasonal occupation, with settlement quite often occurring on top of Mogollon sites as discussed earlier. We can envisage a radiation of summertime sites evolving into permanent habitations as farming success occurred. After all, the main subsistence activity was farming along with related gathering and hunting focussed on current and abandoned fields. Strong pressures would be necessary to have the "main" habitation away from these activities, particularly when they occur over five months and involve not only intensive work but the production of bulky, heavy foodstuffs. So, everything
else being equal (or rather, in the absence of very strong pressures in the other direction), successful large scale summer farming areas distant from habitation areas would become permanent habitation areas in a relatively short time (Woodbury 1961:43).

<The Pueblo II/III Settlement Pattern>

Lipe's original ideas (Lipe and Matson 1971a) about the Pueblo II/III mesa-top occupation and the terminal Pueblo III canyon cliff dwellings are well supported by the analysis carried out in this chapter. The first part of the Pueblo occupation is virtually identical in settlement location with the Mossbacks. The same kind of concentration in the high elevation, deep-soil pinyon-juniper areas for habitation sites is found, even to the extent that many of the Windgate sites are to have Mossbacks components present. While not predicted, the basic site classification of habitation sites and limited activity field stations, is also the same in both periods. Just as the habitation sites have very similar distributions, so do the limited activity sites. Every variable investigated points to habitation sites and field stations as being primarily rainfall farming related, and in both periods, closely tied to divide area pinyon-juniper deep-soil areas.
The primary innovation observed in the main Pueblo occupation is in the existence of two sizes of habitation sites which was not observed during the Mossbacks Phase. In the quadrat survey, the two quadrats which had evidence of extensive use of canyons also had Mossbacks sites (Bullet 17 and 22). The use of the canyons, though, is dramatically different in the two periods, with a much more extensive (and dominately Redhouse) occupation found in the Pueblo period.

The mesa-top Redhouse occupation has a very different settlement pattern than the earlier Pueblo Phases. Instead of a concentration in high elevation, deep-soil pinyon-juniper areas, we find a closer association with known water sources and a de-emphasis on the other variables. The combination of both kinds of settlement pattern is what gives the overall Pueblo settlement pattern its intermediate nature, placed between Mossbacks and Grand Gulch. In fact, there are two patterns: one essentially that of Mossbacks, and the unique canyon one.

The exact nature of the terminal canyon occupation on Cedar Mesa awaits the complete analysis of the architectural tree ring survey material. Whether this occupation coincided with or occurred after the terminal mesa-top occupation is unclear. Our preliminary population estimates indicate that not more than half the population
found on the mesa-top can be fitted into the canyons, so if it occurred after the mesa-top was abandoned for habitation purposes, the population in the area had already been significantly reduced. The canyon occupation shows only a weak relationship with canyon bottom arable land (Lipe and Matson 1975) and a close association with water sources (Matson 1978), as does the mesa-top Redhouse Phase.

Preliminary investigation of the canyon cliff dwellings (Lipe 1978) demonstrates an abundance of storage facilities, and in some sites, kivas, and a corresponding lack of habitation rooms. This pattern corresponds with repeated evidence that when defensive features occur that protect only part of the sites, it is the storage facilities which are protected. Coupland (1981) has shown that protection of harvested foodstuff is associated with internecine warfare. If a group is being raided by another with a similar way of life, the raids will occur only during the seasons having no important subsistence activities. Hunting and gathering raiders could simply raid the fields, but farmers would need to get in their own crops before it would be economical to raid others. Stored crops are the archtypical concentrated and predictable resources that can be economically defended (Dyson-Hudson and Smith 1978). The corresponding lack of defended habitation areas indicates that territorial, or even between cultural group warfare was not occurring. The
small size of most defensible sites further supports the idea that people were not being defended, if the "refuging" number of 10 adults cited by Hamilton and Watts (1970) has any validity. The same economic factors that Braidfield discusses also limits the distance that the raiders would be travelling.

The strategy of concentrating storage facilities into larger groups to arrange for its joint defense, however, does lead to strained compromises for habitation sites. In some cases, such as Hardscrabble C15-1 and West Johns C3-1, defensible sites were built on the edge of the mesa, either close to arable land, or close to water, or both. In other cases, such as the cliff dwellings in lower Grand Gulch, substantial arable land would be quite distant, making daily commuting very difficult. Perhaps the ever anomalous West Johns 17-1 exists as a lightly built compromise half way between fields and defensible storage.

The short lived cliff dwelling period on Cedar Mesa terminated the Anasazi occupation. The relationship between water and sites at this time leads to inferences about the climate that we will explore in the next and final chapter. The sociological and ecological implications of the patterns demonstrated in this chapter, and in previous ones, will also be examined in the final chapter, as well as alternative models of interactions.
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<td>Rank of Watershed Divide Nearest to Sites</td>
<td>--</td>
</tr>
<tr>
<td>XI-5</td>
<td>Number of Features on Pueblo Field Stations</td>
<td>--</td>
</tr>
<tr>
<td>XI-6</td>
<td>Distance from Nearest known Contemporary Habitation site by number of features</td>
<td>--</td>
</tr>
<tr>
<td>XI-7</td>
<td>Drainage Tree-Ring Dates</td>
<td>--</td>
</tr>
<tr>
<td>XI-8</td>
<td>Drainage Quadrats, Pueblo Habitation sites</td>
<td>--</td>
</tr>
<tr>
<td>XI-9</td>
<td>Distribution of Pueblo Habitation sites per Quadrat</td>
<td>--</td>
</tr>
<tr>
<td>XI-10</td>
<td>Clusters of Habitation sites</td>
<td>--</td>
</tr>
<tr>
<td>XI-11</td>
<td>Pueblo Habitation Quadrats compared with Poisson distribution</td>
<td>--</td>
</tr>
<tr>
<td>XI-12</td>
<td>Pueblo Habitation Quadrats compared with Negative Binomial Distribution</td>
<td>--</td>
</tr>
</tbody>
</table>
TABLE XI-1

DISTANCE TO CANYONS, HABITATION SITES

<table>
<thead>
<tr>
<th></th>
<th>Grand Gulch (n=32)</th>
<th>Mossbacks (n=23)</th>
<th>Pueblo (n=35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Quartile</td>
<td>230</td>
<td>300</td>
<td>290</td>
</tr>
<tr>
<td>Median</td>
<td>590</td>
<td>980</td>
<td>660</td>
</tr>
<tr>
<td>Third Quartile</td>
<td>1900</td>
<td>2550</td>
<td>2200</td>
</tr>
<tr>
<td>Mean</td>
<td>1044</td>
<td>1288</td>
<td>1142</td>
</tr>
</tbody>
</table>

Wilcoxon Tests (Unit Normal Deviate)

<table>
<thead>
<tr>
<th>Test</th>
<th>Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Gulch vs. Mossbacks</td>
<td>1.135</td>
<td>.128</td>
</tr>
<tr>
<td>Pueblo vs. Grand Gulch</td>
<td>.490</td>
<td>.312</td>
</tr>
<tr>
<td>Pueblo vs. Mossback</td>
<td>.683</td>
<td>.245</td>
</tr>
<tr>
<td>Quadrat</td>
<td>Site</td>
<td>Elevation</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
<td>-----------</td>
</tr>
<tr>
<td>U1</td>
<td>1</td>
<td>6775</td>
</tr>
<tr>
<td>U7</td>
<td>2</td>
<td>6560</td>
</tr>
<tr>
<td>U9</td>
<td>2</td>
<td>6800</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>N8</td>
<td>3</td>
<td>5740</td>
</tr>
<tr>
<td></td>
<td>2(?)</td>
<td></td>
</tr>
<tr>
<td>N11</td>
<td>2</td>
<td>5995</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B22</td>
<td>4</td>
<td>6280</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>N4</td>
<td>3</td>
<td>6540</td>
</tr>
<tr>
<td>N8(?)</td>
<td>2(?)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W15</td>
<td>1</td>
<td>5280</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>H13</td>
<td>1</td>
<td>5695</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4</td>
<td>1</td>
<td>5715</td>
</tr>
<tr>
<td>H14</td>
<td>1(?)</td>
<td>6040</td>
</tr>
<tr>
<td></td>
<td>2(?)</td>
<td></td>
</tr>
</tbody>
</table>

n= 12 20


### TABLE XI-3

**Distribution of Archaeological Sites**

Among landforms. Chi-square one sample goodness-of-fit test.

**Field Stations**

<table>
<thead>
<tr>
<th></th>
<th>Drainage Bottom</th>
<th>Watershed Divides</th>
<th>Sagebrush Flat/Alluv. Terrace</th>
<th>Rocky Breaks</th>
<th>Sandstone Cliffs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Stations</td>
<td>7</td>
<td>32</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Random Points</td>
<td>6</td>
<td>20</td>
<td>5</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Totals</td>
<td>13</td>
<td>52</td>
<td>10</td>
<td>11</td>
<td>7</td>
</tr>
</tbody>
</table>

\[ X^2 = 19.8 \quad \text{df} = 4 \]

\[ P \text{ of } H_0 < .005 \quad T_s = .13 \]

**Habitations**

<table>
<thead>
<tr>
<th></th>
<th>Drainage Bottom</th>
<th>Watershed Divides</th>
<th>Rocky Breaks/Sagebrush Flat/Alluv. Terrace</th>
<th>Sandstone Cliffs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitations</td>
<td>2</td>
<td>22</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>Random Points</td>
<td>6</td>
<td>17</td>
<td>9</td>
<td>32</td>
</tr>
<tr>
<td>Totals</td>
<td>8</td>
<td>39</td>
<td>17</td>
<td>64</td>
</tr>
</tbody>
</table>

\[ X^2 = 4.24 \quad \text{df} = 2 \]

\[ P \text{ of } H_0 = .25 \quad T_s = .04 \]

**Note:** Some landforms have been combined to achieve adequate sample sizes.
TABLE XI-4

RANK OF WATERSHED DIVIDE NEAREST TO SITES

Chi-square one-sample goodness-of-fit test.

<table>
<thead>
<tr>
<th>FIELD STATIONS</th>
<th>Divide Rank</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3+</td>
</tr>
<tr>
<td>Field Stations</td>
<td>24</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>Random Points</td>
<td>25</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Totals</td>
<td>49</td>
<td>28</td>
<td>15</td>
</tr>
</tbody>
</table>

\[ X^2 = 0.18, \text{ df } = 2 \]
\[ P \text{ of } H_0 = 7.5 \quad T_a = .001 \]

<table>
<thead>
<tr>
<th>HABITATIONS</th>
<th>Divide Rank</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3+</td>
</tr>
<tr>
<td>Habitations</td>
<td>12</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Random Points</td>
<td>17</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Totals</td>
<td>29</td>
<td>20</td>
<td>15</td>
</tr>
</tbody>
</table>

\[ X^2 = 6.47, \text{ df } = 2 \]
\[ P \text{ of } H_0 = 0.5 \quad T_a = .04 \]

**Note:** Third order or greater drainages have been collapsed to achieve adequate cell size.
### TABLE XI-5

**NUMBER of FEATURES on PUEBLO FIELD STATIONS**

in

**HARDSCRABBLE, BULLET, and NORTH ROAD DRAINAGES**

<table>
<thead>
<tr>
<th>Features</th>
<th>Ground Stone</th>
<th>Ash Hearth</th>
<th>Slab Lined Hearth</th>
<th>Slab Lined Cist</th>
<th>Jacal Present</th>
<th>Ash Hearth Only</th>
<th>Slab Lined Hearth Only</th>
<th>Ground Stone (with Hearth)</th>
<th>No Features or Ground Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sites</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H 14-2A</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H 14-2C</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H 8-3</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N 11-12</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B 21-10</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N 4-1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H 3-1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N 11-1</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B 3-4</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>(n of sites)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Sites = 46</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Ground stone is also present on some of these sites.*
TABLE XI-6

DISTANCE FROM NEAREST KNOWN CONTEMPORARY HABITATION SITE BY NUMBER OF FEATURES

Distance

<table>
<thead>
<tr>
<th>Number of Features (n)</th>
<th>Median</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Features (n = 7)</td>
<td>250 m</td>
<td>940 m</td>
</tr>
<tr>
<td>1 Feature (n = 13)</td>
<td>690 m</td>
<td>3.06 km</td>
</tr>
<tr>
<td>2 Features (n = 13)</td>
<td>950 m</td>
<td>4.62 km</td>
</tr>
<tr>
<td>3 or 4 Features (n = 8)</td>
<td>4.06 km</td>
<td>7.25 km</td>
</tr>
</tbody>
</table>
### TABLE XI-7

**DRAINAGE TREE RING DATES**

<table>
<thead>
<tr>
<th>Site</th>
<th>Prov.</th>
<th>Inside</th>
<th>Outside</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>UGG C10-1</td>
<td>St 3</td>
<td>788</td>
<td>951++VV</td>
<td>Middle Red House in Seriation</td>
</tr>
<tr>
<td>UGG C10-1</td>
<td>St 1</td>
<td>765</td>
<td>1130+VV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>St 6</td>
<td>1057+</td>
<td>1217++VV</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1102</td>
<td>1218+B</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1111</td>
<td>1229++B</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1118</td>
<td>1238B</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1023</td>
<td>1238B</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1182</td>
<td>1238B</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1027+P</td>
<td>1241B</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1125</td>
<td>1241B</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1132</td>
<td>1241B</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1197P</td>
<td>1242B</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1155</td>
<td>1248B</td>
<td></td>
</tr>
<tr>
<td>UGG C10/11-4</td>
<td>Str 2</td>
<td>1042</td>
<td>1211++VV</td>
<td>Middle Red House in Seriation</td>
</tr>
</tbody>
</table>

A whole lot of early dates, probably reuse of wood from earlier structure. 8 earlier dates for Str 2, most in 1120-1170 range.

<table>
<thead>
<tr>
<th>Site</th>
<th>Prov.</th>
<th>Inside</th>
<th>Outside</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>UGG C14-1</td>
<td>1</td>
<td>1000</td>
<td>1136++B</td>
<td>Low Red House in Final Seriation</td>
</tr>
<tr>
<td>NR C7-3</td>
<td>4</td>
<td>845P</td>
<td>1196B</td>
<td>High Red House in Seriation</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1034P</td>
<td>1203VV</td>
<td></td>
</tr>
<tr>
<td>NR C8-2</td>
<td>4</td>
<td>759</td>
<td>1203VV</td>
<td>Few ceramics, 3 decorated, 1 MV B/W min pigment</td>
</tr>
<tr>
<td>NR C17-2</td>
<td>G</td>
<td>1095P</td>
<td>1219+B</td>
<td>2 MV B/W organic pigments</td>
</tr>
<tr>
<td>Site</td>
<td>Prov.</td>
<td>Inside</td>
<td>Outside</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>--------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>1083</td>
<td>-</td>
<td>1259B</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>1141</td>
<td>-</td>
<td>1225+B</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>1129P</td>
<td>-</td>
<td>1226+V</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>1128P</td>
<td>-</td>
<td>1228V</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>1177</td>
<td>-</td>
<td>1232VV</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>1078</td>
<td>-</td>
<td>1245+VV</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>1173</td>
<td>-</td>
<td>1247VV</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>1102</td>
<td>-</td>
<td>11172VV</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>1034</td>
<td>-</td>
<td>1255+VV</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>976+P</td>
<td>-</td>
<td>1060VV</td>
<td></td>
</tr>
<tr>
<td>C (EXT)</td>
<td>1079</td>
<td>-</td>
<td>1251+VV</td>
<td></td>
</tr>
<tr>
<td>C (EXT)</td>
<td>1127</td>
<td>-</td>
<td>1274VV</td>
<td></td>
</tr>
<tr>
<td>C (EXT)</td>
<td>1288</td>
<td>-</td>
<td>1379VV</td>
<td></td>
</tr>
<tr>
<td>C (EXT)</td>
<td>1288</td>
<td>-</td>
<td>1379VV</td>
<td></td>
</tr>
</tbody>
</table>

Woodenshoe in discriminant analysis

Reliable date?

Not reliable dates

---

NR C23-2

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1039</td>
<td>- 1217++R</td>
</tr>
<tr>
<td>5</td>
<td>1134</td>
<td>- 1229++VV</td>
</tr>
<tr>
<td>5</td>
<td>1069</td>
<td>- 1252V</td>
</tr>
</tbody>
</table>

Few ceramics, only five decorated, All Mesa Verde B/W, organic pigment
<table>
<thead>
<tr>
<th></th>
<th>UGG</th>
<th>BULL</th>
<th>NR</th>
<th>WJ &amp; HS</th>
</tr>
</thead>
<tbody>
<tr>
<td># Red House Habitations</td>
<td>0</td>
<td>9</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td># All Other Habitations</td>
<td>5</td>
<td>17</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>26</td>
<td>8</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>UGG</th>
<th>BULL</th>
<th>NR</th>
<th>WJ &amp; HS</th>
</tr>
</thead>
<tbody>
<tr>
<td># Red House and Woodenshoe Habitation</td>
<td>0</td>
<td>15</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td># All Other Habitations</td>
<td>5</td>
<td>11</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>26</td>
<td>8</td>
<td>15</td>
</tr>
</tbody>
</table>
### TABLE XI-9

**A) DISTRIBUTION OF PUEBLO HABITATION SITES**

<table>
<thead>
<tr>
<th>Number of Quadrats</th>
<th>Number of Habitation Sites Per Quadrat</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>0</td>
</tr>
<tr>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>76</td>
</tr>
</tbody>
</table>

**B) NUMBER OF HABITATIONS**

<table>
<thead>
<tr>
<th>Sites Per Quadrat (Class)</th>
<th>Sites Per Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>57</td>
</tr>
</tbody>
</table>
### TABLE XI-10

A) "CLUSTERS" OF HABITATION SITES

<table>
<thead>
<tr>
<th>Number of Sites Per Cluster</th>
<th>Number of Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>≥ 5</td>
<td>1</td>
</tr>
</tbody>
</table>

B) TOTAL NUMBER OF SITES PER CLUSTER

<table>
<thead>
<tr>
<th>Cluster Size</th>
<th>Total Number of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>≥ 4</td>
<td>10</td>
</tr>
</tbody>
</table>
TABLE XI-11
PUEBLO HABITATION QUADRATS
COMPARSED WITH POISSON DISTRIBUTION

<table>
<thead>
<tr>
<th>Class</th>
<th>Expected</th>
<th>Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>35.90</td>
<td>41</td>
</tr>
<tr>
<td>1</td>
<td>26.92</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>10.10</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>2.524</td>
<td>4</td>
</tr>
<tr>
<td>≥ 4</td>
<td>.556</td>
<td>2</td>
</tr>
</tbody>
</table>

Lambda = .750
Variance = 1.0296
Chi square = 5.23

D.F. = 2, Approx. probability = .07
TABLE XI-12

PUEBLO HABITATION QUADRATS COMPARED
WITH NEGATIVE BINOMIAL DISTRIBUTION

K BY MOMENTS 1.9176

<table>
<thead>
<tr>
<th>Class</th>
<th>Expected</th>
<th>Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>40.355</td>
<td>41</td>
</tr>
<tr>
<td>1</td>
<td>21.757</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>8.924</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>3.276</td>
<td>4</td>
</tr>
<tr>
<td>≥4</td>
<td>1.688</td>
<td>2</td>
</tr>
</tbody>
</table>

Chi square = .349
D. F. = 1 Approx. Probability ~.60