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PRELIMINARY ANALYSES OF SOILS
AND VEGETATION IN THE VICINITY OF THE
MOHAVE GENERATING STATION IN SOUTHERN NEVADA
by

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ABSTRACT

Soils and vegetation were characterized at sites distributed over a 27-mile section of Nevada Route 77 and Arizona Route 68 north of the Mohave Generating Station in southern Nevada. Vegetation was also analyzed at two sites along the Colorado River, near River Bend. Sites ranged from 168 to 1069 m in elevation.

The soils of this area are generally young and much of their morphology is inherited from parent material. Soils have developed under conditions of high temperatures and low rainfall. Most profiles examined were developed on alluvial deposits containing unconsolidated parent materials low in clay content. Some soils contained restrictive layers of caliche hardpan. Generally, soils were unleached and exhibited a high base status.

Vegetation on sites below 800 m (bajadas, alluvial fans, washes) was characteristic of the Mohave Desert. Aggregate densities were some thousands of plants per ha, total coverage was around 10-20%, and diversities were low ($\hat{H}' < 1.0$). Based on importance value indexes, the dominant plants were creosotebush (Larrea tridentata) and bursage (Ambrosia dumosa), while other species assumed subdominant roles depending on particular sites (e.g., Krameria grayi, Encelia farinosa, Ephedra sp., and various cacti).

Analyses were made of Zn, Cu, B, V, Cr, Cd, Ni, Pb and Sn in samples of plants collected from sites believed to be exposed to fallout from the station and from more remote control areas. Unusually high levels of Zn, Cu, B, Cd, Ni, Pb and Sn were detected in some

samples--levels higher than those normally associated with root uptake. These higher levels were measured in samples from both exposed and control areas. Deposition of airborne particulate material including various trace metals was inferred, but the role of emissions from the Mohave Generating Station vis à vis other sources was not determined. Amounts of trace metals measured at sites along Route 77 and 68 were not obviously correlated with deposition rates predicted by an atmospheric transport model, but the number of samples considered was small.

I. INTRODUCTION

The Mohave Generating Station is located in extreme southern Nevada, just across the Colorado River from Bullhead City, Arizona. The station, which went on line in 1970, consists of two 790 megawatt units and one 500 ft stack.

The Atmospheric Physics Division of the Desert Research Institute of the University of Nevada has created a meteorological model and generated predictions of fallout from stack effluents. According to these predictions, the smoke plume is most often blown southward, towards Needles, California. However, when moving south the plume remains well above the ground surface for many miles and the model does not predict significant fallout over that portion of the Mohave Valley lying south of River Bend. Winds also blow from the southwest and west, however, and under these conditions the model predicts fallout of up to $100 \mu\text{g}/\text{m}^3$ of air just east of Davis Dam, about three miles northeast of the station. Fallout predictions along Nevada Route 77 (east from U.S. Highway 95) to the river and continuing east on Arizona Route 68 to Union Pass range from as low as $1 \mu\text{g}/\text{m}^3$ to the high of around $100 \mu\text{g}/\text{m}^3$ just described. This range of fallout intensity embraces all predictions in the general vicinity of the station.

The potential effects of such deposition rates are not presently predictable. Although current levels of trace metal contaminants are low, the life of a coal-burning plant may be 30-35 years and contaminants will continue to accumulate in areas exposed to fallout

deposition. Any assessment of potential risks associated with the operation of the Mohave station must, perforce, begin with the basic mechanics of fallout deposition and the interaction between various contaminants and the soil-vegetation complex. One of the early requirements associated with such research is a descriptive analysis of the soils and vegetation in the areas of greatest long-term interest. From the fallout predictions reviewed above we judge these areas to lie generally north of River Bend, and between U.S. Highway 95 in California (to the west) and Union Pass to the east.

This report describes preliminary quantitative surveys of soils and vegetation in this area. The work done involved two general approaches: a broad and qualitative survey of the general environs of the Mohave Generating Station--with emphasis on the conspicuous aspects of geomorphology, lithology, pedology and vegetation--and a more detailed and quantitative analysis of soils and vegetation along Nevada Route 77. and Arizona Route 68. The work also compares amounts of selected trace metals adsorbed on plants in areas exposed to fallout from the stack with amounts on plants growing in unexposed areas.

II. PROCEDURES

A. General survey of the environs of the Mohave Generating Station

The general limits of the area surveyed were: the Kingman-Oatman Road to the southeast, the parallel of 35° on the south, U.S. Highway 95 on the west, Empire Wash Road and the parallel of $35^{\circ} 20'$ on the north, and Estrella Road on the east.

This area is covered by U. S. Geological Survey topographic maps, but at two different scales (1:24,000 in the eastern area and 1:62,500 in the western portion). The maps are highly accurate and were compiled from aerial photographs. Also available was a set of aerial photographs (1:36,000) flown in April, 1971, by American Aerial Surveys of Covina, California.

Available geological data included:

1. Geologic Map of Arizona, by Eldred D. Wilson, Richard T. Moore and John R. Cooper. Arizona Bureau of Mines and U. S. Geological Survey. 1:500,000. 1969.
2. Preliminary Geologic Map of Nevada, by John N. Stewart and John E. Carlson. Nevada Bureau of Mines and Geology. 1:500,000. 1974.
3. Geological Map of California, Kingman Sheet. Charles W. Jennings, compiler. 1961. 1:250,000. California State Division of Mines.
4. Geologic Map of Mohave County, Arizona, by Eldred D. Wilson and Richard T. Moore. Arizona Bureau of Mines. 1959. 1:375,000.

Unfortunately, neither lithologic units nor field boundaries correlated across state lines on these maps. Descriptions were often vague, and units included non-related, disjunct types whose sole common

characteristic was their geologic age. These maps were of limited use in this particular project.

Field work was carried out by Dr. Richard F. Logan of the Department of Geography, University of California, Los Angeles, and Dr. Ian Straughan of Southern California Edison, between January 3-5, 1975. The following reconnaissance procedures were adopted:

1. Various landform units were identified on aerial photographs by two-dimensional inspection.

2. Many of these landform units were visited on the ground. Time was limited and the terrain was generally roadless and extraordinarily rugged, so not all units could be inspected. For inaccessible areas, lithologic and geomorphic information could usually be deduced from aerial photos. Pedological aspects could often be inferred from photographs, but information on vegetation was totally lacking.

3. At each unit visited, a representative site (or sites) was selected. A number of aspects were observed and recorded at these sites:

- a. Lithology
- b. Geomorphology
 - Slope angles
 - Local relief
 - Origin of landform
 - Evidences of active erosion
- c. Pedology
 - Nature of surface material
 - Depth of surface material

Sizes of component particles

Degree of cementation

d. Vegetation

Species present

General features (size, dispersions, etc.)

Aerial photographs were later subjected to detailed stereoscopic examinations. The boundaries of each landform-lithologic unit were carefully determined, assisted in part by reference to geologic maps. These boundaries were traced on transparent acetate overlays and eventually transferred to topographic maps. Field descriptions of the various study sites were augmented or modified in terms of the larger scene and altered perspectives revealed by stereoscopy. Individual site descriptions were then assembled into groups of similar nature and a generalized description of each type compiled. The various individual topographic maps were combined and photographically adjusted to a common scale. Finally, boundaries of the various geographic units were drawn on the map and units were numbered so as to correspond with text descriptions.

B. Establishment of sampling sites

Eight primary sampling sites (1-8) were selected along Nevada Route 77 and Arizona Route 68 during December 1974. Four of these were east and four were west of the Colorado River. Two more such sites (9-10) were established in February 1975, south of the generating station on opposite sides of the river. Figure 1 illustrates the location of these ten sites. Analyses of soils were made at Sites 1-8. Quantitative

Fig. 1. Environs of the Mohave Generating Station in southern Nevada. Map shows sampling Sites 1-8 along Nevada Route 77 and Arizona Route 68, and Sites 9 and 10 near River Bend. Location of the generating station is indicated by a star.

analyses of vegetation were carried out at Sites 1-10. Twelve additional sites (A-L) were selected along Nevada Route 77 and Arizona Route 68 during early December 1974. Six of these sites were east and six were west of the river. Site A was in the same vicinity as Site 1 (near Union Pass). The other eleven (B-L) were distributed along the transect between Sites 1 and 8. Qualitative analyses of vegetation were made at Sites A-L.

C. Soils analyses

At each of sites 1-8 an observation pit (ca. 1 m²) was dug into the C Horizon, or into the restrictive hardpan. Each of these pits was photographed.

Profile descriptions of the typifying pedon were made by Verr D. Leavitt, Soil Scientist, National Environmental Research Center, Environmental Protection Agency, Las Vegas, Nevada. Soil characterizations were according to the U.S. Soil Taxonomy System (Soil Survey Staff, 1967). Soil colors were determined by comparisons with the Munsell Soil Color Chart (1954). Field determinations of soil texture (particle sizes) were made by feeling the soil. Confirming particle size analyses were later made in the laboratory using samples taken from each horizon of soil profiles. Soil structure and consistence (the aggregation of primary soil particles into compound structural material) were determined according to criteria of U.S. Department of Agriculture Handbook Number 18 (1951). Effervescence, an indicator of crystalline salts, was determined by adding a few drops of 0.1N HCl to the soil. Soil pH was

determined in the laboratory using samples taken from each horizon.

D. Vegetation analyses

1. Qualitative estimates of relative abundance

General inspections of vegetation were made at Sites A-L along Nevada Route 77 and Arizona Route 68 during December 1974. These inspections, made by four people, ranged over areas of about 8-10 ha. Our purpose was to obtain data pertaining to areas between the principal sites, especially where mountainous terrain prevented the convenient use of quadrats. Perennial plants were ranked on a scale of 1 to 5, according to relative abundance. This approach has been used by phytosociologists to get information about a large number of sites in a short time (Daubenmire 1968, Shimwell 1971). Only major species and the more conspicuous minor ones were ranked at each of sites A-L.

2. Quantitative estimates of density, frequency and coverage

a. Quadrats. Ten quadrats were established at each of Sites 1-10 (Fig. 1). The usual arrangement was five quadrats north of and five quadrats south of the highway. Each quadrat was 2 x 50 m in size.

b. Locations of quadrats. At each site a stake was driven at the end of a line 100 paces from, and perpendicular to, the highway. The line was continued to a distance of 200 m from the stake. Along this 200-m extent five points were selected randomly. Quadrats were then laid out perpendicularly to the line and on alternating sides of the line

from these five points. Figure 2 illustrates the disposition of ten quadrats at Site 5.

c. Counts and measurements of plants. Perennial shrubs and major grasses were counted in each quadrat. Measurements of shrub canopies were made along two perpendicular axes (d and f). For less common species additional measurements were made of individuals outside of quadrats.

d. Mean diameters of shrubs. Mean diameters, $\bar{D}$ (m), of shrubs were computed for each site from canopy measurements (d and f) made in all ten quadrats. For the ith species, with measurements of n_i individuals:

$$\bar{D}_i = (\Sigma d_i + \Sigma f_i) / 2n_i \quad (1)$$

e. Estimating densities and relative densities. Site densities were estimated from the number of plants counted in ten quadrats. In most instances the extents of the sampled areas were adjusted in terms of the mean diameters of each plant species. Hence, the adjusted area sampled for the ith species, A_i (m^2), was computed as:

$$A_i = 10 (50 + \bar{D}_i)(2 + \bar{D}_i) m^2 \quad (2)$$

However, if at a given site, five or fewer individuals of a plant species were counted (in all 10 quadrats), then no adjustment of sampling area was made. The only exceptions to this procedure were eight plants of large stature: Acacia greggii, Condalia lycioides, Dalea fremontii, Juniperus osteosperma, Opuntia ramosissima, Prunus sp., Quercus turbinella,

Fig. 2. Distribution of ten 50 x 2 m quadrats at Site 5 on Nevada Route 77.

and Rhus trilobata.

The density of the $\underline{i}$ th species, $\underline{D}_i$, was estimated from the number of individuals counted in ten quadrats, $\underline{n}_i$, and the sampled area, $\underline{A}_i$:

$$\underline{D}_i = \underline{n}_i / \underline{A}_i \text{ per m}^2 \quad (3)$$

The relative density of the $\underline{i}$ th species, $\underline{DR}_i$, was computed as follows:

$$\underline{DR}_i = 100 \underline{D}_i / \sum \underline{D} \quad (4)$$

f. Estimating frequencies and relative frequencies. The frequency of the $\underline{i}$ th species, $\underline{F}_i$, was calculated by dividing the number of quadrats in which the $\underline{i}$ th species occurred by the total numbers of quadrats examined and multiplying by 100. The relative frequency of the $\underline{i}$ th species, $\underline{RF}_i$ was:

$$\underline{RF}_i = 100 \underline{F}_i / \sum \underline{F} \quad (5)$$

g. Estimating coverage and relative coverage. Coverage was estimated by assuming shrubs to have elliptical canopies. Hence, the coverage of a shrub with measurements of 0.8 and 0.6 m would be $\pi(0.4)(0.3)\text{m}^2$, or 0.38 m^2 . The mean coverage (m^2) of one individual of the $\underline{i}$ th species, based on measurements of $\underline{n}_i$ shrubs was:

$$\underline{MC}_i = (\sum \pi \underline{d}_{i1} \underline{f}_{i1}) / 4 \underline{n}_i \quad (6)$$

Coverage of the $\underline{i}$ th species, $\underline{C}_i$ (%), with $\underline{N}_i$ individuals counted, was simply:

$$\underline{C}_i = 100 \underline{MC}_i \underline{N}_i / \underline{A}_i \quad (7)$$

Total coverage, $\underline{CT}$ (%), was the sum of the coverages of all species, and the relative coverage of the $\underline{i}$ th species, $\underline{CR}_i$, was $100\underline{CR}_i/\underline{CT}$.

3. Estimating importance value indexes

Importance value indexes were computed for each species at each site (Cain and Castro 1959, p. 211). The importance value index of the $\underline{i}$ th species, $\underline{IV}_i$, was computed as:

$$\underline{IV}_i = \underline{RF}_i + \underline{CR}_i + \underline{DR}_i \quad (8)$$

4. Estimating shrub species diversity

Shrub species diversity was estimated as $\hat{\underline{H}}'$, as defined by Pielou (1969) for each site. The estimation of $\hat{\underline{H}}'$ assumes that the samples are drawn from infinite populations, and depends on the various estimates of relative abundance, $\hat{\underline{P}}_i$, obtained from the density estimates, with $\sum \hat{\underline{P}}_i = 1$. Then:

$$\hat{\underline{H}}' = -\sum \hat{\underline{P}}_i \log \hat{\underline{P}}_i \quad (9)$$

E. Analyses of metals on native plants and crops

1. Parts of native shrubs growing at both potentially contaminated sites, and in other areas unlikely to receive fallout from the Mohave Generating Station, were collected in December 1974. Materials gathered for analysis were leaves and associated small stems. These tissues were oven dried and ground at the Nevada Test Site. Plant material was taken from each of the eight primary sites along Nevada Route 77 and Arizona Route 68. All samples were taken from plants at least 100 yards from the highway. Plant material was also gathered from eight sites more remote from the generating station. Control

sites 1, 2 and 3 were on Christmas Tree Pass Road, 3.2, 4.2 and 7.6 miles, respectively, east of U. S. Highway 95. Control site 4 was 13.3 miles east of the Nevada-Arizona state line on Arizona Route 68, i.e., about one mile east of Union Pass. Control sites 5, 6 and 7 were, respectively, 1.5, 6.5 and 10.5 miles east of Searchlight, Nevada, on Cottonwood Cove Road. Control site 8 was 1.5 miles north of Searchlight on U. S. Highway 95.

2. A lesser number of samples of agricultural crops was taken from fields along Arizona Route 95 (south of the generating station). Site 11 was a cotton field about 17 miles south of the generating station and site 12 was a clover field about 19 miles south of the station. Samples of cotton included cotton fibers, stems and leaves. Agricultural control sites were in the Pahrump Valley in Nye County, Nevada. Control site 9 was a clover field 3.1 miles southeast of Pahrump and Control site 10 was a cotton field 2.1 miles southeast of Pahrump on Nevada Route 16.

3. Analytical procedures

Plant samples were oven dried and processed for emission spectrometric analysis using methods described by Wallace and Romney (1972: 363). Tissues were ground in plastic containers using a Spex No. 5000 Mixer/Mill, in which a lucite plastic pellet pulverized plant material within a polystyrene vial. Samples were never in contact with metal surfaces during grinding.

Plant samples were analyzed for amounts of the following elements: P, Na, K, Ca, Mg, Zn, Cu, Fe, Mn, B, Al, Si, Ti, V,

Co, Ni, Mo, Cr, Sr, Ba, Li, Ag, Sn, Pb, Be, and Cd. The analytical instrument was an Applied Research Laboratories 1.5 m direct reading optical emission spectrometer. Weighed amounts of dry, powdered plant tissues varying from 5 to 10 mg were placed in crater electrodes for analysis. A carefully designed electrode system volatilized and excited the sample in a reproducible manner, eliminating the need for internal standards. Our procedures included a method for determining the background values of the carbon arc, so as to better evaluate true line intensities. The spectrograph was interfaced with an IBP 026 key punch using a Dymec 2013D Data Acquisition System to permit signal intensities to be transferred directly to data cards. Computer programs carried out calculations needed to calibrate the system and to convert signal intensity levels to concentration values. All numerical operations were carried out on an IBM 360/91 computer at the UCLA Computing Facility.

III. FINDINGS

A. The general survey

Surface features were classified as to 25 general types. Table 1 summarizes the landscape types defined in the environs of the Mohave Generating Station. Detailed type and site descriptions are given in Appendix A.

Table 1. Topographic types in the vicinity of the Mohave Generating Station

Type	General Description	Specific Sites
1	Active alluvial fans and bajadas	1A, 1B, 1C, 2, 17, 20 40, 41, 47, 48, 53
2	Granitic alluvial fans and bajadas	4, 5
3	Dissected bajadas, low relief	9, 10, 12, 36
4	Dissected bajadas, moderate relief	26, 33, 39
5	Dissected bajadas, high relief	6
6	River floodplain	7, 34
7	Low, recent river terraces	
8	Higher, older river terraces	
9	Dissected terraces	
10	Pediments	3, 45, 51, 52
11	Dissected pediments	
12	Rolling upland areas	
13	Moderately sloping upland areas	
14	Granite hills	46
15	Granitic mountains	
16	Granite knobs, crags and peaks	
17	Mountains developed on tertiary intrusives	38, 42
18	Mountains developed on metamorphic rocks	
19	Hills developed on metamorphic rocks	13
20	Linear hills	43, 50
21	Bedrock badlands	
22	Hills developed on Cretaceous volcanics	24, 29, 30
23	High rugged mountains developed on volcanic rocks	16, 19, 23, 25
24	Rolling hills developed on volcanic rocks	11
25	Low mountains developed on Cretaceous volcanics	

B. Descriptions of ten primary sampling sites

Figure 1 illustrated the locations of these ten sites. Further information relating to elevations, topography and general vegetation of these sites are now given. Site 1 was 11.8 miles east of the Nevada-Arizona state line on Arizona Route 68 (Fig. 3). The area is mountainous (1069 m) and would be classified as Type 25 (see Table 1). The dominant plant is blackbrush (Coleogyne ramosissima).

Fig. 3. Site 1. Elevation 1069 m.

Site 2 was a mountain bajada 9.0 miles east of the state line on Route 68 (Fig. 4). This area would be classified topographically as Type 1. The elevation was 853 m and the dominant plant was creosotebush (Larrea tridentata).

Fig. 4. Site 2. Elevation 853 m.

Site 3 was a dissected alluvial fan 4.4 miles east of the state line on Route 68 (Fig. 5). This area would be classified topographically as Type 3. The elevation was 427 m and the dominant plant was creosotebush.

Fig. 5. Site 3. Elevation 427 m.

Site 4 was a broad wash 1.8 miles east of the state line on Route 68 (Fig. 6). The elevation was 229 m and the dominant plant was creosotebush.

Fig. 6. Site 4. Elevation 229 m.

Site 5 was a lower bajada 2.8 miles west of the state line on Nevada Route 77 (Fig. 7). This area would be classified topographically as Type 1. The elevation was 305 m and the dominant plant was creosotebush.

Fig. 7. Site 5. Elevation 305 m.

Site 6 was an upper bajada 4.3 miles west of the state line on Nevada Route 77 (Fig. 8). This area would be classified topographically as Type 1. The elevation was 411 m and the dominant plant was bursage (Ambrosia dumosa).

Fig. 8. Site 6. Elevation 411 m.

Site 7 was a mountain bajada 11.1 miles west of the state line on Nevada Route 77 (Fig. 9). This area would be classified topographically as Type 20. The elevation was 732 m and the dominant plant was creosotebush.

Fig. 9. Site 7. Elevation 732 m.

Site 8 was an alluvial fan 15.5 miles west of the state line on Nevada Route 77 (Fig. 10). This area would be classified topographically as Type 1. The elevation was 884 m and the dominant plant was creosotebush.

Fig. 10. Site 8. Elevation 884 m.

Site 9 was an alluvial fan 3.7 miles west of the state line and 8.2 miles south of Route 77 on River Road (Fig. 11). This area would be classified topographically as Type 1. The elevation was 183 m and the dominant plant was creosotebush.

Fig. 11. Site 9. Elevation 183 m.

Site 10 was an alluvial fan 0.9 miles east of the state line and 7.6 miles south of Route 68 on Arizona Route 95 (Fig. 12). This area would be classified topographically as Type 1. The elevation was 168 m and the dominant plant was creosotebush.

Fig. 12. Site 10. Elevation 168 m.

C. Soil profiles

The following descriptions are arranged according to taxonomy, general attributes of each site and soil profile features. The characteristics of each profile horizon are listed according to designation code, depth (cm), texture and color (hue, value, chroma) when dry and moist, consistence when dry, moist and wet; existence of plant roots, boundary conditions, and reaction and pH values. Numerical designations of profiles match those of Sites 1-8.

1. Profile 1. Lithic Camborthid: coarse-loamy, mixed, mesic, shallow (Fig. 13).

Fig. 13. Soil profile at Site 1. Elevation 1069 m.

Aridisol, located in hilly uplands; slope west at 10-20%; rolling relief; well-drained to bedrock; moderate permeability; slight to severe erosion; limestone-tuff-granite parent material; surface 40-50% rock and gravel; shallow over bedrock.

A₁ 0 to 4 cm - pale brown (10YR6/3) gravelly sandy loam, dark brown (10YR4/3) moist; weak, fine subangular blocky structure; soft, friable, non-sticky, non-plastic; few very fine roots; clear, wavy boundary; slightly effervescent, pH 7.4.

B₁₁ 4 to 14 cm - gravelly, sandy loam, reddish brown (5YR4/4) moist, moderate, medium, subangular blocky structure; soft, friable, non-sticky, non-plastic; few fine roots; clear, wavy boundary; slightly effervescent, pH 7.6.

B₁₂ 14 to 24 cm - gravelly, sandy loam, reddish brown (5YR4/4) moist, medium, subangular blocky structure; soft, friable, slightly sticky, slightly plastic; few fine to medium roots; clear, wavy boundary; slightly effervescent, pH 7.6.

C 24+ cm - duripan (tuff); white (5YR8/1) dry, pinkish grey (5YR7/2) moist; slightly effervescent.

2. Profile 2. Typic Torripsamment: sandy-skeletal, mixed, hyperthermic (Fig. 14).

Entisol, located on an alluvial fan; slope west at 2-4%; smooth relief; well to excessive drainage; rapid to very rapid permeability; slight erosion; limestone-tuff-granite parent material; surface 10-20% rock and gravel.

Fig. 14. Soil profile at Site 2. Elevation 853 m.

- A₁ 0 to 6 cm - brown (7.5YR5/2) gravelly, loamy sand, dark brown (7.5YR4/2) moist, single grain structure; loose dry and moist, non-sticky, non-plastic; many very fine roots; clear, wavy boundary; slightly effervescent, pH 7.6.
- C₁ 6 to 18 cm - brown (7.5YR5/2) gravelly sand, dark brown (7.5YR4/2) moist; single grain structure; same consistence as A; many very fine, fine, and medium roots; clear, wavy boundary; slightly effervescent, pH 7.6.

C₂ 18 to 34 cm - brown (10YR5/3) gravelly sand, dark grey brown (10YR4/2) moist; single grain structure; loose, non-sticky, non-plastic; many very fine, fine, and medium roots; clear wavy boundary; effervescent, pH 7.6.

C₃ 34 to 52 cm - brown (7.5YR5/2 to 10YR5/3) gravelly sand, dark grey brown (10YR4/2) moist; single grain structure; same consistence as C₂ with many fine roots; clear, wavy boundary; effervescent, pH 7.8.

C₄ 52 to 68 cm - same as C₃ with fewer roots; pH 7.8.

C₅ 68 to 75 cm - same as C₄, except slightly harder consistence, with fewer roots overlying strata of si-cemented gravel; pH 7.8.

3. Profile 3. Typic Durorthid: coarse-loamy, mixed, thermic, shallow (Fig. 15).

Aridisol, located on a dissected alluvial fan; slope west at 2-20%; rolling relief, well drained to pan - slow through cemented pan to bedrock; moderately rapid permeability to pan; moderate to severe erosion; limestone-tuff-granite parent material; surface 60-70% rock and gravel with outcrops of bedrock.

A₁ 0 to 6 cm - brown (10YR5/3) gravelly, loamy sand, dark grey brown (10YR4/2) moist; very weak, fine, subangular blocky structure; soft, loose, non-sticky, non-plastic; plentiful very fine roots; clear, wavy boundary; slightly effervescent, pH 7.8.

Fig. 15. Soil profile at Site 3. Elevation 427 m.

- C₁ 6 to 16 cm - brown (10YR5/3) gravelly, loamy sand, dark grey brown (10YR4/2) moist, with white limestreaks (10YR8/1); single grain structure; loose dry and moist, non-sticky, non-plastic; many very fine and fine roots; clear, wavy boundary; effervescent, pH 8.0.
- C₂ 16 to 25 cm - reddish brown (5YR4/3) gravelly sand, dark reddish brown (5YR3/2) moist, with pinkish white (5YR8/2) limestreaks; single grain structure; loose dry and moist, non-

sticky, non-plastic; few very fine roots; clear, wavy boundary; effervescent, pH 8.2.

C₃ 25 to 35 cm - light, reddish brown (5YR6/3) gravelly sand, reddish brown (5YR4/3) moist, with pinkish white (5YR8/2) limestreaks; single grain structure; loose dry and moist, non-sticky, non-plastic; very few roots; clear, wavy boundary; effervescent, pH 8.2.

C₄ 35 to 52 cm - massive, cemented sand and gravel hardpan overlying slightly cemented gravel.

4. Profile 4. Typic Torripsamment: sandy-skeletal, mixed, mesic (Fig. 16).

Fig. 16. Soil profile at Site 4. Elevation 229 m.

Entisol, located on an alluvial fan; slope west at 2-4%; smooth relief; well to excessive drainage; rapid to very rapid permeability; slight to moderate erosion; limestone-tuff-granite parent material; surface 20-30% rock and gravel; elevation 228 meters.

- C₁ 0 to 9 cm - brown (10YR5/3) gravelly, loamy sand, dark grey brown (10YR4/2) moist, very weak, fine, subangular blocky structure; soft, loose, non-sticky, non-plastic; many very fine and fine roots; clear, smooth boundary; slightly effervescent, pH 7.9.
- C₂ 9 to 19 cm - pale brown (10YR6/3) sandy gravel, dark grey brown (10YR4/2) moist; single grain structure; loose dry and moist; non-sticky, non-plastic, many very fine and fine roots; clear, smooth boundary; effervescent, pH 8.0.
- C₃ 19 to 28 cm - same as C₂ with fewer roots, and slightly more gravel; pH 8.1.
- C₄ 28 to 53 cm - same as C₂ and C₃ with cobbly, gravelly sand texture and few fine and very fine roots; pH 8.1.

5. Profile 5. Typic Calciorthid: coarse-loamy, mixed, thermic, shallow (Fig. 17).

Aridisol, located on a dissected alluvial fan; slope southeast at 2-6%; rolling relief; well drained; moderately slow permeability; slight to severe erosion; granite and limestone parent material; surface 40-50% rock and gravel.

- C₁ 0 to 9 cm - very pale brown (10YR7/3) gravelly, sandy loam, brown (10YR5/3) moist; weak, medium, subangular blocky

Fig. 17. Soil profile at Site 5. Elevation 305 m.

structure; soft, friable, non-sticky, non-plastic; very few fine and very fine roots; clear, smooth boundary; effervescent pH 8.2.

C₂ 9 to 17 cm - very pale brown (10YR7/3) gravelly, sandy loam, brown (10YR5/3) moist; weak, fine, subangular blocky structure; soft, friable, non-sticky, non-plastic; few fine roots; clear, wavy boundary; effervescent, pH 8.2.

C₃ 17 to 26 cm - white (10YR8/2) gravelly, sandy loam, pale brown (10YR6/3) moist; weak, medium, subangular blocky to massive structure; slightly hard, friable, non-sticky, non-plastic; very few roots; clear, irregular boundary; effervescent, pH 8.3.

C₄ 26+ cm - massive calcic-gypsic hardpan; violently effervescent

6. Profile 6. Typic Torripsamment: sandy, mixed, thermic (Fig. 18).

Entisol, located on an alluvial fan; slope to southeast at 2-4%; smooth relief; well drained, rapid to very rapid permeability;

Fig. 18. Soil profile at Site 6. Elevation 411 m.

slight to moderate erosion; limestone-granite parent material; surface 5-10% gravel.

C₁ 0 to 12 cm - brown (10YR5/3) gravelly, loamy sand, dark gray brown (10YR4/2) moist; weak, fine subangular blocky structure; soft, loose, non-sticky, non-plastic; very few fine and very fine roots; clear, smooth boundary; slightly effervescent, pH 7.8.

C₂ 12 to 29 cm - brown (10YR5/3) gravelly sand, brown to dark brown (10YR4/3) moist; single grain structure; loose, dry and moist, non-sticky, non-plastic; plentiful very fine roots; clear, smooth boundary; slightly effervescent, pH 7.8.

C₃ 29 to 61 cm - same as C₂ with slightly finer texture and very few fine roots; pH 7.9.

C₄ 61+ cm - pale brown (10YR6/3) gravelly sand, grey brown (10YR5/2) moist; single grain structure; loose, dry and moist, non-sticky, non-plastic; clear, smooth boundary; effervescent, pH 8.1.

7. Profile 7. Duric Torripsamment: sandy, mixed, mesic (Fig. 19).

Entisol, located on an alluvial fan; slope to south at 2-4%; smooth relief; well to excessive drainage; rapid to very rapid permeability; slight to moderate erosion; limestone and granite parent material.

C₁ 0 to 13 cm - pale brown (10YR6/3) loamy sand, brown to dark brown (10YR4/3) moist; very weak, subangular blocky breaking to single grain; soft, friable, non-sticky, non-plastic; few fine roots; clear, smooth boundary; slightly effervescent, pH 7.5.

Fig. 19. Soil profile at Site 7. Elevation 732 m.

- C_2 13 to 36 cm - brown (10YR5/3) sand, dark, yellowish brown (10YR4/4) moist; single grain structure; loose dry and moist, non-sticky, non-plastic; very few fine roots; clear, smooth boundary; slightly effervescent, pH 7.3.
- C_3 36 to 57 cm - same as C_2 with clear, wavy boundary and few roots; pH 7.4.
- C_4 57+ cm - white (10YR8/1) silty sand, very pale brown (10YR7/3) moist; cemented, single grain structure, very hard to extremely hard, friable to very friable, non-sticky non-plastic; duripan thicker than 10 cm; violently effervescent.

8. Profile 8. Typic Torripsamment: sandy, mixed, mesic (Fig.20).

Entisol, located on an alluvial fan; slope to west at 2-4%; smooth relief; well to excessive drainage; rapid permeability; slight erosion; limestone-granite parent material; surface 10-20% gravel.

Fig. 20. Soil profile at Site 8. Elevation 884 m.

A₁ 0 to 10 cm - brown to dark brown (10YR4/3) gravelly, sandy loam (moist); weak, fine, subangular blocky structure; soft, non-sticky, non-plastic; few fine roots; clear, smooth boundary; slightly effervescent; pH 7.8.

C₁ 10 to 21 cm - brown to dark brown (10YR4/3) gravelly, loamy

sand (moist); weak, fine, subangular blocky structure; soft, non-sticky, non-plastic; clear, smooth boundary; slightly effervescent, pH 7.9.

C₂ 21 to 35 cm - dark, yellowish brown (10YR4/4) gravelly, loamy sand (moist); weak, fine, subangular blocky, breaking to single grain structure; loose, non-sticky, non-plastic; clear, wavy boundary; effervescent, pH 8.0.

C₃ 35 to 50 cm - pale brown (10YR6/3) gravelly sand, brown to dark brown (10YR4/3) moist; single grain structure; loose, non-sticky, non-plastic; clear, wavy boundary; effervescent, pH 8.1.

C₄ 50+ cm - same as C₃ with some larger sized gravel and few cobbles; effervescent, pH 8.1.

D. Vegetation analyses

1. Qualitative estimates of relative abundance

Table 2 gives the locations of sites A-L along Nevada Route 77 and Arizona Route 68. Table 3 gives rankings of relative abundance of species at these twelve sites. Abundance ratings are as described by Shimwell (1971): 1 = scarce, 2 = infrequent, 3 = here and there, 4 = abundant, and 5 = very abundant.

The sites at lower elevations (E, F, G, H) generally exhibited lower species diversity. This is at least partly due to greater topographic relief at higher elevations. Only one species, Larrea tridentata, was present at all sites. Ambrosia dumosa was absent only at higher elevations near Union Pass (A, B). Cacti were recorded at every site, but no one species was ubiquitous.

Table 2. Locations, elevations and topographies of twelve sites on Nevada Route 77 and Arizona Route 68.

Site	Location with respect to Nevada-Arizona state line	Elevation and topography
A	11.8 mi E on Az 68; vicinity of Site 1	1128 m; mountainous area, volcanic soils dissected by deep arroyos
B	11.3 mi E on Az 68; between Sites 1 & 2	1036 m; steep slopes, rocky, volcanic soils
C	10.0 mi E on Az 68; between Sites 1 & 2	914 m; upper alluvial fan, small knolls with rocky outcrops dissected by shallow washes
D	8.0 mi E on Az 68; between Sites 2 & 3	823 m; low granite mountains and associated valleys
E	6.8 mi E on Az 68; between Sites 2 & 3	610 m; middle of alluvial fan, rolling hills dissected by gulleys
F	1.5 mi E on Az 68; between Site 4 and state line	244 m; alluvial toe, highly dissected hills
G	5.6 mi W on Nv 77; between Sites 6 & 7	518 m; low granite mountains and associated valleys
H	6.4 mi W on Nv 77; between Sites 6 & 7	594 m; broad sandy wash at base of Christmas Tree Pass
I	7.5 mi W on Nv 77; between Sites 6 & 7	671 m; rolling granite hills and associated washes
J	8.6 mi W on Nv 77; between Sites 6 & 7	732 m; steep granite mountains
K	11.9 mi E on Nv 77; between Sites 7 & 8	671 m; lower bajada and broad wash at base, sandy soils
L	13.9 mi W on Nv 77; between Sites 7 & 8	732 m; low granite hills and deep washes

Table 3. Estimated abundance indexes of perennial plants occurring at twelve sites on Nevada Route 77 and Arizona Route 68. Asterisks indicated highly localized dispersions.

Species	Sites											
	A	B	C	D	E	F	G	H	I	J	K	L
<u>Ambrosia dumosa</u>			3	3	3	3	3	3	2+	4	4	1
<u>Larrea tridentata</u>	2*	3	4	3+	4+	3+	2	3	1	1	3	2
<u>Eriogonum fasciculatum</u>	4	4	3	1			1		4	2	2	2
<u>Encelia farinosa</u>	3		1	2*	1		4	1	1	1		
<u>Ephedra</u> sp.	3	3	2	1+	1				1	1		1
<u>Yucca schidigera</u>	2	3	3	1+				1	2	1		3
<u>Viguiera deltoidea</u>	3	4	2				1		1	1		1
<u>Acacia greggii</u>	1	1	1+	1				1	1	1	1	1
All cacti	2	4	2+	3	1	2	2	3	3+	3+	3	2
<u>Opuntia acanthocarpa</u>		3	2	2	1			2	3	2	1*	
<u>Opuntia bigelovii</u>				1*			1		1*			1
<u>Opuntia ramosissima</u>						2		2			2+	
<u>Ferocactus</u> sp.				1			1		1	2		1
<u>Juniperus osteosperma</u>	2+	1	1					1				1
<u>Krameria grayi</u>			1	1	2	1					1	1
<u>Krameria parvifolia</u>			2	1+					1	1	1	1
<u>Acamptopappus</u>			4							1	2	2
<u>sphaerocephalus</u>												
<u>Hymenoclea salsola</u>			2*					3			1+*	
<u>Sphaeralcea</u> sp.	2			1*			1					1
<u>Gutierrezia microcephala</u>	3											1
<u>Muhlenbergia porteri</u>			3								1	
<u>Coleogyne ramosissima</u>	5	3										
<u>Coldenia canescens</u>	4		1*									
<u>Tridens</u> sp.	3		1	1								
<u>Chrysothamnus teretifolius</u>	3											
<u>Lycium andersonii</u>	1		1*	1								
<u>Porophyllum gracile</u>		2	1									
<u>Salvia</u> sp.	1*	1										
<u>Aristida</u> sp.	2											
<u>Fouquieria splendens</u>		1	1									
<u>Hilaria rigida</u>			2									
<u>Nolina bigelovii</u>	1											
<u>Quercus turbinella</u>	1*											
<u>Bebbia juncea</u>							1			1		
<u>Cassia armata</u>										1		1
<u>Tetradymia axillaris</u>												1*

2. Quantitative estimates of vegetation attributes

Sixty-five species of perennial plants were identified at Sites 1-10. Seven other species were identified to genera, and two unknown species were recorded at Site 1. Table 4 lists the species recorded and indicates their occurrence at each of the ten sampling sites. Forty-nine species were recorded at Site 1, while only three were recorded at Site 9. Over one-third (25) of the total species registered (74) were observed only at Site 1. Only creosotebush (Larrea tridentata) was recorded at all ten sites; bursage (Ambrosia dumosa) and Krameria grayi occurred at all but one site. Table 5 summarizes the basic attributes of combined density, cover and diversity computed for each of ten sites.

Table 5. Combined density, cover and diversity exhibited by perennial plants at each of ten sites in the vicinity of the Mohave Generating Station

Site	Elevation (m)	Number of species recorded	Combined density (n/ha)	Combined cover (%)	Diversity ($\hat{H}'$)
1	1069	49	15,962	34.6	1.17
2	853	29	4,436	15.1	1.16
3	427	16	3,130	11.5	0.89
4	229	10	1,508	11.7	0.70
5	305	12	1,875	12.8	0.62
6	411	12	1,904	12.8	0.82
7	732	22	4,033	22.7	0.68
8	884	22	3,906	13.8	1.01
9	183	3	737	12.9	0.39
10	168	7	1,289	11.7	0.63

TABLE 4. OCCURRENCE OF PERENNIAL PLANT SPECIES AT EACH OF TEN SITES IN THE VICINITY OF THE MOHAVE GENERATING STATION IN SOUTHERN NEVADA.

SPECIES		SITES									
		1	2	3	4	5	6	7	8	9	10
ACACIA	GREGGII	X	X		X		X	X			
ACAMPTOPAPPUS	SPHAEROCEPHALUS		X					X	X		
AMBROSIA	DUMOSA		X	X	X	X	X	X	X	X	X
ARENARIA	MACRADENIA	X									
ARISTIDA	SP.	X		X							
ASCLEPIAS	SUBULATA							X			
BACCHARIS	BRACHYPHYLLA	X									
BAILEYA	MULTIRADIATA								X		
BEBBIA	JUNCEA		X	X	X	X	X				X
BRICKELLIA	ATRACTYLOIDES	X									
CASSIA	COVESII		X								
CERATOIDES	LANATA	X							X		
CHRYSOTHAMNUS	TERETIFOLIUS	X									
COLDENIA	CANESCENS	X									
COLEOGYNE	RAMOSISSIMA	X									
COLDENIA	SP.	X									
CONDALIA	LYCIOIDES	X						X			
COWANIA	MEXICANA	X									
DALEA	FREMONTII					X	X				
DITAXIS	NEOMEXICANA			X							
DYSSODIA	POROPHYLLOIDES	X	X								
ECHINOCEREUS	ENGELMANNII		X					X			
ECHINOCACTUS	POLYCEPHALUS								X		
ENCELIA	FARINOSA		X	X	X			X			
ENCELIA	VIRGINENSIS	X	X			X					
EPHEDRA	SP.	X	X					X	X		
ERIOGONUM	FASCICULATUM	X	X	X				X	X		
ERIOGONUM	INFLATUM	X	X	X	X	X			X		
ERIOGONUM	WRIGHTII	X									
FEROCACTUS	ACANTHODES	X	X					X			
GALIUM	STELLATUM	X	X								
GRAYIA	SPINOSA								X		
GUTIERREZIA	MICROCEPHALA	X									
GUTIERREZIA	SAROTHRAE	X									
HAPLOPAPPUS	LINEARIFOLIUS	X									
HILARIA	RIGIDA		X								X
HYMENOCLEA	SALSOLA		X			X	X	X			
JUNIPERUS	OSTEOSPERMA	X									
KRAMERIA	GRAYI	X	X	X	X	X	X	X	X		X
KRAMERIA	PARVIFOLIA			X					X		
LARREA	TRIDENTATA	X	X	X	X	X	X	X	X	X	X
LIPPIA	WRIGHTII	X									
LOTUS	RIGIDUS	X									
LYCIUM	ANDERSONII	X	X					X	X		

TABLE 4 . CONTINUED.

SPECIES		SITES									
		1	2	3	4	5	6	7	8	9	10
<u>LYCIUM</u>	<u>SP.</u>	X		X							
<u>MACHAERANTHERA</u>	<u>TORTIFOLIA</u>	X							X		
<u>MAMMILLARIA</u>	<u>MICROCARPA</u>		X								
<u>MIRABILIS</u>	<u>BIGELOVII</u>		X						X		
<u>MUHLENBERGIA</u>	<u>PORTERI</u>	X						X	X		
<u>NEOLLOYDIA</u>	<u>JOHNSONII</u>			X							
<u>NOLINA</u>	<u>BIGELOVII</u>	X									
<u>OPUNTIA</u>	<u>ACANTHOCARPA</u>		X	X	X	X	X	X			
<u>OPUNTIA</u>	<u>BASILARIS</u>					X	X				
<u>OPUNTIA</u>	<u>BIGELOVII</u>		X								
<u>OPUNTIA</u>	<u>ECHINOCARPA</u>				X	X	X		X		X
<u>OPUNTIA</u>	<u>RAMOSISSIMA</u>			X	X	X	X			X	X
<u>OXYBAPHUS</u>	<u>SP.</u>	X									
<u>POROPHYLLUM</u>	<u>GRACILE</u>	X	X	X					X		
<u>PRUNUS</u>	<u>SP.</u>	X									
<u>QUERCUS</u>	<u>TURBINELLA</u>	X									
<u>RHUS</u>	<u>TRILOBATA</u>	X									
<u>SALAZARIA</u>	<u>MEXICANA</u>	X		X				X			
<u>SALVIA</u>	<u>MOHAVENSIS</u>	X									
<u>SARCOSTEMMA</u>	<u>HIRTELLUM</u>		X				X				
<u>SENECIO</u>	<u>DOUGLASII</u>	X	X								
<u>SPHAERALCEA</u>	<u>SP.</u>	X						X	X		
<u>STANLEYA</u>	<u>PINNATA</u>	X									
<u>STEPHANOMERIA</u>	<u>PAUCIFLORA</u>	X	X					X	X		
<u>STIPA</u>	<u>SPECIOSA</u>	X									
<u>THAMNOSMA</u>	<u>MONTANA</u>							X	X		
<u>UNKNOWN</u>	<u>ONE</u>	X									
<u>UNKNOWN</u>	<u>TWO</u>	X									
<u>VIGUIERA</u>	<u>DELTOIDEA</u>	X	X					X			
<u>YUCCA</u>	<u>SCHIDIGERA</u>	X	X					X	X		

Density, cover and diversity are all positively correlated with elevation, though not necessarily in a linear manner. We consider the seven sites at elevations less than 800 m to be most typical of the environs of the Mohave Generating Station. These sites generally exhibit combined densities of a few thousand perennial plants per ha, aggregate coverage in the range of 10-20%, and low diversities ($\hat{H}' = < 1.0$).

Estimates of density, frequency and coverage and associated importance value indexes for all perennial species recorded at the ten sites are given in Appendix B. Table 6 abstracts these data for the three most important species at each of ten sites. With the exception of Site 6, creosotebush (Larrea tridentata) emerged as the dominant species at all of the lower elevation sites (<1,000 m). Bursage (Ambrosia dumosa) was often a virtual co-dominant, but usually exhibited importance value indexes lower than those of Larrea.

Table 6. Density, frequency, cover and importance value indexes for the three most important perennial plants at Sites 1-10.

Site	Species	Density (n/ha)	Frequency (%)	Cover (%)	Importance Value Index
1	<u>Coleogyne ramosissima</u>	3,433	100	11.6	60.0
	<u>Coldenia canescens</u>	3,069	90	1.6	28.3
	<u>Juniperus osteosperma</u>	167	100	5.1	20.8
2	<u>Larrea tridentata</u>	627	100	7.7	73.7
	<u>Cassia couesii</u>	757	100	0.4	28.0
	<u>Ephedra</u> sp.	296	100	1.8	26.9
3	<u>Larrea tridentata</u>	686	100	5.4	84.0
	<u>Ambrosia dumosa</u>	695	90	1.6	49.8
	<u>Encelia farinosa</u>	610	70	1.4	41.9
4	<u>Larrea tridentata</u>	313	100	6.6	98.9
	<u>Ambrosia dumosa</u>	554	100	2.6	81.0
	<u>Encelia farinosa</u>	370	100	1.6	60.1
5	<u>Larrea tridentata</u>	534	100	7.7	110.7
	<u>Ambrosia dumosa</u>	960	100	3.5	100.4
	<u>Krameria grayi</u>	94	50	0.4	19.0
6	<u>Ambrosia dumosa</u>	830	50	3.1	76.6
	<u>Larrea tridentata</u>	288	80	4.2	62.1
	<u>Dalea fremontii</u>	117	90	1.8	35.7
7	<u>Larrea tridentata</u>	804	100	14.6	98.3
	<u>Ambrosia dumosa</u>	2,351	100	5.0	94.4
	<u>Hymenoclea salsola</u>	103	50	0.4	11.2
8	<u>Larrea tridentata</u>	632	100	8.2	85.5
	<u>Ambrosia dumosa</u>	751	100	1.1	37.3
	<u>Krameria grayi</u>	284	100	1.1	24.8
9	<u>Larrea tridentata</u>	472	100	10.0	181.6
	<u>Opuntia ramosissima</u>	155	90	2.4	75.9
	<u>Ambrosia dumosa</u>	110	60	0.5	42.5
10	<u>Larrea tridentata</u>	640	100	9.6	156.6
	<u>Ambrosia dumosa</u>	234	80	0.6	43.3
	<u>Krameria grayi</u>	145	80	0.9	39.0

E. Analyses of metals on native plants and crops

We analyzed 102 samples at our laboratory in Los Angeles. Of these, 73 were from sites likely to have been exposed to fallout from the Mohave Generating Station and the other 29 were from what we considered control sites. Twenty samples yielded results which were checked by running two more replicates from each sample. We will not comment in this report on analyses of P, Na, K, Ca, Mg, Fe, Mn, Al, Si, Ti, Mo, Sr, Ba and Li, except to state that observed concentrations were typical in terms of previous studies of desert vegetation at the Nevada Test Site (Romney et al. 1973).

The amount of variation between individual samples from different species of plants and from various sites, as well as variation between different replicates of the same sample, was so great that no detailed statistical treatments will be attempted at this time. Rather we will simply report the higher amounts of metals measured and make general comments on the ranges of concentrations exhibited.

Zinc, copper and boron were detected in all samples, usually in the range of about 10-70 ppm. Two grass samples (Aristida sp.), from Site 1 and Site 3, exhibited unusual amounts of Zn (~ 105 ppm) and Cu (100-131 ppm), but typical concentrations of boron. A cotton sample from the Pahrump Valley, a sample of yucca from Control Site 1, and a sample of Bebbia juncea from Control Site 6 showed unusual levels of boron (123-169 ppm). None of these values was included in calculations of average concentrations. Table 7 gives mean concentrations of Zn, Cu and B on four plant species ($n \geq 5$).

Table 7. Mean concentrations (ppm) $\pm$ one standard error of zinc, copper and boron in samples of four plants from the environs of the Mohave Generating Station in southern Nevada

Species	n	Zn	Cu	B
<u>Ambrosia dumosa</u>	9	38.4 $\pm$ 3.1	26.9 $\pm$ 2.6	30.8 $\pm$ 3.6
<u>Krameria grayi</u>	6	29.3 $\pm$ 3.0	24.5 $\pm$ 3.1	19.4 $\pm$ 2.6
<u>Larrea tridentata</u>	11	29.7 $\pm$ 2.8	16.8 $\pm$ 1.7	32.2 $\pm$ 2.4
<u>Yucca schidigera</u>	5	26.9 $\pm$ 6.9	14.7 $\pm$ 3.4	41.8 $\pm$ 7.0

Although further measurements may show significant differences between plant species, we combined all samples in order to make the site comparisons given in Table 8.

Comparisons of mean concentrations of metals on native plants growing at Sites 1-10 and in control areas (C1-4, 6-8) indicate no differences, except for apparently higher amounts of zinc in samples from control sites. Similarly, comparisons of concentrations in agricultural plants (Sites 11, 12) and Control Site 9 fail to indicate differences, though amounts of zinc and boron on agricultural samples are apparently higher than those measured on native plants. These differences may be associated with applications of insecticides or fertilizers, or possibly to ^{physiological} differences between crop species and native shrubs.

Vanadium was detected in 84% of samples from exposed sites, from 97% of samples from control sites, and from 87% of all samples.

Table 8. Mean concentrations (ppm) $\pm$ one standard error of zinc, copper and boron in plant samples from the environs of the Mohave Generating Station in southern Nevada. Sites 11 and 12 and Control Site 9 are agricultural areas

Site	n	Zn	Cu	B
1	13	41.3 $\pm$ 5.0	25.2 $\pm$ 3.3	31.4 ¹ $\pm$ 5.8
2	11	34.2 $\pm$ 3.1	23.2 $\pm$ 3.1	30.4 ₁ $\pm$ 6.6
3	5	36.1 $\pm$ 3.7	22.9 $\pm$ 4.1	27.7 ¹ $\pm$ 5.4
4	4	33.6 $\pm$ 7.7	19.4 $\pm$ 5.5	31.9 $\pm$ 3.5
5	4	39.3 $\pm$ 2.9	37.3 $\pm$ 6.3	26.7 $\pm$ 0.9
6	7	27.3 $\pm$ 3.2	20.1 $\pm$ 2.5	31.1 $\pm$ 8.8
7	5	20.0 $\pm$ 3.2	16.1 $\pm$ 2.3	31.4 $\pm$ 6.4
8	9	33.7 $\pm$ 5.9	18.0 $\pm$ 2.2	30.5 $\pm$ 7.0
9	3	24.3 $\pm$ 3.7	19.1 $\pm$ 4.8	30.4 $\pm$ 5.4
10	4	36.0 $\pm$ 11.1	38.5 $\pm$ 16.5	17.7 $\pm$ 4.6
1 - 10	65	33.8 $\pm$ 1.8	23.3 $\pm$ 1.6	29.7 ² $\pm$ 2.2
11, 12	6	62.2 $\pm$ 8.8	16.0 $\pm$ 2.4	49.3 $\pm$ 5.7
C1	13	43.2 $\pm$ 3.5	27.5 $\pm$ 2.4	33.4 ³ $\pm$ 5.3
C2	4	56.2 $\pm$ 6.4	24.9 $\pm$ 3.1	29.8 $\pm$ 7.6
C3	5	61.7 $\pm$ 7.1	29.2 $\pm$ 10.8	13.4 ₃ $\pm$ 3.2
C4, 6-8	5	48.1 $\pm$ 8.5	26.4 $\pm$ 5.4	27.1 ³ $\pm$ 1.8
C1 - 4, C6 - 8	27	49.5 $\pm$ 3.0	27.2 $\pm$ 2.4	27.8 ⁴ $\pm$ 3.2
C9	2	57.8 $\pm$ 28.0	18.2 $\pm$ 8.3	51.9 ³

¹ sample size of n+1

² sample size of n+2

³ sample size of n-1

⁴ sample size of n-2

About 13% of the samples containing vanadium had less than one ppm.

In other samples, vanadium ranged from 1.6 to 6.8 ppm. These values are in the same range (or lower) as those measured on vegetation from the Nevada Test Site.

Chromium was detected in 99% of samples from exposed sites, from all samples from control sites, and from 99% of all samples. About 8% of samples contained less than 0.2 ppm. In other samples, chromium ranged from 0.3 to 3.2 ppm, except for one sample (11.8 ppm) from a tamarisk tree growing beside a cotton field about 17 miles south of the generating station (Site 11).

Nickel was present in about 85% of samples from exposed sites, from 66% of samples from control sites, and from 79% of all samples. Among the 81 samples containing nickel, only about 11% contained ≥ 2 ppm.

Table 9. Concentrations of nickel (> 5 ppm) in plant samples collected in the environs of the Mohave Generating Station

Site	Species	Nickel (ppm)
1	<u>Lycium andersonii</u>	13.9
2	<u>Larrea tridentata</u>	32.3
4	<u>Larrea tridentata</u> (3 replicates)	< 2
		< 2
		87.6
8	<u>Lycium andersonii</u>	8.2
11	<u>Tamarix gallica</u> (3 replicates)	9.5
		8.2
		< 2
C1	<u>Larrea tridentata</u>	27.1
C2	<u>Coleogyne ramosissima</u>	4.0

Nickel concentrations > 5 ppm are unusually high if only root uptake is involved. Higher levels suggest the possibility of airborne contamination. Table 9 pertains to plant samples containing more than 5 ppm nickel.

Tin was present in 24 of 102 samples, but in concentrations of more than 0.3 ppm in only 16 of these. Tin concentrations in plant foliage owing to root uptake are normally less than 3 ppm. Table 10 gives data pertaining to samples containing ≥ 3 ppm.

Table 10. Concentrations of tin (≥ 3 ppm) in plant samples collected from the environs of the Mohave Generating Station

Site	Species		Tin (ppm)
1	<u>Juniperus osteosperma</u>		4.0
4	<u>Larrea tridentata</u>	(3 replicates)	21.3 18.6 19.8
7	<u>Larrea tridentata</u>		3.0
8	<u>Larrea tridentata</u>	(3 replicates)	22.6 n.d. n.d.
11	cotton	(3 replicates)	16.0 n.d. n.d.
11	cotton	(3 replicates)	20.3 n.d. n.d.
11	<u>Tamarix gallica</u>	(3 replicates)	n.d. 125.6 35.0
C1	<u>Eurotia lanata</u>		6.6
C1	<u>Larrea tridentata</u>		10.0
C1	<u>Opuntia echinocarpa</u>		9.3
C7	<u>Encelia farinosa</u>		24.8

The sporadic occurrence of higher concentrations of tin indicate external contamination from airborne sources.

Lead was present in 49 of 102 samples, and in concentrations exceeding one ppm in 27 of these. Lead concentrations of 1-5 ppm are not unusual on plants at the Nevada Test Site, so we report only values ≥ 6 ppm in Table 11.

Table 11. Concentrations of lead (≥ 6 ppm) in plant samples collected from the environs of the Mohave Generating Station

Site	Species	Lead (ppm)
2	<u>Larrea tridentata</u>	6.0
4	<u>Larrea tridentata</u> (3 replicates)	14.1 29.4 2.7
7	<u>Larrea tridentata</u>	9.7
11	<u>Tamarix gallica</u> (3 replicates)	n.d. < 1 328.7
C1	<u>Eurotia lanata</u>	8.9
C1	<u>Larrea tridentata</u>	11.2
C2	<u>Coleogyne ramosissima</u>	6.6

The extremely high concentration of lead measured in one of the replicates of tamarisk leaves was apparently due to externally deposited particulate material.

Cadmium was present in 36 of 73 samples from exposed areas, but at less than 3 ppm in 24 of these. Cadmium was detected in 17 of 29 samples from control sites, but at less than 3 ppm in all but four of these. More than 3 ppm Cd indicates probable superficial contamination by airborne particulates. Table 12 gives data pertaining to 16 samples in which cadmium exceeded 3 ppm.

Table 12. Concentrations of cadmium (> 3 ppm) in plant samples collected from the environs of the Mohave Generating Station

Site	Species	Cadmium (ppm)
1	<u>Aristida</u> sp.	7.1
1	<u>Ephedra</u> <u>viridis</u>	8.6
1	<u>Juniperus</u> <u>osteosperma</u>	5.9
3	<u>Ephedra</u> <u>viridis</u>	5.5
8	<u>Sphaeralcea</u> sp. (3 replicates)	109.1
		n.d.
		< 3
8	<u>Yucca</u> <u>schidigera</u> (3 replicates)	162.1
		< 3
		< 3
9	<u>Opuntia</u> <u>ramosissima</u> (3 replicates)	4.4
		5.0
		< 3
11	roadside plant (3 replicates)	10.5
		n.d.
		< 3
11	cotton (3 replicates)	n.d.
		< 3
		7.4
11	cotton (3 replicates)	20.0
		n.d.
		< 3
11	cotton (3 replicates)	22.6
		n.d.
		n.d.
11	<u>Tamarix</u> <u>gallica</u> (3 replicates)	107.8
		< 3
		22.8
C2	<u>Ambrosia</u> <u>dumosa</u>	5.5
C3	<u>Ephedra</u> <u>viridis</u>	6.4
C6	<u>Opuntia</u> <u>bigelovii</u>	4.0
C9	cotton	5.0

At this time we will not express any definite conclusions as to the significance of the foregoing measurements of trace metals in plant samples, except to emphasize the variations which may occur among replicates of the same samples. Many of the highest concentrations were measured in materials from an agricultural site (Site 11) along the Colorado River. For all metals reported, unusually high concentrations were observed at control sites as well as at sites believed to be exposed to stack effluents (Sites 1-10). Amounts of metals measured at these latter sites were not obviously correlated with predictions based on wind structure and topography (See Introduction).

IV. DISCUSSION.

At the outset of this discussion we emphasize a problem of overriding importance in considering the possible effects of contaminants released by the Mohave Generating Station. This station has been in continuous operation for almost four years, but we do not know what specific contaminants are released nor where and to what extent such materials are deposited in the environs of the station. The atmospheric transport model alluded to previously is completely unvalidated, and the modest measurements we made during the winter of 1974-5 show no obvious correlations with model predictions.

One evident need, then, is for the development of a monitoring program which will identify specific trace metals in the environment, map existing amounts of these metals, and determine present input rates. Ideally, this work should discriminate between contaminants released by the Mohave Generating Station and those from other sources.

The problems implied here are formidable. We have already emphasized the considerable variability observed among replicates of the same sample, and we may expect comparable variability between samples taken from the same locality. Even the superficially simple task of establishing average existing levels will require a prodigious effort. We know that zinc, copper and boron (> 100 ppm), nickel (> 5 ppm), tin (> 3 ppm), lead (> 6 ppm) and cadmium (> 3 ppm) may be measured in plant materials in the environs of the station at levels clearly implicating deposition of airborne particulate materials. We do not know at present whether such particulates have been dispersed by the

Mohave Generating Station, for high levels of these metals were also measured in samples from control areas. We must also consider the possible roles of automotive emissions, abraded tire rubber, agricultural additives (e.g., fertilizers, insecticides) and other industrial sources. We recommend that ratios of selected trace elements in particulate material emitted from the plant stack be determined. These ratios may then be compared with those observed in plant samples. We also suggest that Southern California Edison consider the use of a non-toxic additive to stack emissions which could be used to identify materials released from the station. ZnS is a commonly used fluorescent marker, but other possibilities should also be weighed.

What factors should we consider in the planning of long-term field experiments in the vicinity of the station? If the areas of highest deposition rates and, presumably, highest concentrations of contaminants were known, such areas should obviously be the focus of continuing study. We do not believe that present levels of trace metals in such areas could be responsible for any detectable effects, and it is quite possible that even a 30-year accumulation would be equally harmless. However, the identification of areas of maximum contamination and the documentation of the function of plants and animals occupying such areas is important. The siting of experiments involving the artificial augmentation of contaminants (say, by addition of a dry material derived from precipitator extracts) is less important. Here we would be interested in comparing threshold toxicity levels (under natural conditions) with those determined in laboratory experiments. However, we should select areas for these

experiments which make sense in terms of the location of the Mohave Generating Station and the plant communities surrounding it.

On the basis of findings given in this report, we judge that a bajada community of Larrea tridentata and Ambrosia dumosa is a sensible choice in terms of topography, soil characteristics and biota. Such a site would not be susceptible to severe flooding. The bajada soils contain no unusual natural concentrations of metals, and are well-drained and non-saline. The Larrea-Ambrosia vegetation type is certainly widespread in the vicinity of the station, and indeed is representative of much of the Mohave Desert. Studies in such a community would, then have considerable generality. The low diversity observed at most of the Larrea-Ambrosia sites might simplify some aspects of field experiments, but is probably a neutral attribute. Sites of this nature could be established fairly close to Bullhead City, which would simplify the logistics of field work.

Finally, we suggest that Southern California Edison consider a program of sampling and analysis involving trace metals in the hair and fingernails of humans occupying the Mohave Valley. It would have been better to initiate such work before the construction of the plant, but it is still not too late to begin such measurements. Assuming that the samples are taken in an intelligent manner, records of trace metals in human tissues--measured over the operating lifetime of the station--could be an economical measure of potential impact on human populations living in the vicinity of a coal-burning generating station.

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APPENDIX A

Richard F. Logan

This Appendix sets forth more detailed descriptions of the 25 topographical types given in Table 1. In addition to identifying and describing these types, Appendix A also gives information gathered in the field pertaining to 41 specific sites. The scientific names of plants in this Appendix have not been standardized with those given in the foregoing text. References to Larrea divaricata and Franseria dumosa in this Appendix should be understood as referring to Larrea tridentata and Ambrosia dumosa in the text. Other inconsistencies in specific epithets may occasionally occur.

TYPE 1. ACTIVE ALLUVIAL FANS AND BAJADAS

Deposits of mixed materials, fluvially transported, deposited due to decrease in stream carrying power resulting from a marked decrease in velocity at and below a pronounced break in slope. Bajadas formed by lateral merging of individual alluvial fans. Fans also extend upstream into the lower reaches of canyons by aggradation due to rising base level associated with continuing deposition on the fan.

Slopes range from 40% or more at fan heads to 1.6% on edge of Colorado River floodplain and 1.3% on floor of Sacramento Valley. Large bajadas on both sides of Colorado River are aggraded to the level of the river; others are aggraded to the level of the thalweg of the Sacramento Valley and of Piute Valley.

Great variations in materials occur from fan to fan, depending upon the bedrock in the headwaters erosive area. There is a tendency for materials to grade from coarser at fan heads to finer at the foot, but exceptions are locally common.

Surfaces everywhere are cut by shallow channels, up to one meter depth minimum in most cases, often over two meters.

SITE DESCRIPTIONS

TYPE 1 - ACTIVE ALLUVIAL FANS AND BAJADAS

SITE 1A - Piute Valley, on Highway U.S. 95, at southwest corner of study area, 12 miles south of Nevada-California boundary, at latitude 35°N. Elevation, 1800 feet.

Geomorphology. An active lower bajada, composed of extremely mixed parent material, cut by channels incised to ca. 1.7 m below surface level. Surface gravelly to sandy, with pebbles to 10 cm. Some cementing of sub-strata, forming caliche, at depths below 0.5 m. Slope of surface, 3%.

<u>Vegetation.</u>	Cover 10%	height (meters)	nearest neighbor distance (meters)	occurrence
<u>Larrea divaricata</u>		1.0	7	common
<u>Franseria dumosa</u>		0.4		common
<u>Opuntia acanthocarpa</u>		1.0		common
<u>Yucca schidigera</u>		2.0		occasional
<u>Opuntia basilaris</u>		0.6		rare
<u>Cassia armata</u>		1.0		rare

SITE 1C - Piute Valley, two miles east of Highway U.S. 95, 1 mile south of Old Government Road. Elevation, 2400 ft.

Geomorphology. An active upper bajada, composed of alluvium derived mostly from granite. Largely grus, with occasional larger fragments of other rock. Slope of surface, 4%.

Vegetation. All species larger and taller than at Site 1.
Cover 30%.

<u>Larrea divaricata</u>	2.0	common
<u>Franseria dumosa</u>	0.6	common
<u>Opuntia acanthocarpa</u>	1.5	common
<u>Yucca schidigera</u>	2.0	occasional
<u>Opuntia basilaris</u>	0.6	occasional
<u>Cassia armata</u>	1.0	rare

SITE DESCRIPTIONS

TYPE 1 - ACTIVE ALLUVIAL FANS AND BAJADAS (continued)

SITE 1B - Same as Site 1A

Geomorphology. Bottoms and slopes of channels incised to ca. 1.7 m below the surface of the bajada. Occasional outcroppings of caliche in the banks, make local vertical areas.

Vegetation. Slightly denser than on the surface, and with slightly taller individuals.

<u>Larrea divaricata</u>	1.0 m	common
<u>Viguiera deltoidea</u>	0.6 m	common
<u>Franseria dumosa</u>	0.5 m	common
<u>Salazaria mexicana</u>	0.6 m	occasional
<u>Acacia greggii</u>	1.5 m	occasional
with <u>Phoradendron</u> sp.		
<u>Dalea spinosa</u>	1.5 m	rare
<u>Chilopsis linearis</u>	1.5 m	rare
wint <u>Phoradendron</u> sp		

SITE 2 - Piute Valley, on Highway U.S. 95, nine miles south of Nevada-California boundary. Elevation, 1800 feet

Geomorphology. A major wash running longitudinally along the valley axis on the line of intersection of the two opposite bajadas. Floor of wash in places at level of adjacent fan surfaces, occasionally incised up to 2 m.

<u>Acacia greggii</u>	4.0 m	in occasional
with <u>Phoradendron</u>		thick clumps
<u>Dalea spinosa</u>	2.0 m	occasional
<u>Hymenoclea salsola</u>	1.0 m	common
? <u>Lepidospartum squamatum</u> ?	2.0 m	common over flooded areas

SITE DESCRIPTIONS

TYPE 1 - ACTIVE ALLUVIAL FANS AND BAJADAS (continued)

SITE 17 Sacramento Valley, on Arizona State Highway 68, two miles east of Union Pass and 2.3 miles west of Estrella Road, at the junction of the old road with the modern State Highway. Elevation 3020 feet.

(A post supporting a small sheltering device within which a Petri dish containing agar was found, stands just south of the intersection.)

Geomorphology. An alluvial fan with a slope of 2%. Very smooth surface veneered with angular to subangular pebbles of tuffaceous material and basalt up to 2.5 cm over a clayey substratum. Trenched by widely separated channels up to 3 m deep, with flaring, gently sloping sides.

Vegetation. Very patchy on the surface areas, with dense areas having a cover up to 40%, and with large open expanses with very little, if any, vegetation. Much thin grass from last year.

<u>Larrea divaricata</u>	1.5 m	dominant
<u>Yucca schidigera</u>	3.0	occasional
<u>Ephedra</u> sp.	1.0	common
<u>Opuntia ramosissima</u>	1.0	common
<u>Krameria parvifolia</u>	0.7	common
<u>Chilopsis linearis</u>	1.0	rare
<u>Acacia greggii</u>	1.0	occasional
<u>Opuntia erinacea</u> or <u>ursina</u>	0.5	occasional

Washes. In the shallow channels mentioned above, the vegetation is a little more dense and the individuals taller than on the fan surfaces. Species include:

Juniperus sp.
Chilopsis linearis
Ephedra sp.
Acacia greggii
Eriogonum polifolium
Yucca schidigera
Lycium sp.
Salvia carnosae
Sphaeralcea ambigua
Krameria parvifolium

The exotic, Salsola kali tenuifolia, is also present in both the surface and the wash situations.

SITE DESCRIPTIONS

TYPE 1 - ACTIVE ALLUVIAL FANS AND BAJADAS (continued)

SITE 20 Sacramento Valley, on Estrella Road, two to four miles south of Arizona State Route 68. Elevation 2700 feet.

Geomorphology. Very smooth bajada, slope 2% to 3%. Alluvium derived largely from tuffaceous materials.

Vegetation. Over large areas, essentially a consociation of Larrea divaricata. Occasional patches of Yucca schidigera scattered amidst Larrea divaricata.

SITE 40 On western side of the Colorado River Valley, west of Davis Dam. On Nevada State Route 77, 2.5 miles by road south and west of Davis Dam. 1.9 miles airline from the Colorado River. 2.7 miles NNW from the stack of the Mohave Generating Station. Elevation 980 feet.

Monitoring station #501, 503

Geomorphology. Bajada of mixed parent material, dipping eastward 4%. Zones of coarse desert pavement and zones of unpaved gravelly alluvium.

Vegetation. Desert pavement areas have very scanty vegetative cover. Other surfaces have 10% cover, chiefly consisting of:

Larrea divaricata
Krameria parvifolia
Franseria dumosa
Opuntia ramosissima

Washes. Aggrading washes only slightly (0.5 m) below general level of the bajada surface. Somewhat heavier vegetative cover - to 20% - but little change in either height of individuals or in their diameters. Species include:

Larrea divaricata
Franseria dumosa
Acacia greggii

SITE DESCRIPTIONS

TYPE 1 - ACTIVE ALLUVIAL FANS AND BAJADAS (continued)

SITE 41 On the western side of the Colorado River Valley at the mouth of Dripping Springs Canyon. On Nevada State Route 77, two miles WNW of Site 40, 3.5 miles west of the Colorado River, 4.5 miles by road from Davis Dam, and four miles NW of the stack of the Mohave Generating Station. Opposite a broad turnout equipped with rubbish barrels.

Monitoring Station #602. Heavily browsed by cattle.

Geomorphology. The active, undissected alluvial fan constructed by the stream in Dripping Springs Canyon. Material largely granitic. Slope 5.5%.

Vegetation. A fairly open growth with a cover of 15%.
Species include:

<u>Larrea divaricata</u>	1.5 m	common
<u>Acacia greggii</u>	1.0 m	common
<u>Hymenoclea salsola</u>	1.0 m	common
<u>Krameria parvifolia</u>	1.0 m	common
<u>Parosela</u> sp. (?)	0.7 m	occasional
Unidentified composite	0.7 m	common

SITE 47 Eastern side of Piute Valley, on Highway U.S.95, five miles north of the Nevada-California boundary, and four miles north of the junction with Nevada State Route 77. Elevation 2550.

Geomorphology. A gently-sloping (1.5%) undissected bajada composed of mixed parent material with granite predominating.

Vegetation. A typical alluvial fan association, including:

Larrea divaricata
Franseria dumosa
Krameria parvifolia
Opuntia acanthocarpa

SITE DESCRIPTIONS

TYPE 1 - ACTIVE ALLUVIAL FANS AND BAJADAS (continued)

SITE 48 Eastern side of Piute Valley, at junction of highways U.S. 95 and Nevada State Route 77. Elevation 2500.

Very similar in all regards to Site 47, except for a reduced development of *Opuntia acanthocarpa*.

SITE 53 Eastern side of Piute Valley, on Nevada State Route 77, 3.8 miles ESE of the intersection with U.S. 95. Elevation 2940.

Monitoring Station #108

Geomorphology. A gently-sloping (2%) undissected bajada of mixed alluvium.

Vegetation. A typical upper alluvial fan assemblage, with a 30% cover. Common species include:

Larrea divaricata
Fraseria dumosa
Sphaeralcea ambigua
Thamnosma montana
Ephedra sp.
Krameria parvifolia
Lycium sp.
Hymenoclea salsola
Salazaria mexicana

SURFACE FEATURES

TYPE 2. GRANITIC ALLUVIAL FANS AND BAJADAS

Deposits of disintegrated (not decomposed) granite in the form of arkose or grus, consisting of sharp, angular fragments of granite, chiefly grains of quartz and feldspar. Devoid of large boulders, cobbles or even pebbles. Only slight diminution in particle size from head of fan to foot of bajada, since no large particles are present in the source area.

Such areas are particularly easy to traverse by motor vehicle, since the sharpness of the fragments causes them to interlock and thus remain rigid, instead of rolling as is normally the case with sand grains, under the pressure of the weight of a vehicle. Thus they provide an excellent driving base even when relatively fine-grained.

SITE DESCRIPTIONS

TYPE 2 - GRANITIC ALLUVIAL FANS AND BAJADAS

SITE 4 - Upper alluvial fan, elevation 2000 feet, 4.5 miles due west of the western bank of the Colorado River at the westernmost point of the Big Bend south of Bullhead City; one mile northeast of the Nevada--California boundary.

Geomorphology. A moderately steep, undissected, active alluvial fan, composed entirely of grus resulting from the disintegration of granite. Slopes very smooth, both transversely and longitudinally. Almost the entire surface is subjected to sheet wash.

Vegetation. Relatively dense, ca. 40%. Larrea and cacti dominate: Larrea divaricata comprising about 60% of the vegetation, and Opuntia echinocarpa and Op. bigelovii about 30%. Prominent species and their heights are:

<u>Larrea divaricata</u>	2 m
<u>Franseria dumosa</u>	1 m
<u>Opuntia acanthocarpa</u>	2 m
<u>Opuntia bigelovii</u>	2 m
<u>Opuntia ramosissima</u>	2 m
<u>Yucca schidigera</u>	3 m
<u>Cereus engelmannii</u>	0.1 m

SITE 5 - The same fan-bajada, but at a lower elevation (1000 feet). 1.2 miles WSW of the west bank at the Big Bend of the Colorado River.

Geomorphology. Relatively steeply sloping (6%) bajada composed entirely of grus. Much of the surface is undergoing recurrent active deposition; such "washes" are at the level of the rest of the bajada surface.

Vegetation: Relatively dense in areas of "washes" - 20% cover. Larrea and Franseria comprise virtually all of the vegetation. Species and their heights include:

<u>Larrea divaricata</u>	2 m
<u>Franseria dumosa</u>	1 m
<u>Opuntia ramosissima</u>	1 m
<u>Hymenoclea salsola</u>	1 m

In the areas between the washes, vegetation is much more sparse, producing a 10% cover. Franseria dominates, and Hymenoclea is absent.

<u>Larrea divaricata</u>	1 m
<u>Franseria dumosa</u>	0.5 m
<u>Opuntia ramosissima</u>	
<u>Opuntia acanthocarpa</u>	
<u>Echinocactus acanthodes</u>	

SURFACE FEATURES

TYPE 3 - DISSECTED BAJADAS, LOW RELIEF

Areas of alluvial deposition which are undergoing, or which have in the past undergone, pronounced dissection by stream erosion. Commonly, undissected remnants occur in the areas between channels. Often their surfaces are covered with desert-varnished pebbles, forming desert pavements, or incipient stages thereof. Relief under 10 m.

SITE DESCRIPTIONS

SITE 9 East side of Bullhead City -- Davis Dam highway, 0.6 miles north of Airport. Elevation, 560-620 feet.

Geomorphology. Dissected old bajada. Steep to vertical sided gullies cut into former bajada surface, isolating or separating remnants of the former surface. Local relief of 8 to 12 m.

Very mixed materials. Boulders in excess of 1 m diameter are common. Many beautifully rounded cobbles. Much desert varnish patina.

Vegetation. Very thin cover (2%), with Larrea dominant (90% of vegetation). Species present include:

Larrea divaricata
Franseria dumosa
Opuntia acanthocarpa

SITE 10 On Arizona State Route 68, 1.6 miles ESE of the east end of Davis Dam. Elevation, 840 feet.

Geomorphology. The floor of a major, active but intermittent wash, incised ca. 10 m below the general level of the bajada, forming a flat-floored valley 800 feet across. Coarse gravel of mixed origin, including boulders to 0.5 m diameter. Many channels, continually shifting during floods.

Vegetation. Relatively dense (to 30%), rather patchy. Species include:

Larrea divaricata
Franseria dumosa equally dominant
Encelia farinosa
Opuntia ramosissima - dwarfed, occasional
Echinocactus acanthodes - rare

SITE DESCRIPTIONS

TYPE 3 - DISSECTED BAJADAS - LOW RELIEF

SITE 12 - Same wash as Site 10, five miles farther east (upstream) at an elevation of 2100 feet, at junction of Arizona State Route 68 with road to Katherine Wash.

Geomorphology. Main floor of wash, rarely flooded, standing one meter above active channel. Fine gravel with boulders up to one meter in diameter. Mixed material with dominance of acid extrusives.

Vegetation. Cover 35 %. Patches wherein Hymenoclea, Franseria, Larrea, and Opuntia bigelovii dominate. Notable species include:

Hymenoclea salsola
Ephedra spp.
Franseria dumosa
Larrea divaricata
Opuntia bigelovii
Opuntia basilaris

SITE 12A Same locality. Ubac (north-facing) slope formed by the dissection of the older alluvial fan. Same material as Site 12. Slope, 30° to 40°.

Franseria dumosa - dominant
Larrea divaricata - minor sub-dominant
Echinocactus acanthodes
Opuntia ramosissima
Ephedra spp.
Eriogonum inflatum

SITE DESCRIPTIONS

TYPE 3 - DISSECTED BAJADAS - LOW RELIEF

SITE 36 Katherine area, east of Colorado River where impounded as Lake Mohave above Davis Dam. Elevation, 800-1000 feet.

Geomorphology. A bajada, undergoing dissection, filling the entire valley. Undissected surface remnants, covered with incipient desert pavement

Vegetation. Very open vegetation - 5%

<u>Larrea divaricata</u>	1 m high
<u>Franseria dumosa</u>	0.4 m high
<u>Opuntia basilaris</u>	

Geomorphology. Broad-bottomed wash, incised 10 m below surface. Coarse gravel. Mixed material

Vegetation. 25% cover.

<u>Larrea divaricata</u>	2 m high
<u>Franseria dumosa</u>	0.5 m high
<u>Hymenoclea salsola</u>	1 m high
<u>Acacia greggii</u>	2 m high

SURFACE FEATURES

TYPE 4 - DISSECTED BAJADS - MODERATE RELIEF

Same as Type 3, but with local relief between 10 and 20 m.

SITE DESCRIPTIONS

SITE 26 Just outside study area. Directly west of the Boundary Cone, 1000 feet west of Old Highway 66. Elevation 1800-1900 feet. East facing slope.

Geomorphology. Steeply (30° to 45°) sloping side of remnant of dissected bajada. Upper parts well cemented forming caliche.

Vegetation.

<u>Encelia farinosa</u>	dominant
<u>Opuntia bigelovii</u>	conspicuous in patches
<u>Larrea divaricata</u>	occasional
<u>Opuntia acanthocarpa</u>	occasional
<u>Opuntia ramosissima</u>	occasional
<u>Echinocactus acanthodes</u>	occasional
<u>Fouquieria splendens</u>	scattered

SITE 33 Six miles SE of Bullhead City. Elevation 1200-1600 feet.

Geomorphology. Surface of older bajada, strongly dissected by steep-sided channels 12 to 25 m deep. Surface often an incipient desert pavement. Larger stones exhibit varying degrees of desert varnish. Mixed parent materials. Large black basalt rocks conspicuous.

Vegetation. 20 % cover.

Larrea divaricata
Franseria dumosa
Encelia farinosa
Opuntia acanthocarpa.

SITE 39 Slope of Colorado Valley east of Lake Mojave, two to four miles north of Katherine.

Geomorphology. Washes in moderately dissected alluvial fans and bajadas. Flat floors, vertical walls.

Vegetation.

<u>Acacia greggii</u>	to 3 m
<u>Hymenoclea salsola</u>	to 2 m
<u>Encelia farinosa</u>	to 1 m
<u>Larrea divaricata</u>	to 2 m

SURFACE FEATURES

TYPE 5 - DISSECTED BAJADAS, HIGH RELIEF

Same as Type 3, but with relief exceeding 20 meters

SITE DESCRIPTION

SITE 6 Western bank of Colorado River at and west of the Big Bend.
Elevation, 500 to 1000 feet.

Geomorphology. Recent alluvium deeply and intensely dissected by 30 m gullies with vertical walls. Some alluvium slightly indurated.

Vegetation. Floor of wash

<u>Encelia farinosa</u>	large compact bushes, 1 m.
<u>Franseria dumosa</u>	1 m high
<u>Hymenoclea salsola</u>	1 m high
<u>Acacia greggii</u>	2 m high
<u>Eriogonum deflexum</u>	small annual (0.3 m) all over floor of wash

Unknown rayless composite

SURFACE FEATURES

TYPE 6 - RIVER FLOODPLAIN

Area of very low relief along the Colorado River. Poor drainage, with many sloughs seasonally filled with water. Formerly all inundated annually by river floods, but the channel is now largely controlled by dikes, and flooding is prevented by them and by the control imposed on the river regimen by the dams upstream. Sandy to clayey materials.

SITE DESCRIPTIONS

SITE 7 West bank of the river at the Big Bend

Vegetation: Very dense thickets of mesquite and arrowweed, with some tamarisk, amid scattered openings of bare ground.

<u>Prosopis pubescens</u>	6 m high
<u>Prosopis juliflora</u>	3 m high
<u>Pluchea sericea</u>	2 m high
<u>Tamarix gallica</u>	2 m high

SITE 34 East bank, two miles south of southern end of Big Bend

Lower floodplain now controlled by dike

Vegetation. Some bare channel patches. Elsewhere, patches of mesquite-arrowweed; mesquite-tamarisk; and arrowweed only. Total cover in each patch, but open ground between patches.

<u>Tamarix gallica</u>	3 m
<u>Prosopis juliflora</u>	6 m
<u>Pluchea sericea</u>	2 m

Upper floodplain level - same patchy growth

<u>Prosopis pubescens</u>	6 m	both with Phoradendron
<u>Prosopis juliflora</u>	6 m	
<u>Pluchea sericea</u>	2 m	
<u>Tamarix gallica</u>	5 m	

SURFACE FEATURES

TYPE 7 - LOW, RECENT RIVER TERRACES

Areas only slightly above river level, composed of silt, sand and clay deposited by the river, and overlain on the inner edge by alluvial material from the bajadas above or from the streams incising into those bajadas.

Sites of towns, subdivisions, and mobile home parks.

TYPE 8 - HIGHER OLDER RIVER TERRACES

One large flat-topped remnant is the site of the Mohave Generating Station. Elsewhere, remnants consist largely of small patches of rounded and varnished pebbles protruding from the bajadas. Probably includes some areas designated as Quaternary Lake Deposits on the California geological map.

TYPE 9 - DISSECTED TERRACES

Borders of the higher terraces (Type 8) fretted into badlands of high relief and steep slope

SURFACE FEATURES

TYPE 10 - PEDIMENTS

Areas of low relief and low slope angle, with bedrock at or near the surface. Often indistinguishable at first glance from alluvial fans and upper bajadas. Commonly have scattered low residual bedrock hills (inselberge) rising above the general level. Developed chiefly on granite and similar coarsely granular igneous rocks.

SITE DESCRIPTIONS

SITE 3 Government Road Pass between the Newberry and Dead Mountains in the vicinity of the Nevada-California boundary. Elevation 2400-2600 feet.

- A. Pediment of very low relief, with scattered bedrock outcrops. Elsewhere, grus 10 cm to 1 m deep. Granite underlying entire area.

Vegetation. Cover 15%

<u>Eriogonum polifolium</u>	1 m
<u>Acacia greggii</u>	1 m
<u>Viguiera deltoidea</u>	1 m
<u>Ephedra sp.</u>	0.5 m
<u>Opuntia ramosissima</u>	1 m
<u>Opuntia acanthocarpa</u>	1 m
<u>Yucca schidigera</u>	2 m
<u>Gutierrezia lucida</u>	0.5 m
<u>Cereus engelmannii</u>	
<u>Mirabilis laevis</u>	0.5 m
<u>Thamnosma montana</u>	0.5 m
<u>Krameria parvifolia</u>	0.4 m
<u>Larrea divaricata</u>	1 m
<u>Franseria dumosa</u>	0.5 m
<u>Echinocactus acanthodes</u>	

- B. Adret (south-facing) slope. All slope angles. Grus disintegrating, collecting in pockets.

Vegetation cover 20%. Composition as above

- C. Rugged, vertical walled granite outcrops. Vegetation sparse, in pockets only. Chiefly bare rock

SITE #3 (continued)

D. North-facing (ubac) slope. More soil, in contrast to areas B and C, generally spread over hillside, with rocks protruding from it. Some decomposition of the grus, particularly the micas and the feldspars. Vegetation cover 30%

Larrea divaricata
Yucca schidigera
Aster tortifolius
Eriogonum pedifolium
Opuntia ramosissima
Cereus engelmannii
Franseria dumosa
Ephedra sp.
Lycium sp
Krameria parvifolium
Acacia greggii with Phoradendron

SITE 45. East of Christmas Tree Pass, at eastern foot of Spirit Mountain. Elevation 2750 - 3400 feet.

Geomorphology. An intermontane basin consisting of an eastward sloping area of granite pediment with occasional protruding knobs of granite bedrock. Largely covered with a thin to locally thick cover of grus. Slope 5% to 12%.

Vegetation. Relatively dense (40%) cover of low brush, thinner in some patches, 1-2 m high. Dominant species are:

Acacia greggii
Tetradymia spinosa
Viguiera deltoidea
Cereus engelmannii
Echinocactus acanthodes

Also present are:

Larrea divaricata
Yucca schidigera
Juniperus sp.
Ephedra sp.
Hymenoclea salsola
Opuntia acanthocarpa

At the foot of rocks, knobs and steep rocky slopes, copses of Quercus dumosa var. turbinella occur.

SITE DESCRIPTIONS

TYPE 10 - PEDIMENTS (continued)

SITE 51 - On Nevada State Route 77, six miles east of intersection with U.S. 95. Elevation 2750

Geomorphology. An east-sloping pediment developed on granitic bedrock. Slope - 3% to 5%. Scattered outcrops and knobs of granitic bedrock. Elsewhere, extremely variable depths of grus overlying the bedrock.

Vegetation. 20% cover of shrubs:

<u>Franseria dumosa</u>	1 m.	dominant
<u>Larrea divaricata</u>	2 m	dominant
<u>Opuntia acanthocarpa</u>	1 m	occasional
<u>Yucca schidigera</u>	3 m	occasional
<u>Opuntia ramosissima</u>	1 m	occasional

SITE 52 - On Nevada State Route 77, 5.3 miles east of intersection with U.S. 95, and just east of summit of pediment pass between Homer Valley and Colorado River drainage via Hiko Springs creek.

Geomorphology similar to Site 51

Vegetation. 15% to 20% cover.

<u>Franseria dumosa</u>	0.8 m	dominant
<u>Larrea divaricata</u>	1 m	
<u>Cassia armata</u>	1 m	
<u>Opuntia acanthocarpa</u>	1.5 m	
<u>Cercus engelmannii</u>		
<u>Yucca schidigera</u>	4 m	
<u>Eriogonum polifolium</u>		
<u>Ephedra sp.</u>		
<u>Opuntia ramosissima</u>		
<u>Viguiera deltoidea</u>		
<u>Juniperus sp.</u>		rare

On granite knobs protruding above the pediment level:

<u>Juniperus sp.</u>
<u>Yucca schidigera</u>
<u>Nolina parryi</u>
<u>Acacia greggii</u>
<u>Larrea divaricata</u>
<u>Opuntia acanthocarpa</u>

SURFACE FEATURES

TYPE 11 - DISSECTED PEDIMENTS

Pediments which have been dissected by fluvial erosion. Accordant slope-lines of surface remnants still persist above steep-sided rock-walled channels.

TYPE 12 - ROLLING UPLAND AREAS

Areas of low slopes at higher altitudes (ca. 3500 feet). Usually covered with a moderate depth of soil, either residual or transported, often lithosolic. Most commonly developed on basic igneous rocks.

TYPE 13 - MODERATELY SLOPING UPLAND AREAS

Similar to Type 12, but with greater slope angles.

SURFACE FEATURES

TYPE 14 - GRANITE HILLS

Areas of moderate relief, developed upon granitic, andesitic and other non-basic crystalline rocks. Commonly have moderate depth of soil in the valleys and on the lower slopes, and much exposed bedrock on the hills and ridges.

SITE DESCRIPTIONS

SITE 46. Area east of Christmas Tree Pass, at south end of Spirit Mountain, between Grapevine Canyon and Sacatone Wash. Elevation 3400 to 4000 feet.

Geomorphology Rolling hills on granitic rocks. Slopes to 20°. Largely soil covered.

Vegetation Open brushy woodland. Conspicuous species include:

Juniperus sp.

Pinus monophylla

Nolina parryi

Quercus dumosa var. turbinella

Echinocactus acanthodes

Franseria dumosa

Salvia carnosae

SURFACE FEATURES

TYPE 15 - GRANITE MOUNTAINS

Similar to Type 14, but with higher relief and higher slope angles.

SITE 31 N.E. spur of Hardy Mountain, 3.4 miles NE of Oatman, Arizona. Elevation 2400 - 2600 feet.

Geomorphology. Relatively steep slopes (40°), thin lithosols, some bare rock.

Vegetation. 20% cover, on south-facing (adret) slopes. Conspicuous species:

Larrea divaricata
Eriogonum polifolium
Opuntia acanthocarpa
Cereus engelmannii
Echinocactus acanthodes

On north-facing (ubac) slopes:

Eriogonum polifolium - dominant
Nolina parryi
Yuoca schidigera
Opuntia acanthocarpa
Cereus engelmannii

Total absence of Larrea divaricata

Opuntia bigelovii conspicuous in patches

SURFACE FEATURES

TYPE 16 - GRANITE KNOBS, CRAGS AND PEAKS

Areas of extremely bold relief, with spires, needles, cliffs and walls of granite standing spectacularly at angles up to and even past vertical. Little talus or scree. Accumulations of grus in pockets and on gentle slopes.

SURFACE FEATURES

TYPE 17 - MOUNTAINS DEVELOPED ON TERTIARY INTRUSIVES

Very rugged, intensively dissected mountains, with steep slopes and narrow ridges. Much bare rock. Lithosols on slopes. Areas of low slope angles almost lacking, hence few areas have deep soils.

SITE DESCRIPTIONS

SITE 38 - Newberry Mountains bordering the western shore of Lake Mojave, as seen from opposite bank at powerline crossing some six miles north of Davis Dam.

Intensely dissected bedrock, almost totally lacking in soil. Barren aspect. East-facing slope.

Vegetation cover 5%: Larrea divaricata
Franseria dumosa
Echinocactus acanthodes

SITE 42 - On road north through Newberry Mountains, just north of junction with Nevada State Route 77, 5 miles airline west of Davis Dam. Elevation 2000.

A. Wash composed largely of grus. Vegetation cover 20%

<u>Franseria dumosa</u>	1 m
<u>Krameria parvifolia</u>	1 m
<u>Larrea divaricata</u>	2 m
<u>Opuntia ramosissima</u>	1 m
<u>Hymenoclea salsola</u>	1 m
<u>Eriogonum polifolium</u>	1 m
<u>Opuntia acanthocarpa</u>	2 m

B. South facing (adret) slope. Grus amid bare rock. Vegetation cover 15%

<u>Encelia farinosa</u>	dominant
<u>Franseria dumosa</u>	sub-dominant
<u>Opuntia bigelovii</u>	sub-dominant
<u>Eriogonum polifolium</u>	sub-dominant
<u>Echinocactus acanthodes</u>	occasional
<u>Larrea divaricata</u>	occasional, dwarfed
<u>Cereus engelmannii</u>	occasional
<u>Yucca schidigera</u>	scattered

SITE DESCRIPTIONS

TYPE 17 - MOUNTAINS DEVELOPED ON TERTIARY INTRUSIVES (continued)

SITE 38 (continued)

- C. Lower slope of west-facing hill. Slope-wash material from hill above - very stony soil, largely composed of grus. Vegetation cover 35%.

<u>Eriogonum polifolium</u>	dominant
<u>Franseria dumosa</u>	dominant
<u>Yucca schidigera</u>	occasional
<u>Larrea divaricata</u>	occasional
<u>Opuntia acanthocarpa</u>	occasional
<u>Opuntia bigelovii</u>	occasional
<u>Echinocactus acanthodes</u>	occasional
<u>Acacia greggii</u>	occasional
<u>Krameria parvifolia</u>	occasional
<u>Viguiera deltoidea</u>	occasional

- D. North-facing (ubac) slope, with grus amid bedrock. Vegetation cover 15%

<u>Franseria dumosa</u>	dominant
<u>Eriogonum polifolium</u>	frequent
<u>Encelia farinosa</u>	occasional
<u>Opuntia sp.</u>	scattered
<u>Opuntia acanthocarpa</u>	scattered

SURFACE FEATURES

TYPE 18 - MOUNTAINS DEVELOPED ON METAMORPHIC ROCKS

Mountains developed on gneiss, various quartzose formations, some schistose rocks and some pre-Cambrian granites. Often a linear appearance is displayed, due to regional banding of beds and occurrences of parallel dikes, and the differential erosion resulting therefrom.

Mineralized zones are fairly common

Moderately steep slopes, with considerable bare rock, but a tendency towards rounded crests and gentler lower slopes, hence some development of thin to moderately deep soils in the summit areas and on the lower slopes.

SURFACE FEATURES

TYPE 19 - HILLS DEVELOPED ON METAMORPHIC ROCKS

Generally the same as Type 18, but of lower relief and lower slope angles, and consequently, less exposure of bedrock and somewhat greater development of soil.

SITE DESCRIPTIONS

SITE 13 - South side of Arizona State Route 68, 7 airline miles east of Davis Dam. Elevation 2340 - 2400 feet.

Geomorphology A coarse-grained, almost quartz-free, igneous intrusive rock with large Carlsbad-twin feldspar crystals. Strongly jointed. Very broken country of low but fairly steep hills - slopes 30° to 80° . Largely covered with lithosols.

Vegetation:

A. Ubac (north-facing) slopes, vegetation cover 50%

Viguiera deltoidea

Ephedra spp.

Franseria dumosa

One lone Fouqueria
splendens

Sphaeralcea ambigua

Acacia greggii

Encelia farinosa absent

Echinocactus acanthodes

B. Hilltop - vegetation cover 30%

Franseria dumosa

dominant

Encelia farinosa

Ephedra spp.

Larrea divaricata

Cereus engelmannii

Opuntia acanthocarpa

Aster tortifolius

C. Adret (south-facing slope) - vegetation cover 40%

Encelia farinosa

dominant

Larrea divaricata

scattered

Franseria dumosa

scattered

SURFACE FEATURES

TYPE 20 - LINEAR HILLS

Developed on granitoid and metamorphic rocks with occasional dikes parallel to the general trend of the banding and the schistosity. Long, narrow, steep-sided ridges, often with bedrock outcrops on the sides and tops, alternating with valleys or plains of gentle slope, commonly covered with a moderate to considerable depth of grus or soil.

SITE DESCRIPTIONS

SITE 43 On north-south road through Newberry Mountains, 0.6 miles north of junction with Nevada State Route 77, five miles airline west of Davis Dam. Elevation 2200 feet.

Grus amid and partly covering granitic bedrock.

Opuntia acanthocarpa
Yucca schidigera
Opuntia ramosissima
Eriogonum polifolium
Larrea divaricata
Acacia greggii

SITE 50 At crossing of power line road and Nevada State Route 77, 0.7 miles north of Hiko Springs and 0.6 miles south of crossing of Bridge Canyon. Elevation 2200 to 2280 feet.

Granitic country with prominent north-south dikes.

Vegetation:

General - 20% cover

Ubac slope - 30%

<u>Encelia farinosa</u>	dominant
<u>Franseria dumosa</u>	dominant
<u>Eriogonum polifol.</u>	dominant
<u>Larrea divaricata</u>	occasional
<u>Yucca schidigera</u>	occasional
<u>Opuntia bigelovii</u>	occasional
<u>Acacia greggii</u>	scattered
<u>Echinocactus acan.</u>	scattered

<u>Ephedra sp.</u>	dom.
<u>Eriogonum poli.</u>	dom
<u>Franseria dum.</u>	dom.
<u>Viguiera delt.</u>	occ.

SURFACE FEATURES

TYPE 21 - BEDROCK BADLANDS

Areas characterized by very steep slopes and very narrow ridge crests, created by intensive erosion by a fine network of steep gradient streams. Virtually soilless.

SITE DESCRIPTION

SITE 8 On NW side of Colorado River at the Big Bend south of Bullhead City. West of the River Road. Elevation 520 to 1100 feet.

Geomorphology. Badlands cut in a granitoid rock. Local relief of several hundred feet, slopes from 40° to past vertical. Essentially soil-less.

Vegetation:

- A. Adret slopes, scattered vegetation, clinging to rocks, with roots in cracks and joints of the bedrock.

Larrea divaricata

Acacia greggii

Encelia farinosa

Echinocactus acanthodes

Opuntia acanthocarpa

Opuntia bigelovii

- B. Bottom of a major wash, composed of coarse gravel.

Tamarix gallica

Encelia farinosa

Acacia greggii

Prosopis juliflora

SURFACE FEATURES

TYPE 22 - HILLS DEVELOPED ON CRETACEOUS VOLCANICS

An area of low relief and low slope angles, developed on andesitic and other flows and tuffs. Highly mineralized, with much prospecting and mining. Considerable soil development everywhere.

SITE 24 On Old Route 66 one mile northwest of Oatman. Fairly steep (40% slope) hillsides, with much bedrock and a thin accumulation of disintegrated material. Elevation 2800.

Vegetation:

Ubac slope, with 40% cover

Eriogonum-Fouquieria association

<u>Eriogonum polifolium</u>	dominant
<u>Fouquieria splendens</u>	dominant and conspicuous
<u>Opuntia acanthocarpa</u>	occasional
<u>Ephedra sp.</u>	occasional

Adret slope, with 35% cover

Eriogonum-Ephedra association

<u>Eriogonum polifolium</u>	dominant
<u>Ephedra sp.</u>	dominant
<u>Yucca schidigera</u>	common
<u>Opuntia acanthocarpa</u>	common
<u>Larrea divaricata</u>	occasional
<u>Cereus engelmannii</u>	occasional
<u>Franseria dumosa</u>	rare
<u>Opuntia basilaris</u>	rare
<u>Acacia greggii</u>	rare

SITE DESCRIPTIONS

TYPE 22 - HILLS DEVELOPED ON CRETACEOUS VOLCANICS (continued)

SITE 29 On Silver Creek Wash road, one mile NNW of intersection with Old Route 66, and two miles NNW of Oatman. Elevation 2500 feet.

Geomorphology. Rolling hills with fairly low slopes, averaging about 20%, although somewhat steeper in vicinity of larger washes. Broken rock fragments in a matrix of fine, dark soil.

Vegetation: low brush with an average cover of 30%.

Unknown very fine leafed composite	dominant in patches
<u>Eriogonum polifolium</u>	dominant
<u>Ephedra</u> sp.	occasional
<u>Yucca schidigera</u>	occasional, conspicuous
<u>Acacia greggii</u>	occasional, dwarfed
<u>Larrea divaricata</u>	occasional

SITE 30 In Silver Creek Wash north of Negrohead, one mile NW of Site 29. Elevation 2400

Vegetation

<u>Chilopsis linearis</u>	in groves
<u>Acacia greggii</u>	scattered
<u>Lepidospartum squamatum</u> (?)	scattered
<u>Opuntia acanthocarpa</u>	
<u>Larrea divaricata</u>	
<u>Hymenoclea salsola</u>	
<u>Cercidium floridum</u>	rare

SURFACE FEATURES

TYPE 23 - HIGH RUGGED MOUNTAINS DEVELOPED ON VOLCANIC ROCKS

Crags, mountains, mesas and buttes developed on a wide range of materials: tuffs, agglomerates, lavas, dikes, plugs and other types of volcanics, ranging from basalts to rhyolites, and of varying ages from Cretaceous to Quaternary.

Very rugged country with vertical cliffs, steep talus slopes, ragged spires, razorback ridges, solitary buttes, and areas approaching badlands.

Where caprock layers have been completely removed, softer underlying beds have been eroded into lower, rounded hills, often in immediate juxtaposition and marked contrast to the rugged areas.

Soil is mainly lacking except in the last-mentioned situation.

SITE DESCRIPTION

SITE 16 South of Arizona State Route 68 in Union Pass in the Black Mountains. Elevation 3600 to 3900.

Geomorphology Tuffaceous beds eroded into steep hillsides (45° plus) underneath high and nearly vertical cliffs. North and west-facing slopes.

Vegetation A wide range of types in a scattered and irregular pattern.

Larrea divaricata

Encelia farinosa

Juniperus sp.

Yucca schidigera

Rhus sp.

Fouquieria splendens

Ephedra viridis

Acacia greggii with Phoradendron

Quercus sp.

Haplopappus sp.

Echinocactus acanthodes

Purshia (?)

Nolina parryi

Sphaeralcea ambigua

Opuntia chloritica (?)

SITE DESCRIPTIONS

TYPE 23 - HIGH RUGGED MOUNTAINS DEVELOPED ON VOLCANIC ROCKS (cont'd)

SITE 19 A solitary mesa $\frac{1}{2}$ mile WSW of a Radio Facility at the end of the graded road into the Black Mountains from the northern end of Estrella Road, 13 miles west of Santa Claus, Arizona; $\frac{3}{4}$ miles east of Burns Spring; $\frac{1}{2}$ mile southeast of Burns Well. Elevation 4000 to 4300.

Geomorphology. The mesa is capped by a thick layer of vesicular basalt. A scree slope, semi-fixed, surrounds the mesa on all sides. The summit has a slope of 15° to the SSW.

Vegetation

A. The lower adret slope. A veneer of pebbles and blocks over loamy soil. Vegetation cover 40%

<u>Coleogyne ramosissima</u>	1 m	dominant
<u>Yucca schidigera</u>	3 m	conspicuous, scattered
<u>Ephedra</u> spp.	1 m	occasional
<u>Yucca baccata</u>	1 m	scattered
<u>Opuntia chloritica</u> (?)	1 m	scattered
<u>Sphaeralcea ambigua</u>	1 m	scattered
<u>Juniperus</u> sp.		scattered
<u>Opuntia</u> sp. (gray spines, thin segments)	0.7 m	conspicuous, occasional
<u>Echinocactus acanthodes</u>		rare

B. Upper part adret slope. Angular blocks of black basalt, forming a still partly unstable scree. Vegetation cover 30%

<u>Juniperus</u> sp.	1 m	dominant
<u>Coleogyne ramosissima</u>	0.7 m	dominant
<u>Eriogonum polifolium</u>	0.7 m	common
<u>Yucca schidigera</u>	2 m	common
<u>Ephedra</u> spp.	0.7 m	common
<u>Opuntia</u> sp.	0.7 m	occasional
<u>Viguiera deltoidea</u>	0.5 m	scattered
<u>Echinocactus acanthodes</u>		scattered
<u>Yucca baccata</u>	1.0 m	scattered
<u>Opuntia chloritica</u> (?)	1.5 m	scattered

SITE DESCRIPTIONS

TYPE 23 - HIGH RUGGED MOUNTAINS DEVELOPED ON VOLCANIC ROCKS (cont'd)

SITE 19 (continued)

- C. Summit. Gentle slope on basalt fragments of all sizes up to 1 m or more, with soil in pockets between.
Vegetation cover 40%

<u>Coleogyne ramosissima</u>	dominant
<u>Yuca schidigera</u>	common
<u>Juniperus</u> sp.	common
<u>Larrea divaricata</u>	occasional
<u>Lycium</u> sp.	occasional
<u>Opuntia</u> sp.	occasional
<u>Ephedra</u> sp.	occasional

- D. Ubao slope nearby, composed of ash, tuff and pumice, with a vegetation cover of 55%

<u>Coleogyne ramosissima</u>	dominant
<u>Juniperus</u> sp.	dominant
<u>Yuca baccata</u>	common
<u>Salazaria mexicana</u>	rare
<u>Eriogonum polifolium</u>	dominant in small patches
<u>Opuntia acanthocarpa</u>	common

SITE 23 Summit of Sitgreaves Pass, northeast of Oatman, elevation 3560 feet. On old Route 66.

Northwest side of ridge on south side of road. Ubao slope with fairly deep soil containing large stones.
Vegetation cover 60%

<u>Coleogyne ramosissima</u>	dominant
<u>Ephedra</u> spp.	common
<u>Opuntia acanthocarpa</u>	common
<u>Larrea divaricata</u>	occasional
<u>Yuca schidigera</u>	occasional
<u>Juniperus</u> sp.	occasional
<u>Salvia carnosa</u>	rare
<u>Gutierrezia sarothrae</u>	rare

Adret slope, same area. Vegetation cover 30%

<u>Opuntia acanthocarpa</u>	rare
<u>Yuca schidigera</u>	dominant
<u>Larrea divaricata</u>	dominant
<u>Coleogyne ramosissima</u>	occasional

SITE DESCRIPTIONS

TYPE 23 - HIGH RUGGED MOUNTAINS DEVELOPED ON VOLCANIC ROCKS (cont'd)

SITE 25 Southwest (adret) slope of the Boundary Cone on Old Route 66 southwest of Oatman. Elevation 1900 - 2200 feet.

Fixed talus with small fragments and loam beneath, and with boulders up to 2 m diameter.

Vegetation - 40% cover. All species less than 0.4 m high except *Larrea* (1.2 m). No real dominant. No cacti.

Larrea divaricata

Franseria dumosa

Encelia farinosa

Krameria parvifolia

Eriogonum polifolia

Ephedra sp.

On rock ledges above, scattered *Opuntia bigelovii*, 1.4 m high.

SURFACE FEATURES

TYPE 24 ROLLING HILLS DEVELOPED ON VOLCANIC ROCKS

Similar materials to those in Type 23, but strongly resistant materials are lacking. Hence a more subdued landscape, with rolling, soil-covered hills and low to moderate slopes.

SITE DESCRIPTION

SITE 11 Hills north of Arizona State Route 68, 4.5 miles east of the Colorado River. Elevation 1600 to 1700

Hills of rhyolitic bedrock, including tuffaceous and cataclastic forms. Covered with lithosols in patches and with well-exposed bedrock elsewhere.

A. Hilltop. Lithosol and bedrock. Soil composed of angular fragments, with pockets of clay beneath.

Vegetation cover 30%.

<u>Larrea divaricata</u>	1 m
<u>Franseria dumosa</u>	0.5 m
<u>Opuntia acanthocarpa</u>	1 m
<u>Encelia farinosa</u>	0.5 m
<u>Echinocactus acanthodes</u>	
<u>Cereus engelmannii</u>	
<u>Ephedra sp.</u>	
<u>Opuntia basilaris</u>	

B. Ubac slope, 30°. Shallow soil with much caliche
Vegetation cover 50%

<u>Larrea divaricata</u>	1 m	
<u>Franseria dumosa</u>	0.3 m	dominant
<u>Krameria parvifolia</u>		
<u>Ephedra sp.</u>		rare
<u>Opuntia basilaris</u>		rare
<u>Acacia greggii</u>		
<u>Eriogonum polifolium</u>		

C. Adret slope, 20°. Disintegrated shattered tuff, almost
no soil. Vegetative cover 20%

<u>Encelia farinosa</u>	dominant
<u>Ephedra sp.</u>	occasional
<u>Larrea divaricata</u>	occasional
<u>Cereus engelmannii</u>	rare

SURFACE FEATURES

TYPE 25 - LOW MOUNTAINS DEVELOPED ON CRETACEOUS VOLCANICS

Same bedrock as that of Type 22.

Fairly high relief, but generally rounded crests
and moderate slope angles. Thin residual soils,
including much lithosols.

APPENDIX B

Bernardo G. Maza

This Appendix (Table 13-22) gives complete lists of plant species recorded at each of Sites 1-10, together with associated estimates of densities, coverages, frequencies and importance values. The reader is reminded that importance value indexes sum to 300 for each site. Species are referred to by the first three letters of the generic names and specific epithets (see Table 4).

TABLE 13. ESTIMATES OF DENSITY, FREQUENCY AND COVERAGE OF PERENNIAL PLANTS RECORDED IN TEN 50 X 2 METER QUADRATS AT STATION 1. IMPORTANCE VALUE INDEXES HAVE BEEN COMPUTED AS THE SUMS OF RELATIVE DENSITIES, FREQUENCIES AND COVERAGE FOR EACH SPECIES.

SPECIES CODE	NUMBER COUNTED	DENSITY	AVERAGE COVERAGE	COVERAGE PERCENT	FREQUENCY PERCENT	RELATIVE	RELATIVE	RELATIVE	IMPORTANCE VALUE INDEX
		N PER SQ M	SINGLE PLANT SQ M			DENSITY PERCENT	COVER PERCENT	FREQUENCY PERCENT	
COL RAM	453.	.3433	.34	11.62	100.	21.51	33.63	4.85	59.99
COL CAN	345.	.3069	.05	1.63	90.	19.23	4.73	4.37	28.32
JUN OST	33.	.0167	3.08	5.14	100.	1.05	14.87	4.85	20.77
ERI FAS	175.	.1509	.11	1.61	100.	9.45	4.65	4.85	18.95
VIG DEL	118.	.1001	.12	1.17	90.	6.27	3.39	4.37	14.03
LYC AND	62.	.0446	.48	2.12	90.	2.79	6.15	4.37	13.31
GUT MIC	101.	.0865	.09	.80	100.	5.42	2.31	4.85	12.59
EPH SP.	55.	.0414	.41	1.68	100.	2.59	4.87	4.85	12.32
ARI SP.	112.	.1079	.01	.06	100.	6.76	.16	4.85	11.78
CHR TER	67.	.0564	.13	.74	70.	3.53	2.13	3.40	9.06
SPH SP.	55.	.0519	.02	.08	100.	3.25	.23	4.85	8.34
MAC TOR	89.	.0825	.03	.24	50.	5.17	.69	2.43	8.28
YUC SCH	20.	.0140	.64	.89	70.	.88	2.58	3.40	6.85
BRI ATR	25.	.0217	.08	.18	70.	1.36	.51	3.40	5.27
LAR TRI	5.	.0022	4.74	1.06	40.	.14	3.07	1.94	5.16
NOL BIG	7.	.0039	1.98	.77	50.	.25	2.24	2.43	4.91
ENC VIR	14.	.0115	.17	.20	50.	.72	.58	2.43	3.73
CON LYC	7.	.0043	1.52	.65	30.	.27	1.89	1.46	3.62
UNK TWO	9.	.0079	.08	.06	60.	.50	.18	2.91	3.58
COW MEX	14.	.0111	.38	.42	30.	.70	1.21	1.46	3.37
SAL MEX	15.	.0126	.11	.14	40.	.79	.42	1.94	3.15
DYS POR	17.	.0153	.05	.08	40.	.96	.22	1.94	3.13
OXY SP.	12.	.0113	.01	.02	40.	.71	.05	1.94	2.70
HAP LIN	16.	.0130	.23	.29	20.	.81	.85	.97	2.63
RHU TRI	5.	.0031	1.01	.32	30.	.20	.92	1.46	2.57
BAC BRA	4.	.0040	1.52	.61	10.	.25	1.76	.49	2.50

TABLE 13. CONTINUED.

SPECIES CODE	NUMBER COUNTED	DENSITY N PER SQ M	AVERAGE COVERAGE		COVERAGE PERCENT	FREQUENCY PERCENT	RELATIVE DENSITY PERCENT	RELATIVE COVER PERCENT	RELATIVE FREQUENCY PERCENT	IMPORTANCE VALUE INDEX
			SINGLE PLANT SQ M							
ACA GRE	3.	.0014	3.14		.45	20.	.09	1.30	.97	2.36
STE PAU	5.	.0044		.05	.02	40.	.28	.07	1.94	2.29
QUE TUR	1.	.0002	23.89		.57	10.	.01	1.65	.49	2.15
KRA GRA	5.	.0037		.36	.13	30.	.23	.38	1.46	2.07
LIP WRI	4.	.0040		.59	.24	20.	.25	.68	.97	1.90
POR GRA	3.	.0030		.16	.05	30.	.19	.14	1.46	1.78
ARE MAC	20.	.0187		.02	.03	10.	1.17	.09	.49	1.75
SAL MOH	5.	.0036		.49	.18	20.	.23	.51	.97	1.71
UNK ONE	8.	.0069		.07	.05	20.	.44	.13	.97	1.54
GUT SAR	5.	.0040		.16	.07	20.	.25	.19	.97	1.41
ERI WRI	4.	.0040		.05	.02	20.	.25	.05	.97	1.28
STI SPE	3.	.0030		.01	.00	20.	.19	.01	.97	1.17
FER ACA	2.	.0020		.04	.01	20.	.13	.02	.97	1.12
ERI INF	2.	.0020		.01	.00	20.	.13	.00	.97	1.10
STA PIN	1.	.0010		.66	.07	10.	.06	.19	.49	.74
MUH POR	1.	.0010		.30	.03	10.	.06	.09	.49	.63
COL SP.	2.	.0020		.04	.01	10.	.13	.02	.49	.63
PRU SP.	1.	.0007		.33	.02	10.	.05	.07	.49	.60
CER LAN	1.	.0010		.16	.02	10.	.06	.05	.49	.59
LOT RIG	1.	.0010		.16	.02	10.	.06	.04	.49	.59
LYC SP.	1.	.0010		.08	.01	10.	.06	.02	.49	.57
SEN DOU	1.	.0010		.01	.00	10.	.06	.00	.49	.55
GAL STE	1.	.0010		.01	.00	10.	.06	.00	.49	.55

TABLE 14. ESTIMATES OF DENSITY, FREQUENCY AND COVERAGE OF PERENNIAL PLANTS RECORDED IN TEN 50 X 2 METER QUADRATS AT STATION 2. IMPORTANCE VALUE INDEXES HAVE BEEN COMPUTED AS THE SUMS OF RELATIVE DENSITIES, FREQUENCIES AND COVERAGE FOR EACH SPECIES.

SPECIES CODE	NUMBER COUNTED	DENSITY N PER SQ M	AVERAGE COVERAGE SINGLE PLANT SQ M	COVERAGE PERCENT	FREQUENCY PERCENT	RELATIVE DENSITY PERCENT	RELATIVE COVER PERCENT	RELATIVE FREQUENCY PERCENT	IMPORTANCE VALUE INDEX
LAR TRI	101.	.0627	1.23	7.73	100.	14.14	51.17	8.40	73.71
CAS COV	85.	.0757	.05	.38	100.	17.06	2.51	8.40	27.98
EPH SP.	42.	.0296	.60	1.78	100.	6.66	11.79	8.40	26.85
ACA SPH	73.	.0628	.11	.67	70.	14.15	4.45	5.88	24.49
KRA GRA	43.	.0313	.42	1.30	90.	7.06	8.62	7.56	23.25
YUC SCH	18.	.0121	.85	1.03	60.	2.73	6.81	5.04	14.59
OPU BIG	33.	.0277	.17	.46	40.	6.25	3.07	3.36	12.68
HYM SAL	29.	.0246	.13	.31	60.	5.55	2.08	5.04	12.67
OPU ACA	13.	.0104	.33	.34	90.	2.35	2.27	7.56	12.18
POR GRA	25.	.0228	.03	.08	60.	5.15	.50	5.04	10.69
ERI INF	15.	.0143	.01	.02	70.	3.22	.10	5.88	9.21
DYS POR	17.	.0157	.03	.05	60.	3.55	.31	5.04	8.90
ERI FAS	17.	.0146	.10	.15	40.	3.30	.96	3.36	7.62
AMB DUM	4.	.0040	.65	.26	20.	.90	1.71	1.68	4.29
ACA GRE	4.	.0028	.60	.17	30.	.63	1.11	2.52	4.27
ENC VIR	8.	.0063	.23	.15	20.	1.42	.97	1.68	4.07
BEB JUN	4.	.0040	.18	.07	20.	.90	.47	1.68	3.05
STE PAU	4.	.0040	.04	.02	20.	.90	.12	1.68	2.70
FER ACA	3.	.0030	.09	.03	20.	.68	.18	1.68	2.53
MIR BIG	3.	.0030	.02	.00	20.	.68	.03	1.68	2.39
ECH ENG	2.	.0020	.01	.00	20.	.45	.02	1.68	2.15
VIG DEL	3.	.0030	.05	.01	10.	.68	.10	.84	1.61
LYC AND	1.	.0010	.63	.06	10.	.23	.42	.84	1.48
GAL STE	1.	.0010	.15	.02	10.	.23	.10	.84	1.17
HIL RIG	1.	.0010	.08	.01	10.	.23	.05	.84	1.12
SEN DOU	1.	.0010	.07	.01	10.	.23	.05	.84	1.11
ENC FAR	1.	.0010	.04	.00	10.	.23	.03	.84	1.09
SAR HIR	1.	.0010	.02	.00	10.	.23	.01	.84	1.08
MAM MIC	1.	.0010	.01	.00	10.	.23	.01	.84	1.07

TABLE 15. ESTIMATES OF DENSITY, FREQUENCY AND COVERAGE OF PERENNIAL PLANTS RECORDED IN TEN 50 X 2 METER QUADRATS AT STATION 3. IMPORTANCE VALUE INDEXES HAVE BEEN COMPUTED AS THE SUMS OF RELATIVE DENSITIES, FREQUENCIES AND COVERAGE FOR EACH SPECIES.

SPECIES CODE	NUMBER COUNTED	DENSITY N PER SQ M	AVERAGE COVERAGE		FREQUENCY PERCENT	RELATIVE DENSITY PERCENT	RELATIVE COVER PERCENT	RELATIVE FREQUENCY PERCENT	IMPORTANCE VALUE INDEX
			SINGLE PLANT SQ M	COVERAGE PERCENT					
LAR TRI	103.	.0686	.79	5.42	100.	21.91	47.18	14.93	84.02
AMB DUM	88.	.0695	.23	1.62	90.	22.22	14.11	13.43	49.76
ENC FAR	76.	.0610	.23	1.38	70.	19.49	12.00	10.45	41.94
KRA GRA	52.	.0396	.32	1.26	100.	12.64	10.96	14.93	38.53
OPU ACA	10.	.0062	1.44	.89	60.	1.98	7.73	8.96	18.67
BEB JUN	11.	.0085	.29	.25	70.	2.71	2.16	10.45	15.31
ARI SP.	29.	.0284	.00	.00	20.	9.07	.04	2.99	12.09
OPU RAM	15.	.0116	.32	.37	30.	3.70	3.19	4.48	11.37
ERI INF	4.	.0040	.17	.07	20.	1.28	.59	2.99	4.85
ERI FAS	3.	.0030	.26	.08	20.	.96	.67	2.99	4.61
DIT NEO	5.	.0047	.01	.01	20.	1.51	.05	2.99	4.54
NEO JOH	3.	.0030	.01	.00	20.	.96	.03	2.99	3.97
POR GRA	2.	.0020	.07	.01	20.	.64	.12	2.99	3.75
LYC SP.	1.	.0010	.80	.08	10.	.32	.70	1.49	2.51
SAL MEX	1.	.0010	.34	.03	10.	.32	.29	1.49	2.11
KRA PAR	1.	.0010	.19	.02	10.	.32	.17	1.49	1.98

TABLE 16. ESTIMATES OF DENSITY, FREQUENCY AND COVERAGE OF PERENNIAL PLANTS RECORDED IN TEN 50 X 2 METER QUADRATS AT STATION 4. IMPORTANCE VALUE INDEXES HAVE BEEN COMPUTED AS THE SUMS OF RELATIVE DENSITIES, FREQUENCIES AND COVERAGE FOR EACH SPECIES.

SPECIES CODE	NUMBER COUNTED	DENSITY		AVERAGE COVERAGE		FREQUENCY PERCENT	RELATIVE DENSITY PERCENT	RELATIVE COVER PERCENT	RELATIVE FREQUENCY PERCENT	IMPORTANCE VALUE INDEX
		N PER SQ	M	SINGLE PLANT SQ	PERCENT M					
LAR TRI	57.	.0313		2.09		100.	20.77	55.98	22.22	98.98
AMB DUM	77.	.0554		.47		100.	36.71	22.07	22.22	81.01
ENC FAR	50.	.0370		.42		100.	24.54	13.31	22.22	60.07
OPU ACA	17.	.0128		.39		40.	8.49	4.31	8.89	21.69
OPU RAM	10.	.0078		.38		40.	5.15	2.54	8.89	16.58
KRA GRA	2.	.0020		.47		20.	1.33	.81	4.44	6.58
ERI INF	2.	.0020		.00		20.	1.33	.01	4.44	5.78
ACA GRE	1.	.0005		1.82		10.	.36	.85	2.22	3.43
BER JUN	1.	.0010		.09		10.	.66	.08	2.22	2.97
OPU ECH	1.	.0010		.04		10.	.66	.04	2.22	2.92

TABLE 17. ESTIMATES OF DENSITY, FREQUENCY AND COVERAGE OF PERENNIAL PLANTS RECORDED IN TEN 50 X 2 METER QUADRATS AT STATION 5. IMPORTANCE VALUE INDEXES HAVE BEEN COMPUTED AS THE SUMS OF RELATIVE DENSITIES, FREQUENCIES AND COVERAGE FOR EACH SPECIES.

SPECIES CODE	NUMBER COUNTED	DENSITY N PER SQ M	AVERAGE COVERAGE		FREQUENCY PERCENT	RELATIVE DENSITY PERCENT	RELATIVE COVER PERCENT	RELATIVE FREQUENCY PERCENT	IMPORTANCE VALUE INDEX
			SINGLE PLANT SQ M	COVERAGE PERCENT					
LAR TRI	90.	.0534	1.44	7.71	100.	28.49	60.43	21.74	110.66
AMB DUM	129.	.0960	.37	3.51	100.	51.19	27.51	21.74	100.44
KRA GRA	13.	.0094	.41	.39	50.	5.02	3.06	10.87	18.95
OPU RAM	8.	.0056	.62	.35	50.	2.97	2.71	10.87	16.55
BER JUN	13.	.0099	.33	.33	40.	5.27	2.56	8.70	16.53
OPU ECH	3.	.0030	.06	.02	30.	1.60	.14	6.52	8.26
ENC VIR	5.	.0036	.48	.18	20.	1.94	1.37	4.35	7.66
OPU BAS	2.	.0020	.30	.06	20.	1.07	.47	4.35	5.89
ERI INF	2.	.0020	.03	.01	20.	1.07	.04	4.35	5.46
HYM SAL	1.	.0010	1.40	.14	10.	.53	1.10	2.17	3.80
DAL FRE	1.	.0006	1.29	.08	10.	.32	.60	2.17	3.09
OPU ACA	1.	.0010	.02	.00	10.	.53	.01	2.17	2.72

TABLE 18. ESTIMATES OF DENSITY, FREQUENCY AND COVERAGE OF PERENNIAL PLANTS RECORDED IN TEN 50 X 2 METER QUADRATS AT STATION 6. IMPORTANCE VALUE INDEXES HAVE BEEN COMPUTED AS THE SUMS OF RELATIVE DENSITIES, FREQUENCIES AND COVERAGE FOR EACH SPECIES.

SPECIES CODE	NUMBER COUNTED	DENSITY	AVERAGE COVERAGE	COVERAGE PERCENT	FREQUENCY PERCENT	RELATIVE DENSITY PERCENT	RELATIVE COVER PERCENT	RELATIVE FREQUENCY PERCENT	IMPORTANCE VALUE INDEX
		N PER SQ M	SINGLE PLANT SQ M						
AMB DUM	111.	.0830	.38	3.11	50.	43.58	24.42	8.62	76.62
LAR TRI	48.	.0288	1.47	4.23	80.	15.13	33.14	13.79	62.07
DAL FRE	20.	.0117	1.53	1.79	90.	6.15	14.02	15.52	35.69
ACA GRE	17.	.0109	1.19	1.30	70.	5.74	10.17	12.07	27.98
HYM SAL	27.	.0199	.41	.82	40.	10.44	6.41	6.90	23.74
BER JUN	15.	.0110	.41	.45	50.	5.80	3.51	8.62	17.93
OPU RAM	7.	.0043	1.36	.58	50.	2.26	4.58	8.62	15.46
OPU ACA	6.	.0050	.27	.14	40.	2.63	1.07	6.90	10.60
OPU BAS	4.	.0040	.16	.07	40.	2.10	.51	6.90	9.51
SAR HIR	7.	.0058	.18	.10	30.	3.02	.80	5.17	9.00
OPU ECH	4.	.0040	.22	.09	30.	2.10	.69	5.17	7.97
KRA GRA	2.	.0020	.42	.08	10.	1.05	.66	1.72	3.44

TABLE 19. ESTIMATES OF DENSITY, FREQUENCY AND COVERAGE OF PERENNIAL PLANTS RECORDED IN TEN 50 X 2 METER QUADRATS AT STATION 7. IMPORTANCE VALUE INDEXES HAVE BEEN COMPUTED AS THE SUMS OF RELATIVE DENSITIES, FREQUENCIES AND COVERAGE FOR EACH SPECIES.

SPECIES CODE	NUMBER COUNTED	DENSITY		AVERAGE COVERAGE		FREQUENCY PERCENT	RELATIVE DENSITY PERCENT	RELATIVE COVER PERCENT	RELATIVE FREQUENCY PERCENT	IMPORTANCE VALUE INDEX
		N PER SQ M	SINGLE PLANT SQ M	COVERAGE PERCENT						
LAR TRI	142.	.0804	1.82	14.63	100.	19.94	64.48	13.89	98.32	
AMB DUM	295.	.2351	.21	5.03	100.	58.30	22.18	13.89	94.37	
HYM SAL	13.	.0103	.37	.38	50.	2.56	1.66	6.94	11.17	
ACA SPH	9.	.0076	.10	.08	60.	1.89	.35	8.33	10.58	
OPU ACA	7.	.0048	.78	.38	40.	1.20	1.66	5.56	8.42	
YUC SCH	8.	.0061	.39	.24	40.	1.51	1.05	5.56	8.11	
ERI FAS	13.	.0104	.23	.24	30.	2.58	1.07	4.17	7.82	
VIG DEL	7.	.0052	.34	.18	40.	1.30	.78	5.56	7.64	
THA MON	6.	.0044	.42	.18	40.	1.10	.81	5.56	7.47	
KRA GRA	4.	.0040	.43	.17	40.	.99	.76	5.56	7.31	
ENC FAR	12.	.0095	.23	.21	20.	2.36	.94	2.78	6.08	
SAL MEX	7.	.0054	.21	.11	30.	1.34	.50	4.17	6.01	
SPH SP.	6.	.0050	.22	.11	30.	1.24	.49	4.17	5.90	
ACA GRE	3.	.0015	2.81	.42	20.	.37	1.86	2.78	5.01	
ASC SUB	5.	.0038	.33	.12	10.	.93	.54	1.39	2.86	
CON LYC	3.	.0026	.09	.02	10.	.64	.10	1.39	2.13	
EPH SP.	1.	.0010	.76	.08	10.	.25	.34	1.39	1.97	
ECH ENG	2.	.0020	.06	.01	10.	.50	.05	1.39	1.93	
LYC AND	1.	.0010	.39	.04	10.	.25	.17	1.39	1.81	
MIR BIG	1.	.0010	.16	.02	10.	.25	.07	1.39	1.71	
STE PAU	1.	.0010	.16	.02	10.	.25	.07	1.39	1.71	
FER ACA	1.	.0010	.10	.01	10.	.25	.05	1.39	1.68	

TABLE 20 . ESTIMATES OF DENSITY, FREQUENCY AND COVERAGE OF PERENNIAL PLANTS RECORDED IN TEN 50 X 2 METER QUADRATS AT STATION 8. IMPORTANCE VALUE INDEXES HAVE BEEN COMPUTED AS THE SUMS OF RELATIVE DENSITIES, FREQUENCIES AND COVERAGE FOR EACH SPECIES.

SPECIES CODE	NUMBER COUNTED	DENSITY	AVERAGE COVERAGE		FREQUENCY PERCENT	RELATIVE DENSITY PERCENT	RELATIVE COVER PERCENT	RELATIVE FREQUENCY PERCENT	IMPORTANCE VALUE INDEX
		N	SINGLE	COVERAGE					
		PER SQ M	PLANT SQ M	PERCENT					
LAR TRI	104.	.0632	1.30	8.22	100.	16.19	59.38	9.90	85.46
AMB DUM	91.	.0751	.15	1.13	100.	19.24	8.18	9.90	37.32
KRA GRA	38.	.0284	.37	1.05	100.	7.28	7.57	9.90	24.76
CER LAN	57.	.0492	.08	.39	70.	12.59	2.81	6.93	22.33
SPH SP.	58.	.0535	.02	.13	70.	13.71	.92	6.93	21.57
LYC AND	24.	.0168	.59	.98	90.	4.29	7.11	8.91	20.31
MAC TOR	52.	.0483	.02	.10	70.	12.36	.73	6.93	20.02
EPH SP.	24.	.0178	.40	.72	100.	4.55	5.17	9.90	19.62
YUC SCH	10.	.0061	1.20	.74	40.	1.57	5.31	3.96	10.84
THA MON	10.	.0079	.22	.17	60.	2.03	1.25	5.94	9.22
ERI FAS	6.	.0052	.09	.05	50.	1.32	.35	4.95	6.62
GRA SPI	4.	.0040	.30	.12	30.	1.02	.86	2.97	4.85
ERI INF	4.	.0040	.00	.00	30.	1.02	.01	2.97	4.01
ACA SPH	2.	.0020	.09	.02	20.	.51	.13	1.98	2.62
MUH POR	2.	.0020	.04	.01	10.	.51	.06	.99	1.56
KRA PAR	1.	.0010	.09	.01	10.	.26	.07	.99	1.31
ECH POL	1.	.0010	.07	.01	10.	.26	.05	.99	1.29
POR GRA	1.	.0010	.04	.00	10.	.26	.03	.99	1.27
OPU ECH	1.	.0010	.02	.00	10.	.26	.02	.99	1.26
BAI MUL	1.	.0010	.02	.00	10.	.26	.01	.99	1.26
STE PAU	1.	.0010	.01	.00	10.	.26	.00	.99	1.25
MIR BIG	1.	.0010	.00	.00	10.	.26	.00	.99	1.25

TABLE 21. ESTIMATES OF DENSITY, FREQUENCY AND COVERAGE OF PERENNIAL PLANTS RECORDED IN TEN 50 X 2 METER QUADRATS AT STATION 9. IMPORTANCE VALUE INDEXES HAVE BEEN COMPUTED AS THE SUMS OF RELATIVE DENSITIES, FREQUENCIES AND COVERAGE FOR EACH SPECIES.

SPECIES CODE	NUMBER COUNTED	DENSITY	AVERAGE COVERAGE	COVERAGE PERCENT	FREQUENCY PERCENT	RELATIVE DENSITY PERCENT	RELATIVE COVER PERCENT	RELATIVE FREQUENCY PERCENT	IMPORTANCE VALUE INDEX
		N PER SQ M	SINGLE PLANT SQ M						
LAR TRI	87.	.0472	2.12	10.01	100.	64.08	77.56	40.00	181.64
OPU RAM	26.	.0155	1.57	2.44	90.	21.01	18.89	36.00	75.90
AMB DUM	15.	.0110	.42	.46	60.	14.91	3.55	24.00	42.46

TABLE 22. ESTIMATES OF DENSITY, FREQUENCY AND COVERAGE OF PERENNIAL PLANTS RECORDED IN TEN 50 X 2 METER QUADRATS AT STATION 10. IMPORTANCE VALUE INDEXES HAVE BEEN COMPUTED AS THE SUMS OF RELATIVE DENSITIES, FREQUENCIES AND COVERAGE FOR EACH SPECIES.

SPECIES CODE	NUMBER COUNTED	DENSITY	AVERAGE COVERAGE	COVERAGE PERCENT	FREQUENCY PERCENT	RELATIVE DENSITY PERCENT	RELATIVE COVER PERCENT	RELATIVE FREQUENCY PERCENT	IMPORTANCE VALUE INDEX
		N PER SQ M	SINGLE PLANT SQ M						
LAR TRI	108.	.0640	1.50	9.62	100.	49.65	81.98	25.00	156.62
AMB DUM	30.	.0234	.24	.57	80.	18.16	4.87	20.00	43.03
KRA GRA	21.	.0145	.63	.91	80.	11.24	7.74	20.00	38.98
HIL RIG	20.	.0156	.26	.41	60.	12.07	3.47	15.00	30.54
OPU RAM	8.	.0064	.26	.17	40.	5.00	1.42	10.00	16.42
OPU ECH	4.	.0040	.02	.01	30.	3.10	.08	7.50	10.68
BEB JUN	1.	.0010	.52	.05	10.	.78	.44	2.50	3.72

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