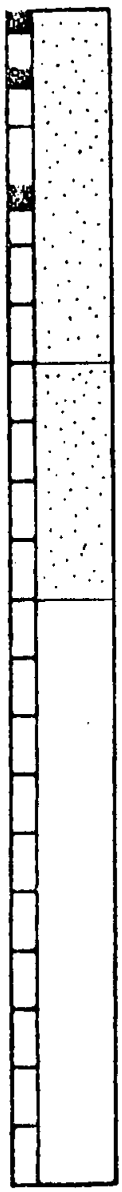
Form 8

JOHN R. BYERLY, INC.

Test Pit No. 6

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)
	100	0.5	86
	97	3.6	80
	95	1.5	82

DEPTH (FEET): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20



Lt. brown fine to coarse sand (SW)
(dry, moderately dense)

Crey fine to coarse sand (SW)
(dry, loose)

Total depth 10.0 feet

No free ground water encountered

Caving below 6.0 feet

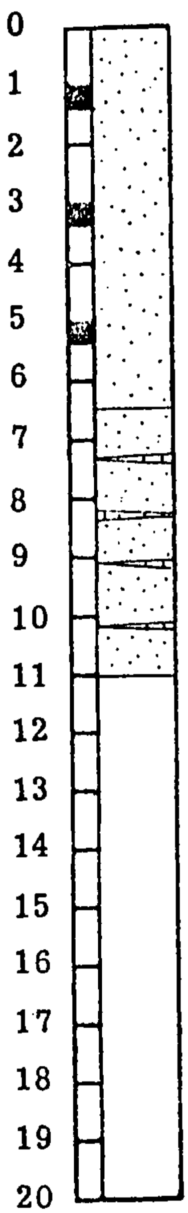
Enclosure 2, Page 6
Rpt. No.: 8844
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Test Pit No. 7

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
	90	4.2	75	1
	90	5.3	74	3.5
	99	2.6	82	5



Lt. brown fine to coarse sand (SW)
(dry, loose, porous)

Grey, lt. brown fine to coarse sand S
w/lenses of silt, (dry & loose)

Total depth 11.0 feet

No free ground water encountered

No caving

Enclosure 2, Page 7
Rpt. No.: 8844
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Test Pit No. 8

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)
	91	1.5	77
	94	2.0	82
	92	2.0	80

DEPTH (FEET): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Lt. brown fine to coarse sand (SW)
(dry, slightly dense, w/some silt)

Lt. brown to grey interbedded fine to coarse sands, (dry, loose)

Total depth 11.0 feet

No free ground water encountered

No caving

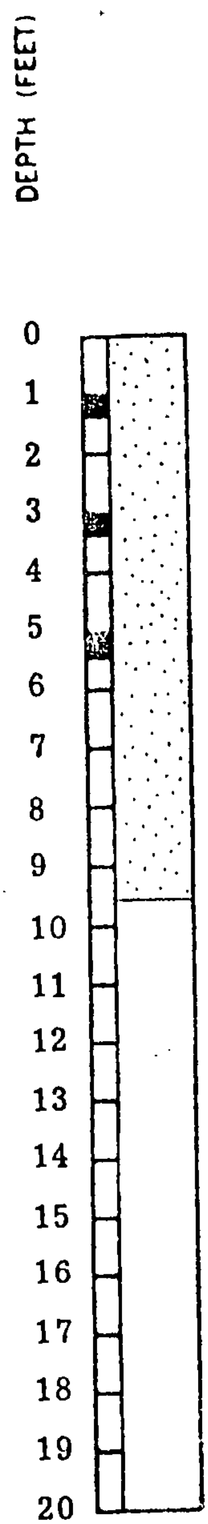
Enclosure 2, Page 8
Rpt. No.: 8844
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Test Pit no. 9

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)
	101	2.6	87
	99	2.0	83
	100	1.5	85



Grey fine to coarse sand (SW)
(dry, moderately dense)

Total depth 9.5 feet

No free ground water encountered

Caving below 3.0 feet

Enclosure 2, Page 9
Rpt. No.: 8844
File No.: S-4559

Form 8

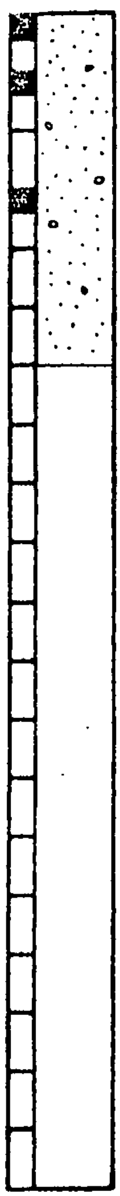
JOHN R. BYERLY, INC.

Test Pit No. 10

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)
	94	1.0	80
	95	1.0	80
	91	1.0	77

DEPTH (FEET)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20



Grey fine to coarse sand (SW) (dry & slightly dense w/some silt and gravel)

Total depth 6.0 feet

No free ground water encountered

Caving below 1.0 feet

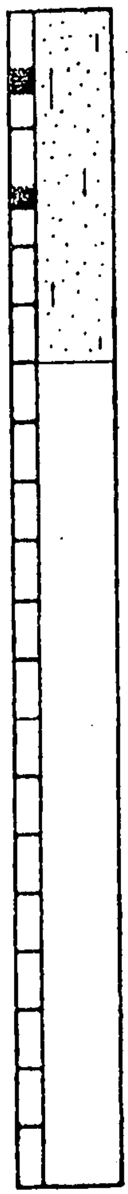
Enclosure 2, Page 10
Rpt. No.: 8844
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Test Pit No. 11

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
				0
	96	3.6	82	1
				2
	102	3.6	87	3
				4
				5
				6
				7
				8
				9
				10
				11
				12
				13
				14
				15
				16
				17
				18
				19
				20



Lt. brown fine to coarse sand (SW)
(dry, mod. dense w/some silt)

Total depth 6.0 feet

No free ground water encountered

Caving below 1.0 feet

Enclosure 2, Page 11
Rpt. No.: 8844
File No.: S-4559

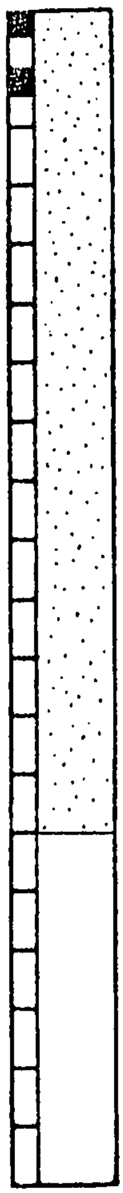
Form 8

JOHN R. BYERLY, INC.

Test Pit No. 12

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)
	80	2.0	70
	77	2.5	67

DEPTH (FEET): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20



Grey to lt. brown fine to coarse sand (SW) (dry, loose, w/some silt)

Total depth 14.0 feet

No free ground water encountered

Caving below 3.0 feet

Enclosure 2, Page 12
Rpt. No.: 8844
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Test Pit No. 13

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
				0
	88	2.0	76	1
				2
	85	4.2	73	3
				4
				5
				6
				7
				8
				9
				10
				11
				12
				13
				14
				15
				16
				17
				18
				19
				20

Lt. brown fine to coarse sand (SW)
(dry, loose w/some silt)

Lt. brown fine to coarse sand (SW)
(dry, loose)

Lt. brown silty fine to coarse sand (SM
(dry, loose)

Total depth 10.0 feet

No free ground water encountered

No caving

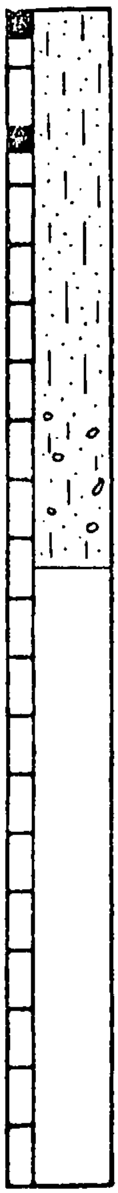
Enclosure 2, Page 13
Rpt. No.: 8844
File No.: S-4559

Form.p

JOHN R. BYERLY, INC.

Test Pit No. 14

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
				0
	87	2.6	75	1
	94	1.0	79	2
				3
				4
				5
				6
				7
				8
				9
				10
				11
				12
				13
				14
				15
				16
				17
				18
				19
				20



Lt. brown silty fine to coarse sand (SM
(dry, loose)

Occasional gravels at 7.0 feet

Total depth 9.5 feet

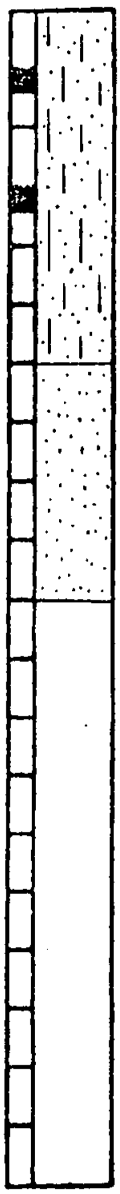
No free ground water encountered

No caving

Enclosure 2, Page 14
Rpt. No.: 8844
File No.: S-4559

Test Pit No. 15

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)	Description
				0	Lt. brown silty fine to coarse sand (SM (dry, loose)
	82	0.5	71	1	
				2	
	87	1.5	75	3	
				4	
				5	Occasional gravels at 5.0 feet
				6	Lt. brown fine to coarse sand (SW)
				7	
				8	
				9	
				10	Total depth 10.0 feet No free ground water encountered No caving
				11	
				12	
				13	
				14	
				15	
				16	
				17	
				18	
				19	
				20	



TEST DATA

LABORATORY STANDARD: ASTM D 1557-70, Mehtod A: 4-Inch Diamter Mold; 1/30 Cubic Foot Volume; 5 Layers; 25 Blows Per Layer; 10 Pound Hammer; 18 Inch Fall; -No. 4 Material.

Type	Classification	Optimum Moisture(%)	Maximum Density(PCF)
A	Lt. brown fine to coarse sand (SW)	12.0	115.5
B	Lt. brown fine to coarse sand (SW)	12.5	118.0
C	Lt. brown silty fine to coarse sand (SM)	11.0	121.5

Enclosure 3
Rpt. No.: 8844
File No.: S-4559

GARY S. RASMUSSEN & ASSOCIATES / ENGINEERING GEOLOGY
1906 SO. COMMERCENTER EAST, SUITE 207 • SAN BERNARDINO, CA 92408 • (714) 888-2422 • (714) 825-9052

GEOLOGY OF BORREGO SPRINGS PARK (BORREGO SPRINGS COUNTRY CLUB) FOR ENVIRONMENTAL IMPACT REPORT WEST OF BORREGO VALLEY ROAD AND 1,300 FEET SOUTH OF PALM CANYON DRIVE BORREGO SPRINGS, CALIFORNIA

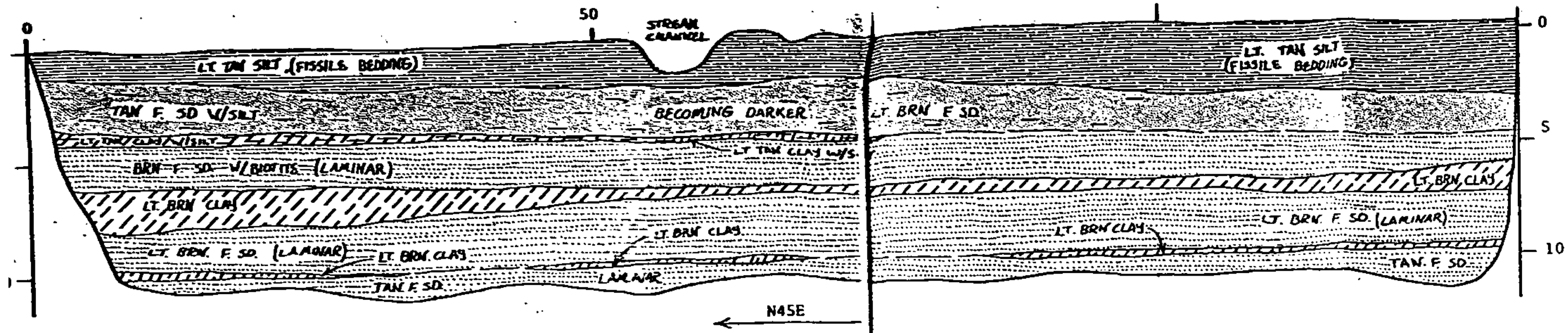
June 13, 1979

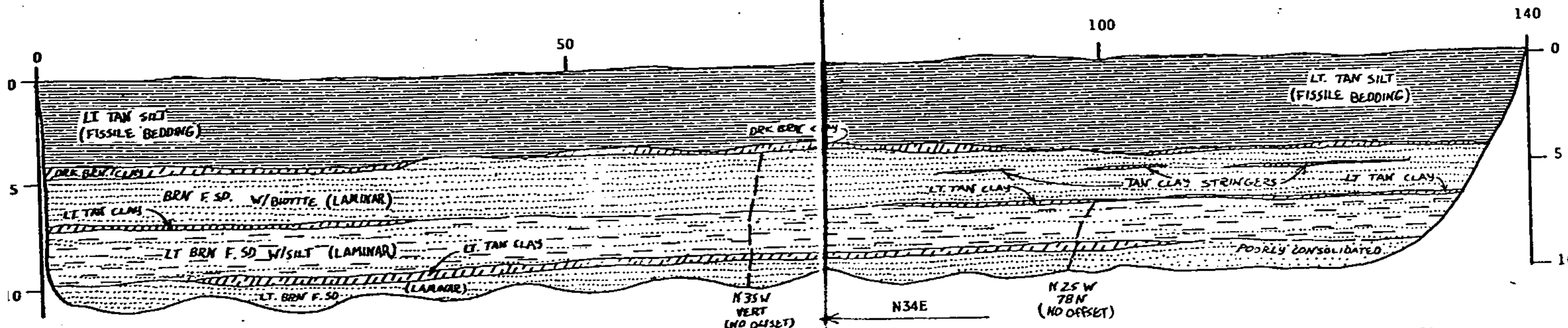
Project No. 1503

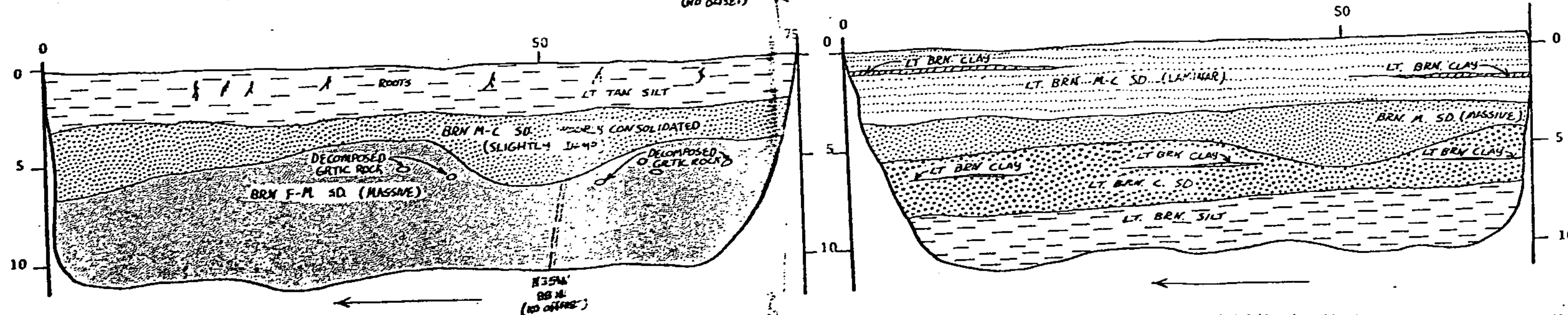
Prepared for

John R. Byerly, Inc.
2230 South Riverside Avenue
Bloomington, California 92316

Enclosure 5
GARY S. RASMUSSEN & ASSOCIATES, INC.
Project No. 1503







JOHN R. BYERLY, INC.

2230 SOUTH RIVERSIDE AVENUE • BLOOMINGTON, CALIFORNIA 92316

PHONES: BLOOMINGTON (714) 877-1324 • RIVERSIDE (714) 684-9775

June 20, 1979

Federated Development Company
1100 Glendon Avenue
Los Angeles, California 90024

Rpt. No.: 8883
File No.: S-4559

Attention: Mr. Hershel Berkes

Subject: Proposed Borrego Springs Development, Borrego Springs, California

Reference: Preliminary Soils Investigation, Rpt. No. 8844, June 1, 1979

Gentlemen:

The referenced report presents our conclusions and recommendations concerning soil conditions encountered during an investigation at the subject site. Enclosure 4 to the referenced report presents an engineering geology report prepared for the subject development by Gary S. Rasmussen and Associates, of San Bernardino. In the geology report, Mr. Rasmussen discussed the existence of a soil formation known as the Indio Silts. This soil formation is shown on USDA Soil Maps and is indicated as having a significant settlement potential. Mr. Rasmussen concluded that these soils should be specifically addressed by the Soils Engineer.

Porous, compressible silts similar to the Indio silt formation were not encountered in any of our test pits during our preliminary soils investigation. However, inasmuch as the soil formation is indicated as existing in an area of the site not heavily explored during our investigation, we are currently conducting an additional investigation in that area. Our additional investigation will involve the exploration of several test pits at selected locations utilizing hand equipment. The soils encountered will be examined and visually classified by one of our staff engineers. Should compressible silts be encountered, undisturbed samples will be obtained and returned to the laboratory for testing and evaluation. Based upon our field observations and laboratory test data, an addendum to the referenced report will be prepared providing specific recommendations concerning the Indio silts. Our field investigation should be completed by the end of this week and our recommendations available within 2 or 3 days thereafter.

GARY S. RASMUSSEN & ASSOCIATES / ENGINEERING GEOLOGY
1906 SO. COMMERCENTER EAST, SUITE 207 • SAN BERNARDINO, CA 92408 • (714) 888-2422 • (714) 825-9052

June 13, 1979

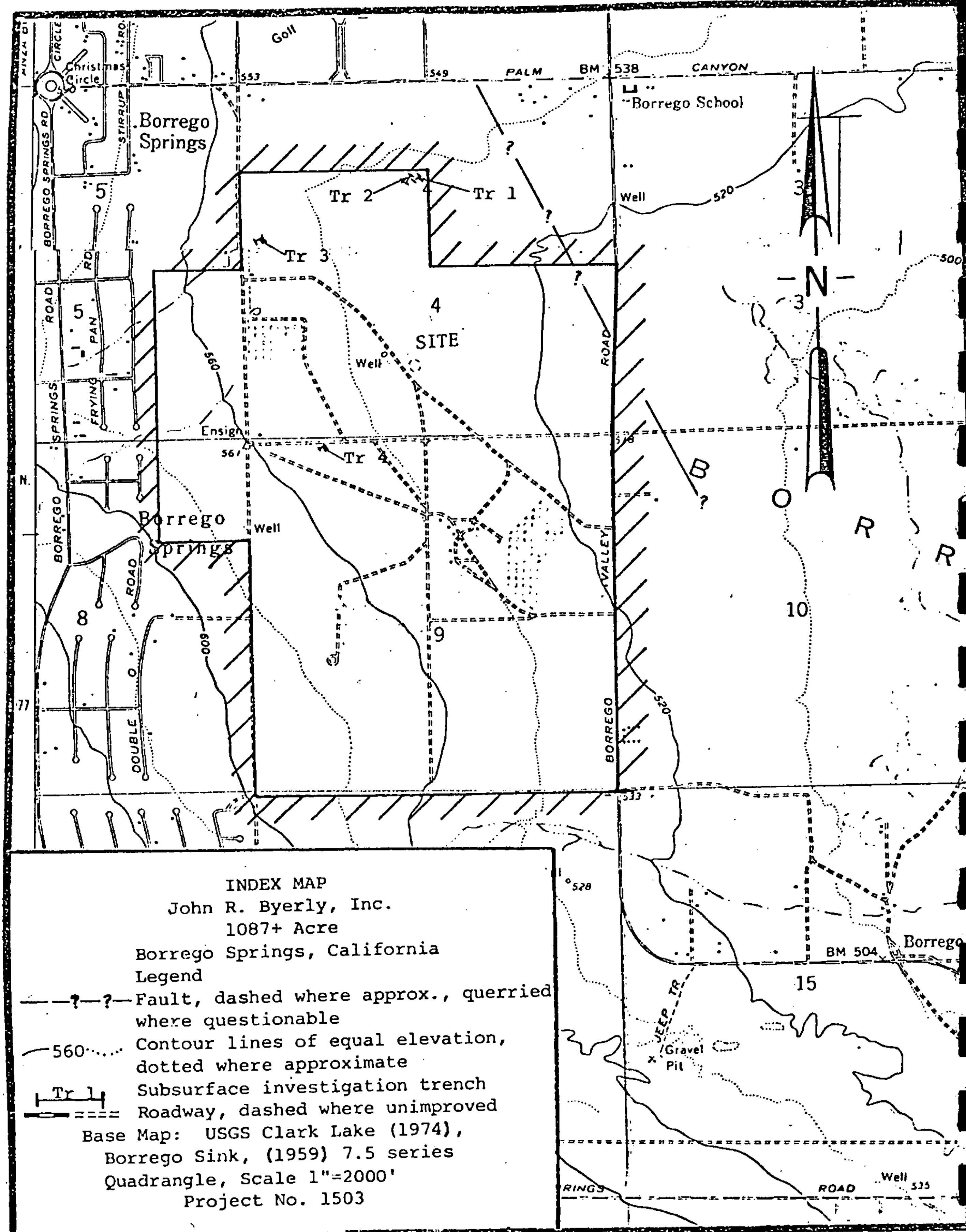
John R. Byerly, Inc.
2230 South Riverside Avenue
Bloomington, California 92316

Project No. 1503

Subject: Geology of Borrego Springs Park (Borrego Springs Country Club) for Environmental Impact Report, West of Borrego Valley Road and 1,300 Feet South of Palm Canyon Drive, Borrego Springs, California.

A geology investigation of the Borrego Springs Park Development also referred to as Borrego Springs Country Club, Borrego Springs, California has been conducted at your request. The purpose of our investigation was to determine the existing geologic setting and assess the probable impact of the geology on the proposed development. The 1087 acre site is located approximately 1/2 mile southeast of the Borrego Springs Christmas Circle. It is our understanding that the site will be developed in five stages and will contain a golf course, clubhouse, community center, sewage treatment plant, single family residences, patio homes, attached single family residential units, 5-acre ranchettes, 10-acre ranches, and open space. The site contains 1,087.3 acres with a total of 835 residential units planned, resulting in 0.77 units per acre. A majority of the site has previously been graded, with the golf course, clubhouse facilities, sewer treatment plant, and occasional residences already in existence. A 400-scale plat map, drawn by Richardson, Nagy, Martin Architecture/Planning of Newport Beach, California, dated September 22, 1978, was used for our investigation. Proposed grading plans were not available at the time of our investigation, but additional grading of those areas previously graded is anticipated to be minimal, with those areas not previously graded probably requiring maximum cut and fill slope heights of the order of 3± feet. The location of the site and property boundaries are shown on the index map on page 2, as well as on the safety element, soil survey, and the geologic maps included as Enclosures 1, 2, and 3.

A geologic field reconnaissance of the site and surrounding area was conducted during May, 1979. In addition to the field work, our investigation included


INDEX MAP
John R. Byerly, Inc.
1087+ Acre
Borrego Springs, California
Legend
Fault, dashed where approx., querried where questionable
560 Contour lines of equal elevation, dotted where approximate
Tr 1 Subsurface investigation trench
Roadway, dashed where unimproved
Base Map: USGS Clark Lake (1974), Borrego Sink, (1959) 7.5 series Quadrangle, Scale 1"=2000'
Project No. 1503
SITE
Tr 1
Tr 2
Tr 3
Tr 4
Borrego Springs
Borrego School
Christmas Circle
PALM CANYON
BORREGO VALLEY ROAD
Well
Gravel Pit
JEEP TR
N
BM 538
BM 504

review of stereoscopic pairs of aerial photographs flown in 1953; review of pertinent geologic literature and maps, including previous reports on the site and surrounding area by other firms; excavation of four short backhoe trenches at selected locations; and review of significant seismic information, including recorded, historic earthquakes. A list of references is enclosed (Enclosure 4).

SITE TOPOGRAPHY

The index map on page 2, a composite 2,000-scale topographic map of the Clark Lake, Borrego Springs Quadrangles, shows a gradual 1 to 2 percent slope of the ground surface to the northeast. Localized, southeast trending swales (minor depressions) were observed on the northwest portion of the site and indicate drainage from this area previously flowed towards the Borrego Sink. No classical topographic evidence of faults (scarps) was found on the site during our investigation or on aerial photographs. Three vegetational lineaments were observed on the aerial photographs, one of which was associated with a linear drainage. Due to the relative close proximity and parallel trend to known faults in the area, plus the observed trend of plotted epicenters (all northwest trending), the possibility existed that these lineaments could be fault related. Therefore, trenches, with a total lineal footage of 414 feet, were excavated across these features, as shown on the index map, to determine if they were in fact caused by active faulting. No faults were found.

The procedure utilized for conducting the subsurface portion of our investigation was to excavate trenches perpendicular to the trend of the lineaments and known faults in the area, to a depth of 10-12 feet. Trenching of sediments to 10± feet is consistent with the current state-of-the-art for investigating recency of faulting for the type of use intended for the site. Trenching enables a detailed visual inspection of subsurface materials for faults, fault related features, and other near surface geologic features. The exact age of sediments at depths of 10-12 feet is not known but is estimated to be late Holocene. The trench logs are enclosed (Enclosure 5).

The undeveloped portions of the site contained natural vegetation in the form of mesquite and sage with the developed portions of the site containing mature date palm trees and occasional grass, as well as a variety of trees. Previously, the northern portion of the site had been used for agricultural purposes, grain and cotton, while the southern portion reportedly has remained in its natural state.

A northwest trending scarp (bench) is located approximately1300 feet northeast of the northerneasternmost portion of the site. This scarp may be the surface expression of a fault, or alternatively, it may be the remnant of an old stream bank or dune deposit. This scarp, if extended to the southeast, would cross a portion of the golf course not containing any human occupancy structures and no structures are proposed in the area on the development plan. If the scarp is fault related and continues to the southeast, it would run through the extreme northeast portion of the golf course (index map on page 2).

SITE GEOLOGY

The Borrego Springs Park Development is located in Borrego Valley, which lies within the Salton Trough. The Salton Trough is defined by a linear and narrow depression which encompasses the low-lying areas of the Colorado River Delta Region in Mexico and the Imperial and Coachella Valley Regions of southern California, comprising a physiographic province 1400 kilometers (875 miles) long. The land surface in the north-central section of the Salton Trough is below sea level, having been cut off from the Gulf of California by the deposition of a delta cone of the Colorado River within the last 11,000 years (Holocene) This Salton Trough Basin has been periodically inundated by bodies of water, the latest having formed the Salton Sea in 1905 (Mendenhall, 1909). The present geographic limits of the Salton Trough correspond approximately to the boundaries of the San Andreas fault system (San Andreas, San Jacinto, Agua Caliente and Elsinore fault zones). Intermittent, right-lateral movement along the southeast fault zones within this system have continued to change the shape of the basin with vertical displacement forming the dominant physiographic elements (mountains) within the Trough and bordering areas. These mountain masses include the Borrego Mountains, Fish Creek Mountains, Superstition Mountains, and the Coyote Mountains (Sharp, 1972).

Sediments in the Salton Trough range from older gravel (or its consolidated fanglomerate equivalents) through predominately sandy flood-plain and deltaic deposits including marine silts and clays. Deposition through the erosion of continental materials may have prevailed in some marginal parts of the trough throughout its history, although much of the deposition has alternately been marine and non-marine. Other lithology found within the trough included bedded gypsum deposits (Ver Planck, 1952) and Matric volcanic rocks (Allen, 1957). Widespread and various source areas around the Salton Trough have contributed clastic material at various times.

The entire site lies on Quaternary alluvium (Rogers, 1965) as shown on the geologic map (Enclosure 3). Data from water wells drilled on-site indicates that this alluvium continues to a minimum depth of 600 feet below the surface and consists of sands, clays, fine gravel and gravels (Department of Water Resources, January, 1968). This alluvium is underlain by crystalline rock (metamorphic and granitic) which rises to the west and forms the San Ysidro Mountains.

SEISMIC SETTING

The principal fault zones in the Salton Trough consist of the San Andreas, located near the northeast margin; a group of unnamed boundary faults that are concealed along the southwest edge of Coachella Valley; the widely branching San Jacinto fault zone, which crosses the southwest portion of the Trough; and the Aqua Caliente and the Elsinore fault zones located along the southwest edge of the Trough. All of these fault zones are considered part of the San Andreas fault system and display the surficial features characteristic of this system: linearity, northwest-southeast trends, evidence of Holocene activity, and right-laterial, strike-slip offset.

San Andreas Fault Zone

The San Andreas fault zone consists of two principal faults in the northern

Coachella Valley, the Mission Creek and Banning faults. The Mission Creek fault, an eastern branch of the San Andreas fault zone, extends along a nearly straight line to the Little San Bernardino Mountains from Indio (Allen, 1957, Proctor, 1968). The Banning fault, the western branch, curves to a nearly east-west trend at the north end of the Salton Trough and mergeswith the Mission Creek fault near Indio. Near the City of Indio, the San Andreas fault zone includes a number of subsidiary breaks that lie along the northeast side of the main fault. Southeast of Indio, the San Andreas zone is relatively straight and continues to the northeast shore of the Salton Se (Allen, 1957). Throughout most of the Coachella Valley, the fault zone is well defined in alluvium by scarps and by ground water and/or vegetational lineaments. Geophysical data indicates that the basement rocks have been vertically displaced a minimum of 3.2 kilometers (2 miles) along the southwest side of the San Andreas fault zone in Coachella Valley (Biehler, Kovack and Allen, 1964).

Southeast of the Salton Sea, the surficial expression of the San Andreas fault zone is not readily apparent. Following the fault trace of the San Andreas fault zone from the northwest to the southeast results in an intermittent surficial expression of the fault evident in the northern part of the Imperial Valley (Babcock, 1971). Historic movement on the San Andreas fault zone within the Salton Trough has not been recorded in conjunction with any earthquakes, prior to the Borrego Mountain event in 1968 (Sharp, 1972).

San Jacinto Fault Zone

The San Jacinto fault zone, trending northwest-southeast, enters the Salton Trough through the Santa Rosa mountains and cuts diagonally into the basin. The San Jacinto fault zone, in the vicinity of the Salton Trough, consists of three recognizable faults forming a zone of approximately 10 kilometers wide (6.25 miles). The northern fault (Clark) extends through Clark Valley and along the southern tip of the Santa Rosa Mountains, with the middle fault lying along the west edge of Clark Valley and extending southward from the Clark fault into the Borrego Badlands, where it possibly dies out (Sharp, 1967).

The southwesternmost fault within the San Jacinto fault zone is the Coyote Creek fault, located approximately 5.75 kilometers (3.6 miles) northeast of the site. The Coyote Creek fault experienced substantial movement during the 1968 Borrego Mountain earthquake. This fault is an en echelon feature with fault splays that generally follow the northeast edge of the Borrego Valley and traverse along the margins of the Borrego Mountains and the Borrego Badlands to a point near the easternmost Fish Creek Mountains. Other faults lying farther southeast and extending into Mexico have also been regarded as part of the San Jacinto fault zone (Beal, 1915; Dibblee, 1954; Biehler, et.al., 1964; Merriam, 1965; Sharp, 1968). These include the Superstition Mountain fault and the Superstition Hills fault as well as a fault extending southeastward from the Cerro Prieto in Baja California.

The Imperial fault, as defined by the 1940 Imperial Valley earthquake, may also belong to the San Jacinto fault zone. The Imperial fault lies nearly along the projection of the Clark fault and may join at depth (Sharp, 1968). Alternatively, it has also been suggested that the movement on the Imperial fault is partially transferred northeastward to the San Andreas fault by crustal spreading near the southern portions of the Salton Sea (Lomnitz, et. al., 1970).

Elsinore Fault Zone

The Elsinore fault zone, as described in this report, includes the Aqua Caliente fault and is a discontinuous zone of fractures extending southeastward from the Peninsular Ranges into the Salton Trough near the Terra Blanca Mountains, approximately 16 kilometers (10 miles) southwest of the site. Continuity between many individual faults within the Elsinore fault zone are concealed by alluvium within the Imperial Valley. The total strike-slip displacement along the Elsinore fault zone is relatively small when compared with the San Jacinto and San Andreas fault zones (Sharp, 1968; Baird, et.al. 1970). Historic movement has not been documented within the Salton Trough along the Elsinore fault zone, with only the southern section of this zone characterized by appreciable seismicity in recent times (Sharp, 1972).

SEISMIC HISTORY

The Salton Trough region is considered to be one of the most seismically active areas of tectonicism in California (Enclosure 3). The Salton Trough has been dominated in this century by earthquakes of intermediate magnitudes (Richter magnitudes 3-6) originating along two members of the San Andreas system, the San Jacinto fault zone and the Imperial fault. Nine or more earthquakes of Richter magnitude 6+ have occurred along these faults since 1915 (Sharp, R.V., 1972). Of these nine historic earthquakes of Richter magnitude 6 or greater, six were located within 88 kilometers (55 miles) of the site, with eight of these earthquakes having occurred on or near fault breaks within the San Jacinto fault zone (Sharp. R.V., 1972). These earthquakes have caused relatively little damage, mainly because they were centered in sparsely settled desert regions. The most important of these earthquakes, in relation to the proposed development,was the 1968 Borrego Mountain earthquake of Richter magnitude 6.4, which occurred along the Coyote Creek fault within the San Jacinto fault zone. This earthquake resulted in horizontal (right-lateral) surface displacement along the Coyote Creek fault approximately 4 miles northeast of the site, as well as along several other faults within the complex San Jacinto fault zone. This Richter magnitude 6.4 earthquake ranks among the larger shocks recorded in southern California since the establishment of modern seismographic stations, and resulted in faulting along a 33 kilometer (20 mile) segment of the Coyote Creek fault (Clark,1972). The Borrego Mountain earthquake triggered a small displacement along a number of distant faults far outside the aftershock area (Allen, 1972) with these aftershocks lasting for several months after the main shock. The San Jacinto fault zone, of which the Coyote Creek fault is a member, has been the location of repeated moderate seismic activity within the entire historic record (Allen, 1965). This fault zone has been well delineated by seismic activity, with no one location along the San Jacinto fault zone in the Salton Trough seeming more prone to earthquake faulting. Many of the epicenters of these earthquakes have been about equidistant along the fault, with the 1968 Borrego Mountain epicenter lying approximately midway between the epicenters of the lower Borrego Valley earthquake (Richter magnitude 6.5) and the Santa Rosa earthquake (Richter magnitude 6.2) of 1954. The 1968 Borrego Mountain earthquake resulted in visible surface waves which caused anchored objects (utility poles, buildings) to move at the proposed developmental site (Sharp, R.V., 1972, Plate 4).

The location of the site, in relation to earthquake epicenters between 1934 and 1968 in San Diego County, is shown on Enclosure 3 (Seismic Safety Element to the County of San Diego). Two epicenters between Richter magnitudes 2.0 to 3.0 have been plotted as having occurred at depth below the site.

SOIL SURVEY

The entire site is located on alluvium, part of a large bajada (nearly flat surface of confluent alluvial fans) which skirts the mountains to the west. The barren slopes of these mountains provide runoff from precipitation which has deposited the alluvium in the valley.

The soils of the area and on-site are divided into two associations (Mecca-Indio, Rositas-Carrizo) and four series (Enclosures 2 and 2A). These soils (alluvium) may be generally characterized as loosely consolidated, highly permeable, and susceptible to wind and water erosion, with one of these series (Indio Silt Lome) being subject to settling (See Enclosure 2A for detailed description).

HYDROLOGIC SETTING

The Borrego Valley is a structural depression created by the Coyote Creek fault and is a desert basin located in the northeast portion of San Diego County. The area contributing water to the Borrego Valley consists of approximately 280 square miles, of which 195 square miles are steep rocky slopes (Lough, C.F., 1974). The remaining portion of the Borrego Valley watershed consists of approximately 85 square miles (55,000 acres) and is the valley portion of Borrego Valley. The basin is filled to an unknown depth with alluvium and based on water well data on-site, is a minimum of 600 feet in thickness. This alluvium is comprised of randomly sequenced lithological units of sand, silts, clays, and gravels. The average annual precipitation varies from less than 4 inches on the valley floor to 15 inches in the mountains to the west and is the only known source of water recharge for the basin. A majority of the water recharge occurs between the mouth of Coyote Creek and the present agriculture area. Natural discharge is largely by transpiration from mesquite bushes growing in Borrego Valley and around Borrego Sink. It has been estimated that 100,000-acre-feet of precipitation falls on the drainage area during the average year, with only a small portion of this precipitation reaching the valley floor through runoff (Lough, C.F., 1974). A majority of this precipitation is taken up as soil moisture along the hillsides.

GROUND WATER

The alluvial materials under the site continue to a minimum depth of 600 feet, based on water well data (Department of Water Resources, 1968). The development is currently supplied by a private water supply system on-site, with the ground water being drawn from various subsurface aquifers. The minimum depth (ground water) from which water is drawn was 70 feet in 1965, with the deepest recorded aquifer located at approximately 325 to 345 feet (California Department of Water Resources, 1968). A well on site, with a 16 inch louvered casing, initially (1945) had a static water level 45 feet below the ground surface, which has subsequently been lowered to 75 feet below the surface by 1978. This well had an approximate drawdown of 250 feet in 1978 (David, T., personel communication).

Large quantities of ground water have been withdrawn from the shallower aquifers in Borrego Valley for irrigation and domestic purposes, with a resulting lowering of the ground water table. This ground water lowering has been documented as much as approximately 20 feet over a period of 12 years (1954-1965 inclusively). This reduction in ground water may be a contributing factor in the collapse fissures located along fractures associated with breaks along the Coyote fault. No evidence of subsidence cracking through the site was observed during our field investigation.

GEOLOGIC AND SOIL IMPACT

At the completion of the proposed five-stage development, the land will be utilized in a manner wherein any future agriculture use will not be feasible, while still allowing for substantial areas of native vegetation.

The soils on-site are highly alkaline with little or no potential use as a natural resource.

Erosion through wind and water are a potential problem. This potential can be reduced through the planting of windbreaks and vegetation that have proved useful in other areas of Borrego Valley. Settlement of soils within the Indio Silt (IoA) series can be mitigated through proper engineering by the Soils Engineer. The site developmental plan indicates that only a small portion of the site, the extreme northeast portion, will be on this soil type. The golf course and a dedicated flood channel will occupy most of this area, with only a small portion planned for residential purposes.

Landsliding or shallow surface failures do not appear to be a problem as the site is relatively flat and is not located adjacent to any hillside portions which could fail onto the site.

SEISMIC ANALYSIS

Significant earthquakes affecting the site are likely to occur on the nearby San Jacinto (Coyote Creek), Elsinore or the more distant San Andreas fault zones during the life of the proposed structures. Recurrence intervals for maximum probable earthquakes cannot yet be precisely determined from a statistical standpoint, as recorded information on seismic activity does not encompass a sufficient span of time. However, based on the information available at this time, it is our opinion that the following maximum probable earthquakes should be expected (at least 50 percent chance of occurrence within the next

100 years); up to Richter magnitude 7.0 along the San Jacinto fault zone and Richter magnitude 6.5 along the Elsinore fault zone. An earthquake of these magnitudes along the nearby San Jacinto and Elsinore fault zones can be expected to produce maximum peak accelerations in bedrock under the site of approximately 0.55g and 0.30g respectively (Schnabel and Seed, 1973). These correspond to maximum repeatable accelerations of approximately 0.36g and 0.20g respectively (Ploessel and Slossen, 1974). These accelerations should not necessarily be used as a design value as they are peak accelerations and are estimated for bedrock which is a minimum of 600 feet below the site. Larger earthquakes could occur on any of these faults, but their probability of occurrence for shorter time periods is much lower. Large earthquakes could occur within other fault zones (San Andreas fault zone) but are considered less significant to the site because of their greater distance and/or lower probability of occurrence within that time period.

CONCLUSIONS

No evidence of active faulting along three vegational lineaments, as observed on the aerial photographs, was found by trenching to a depth of 10+ feet. Therefore, fault rupture is not anticipated through the site during the life of the proposed structures. A possible fault scarp was observed off the property but would project through the extreme northeast portion of the golf course as shown on the index map on page 2. No human occupancy structures should be placed across this feature unless trenching proves it is not an active fault. This area is not scheduled for development other than the existing golf course. The feature observed in the field is short and does not continue to the northwest or southeast.

Severe seismic shaking of the site should be expected within the next 100 years from an earthquake on one or more branches of the San Jacinto and/or Elsinore fault zones. Two earthquake epicenters of Richter Magnitude 2.0-3.0 have been plotted as having occurred on the site between 1931-1968 (San Diego County Seismic Safety Element).

The north-central portions of the site have a strong potential for flooding during periods of intense precipitation. This is evidenced by the presence of a youthful stream course, growing vegetation and the depth of silt as observed in our subsurface investigation.

Earthquake induced landslides, sieches, and flooding is not expected as the site does not contain any large bodies of water and is not located adjacent to any hillside areas, or does it contain any reservoirs which could catastrophically fail during an earthquake.

Liquefaction and other shallow ground water related hazards are not expected as the ground water table is currently estimated to be more than 70 feet below the surface. Semi-perched ground water may occasionally occur under the site as water well drilling logs and our subsurface investigation indicates that intermittent clay layers exist below the site.

Subsidence cracking through the site is not expected as the major geologic contact between the bedrock mountains and the alluvial valley is along the Coyote fault trace, approximately 3 3/4 miles northeast of the site. Major subsidence cracking would be expected to occur along a relatively narrow zone along this fault trace. Subsidence cracking due to excessive ground water withdrawal along the west side of Borrego Valley is expected to occur farther west, closer to the bedrock-alluvial contact there.

Subsidence of the ground surface on a regional basis should be expected as the ground water basin is expected to be continually overdrafted in the future.

Some potential for settlement of the Indio Silts (IoA) as shown on Enclosures 2 and 2A exists according to USDA soil maps . These need to be specifically addressed by the Soils Engineer.

The topographic and geologic environmental impacts of the additional development are considered minimal. The potential for windblown sand within the vicinity of the development will be slightly decreased by the placement of structures and roadways on the site.

RECOMMENDATIONS

A maximum probable earthquake of Richter magnitude 7.0 is expected along the San Jacinto fault zone in the Salton Trough, 3.6 miles from the site; therefore, we recommend human occupancy structures be designed accordingly.

No human occupancy structures should be placed across the possible fault through the extreme northeast portion of the golf course unless trenching proves the possible fault to be non-existent or inactive.

The potential for flooding on site should be evaluated and mitigated by the design engineer.

That portion of the site shown on Enclosure 2 as containing the Indio Silt (IoA) series should be investigated by the Soils Engineer for possible special foundation recommendations.

Respectfully submitted,
GARY S. RASMUSSEN & ASSOCIATES

Dan D. Bush

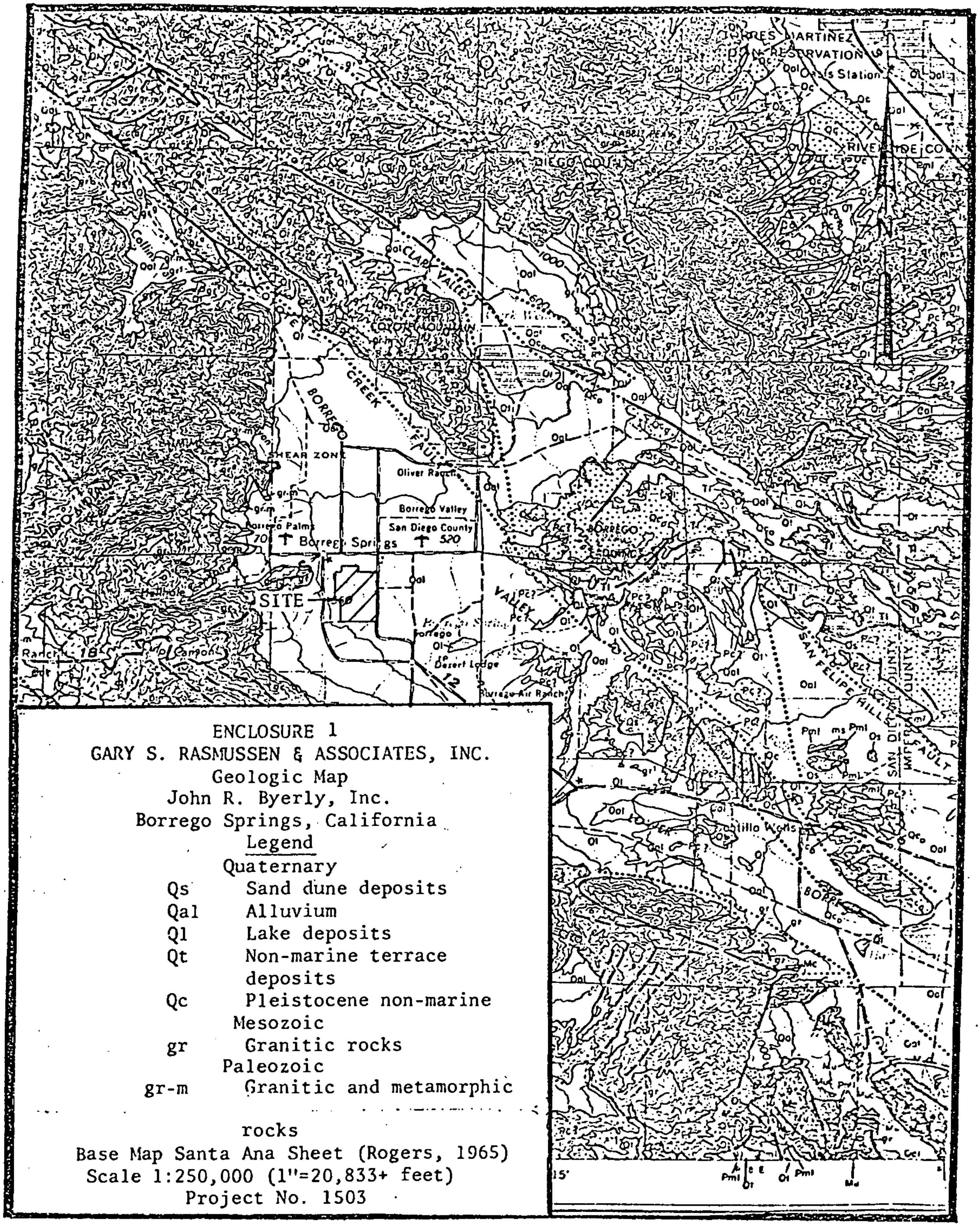
Daniel D. Bush,
Staff Geologist

Lou BIANCK
Gary S. Rasmussen

Gary S. Rasmussen
Engineering Geologist, EG 925

DDB:GSR/rc
Enclosures: 1-Geologic Map
2, 2A-Soil Survey and Description
3-Seismic Safety Element
4-References
5-Trench Logs

Distribution-John R. Byerly, Inc. (8)



ENCLOSURE 1
GARY S. RASMUSSEN & ASSOCIATES, INC.
Geologic Map
John R. Byerly, Inc.
Borrego Springs, California

Legend

Quaternary

Qs	Sand dune deposits
Qal	Alluvium
Ql	Lake deposits
Qt	Non-marine terrace deposits
Qc	Pleistocene non-marine

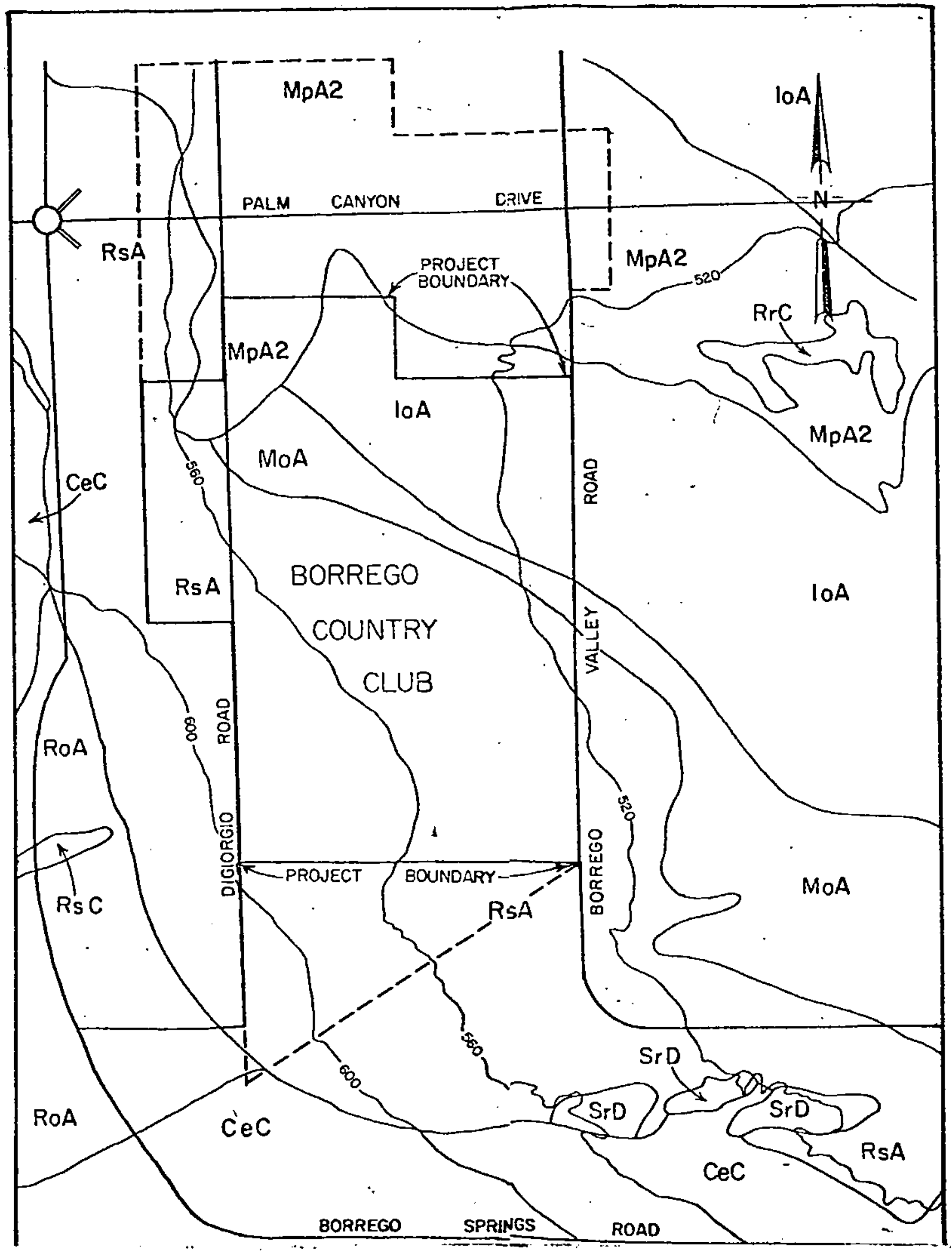
Mesozoic

gr	Granitic rocks

Paleozoic

gr-m	Granitic and metamorphic rocks

Base Map Santa Ana Sheet (Rogers, 1965)
Scale 1:250,000 (1"=20,833+ feet)
Project No. 1503



ENCLOSURE 2
GARY S. RASMUSSEN & ASSOCIATES, INC.
John R. Byerly, Inc.
Borrego Springs, California

Legend

IoA	Indio Silt Loam
MoA	Mecca Sandy Loam
MpA2	Mecca Fine Sandy Loam
RsA	Rositas Loamy Coarse Sand

Base Map: USDA Soil Conservation Service Soils Classification
Scale 1"=2000'
Project No. 1503

Enclosure 2A
Gary S. Rasmussen & Associates
John R. Byerly, Inc.
Borrego Springs, California

SOIL CAPABILITY AND CHARACTERISTICS

Individual Soils	Slope	Land Capability	Characteristics	Erodibility	Suitability as Topsoil
Indio Silt Loam (IoA)	0-2%	IIIs-6	Subject to flooding, ponding or overflow, slow infiltration rate, settlable	Severe	Poor
Mecca Sandy Loam (MoA)	0-2%	IIIs-6	Subject to flooding, ponding or overflow, moderate infiltration rate	Severe	Fair
Mecca Fine Sandy Loam (MpA2)	0-2%	IIe-4	Moderate infiltration rate, subject to wind erosion and abrasion	Severe	Good
Rositas Loamy Coarse Sand (RsA)	0-2%	IVs-4	High infiltration rate, well drained	Severe	Poor

*Notes

- e - Main limitation is risk of erosion
- s - Limited because it is shallow, droughty, or stony
- 4 - Coarse texture or excessive gravel
- 6 - Salts or alkali
- II - Moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- III - Severe limitations that reduce the choice of plants, require special conservation practices, or both.
- IV. - Very severe limitations that reduce the choice of plants, require very careful management, or both.

REFERENCES

Advance Planning and Research Associates, August, 1978, Draft Environmental report, Rodgriquez Borrow Pit, p. 77-64, EAD Log No. 77-5-4, Borrego Springs, California, Report No. 78-0704.

Allen, C.R. 1957, San Andreas fault zone in San Gorgonio Pass, southern California: Geol. Soc. America Bull., v. 68, no. 3, pp 315-350

Allen, C.R., Saint Amand, P., Richter, C.F., and Hordquist, J.M., 1965, Relationship between seismicity and geologic structure in southern California region: Seismological Society of America Bulletin, v. 55, no. 4, pp. 753-797.

Babcock, E.A., 1971, Detection of active faulting using oblique infarred aerial photography in the Imperial Valley, California, Geol. Soc. America Bull., v. 82, p 3189-3196.

Baird, A.K., Welday, E.E., and Baird, K.W., 1970, Chemical variations in batholithic rock of southern California: Geologic Society of America, abstracts with programs, v. 2, no. 2, p. 69.

Beal, C.H., 1915, The earthquake in Imperial Valley, California, June 22, 1915: Seismological Society of America Bulletin, vol. 5, pp 130-149.

Bennett, J.H., & Rodgers, D.A., 1975, Crustal movement investigations along the San Andreas fault in southern California, in Crowell, J.C., ed., 1975, San Andreas fault in southern California, a guide to San Andreas fault from Mexico to Carrizo Plain: Calif. Div. Mines & Geol. Special Report 118, pp 53-60.

Biehler, S., Kovach, R.L., and Allen, C.R., 1964, Geophysical framework of northern end of Gulf of California structural province, in Van Andel T.H., and Shor, G.G., Jr., Marine Geology of Gulf of California; American Association of Petroleum Geologist, Mem. 3, p. 126-143.

Bonilla, 1970, Surface faulting and related effects in Earthquake engineering, Prentice-Hall, Englewood Cliffs, Ch. 3, pp 47-74.

California Department of Water Resources, 1964, Crustal strain and fault movement investigation-faults and earthquakes in California: Department of Water Resources Bulletin 116-2.

California Department of Water Resources, 1968, Water Wells and springs in Borrego, Corrizo and San Felipe Valley areas; Dept. of Water Resources Bulletin 91-15.

Clark, M.M., Grantz, A., and Rubin, M., 1972, Holocene activity of the Coyote Creek fault as recorded in sediments of Lake Coahuila, Professional Paper 787, pp 112-130, U.S. Geological Survey, Washington, D.C.

Dibblee, T.W., Jr., 1968, Displacement of the San Andreas fault system in the San Gabriel, San Bernardino, and San Jacinto Mountains, southern California, in Dickinson, W.R., and Grantz, A., eds., Conference of geologic problems of San Andreas fault system, Stanford, California, 1967, Proceedings, Stanford University Publications, Dept. of Geol. Sciences, v. II, pp 260-276.

Dibblee, T.W., Jr., 1970, Regional geologic map of the San Andreas and related faults in eastern San Gabriel Mountains, San Bernardino Mountains, western San Jacinto Mountains and vicinity, Los Angeles, San Bernardino, and Riverside Counties, CA: U.S. Geological Survey Open-file report.

Dibblee, T.W., Jr., 1975, Late Quaternary uplift of the San Bernardino Mountains on the San Andreas and related faults, in Crowell, J.C., ed., 1975, San Andreas fault in southern California, a guide to San Andreas fault from Mexico to Carrizo Plain: California Division of Mines and Geology Special Report 118, p. 127-135.

Dickinson, W.R., and Grantz, A., 1968, Indicated cumulative offsets along the San Andreas fault in the California coast ranges; proceedings, Conference on Geological Problems of San Andreas fault system, Stanford University Publications, Geological Sciences, Publisher, Stanford, California, Vol. 11, pp 117-119.

Friedman, M.E., Whitcomb, J.H., Allen, C.R., and Hileman, J.A., 1976. Seismicity of the southern California region, 1 January 1972, to 31 December 1974, Seismological laboratory, California Institute of Technology.

Greensfelder, R.W., 1972, Crustal movement investigations in California, their history, data, and significance: California Division of Mines and Geology, Special Publication 37.

Greensfelder, R.W., 1974, Maximum credible rock acceleration from earthquakes in California: California Division of Mines and Geology Map Sheet 23.

Hart, E.W., 1976, Fault hazard zones in California: California Division of Mines and Geology Special Publication 42, Revised Edition.

Heaton, T.H., Helmberger, D.V., April 1977, A study of strong ground motion of the Borrego Mountain California earthquake, in Bulletin of the Seismol. Soc. of America, v. 67, no. 2.

Hileman, J.A., Allen, C.R., and Nordquist, J.M., 1973, Seismicity of the southern California region, 1 Jan 1932 to 31 Dec 1972: Seismol. Lab. California Institute of Technology, Pasadena, California, p. 404.

Hope, R.A., 1969, Maps showing recently active breaks along the San Andreas and related faults between Cajon Pass and Salton Sea, California: U.S. Geological Survey Open-file report, 1:24,000.

Jennings, C.W., 1975, Fault map of California with locations of volcanoes, thermal springs and thermal wells: California Division of Mines and Geology, 1:750,000.

Lamar, D.L., Merifield, P.M., and Proctor, R.J., 1973, Earthquake recurrence intervals on major faults in southern California, in Moran, D.E., and others, eds., 1973, Geology, seismicity and environmental impact: Assoc. Engineering Geologist, Spec. Pub., pp 265-276.

Lomnitz, et. al., 1970, Seismicity and tectonics of the norther Gulf of California region, Mexico, Preliminary results. Geofisica Internacional, vol. 10, no. 2, pp 37-48.

Lough, C.F., November 1974, Water budget for Borrego Valley, San Diego County Planning Div., San Diego County, California.

McEven, Robert, Piuckney, C.J., Seismic Risk in San Diego, Studies on the geology and geological hazards in greater San Diego Area, California and San Diego Society National History Transactions, v. 17, p. 33-62, 1972.

Mendenhall, W.C., 1909, Ground water of the Indio region, California: U.S. Geological Survey Water Supply Paper 225, p 56.

Ploessel, M.R., & Slossen, J.E., 1974, September, Repeatable high ground accelerations from earthquakes; from California Geology, vol. 27, no. 9, pp 195-199.

Proctor, R.J., 1968, Geology of the Desert Hot Springs-Upper Coachella Valley area, California: California Division of Mines and Geology Special Report 94.

Richter, C.F., Allen, C.R., and Nordquist, J.M., 1958, The Desert Hot Springs earthquakes and their tectonic environment: Seismol. Soc. America Bulletin, pp 315-337.

Rogers, T.H., 1965, Geologic map of California, Olaf P. Jenkins edition, Santa Ana Sheet: California Division of Mines and Geology.

Rogers Engineering Company, August 1977, Non-electric applications of geothermal resources at Desert Hot Springs, California, quarterly report for period May 23, 1977-August 12, 1977: Prepared for the Energy Research and Development Administration, Div. of Geothermal Energy.

San Diego County Seismic Safety Element to the General Plan, Part V, 1975.

Schnabel, P.B., and Seed, H.M., 1973, Accelerations in rock for earthquakes in the western United States: Seismol. Soc. America Bull., v. 63, no. 2, pp 501-516.

Sharp, R.V., 1967, San Jacinto fault zone in the Peninsular Ranges of southern California, Geological Society of America Bulletin, v. 78, pp 705-730.

Sharp, R.V., 1972, Map showing recently active breaks along the San Jacinto fault zone between the San Bernardino area and Borrego Valley, Calif: U.S. Geological Survey Misc. Geologic Investigations Map I-675, Scale 1:24,000.

Sharp, R.V., 1972, The Borrego Mountain earthquake of April 9, 1968, Geologic Survey Professional Papers 787.

Slemmons, D.B., 1977, State-of-the-art for assessing earthquake hazards in the United States: U.S. Army Engineer Waterways Experiment Station Report 6

Tyler, S.J., 1974, Analog model study of the ground water basin of the Upper Coachella Valley, California: USGS Water Supply Paper 2027.

U.S.D.A. Stereoscopic aerial photographs, May 12, 1953, photo numbers AXN 12M 130-133, AXN 13M 69-72, AXN 14M 171-174, AXN 17M 20-23, Nominal scale 1"=1,667'.

Ver Planck, W.E., 1952, Gypsum in California: Calif. Div. of Mines and Geology Bulletin 163, p 151.

Wallace R.E., 1970, Earthquake recurrence intervals on the San Andreas fault: Geological Society of America Bulletin, v. 81, pp 2875-2889.

Woodward, Clyde, Sherard & Associates, Soil investigation for the proposed Borrego Springs Park Development, San Diego, California, April, 1962.

JOHN R. BYERLY, INC.

2230 SOUTH RIVERSIDE AVENUE • BLOOMINGTON, CALIFORNIA 92316

PHONES: BLOOMINGTON (714) 877-1324 • RIVERSIDE (714) 684-9775

PRELIMINARY SOILS INVESTIGATION

PROPOSED BORREGO SPRINGS DEVELOPMENT

FEDERATED DEVELOPMENT COMPANY

CONSULTING SOIL AND FOUNDATION ENGINEERS
MATERIALS TESTING AND INSPECTION

We trust this information is sufficient for your needs at this time. Should questions arise, please do not hesitate to contact this office.

Respectfully submitted,

JOHN R. BYERLY, INC.

Roger A. Shervington, Civil Engineer

RAS:lw

Copies: (3) Client
(3) Boyle Engineering
Attention: Wesley Hylen

Rpt. No.: 8883
File No.: S-4559

JOHN R. BYERLY, INC.

2230 SOUTH RIVERSIDE AVENUE • BLOOMINGTON, CALIFORNIA 92316

PHONES: BLOOMINGTON (714) 877-1324 • RIVERSIDE (714) 684-9775

July 26, 1979

Federated Development Company
1100 Glendon Avenue
Los Angeles, California 90024

Rpt. No.: 8977
File No.: S-4559

Attention: Mr. Hershel Berkes

Subject: Proposed Borrego Springs Development, Borrego Springs, California; Addendum to Preliminary Soils Investigation

Reference: Preliminary Soils Investigation, Report No. 8844, June 1, 1979

Gentlemen:

The referenced report presents our conclusions and recommendations concerning soil conditions encountered during an investigation at the subject site. Enclosure 4 to the referenced report presents an engineering geology report prepared for the subject development by Gary S. Rasmussen & Associates of San Bernardino. In the geology report, Mr. Rasmussen discussed the existence of a soil formation known as the Indio Silts. This soil formation is shown on USDA soil maps and is indicated as having significant settlement potential. Mr. Rasmussen concluded that these soils should be specifically addressed by the Soils Engineer.

Inasmuch as our initial investigation did not heavily explore areas believed to be underlain by the Indio Silt formation, additional investigation was performed by this firm. Our additional investigation involved the excavation of 3 additional test pits excavated to a maximum depth of 7.0 feet utilizing hand equipment. The soils encountered were examined and visually classified by one of our field engineers. Undisturbed samples of the Indio Silts were obtained at selected levels within the test pits and returned to the laboratory for testing and evaluation. Included in our laboratory testing were moisture-density determinations on all undisturbed samples. In addition, selected samples were tested in consolidation in order that we might evaluate the settlement potential of this soil formation. Our test pit logs, together with our moisture density data, is presented on Enclosure 2. The test pit logs show the subsurface conditions at the locations and date indicated and may not be representative of subsurface conditions at other locations and times. The stratification lines presented on the test pit logs represent the approximate boundaries between soil types and the transitions may be gradual. Summaries of our consolidation tests are presented on Enclosure 3.

Our laboratory test data indicates that the Indio Silts are subject to significant consolidation under the anticipated foundation loads, especially upon saturation. To provide adequate foundation support, residential structures placed in areas known to be underlain by the Indio Silts should be founded on a compacted fill mat. A compacted fill mat will provide a uniform, dense, high strength soil area layer to distribute the foundation loads over the compressible underlying soils. In addition, a compacted fill mat will provide a relatively impermeable soil layer to inhibit percolation of surface water to the collapsible underlying soils. We anticipate that conventional spread or continuous wall footings may be safely utilized in conjunction with a compacted fill mat. Additional measures to minimize settlement would be positive drainage away from the structures. In addition, residences in these areas should be provided with eave gutters and downspouts.

We trust this information is sufficient for your needs at this time. If we may be of further assistance or should questions arise, please do not hesitate to contact this office.

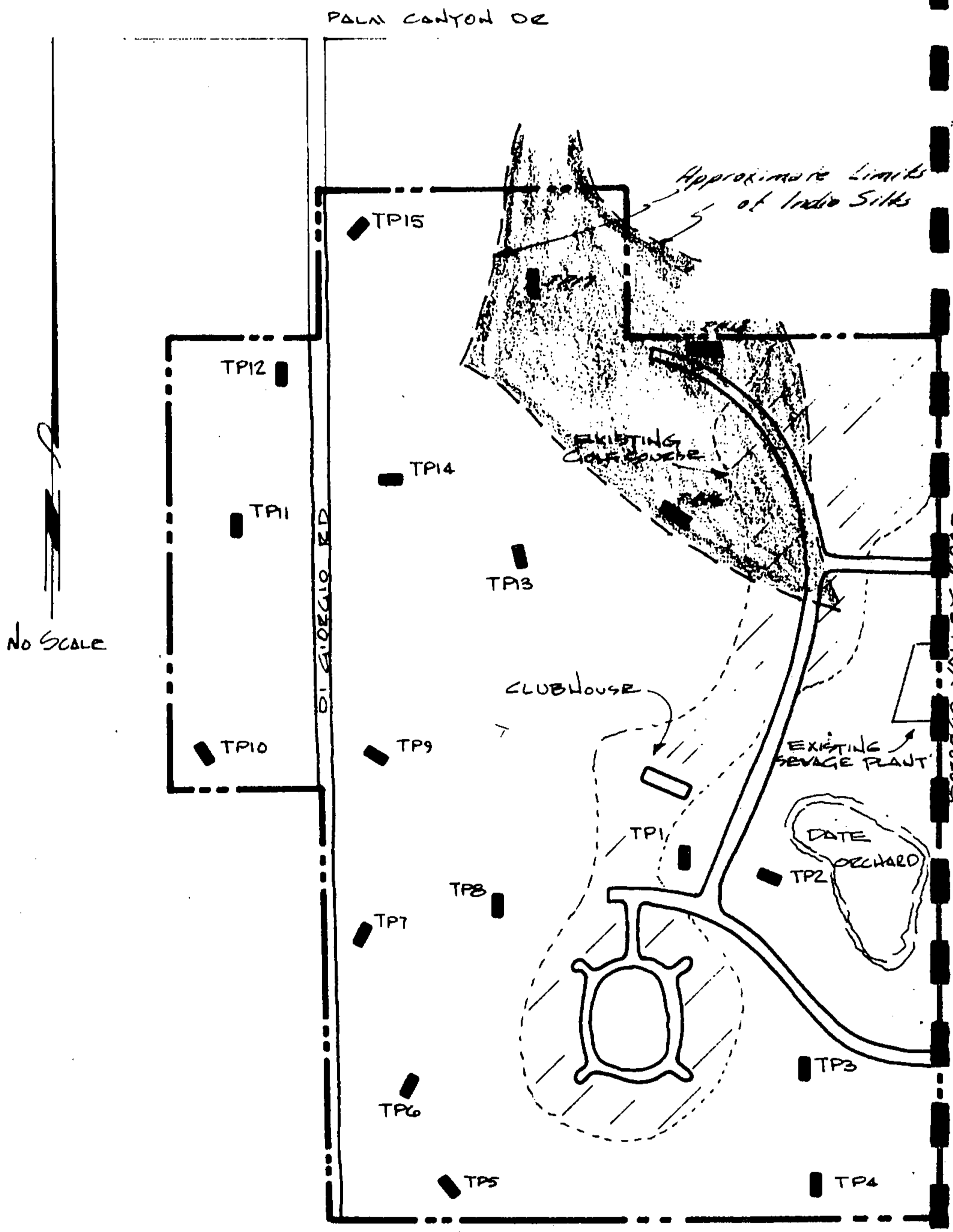
Respectfully submitted,

JOHN R. BYERLY, INC.

Roger A. Shervington, Civil Engineer

Enclosures: (1) Plot Plan
(2) Test Pit Logs
(3) Consolidation Test Data

cc: (3) Boyle Engineering
Attn: Wesley Hylen

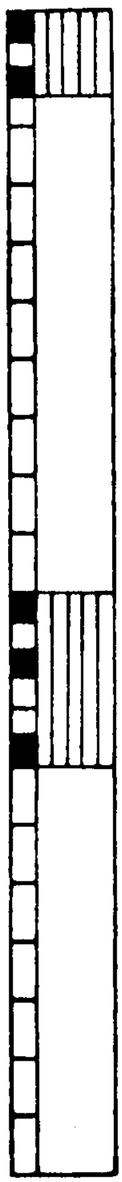


Enclosure 1
Rpt. No.: 8977
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)	
					Test Pit No. 16
				0	Grey fine sandy silt (ML) (dry & firm) (porous)
	77	1.8		1	
	80	5.4			Total depth 1.5 feet
				2	No free ground water encountered
					Test Pit No. 17
	78	2.2		0	Grey fine sandy silt (ML) (dry & firm) (porous)
	78	2.5		1	
				2	
	91	1.7		3	Total depth 3.0 feet
				4	No free ground water encountered



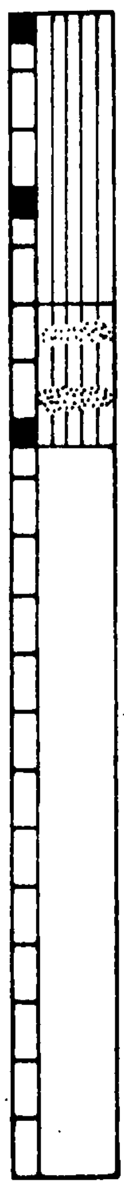
Enclosure 2, Page 1
Rpt. No.: 8977
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Federated Development Company
Proposed Borrego Springs Development
Test Pit No. 18

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
				0
	92	1.7		1
				2
				3
	80	4.5		4
				5
				6
	87	4.1		7
				8
				9
				10
				11
				12
				13
				14
				15
				16
				17
				18
				19
				20



Grey fine sandy silt (ML) (dry and firm) (porous)

As above, w/inclusions of fine sand (S

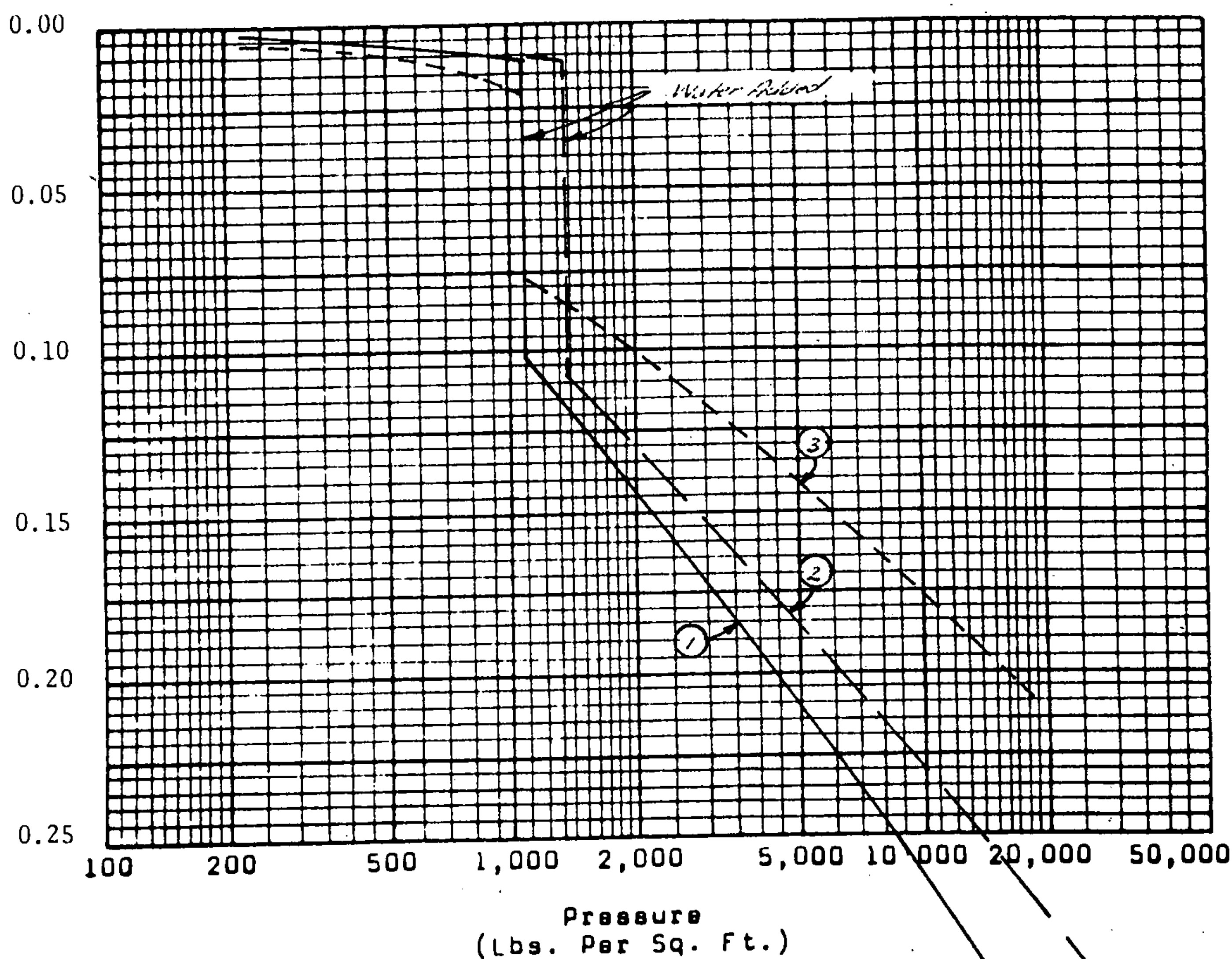
Total depth 7.5 feet

No free ground water encountered

Enclosure 2, Page 2
Rpt. No.: 8977
File No.: S-4559

PROJECT: BORREGO SPRINGS

CONSOLIDATION TEST DATA



Curve	Boring	Depth	Soil	Moisture Content Before	Moisture Content After	Dry Density Lbs./Cu.Ft.
1	16	0.0	Grey fine sandy silt (ML)	1.8		77.1
2	16	1.0	Grey fine sandy silt (ML)	5.4		79.9
3	18	7.0	Grey fine sandy silt (ML)	4.7		87.1

Enclosure 3
Rpt. No.: 8977

APPENDIX D

Soils Investigation

Woodward-Clyde-Sherard and Associates

SOIL INVESTIGATION FOR THE PROPOSED

BORREGO SPRINGS PARK DEVELOPMENT

San Diego, California

by

WOODWARD-CLYDE-SHERARD AND ASSOCIATES
Consulting Soil and Foundation Engineers

San Diego, California

BORREGO SPRINGS PARK

3010 Cowley Way
San Diego, California

WOODWARD • CLYDE • SHERARD & ASSOCIATES Consulting Civil Engineers

3467 KURTZ STREET • SAN DIEGO 10, CALIFORNIA • TELEPHONE ACADEMY 2-1187
Soil and Foundation Engineering

DENVER, COLO.
KANSAS CITY, MO.
OAKLAND, CALIF.
OMAHA, NEB.
MONTCLAIR, N. J.
SAN DIEGO, CALIF.
NEW YORK, N. Y.

April 13, 1962
Job No. 62-164

Borrego Springs Park
3010 Cowley Way
San Diego, California

Attention: Mr. Vince Mattingly

Gentlemen:

At the requst of Mr. Vince Mattingly of your organization, we have made an investigation of the underlying soil conditions at the site of the proposed Borrego Springs Park development.

The accompanying report gives our conclusions and recommendations as well as the results of the subsurface exploration and laboratory tests upon which these recommendations are based.

Very truly yours,

WOODWARD-CLYDE-SHERARD & ASSOCIATES

By Gerald L. Baker
Gerald L. Baker, R. E. 12112

Reviewed by
Douglas C. Moorhouse, R. E. 9027

(8 cc)

Lewis Lee
224-291

TABLE OF CONTENTS

SCOPE

This report describes an investigation of the underlying soil conditions at the site of the proposed Borrego Springs Park development, located in portions of Sections 4, 5, 8, and 9, T11S, R6E SBBM, near Borrego Springs, California. The study is intended to determine the most suitable foundation type, required footing depths and allowable soil bearing pressures for residential construction, as well as to make recommendations regarding site grading. In addition, the requirements of the Federal Housing Administration and the San Diego Department of Public Health regarding sewage disposal are presented.

FIELD INVESTIGATION

Fourteen test borings were made with a 6-inch diameter power auger at the locations shown on the Site Plan, Figure 1. The drilling was done on March 29, 30 and 31, 1962, under the supervision of a staff engineering geologist. Field boring logs were prepared by the geologist on the basis of an examination of the samples secured and the excavated material. The Logs of Borings presented on Figures 1 through 4, are based on an inspection of the samples, on the laboratory test results, and on the field boring logs. The vertical position of each sample is shown on the Logs of Borings.

In addition to the work done to determine the soil conditions, twelve percolation tests and four field permeability tests were performed to aid in estimating the requirements for sewage disposal systems. The percolation tests were made at a depth of 3 feet and in accordance with the procedure outlined on page 4 of "Manual of Septic Tank Practice" published by the U.S. Department of Health, Education and Welfare. The field permeability tests were performed in accordance with test Designation E-19, as described in the "Earth Manual" published by the U. S. Department of the Interior, Bureau of Reclamation. The results of these tests are given in Tables 1 and 2.

LABORATORY TESTS

The soils encountered were visually classified and evaluated with respect to strength, compressibility characteristics, dry density and moisture content. The classification was substantiated by grain size analyses on representative samples of the soils. Fill suitability tests, including compaction tests, direct shear tests, and grain size analyses were performed on representative samples of the on-site soils. The strength of the soils was evaluated by consideration of the density and moisture content of the samples and the penetration resistance of the sampler. Compressibility characteristics were evaluated by confined compression tests on undisturbed samples and consideration of the density of the samples and the penetration resistance of the sampler.

The results of tests on undisturbed samples, except for the confined compression tests, are shown with the penetration resistance of the sampler at the corresponding sample location on the Logs of Borings. The confined compression tests are reported in Table 3, and the fill suitability tests are reported on Figures 5, 6 and 7.

SITE AND SOIL CONDITIONS

The site is located in the western portion of Borrego Valley along the eastern margin of the alluvial fans extending eastward from the mountains. The ground surface slopes gradually toward the northeast at a maximum grade of about 1 percent. As indicated on the site plan, a portion of the site is used for date orchards. An unpaved airstrip and three high capacity wells also exist on the property. The northern portion of the property has been used in the past to raise various grains and cotton; however according to long-time residents of the area, the southern portion has always remained dormant.

The soils encountered at the site consist of sands and silts varying in consistency from loose to dens. In general, the soils become finer in texture and slightly lower in density in a northeast direction. Above an elevation of approximately 560 feet, the soils are loose silty sands to a depth of 1 to 2 feet, and are underlain by medium dense to dense silty sands. Below an elevation of approximately 560 feet, the soils are loose silty sands and sandy silts to depths varying from 3 to 13 feet; these soils are underlain by medium-dense to dense silty sands and sandy silts.

The maximum depth of the alluvial material is not known, although the logs of the wells on the property indicate that they extend below a depth of 630 feet. Ground water was not encountered in any of the borings, and the soils, except for some of the underlying silt layers were very low in moisture content.

DISCUSSION

Two requirements must be fulfilled by any foundation material. First, it must be safe against shear failure, which would result in lateral movement of soil from under the load. Second, the settlement must not exceed the amount permissible for the particular type of structure.

Sandy soils, such as those encountered at the site, have good shear strengths when properly confined. Settlement on such soils is not excessive if the bearing capacity is governed by the compactness of the material. Compactness is best measured by the dry density of the sample and the resistance to penetration of the sampler. As mentioned previously, below an elevation of approximately 560 feet, the soils tend to be low in density to greater depths. In their present condition, some of these soils could densify under normal residential footing loads, resulting in undesirable settlements of the structures. Additional densification could take place if the soils became saturated at a later date, for example, from lawn watering. It is anticipated that this condition can be alleviated by surface compaction with a heavy vibrating sheepsfoot roller, although the type and extent of treatment necessary can best be determined when development plans showing the location and type of structures and any proposed grading are available.

The percolation and permeability test data indicate that the soils at the site are capable of readily accepting water, and for the most part, the minimum acceptable lengths of disposal trenches will be satisfactory. However, we have discussed this project with Mr. Edwin Heimlich, Chief Land Planner for the San Diego office of the Federal Housing Administration and Mr. J. H. Whitman, Assistant Chief, Division of Sanitation, San Diego Department of Public Health, and Mr. Arthur Swajian, Chairman, Water Pollution Control Board, Colorado River Basin, Region 7. These gentlemen indicate that if multiple family dwellings on large lots are proposed, a sewage treatment plant must be constructed. It appears, though, that if the development consists of single family residences on individual lots, individual septic tanks and disposal fields will be acceptable. For this case, the other agencies have indicated that the requirements of the San Diego Department of Public Health will govern. For the types of soils encountered, the publications of the San Diego Department of Public Health (Ordinance 1258 New Series, and SAN 88) indicate that two-compartment septic tanks having a minimum capacity of 960 gallons will be required and two 100 foot long disposal trenches will probably suffice for each lot. The Department of Public Health does not encourage the use of seepage pits (rather than disposal trenches), however, according to local residents standard practice in the Borrego Springs area appears to be the use of a horizontal seepage pit 4 feet wide, 6 feet deep, and 10 feet long. The Department of Public Health also requires that at least twenty percent of the lots in a subdivision be tested to determine the rate of percolation.

If the proposed development consists of multiple family living units on large lots, the requirements for sewage treatment and disposal will be determined by the Federal Housing Administration and the State Water Pollution Control Board. Both of these agencies have indicated that the requirements for treatment and disposal can be determined only after a study of the proposed development. The normal procedure is to submit plans for the proposed development, including plans showing the method of sewage treatment and disposal. These agencies will then study the plans to determine if the proposed treatment is satisfactory and recommend modifications where necessary.

CONCLUSIONS

1. Footings for residential structures placed on the underlying medium-dense undisturbed native soils (above elevation 560 feet) or properly compacted fill may be designed for a bearing pressure of 1500 psf at a depth of 8 inches or 2000 psf at a depth of 12 inches below rough lot grade.

2. When development plans for the northeast portion of the site (below elevation (560 feet) are available, additional study should be made of this area to determine the possible effects of saturation of the loose soils under the load. The study should include field plate bearing tests on saturated areas and laboratory tests on both undisturbed and compacted samples.

3. The soils expected to be used in fills have low volume change characteristics.

4. If single family residences on individual lots are planned for this development, two-compartment septic tanks having a minimum capacity of 960 gallons will be required for each residence. Disposal of the effluent can probably be accomplished by two 100 foot long disposal trenches or one seepage pit 4 feet wide 6 feet deep and 10 feet long. At least twenty percent of the lots in a subdivision must be tested to determine the rate of percolation.

5. If the proposed development consists of multiple family living units on large lots, a sewage treatment plant will be required by the San Diego Department of Public Health and the Federal Housing Administration. The design of the treatment plant and the means of disposal of effluent must be approved by the Federal

Housing Administration and the State Water Pollution Control Board, Colorado River Basin, Region 7.

RECOMMENDATIONS

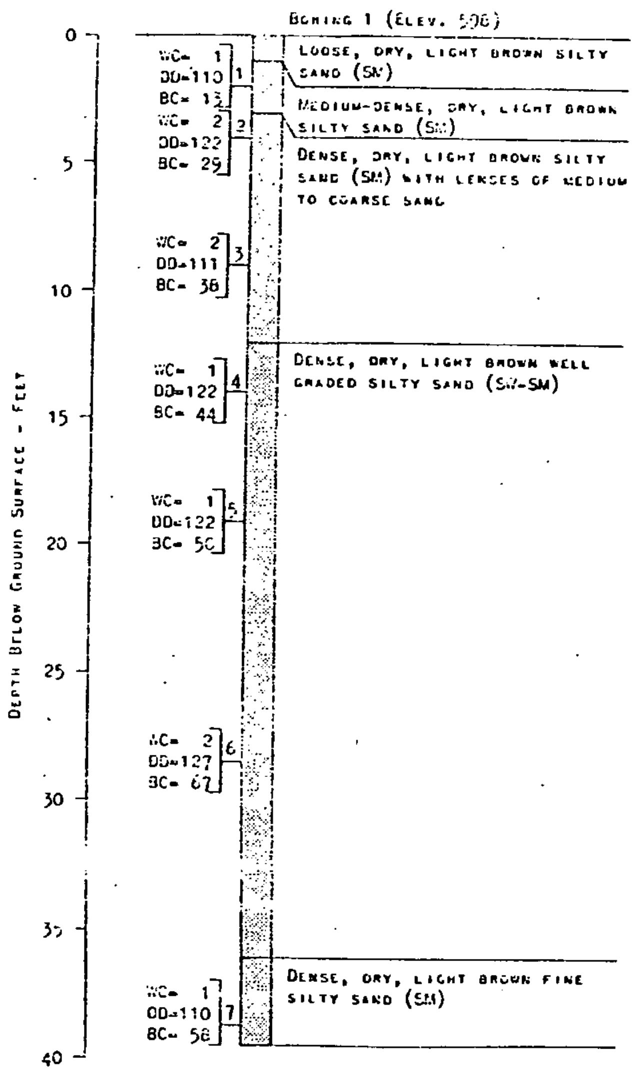
1. It is recommended that the loose surface soils not removed by grading operations be compacted before footings or slabs are placed.

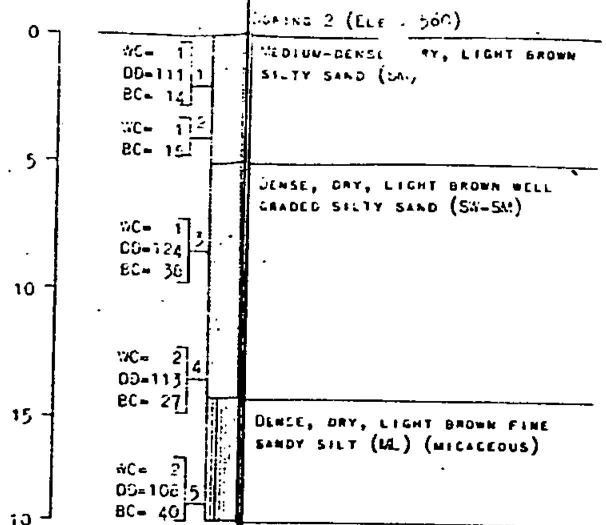
2. It is recommended that a study of the disposition of the loose material in the northeast portion of the site be made when development plans are available. It is anticipated that compaction from the surface by heavy compaction equipment will densify the soils sufficiently, although it may be necessary to remove part of these materials and replace them as compacted fill.

3. A set of earthwork specifications is attached. The recommendations made as a part of this preliminary soils report shall become a part of the earthwork specifications.

LIMITATIONS

The recommendations made in this report are based on the assumption that the soil conditions do not deviate appreciably from those disclosed by the borings. If variations are encountered during construction, we should be notified so we may make supplemental recommendations if this should be required.





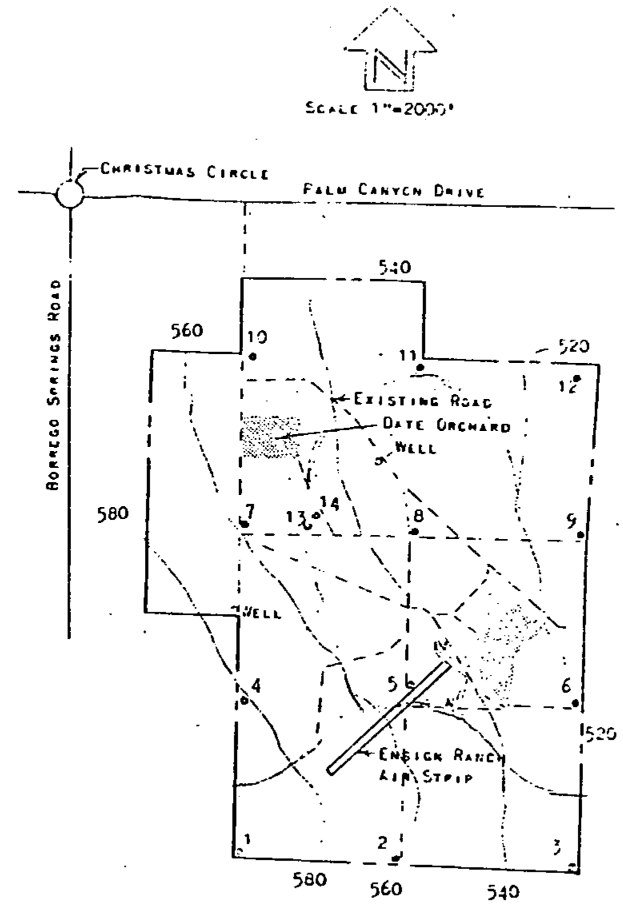
LEGEND

WC = Water Content in percent of dry weight.

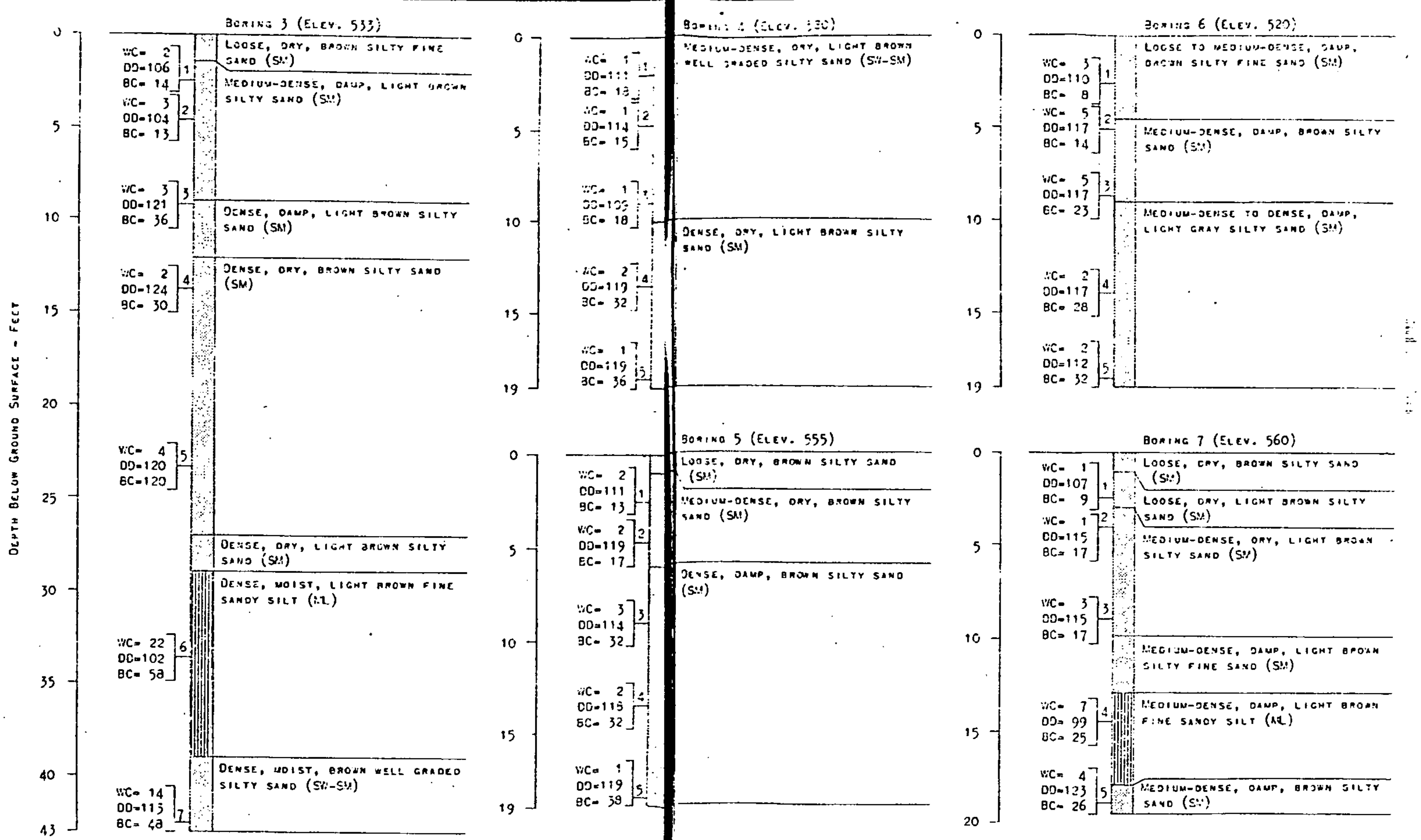
DD = Dry Density in Lbs./Cu.Ft.

BC = Number of blows by 140-Lb. hammer falling 30 inches to drive sampler 12 inches. Sampler Data: ID = 2.0", OD = 2.5".

(SM) = Group classification symbol in accordance with the Unified Soil Classification System.

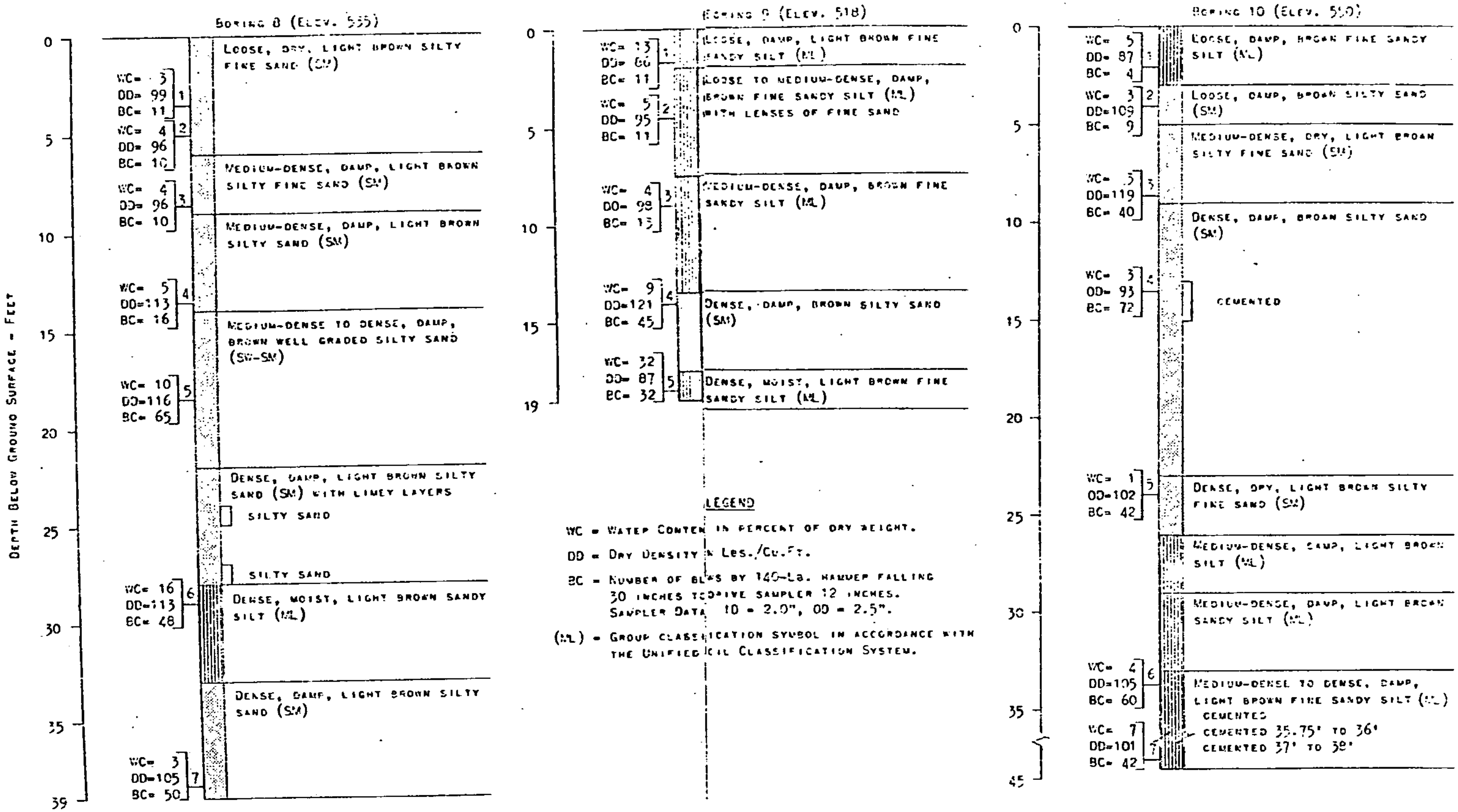


SITE PLAN
AND
LOGS OF TEST BORINGS 1 & 2
BORREGO SPRINGS PARK
JOB NO. 62-164

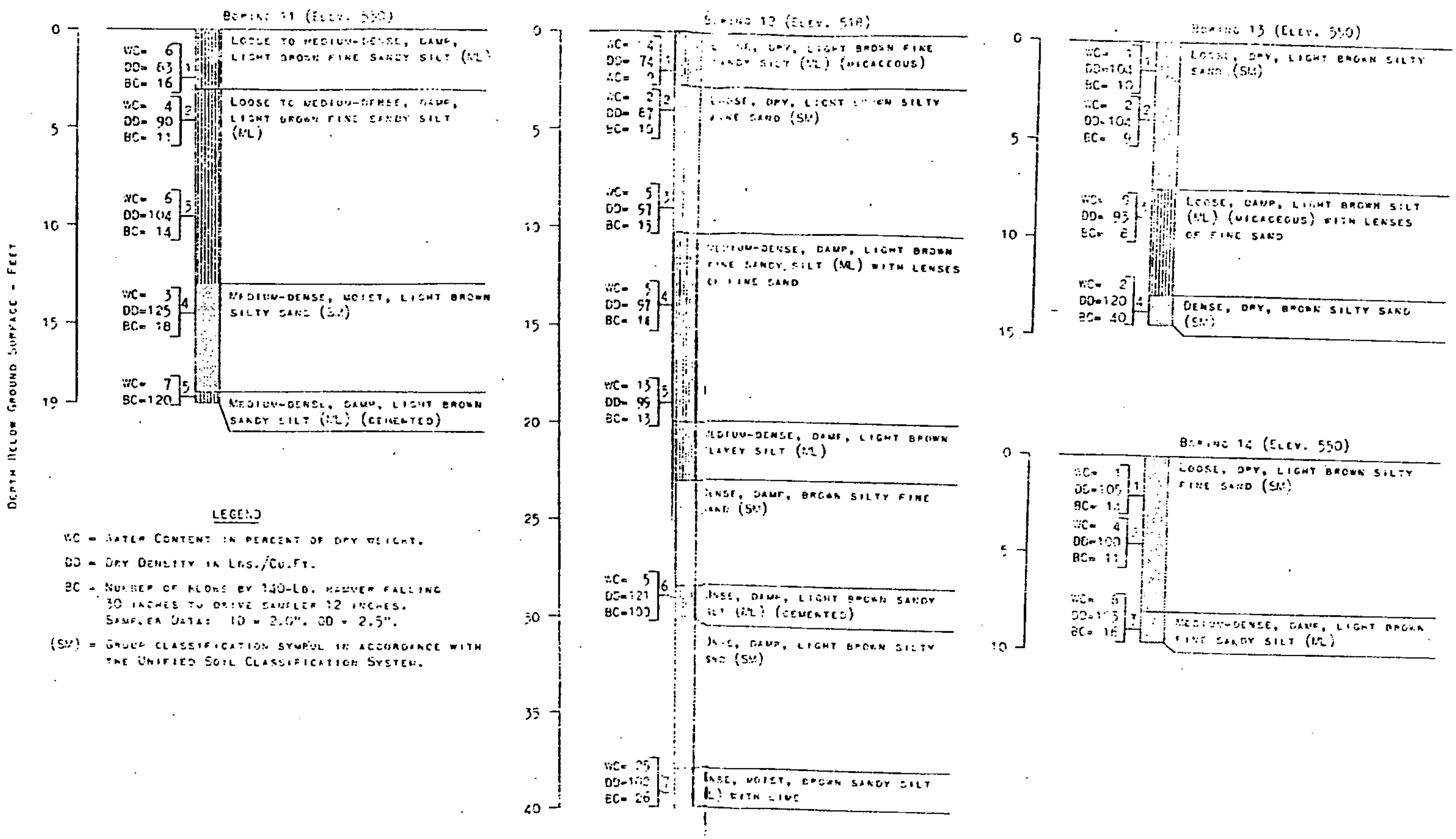


Note: For Legend see Fig. 1

LOGS OF TEST BORINGS
3 THROUGH 7
BORREGO SPRINGS PARK
JOB NO. 62-164



LOGS OF TEST BORINGS
8 THROUGH 10
EORREGO SPRINGS PARK
JOB NO. 62-164



LEGEND

WC = Water content in percent of dry weight.

DD = Dry density in Lbs./Cu.Ft.

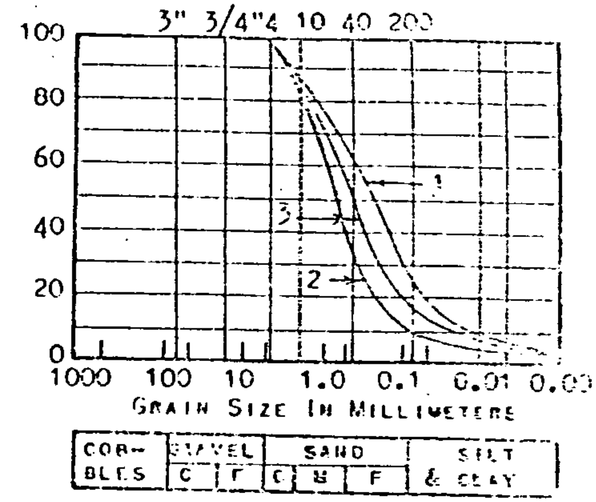
BC = Number of blows by 140-Lb. hammer falling 30 inches to drive sampler 12 inches. Sampler Data: ID = 2.0", OD = 2.5".

(SM) = Group classification symbol in accordance with the Unified Soil Classification System.

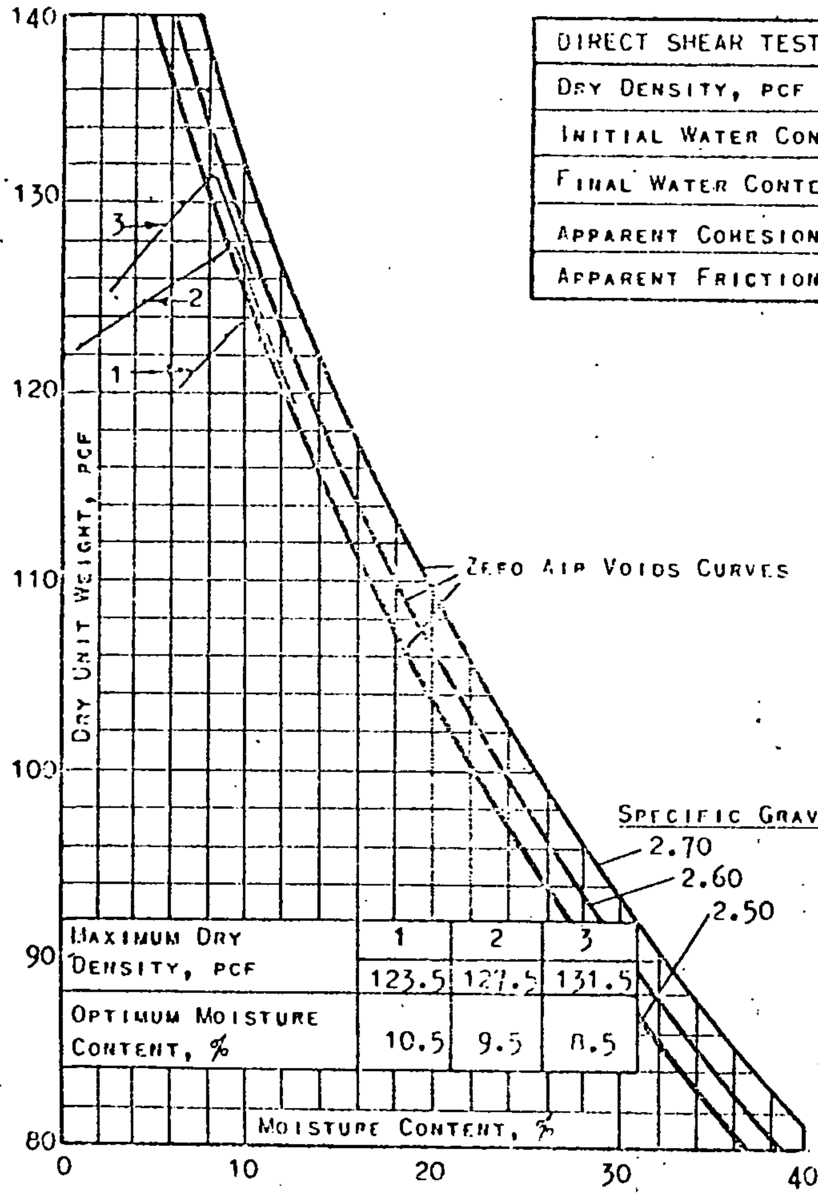
LOGS OF TEST BORINGS
11 THROUGH 14
BORREGO SPRINGS PARK
JOB NO. 62-164

DIRECT SHEAR TEST

DIRECT SHEAR TEST DATA	1	2	3
DRY DENSITY, PCF	111	115	118
INITIAL WATER CONTENT, %	11.1	6.9	7.5
FINAL WATER CONTENT, %	16.4	14.5	13.5
APPARENT COHESION, PCF	250	200	210
APPARENT FRICTION ANGLE, °	28	36	34



EXPANSIBILITY CHARACTERISTICS	1	2	3
LIQUID LIMIT, %			
PLASTICITY INDEX, %			
SHRINKAGE LIMIT, %			
COLLOIDAL CONTENT, %			
POTENTIAL EXPANSIBILITY:			



	1	2	3
MAXIMUM DRY DENSITY, PCF	123.5	127.5	131.5
OPTIMUM MOISTURE CONTENT, %	10.5	9.5	8.5

LABORATORY COMPACTION TEST

WOODWARD-CLYDE-SHERARD & ASSOCIATES

FILL SUITABILITY TESTS

BORREGO SPRINGS PARK

JOB NO. 62-164

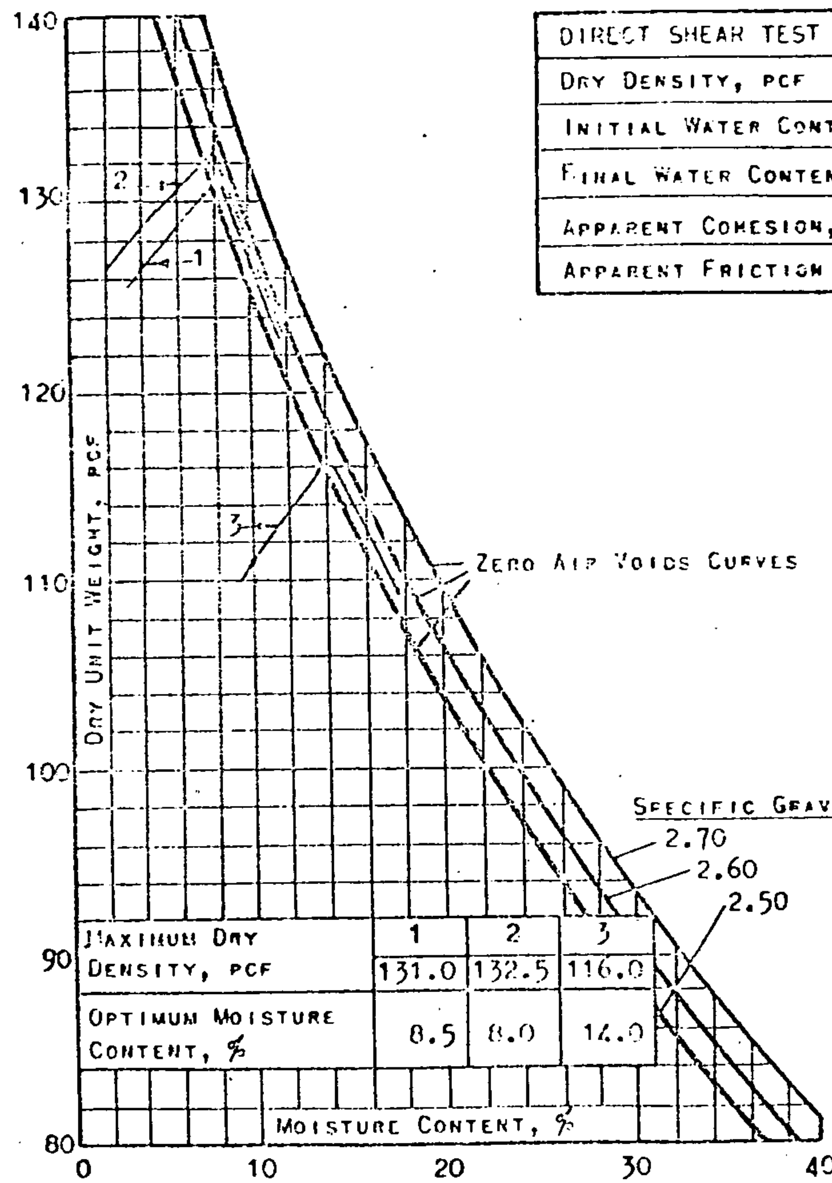
SPECIMEN 1: SAMPLE 3-1

SPECIMEN 2: SAMPLE 4-1

SPECIMEN 3: SAMPLE 5-1

DIRECT SHEAR TEST

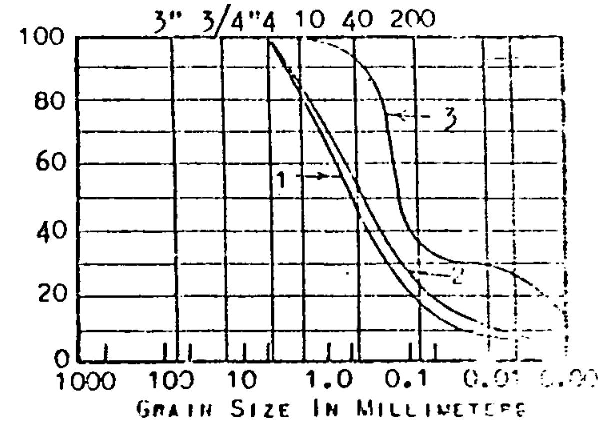
DIRECT SHEAR TEST DATA	1	2	3
DRY DENSITY, PCF	118	119	104
INITIAL WATER CONTENT, %	8.1	8.8	16.2
FINAL WATER CONTENT, %	15.2	13.8	21.4
APPARENT COHESION, PCF	210	240	370
APPARENT FRICTION ANGLE, °	34	33	25



	1	2	3
MAXIMUM DRY DENSITY, PCF	131.0	132.5	116.0
OPTIMUM MOISTURE CONTENT, %	8.5	8.0	14.0

LABORATORY COMPACTION TEST

MECHANICAL ANALYSIS



COBBLES	GRAVEL		SAND			SILT & CLAY
	C	F	C	M	F	

EXPANSIBILITY CHARACTERISTICS	1	2	3
LIQUID LIMIT, %			
PLASTICITY INDEX, %			
SHRINKAGE LIMIT, %			
COLLOIDAL CONTENT, %			
POTENTIAL EXPANSIBILITY:			

WOODWARD-CLYDE-SHERARD & ASSOCIATES

FILL SUITABILITY TESTS

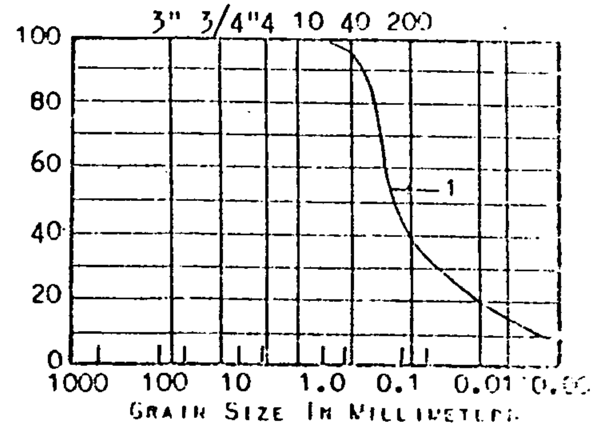
BORREGO SPRINGS PARK
JOB NO. 62-164

SPECIMEN 1: SAMPLE 6-3
SPECIMEN 2: SAMPLE 10-4
SPECIMEN 3: SAMPLE 11-1

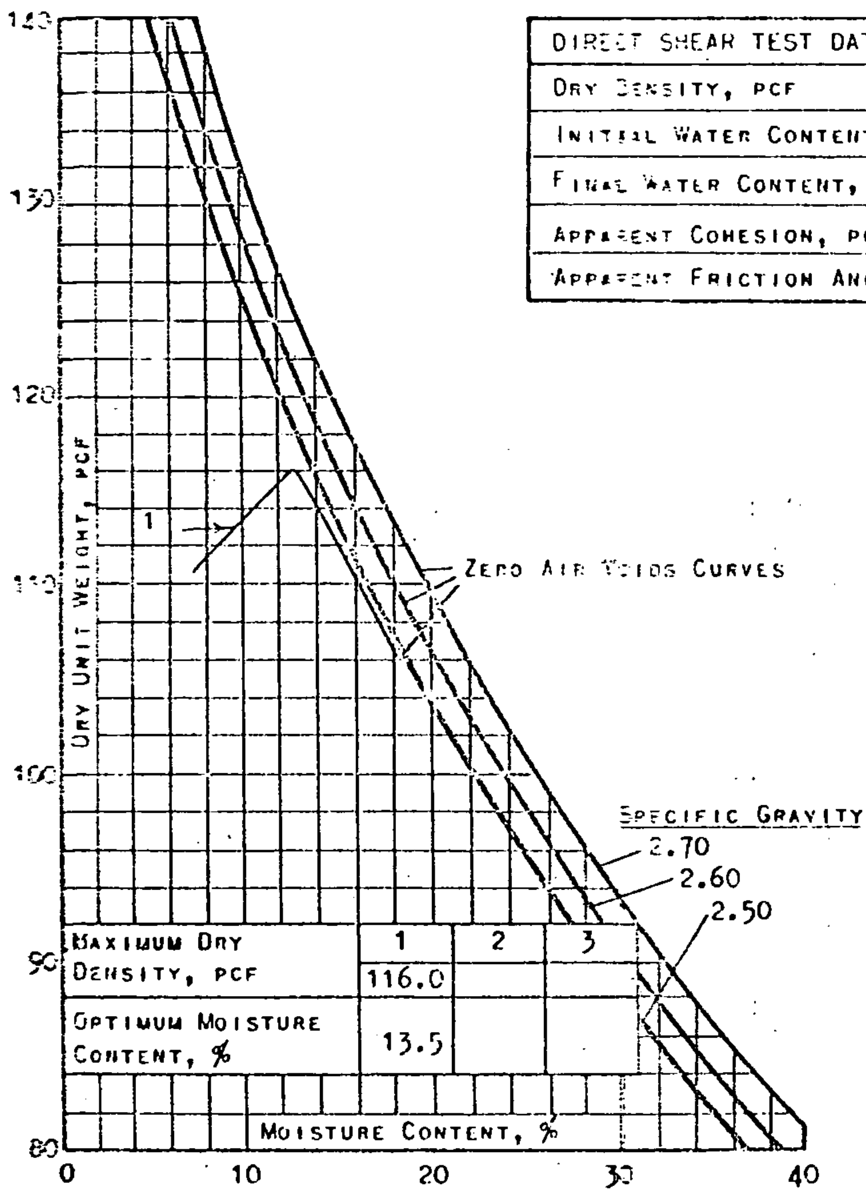
DIRECT SHEAR TEST

DIRECT SHEAR TEST DATA	1	2	3
Dry Density, pcf	104		
Initial Water Content, %	14.2		
Final Water Content, %	21.2		
Apparent Cohesion, pcf	290		
Apparent Friction Angle,°	26		

MECHANICAL ANALYSIS



COB-BLES	GRAVEL		SAND			SILT & CLAY
	C	F	C	M	F	



Maximum Dry Density, pcf	1	2	3
	116.0		
Optimum Moisture Content, %	13.5		

LABORATORY COMPACTION TEST

EXPANSIBILITY CHARACTERISTICS	1	2	3
Liquid Limit, %			
Plasticity Index, %			
Shrinkage Limit, %			
Colloidal Content, %			
Potential Expansibility:			

Woodward-Clyde-Sherard & Associates

FILL SUITABILITY TESTS

BORREGO SPRINGS PARK

JOB NO. 62-164

Specimen 1: Sample 12-3

TABLE 2 - RESULTS OF FIELD PERMEABILITY TESTS

Test No.	Location	Depth of Well feet	Radius of Well feet	Depth of Water feet	Rate of Flow Ft^3/Min.	Permeability * Ft/Year
1	Boring 1	5.0	0.25	4.0	.122	17,000
2	Boring 3	5.0	0.25	4.0	.030	410
3	Boring 10	5.0	0.25	4.0	.030	410
4	Boring 12	5.0	0.25	4.0	.070	950

* Permeability determined from Figure 19-6 "Earth Manual" U.S. Department of Interior, Bureau of Reclamation.

TABLE 1 - RESULTS OF PERCOLATION TESTS

Test No.*	Time	Depth of Water Inches	Percolation Rate ** Minutes/Inch
1	8:00	7.0	
	8:10	3.0	
	8:20	0	
	8:20	7.0	
	8:30	3.0	
	8:40	0	0.30
2	8:15	6.0	
	8:25	0	
	8:25	6.0	
	8:35	0	0.60
3	8:43	6.0	
	8:53	1.8	
	8:55	6.5	
	9:25	2.2	0.43
4	3:02	8.0	
	3:12	1.8	
	3:15	6.5	
	3:25	1.7	0.48
5	1:35	7.5	
	1:45	6.25	
	1:55	4.75	
	2:05	3.5	
	2:15	2.5	
	2:25	1.25	
	2:35	0	0.12
6	1:39	7.0	
	1:49	5.75	
	2:00	4.5	
	2:10	3.25	
	2:20	2.0	
	2:30	1.0	0.10
7	10:54	6.0	
	11:04	4.5	
	11:04	6.0	
	11:14	4.5	0.15
8	10:51	6.0	
	11:07	4.5	
	11:07	6.0	
	11:17	4.5	0.15
9	11:00	6.5	
	11:10	5.5	
	11:10	7.0	
	11:20	6.0	0.10
10	1:47	8.0	
	1:47	4.0	
	2:10	0	
	2:11	7.0	
	2:21	3.5	
	2:31	0	0.35
11	8:30	7.0	
	8:40	5.0	
	8:50	2.0	
	9:00	1.0	0.10
12	7:45	8.0	
	7:55	4.0	
	8:05	1.0	
	8:15	6.0	
	8:25	3.0	
	8:35	0	0.30

* Tests were performed adjacent to Borings with same number

** Computed for the last 10 minutes

RESULTS OF CONFINED COMPRESSION TESTS

Sample Number	Initial: Dry Density (PCF)	Initial: Water Content (Percent of Dry Weight)	Degree of Saturation: Initial (Percent)	Degree of Saturation: Final (Percent)	Load (PSF)	Deformation, Percent of Initial Height: Before Saturation	Deformation, Percent of Initial Height: After Saturation
6-1	101.9	3.4	13	88	500	1.0	1.4
6-1	102.2	3.3	14	89	1000	2.0	2.1
8-2	90.5	4.4	13	89	500	0.7	0.8
8-2	91.4	3.9	12	94	1000	1.7	0.7
9-1	80.0	12.7	31	94	500	0.7	0.9
9-1	78.4	16.1	38	98	1000	1.1	1.7
10-1	71.0	7.0	13	94	500	1.3	6.2
10-1	78.7	5.0	12	91	1000	2.4	7.9

Job No. 62-164

September 23, 19[illegible]
Revised February 15, 196[illegible]

EARTHWORK SPECIFICATIONS

GENERAL REQUIREMENTS

This specifications covers the method of control and supervision, and preparation of existing surfaces to receive fill; the type of soil suitable; the control of compaction and methods of testing compacted fills.

SCOPE

The earthwork shall consist of performing all operations necessary to excavate earth and rock from the cut areas, as designated on the plans; to excavate ditches, including ditches at the top of cut slopes, channels, and borrow pits; to build fills in the locations and to the elevations and form shown on the plans; to dispose of all unsuitable material and excess excavation as shown on the plans or as directed by the Soil Engineer; and to perform all incidental work of whatsoever nature which may be required for cutting, filling, and grading as shown on the plans; and to maintain the finished products in the form specified until the completion and acceptance of the contract.

EXCAVATION

Excavation shall be made to the elevations and the form planned, with finish grades and slopes cut true and straight in conformity with the plans and specifications.

Select material from the excavations shall be placed and compacted as hereinafter specified in the "filled areas" and as shown on the plans.

COMPACTED FILLS

General

Fills shall be constructed to the depth and elevations as shown on the grading plan by placing and compacting select soil, as hereinafter specified, with finished grades and slopes true and straight in conformity with the plans.

Clearing, Grubbing and Preparing Areas to be Filled

(a) All timber, logs, trees, brush and other rubbish shall be removed, piled and burned or otherwise disposed of so as to leave the areas that have been disturbed with a neat and finished appearance free from unsightly debris.

(b) All vegetable matter shall be removed from the surface upon which the fill is to be placed and the full depth of loose soils shall be removed. The surface shall then be plowed or scarified to a depth of six inches (6"), and until the surface is free from ruts, hummocks or other uneven features which would tend to prevent uniform compaction by the equipment to be used.

(c) Where fills are made on hillsides or slopes, the slope of the original ground upon which the fill is to be placed shall be plowed or scarified deeply or where the slope ratio of the original ground is steeper than 6 horizontal to 1 vertical, the bank shall be stepped or benched.

(d) After the foundation for the fill has been cleared, plowed or scarified, it shall be disced or bladed until it is uniform and free from large clods brought to the proper moisture content and compacted to not less than ninety percent (90%) of maximum density in accordance with AASHO test No. T180-57 Method A., or other density test methods which will obtain equivelent results.

Select Materials

Select material shall be any soil excavated from the cut areas which, in the opinion of the Soil Engineer, is suitable for use in constructing fills, and which contains no rocks or hard lumps six inches or over in diameter, and which contains at least 40% of material smaller than one-quarter inch (¼") in diameter. The material used within two feet of rough lot grade shall be nonexpansive select material. For the purpose of this specification nonexpansive materials are defined as those materials which have a liquid limit less than 30 percent, a plasticity index less than 10 percent and which swell less than one percent when compacted as hereinafter specified for compacted fill and when subjected to an axial pressure of 150 pounds per square foot.

No material of a perishable, spongy, or otherwise of an improper nature shall be used in filling.

Placing, Spreading, and Compacting Fill Material

(a) The selected fill material shall be placed in layers which when compacted shall not exceed six inches (6"). Each layer shall be spread evenly and shall be thoroughly blade mixed during the spreading to insure uniformity of material in each layer.

(b) When the moisture content of the fill material is below that specified by the Soil Engineer, water shall be added until the moisture content is as specified to assure thorough bonding during the compacting process.

(c) When the moisture content of the fill material is above that specified by the Soil Engineer, the fill material shall be aerated by blading or other satisfactory methods until the moisture content is as specified.

(d) After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted to not less than ninety percent (90%) of maximum density in accordance with the AASHO Test No. T180-57 Method A, or other density tests which will obtain equivalent results. Compaction shall be accomplished by sheepsfoot rollers, multiple-wheel pneumatic-tired rollers or other types of acceptable rollers. Rollers shall be of such design that they will be able to compact the fill to the specified density. Rolling shall be continuous over its entire area and the roller shall make sufficient trips to insure that the desired density has been obtained.

(e) Fill slopes shall be compacted by means of sheepsfoot rollers or other suitable equipment. Compacting operations shall be continued until the slopes are stable but not too dense for planting and there is no appreciable amount of loose soil on the slopes. Compacting of the slopes may be done progressively in increments of 3 to 5 feet in fill height or after the fill is brought to its total height.

(f) Field density tests shall be made in accordance with A.S.T.M. Test No. D1556-58T by the Soil Engineer for each layer of fill. Density tests may be made at intervals not exceeding 2 feet of fill height provided all layers are tested. Where sheepsfoot rollers are used the soil may be disturbed to a depth of several inches. Density tests shall be made in the compacted materials below the disturbed surface. When these tests indicate that the density of any layer of fill or portion thereof is below the required (90%) density, the particular layer or portion shall be reworked until the required density has been obtained.

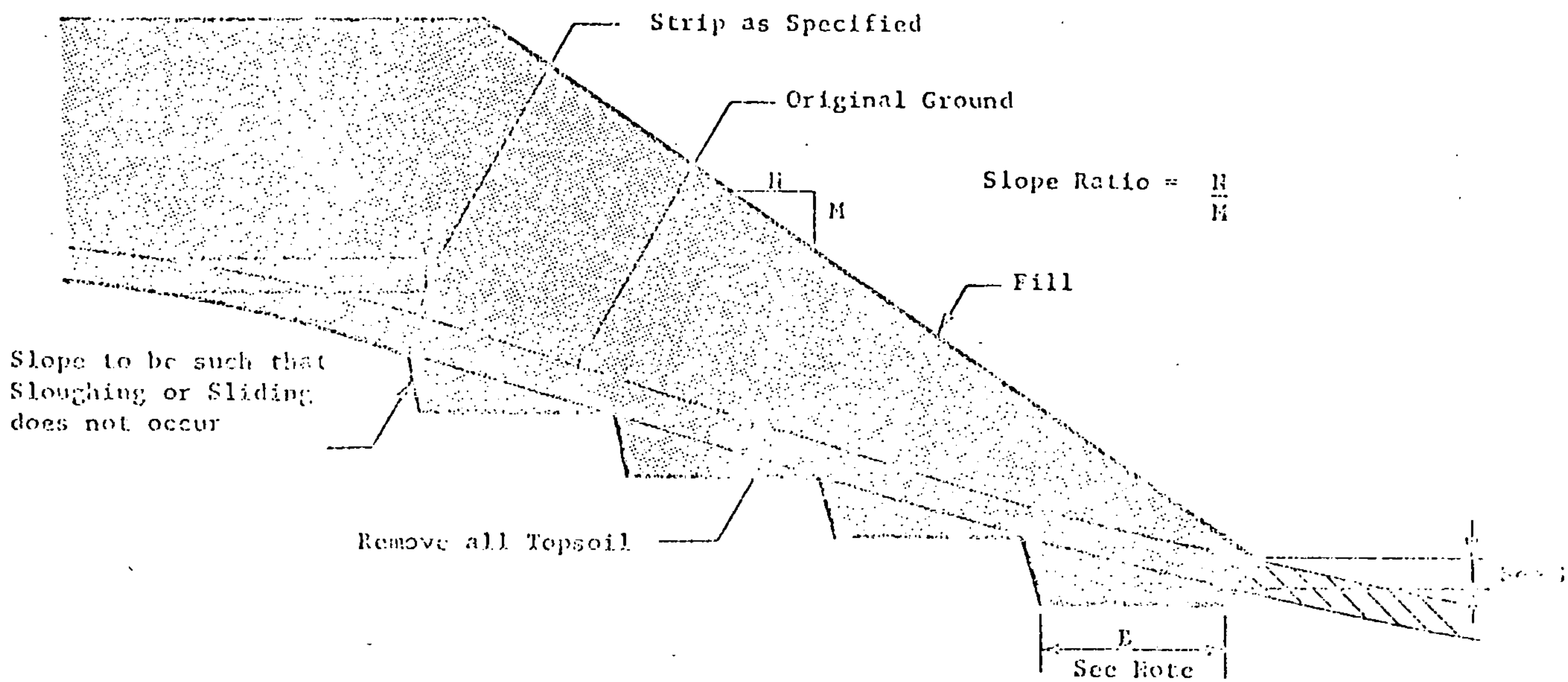
Supervision

Supervision by the Soil Engineer shall be made during the filling and compacting operations so that he can certify that the fill was made in accordance with accepted specifications.

Tests

During grading operations, soil types other than those analyzed in the preliminary soils report may be encountered. The Soil Engineer shall decide the suitability of these soils. Any special treatment recommended by the Soil Engineer in the preliminary and subsequent suitability soil reports, which is not covered in the Earthwork Specifications, shall become an addendum to the Earthwork Specifications.

Representative samples of material to be used for fill and/or sub-base shall be tested in the laboratory in order to determine the maximum density, optimum water content, and classification. In addition, the laboratory shall determine the approximate bearing value of a recompacted, saturated sample by direct shear or other method applicable to the particular soil.



NOTES

The minimum width "B" of key shall be 2 feet wider than the compaction equipment, and not less than 10 feet.

The outside edge of bottom key shall be below topsoil or loose surface material.

Keys are required where the natural slope is steeper than 6 horizontal to 1 vertical, or where specified by Soil Engineer.

WOODWARD · CLYDE · SHERARD & ASSOCIATES
CONSULTING SOIL ENGINEERS AND GEOLOGISTS

3467 Kurtz Street
San Diego
California 92110
(714) 224-2911

December 21, 1967
Project 67-103-115

Federal Mortgage Investors
10889 Wilshire Boulevard
Suite 1040
Los Angeles, California

Attention: Mr. Keith A. Miller

BORREGO SPRINGS PARK, CALIFORNIA

In accordance with your request, we have obtained two representative samples of soil from the area of the proposed lake at the subject site. Chemical and grain size analyses were performed on these materials in order to determine their general characteristics in relation to possible reaction with the proposed lining materials. The test results are presented on the attached forms.

Louis J. Lee, R. E. 14129
Chief Engineer

LJL/jsk

(4) Federal Mortgage Investors
(2) Campbell, Miller & Associates

December 21, 1967

MEMBER OF:
AMERICAN SOCIETY FOR METALS
INSTITUTE OF ENVIRONMENTAL SCIENCES
SOCIETY OF APPLIED SPECTROSCOPY
SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS

MEMBER OF:
AMERICAN WELDING SOCIETY
SOCIETY FOR NONDESTRUCTIVE TESTING
AMER. ASSN. FOR THE ADV. OF SCIENCE
NATIONAL RIFLE ASSN. OF AMERICA

CHEM-MET ASSOCIATES

MITCHELL P. CHRISTENSEN
E.M. Ch.E. Dmkr

2661 REYNARD WAY SAN DIEGO, CALIFORNIA 92103 298-5062

REPORT NO: CM-1519: December 20, 1967

Woodward, Clyde Sherard & Associates
3467 Kurtz Street
San Diego, California 92110

JOB. NO: 67-103-115
Borrego Springs Park
2-Samples Rec'd: 12-19-67AM

REPORT OF DETERMINATIONS OF SOLUBLE SALTS IN TWO SOIL SAMPLES:

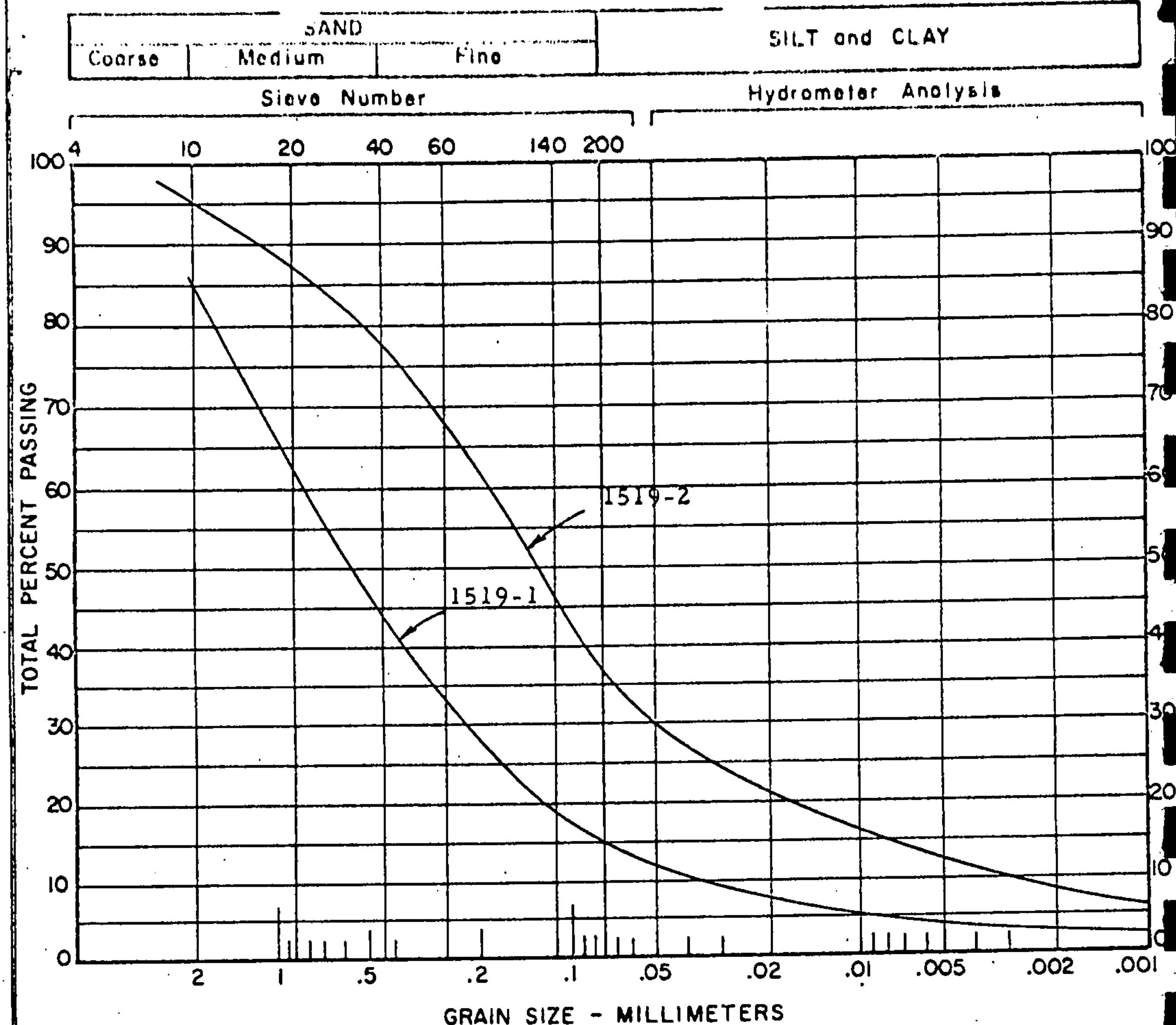
At your request we made the following determinations on two soil samples which you submitted, prepared for extraction, from test drillings:

DETERMINATIONS:	MARK:	SAMPLE 1519-1 "Borrego Springs Park Well #3 @6'7":"	SAMPLE 1519-2 "Borrego Springs Park@6'7", 300' South of Green #26:"
pH Value=		8.12 (Alkaline)	9.35 (VERY ALKALINE)
Nitrate:	(NO_3) =	0.0004% = 4 ppm	0.0006% = 6 ppm
Phosphate:	(P_2O_5) =	Nil	Nil
Potash:	(K_2O) =	0.0005%	0.0012%
Calcium:	(Ca) =	0.0210%	0.0365%
Magnesium:	(Mg) =	0.0014%	0.0045%
Sodium:	(Na) =	0.1550%	0.2240%
Iron:	(Fe) =	Nil	Nil
Manganese:	(Mn) =	Nil	Nil
Chloride:	(Cl)	0.1860%	0.2940%
Sulfate:	(SO_4)	0.0440%	0.0620%
Carbonates:	(CO_3)	Present LARGE AMOUNTS	Present Large Amounts

These are both definitely "Alkalie" soils and the presence of the high sulfate content would indicate deleterious reactions with Concrete, buried structures even if Low Alkalie Cement were used. This might also be true of certain plastic membrane materials, but a well graded, Asphaltic Concrete with a chlorinated-rubber sealant to protect against Ultra Violet degredation of the bitumins, should be satisfactory in contact with this caustic soil.

CHEM-MET ASSOCIATES,
By M. P. Christensen
M.P. Christensen-Ch.E. #2452 Calif.

(5) w/invoices Attn: L. Lee



SAMPLE	CLASSIFICATION AND SYMBOL
1519-1	Silty Sand (SM-SW)
1519-2	Silty Sand (SM)

WOODWARD, CLYDE, SHERARD & ASSOCIATES

GRAIN SIZE DISTRIBUTION CURVES

Borrego Springs Park

67-103-115

APPENDIX E

BIOLOGICAL DATA

ULTRASYSTEMS, INC.

APPENDIX E

TABLE 1

PLANTS OBSERVED* ON THE PROJECT SITE

CREOSOTE BUSH SCRUB/CREOSOTE - MESQUITE ASSOCIATION

Common Name	Scientific Name	Occurrence**
Asteraceae - Sunflower Family		
Arrowweed	Pulchea sericea	O
Burrobrush	Ambrosia dumosa	C
Cheesebush	Hymenoclea salsola	D
Desert Baccharis	Baccharis sergiloides	I
Desert Dandelion	Malacothrix glabrata	I
Pincushion Flower	Chaenactis stevioides	I
Spanish Needle	Palafoxia linearis	I
Sweetbush	Bebbia juncea	I
Cactaceae - Cactus Family		
Beavertail Cactus	Opuntia basilaris	I
Silver Cholla	O. echinocarpa	I
Pencil Cactus	O. ramosissima	I
Caryophyllaceae - Pink Family		
Frost Mat	Achyronychia cooperi	I
Cucurbitaceae - Gourd Family		
NCN	Cucurbita palmata	I
Euphorbiaceae - Spurge Family		
Croton	Croton californicus	I
Rattlesnake Weed	Euphorbia albomarginata	O
NCN	Euphorbia setiloba	

* Nomenclature Munz (1974)
** Occurrence

D = Dominant   S = Scattered   R = Restricted
I = Infrequent   O = Occasional

NCN = No Common Name

APPENDIX E CONTINUED

PLANTS OBSERVED* ON THE PROJECT SITE

CREOSOTE BUSH SCRUB CONTINUED

Common Name	Scientific Name	Occurrence**
Fabaceae - Pea Family		
Palo Verde	*Cercidium floridum*	I
Mesquite	*Prosopis juliflora*	I
Smoke Tree	*Dalea spinosa*	I
Krameriaceae - Krameria Family		
Krameria	*Krameria grayi*	O
Nyctaginaceae - Four-O'Clock Family		
Wish bone	*Mirabilis bigelovii*	I
Onagraceae - Evening Primrose Family		
Evening Primrose	*Camissonia claviformis*	O
Evening Primrose	*C. refracta*	I
Dune Primrose	*Oenothera deltoides*	I
Plantaginaceae - Plantain Family		
Woody Plantain	*Plantago insularis*	C
Poaceae - Grass Family		
Abu Mashi	*Schismus barbatus*	D
Gallita Grass	*Hilaria rigida*	O
Polemoniaceae - Phlox Family		
NCN	*Langloisia setosissima*	I
Polygonaceae - Buckwheat Family		
Buckwheat	*Eriogonium thomasii*	I
Desert Trumpet	*E. inflatum*	I

* Nomenclature Munz (1974)

** Occurrence

D = Dominant S = Scattered R = Restricted

I = Infrequent O = Occasional

APPENDIX E CONTINUED

PLANTS OBSERVED* ON THE PROJECT SITE

CREOSOTE BUSH SCRUB CONTINUED

Common Name	Scientific Name	Occurrence**
Zygophyllaceae - Caltrap Family		
Creosote Bush	Larrea tridentata	C
NCN	Kallstroemia californica	I
SALTBUSH SCRUB/DISTRUBED		
Amaranthaeceae - Pigweed Family		
Fringed Pigweed	Amaranthus fimbriatus	O
Arecaceae - Palm Family		
Date Palm	Phoenix dactylfer	C
Asteraceae - Sunflower Family		
Alkali Goldenbush	Haplopappus acradenius	I
Annual African Daisy	Dimorphotheca sinuata	I
Brittle Bush	Encelia farinosa	I
Cheesebush	Hymenoclea salsola	O
Desert Sunflower	Geraea canescens	O
Mule Fat	Baccharis glutinosa	I
Sow Thistle	Sonchus oleraceus	O
Telegraph Weed	Heterotheca grandiflora	O
Boraginaceae - Borage Family		
Comb-Bur	Pectocarya penicillata	I
Fiddleneck	Amsinckia tessellata	I
Popcorn Flower	Cryptantha augustifolia	D
Brassicaceae - Mustard Family		
London Rocket	Sisymbrium irio	C
Oriental Mustard	Sisymbrium orientale	I
Pepper Grass	Brassica tournefortii	O
Pepper Grass	Lepidium lasiocarpum	O
Pepper Grass	L. virginicum	O
Short Pudded Mustard	Brassica geniculata	I
NCN	Tropidocarpum gracile	I

* Nomenclature Munz (1974)

** Occurrence

D = Dominant S = Scattered R = Restricted

I = Infrequent O - Occasional

NCN = No Common Name

APPENDIX E CONTINUED

PLANTS OBSERVED* ON THE PROJECT SITE

SALTBUSH SCRUB/DISTURBED

Common Name	Scientific Name	Occurrence**
Poaceae - Grass Family Continued)		
Foxtail Chess	*Bromus rubens*	O
Ripgut Grass	*B. diandrus*	I
Salt Grass	*Distichlis spicata*	O
Sand Dropseed	*Sporobolus cryptandrus*	C
Stinkgrass	*Eragrostis cilianensis*	I
Salicaceae - Willow Family		
Fremont Cottonwood	*Populus fremontii*	I
Solanaceae - Nightshade Family		
Desert Datura	*Datura discolor*	I
Ground Cherry	*Physalis acutifolia*	I
Silverleaf Nettle	*Solanum elaeagnifolium*	O
Tamaricaceae - Tamarisk Family		
Athel Tree	*Tamarix aphylla*	O
Salt Cedar	*T. ramosissima*	O
Typhaceae - Cat-Tail Family		
Cat-Tail	*Typha domingensis*	I
Zygophyllaceae - Caltrap Family		
Puncture Vine	*Tribulus terrestris*	O

* Nomenclature Munz (1974)

** Occurrence

D = Dominant S = Scattered R = Restricted

I = Infrequent O = Occasional

APPENDIX E

TABLE 2

BIRDS OBSERVED ON THE PROJECT SITE

COMMON NAME*	SCIENTIFIC NAME*	NUMBER OBSERVED	STATUS**	HABITAT***
Red-tailed Hawk	Buteo jamaicensis	1	N,R	CS
American Kestrel	Falco sparverius	1	N,R	CS
Gambel's Quail	Lophortyx gambellii	25	N,R	CS
Mourning Dove	Zenaida macroura	42	N,R	DIS
Roadrunner	Geococcyx californianus	5	N,R	CS
White-throated Swift	Aeronautes saxatalis	6	N,R	CS
Common Flicker	Colaptes auratus	2	R	R
Common Crow	Corvus brachyrhynchos	22	R	DIS
Common Raven	Corvus corax	2	N,R	DIS
Le Conte's Thrasher	Toxostoma lecontei	1	R	CS
Mockingbird	Mimus polyglottos	5	R	CS, DIS
Loggerhead Shrike	Lanius ludovicianus	3	N,R	DIS
Starling	Sturnis vulgaris	19	N,R	DIS
Verdin	Auriparus flaviceps	1	R	CS
House Finch	Carpodacus mexicanus	20	N,R	DIS
Song Sparrow	Melospiza melodia	1	R	DIS
White-crowned Sparrow	Zonotrichia leucophrys	25	M,Sp.,FW	CS
Anna's Hummingbird	Calypte anna	2	N,R	CS, DIS

* Nomenclature: American Orinthologists' Union (1957, 1973).

** Status Designation from Sams and Stott (1959) and the Anza-Borrego Desert Natural History Association - Birds of Anza-Borrego Desert State Park:

R = Resident　M = Migrant　Sp = Spring　F = Fall
V = Visitant　N = Nests　S = Summer　W = Winter

*** Habitat Key

CS = Creosote Bush Scrub
DIS= Disturbed Area
R = Riparian

APPENDIX E

TABLE 3

BIRDS EXPECTED* ON PROJECT SITE

COMMON NAME**	SCIENTIFIC NAME**	STATUS**
Violet-Green Swallow	Tachycineta thalassina	M,Sp
Barn Swallow	Hirundo rustica	M,Sp
Cliff Swallow	Petrochelidon pyrrhonota	M,S,F
Purple Martin	Progne subis	V,Sp
Bewick's Wren	Thryomanes bewickii	R
Cactus Wren	Campylorhynchus brunneicapills	R
Canyon Wren	Catherpes mexicanus	R
Rock Wren	Salpinctes bsoletus	R
Crissal Thrasher	Toxostoma dorsale	Sp,S,F
Western Bluebird	Sialia mexicana	M,Sp,F,W
Blue-gray Gnatcatcher	Polioptila caerulea	Sp,F
Black-tailed Gnatcatcher	Polioptila melanura	R
Cedar Waxwing	Bombycilla cedrorum	Sp,F,W
Phainopepla	Phainopepla nitens	R
Western Meadowlark	Sturnella neglecta	R
Scott's Oriole	Icterus parisorum	R,Sp,S,F,W
Lesser Goldfinch	Carduelis psattria	N,R
Lark Sparrow	Chondestes grammacus	N,R
Black-throated Sparrow	Amphispiza belineata	F,W
Sage Sparrow	Amphispiza belli	F,W
Brewer's Sparrow	Spizella breweri	S,F,W

* Compiled from Anza-Borrego Natural History Association Birds in the Anza-Borrego Desert State Park Area.

** Nomenclature: American Ornithologists' Union (1957, 1973)

*** Status Key

R = Resident V = Visitant S = Summer W = Winter
M = Migrant Sp = Spring F = Fall

TABLE 3 CONTINUED

BIRDS EXPECTED* ON PROJECT SITE

COMMON NAME**	SCIENTIFIC NAME	STATUS***
Turkey Vulture	Cathartes aura	R
Sharp Shinned Hawk	Accipiter striatus	M,Sp,F,W
Cooper's Hawk	Accipiter cooperii	R,Sp,F,W
Red Shouldered Hawk	Buteo lineatus	V,Sp,F,W
Rough Legged Hawk	Buteo lagopus	M,F,W
Ferruginous Hawk	Buteo regalis	R
Golden Eagle	Aquila chrysaetos	R
Prairie Falcon	Falco mexicanus	R
Peregrine Falcon	Falco peregrinus	M,Sp,S,W
Killdeer	Charadrius vociferus	M,Sp,F
Rock Dove	Columba livia	R
Ground Dove	Columbina passerina	R
Barn Owl	Tyto alba	R
Great Horned Owl	Bubo virginianus	R
Burrowing Owl	Athene cunicularia	R
Long Eared Owl	Asio otus	R
Poor-Will	Phalaenoptilus nuttallii	R
Lesser Nighthawk	Chordeiles acutipennis	Sp,S,F
White-throated Swift	Aeronautes saxatalis	R
Costa's Hummingbird	Calypte costae	M,Sp,W
Yellow-bellied Sapsucker	Sphyrapicus varius	V,F
Ash-throated Flycatcher	Myiarchus cinerascens	R
Black Phoebe	Sayornis nigricans	R
Say's Phoebe	Sayornis saya	R

* Compiled from Anza-Borrego Natural History Association, Birds in the Anza-Borrego Desert State Park Area.

** Nomenclature: American Ornithologists' Union (1957, 1973)

*** Status Key

R = Resident V = Visitant S = Summer W = Winter

M = Migrant Sp = Spring F = Fall

ultrasystems

TABLE 4

MAMMALS OBSERVED AND EXPECTED ON PROJECT SITE

COMMON NAME	SCIENTIFIC NAME*	DETECTION**	HABITAT
Desert Cottontail	Sylvilagus audubonii arizonae	O	CS
Black-tailed Jack Rabbit	Lepus californicus deserticola	O	CS
White-tailed Antelope Squirrel	Ammospermophilus leucurus leucurus	O	CS
Round-tailed Ground Squirrel	Spermophilus tereticaudus tereticaudus	O	DIS
Southern Pocket Gopher	Thomomys bottae boregoensis	B	DIS
Coyote	Canis latrans	O, S	CS, DIS
EXPECTED			
Merriam's Kangaroo Rat	Dipodomys merriami arenivagus		
Desert Kangaroo Rat	Dipodomys deserti deserti		
Desert Woodrat	Neotoma lepida lepida		
Western Pipestrel	Pipistrellus hesperus hesperus		
Pallid Bat	Antrozous pallidus pallidus		
California Myotis	Myotis californicus californicus		
Brazilian (Mexican) Free-tailed Bat	Tadarida brasiliensis mexicana		
Little Pocket Mouse	Perognathus longimembris bangi		
Desert Pocket Mouse	Perognathus penicillatus angustirostris		
Spiny Pocket Mouse	Perognathus spinatus rufescens		
Cactus Mouse	Peromyscus eremicus eremicus		
Deer Mouse	Peromyscus maniculatus sonoriensis		
Southern Grasshopper Mouse	Onychomys torridus pulcher		

* Nomenclature Bond (1977)

** O = Observed; B = Burrow; S = Scat

*** Habitat

CS = Creosote Bush Scrub

DIS = Disturbed

TABLE 5

AMPHIBIANS AND REPTILES OBSERVED OR EXPECTED *

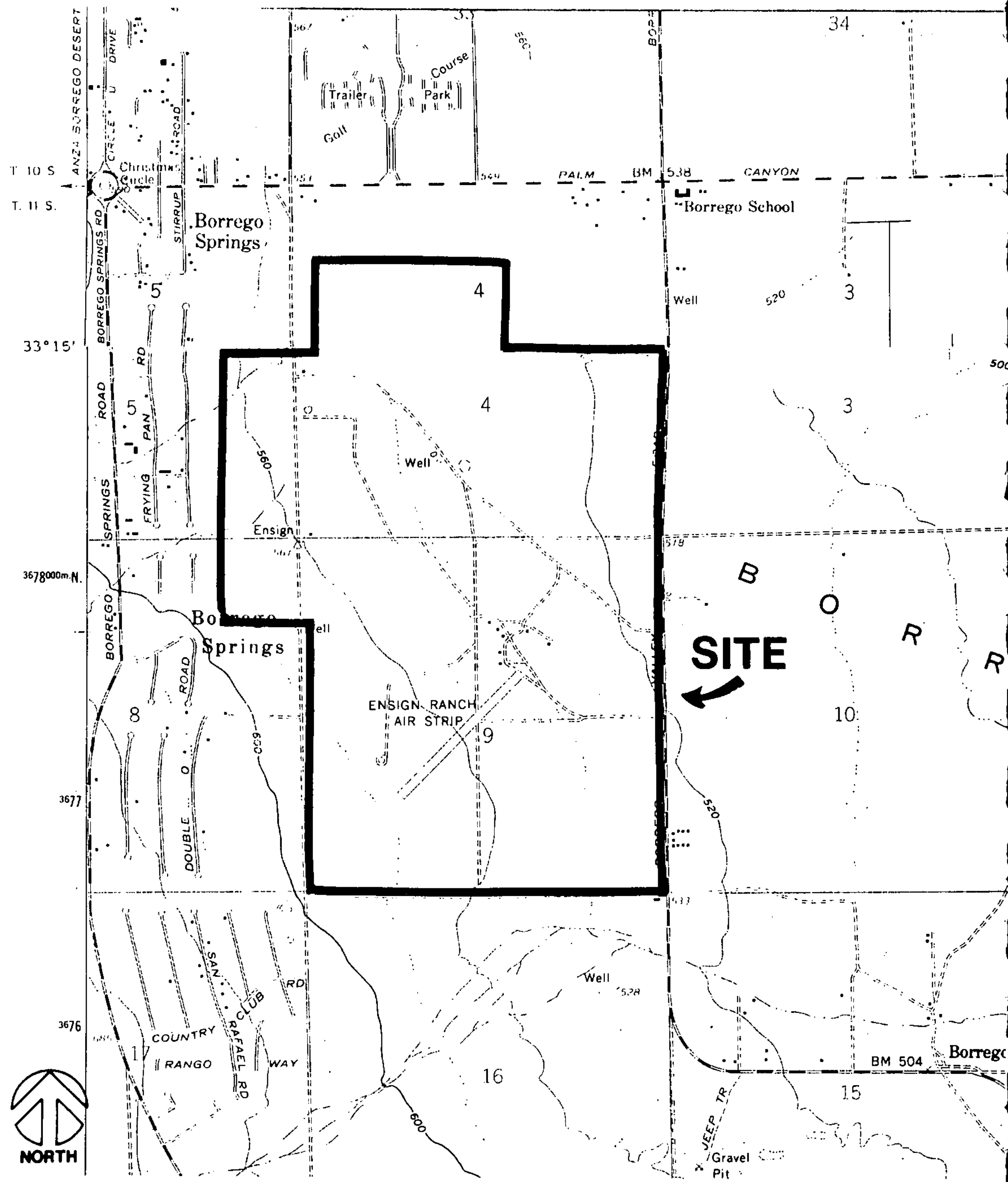
COMMON NAME	SCIENTIFIC NAME	NUMBER OBSERVED
Leopard Lizard	Crotaphytus wislizeni	1
Western Fence Lizard	Sceloporus occidentalis	8
Desert Spiny Iguana	Sceloporus magister	1
Desert Side Blotched Lizard	Uta stansburiana stejnegeri	2
Long-tailed Brush Lizard	Urosaurus graciosus	3
Expected **		
Desert Iguana	Dipsosaurus dorsalis dorsalis	
Zebra-tailed Lizard	Callisaurus draconoides	
Collard Lizard	Crotaphytus collaris	
Flat-tailed Horned Lizard	Phrynosoma m'callii	
Desert Banded Gecko	Coleonyx variegatus variegatus	
Western Brush Lizard	Urosaurus graciosus	
Desert Horned Lizard	Phrynosoma platyrhinos	
Gilbert Skink	Eumeces gilberti	
Sonora Gopher Snake	Pituophis melanoleucus affinis	
Common King Snake	Lampropeltis getulus	
Colorado Desert Sidewinder	Crotalus cerastes laterorepens	
Colorado Desert Shovel-Nosed Snake	Chionactis occipitalis annulata	
Red Racer	Masticophis flagellum piceus	
Southwestern Speckled Rattlesnake	Crotalus mitchelli pyrrhus	
Red Diamond Rattlesnake	Crotalus ruber ruber	
Desert Night Snake	Hypsiglena torquata deserticola	

* Nomenclature from Stebbins (1966) and Sloan (1964).
** Anza-Borrego Desert Natural History Association. The Reptiles and Amphibians of Anza-Borrego State Park.

TABLE 5 (CONTINUED)

AMPHIBIANS AND REPTILES OBSERVED OR EXPECTED

COMMON NAME	SCIENTIFIC NAME
Western Long-nosed Snake	Rhinocheilus lecontei lecontei
Desert Patchnosed Snake	Salvadora hexalepis
Southern Pacfic Rattle-snake	Crotalus viridis helleri
Pacific Tree Frog	Hyla regilla
Great Basin Whiptail	Cnemidophorus tigris tigris
Western Spadefoot Toad	Scaphiopus hammondii
California Toad	Bufo boreas halophilus



Source: ULTRASYSTEMS, INC.

Title: U.S.G.S. MAP

APPENDIX E

THE RARITY-ENDANGERMENT-VIGOR-DISTRIBUTION CODE*

R (RARITY)

1 - Rare, but found in sufficient numbers and distributed widely enough that the potential for extinction or extirpation is low at this time.

2 - Occurrence confined to several populations or to one extended population.

3 - Occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported.

E (ENDANGERMENT)

1 - Not endangered.

2 - Endangered in a portion of its range.

3 - Endangered throughout its range.

V (VIGOR)

1 - Increasing or stable in number.

2 - Declining in number.

3 - Approaching extinction or extirpation.

D (DISTRIBUTION)

1 - More or less widespread outside California.

2 - Rare outside Calfiornia.

3 - Endemic to California.

---

* California Native Plant Society, Inventory of Rare and Endangered Vascular Plants, Special Publication NO. 1 (2nd Edition) April 1980.

Literature Cited

Anza-Borrego Desert National History Association - The Birds of Anza-Borrego Desert State Park; The Mammals of Anza-Borrego Desert State Park; The Reptiles and Amphibians of Anza-Borrego Desert State Park.

Burt, W. H. and Grossenheider R. P. 1976. A Field Guide to Mammals. Hougton Mifflin Company, Boston. 189 pp.

California Native Plant Society: Inventory of Rare and Endangered Vascular Plants of California. California Native Plant Society Special Publication No. 1. (2nd Edition) April, 1980.

Higgins, E.B. 1949. Annotated Distributional List of the Ferns and Flowering Plants of San Diego County. California. Occ. Pap. S.D. Soc. Nat. Hist. No.8. 174 pp.

McMinin, H.E. 1974. An Illustrated Manual of California Shrubs. Univ. Calif. Press. 663 pp.

Munz, P.A. 1974. A Flora of Southern California. Univ. Calif. Press 1085 pp.

Sams, J.R. and Stott, K. 1959. Birds of San Diego County, California. An Annotated Checklist. Occ. Pap. S.D. Soc. Nat. Hist. No.10. 49 pp.

Sloan, A.J. 1964. Amphibians of San Diego County. Occ. Pap. S.D. Soc. Nat. Hist. No.13. 40 pp.

Stebbins, R.C. 1966. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co. Boston. 179 pp.

Udvardy, M.D.F. 1977. The Audubon Society Field Guide to North American Birds: Western Region. Alfred A. Knoph, Inc. 855 pp.

PROJECT BIOLOGISTS

David Clark

Ultrasystems, Inc.
(714) 752-7500
Survey: January 30, 1981

Ted L. Hanes, Ph.D.

California State University, Fullerton
(714) 773-3614
Survey: April 9, and April 14, 1981

Oscar F. Clark

University of Calfiornia, Riverside
(714) 686-3746
Survey: February 18, 1981
(Report incorporated by reference from Borrego
Country Club General Plan Amendment EIR)

DR. TED L. HANES

Dr. Hanes is Associate Professor of Biology at California State University, Fullerton. He teaches courses in plant ecology, general ecology, botany, biology, crisis biology, ecological internship and graduate seminars in ecology and environmental assessment. His current research interests are in fire ecology of California chaparral and the inventory of natural areas in Southern California.

Dr. Hanes holds three degrees in plant sciences from UCLA, a Master's degree from Claremont Graduate School in Science Education, and has done graduate work on various subjects in biology at Indiana University, California Institute of Technology, University of Iowa, and Oak Ridge Institute of Nuclear Studies. He has received research grants from the National Science Foundation and the National Park Service to carry out work on fire ecology, pollution problems, and natural areas. He has been resident ecologist and naturalist several summers at the National Audubon Camp of the West, Dubois, Wyoming. He is active in several local, state and national ecology and conservation organizations and is a consultant to Ultrasystems, Inc. on environmental planning, wildland management, and ecological impact studies.

His professional memberships include:

National:
- Sigma Xi
- Ecological Society of America
- American Institute of Biological Sciences
- American Association for the Advancement of Science
- American Scientific Affiliation
- The National Audubon Society
- The National Geographic Society

State:
- California Native Plant Society
- Southern California Botanists (1961-present; Board Member 1968-present; President 1969-1971)
- The Nature Conservancy, Southern California Chapter (1963-1972; board member, past treasurer and vice chairman 1967-1971)
- Tri-County Conservation League
- Southern California Academy of Sciences
- California Natural Areas Coordinating Council (Director and Regional Chairman)
- California Native Plant Society. President of the Southern California Botanists Chapter (1972).

DR. HANES (Continued)

Dr. Hanes has recieved honors from:

W. Atlee Burpee Award - UCLA, 1950
National Science Foundation Faculty Fellowship - UCLA, 1961-1962
N.S.F. Research Grant - Chaparral Succession, 1966-1968
California State College, Fullerton Faculty Grant, 1969-1970
National Park Service Grant - UC Davis, 1971-1972
Consultant: Thorne Ecological Institute, Boulder, Colorado 1971-1972

Dr. Hanes' publications include:

Hanes, T.L., 1973. Chaparral ecology of the San Gabriel Mts., California

In preparation:

_____________. 1973. The vegetation called chaparral. Proceedings Symposium on Living with the Chaparral, Univ. Calif. Riverside, Calif. (in press)

_____________. 1971. Succession after fire in the chaparral of southern California. Ecol. Monogr. 41. (1): 27-52

_____________. 1970. California sage and chaparral. Grizzly - Bul. Tucker Wildlife Sanc. 1 (2): 7-10

_____________. 1967. Problems related to biology in the junior college. Amer. Bio. Teacher 29 (8): 639-640

Hanes, T.L. and H.W. Jones. 1967. Postfire chaparral succession in southern California. Ecology 48 (2): 259-264

Hanes, T.L. et al. 1966. General Biology laboratory manual. Brown Book Co., Iowa. 295 pp.

Hanes, T.L. 1965. Ecological Studies on two closely related chaparral shrubs in southern California. Ecol. Monogr. 34: 213-235

Patric, J.H. and T.L. Hanes. 1964. Chaparral succession in a San Gabriel Mountain area of California. Ecology 45 (2): 353-360.

David D. Clark

Mr. Clark is a Project Manager at Ultrasystems, Inc., and is primarily responsible for the preparation of environmental impact reports (EIR's), environmental assessments (EA's) and related special studies.

Mr. Clark received his Master of Science Degree in Ecology and Bachelor of Arts Degree in Biology from California State University, Fullerton. Mr. Clark has augmented his educational background with additional study in Environmental Impact Analysis, Statistical Analysis, Urban Planning Problems, etc. He is currently pursuing a Master of Business Administration Degree from California Polytechnic University, Pomona.

Prior to joining the professional staff at Ultrasystems, Inc., Mr. Clark was employed as an Environmental Systems Analyst and Proposal Manager with Systems Control, Inc. (formerly Olson Laboratories). During this period, he was actively involved with a number of U.S. E.P.A. Inspection/Maintenance programs for the control of automotive emissions at the State level.

Mr. Clark has conducted a number of biological assessments under the sponsorship of the Bureau of Land Management (BLM). His most recent effort has included an exhaustive analysis of utility construction impacts on the vegetation and soils of arid environments. Project emphasis was placed on vegetational inventories, soil dynamics and computer modeling.

He has taught environmental and ecological courses at California State University, Fullerton, and Cerritos College. He holds a Teaching Credential in California.

Mr. Clark has numerous publications in both the engineering and environmental fields. Recent publications include:

1. "Resource Allocation Patterns in Two Annuals of the California-Sonoron Desert." Submitted to Ecologia, 1979.

David D. Clark - (Continued)

2. "An Analysis of Construction Effects on Vegetation and Soils of the Colorado Desert." Bureau of Land Management (BLM), Riverside.

3. "Xylem Anatomy Variation in Creosote Bush (Larrea tridentata) of the Southwest Deserts." In preparation.

4. "Evaluation of Motor Vehicle Inspection/Maintenance Programs for the Control of Automotive Emissions." U.S. E.P.A.

TABLE 5 (CONTINUED)
AMPHIBIANS AND REPTILES OBSERVED OR EXPECTED

COMMON NAME	SCIENTIFIC NAME
Western Long-nosed Snake	Rhinocheilus lecontei lecontei
Desert Patchnosed Snake	Salvadora hexalepis
Southern Pacfic Rattle-snake	Crotalus viridis helleri
Pacific Tree Frog	Hyla regilla
Great Basin Whiptail	Cnemidophorus tigris tigris
Western Spadefoot Toad	Scaphiopus hammondii
California Toad	Bufo boreas halophilus

APPENDIX F

Archaeological Data

Dr. David M. Van Horn

BIBLIOGRAPHY

Bean, L.J. and K.S. Saubel
1961 "Cahuilla Ethnobotanical Notes. The Aboriginal Uses of The Mesquite and Screwbean." UCLA Archaeological Survey Annual Report.

Bean, John Lowel
1972 Mukat's People. Banning: Malki Museum Press.

Bean, L.J. and K.S. Saubel
1972 Temalpakh: Cahuilla Indian Knowledge and Usage of Plants. Malki Museum Press, Banning.

1961 Cahuilla Ethnobotanical Notes: The Aboriginal Uses of The Oak, UCLA Archaeological Survey Annual Report.

Bean, Lowell, J. and Shipek, Florence C.
1978 Luiseno. In the Handbood of North American Indians, v. 8, 550ff. Washington, D.C.

Bettinger, Robert L.
1974 Dating the Perris Reservoir Assemblages. Perris Reservoir Archaeology. Archaeological Report 14, Cal. Dept. of Parks and Recreation. Sacramento.

1974 Environment and Ethnography at Perris Reservoir. Perris Reservoir Archaeology. Archaeological Report 14, Cal. Dept. of Parks and Recreation. Sacramento.

Colton, H.S.
1939 An Archaeological Survey of Northwestern Arizona, Including the Descriptions of Fifteen new Pottery Types. Bulletin of the Museum of Arizona. 16

1956 Pottery Types of the Southwest. Ceramic Series 3C, Museum of Northern Arizona.

Euler, Robert C. & Henry Dobyns
1958 Tizon Brown Ware in Pottery Types of the Southwest. Edited by H.S. Colton. Museum of Northern Arizona Ceramic Series No. 3D. Flagstaff.

Heizer, R.F. and Whipple, M.A.
1951 The California Indians. University of California
1973 Press, Berkeley

Hubbs, C.L., G.S. Bien, and H.E. Suess
1960 La Jolla Natural Radiocarbon Measurements I. Radiocarbon 2:197-223.

Kroeber, A.L.
1925 Handbook of the Indians of California. Washington, D.C.: Smithsonian Institute, Bureau of American Ethnology Bulletin, 78: 1-995.

Kroeber, Alfred L. and M.J. Harner
1955 Mojave Pottery. U.C. Anthropological Records 16(1). Berkeley.

May, Ronald V.
1975 A Brief Survey of Kumeyaay Ethnography: Correlations Between Environmental Land-Use Patterns, Material Culture, and Social Organization. PCAS 11:4: 1-25.

1977 No Title. Unpublished Manuscript Draft.

Meighan, Clement W.
1959 Archaeological Resources of Borrego State Park. Archaeological Survey Annual Report. 1958-1959, pp. 185-216. UCLA.

1965 Pacific Coast Archaeology. In The Quarternary of the United States, Wright and Frey, Eds.

1954 "A Late Complex in Southern California Prehistory." Southwestern Journal of Anthropology, Vol. 10, No. 2, pp. 215-227. University of New Mexico Press, Albuquerque.

Michelsen, Ralph C.
1967 "Pecked Metates of Baja California." The Masterkey Southwest Museum Publications.

Moratto, M.J.
1972 A Study of Prehistory in the Southern Sierra Nevada Foothills, California. Unpublished Ph.D. dissertation presented to the Dept. of Anthropology, University of Oregon.

O'Brian, T.P.
1973 Ceramic Artifacts in Perris Reservoir Archaeology: Late Prehistoric Demographic Change in Southeastern Calif. J.F. O'Connell et al., Eds. Archaeological Report 14, California Dept. of Parks and Recreation, Sacramento.

Rogers, Malcom J.

1936 "Yuman Pottery Making." San Diego Museum Papers, No. 2, San Diego.

1945 "An Outline of Yuman Prehistory" Southwestern Journal of Anthropology No. (2): 167-198.

Schroeder, Albert H.

1958 Lower Colorado Buff Ware in Pottery Types in the Southwest. Museum of Northern Arizona Ceramic Series. 31.

Spier, Leslie

1923 "Southern Digueno Customs". University of California Publications in American Archaeology and Ethnology. Vol. 20, No. 16, pp. 297-360. Berkeley.

Strong, W.D.

1929 "Aboriginal Society in Southern California." University of California Publications in American Archaeology and Ethnology 26. Berkeley

True, D.L.

1970 "Investigation of a Late Prehistoric Complex in Cuyamaca Rancho State Park, San Diego, California." Archaeological Survey Monograph, University of Calif., Los Angeles.

Wallace, W.J. and E.S. Taylor

1960 The Indian Hill Rockshelter: Preliminary Excavations. The Masterkey Vol. 34, pp. 66-82.

Wilke, Phillip J.

1974 Settlement and Subsistence at Perris Reservoir: A Summary of Archaeological Investigations. Perris Reservoir Archaeology, Late Prehistoric Demographic Change in Southeastern California. S.F. O'Connel, et al., eds. Archaeological Report 14. Sacramento Dept. of Parks and Recreation.

List of Figures

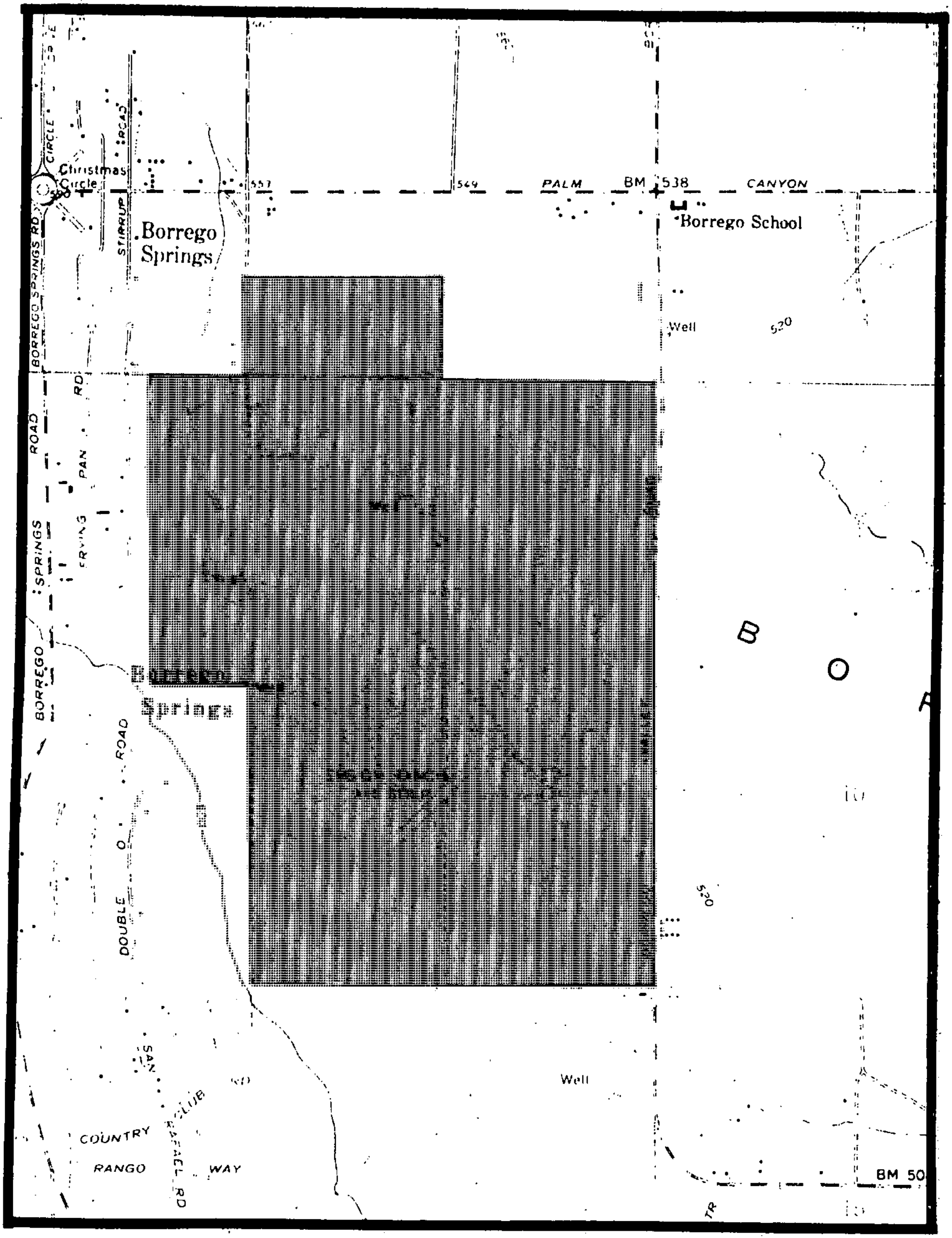


Figure 1. Property Survey-
ed Plotted on 7.5' USGS
Clark Lake and Borrego
Sink Topographic Quad-
rangles.

FIGURE 2

A large scale map depicting the location of the archaeological sites on the project site is available for review by qualified archaeologists at the County of San Diego Environmental Analysis Division.

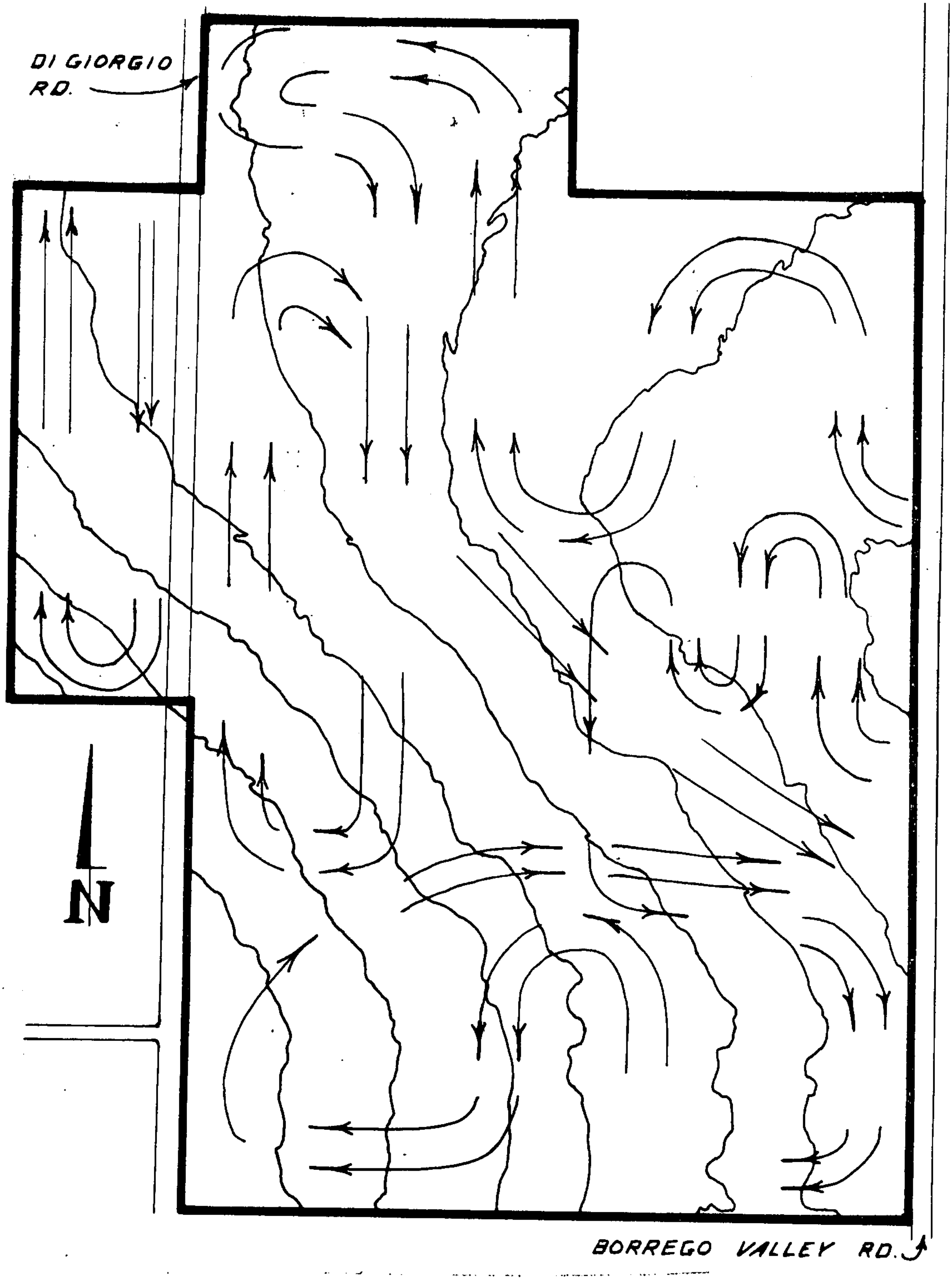
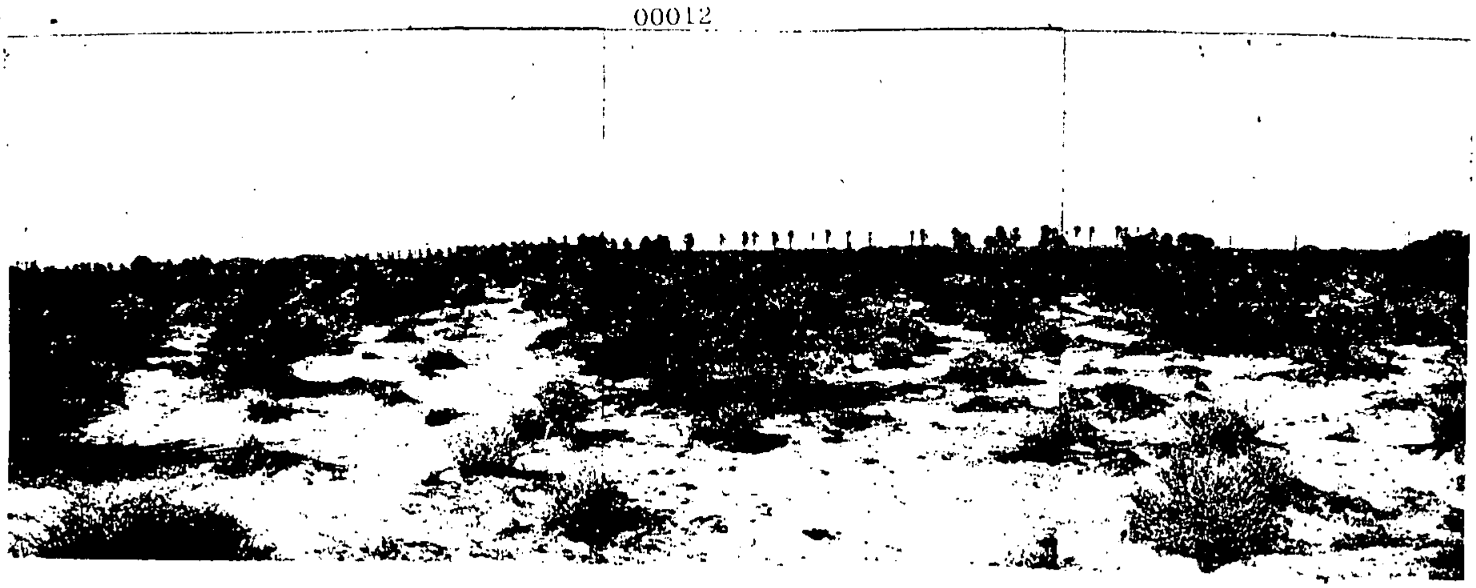
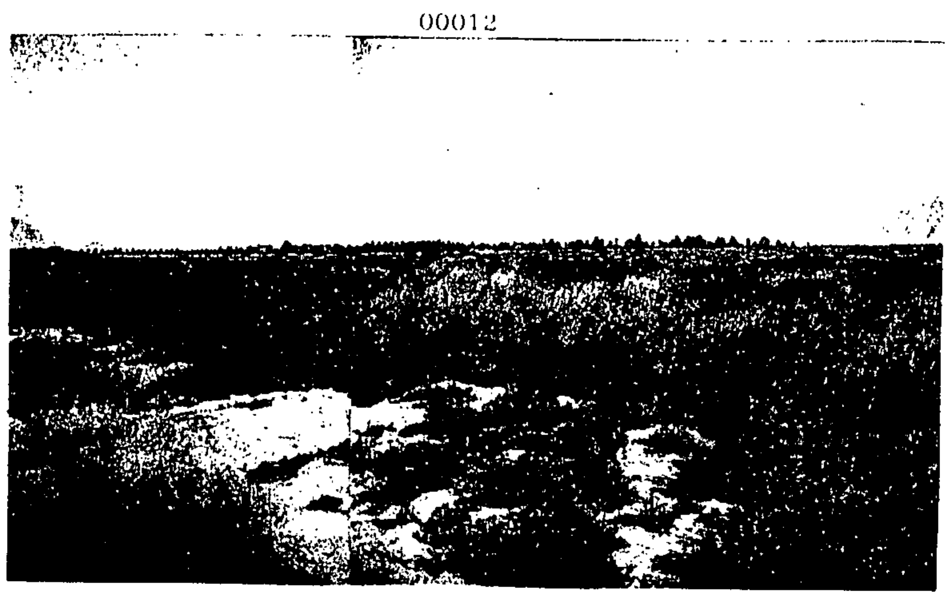


Figure 3. Survey Route Map.



A. Southern portion of subject property looking northwest.



B. Northern portion of subject property looking northwest. Area shown is part of the abandoned golf course now overgrown with weeds.

Fig.4

00012

00012

A. Modern development in south-central portion looking northwest.

B. Golf course on perimeter of modern development

00012

C. Old irrigation ditch in northern portion of property looking east.

Fig.5

00011

A. Site A looking north. Northern boundary of site is approximately 50 yds. in front of the date palms.

00011

B. Tizon Brown Ware sherd (just right of stake) at Site A.

00011

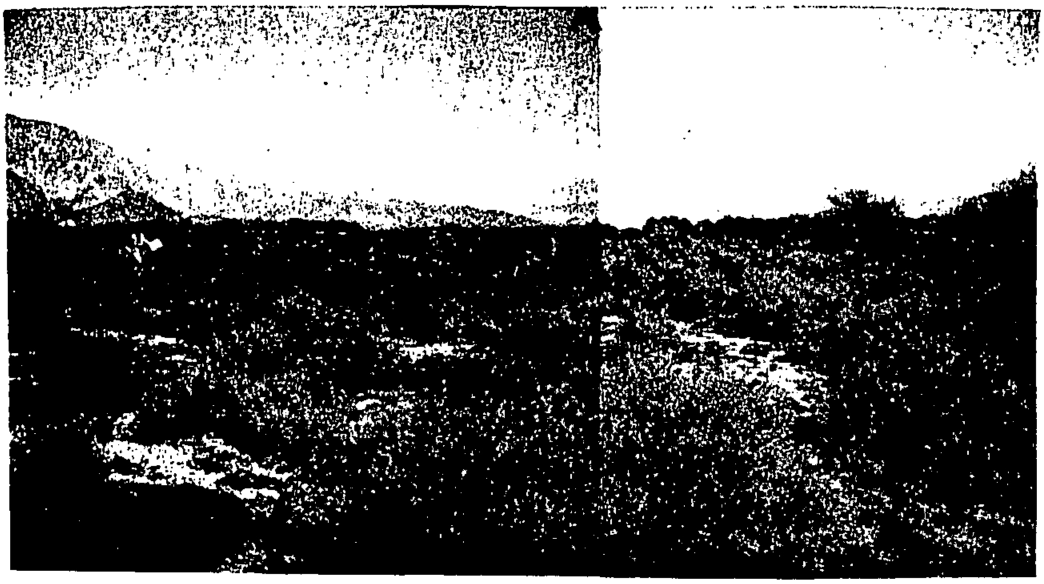
A. Site B looking southwest. Note trailer park beyond site.

00011

B. Sherds at Site B.

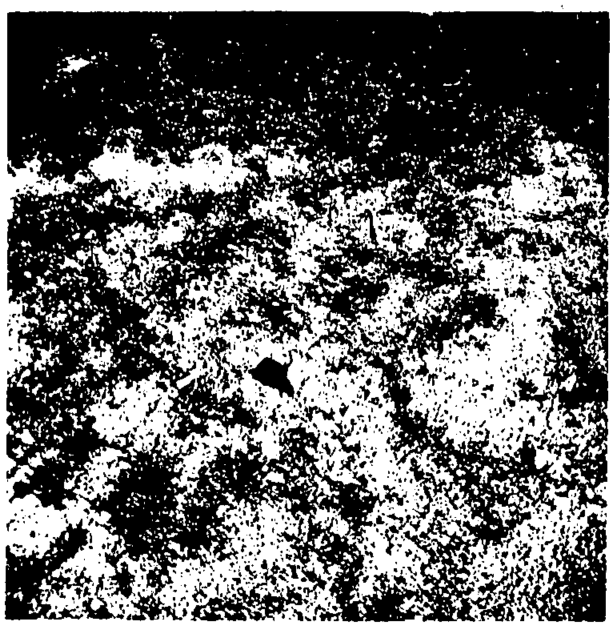
Fig.7

00011



A. Vicinity of light sherd scatter designated on Site C. Looking northwest.

00011



B. Sherds at the site shown above.

Fig.8

1022-B Victoria
Costa Mesa, Ca. 92627

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
ARCHEOLOGICAL SITE SURVEY RECORD

SITE No. ____________

1. Previous Site Designation None 2. Temporary Field No. Borrego Site A
3. USGS Quad Borrego Sink 7½' x 15' Year 1959
4. UTM Coordinates 3678,400 N ; 559.280 E
5. Twp. 11S Range 6E ; SW ¼ of SW ¼ of Sec. 4
6. Location 50 to 100 meters south of a date palm orchard and 50 meters east of DiGiorgio Road about 1 mile southeast of Borrego Springs.
7. Contour 560 8. Owner & Address Federated Development Co.
9. Prehistoric x Ethnographic ___ Historic ___ 10. Site Description Light scatter of Tizon Brown Ware
11. Area 70 x 70 meters 4900 square meters. 12. Depth of Midden None observed
13. Site Vegetation Creosote Surrounding Vegetation Same
14. Location & Proximity of Water Well for date palm orchard, no perennial water in vicinity
15. Site Soil dry sandy loam Surrounding Soil Same
16. Previous Excavation None
17. Site Disturbance None
18. Destruction Possibility Property scheduled for development
19. Features None
20. Burials None
21. Artifacts Tizon Brown Ware sherds - no other cultural materials observed.
22. Faunal Remains None
23. Comments Probably a gathering site where a vessel was accidentally broken
24. Accession No. ______ 25. Sketch Map x by A.A. where attached
26. Date Recorded 3/13/79 27. Recorded By Van Horn
28. Photo Roll No. 00011 Frame No. ______ Film Type(s) B/W Taken By Van Horn

DPR 422 (Rev. 9/76)

% Destroyed 0 How ________ Date Destroyed ________ % if known

National Register Status: Listed ____ Potential ____ No Determination ____ Nominated ____ Ineligible X

State Historical Landmark (No.) ________ Point of Historical Interest ________

SPECIAL ATTRIBUTES (Place an X in only those spaces which pertain to the site)

Midden/Habitation Debris ____ Lithic and/or Ceramic Scatter X

Bedrock Mortars/Milling Surfaces ____ Petroglyphs/Pictographs ____, Stone Features ____

Burials ____ Caches ____ Hearths/Roasting Pits ____, Housepits ____, Structure Remains ____

Underwater ____, Open Air ____ Rockshelter ____ Cave ____ Quarry ____, Trails ____

REMARKS probably no depth - a very light sherd scatter

SKETCH LOCATION MAP (Include permanent reference markers, North Arrow, and Scale)

Attached

SKETCH SITE MAP (Same criteria as above)

Attached

1022-B Victoria
Costa Mesa, Ca. 926..

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
ARCHEOLOGICAL SITE SURVEY RECORD

SITE No. ____________

1. Previous Site Designation None 2. Temporary Field No. Borrego Site B
3. USGS Quad Borrego Sink 7½' x 15' Year 1959
4. UTM Coordinates ^{36}77,800 – ^{36}78,200N; ^{5}58,760 – ^{5}59,100E
5. Twp. 11S Range 6E ; eastern ½ of NE ¼ of Sec. 8
6. Location One mile SSE of Borrego Springs just west of DiGiorgio Rd. and north of a modern trailer park (not shown on Quad).
7. Contour 580 8. Owner & Address Federated Development Co.
9. Prehistoric x Ethnographic ____ Historic ____ 10. Site Description Expansive light scatter of Tizon Brown Ware sherds (see item 21 below)
11. Area 400 x 340 meters, 136,000 square meters. 12. Depth of Midden None observed
13. Site Vegetation Creosote Surrounding Vegetation Same
14. Location & Proximity of Water Well for date palm orchard, no perennial water in vicinity
15. Site Soil dry sandy loam Surrounding Soil Same
16. Previous Excavation None
17. Site Disturbance Uncertain
18. Destruction Possibility Property scheduled for development
19. Features None
20. Burials None
21. Artifacts Tizon Brown Ware sherds, several Lower Colorado River Buff Ware sherds on northern periphery. No other cultural materials observed.
22. Faunal Remains ~~None observed~~
23. Comments Probably a gathering site. No indications of occupation.
24. Accession No. ____ 25. Sketch Map x by A.A. where attached
26. Date Recorded 3/13/79 27. Recorded By Van Horn
28. Photo Roll No. 00011 Frame No. ____ Film Type(s) B/W Taken By Van Horn

DPR 422 (Rev. 9/76)

% Destroyed ______ How ______ Test Excavated ______ Unknown

National Register Status: Listed ______ Potential ______ No Determination ______ Nominated ______ Ineligible X

State Historical Landmark (No.) ______ Point of Historical Interest ______

SPECIAL ATTRIBUTES (Place an X in only those spaces which pertain to the site)

Midden/Habitation Debris ______ Lithic and/or Ceramic Scatter X

Bedrock Mortars/Milling Surfaces ______ Petroglyphs/Pictographs ______, Stone Features ______

Burials ______, Caches ______, Hearths/Roasting Pits ______, Housepits ______, Structure Remains ______

Underwater ______, Open Air ______ Rockshelter ______, Cave ______, Quarry ______, Trails ______

REMARKS Probably no depth.

SKETCH LOCATION MAP (Include permanent reference markers, North Arrow, and Scale)

Attached

SKETCH SITE MAP (Same criteria as above)

Attached

8022-B Victoria
Costa Mesa, Ca. 92627

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
ARCHEOLOGICAL SITE SURVEY RECORD

SITE No. ______

1. Previous Site Designation ______ 2. Temporary Field No. Borrego Site C
3. USGS Quad Clark Lake 7.5' x 15' Year 1959
4. UTM Coordinates ^{36}79,320N ; ^{5}59,160E
5. Twp. 11S Range 6E ; SW ¼ of NW ¼ of Sec. 4
6. Location Adjacent to east side of DiGiorgio Rd., one and ½ miles ESE of Borrego springs.
7. Contour 520 8. Owner & Address Federated Development Co.
9. Prehistoric x Ethnographic ___ Historic ___ 10. Site Description Small light sherd scatter
11. Area 20 x 20 meters. 400 square meters. 12. Depth of Midden None observed
13. Site Vegetation Creosote Surrounding Vegetation Same
14. Location & Proximity of Water Only modern wells in vicinity
15. Site Soil dry sandy loam Surrounding Soil Same
16. Previous Excavation None
17. Site Disturbance Construction of DiGiorgio Rd.
18. Destruction Possibility Property scheduled to be developed
19. Features None
20. Burials None
21. Artifacts Tizon Brown Ware sherds - no other cultural material observed.
22. Faunal Remains None observed
23. Comments Historic sherds also present. Road destroyed unknown percentage of site
24. Accession No. ______ 25. Sketch Map x by A.A. where attached
26. Date Recorded 3/13/79 27. Recorded By Van Horn
28. Photo Roll No. 00011 Frame No ______ Film Type(s) B/W Taken By Van Horn

DPR 422 (Rev. 9/76)

[illegible] ? By Road construction [illegible] ___ %, if known

National Register Status: Listed ___ Potential ___ No Determination ___ Nominated ___ Ineligible x

State Historical Landmark (No.) ___ Point of Historical Interest ___

SPECIAL ATTRIBUTES (Place an X in only those spaces which pertain to the site)

Midden/Habitation Debris ___ Lithic and/or Ceramic Scatter x

Bedrock Mortars/Milling Surfaces ___ Petroglyphs/Pictographs ___, Stone Features ___

Burials ___, Caches ___, Hearths/Roasting Pits ___, Housepits ___, Structure Remains ___

Underwater ___, Open Air ___, Rockshelter ___, Cave ___, Quarry ___, Trails ___

REMARKS Much of site probably destroyed by DiGiorgio Road. More of the site may be present on the west side of the road -- this area was not surveyed as it was not a part of the subject property.

SKETCH LOCATION MAP (Include permanent reference markers, North Arrow, and Scale)

Attached

SKETCH SITE MAP (Same criteria as above)

Attached

1350 El Prado, Balboa Park, San Diego, California 92101, Telephone (714) 239-2001

REPORT ON ARCHAEOLOGICAL SITE FILES RECORD SEARCH

Source of Request: Archaeological Associates - David M. Van Horn

Date of Request: 29 January 1979 (X)Letter ( )Telephone ( ) In Perso

Date Request Received: 30 January 1979 (X)Map Received (X)Map Returned

Name of Project: Borrego Springs area

( ) The Museum of Man files show no recorded sites for the project area.

(X) The Museum of Man files show the following sites ( )within (X)in the vicinity of the project area.

Site No. C-131 Culture(s): Cahuilla

Description: General site number for Borrego Valley; many campsites with cobble hearths, cremations, sherds, etc. No specific locations.

Recorded by: M.J.Rogers

Site No. C-490 Culture(s): Late Pre-historic

Description: Camp site; hearths; stacked rock circle; hammerstones; cores; flakes/debitage; scrapers; metates; manos; sherds; shell; retouched tools; milling slabs.

Recorded by: R.May 1977

Site No. Culture(s):

Description:

Recorded by:

Site No. Culture(s):

Description:

Recorded by:

Site No. Culture(s):

Description:

Recorded by:

Site No. Culture(s):

Description:

Recorded by:

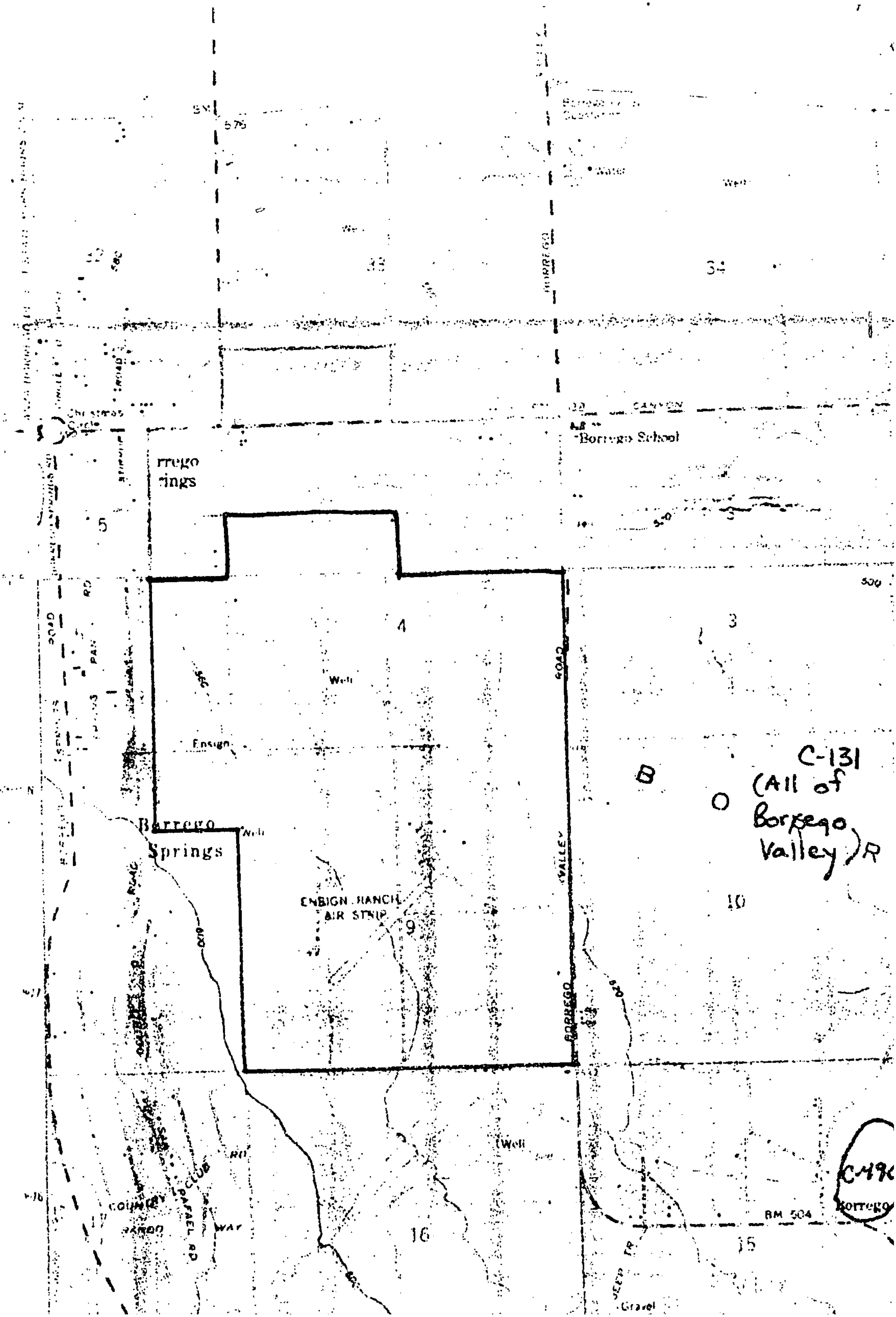
Please note: The project area may contain archaeological resources in addition to those noted above. This report is made from San Diego Museum of Man files only and may not include data pertaining to localities other than those covered in previous Museum of Man surveys or gathered by other institutions or by individuals.

Record check by: Grace Johnson

Date: 31 January 1979

Signed: Lowell E. English

Borrego Sink 7.5' ⟷ Clark Lake 7.5'



SAN DIEGO STATE UNIVERSITY
SAN DIEGO, CALIFORNIA 92182

Department of Anthropology

REPORT ON ARCHAEOLOGICAL SITE FILES RECORD SEARCH

Source of Request-- ARCHAEOLOGICAL ASSOCIATES, LTD

Date of Request--January 29, 1979

Date Request Received-- January 30, 1979

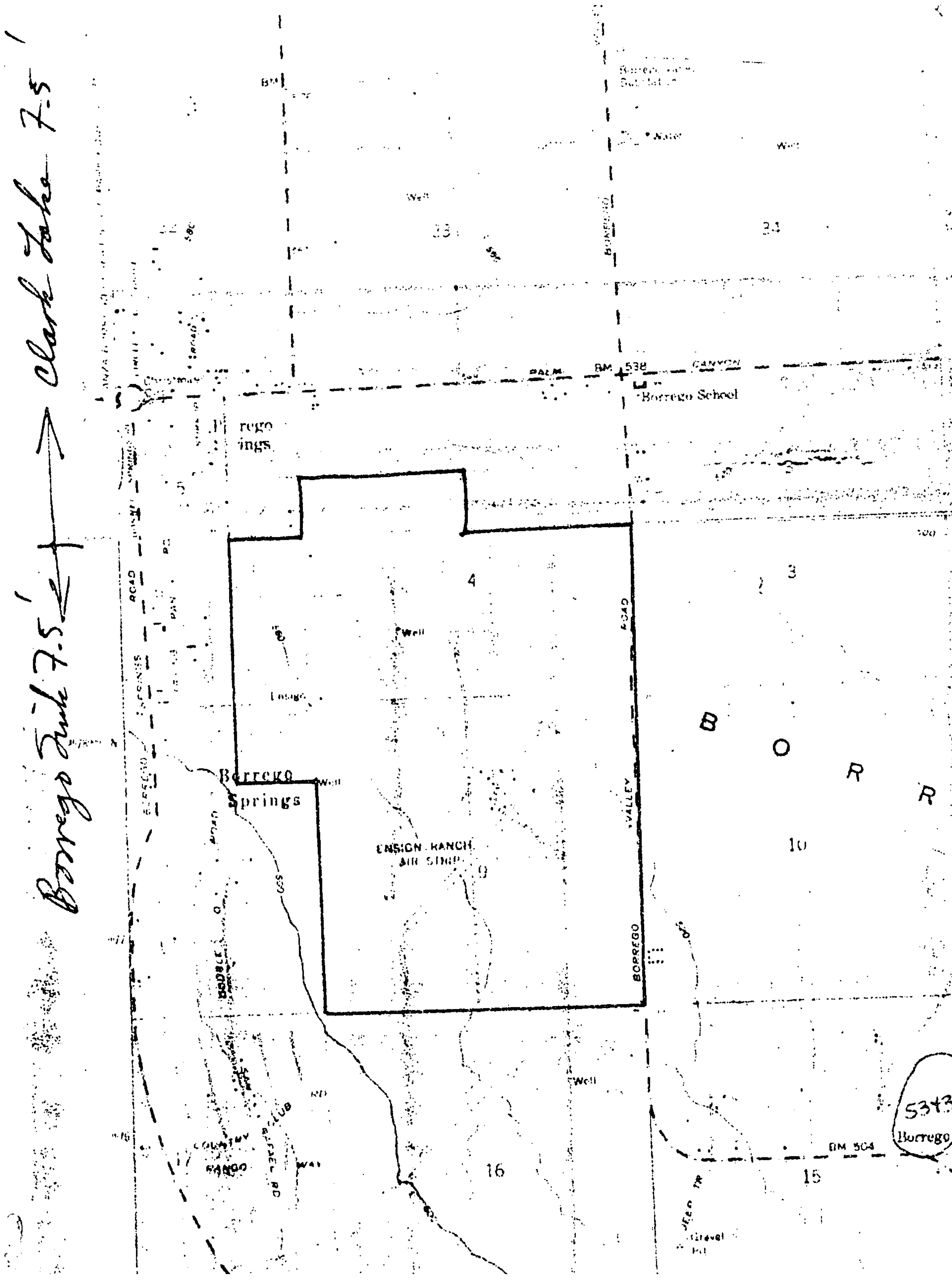
Project Identification-- Clark Lake, Borrego Sink

(X) The San Diego State University files show no recorded site for the Project area

( ) The files show positive site locations in the vicinity/on the project area. Site forms are included.

Record check by-- Melissa Johnson   Date-- Feb 1, 1979

Signed-- Larry L. Leach


Borrego Sink 7.5' ←→ Clark Lake 7.5'
Borrego School
BM 538
PALM
CANYON
Borrego Springs
ENSIGN RANCH AIR STRIP
Well
BORREGO VALLEY ROAD
B O R R
COUNTRY CLUB RD
RANGO
BM 504
Gravel Pit
5343
Borrego
33
34
5
4
3
9
10
16
15

SAN DIEGO MUSEUM OF MAN

1350 El Prado, Balboa Park, San Diego, California 92101, Telephone (714) 239-2001

REPORT ON ARCHAEOLOGICAL SITE FILES RECORD SEARCH

Source of Request: Archaeological Associates - David M. Van Horn

Date of Request: 29 January 1979 (X) Letter ( ) Telephone ( ) In Perso

Date Request Received: 30 January 1979 (X) Map Received (X) Map Returned

Name of Project: Borrego Springs area

( ) The Museum of Man files show no recorded sites for the project area.

(X) The Museum of Man files show the following sites ( ) within (X) in the vicinity of the project area.

Site No. C-131 Culture(s): Cahuilla

Description: General site number for Borrego Valley; many campsites with cobble hearths, cremations, sherds, etc. No specific locations.

Recorded by: M.J.Rogers

Site No. C-490 Culture(s): Late Pre-historic

Description: Camp site; hearths; stacked rock circle; hammerstones; cores; flakes/debitage; scrapers; metates; manos; sherds; shell; retouched tools; milling slabs.

Recorded by: R.May 1977

Site No. Culture(s):

Description:

Recorded by:

Site No. Culture(s):

Description:

Recorded by:

Site No. Culture(s):

Description:

Recorded by:

Site No. Culture(s):

Description:

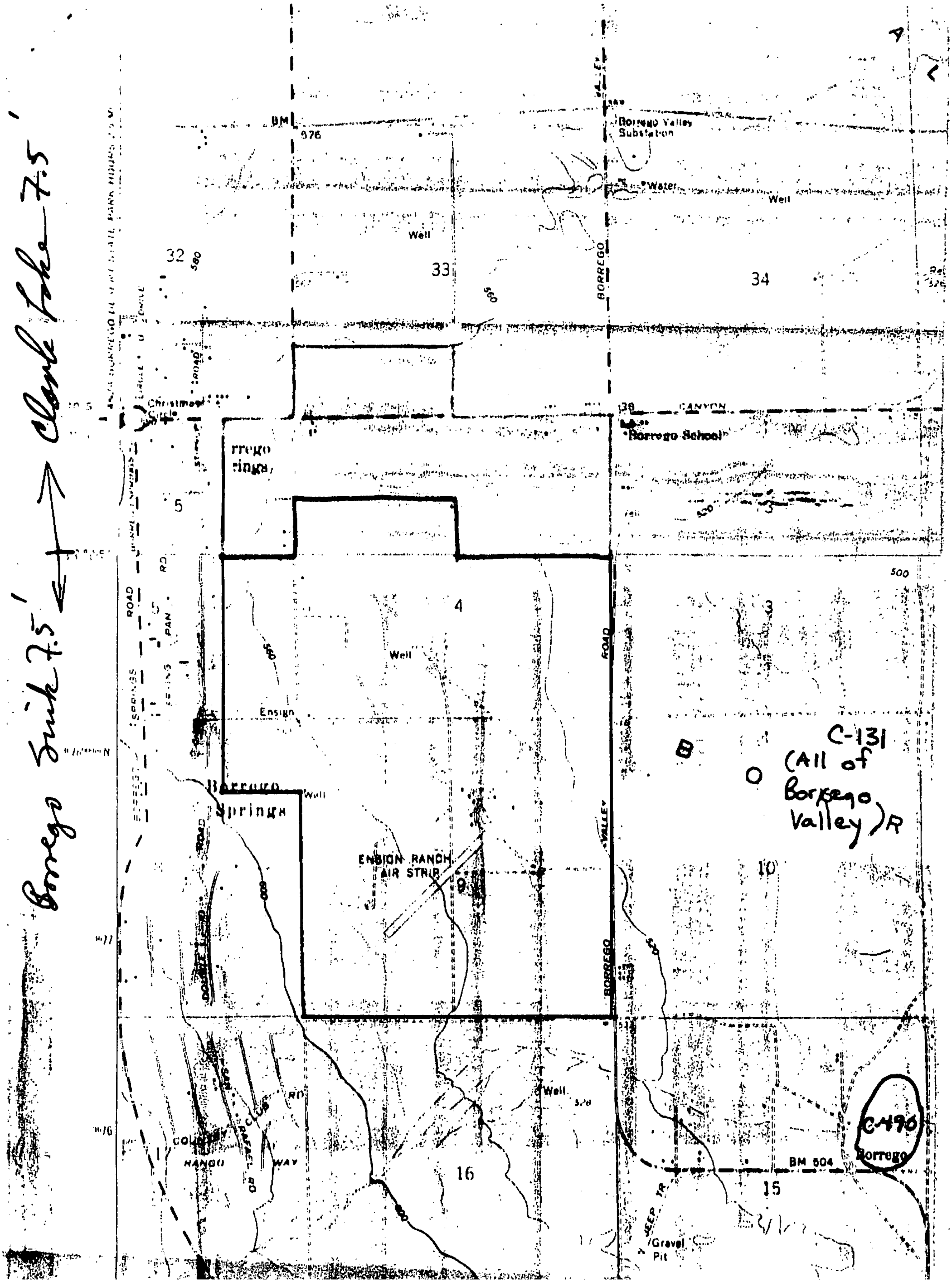
Recorded by:

Please note: The project area may contain archaeological resources in addition to those noted above. This report is made from San Diego Museum of Man files only and may not include data pertaining to localities other than those covered in previous Museum of Man surveys or gathered by other institutions or by individuals.

Record check by: Grace Johnson

Date: 31 January 1979

Signed: Lowell E. English


Borrego Sink 7.5' ⟷ Clark Lake 7.5'
Borrego Valley Substation
Water
Well
BM
576
32
33
34
Christmas Circle
CANYON
Borrego School
Borrego Springs
5
4
3
Ensign
ENSIGN RANCH AIR STRIP
9
10
16
15
BORREGO
VALLEY
ROAD
PAN
CLUB
WAY
RD
500
BM 504
Borrego
JEEP TR
Gravel Pit
C-131 (All of Borrego Valley) R
C-490

SAN DIEGO STATE UNIVERSITY

SAN DIEGO, CALIFORNIA 92182

Department of Anthropology

REPORT ON ARCHAEOLOGICAL SITE FILES RECORD SEARCH

Source of Request— ARCHAEOLOGICAL ASSOCIATES, LTD

Date of Request—January 29, 1979

Date Request Received— January 30, 1979

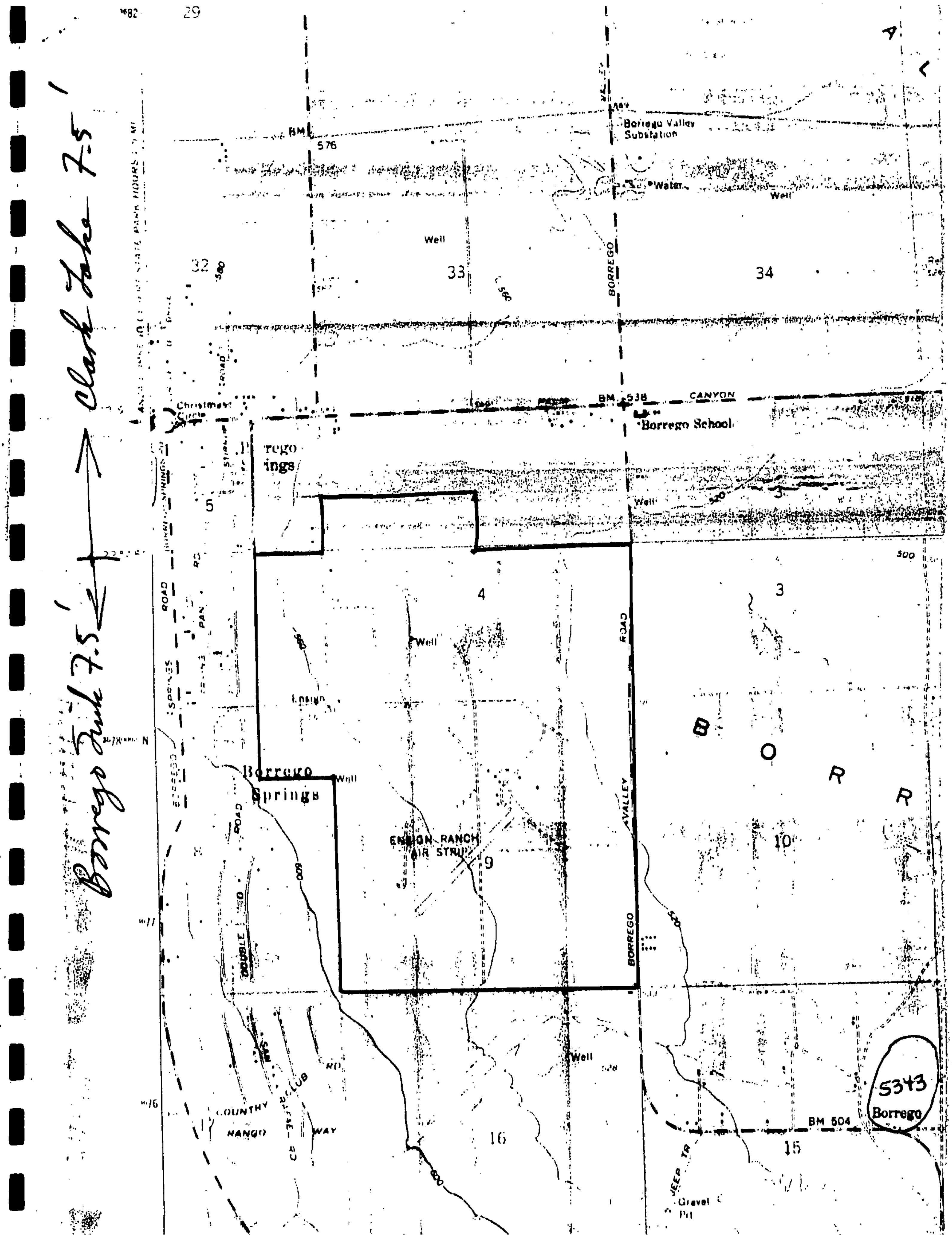
Project Identification— Clark Lake, Borrego Sink

(X) The San Diego State University files show no recorded site for the Project area.

( ) The files show positive site locations in the vicinity/on the project area. Site forms are included.

Record check by— Melissa Johnson   Date— Feb 1, 1979

Signed— Larry L. Leach



29
BM 576
Borrego Valley Substation
Water
Well
32
33
34
BORREGO
Christmas Circle
BM 538
CANYON
Borrego School
Borrego Springs
5
4
3
Well
Ensign
B O R R
Borrego Springs
ENSIGN RANCH AIR STRIP
9
10
BORREGO VALLEY ROAD
DOUBLE O ROAD
COUNTRY CLUB RD
RANCHO WAY
16
15
BM 504
JEEP TR
Gravel Pit
5343
Borrego

APPENDIX G

TABLE 1

TRAFFIC CHARACTERISTICS/TILTING T DRIVE

Average Daily Traffic	7300.
Percent Medium Trucks	.5
Percent Heavy Trucks	.5
Speed-Autos (MPH)	40.
Speed-Trucks (MPH)	40.
CNEL Criteria (dB)	55.

Distribution of Traffic

	Percent Daytime	Percent Evening	Percent Night Time
Autos	77.5	12.9	9.6
M-Trucks	84.8	4.9	10.3
H-Trucks	86.5	2.7	10.8

Noise Barrier Geometry

Horizontal Distance from Source to Barrier (Ft.)	65.0
Height of Barrier Base Above Roadway Base (Ft.)	0.0
Horizontal Distance From Source to Receptor (Ft.)	80.0
Height of Receptor Above Roadway Base (Ft.)	5.0

Traffic Noise Levels and Noise Barrier Heights

Traffic Noise Level (CNEL) Without Noise Barrier	59.9
Noise Barrier Height to Meet CNEL Criteria	6.0
Height of Top of Barrier Above Roadway Base	6.0
Attenuated Noise Level (CNEL) Achieved With Barrier	54.9

APPENDIX G

TABLE 2

TRAFFIC CHARACTERISTICS/BORREGO VALLEY ROAD

Average Daily Traffic	16000.
Percent Medium Trucks	1.5
Percent Heavy Trucks	.5
Speed-Autos (MPH)	45.
Speed-Trucks (MPH)	40.
CNEL Criteria (dB)	55.

Distribution of Traffic

	Percent Daytime	Percent Evening	Percent Night Time
Autos	77.5	12.9	9.6
M-Trucks	84.8	4.9	10.3
H-Trucks	86.5	2.7	10.8

Noise Barrier Geometry

Horizontal Distance From Source to Barrier (Ft.)	65.0
Height of Barrier Base Above Roadway Base (Ft.)	0.0
Horizontal Distance From Source to Receptor (Ft.)	80.0
Height of Receptor Above Roadway Base (Ft.)	5.0

Traffic Noise Levels and Noise Barrier Heights

Traffic Noise Level (CNEL) Without Noise Barrier	64.7
Noise Barrier Height to Meet CNEL Criteria	10.0
Height of Top of Barrier Above Roadway Base	10.0
Attenuated Noise Level (CNEL) Achieved With Barrier	54.9

APPENDIX G

TABLE 3

TRAFFIC CHARACTERISTICS/DI GIORGIO ROAD

Average Daily Traffic	6000.
Percent Medium Trucks	.5
Percent Heavy Trucks	.5
Speed-Autos (MPH)	40.
Speed-Trucks (MPH)	35.
CNEL Criteria (dB)	55.

Distribution of Traffic

	Percent Daytime	Percent Evening	Percent Night Time
Autos	77.5	12.9	9.6
M-Trucks	84.8	4.9	10.3
H-Trucks	86.5	2.7	10.8

Noise Barrier Geometry

Horizontal Distance From Source to Barrier (Ft.)	65.0
Height of Barrier Base Above Roadway Base (Ft.)	0.0
Horizontal Distance From Source to Receptor (Ft.)	80.0
Height of Receptor Above Roadway Base (Ft.)	5.0

Traffic Noise Levels and Noise Barrier Heights

Traffic Noise Level (CNEL) Without Noise Barrier	58.8
Noise Barrier Height to Meet CNEL Criteria	6.0
Height of Top of Barrier Above Roadway Base	6.0
Attenuated Noise Level (CNEL) Achieved With Barrier	53.8

BORREGO SPRINGS PARK
San Diego County, California

SUPPLEMENTAL ENVIRONMENTAL IMPACT DATA FOR FLOOD CONTROL, WATER, AND SEWERAGE FACILITIES

Prepared by

Boyle Engineering Corporation
1501 Quail Street
Newport Beach, California 92660

January 1980

Boyle Engineering Corporation

FEDERATED DEVELOPMENT COMPANY
Attention Mr. Herschel Berkus, Vice President
10880 Wilshire Blvd., Suite 1212
Los Angeles, CA 90024

May 8, 1980

Borrego Springs Country Club
Flood Control, Water and Sewerage Facilities

This report concludes an engineering investigation concerning flood control, water and sewerage facilities required for the ultimate development of Borrego Springs Country Club. Its purpose is to provide supplemental information that can be used in a more comprehensive EIR (by others) that will satisfy CEQA requirements for the property.

Recommendations are made for the type of flood control, water and sewerage facilities based on an analysis of alternatives that are presented. Environmental impacts and mitigation measures are discussed for the alternatives.

The water supply study in this report is based on a separate study performed by Mr. David A. Phoenix entitled "An Appraisal of the Groundwater Resources in the Northern Subbasin of the Borrego Valley Reservoir, San Diego County, with Emphasis on the Recovery of Groundwater from the Borrego Springs Park Area," dated July 1979.

BOYLE ENGINEERING CORPORATION

Victor E. Opincar, Jr., PE
Senior Civil Engineer

vm

Encl.

W-F01-001-01

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

* * * * *

TABLE OF CONTENTS - Continued

1.0 DESCRIPTION OF PROJECT

1.1 PURPOSE AND NEED

1.1.1 New Development

Additional flood control, water, and sewerage facilities are required to complete the development of 1,087.3 acres known as Borrego Springs Park located in Borrego Springs, San Diego County, California. Figures 1-1 and 1-2 show the vicinity map and general location of the proposed Borrego Springs Park development. The existing general plan for the area consists of three classifications: residential, rural residential, and multiple rural use. The development plan proposes a variety of housing types, densities, and consequently price ranges to meet that demand. Ultimately, 329 single family units, 202 patio homes, 244 attached units, forty 5-acre ranchettes, and twenty 10-acre ranchettes are proposed in addition to existing homes for a total of 967 dwelling units.

The plan proposes to provide permanent as well as seasonal housing for future residents. Many residents are expected to be retired and the developer plans to propose incorporation of energy conservation measures in the design of housing to reduce utility demand: evap-coolers in place of air-conditioners, solar heating in pools, north window orientation, and roof overhangs.

A resort complex and community center incorporating commercial development is also proposed. It is expected to offer local convenience shopping, hotel facilities, and future office space, some of which could be devoted to medical and dental offices. It is proposed to be located along Tilting "T" Drive on the east side of the development. This central location will serve residents with a minimum of travel distance. The central shopping area in Borrego Springs is 1 mile to the northwest of the site.

The proposed development meets the recreation and open space requirements by the retention of a nine-hole golf course and a par-3 golf course as two open space entities surrounded by and integrated with the residential units. Additional open space is proposed around an existing sewage treatment plant on the east side of the site and along flood control levees which are either existing or will be necessary within the site. Tennis courts, a clubhouse, and a driving range are included in the recreation designation.

Table 2-4 summarizes the total development for Borrego Springs Park which is completely within the boundary of Borrego Springs.

1.1.2 Flood Control

Flood protection provisions are required for the ultimate build out of the Borrego Springs Park development.

The recommended flood protection for Borrego Springs Park is to control intermittent upstream runoff around and through the development utilizing earth levees, drainage swales, ditches, raised building pads, and the existing golf course areas in a manner that will maintain the integrity of the onsite improvements and minimize adverse effects to any downstream properties. Onsite drainage runoff mostly follows the natural drainage pattern and will be directed utilizing drainage swales, streets, and the existing golf courses to the areas designated to carry the upstream runoff. This can be accomplished by the flood control system shown in Figure 4-1.

1.1.3 Water Supply

Water supply, storage, pumping, and distribution facilities are required for the development of 835 residential units and related facilities proposed in the Borrego Springs Park plan. The development is completely within the boundary of the Borrego Springs Park County Water District (BSPCWD) and will be supplied by water from that entity.

The water district owns and maintains water wells and a distribution system to serve existing development. The District's system will need to be expanded to serve the proposed development which will result in a buildout condition within the District.

The proposed water system improvements consist of a 1.5-million gallon (MG) below-grade reservoir, booster pumping station with at least one fire pump driven by an engine for emergency power outages, and a new well as backup to the District's existing supply wells. All new facilities would be built as part of the Borrego Springs Park development and turned over to the District.

The purpose of these improvements to the water system is to provide a reliable source of water within the District in accordance with sound engineering practices for a high quality water system. This system will meet standards set by the state health department effective January 6, 1980, under Title 17 of the California Administrative Code.

1.1.4 Sewerage Facilities

Sewage collection, treatment, and disposal facilities are also required for the Borrego Springs Park development. The BSPCWD will also provide this service to the development since it currently operates the sewage system that serves existing homes within the District and is master planned to serve the proposed Borrego Springs Park development (i.e., which will completely build out the area within the District).

The treatment and disposal facilities proposed for the District to serve the ultimate development consist of constructing a new secondary treatment plant. Chlorination and filtration of the effluent will be provided so it can be used for irrigation of the golf course areas. During low flow or wet weather periods, the District will have the option of percolating the effluent into the basin by using percolation areas within the treatment plantsite.

Significant cost savings may be realized by construction of this plant under joint-powers agreement with the adjacent Borrego Water District with adequate capacity to serve new development in both districts. The cost savings would not only be in the capital costs but also in the long-run annual operational and maintenance expense.

The purpose of the new treatment facilities is to provide adequate treatment to meet requirements of the state and local regulatory agencies.

1.2 APPLICATION AND PERMITS

1.2.1 Flood Control

The earthen levees at the northern end of the project site are intended to eventually become part of the Borrego Valley General Plan for Flood Control Improvements under the authority of the Zone 5, Advisory Commission of the San Diego Flood Control District (ACSDFCD No. 5). Application to the ACSDFCD No. 5 will be made to assure the coordination of flood control improvements in the Borrego Valley.

1.2.2 Water Supply

The BSPCWD currently has the appropriate permits to operate the existing water supply system. The expansion of the existing water supply system to construct a new well will require application to the State of California Board of Health to document the quality of the well.

1.2.3 Sewage Reclamation

The BSPCWD currently has Order No. 76-10 from the California Regional Water Quality Control Board (CRWQCB), Colorado River Region, setting waste discharge requirements for the existing development. The BSPCWD has applied for a permit with discharge requirements for the utilization of sewage effluent for golf course irrigation from an expanded treatment plant. The following two objectives will be required to provide sewage treatment and disposal at the Borrego Springs Park development:

1) Processing of a new wastewater discharge permit by the CRWQCB.

2) The construction of fully operational facilities which comply with treatment and discharge requirements.

1.3 MATERIALS TO BE TREATED AND DISCHARGED

1.3.1 Flood Control

In order to protect the site to the most efficient and effective extent feasible, a system of levees, drainage ditches, and utilization of raised building pads would be built to divert flow around and away from proposed structures. Figure 4-1 shows the direction and volume of the peak 100-year canyon runoff flows that sheet across the Borrego Valley floor from the mountain watersheds to the Borrego Sink. Figure 4-2 shows the proposed floodworks diverting or controlling the flows.

The peak flows shown in Figure 4-1 were compiled in the San Diego County Department of Sanitation and Flood Control 1972 Borrego Valley report using the hydrograph method for the mountain watersheds. Due to the individual geography of each canyon and history of valley floods, these peaks are not considered by the county to occur simultaneously. These individual peak flows pass from the mouth of the canyons, meandering in many cases, forming a series of channels. Structures would be protected from the worst case since the floodworks are sized to divert or control the largest peak runoff flow from the mountain watersheds. Structures would be protected from the northerly direction with a 4-foot-high levee diverting flows around the north end of the project for the 11,700-cubic foot per second (cfs) flow from Borrego Palm Canyon, the largest of the northwesterly mountain watersheds. Structures would be protected from the westerly direction by raising the building pad on the 10-acre ranch parcels just west of Di Giorgio Road 2 feet above the calculated depth of flow and then controlling the flow at Di Giorgio Road to divert the flow around and through the project site for the 1,300-cfs flow from Dry Canyon, the largest uncontrolled westerly mountain watershed. Tubb Canyon, the largest of the westerly watersheds, has been effectively diverted around the project site. Even in the worst case of this diversion being removed, the raised structures and diversions would still protect the project site. The appendix contains the calculations for the depths of flow and velocities using the Federal Flood Insurance guidelines for alluvial fan special flood hazard zone mapping.

The 100-year frequency onsite runoff was calculated by the unit hydrograph method to show an approximate 8 percent increase between the existing condition before development versus the proposed condition after development. The following is a summary of these computations:

ONSITE RUNOFF

	Before Development	After Development
Area	1,087.3 acres	1,087.3 acres
Runoff [1,2]	1,336 cfs	1,442 cfs
cfs/acre	1.23	1.33

[1]100-year frequency, 6-hour precipitation for Borrego Valley zone found to be 3 inches per Sheet II-A-7. County of San Diego hydrology manual approximated for computation method.

[2]County of Orange Flood Control District hydrology manual method for development of unit hydrograph computations.

1.3.2 Water

The BSPCWD currently provides service to 132 dwelling units (i.e., 92 existing and 40 under construction). In addition, it is capable of serving the two golf courses within the District which are not currently being used.

Previous studies for per capita flow rates in similar desert communities in California[1] have found a variation from 150 gallons per capita per day (gpcd) in January to 330 gpcd in July. These per

[1]California Department of Water Resources, "Urban Per Capita Water Use Study, 1971-1977," November, 1978.

capita flow rates take into account water for all municipal and industrial purposes (i.e., residential, commercial, parks, etc.). When large golf course areas are included in a service area, the per capita flows must be increased to account for the large irrigation requirements. An analysis of the type of land use within the water district was used to estimate the water use at ultimate development. A summary of this analysis (Table 5-2) is as follows:

Type of Water Use	Water Use in BSPCWD Based on Development Status (acre-feet/year)		
	Existing	New	Total
Residential	58	521	579
Nonresidential	---	172	172
Golf Course Irrigation	231	750	981
	289	1,443	1,732

The golf course irrigation demand on the domestic water system can be reduced by using reclaimed water from the sewage treatment plant. This is discussed further in Subsection 1.3.3.

The wells used by the water district are of adequate quality to meet drinking water standards. Treatment of the well water is not required.

1.3.3 Sewage Reclamation

The development of Borrego Springs Park within the BSPCWD will add 835 dwelling units within the District's service area. The per capita flow rate to establish the design flow for the existing and proposed development is 70 gpcd, or 240 gallons/dwelling unit/day. The resulting estimated sewage flow is as follows:

Existing Dwelling Units	132 x 240	=	31,700 gallons per day (gpd)
New Dwelling Units	235 x 240	=	200,400 gpd
			232,100 gpd

As indicated by these figures, the estimated quantity of sewage from the new development will be approximately 86 percent of the total flow within the District. This will result in the following quantity of sewage and sludge to be handled by the District:

Resource	Unit	Existing	New	Total
Treated Effluent	Acre-Feet/Year	38	238	276
Treated Sludge	Dry Tons/Year	13	73	86

It is proposed to use treated effluent to irrigate the golf courses to reduce the need for groundwater. During wet weather or seasonal low flow periods, the effluent will be percolated into the basin within the treatment plantsite.

The digested and dried sludge can readily be used on the golf course by mixing it with sand and other materials to fertilize a greens nursery where grass can be grown to use as "plugs" on the golf course. The use of sludge in this manner would reduce the need to import soil amendments to the site for the same purpose.

1.4 METHOD OF TREATMENT AND DISCHARGE

1.4.1 Flood Control

There may be a precipitation of sediments as runoff passes across the project due to a reduction in flow velocity of this runoff, thus encouraging the settlement of solid sediments.

1.4.2 Water Supply

There is sufficient well water of good quality from the BSPCWD such that any newly developed or existing well water sources with excessive chemical constituents or total dissolved solids (TDS) may be brought to an acceptable level by blending.

1.4.3 Sewage Reclamation

The alternative selected for this project to provide sewage treatment is to construct a new treatment facility and reclaim the effluent for irrigation on the golf courses. This can be accomplished in a properly designed treatment facility that is properly operated by a public agency, such as the BSPCWD, with a full-time operator.

1.5 EXISTING FACILITIES

1.5.1 Flood Control

Earthen levees have been built in the past across the northern portion of the project site but appear to be minimally effective. Based on observation of subsequent storm runoff, a rock dike behind a row of tamarisk trees along Di Giorgio Road near Well No. 2 was constructed several years ago to direct runoff from the western watershed area toward a dip crossing in Di Giorgio Road to pass across the property. The existing drainage pattern for the original Borrego Country Club development is shown in Figure 4-2. The new flood control system proposed for this project will be integrated into the existing onsite drainage pattern.

1.5.2 Water System

The existing water system is operated by BSPCWD and serves 132 dwelling units and a small golf course. It also serves to supply irrigation water for an 18-hole golf course and clubhouse that have not been used for several years.

The water supply is from a 387-foot-deep well with 14-inch-diameter casing with a 125-horsepower pump capable of producing 1,200-gallon per minute (gpm). The well is pumped into the system and into a 10,000-gallon storage tank. The distribution pipelines consist of 12-, 10-, and 8-inch-diameter mains. The well water is not treated. The District has another well that is reserved for emergency demands capable of 400-gpm capacity.

The existing water supply and distribution system is shown in Figure 5-1.

1.5.3 Wastewater

The existing wastewater system is operated by BSPCWD and serves the same dwelling units as the water system. The 75,000-gpd plant is an 18-year-old activated sludge packaged plant located on the east side of the District. Treated effluent flows into a percolation area adjacent to the plant where it both evaporates and percolates underground. Sludge is removed from the aerobic digester periodically and placed on a drying bed adjacent to the plant. Dried sludge has been stored on the plantsite due to its low quantity.

The sewage collection system consists of a gravity system from the dwelling units until approximately 50 feet from the treatment plant where a lift station intercepts the flow and pumps it up to the treatment plant. There are two 5-horsepower pumps that lift the sewage approximately 30 feet to the treatment plant.

1.6 NEW FACILITIES

1.6.1 Flood Control

To protect the project from potential floods, a series of levees and drainage ditches as illustrated in Figure 4-2 are designed to divert and control the 100-year peak runoff for the largest potential individual contributing watershed.

A 4-foot-high levee with a riprap 2:1 sloped facing and a 12-foot width at the top would divert the 11,700-cfs flow potentially occurring from Borrego Palm Canyon away from the structures at the north end of the project across Borrego Valley Road towards the Borrego Sink. This type of levee which would be used was one of the recommended designs in the San Diego County Borrego Valley Flood Control Master Plan.

The drainage ditch that parallels Di Giorgio Road would be improved to pick up the flows resulting from the 1,300-cfs flow potentially occurring from Dry Canyon carrying them down either north or south to a culvert designed to pass these flows. The flows being carried northerly will pass under Di Giorgio Road and again enter a drainage ditch to carry the flows through the project to Borrego Valley Road where they are discharged toward the Borrego Sink. The flows intercepted to be carried southerly will be passed around the southern end of the project to a culvert across Borrego Valley Road to be discharged to Tubb Canyon Wash. Final engineering has not been completed but preliminary calculation indicates a channel at a depth of 6 feet and 14 feet wide at its top would be necessary to carry the flow. The excavated material may be used to construct the new flood control levees. The culvert would be designed such that if sedimentation should plug a portion of the culvert, flows could pass over the road without structural damage.

Building pads for the 10-acre ranch-style parcels at the westerly end of the project will be elevated 2 feet above the calculated one-half foot depth of flow from the Dry Canyon sheet flow. The flows will then be collected at the drainage ditch along Di Giorgio Road.

Drainage within the project from onsite rainfall will utilize the street gutters essentially following the existing onsite drainage pattern. Golf courses will be used as drainage swales to collect onsite drainage. Onsite drainage would be discharged across Borrego Valley Road just south of the sewage treatment plant.

The energy consumption associated with the flood control improvements for continued operation and maintenance will be minimal since this function will be part of the normal road maintenance for the area.

1.6.2 Water

The proposed water facilities to serve the Borrego Springs Park development will consist of a 1.5-MG storage reservoir, a booster pumping station with an emergency power source, and a new well to back up the existing wells. The water system will be designed to supply water for the maximum day demand at ultimate development plus fire flow.

Treatment of the groundwater is not required based on historical records from the water district. Water samples will be taken at six-month intervals to detect possible lateral migration of nitrates into the area being pumped by the wells. The new water storage reservoir will provide blending of the well water should the nitrate levels in any one of the wells exceed 45 milligrams per liter (mg/l), the maximum allowed by the state health department.

The estimated energy consumption of the wells and booster pumping station to supply both domestic and irrigation demands at ultimate development is 650,000 kilowatt-hours (kwh) per year.

1.6.3 Sewage

The proposed wastewater treatment plant to serve the project will consist of an oxidation ditch plant with chlorination and filtration of effluent to meet a coliform bacteria count of 2.2 MPN/ 100 milligrams (mg). The treated effluent will be pumped to the golf course within the District for spray irrigation of the greens and turf area. The new plant will have a design capacity of 0.23 million gallons per day (mgd) with allowance in the design for peak flows through key components for proper operation and consistent effluent quality.

The oxidation ditch is an extended aeration process using a long narrow continuous oval or circular channel with a paddle-wheel or jet pumps for aeration. A combination of conservative design and a basically simple process for small communities is increasing the popularity of this type of treatment.

The oxidation ditch process for the new plant will use two circular reactor basins with surface aerators to maintain circulation and aeration. Separate basins will be required for clarification and chlorination. Waste sludge will be treated in an aerobic digester.

The process flow schematic and site plan are shown in Figures 6-1 and 6-2. The design criteria and cost estimates are shown in Tables 6-1, 6-2, and 6-3, respectively.

The estimated annual energy consumption to operate the new facility is 297,000 kwh/year. This includes the comminutor, aeration equipment, sedimentation tanks, chlorination, sludge handling, and aerobic digestion.

1.7 SERVICE AREA BOUNDARY

1.7.1 Flood Control

The earthen levees at the northern end of the project are proposed to be part of the ACSDFCD No. 5 General Plan, which serves the entire Borrego Valley. There will be a drainage ditch along Di Giorgio Road and several culverts which will be within the limits of the San Diego County Road Department service area. The remaining flood control facilities will be within the limits of the project boundary.

1.7.2 Water Supply

The existing and proposed water supply system will be served by the BSPCWD.

1.7.3 Sewage Reclamation

The existing and proposed wastewater reclamation plants will be served by the BSPCWD.

2.0 ENVIRONMENTAL SETTING

2.1 LOCATION

Borrego Springs Park encompasses 1,087.3 acres of land located approximately 1 mile southeast of Borrego Springs in San Diego County, California, as shown in Figure 1-2. The project site is bordered on the east by Borrego Valley Road, on the west by Di Giorgio Road, and is about 1 mile south of Palm Canyon Drive.

Water supply, transmission, and storage facilities to serve the domestic and irrigation requirements of the project will be from the BSPCWD, a public agency that includes the project area within its boundary (Figure 2-1). The District pumps water from the groundwater basin to serve its existing and future demands.

Sewage collection, treatment, and reclamation facilities will also be served by the BSPCWD. The sewage treatment plant is located on the east side of the District's boundary adjacent to Borrego Road.

2.2 REGIONAL SETTING

The project site is located in the northeastern section of San Diego County within Borrego Valley as shown in Figure 1-2. The Borrego Valley is a 70-square-mile privately held enclave within the Anza-Borrego Desert about 60 miles inland from Oceanside. The valley is fairly flat with an elevation drop in 15 miles from 1,000 on the northwest side to 600 on the northeast side. This small topographic variation is in sharp contrast to the surrounding Anza-Borrego State Park with its rugged terrain, steep canyons, and high peaks. The valley has three centers of recreation golfing activity: the De Anza Country Club, the Road-Runner Club, and the

Club Circle Golf Course which is located within the boundary limits of the project site. The north end of the valley is primarily agricultural; the westerly and central portions of the area are primarily residential and recreational areas.

The project is part of the original site of the old Ensign Ranch. The first well in the valley was drilled for the Ensign Ranch in 1913, and the first irrigation well was drilled on this ranch in 1926, and for many years it was the center of agriculture in the valley. The ranch grew alfalfa, barley, and date palms as well as operating a dairy farm and a hog farm at various times in its history. The old Ensign Ranch airstrip also operated on the project site. The ranch was sold in 1957. A portion of the ranch was developed for residences and golf courses as the Borrego Country Club. An 18-hole golf course operated from 1964 to 1970, after which only the nine holes around the residences were left operating.

2.3 PROJECT CHARACTERISTICS

Borrego Springs Park involves the subdivision of 1,087.3 acres of vacant land into 835 single family dwelling units of various types. Table 2-1 has a breakdown of the land use proposed for the project.

The proposed project involves the expansion of the existing BSPCWD water and sewerage systems to accommodate water demands and project-generated wastewater.

TABLE 2-1

BORROGO SPRINGS PARK DEVELOPMENT
PROPOSED LAND-USE CLASSIFICATION

Land Use	Area	Units
Single Family	154.5	329
Patio Homes	65	202
Attached Single Family	50.2	244
5-Acre Ranchettes	288	40
10-Acre Ranches	200	20
Open Space	69.1	---
Community Center	43	---
Golf Course	163.5	---
Major Circulation	49	---
Water Reclamation Plant	5	---
	1,087.3	835

2.4 GEOLOGY

Borrego Springs Park is located in the western portion of Borrego Valley along the eastern margin of the alluvial fans extending eastward from the mountains. This surface alluvium is part of a larger bajada which forms the Borrego Valley.

The soils encountered at the project site consist of sands and silts varying in consistency from loose to dense. In general, the soils become finer in texture and slightly lower in density in a northeast direction. Above an elevation of approximately 560 feet, which is in the southwesterly portion of the property, the soils are loose silty sands to a depth of 1 to 2 feet and are underlain by medium dense to dense silty sands. Below an elevation of approximately 560 feet, the soils are loose silty sands and sandy silts to depths varying from 3 to 13 feet; these soils are underlain by medium dense to dense silty sands and sandy silts.[1]

The maximum depth of the alluvial material is not known, although the logs of the wells on the property indicate that they extend below a depth of 630 feet. Groundwater was not encountered in any of the soil borings, and the soils, except for some of the underlying silt layers, were very low in moisture content.

Storm runoff is usually intercepted and reduced as the water passes over the onsite porous soils percolating into the groundwater basin.

Onsite reclamation of sewage effluent by the BSPCWD is feasible since the alluvial deposits were amenable to rapid percolation.

Reclamation can be either by the current method of percolation of effluent or by using the effluent for irrigation landscape.

Regarding seismicity, a draft environmental impact report (EIR) dated May, 1977, stated that: "The Borrego Valley is seismically active. The project site is between two major fault zones shown in Figure 2-3, the San Jacinto and the Agua Caliente. There are at least four other small faults within 5 miles of the project site. Further to the east is the San Andreas Fault. All of the faults pose a major threat to residents in the Borrego Valley.

---

[1]Woodward, Clyde, Sherard and Associates, "Soil Investigation for the Proposed Borrego Springs Development," San Diego, California, 1967.

"The epicenters of many earthquakes have been located in the Borrego Valley and one was located within the project boundary. A strong magnitude (6.4) earthquake occurred to the east of the project site in 1968 on the Coyote Creek Fault, a branch of the San Jacinto, which produced local intensities between VIII and IX."[2]

2.5 TOPOGRAPHY

Borrego Park is located on a relatively flat area (1 to 2 percent slope) and is interrupted by one intermittent stream course. Drainage flows in the development are easterly toward Borrego Valley Road. Runoff is collected in the street pattern and directed to the existing golf courses which act as drainage swales. The runoff is then directed to its exit on Borrego Valley Road just south of the existing sewage treatment plant. The gentle slope of the terrain will minimize necessary grading.

Gravity sewerlines will follow drainage patterns established by the existing developed area and the final design of the new tracts with the BSPCWD boundary. The sewage must be lifted by a pumping station to the surface for treatment at the reclamation plant.

The existing water system is pressurized directly by pumps since there are no hills nearby on which to locate ground storage reservoirs. The District will continue to serve the new development with a similar system.

---

[2]Ibid.

2.6 CLIMATE

The climate in North Borrego Valley is severely arid, abundant sunshine, little rainfall, little or no humidity with hot dry summers and cool dry winters; it is characteristic of the lowland desert regions of Southern California. It is also a climate where the extremes are highly noticeable. Diurnal changes in temperature exceeding 60° F are common summer and winter; uncommon but severe rainfall originating from warm tropical storms in the summer are broadly cyclical in occurrence. They create flood conditions over much of the valley, but their frequency of occurrence is unknown.

Borrego Valley is an area where mean minimum temperatures in January are about 36° F, but mean maximum temperatures in July are about 106° F; the winters are comfortably cool, the summers uncomfortably hot. More importantly to its water supplies, it is also an area where potential evapotranspiration far exceeds actual precipitation; the native vegetation is capable of using far more water than is supplied by precipitation, and thus it is an area of water deficiency.

According to 20 years of record at Borrego Desert Park on the west side of the valley, the normal annual precipitation is about 8 inches and rainfall occurs mainly between November and March on the central and west side of the valley floor. In the mountains and elevated small valleys bordering the west side of Borrego Valley, temperatures are cooler and average annual precipitation is 16 inches or more and perhaps very locally as high as 40 inches.

2.7 WATERSHED PHYSIOGRAPHY

The watershed areas may best be described as consisting of two components: the mountain watersheds and the valley floor watershed. The mountain canyon watersheds are typically steep and rigid, emptying out onto the rather flat valley floor alluvial fans. The nature of the canyon watersheds is to concentrate flows to the mouth of the canyon where they are then carried in intermittent streambeds across the valley floor. These valley streambeds ordinarily do not have the capacity to carry the flows that may be generated from local thunderstorms or rainstorms. Such flow paths are prone to lateral migration and to sudden relocation to any other portion of the fan during a single runoff event. This erratic, unpredictable behavior subjects all portions of the fan to potential flood hazard, regardless of location (see Figure 4-1). In this manner, new channels are found and old channels are lost. The water and sediment tend to spread out in a fan from the mouth of the canyon abandoning the traditional existing channels, sheeting across the valley floor, and depositing any accompanying sediment as the velocity of the water decreases, thus creating the typical desert alluvial fan of which Borrego Valley is an example.

The project site is situated on the southerly part of the Borrego Valley bajada, a confluence of the several alluvial fans formed by the mountain watersheds to the western edge of the valley. Runoff from the mountain watershed approach the project site from the west and the northwest (see Figure 4-1). The ridge upon which the Montezuma

Grade Road descends into the Borrego Valley effectively splits the contributing watersheds that approach the project site into southwesterly and northwesterly approaches.

Southwesterly of the project site, the Tubb Canyon watercourse at one time split into two directions at the southwest edge of the Borrego Springs community. One watercourse split to the northeast to converge with the Dry Canyon watercourse, then proceeded towards the Borrego Springs community and the project site. The other watercourse split southeasterly around the southerly end of the Borrego Springs community and away from the southern edge of the project site. Since 1968, the runoff from Tubb Canyon has been directed to the southeast around the developed area in the valley by an 8-foot-high rock and wire reinforced revetment levee. Historically, flash floods have fanned out from the mouth of Tubb Canyon at a relatively shallow depth.[3] Dry Canyon and the relatively small watersheds northerly to the end of the Montezuma Grade Road are the only contributing runoff to the western edge of the project site.

The northern edge of the project site is approached by runoff from the Hellhole, Borrego-Palm, and Henderson Canyon watersheds. Just at the northern boundary of the project site along Di Giorgio Road, these flows are joined by the runoff from the watersheds to the west of the project site. The confluence of this runoff goes across the northern boundary of the property where it is either intercepted by Borrego Valley Road going down to the

---

[3]Telecon, George Howard, San Diego County Department of Sanitation and Flood Control, and Pat Kelly, Boyle Engineering Corporation, November 29, 1979.

dip-cross just south of the existing sewage treatment plant[4] or sheets across Borrego Valley Road towards Borrego Sink. This has been the characteristic of sheet flows around and across the project site during the 1976 and 1977 flash floods, respectively, from tropical storms Kathleen and Doreen. These flash floods have been equated to have a recurrence frequency of 100 and 50 years, respectively, and were the largest storm runoff events in the valley's recent history.[5,6] It is probable that any future flows will follow this same pattern.

2.8 WATERSHED HYDROLOGY

The hydrology used to obtain the 50-year and 100-year flood discharges from the Borrego mountain watersheds which were used in the project flood analysis (see Appendix 1) is defined in the San Diego County Department of Sanitation and Flood Control, July 1972 Borrego Valley General Plan for Flood Control Improvements:

> "The hydrology for (the General Plan) study . . . was approached by estimating the rainfall in this area for 50-year, 100-year and maximum storms and computing the runoff by applying this rainfall to the terrain characteristics of

---

[4] Conversation, Tom Davis, BSPCWD, and Pat Kelley, Boyle Engineering Corporation, October 31, 1979.

[5] "Tropical Storm Kathleen - Storm Report," County of San Diego Community Services Agency, Department of Sanitation and Flood Control, September 9-10, 1976 (includes Borrego Valley Thunderstorm, September 23), pp 2-7.

[6] "Tropical Storm Doreen - Storm Report," County of San Diego Community Services Agency, Department of Sanitation and Flood Control, August 15-17, 1977, pp 2-8.

each canyon. This approach was adopted because of availability of rain gage records and the lack of long-term stream gage records.

"Flood peaks and runoff quantities were computed by developing hydrographs using Corps of Engineers methodology for Southern California areas. The hydrographs are applied to specific watersheds by adjusting the vertical scale to conform to design rainfall and the horizontal scale to conform to the combination of basin characteristics. The flood peak is indicated at the top of the curve and the acre-feet of runoff is proportional to the area beneath the curve.

"The rainfall estimates were derived from statistical analysis of 223 total gage-years of desert rainfall data in the Salton Sea Basin. The short-term records from rain gages in Borrego Valley (all less than 20 years) were analyzed and compared with long-term records from Indio (92 years) and Mecca (65 years). Storms were found to be either local thunderstorms or general rainstorms by checking rainfall in surrounding areas. Rainfall recurrence curves were plotted for each station. The curve from Borrego Park Station was representative and was selected for use in determining 50-year and 100-year rainfall for both summer and winter storm types. These were compared with data from the U.S. Weather Bureau Technical Paper 40. The maximum rainfall was taken directly from the Corps of Engineers report on Tahquitz Creek.

"These rainfall quantities were applied to the canyon areas using a precipitation pattern measured during the most severe thunderstorm recorded in the California desert."

In addition to the hydrological data used to find the 100-year and 50-year frequency floodflows from the mountain watersheds which surround Borrego Valley and the project site, data from the September 1976 and August 1977 tropical storms Kathleen and Doreen can provide a basis of flood behavior at the project site. The effects on the Borrego Valley area of these thunderstorms were varied. Tropical storm Kathleen in 1976 resulted in no large flow quantities being measured in the storms as the rain fell on open desert areas (Borrego Valley) and was not concentrated into a single flow. Damage was limited to road washouts and minor flooding of residences and businesses. This storm may be typical of the desert floor thundershower (tropical storm) which results in shallow sheet flows that would come from the project site itself and from a short area upstream from the project site.[7] The storm report for tropical storm Doreen in 1977 describes as a different type of event, where rainfall was in the mountain watersheds and concentrated the stormflows at the mouth of the canyons and their reasonably stable, well-defined channels.[8]

The Federal Insurance Administration (FIA) has not prepared an official flood hazard boundary map for the Borrego Valley, since the FIA has not designated this area as having any special flood

---

[7]"Tropical Storm Kathleen - Storm Report."

[8]"Tropical Storm Doreen - Storm Report."

hazard.[9] The United States Geological Survey (USGS), however, has prepared flood inundated maps which delineate the approximate boundaries of areas that may be inundated by a 100-year flood frequency event (Figure 4-1). Figure 4-1 shows that the Borrego Valley is subject to 100-year frequency sheet flooding from intermittent watercourses. Some areas near the mouth of the mountain watersheds in the Borrego Valley have been specially designated as flood-prone watercourses but none of these extended to the project area.

The available hydrological information will be utilized in conjunction with the FIA instructions, "Alluvial Fan Special Flood Hazard Mapping," to calculate the limits of flood hazards and to determine the depth of flooding and velocity of flooding at the project from the mountain watersheds' 100-year discharges. The initial step in the quantitative determination of flood hazard on an alluvial fan is to develop an appropriate 100-year peak discharge value. This project study uses the peak runoffs generated in the 1972 Flood Control General Plan, per the peak hydrograph method which is described at the beginning of this section.

The approach outlined in the FIA instructions makes use of statistical analyses that relate the probability of given discharges at the apex of a fan to the probability of certain depths and velocity of flow occurring at any point on the fan below the apex.

At the time of maximum flow during a major flood event on an active fan, flow does not spread evenly over the fan surface but is confined to a single channel that carries the water from the

---

[9] Telecon, Ray Lenaberg, FIA, San Francisco, California, and Pat Kelly, Boyle Engineering Corporation.

apex to the toe of the fan. A channel is formed by the flow itself through erosion of the loose material that makes up the fan. Below the apex of the fan, the channel will occur at random locations at any place on the fan surface; and under natural conditions, it is no more likely to follow a preexisting flow path than it is to follow a new flow path. This channel has an approximately rectangular cross section.[10]

The probability of a point being flooded in a given flood event decreases from the apex to the toe of a fan, because the downslope widening of the fan surface provides a greater area over which a channel of given width may occur.[11]

Once the calculated depth of flooding is found, the necessary height of building pads and of the flood control levees to protect the project site from flooding may be found.

The following table summarizes the calculations from Appendix 1, which was the Federal Insurance Administration Alluvial Fan Special Flood Hazard Mapping guidelines.

Item Watershed	Q_{100}	Max. Depth At Site	Max. Velocity At Site
Dry Canyon	1,300 cfs	0.5 ft	3.5 fps
Borrego-Palm Canyon	11,700 cfs	1.5 ft	5.5 fps
Tubb Canyon	7,700 cfs	1.5 ft	5.5 fps

[10] "Appendix, Alluvial Fan Special Flood Hazard Zone Mapping," FIA, July 17, 1979, pp 1-3.

[11] Ibid.

2.9 GROUNDWATER

The analysis of the groundwater supply to the project site is primarily based on an engineering study by Mr. David A. Phoenix.[12] Mr. Phoenix is a groundwater expert whose fields of expertise are hydrology and geology. He has a California registration in geology. His report is included with this study as Appendix 2.

2.9.1 Existing Setting

The only water available to homes and agriculture in the valley is that which comes from local sources. Inasmuch as the area is a desert, the water supply is limited and almost entirely underground. It is within the reach of wells, some deeper and more costly than others, but available over most of the valley floor. The groundwater reservoir is large and it probably contains about 700,000 acre-feet or more of usable water, enough to provide a "standby" resource in periods of drought and enough to last for many years if uncontaminated and used carefully in accordance with the natural supply.

Over a 40-year period, the valley has changed from a thinly populated, remote, and primitive desert into an attractive resort and agricultural community. It has been accomplished by the pumpage of underlying groundwater.

---

[12] David A. Phoenix, "An appraisal of the groundwater resources in the northern subbasin of the Borrego Valley Reservoir, San Diego County, with emphasis on the recovery of groundwater from the Borrego Springs Park area," July, 1979.

Well measurements made during the period 1952 to 1965 indicated that a decline in water levels had occurred in the area north of Borrego Sink.[13] Later in 1974, a contour map of the water table in Borrego Valley showed decline to coincide with an area of extensive irrigation development. During the 12-year period, in places the decline was 30 to 40 feet. Further south it was from 20 to 44 feet; and in the vicinity of the project site, the decline was locally as much as 20 feet below the early period of water level measurements.[14]

However, at current rates of usage, the calculated recoverable water in storage in the upper 100 feet of saturated sediments, about 770,000 acre-feet, is sufficient to support a growing rural desert-modified community for many years, providing changes in water quality do not seriously influence use of the water and providing the demand for water for agriculture reverses in years to come. A reversal from below-average to above-average precipitation may also result in replenishment of the accumulated groundwater deficit in the valley.

2.9.2 Groundwater Basin Characteristics

The alluvium that underlies Borrego Valley has originated by erosion of rocks in the nearby mountainous areas; it is porous and permeable sand and gravel, particularly so near the mountains and

---

[13] W. R. Moyle, Jr., Water Wells and Springs in Borrego Carrizo and San Felipe Valley Areas, California, Department of Water Resources, Bulletin No. 91-15, 1968.

[14] W. R. Moyle, Jr., Geohydrologic Map of Southern California, U.S. Geological Survey, Water Resources Invoice No. 48-73, Open File, 1974.

opposite the mouths of canyons where it has been winnowed and sorted by streamflow and deposited as broad alluvial fans. Farther from the mountains in lower and more planar parts of the valley, the underlying sediments are less permeable, fine-grained sand, silt, and clay. The specific capacity of wells in North Borrego Valley reflect the general physical and water-bearing properties of the sediments. In the northern and most western parts of the valley, specific capacities for most of the wells are between 40 to greater than 100 gallons of yield per foot of drawdown. In the central and planar parts of the valley near Borrego Sink, the specific capacity of wells is about 30 or even less. The geologic logs of wells in various parts of the valley[15] also indicate that the water-bearing strata underlying the valley are highly lenticular. In general, between adjacent wells, the deposits are uniform in their heterogeneity; extractions of water in one area will reflect upon water levels in nearby areas. Also, extractions or additions of water over extended periods of time will be reflected by the lowering or raising of water levels in large parts of North Borrego Valley.

The deposits of siltstone, sandstone, and clay underlie deposits of alluvium beneath much of Borrego Valley, and the deposits of alluvium also extend into a smaller adjacent valley, Clark Valley, lying to the northeast of the central part of Borrego Valley. The northwesterly trending Coyote Canyon Creek Fault located at the north boundary of the valley transects all of these rocks. Erosion and displacement along this fault has controlled the development

---

[15] W. R. Moyle, Jr., Water Wells and Springs in Borrego Carrizo and San Felipe Valley Areas, California.

and trend of Coyote Creek and Coyote Canyon and the northeastern boundary of the North Borrego Valley groundwater reservoir. Displacement along this fault has been sufficient to interfere with the movement of groundwater between Clark and North Borrego Valleys, but the degree of interference is not known.

2.9.3 Groundwater Basin Recharge

The main source of recharge to the groundwater reservoir comes by the infiltration of streamflow rather than from direct precipitation. Some of this recharge is hidden from sight, for it enters the reservoir via the alluvium beneath the streams (underflow), but most of it is measurable as streamflow. As it leaves the canyons and within a short distance, it percolates into the permeable sand and gravel that underlies alluvial slopes of the valley and from here it disperses widely into the groundwater reservoir.

Other sources of recharge to Borrego Valley include underflow through alluvium underlying each of the streams as well as water which may enter the sediments from deeply buried sources. As for the first item, underflow, the amount entering the valley depends upon the wetted cross-sectional area of alluvium beneath each stream, the transmissivity of the alluvium, and the hydraulic gradient. The alluvium underlying Coyote Canyon is probably the greatest source of perennial underflow to the valley; underflow from the other canyons is probably ephemeral in somewhat the same pattern as is discharge from the ephemeral streams that occupy these canyons. The material underlying each channel is more than likely highly permeable sand and gravel.

Groundwater recharge to the area originates by infiltration into alluvial fans below the mouths of Tubb, Culp, and Henderson Canyons and probably to a lesser degree from Coyote Canyon. Recharge from the nearby canyons is ephemeral and on the average not great, probably no more than 300 to 400 acre-feet per year. Heavy rains occur in the area and probably help to replenish the groundwater reservoir, but the occurrence of these rains, although probably broadly cyclical, is unpredictable. Furthermore, most of the groundwater from Coyote Canyon in the northern part of the valley is probably intercepted by wells before it reaches the Borrego Springs Park area.

Today, the hydrologic budget has been modified considerably from its original condition. During the period 1954 to 1965, pumpage from North Borrego Valley groundwater reservoir each year annually exceeded the amount replenished (Bureau of Reclamation, 1969). The consequence was an annual lowering of the water table, greater in some areas than others, but still sufficient to reflect an average decline of about 1.7 feet per year over this period of development. During this period, a peak amount of 23,470 acre-feet per year (Threet, 1979) was being applied to about 2,500 acres of agriculture, whereas the average was about 14,500 acre-feet per year (Webb, A.A., Fig. C3, pp C16-C17, 1977). Today it would appear that less than this amount of water, probably about 10,000 acre-feet, is being used for mixed forms of agriculture, and the average annual rate of water level decline in the southern part of the reservoir is less than one-half the average rate during the early 1952-1964 period of pumpage. Water budget calculations based upon rates of consumptive use and calculated volumetric changes in storage resulting from declining water levels establish a natural recharge of 8,500 acre-feet per year, 1950-1958, or 12,104 acre-feet per year, 1950-1965 (Webb, A.A., pp C9-C17, 1977), depending upon the period of consumptive use selected for calculation. One of these latter methods suggests that current use of water is very nearly in balance with the rate of replenishment during the 1950-1965 period.

2.9.4 Groundwater Basin Use

The greatest amount of groundwater is withdrawn from North Borrego Valley for the benefit of homes and agriculture. Irrigation wells are located chiefly in the central and north end of the valley, and several large wells are used for public water supply to homes and small businesses located along the west side and in the central part of the valley. About 30 large turbine-pump equipped wells have been used for irrigation or public water supply purposes, but of that number probably no more than eight or ten are now operating at any one time. The irrigation wells probably operate continuously during the summer and intermittently during the winter; those used for public water supplies operate more intermittently in the summer when the population is low than in the winter when the population is greater. Wells servicing individual homes and small business establishments are scattered throughout the central part of the valley; most of these wells are connected to pressure tanks and most supply water to homes occupied by full-time residents in the valley. There are about 50 domestic wells in the valley and between 30 to 40 of these are believed to be in constant use.

The project area has had a long history of groundwater development. The first well in the valley was drilled for the Ensign Ranch, now the Borrego Springs Park area, in 1913, and the first irrigation well in the valley was drilled on this ranch in 1926. Irrigation from wells was an important activity in the park area until it was developed for homesites in the early 1960's. The park area, Sections 4 and 9, T. 11 S., R. 6 E., and the adjoining section of land to the north and east have been explored by almost 45 wells ranging in depth from 120 to 600 feet. Currently, groundwater discharge is taking place at no more than ten of them, seven of which are used for domestic purposes and three for public water supply (the Road-Runner Club, the Club Circle area, and a public school). It is estimated that no more than 100 to 200 acre-feet of water is withdrawn from the underlying groundwater reservoir each year by these wells. A small amount of this discharge, probably no more than 20 acre-feet per year, is returned to the reservoir by infiltration to the water table and is later recycled back to the surface by pumpage.

2.10 GROUNDWATER AND SURFACE WATER QUALITY

The chemical quality of the groundwater has been summarized by almost 200 complete and partial analyses of water collected from wells throughout the valley, mostly during the period 1952 to 1965.

The groundwater at the north end of the valley, with its high concentration of magnesium and nitrate, contrasts with the water from other areas of the valley, such as along the west side of the valley, including the state park headquarters, the project area, and as far east as Desert Lodge. The water there is a relatively dilute calcium or sodium-bicarbonate solution with smaller amounts of sulfate. Nitrate concentrations in the water are ordinarily less than 5 parts per million (ppm) and TDS concentration is between 300 and 400 ppm or less. Fluoride is a characteristic constituent in in these waters, but its concentration is less than 1 ppm. This water is of somewhat different chemical composition, and it is more dilute in TDS than that from directly below Coyote Canyon in the northern part of the valley. It has probably mostly originated as runoff from the ephemeral streams in the nearby Peninsular Ranges a short distance to the west and, hence, has had little opportunity to react chemically with the soils and fine-grained sediments that underlie more central parts of the valley.

Drinking water in the north end of the valley is obtained by reverse osmosis from the well water used by the ranches in this area. All wells in the project area provide water with less than 8-ppm nitrate. Storm runoff normally flows only a short distance before it evaporates or percolates into the alluvial deposits. Only very major storms produce significant runoff that passes across the entire valley floor. Floodwater uses, except for recharge of the groundwater basin, are limited since they are intermittent and short lived before they are absorbed into the alluvial soils. Portions of Coyote Creek are a perennial stream being only intermittent in the valley.

The nature of floodwaters is that of high-velocity flows that are relatively highly erosive in the confined limits of the upper portions of their watercourses. As a result, these floodwaters are usually accompanied with suspended sediment as they begin to fan out across the valley floor. Storm floodwaters then have poor surface water quality until these flows have had time to settle out the suspended sediment. Once this has occurred, they will usually have the water quality characteristics of the local surface waters, such as in the upper portions of Coyote Canyon.

2.11 MUNICIPAL WATER SUPPLY

The BSPCWD is the water supplier to the Club Circle Golf Course and for the proposed Borrego Springs Park development (Figure 5-1). The existing development is supplied by two wells within the project area, well No. 1 and well No. 4. Well No. 4 is the primary source of domestic water with well No. 1 serving as a backup during peak demands. Wells Nos. 2 and 3 are presently not in use. It is anticipated that well No. 3 will be tied into the existing BSPCWD domestic water distribution system prior to the ultimate development of the Borrego Country Club is completed. Well No. 2 is adjacent to the Date Palm Garden which is no longer being cultivated. Table 2-2 summarizes the total capacity of pumped well water from the BSPCWD.

TABLE 2-2

BSPCWD EXISTING WELL CAPACITY[1]

	Existing System Pump Capacity (gpm)	Proposed System Pump Capacity (gpm)	Available Total Pump Capacity (gpm)
Well No. 1	400	400	400
No. 2	Not Used	Not Used	750
No. 3	Not Used	Not Used	750
No. 4	1,200	1,200	1,200
	1,600	1,600	3,100

[1]Per Tom Davis, BSPCWD, Operator.

The well water is pumped directly into the existing distribution system and a 10,000-gallon pressure storage tank. The existing distribution lines consist of 12-inch, 10-inch, and 8-inch pipelines as shown per Figure 4-1. When the pumps are not in service, the distribution system is fed from the storage tank. There is no treatment of this well water. The quality of this well water is shown in Table 2-3. The quality of Well Nos. 2 and 3 is similar to Well No. 1, per Tom Davis of BSPCWD.

TABLE 2-3

BSPCWD DOMESTIC WATER QUALITY

Constituent	Concentration[1] (mg/l) Well No. 1[2]	Well No. 4
Calcium (Ca)	96	29
Magnesium (Mg)	17	4.1
Sodium (Na)	198	93.5
Potassium (K)	7.3	5.0
Sulfate (SO_4)	280.5	106
Chloride (Cl)	174.5	61.5
Flouride (F)	1.1	1.35
Nitrate (NO_3)	7.1	1.6
Total Hardness (Ca CO_3)	310	90
Dissolved Solids	997.5	323.5

[1]Average measurements for 1977 and 1978.

[2]See Figure 5-1 for well location.

In evaluating the ultimate BSPCWD demands, the project area will not be treated as a resort community or a "second home" community. Previously, in determining the annual demands for the Borrego Valley area, it was assumed that 60 percent of the units were occupied year round, and hence, the per capita consumption demands were reduced by 40 percent. This was equivalent to using the criteria from the San Diego County "Water Budget for Borrego Valley"[16] report which assumed the dwelling unit consumption to be .5 acre-foot/dwelling unit. But, in assessing the ultimate demands on a water system, it is conceivable that 100 percent of the population could occur, and thus, it will be used as the design population.

Table 2-4 shows the projected BSPCWD ultimate population the BSPCWD domestic water system is to be designed to.

Historical domestic water use within the District for a seasonal population is as follows:

Year	Domestic Water Use (acre-feet/year)
1972	54
1973	65
1974	61
1975	52
1976	51
1977	46
1978	43

Irrigation water deliveries to the golf course run at approximately the same level as domestic consumption.

[16] Charles F. Lough, "Water Budget for Borrego Valley," November, 1974.

TABLE 2-4

BSPCWD ULTIMATE POPULATION

	Units	Household Size	Ultimate Population
Borrego Springs Park Existing:			
Condominiums	92[1]	3.0	276
Single Family	40	3.5	140
Total Existing	132	3.15	416
Borrego Springs Park Expansion:			
Single Family	329	3.5	1,152
Patio Homes	202	3.5	707
Condominiums	244	3.0	732
5-Acre Ranchettes	40	3.5	140
10-Acre Ranchettes	20	3.5	70
Total Future	835	3.35	2,801
Total Ultimate	967	3.33	3,217

[1]Includes 30 units under construction.

2.12 RECEIVING WATERS

The portion of the groundwater basin underlying the BSPCWD is considered to have relatively good quality (see Table 2-3). The static water table is approximately 120 feet deep. The BSPCWD has obtained discharge requirements from CRWQCB, Colorado River Region to mix groundwater with sewage treatment plant effluent under two situations: discharging into ponds for percolation and evaporation and golf course irrigation. Waste discharge requirements have been set for the existing treatment plant for the BSPCWD in Order No. 76-10 by the CRWQCB, Colorado River Region. A copy of this order is attached in Appendix A.

2.13 EXISTING EFFLUENT COMPLIANCE

The existing treatment plant is located on the east side of the water district boundary and consists of an 18-year-old 75,000-gpd package-type activated sludge plant. The collector system feeds from 62 condominiums, 40 single family homes, and about 30 more condominiums that are under construction (see Figure 6-1). The system is gravity fed until the trunklines are within about 50 feet of the treatment plant. At this point, the sewer is about 20 feet in the ground and discharges into a lift station utilizing about 5-horsepower pumps which pump the sewage up to the treatment plant level. The treatment plant effluent is discharged to two unlined ponds for disposal by evaporation and percolation. The ponds are approximately 50' x 100' x 5' deep and are located adjacent to the treatment plant.

At the present time, the treatment plant is operating below its manufacturer's rated design capacity, and the effluent BOD is very low. The actual capacity that can be handled through the treatment plant is estimated to be below the rated design capacity from 30,000 to 35,000 gpd according to information from the District personnel. Effluent characteristics for several sampling periods are shown on Table 2-5. The total discharges from the treatment plant are fairly constant at 15,000 to 16,000 gpd. Over the last several years, the peak discharge reported to the regional board was 22,000 gpd and the minimum discharge was 13,000 gpd.

TABLE 2-5

BSPCWD EFFLUENT CHARACTERISTICS[1]
(mg/l)

Constituent	Dec. 1978	June 1978	Dec. 1977	Oct. 1977	March 1977
BOD	9.4	5.1	8.5	12.0	12.0
TDS	531	456	597	508	575
Cl	91	---	93	88	100
SO_4	115	---	104	112	115
F	1.4	---	1.3	1.3	1.4

[1]Source: RWQCB.

3.0 IMPACTS

3.1 CONSTRUCTION IMPACTS

The grading of the flood control improvements and the construction of water storage and new wastewater treatment facilities will result in changes to the natural topography. In addition, visual features will be altered by the construction of flood control facilities. The existing Borrego Springs Park Country Club Community and the eastern fringes of the Borrego Springs Community in the vicinity of the flood control improvements will experience short-term noise impacts resulting from grading and construction activities associated with the above improvements.

The construction activities will cause the following short-term unavoidable adverse impacts:

1) The creation of noise, dust, and air pollution from the operation of mechanical construction equipment.
2) Disturbance to natural vegetation and wildlife habitat.
3) Landform alterations through the movement of excavated material generated by construction activities and cut and fill operations required for emplacement of the levees.
4) Increased risks of erosion, sedimentation, flooding, fire, and accidental injury.

In addition, the project will require gasoline and diesel fuel for use in private vehicles. At this time, energy utilized during the construction phase is difficult to calculate. The engergy consumed will depend upon the amount and type of earthmoving equipment, number of days allotted for grading, number of workers, and distance traveled to and from the construction site. These factors are presently unknown.

The magnitude of these short-term impacts during the project construction will be reduced substantially through the incorporation of mitigation measures in the project design and construction contracts, but their effects cannot be eliminated entirely.

3.2 CHANGES IN SURFACE WATER QUANTITY AND QUALITY

3.2.1 Flood Control

The effect of constructing levees and drainage swales to channelize a 100-year flood will be to concentrate the typical desert valley sheet flows from runoff events into channels. As a result, the waters that would have distributed themselves across the project property and onto the downstream property in the same manner will now be concentrated in a channel before being outlet onto the downstream property. The storm waters, once past the project levees and drainage swales, will tend to fan out across the downstream property. These waters will be to a small degree in greater quantity than if there had been no flood protection facilities made, since these facilities will reduce the time retention of the storm waters on the property and therefore their ability to be lost to percolation into the ground. The differential increase of storm water due to the development of the project plus most of the expected upstream sheet flows will be directed to existing floodways terminating at the Borrego Sink which is approximately 3 miles southeasterly of the project. At the point of discharge from the levees, the water will have a greater velocity there than they would have had if the waters had been distributed in sheet flow. This will increase the trend for erosion of the streambed at this point of discharge. This immediate impact will be reduced through the incorporation of energy dissipation and erosion protection mitigation measures.

Impacts to the downstream properties from the project site, due to the implementation of the general plan flood control levee system and the other onsite drainage improvements for the project, may be mitigated by some kind of consensus for a drainage easement or waiver with the downstream property owners on any changes to the existing flow pattern for their property.

3.2.2 Water Supply

Water supply for the project will be from BSPCWD's existing and proposed wells. There will be minimal runoff from irrigated areas due to minimal watering requirements of the landscaping. Any runoff would be of the same quality as the well water, since there will be no opportunity to collect minerals or sediment.

3.2.3 Sewage Reclamation

Golf course irrigation will be a mixture of treated sewage effluent and well water. It is anticipated that most of the sewage effluent will be utilized in this manner. Whatever is not utilized by the golf course may be percolated, utilizing the ground as a filter. This will result in no impact to the surface drainage courses.

3.3 CHANGES IN GROUNDWATER QUANTITY AND QUALITY

3.3.1 Flood Control

The full implementation of a levee flood control system will have an impact on the availability of area for storm runoff to percolate into the groundwater basin on the project site. The proposed implementation of levees for this project will have little effect on groundwater percolation patterns in the Borrego Valley. The project will result in reduced ability of subject area to percolate onsite rainfall due to compaction of the onsite residential improvement and from the construction of paved access corridors. Approximately 45 percent of the project area (488 acres), however, will still be available to onsite percolation of rainwater, since this area is reserved for 5- and 10-acre parcels. The reduced groundwater quality related to the construction of flood control facilities will be so minor as to be inconsequential, since the major recharge area is closer to the canyons.

3.3.2 Water Supply

The greatest impact to the groundwater basin under Borrego Springs Park is due to the migration of high nitrate-bearing water into the area pumped by the BSPCWD for its domestic water supply. Withdrawal of more water to serve the additional development within the District could increase the rate of migration by a lowering of the water table, thus creating more differential in relative water surface elevations.

Conversion of the District's wells that become contaminated (from high nitrates) can be made so they are used to supply only irrigation water to the golf course. This would also serve to intercept any nitrate-rich water from further migration toward the southern part of the District from which its domestic supply could be withdrawn.

The impact of nitrate contamination within the District can be further reduced by a deliberate attempt to recharge the basin from canyons to the west and southwest of the District. This recharge would create a water mound that could act to stop the southerly migration of contaminated water.

The quality of the domestic water supply will be improved by the blending of the various qualities of water in the new 1.5-MG water storage reservoir. This blending capability can result in a lower TDS water consumed and returned to the District for ultimate treatment and reclamation.

3.3.3 Sewage Reclamation

The impact to the basin by the District's sewage reclamation efforts will be minor compared to the nitrate contamination from the agricultural operations. The primary impact from sewage is an increase in the TDS concentration of the domestic water from 250 to 300 mg/l.

However, the District's existing wells are producing water that ranges from 323 to 997.5 mg/l which is consistent with the variation found within the basin at different wells. The use of lower TDS water can be increased with the new water storage reservoir by blending a ratio of high and low TDS water to obtain a 500-mg/l TDS concentration. This would result in a sewage effluent TDS of 750 to 800 mg/l.

The CRWQCB, Colorado River Basin Region, has also assessed the impacts of development to the Anza-Borrego Basin in their "Water Quality Control Plan Report," dated April, 1975. The stated chemical quality objectives for Anza-Borrego are as follows:

Constituent	Average Annual Value 90th Percentile Value
SO_4	330/750
Cl	100/250
NO_3	20/100
F	0.6/0.9
B	0.1/0.35
TDS	840/1,750

The regional board's report pointed out that a small amount of degradation may occur in local areas, but that the small amount of wastewater that will reach the groundwater should not measurably change its quality within the planning period.

This eliminates the need for either tertiary treatment of the sewage effluent to reduce the mineral concentration or the exportation of effluent to the Borrego Sink where the water quality of the groundwater basin is very low.

3.4 LAND-USE CHANGES

3.4.1 Flood Control

The proposed flood control levees follow the recommended plan for flood control improvements by the San Diego County Department of Sanitation and Flood Control. The construction of the proposed flood control levees does not preclude present uses for this area or suggested uses outlined in Part 1 of the Open Space Element for Floodplain Use from the 1990 General Plan.

3.4.2 Water Supply

The new reservoir, booster pumping station, and well will require approximately 1 acre of land within the District for their construction. The reservoir will be constructed below grade to minimize its impact on the desert floor. Its impact could be further reduced by integrating the roof into recreational facilities, such as tennis courts.

The booster pumping station will be located in an aesthetically pleasing above-grade structure with interior soundproofing to eliminate motor and engine noise from its equipment. The water well will have a minimal impact on land use due to its small space requirements.

3.4.3 Sewerage System

The sewerage system's impact on land use will be minimal since the new plant can be located within the existing plants 8-acre site. The plant will consist of low structures to house the aeration basins, clarifiers, and chlorination chamber. In addition, a small building will be necessary for the laboratory and electrical control gear.

3.5 REGIONAL AND LOCAL POLICIES

3.5.1 Flood Control

The proposed flood control improvements are intended to be designed in accordance with regional and local policies established by the county of San Diego and the Zone 5 Flood Control Advisory Commission.

3.5.2 Water Supply

This project, as well as the existing development within the project site, is served by the BSPCWD. The domestic water supply will be designed and operated in accordance with criteria set forth by the California Department of Health Service. These standards were revised as of January 6, 1980, and apply to new construction.

3.5.3 Sewage Reclamation

BSPCWD will also serve the proposed project to provide sewage collection, treatment, and disposal. The District presently has a permit from the regional board setting discharge standards for its sewage effluent. The expansion of the District's treatment plant to replace the existing deteriorated facility and accommodate the project will be done to meet new discharge standards set by the regional board. The policy of the District is to serve the area within its boundary.

3.6 REGIONAL AND LOCAL SERVICES

3.6.1 Flood Control

The construction of the proposed flood control levees at the northerly end of the project site will require maintenance by the authority of the Regional Flood Control Commission. The maintenance of this levee which is intended to be part of the Borrego Valley 1972 General Plan flood control levee system will consist of periodic visits at the beginning of the rainfall and summer thundershower season, plus a review after each significant rainfall event. Repair or at least inspection of the levee system may be necessary after each significant rainfall event that would cause the storm water to lap against the levees. Many of the facilities are within public road right-of-way and therefore subject to maintenance by the San Diego County Transportation Department. The transportation department has existing facilities to maintain the local roads. Once the extent and limit of any repair is identified, the Regional Flood Control Commission could then contract with the San Diego County Road Department as it has done in the past or with a local contractor to do the appointed work as necessary.

3.6.2 Water Supply

This project will require the expansion of domestic water supply services provided by BSPCWD. The development of the project will require the construction of the reservoir and booster pumping station in the initial phase of the project. Personnel can then be added as the customers within the District increase with an anticipated full-time staff of three to four people. Service to the existing development within the project site will be more reliable, since new storage, pumping, and additional sources and pipelines will be available.

3.6.3 Sewage Reclamation

This project will require the expansion of sewage treatment and reclamation services provided by BSPCWD. These capabilities will be added during the initial phase of the project construction. Service to the existing development may be considered to be more reliable, since a new treatment system will be built and more personnel will be available to maintain the system.

3.7 AIR QUALITY

3.7.1 Flood Control

The project flood control system will have no impact to the local and regional air quality.

3.7.2 Water Supply

The existing and proposed domestic water supply wells will operate by electric motors. The proposed booster pumping station will have a diesel engine-driven pump (for emergency power outages) that will meet the Air Quality Maintenance District's permit requirements for a stationary power source.

3.7.3 Sewage Treatment Plant

A potential concern with wastewater treatment facilities is the emission of odors which may (or may not) be offensive to some people. The two most common reasons for such odors are (1) biological upset of the plant, or (2) waste solids handling.

One of the major reasons for selecting the oxidation ditch treatment process is its ability to withstand shock loadings and not be subject to biological upset. In addition, selection of aerobic digestion of the sludge minimizes odors from solids handling. However, even the best designed and operated plants will create minor musky odors which may or may not be offensive to people.

Digested sludge will be pumped to sludge drying beds on the end of the fairway where adequate area will be provided for drying. Local drainage will be diverted around the beds to eliminate flooding of the beds. The dried sludge can be used in the golf course's nursery for raising "plugs" to be used on the course. Odors from the sludge beds will be minimal and far removed from the residential and clubhouse area.

3.8 OPERATION OF FACILITIES

3.8.1 Flood Control

The only operations associated with the project flood facilities will be the maintenance of the facilities to assure their proper function. The drainage ditches along Di Giorgio Road and Borrego Valley Road are anticipated to be maintained by the San Diego County Road Department. The levee at the northerly end of the project is anticipated to be maintained by the authority of the Regional San Diego County Flood

Control Board, since this levee is part of the proposed Borrego Valley Flood Control System. Facilities within the project are anticipated to be maintained by a flood control assessment district with work performed by a contractor. There will be an increase in the amount of work to be performed by the San Diego County Road Department.

3.8.2 Water System

Proper operation of the water system requires good operator skills, routine maintenance procedures, and maintenance of the water sampling program required by the State Health Department. An important aspect of operating the water system is to set water rates at the proper level to provide an adequate budget with which to make repairs and purchase new equipment parts.

Electrical power outages in the Borrego Valley can shut down all of the existing electrically driven wells, thus interrupting water service for domestic or firefighting uses. This potential problem can be eliminated by a water storage reservoir with a diesel-driven pump to maintain water service during periods of power outages.

3.8.3 Sewage Treatment Plant

Proper operation of the sewage treatment plant will require good operator skills and routine monitoring. An important aspect of operation is an adequate budget with which to make repairs and purchase new parts.

Electrical power outages in the valley is one aspect of operation that can make the plant inoperative during which time the biological process can become upset and fail, thus resulting in strong odors. This potential problem can be eliminated by including an electrical generator for standby power during outages.

The treatment plant will normally discharge its oxidized, disinfected, and filtered effluent to the golf course during the night hours for irrigation. During wet weather periods (or when the sewage flow is low due to seasonal variations in population), the effluent will gravity flow to the percolation ponds.

Dried sludge can be recycled through the golf course nursery to raise "plugs" for the greens and fairways. This can be done by mixing the sludge with sand and soil amendments to make a growing medium in which to raise the "plugs."

3.9 ENERGY

Total annual energy consumption for the water and sewerage facilities within the District is estimated to increase from 74,000 kwh/yr at the present time to 1,186,000 kwh/yr at the time of ultimate development (Table 3-1).

TABLE 3-1

ESTIMATED ENERGY CONSUMPTION WITHIN BSPCWD
January, 1980

	Energy Used (kwh per year)	
	Existing	Ultimate
Water System		
Wells	40,000	270,000
Booster Pumps	N/A	520,000
Sewerage System		
Lift Station	4,000	26,000
Treatment Plant	30,000	314,000
Reclaimed Water Booster Station	N/A	56,000
TOTAL	74,000	1,186,000

4.0 FLOOD CONTROL SYSTEM ALTERNATIVES

4.1 NO PROJECT

If the project is not implemented, the existing development within the boundary limits of the Borrego Springs Park project will continue to be subject to the meandering streamflows and uncontrolled sheet flows from the northwesterly and westerly watersheds. The San Diego County Flood Control General Plan for Borrego Valley[1] states the following:

"The alternative of 'no action' would virtually preclude the orderly development of the private enclave. Flood problems are recurrent in valley areas and floods of disastrous proportions have been measured in similar areas nearby. When the waters of a flash flood discharge from the surrounding canyons onto the valley floor, they spread out in freely changing, unpredictable flow patterns. The shifting nature of these undefined watercourses precludes intelligent land-use planning and casts the shadow of calculated risk over the existing population as well as any future development which might take place. This area surrounded by the park is available for private use and a degree of expansion appears to be inevitable. In light of this, some method of flood protection must be considered as vital to orderly well-planned growth in harmony with the natural environment. One of the objectives of this study, therefore, has been to provide a plan to coordinate the localized

---

1 ?

flood control measures to be taken by private developers and thus insure the maximum safety of people and property with minimum environmental impact."

Figure 4-1 shows the USGS 100-year flood inundation map which indicates the entire project area is subject to flooding. This alternative is not considered a reasonable alternative, since this would leave the existing development within the project area as a public liability to future flood control problems.

4.2 LEVEE PROTECTION SYSTEM

This type of flood control protection was recommended in the Borrego Valley Flood Control General Plan[2] which states:

". . . a system of earth levees is the least costly of several alternate systems due to reduced excavation, simple construction, and less maintenance. This type of construction has the least environmental impact, in our opinion.

"Levees are generally used to direct flood flows safely along chosen natural watercourses. In Borrego Valley, flood waters would be directed from the western canyons through developed areas into relatively flat agricultural fields. Areas outside the levees would, in this way, be protected from flooding.

"Inside the levees, open space would be available for recreation, agriculture, equestrian, or other uses compatible with infrequent inundation. By using relatively wide areas for infiltration along the stream, water loss to the Borrego Sink is minimized.

[2] Ibid.

"A levee system requires neither dams nor excavated channels but still affords a high degree of safety from uncontrolled floods. This type of system has been used successfully in desert areas of Riverside and San Bernardino Counties."

The effectiveness of the levee system proposed in the General Plan is dependent upon the full upstream implementation of the proposed levees. The Borrego Valley Flood Control General Plan recommends and shows a 4-foot-high levee at the northern boundary of the project site. This levee and its upstream counterparts would protect the project site from the northwesterly watersheds, Hellhole Canyon, Borrego-Palm Canyon, and Henderson Canyon floodflows. The project site would be protected from the westerly watersheds, Tubb Canyon and Dry Canyon, in the proposed levee system by a levee that would divert the storm floodflows from these watersheds around to and away from the southern end of the project site. If fully implemented, this system would effectively protect the project site. Presently, there is no plan to fully implement this levee system proposed in the 1972 Flood Control General Plan. Since 1972, there have been modifications to the implementation of the plan and the ultimate implementation of the plan. An 8-foot-high earthen levee with wire and rock revetment facing has been built across the Tubb Canyon alluvial fan diverting flood streamflows around the southerly end of the Borrego Springs community and beyond the southerly boundary of the project site. Recently, there has been discussion about building a phased levee system to carry the flows from the northwesterly canyons beyond the project site at Borrego Valley Road.[3] "The plan is dependent on obtaining funds and the donation of right-of-way." This new proposal affects the project site in the same manner as did the 1972 Flood Control General Plan.

The property site has been protected in the past with low levees. These levees have since deteriorated with no maintenance. The concept of protecting the project site with levees is not a new concept.

Any levee construction on the project site would allow for the ultimate implementation of the flood control levee plans and would take into account the status of upstream levee construction. The levee system of flood protection is feasible and appropriate to protect this project when the upstream conditions are taken into account.

4.3 CONVENTIONAL FLOOD-CHANNEL SYSTEM

This system utilizes open channels with debris basins and dams at its beginning. The San Diego County Flood Control Master Plan states the following:

> "At each of the four larger canyons west of Borrego Valley, the feasibility of debris basins was studied. Dams for these basins would be constructed of fill, with 3:1 side slopes, 20-foot crest width, and 36-inch drains.
>
> "Each dam would be provided with an ungated concrete or masonry spillway with capacity for the maximum probable flood . . . Below each dam, a trapezoidal channel was studied with capacity for the 50-year or 100-year flood . . . Concrete

[3] Borrego Sun, May 24, 1979.

lining would be necessary in the steeper portions of the channels near the mountains, due to the excessive slopes and high-velocity flows.

"The debris dam and flood channel system would utilize concrete-lined flood control channels resulting in impediments to wildlife movement and decreased percolation of runoff into the groundwater. The water which would finally be released near the Borrego Sink would be contaminated by the natural sulfates in that area. The structures involved . . . would have been much more prominent visually, thus reducing the scenic value of the area."

The consequence of this system would be an extensive perennial maintenance program to assure the efficiency of the facilities. Operation and maintenance would involve occasional excavation of debris from the debris retention structures to maintain the minimum design capacity of the facilities. The channel structures would also require a certain maintenance of their design efficiency.

This system of flood control protection from upstream watersheds is not feasible unless the entire system is built which is beyond the scope of this project. This system would remove a large percentage of the valley floor from the opportunity of groundwater recharge from floodflows. This project will not use this concept so as to maximize the opportunity for groundwater recharge.

4.4 IMPOUND SYSTEM

This flood control system consists of large basins and dams which impound stormflows as well as debris. As stated in the Flood Control General Plan:

". . . large flood channels would be reduced in size by spreading the basins over considerable area (averaging about 150 acres per basin). Sufficient capacity would be available to impound an entire flash flood, including water plus debris. The main advantages to impounding reservoirs are that nearly all of the runoff would infiltrate into the groundwater and large flood channels would not be required. As compared with an equivalent levee flood protection system, impound dams are more costly for priority construction and include the hazards associated with any dam located upstream from a populated area.

"Besides being more expensive, . . . the impound system . . . would have had much greater impact on the aesthetic and environmental characteristics of the area. The impound system would have required high dams at several of the canyon mouths along with a system of channels for release of the contained flood waters. Among the adverse effects of this system would be a partial blockage of the wildlife forage routes up and down the canyons to feeding and watering areas."

The implementation of this system is beyond the scope of this project. The largest benefit from this system would be the recharge of the groundwater basin. Flood protection of the project site would still be necessary. This system would only affect the magnitude of this protection; rather, this system would lessen the severity of any flood event. The flood protection for the site will not assume that this system will be implemented, whereupon if this system is implemented, the project site will have additional flood protection.

4.5 ELEVATED BUILDING PADS SYSTEM

This type of flood protection would elevate pads for onsite dwellings up to 2 feet above the surrounding desert floor with a minimum of 1 foot above the sheet floodflows. This allows street improvements and drainage swales to carry sheet flows across the project site and gives floodwater more of an opportunity to percolate into the groundwater basin.

This flood control system will reduce the peak of floodflow, but it does not remove the project site from the need to provide flood protection. This system will reduce the amount of floodflows the project site would need to be protected against. This system may or may not be implemented in the future as this is beyond the concept of this project and the project site will need to be protected from potential floodflows.

The effect on the proposed residential development in the project would be varied according to the density of the development's land use as shown in Table 1-1. The following discussion lists the residential land uses and the expected result of elevating building pads for flood protection.

4.5.1 Ten-Acre Ranch Residences

This type of development with a density of 0.1 dwelling units/acre occupies 18 percent of the project area and will have little effect upon the existing nature of sheet flows across the project area. The residential dwelling and appurtenant facilities will be raised above the surrounding topography with the sheet flows passing around. It is expected that onsite dwellings and facilities will represent between 1 to 3 percent for each of the 10-acre residential sites. During the period of sheet floodflows, the occupants of each site will be essentially isolated until the flows subside. In some cases, it may be necessary to clear the driveway roads to each residence after the flooding has ceased.

4.5.2 Five-Acre Ranchette Residences

This type of development with a density of 0.2 residential unit/acre occupies 26 percent of the total project area. The construction of cul-de-sacs to gain access to these residential sites will have the most significant effect on the existing nature of sheet floodflows across the property. It is expected that the residence and facilities will occupy between 2 to 5 percent for each of the 5-acre residential sites. The residence and any facilities will have little effect on sheet flows. During periods of floods, access will be limited, since once the sheet flows have crossed the property, they will tend to concentrate on the access roads and cul-de-sacs.

4.5.3 Single-Family Type Residences

This type of residence with a density of 2.1 residential units/acre occupies 14 percent of the project area. Existing sheet flow drainage will be significantly affected by these residences. It is expected that the residence and facilities will occupy 20 to 25 percent for each of the 0.47-acre residential sites. Streets and drainage swales between each residence will be expected to intercept the sheet flows and channel them to flood control drainage swales and catch basins. It may be expected that after each flood occurrence, project area access roads will need to be cleared.

4.5.4 Patio-Home Type Residences

This type of residence with a density of 3.1 residential units/acre occupies 6 percent of the project area. It is expected that the residences and facilities will occupy 40 to 50 percent of each of the 0.32-acre sites. Consequences to sheet flows will be somewhat more significant than that for the single-family type residence. Streets, rather than drainage swales, will be expected to transmit more of any floodflows.

4.5.5 Attached Single Family Residences

This type of residence with a density of five residential units/acre occupies 4.6 percent of the project area. Each one of the three proposed sitings will be completely removed from the occurrence of sheet flows. All flows will be diverted to streets and flood control drainage swales. It may be expected that after each flood occurrence, project area access roads will need to be cleared.

4.5.6 Community Center

This portion of the development occupies 4 percent of the project area. The consequences to sheet flow will be the same as that for the attached single family residences.

4.5.7 Open Space, Golf Course, Major Circulation, and Existing Development

The streets, drainage ditches, and golf courses will be utilized to collect and transmit the sheet flows off the project site. A certain amount of maintenance and repair of these facilities will be necessary after each flood occurrence.

4.5.8 Conclusion

This type of flood protection has been used successfully in the sparsely populated low-density areas of the Borrego Valley where random sheet flows are encountered. The 10-acre and 5-acre residences appear to be well suited for this type of flood protection. The golf course can serve as a good means of collecting water draining from the streets and the relatively high-density areas of the project without wholly relying on the streets, thereby minimizing interruption of the transportation within the project site. The single-family, patio-home, and attached single-family type residences which may be considered high-density areas are not suited for this type of protection.

4.6 RECOMMENDED FLOOD PROTECTION SYSTEM

The recommended system of flood protection for this project is the combination of several conventional flood protection systems. These proposed systems are adapted to the several types of housing densities within the project area and are adapted to the historical drainage pattern of floodflows that has been established. The following is a summary description of Figure 4-2 outlining the flood control protection for the project site.

1) A 4-foot-high levee will be constructed on the northern boundary of the project site. This is in conformance with the 1972 Borrego Valley Flood Control General Plan and the most recent available proposed modification to this plan. This is a design to protect the project site from the northwesterly watersheds' floodflows.

2) A drainage ditch on the east side of Di Giorgio Road will collect the sheet flows from the westerly watersheds of the project site. The twelve 10-acre ranch residences to the west of Di Giorgio Road will be protected from sheet floodflows by raising their building pads 2.5 feet. The expected depth of sheet flow is calculated to be 0.5 foot above the surrounding ground. The drainage ditch will then convey the intercepted flood according to the existing drainage pattern either northerly or southerly along Di Giorgio Road. Some of the flow will be carried to the drainage swale at the northern end of the property, at which point it is to be collected in a drainage swale and dispersed into the watercourse defined by the northerly levees for the northwesterly watershed. The remainder of the western project site drainage will be carried in a drainage ditch to a drainage swale at the southern end of the property. This drainage swale will then convey this intercepted flow along the southern boundary of the property eventually into the Tubb Canyon drainage course.

3) The project onsite drainage will be conveyed on streets to drainage swales through the golf course following the existing pattern where it exists onto Borrego Valley Road.

5.0 WATER SUPPLY ALTERNATIVES

5.1 NO PROJECT

If the project is not implemented to construct new water facilities, there will not be sufficient pumping and storage capacity to accommodate the proposed new residential development and related community center. The existing wells and distribution system will be adequate to serve the existing residential development and the two existing golf courses.

A water storage reservoir should still be built to serve as a source of water during emergency outages which would shut down the wells. The size of the reservoir would be determined by the number of days of emergency supply desired by the District.

There would be no additional demand on the groundwater basin since the total annual water demand would be the same as it is presently.

5.2 BORREGO GROUNDWATER BASIN

5.2.1 Water Supply

The annual total water demand for the ultimate development within the District's boundary is estimated to be 1,732 acre-feet annually. Of this total demand, 1,443 acre-feet would result from new residential and commercial development and reactivation of the 18-hole golf course. The remaining 289 acre-feet is a result of the existing residential development and one nine-hole golf course.

An extensive analysis of the groundwater basin as part of this project has been prepared by David A. Phoenix, a geologist who is an expert in analysis of groundwater basins. His report is entitled "An appraisal of the groundwater resources in the northern subbasin of the Borrego Valley reservoir, San Diego County, with emphasis on the recovery of groundwater from the Borrego Springs Park area."

The Phoenix report concludes there is a calculable reservoir of about 770,000 acre-feet of water in the upper 100 feet of saturated sediments in the Borrego Valley which can support a desert community for many years. Phoenix further comments that the total annual demand on the basin should not increase as residential development replaces agricultural uses, resulting in a trade-off in water demand.

The total annual demand for groundwater to irrigate the golf courses can be reduced approximately 270 acre-feet annually by reclamation of sewage from the District's plant. This would result in a total annual demand of 1,460 acre-feet in the District at ultimate development.

5.2.2 Water Demand

The water supply system must be capable of meeting a combination of domestic demands and fire demands. The pumping, storage, and pipeline facilities are sized based on the estimated maximum flow rates and the capacity of the total water supply source. The water requirements of the existing and new development are summarized in Tables 5-2 and 5-3.

The estimated peak day demands plus fire flows for the domestic system are shown in Table 5-1.

TABLE 5-1

BSPCWD ESTIMATED PEAK DAY DEMANDS WITH FIRE FLOWS

Development Status	Estimated Maximum Population	Water Demand (gpm) Peak Day in July	Fire Flow	Total
Existing Residential	416	190	1,000	1,200
Ultimate Residential	3,262	1,500	1,800	3,300

TABLE 5-2

BSPCWD ESTIMATED WATER USE AT ULTIMATE DEVELOPMENT

New Development	Water Use (acre-feet/year)
1. Single family homes (desert style landscaping) 329 units at .75 acre-feet/unit/year	247
2. Patio and attached single family homes 446 units at .3 acre-feet/unit/year	134
3. Ranchettes (5-acre sites, desert style landscaping) 40 units at 2.0 acre-feet/unit/year	80
4. Ranches (10-acre sites, desert style landscaping) 20 units at 3.0 acre-feet/unit/year	60
5. Community center 43 acres at 4 acre-feet/acre/year	172
6. Golf course 125 acres at 6 acre-feet/acre/year	750
SUBTOTAL	1,443
Existing Development	
7. Single family homes 40 units at .75 acre-feet/unit/year	30
8. Condominiums 92 units at .3 acre-feet/unit/year	28
9. Golf course 38.5 acres at 6 acre-feet/acre/year	231
SUBTOTAL	289
TOTAL	1,732

TABLE 5-3

BSPCWD WATER SUPPLY REQUIREMENTS

System Demand	Description
Domestic	January - 150 gpd per capita July - 330 gpd per capita Average - 200 gpd per capita
Golf Course	6 acre-feet/acre/year
Peak Hour	200% of average daily demand
Peak Day	400% of average daily demand
Fire Flows	Insurance Services Organization Criteria
System Pressure	Minimum of 20 psi during peak day plus fire flow
Golf Course Irrigation	Occurs during nighttime only

5.2.3 Water Storage

The water supply capacity requirements to meet the projected July 3,300-gpm peak day and fire flow requirement can be reduced by water storage facilities and a booster pumping station.

A water storage facility meets four criteria: (1) regulation of hourly fluctuations in water demand; (2) firefighting; (3) emergency outages or disruptions of source water; and (4) blending of various quality groundwater to meet minimum water quality requirements.

The water district has indicated that Wells 1 and 4 can produce 1,200 gpm and 400 gpm (see Table 2-2) for a total source capacity of 1,600 gpm. Based on this as a firm supply, the following quantity of water storage should be provided for ultimate development:

Storage Purpose	Quantity (gallons)
Regulation	0
Fire Flows	750,000
Emergency - One Average Day	750,000
TOTAL	1,500,000

5.2.4 Water Distribution System

The water distribution system should consist of a centrally located 1.5-MG storage reservoir into which all well water would be pumped. A booster pumping station with standby power would pump from this reservoir into the system and maintain system pressure. A pump for fire flows should be driven by an engine in case the power supply to the electric motors is cut off.

A schematic of the proposed water distribution system is shown in Figure 5-1. As indicated on the schematic, an additional well with at least 1,000-gpm capacity should be developed as backup to well No. 4. This well should be located in the southwest corner of Section 9 per the Phoenix report recommendation.

5.2.5 Cost Estimate

The estimated capital cost of the water supply, storage, and transmission facilities is $1,995,000 (Table 5-4). This excludes the cost of distribution pipelines within the development.

The annual energy requirement at ultimate development is 630,000 kwh based on average annual demand estimates for domestic and irrigation water with a total dynamic head of 300 feet for the pumping system.

TABLE 5-4

BSPCWD ESTIMATED CAPITAL COST OF MAJOR WATER FACILITIES
FOR ULTIMATE DEVELOPMENT
January, 1980

1.	Water Supply		
	Well 1 - New Pump and Motor		$ 20,000
	Well 4 - New Pump and Motor		20,000
	New Well and Pump		100,000
2.	Water Storage Reservoir		
	1.5-MG Capacity, Below-Grade Concrete		750,000
3.	Booser Pumping Station		
	Electric and Diesel-Driven Fire Pump		500,000
4.	Transmission Pipelines		
	12-Inch Diameter		200,000
5.	Technical Services		
	Water Wells	20,000	
	Reservoir	75,000	
	Booster Station	50,000	
	Transmission Pipelines	20,000	165,000
6.	Contingencies at 15%		240,000
	TOTAL ESTIMATED CAPITAL COST		$1,995,000

5.3 IMPORTED SUPPLEMENTAL WATER SUPPLY

Importation of water into Borrego Valley is an alternative source of water to allow BSPCWD to meet the water demand of new development (1,443 acre-feet as shown in Table 5-2). However, the cost to import 1,443 acre-feet, or 0.6 mgd, at least 41 miles would be economically unfeasible unless it were done on a regional basis (i.e., in excess of $15,000,000).

While it is physically feasible to import water to the Borrego Valley area, there are potential problems which exist. First, the cost of importation may not be justified except for a very intensive development plan. Secondly, there may not be an allotment of Colorado River water or State Project water available.

Since the source of a future supplemental water supply is not known at this time, it was decided to examine several development plans that were presented in a 1968 USBR report which are believed to be representative of alternatives that may be available in the future.

Each plan would require a terminal reservoir for peaking of municipal and industrial water supplies. This peaking reservoir (proposed Borrego Springs Reservoir) could be located near Borrego Springs Community Center. The reservoir would have sufficient capacity to allow the pipeline to flow at a uniform rate of 25 cfs and would also provide the emergency storage required in case of a pipeline outage, to meet a one-week demand during the maximum monthly demand period.

There are three possible sources of imported water for the Borrego Springs area. The three representative points of diversions that were considered are located on the San Diego Aqueduct, in Coachella Valley near Oasis, and on the Imperial Irrigation District's Westside Main Canal of the All-American Canal System. The three alternatives are shown on Figure 5-2 and are briefly described as follows:

Importation of Water From the San Diego Aqueduct

Imported water from the San Diego Aqueduct to be referred to as the Escondido-Borrego Route would be diverted through a pipeline called the Escondido-Borrego Route to the proposed Borrego Springs Reservoir. That proposed route is 52 miles long and would require a total static lift of 7,200 feet.

Importation of Water From Coachella

Delivery of import water through the Coachella distribution system would be taken near Oasis, California, to be referred to as the Oasis-Borrego Route. From this delivery point, a pipeline called Oasis-Borrego Route would convey the water to the proposed Borrego Springs Reservoir. The proposed route is 41 miles long and requires a lift of 980 feet.

Importation of Water From the Imperial Irrigation District

Delivery of import water through the Imperial Irrigation District's canal system would be from the Westside Main Canal to be referred to as the Westside-Borrego Route. From this point, the water would be conveyed by a pipeline called Westside-Borrego Route to Borrego Springs Reservoir. The proposed route is 53 miles long and requires a lift of 800 feet.

Table 5-5 shows the alternative project data for the conveyance facilities which provide supplemental imported water supplies to the Borrego Valley. Table 5-6 shows the estimated costs in 1968 dollars as proposed by the USBR report. The report concluded that:

> "Unless extremely low initial water costs become obtainable in the coastal area of southern California, importations through the Escondido-Borrego Route would not appear feasible. The Oasis-Borrego and the Westside-Borrego Routes are potentially feasible for importation

of water and future selection will depend upon provision of a dependable economical source of water."

By evaluating the least expensive alternative in today's dollars and assuming a project life of 50 years, the cost of delivering water from the diversion points at the maximum capacity to the Borrego Springs area would be on the order of $500 per acre-foot. This does not include the cost of the water that is delivered to the diversion point which would add about $100 per acre-foot.

TABLE 5-5

PROJECT CONVEYANCE FACILITIES DATA* TO IMPORT WATER TO BORREGO VALLEY

Conveyance System	Design Capacity	Type	Length (miles)	No. of Pump	Total Static Lift For Pipeline (feet)
Escondido-Borrego Route	25 cfs (17,000 A-F/yr)	Steel Pipeline (57-Inch Dia.)	52	9	7,200
Oasis-Borrego Route	25 cfs (17,000 A-F/yr)	Steel Pipeline (57-Inch Dia.)	20		
		Concrete Pipeline (57-Inch Dia.)	21	3	980
Westside-Borrego Route	25 cfs (17,000 A-F/yr)	Steel Pipeline (57-Inch Dia.)	13		
		Concrete Pipeline (57-Inch Dia.)	40	1	800

*USBR Report 1968.

TABLE 5-6

ESTIMATED COST OF DEVELOPMENT PLANS[1, 2] TO IMPORT WATER TO BORREGO VALLEY

Conveyance System	Total Construction Cost	Annual OM&R	Annual Power Cost
Escondido-Borrego Route	$53,402,000	$318,300	$1,980,000
Oasis-Borrego Route	30,122,000	87,000	267,000
Westside-Borrego Route	33,427,000	45,000	220,000

[1]Source: USBR Report 1968.

[2]Cost Estimates in 1968 Dollars.

Importation of Water From the Salton Sea

In 1968, the USBR evaluated this alternative for a demineralized supplemental water supply as follows:

"Each year over 1,000,000 acre-feet of brackish water flows from Coachella and Imperial Valleys into the Salton Sea. It would be possible to place an electrodialysis demineralizing plant within one of these areas to intercept some of this brackish water. This plant could convert brackish waters from approximately 3,000 ppm to 500 ppm of total dissolved solids. However, records indicate there are undesirable concentrations of boron in this water that probably would not be removed by this process. Moreover, the processing and exportation of water now flowing into the Salton Sea would further aggravate the existing salinity and water level problems at the sea. Therefore, this plan does not offer an acceptable prospect for future study."

5.4 RECLAMATION OF SEWAGE EFFLUENT

The irrigation water demand to water the golf courses can be partially met with reclaimed water from the BSPCWD Sewage Treatment Plant. However, to have reclaimed water, there must be development to generate sewage. The existing domestic water demand is substantially less than the potential water requirements of both golf courses if both were in full operation.

At ultimate development, the estimated sewage flow will be 0.23 mgd, or 273 acre-feet, annually. Assuming a total reclamation program, the golf course irrigation demand could be reduced from 980 acre-feet annually to 707 acre-feet annually, a 28 percent reduction in water usage.

5.5 REGIONAL WATER SUPPLY MANAGEMENT

The Phoenix report points out the lack of overall coordination and recordkeeping for the groundwater supply in Borrego Valley. This lack of regional management is made more complex because of the many purveyors of water in the valley (Table 5-7).

The integration of BSPCWD into a regional plan could not only result in a better understanding of the groundwater basin but also of joint participation in wells, storage reservoirs, and pipelines. Regional planning could also develop artificial recharge projects as recommended in the Phoenix report to increase the yield to the groundwater supply in the valley.

TABLE 5-7

WATER SERVICE AGENCIES[1]

Name of Water Agency	Type of Water Service Agency
Borrego Springs Water Company	Commercial
Borrego Springs Air Ranch Mutual Water and Improvement Company	Incorporated Mutual
Borrego Valley Water District	Public
Borrego Springs Park County[2] Water District	Public
Golden Sand Mutual Water Company	Incorporated Mutual
Ocotillo Wells Mutual Water Company	Unverified Agency
Rancho Borrego Mutual Water Company	Incorporated Mutual
South Borrego Mutual	Unverified Agency

[1]Sources: "Directory of Water Service Agencies in California," Bulletin No. 114, State of California Department of Water Resources, June, 1962, and "Property Valuations, Tax Rates, Useful Information for Taxpayers," County of San Diego, June 30, 1967.

[2]Project service area.

5.6 RECOMMENDED ALTERNATIVE

It is recommended that groundwater continue to be used to supply water within the BSPCWD, supplemented by reclaimed water to irrigate the golf courses. The water supply and distribution system should be developed to include a new well, water storage reservoir, and booster pumping station with an emergency engine-driven pump to develop fire flows. (See Section 5.2.)

The alternative to supplement the groundwater basin is not required for many years and must be done on a regional basis to be cost effective.

The alternative to join in with regional planning is practical and should be done when an agency is established with the appropriate authority.

6.0 SEWAGE TREATMENT AND DISPOSAL ALTERNATIVES

6.1 NO PROJECT

No new sewage treatment and disposal facilities would be constructed for the ultimate development within BSPCWD under this alternative. The existing plant would continue to be used until its maximum treatment capacity of 75,000 gpd was reached based on its ability to treat peak flow rates. This would limit development within the water district to approximately 150 dwelling units.

The existing facility is an 18-year old "packaged plant" that is rerching the end of its anticipated 20- to 25-year life. It is in deteriorated condition and will require either replacement or rehabilitation within the next two years to simply maintain its treatment capability to meet required discharge standards.

Benefits which could be realized from water conservation by reclamation would not be realized under this alternative.

6.2 EXPANSION OF EXISTING PLANT

The capacity of the existing plant is adequate to treat sewage from about 150 residential units. The plant will have to be expanded to treat the additional 817 dwelling units proposed at ultimate development within the District.

The nonmodular design of the plant limits expansion possibilities to new facilities separate from the existing one. Due to the deteriorated condition and cost to rehabilitate the plant, it will be cost effective to replace the existing plant's facility in the new one and abandon the old plant.

6.3 WASTE TREATMENT DISCHARGE STANDARDS

New treatment facilities will have to meet discharge standards set forth by the Colorado Regional Water Quality Control Board, Colorado River Basin Region. The new standards for ultimate development within the District are anticipated to be similar to the District's existing Waste Discharge Standards, Order 76-10 (Appendix).

Order 76-10 was established to allow the District to percolate effluent into the groundwater basin. Reclamation of the effluent will require more stringent conditions so the effluent will be in compliance with the state health department's Title 22 regulations, which require varying levels of disinfection depending on the proposed type of reclamation. Landscape irrigation for golf courses requires an oxidized effluent with a median coliform count of 2.2/100.

6.4 WASTE TREATMENT FOR PERCOLATION

Secondary waste treatment to provide an oxidized effluent will be required for continued percolation of the effluent. The following alternative types of treatment processes were analyzed for the District to economically treat sewage at its ultimate development of approximately 3,300 people: extended aeration, contact stabilization, and oxidation ditch.

The most economical and reliable process for the District is the oxidation ditch. The advantages of this process compared to the disadvantgages are as follows:

Advantages	Disadvantages
1. Stable process when proper sludge management is performed.	1. Major maintenance requires crane to remove equipment.

Advantages	Disadvantages
2. High quality effluent.	2. Requires good operator skills and routine monitoring.
3. Predictable process.	3. Sufficient oxygen supply should be provided for nitrification and pH may need to be controlled.
4. Low energy.	
5. Low sludge yield.	
6. High shock load capacity.	
7. Small land area usage.	

The treatment facility will be sized for a per capita flow rate of 70 gpcd, which amounts to a total capacity of

3,262 people x 70 gpcd = 0.23 mgd.

The process flow schematic and site plan are shown in Figure 6-1. The design criteria and cost estimate for this facility are shown in Tables 6-1 and 6-2.

6.5 WASTE TREATMENT FOR RECLAMATION

Reclamation of the wastewater will require chlorination and filtration to meet the Title 22 standard for 2.2/100 median coliform count. Filtration is required in addition to chlorination to ensure removal of algae and other suspended material in the effluent so it will not clog up sprinkler heads on the golf course and lessen its desirability. The chlorination and sand filtration facilities will add additional cost to the treatment facilities since it would require not only use of chlorine but also will require a reclaimed water pumping station.

The chlorine contact chamber design criteria is also shown in Part B of Table 6-1. The estimated additional cost of chlorinating and filtering the effluent for reclamation by golf course irrigation is shown in Table 6-3.

TABLE 6-1

BSPCWD DESIGN CRITERIA SUMMARY
FOR WASTE TREATMENT PLANT

Unit Process	Units	Design Criteria
A. PERCOLATION OF EFFLUENT		
Suspended Growth - Biological Treatment		
Detention time	hours	24 @ 2 x Qave
SRT	days	20
Waste sludge	lb/lb of BOD	0.6
Oxygen supply	lb/lb of BOD	2.0
Final Sedimentation		
Overflow rate	gpd/SF	600 @ 2 x Qave
Detention	hours	3
Aerobic Digestion		
Detention	days	15
Sludge concentration	percent	15
Sludge drying beds	SF/lb/day of solids	20
Percolation Ponds		
Loading	acre-feet/day	0.5
B. RECLAMATION OF EFFLUENT		
Chlorine Contact Chamber		
Contact retention at peak flow	hours	1 @ 2 x Qave
Dosage at peak flow	mg/l	10
Sand Filters		
Loading	gpm/SF	20

TABLE 6-2

BSPCWD COST ESTIMATE FOR WASTE TREATMENT PLANT TO PERCOLATE EFFLUENT
January, 1980

A. CONSTRUCTION COST

Item	Description	Estimated Cost ($)
1.	Parshall flume	15,000
2.	Rotary screens	50,000
3.	Oxidation ditch	125,000
4.	Secondary clarifiers	40,000
5.	Return sludge pumping station	40,000
6.	Sludge drying beds	5,000
7.	Percolation ponds	30,000
8.	Emergency generator	40,000
9.	Electrical work	75,000
10.	Plant water system	10,000
11.	Piping, valves, and fittings	150,000
12.	Plant paving and fencing	50,000
Construction Cost Subtotal		630,000
Contingencies @ 15%		95,000
	Estimated Construction Cost	725,000
Technical Services, Inspection, Legal, and Administrative @ 20%		145,000
	Total Project Cost	870,000

B. POWER REQUIREMENTS

Item	Description	Estimated Horsepower
1.	Rotary screens	2
2.	Oxidation ditch with aspirating propeller pump aerators	17
3.	Secondary clarifier	1
4.	Return sludge pumps	3
5.	Miscellaneous (lights, etc.)	1
		24

Power consumption = (24 hp) (.746) = 430 kwh/day
(157,000 kwh/year)

TABLE 6-3

BSPCWD COST ESTIMATE FOR ADDITIONAL TREATMENT FACILITIES TO RECLAIM EFFLUENT
January, 1980

A. CONSTRUCTION COST

Item	Description	Estimated Cost ($)
1.	Chlorine contact chamber	75,000
2.	Chlorination building	34,000
3.	Laboratory	25,000
4.	Sand filters	30,000
5.	Reclaimed water pumping station	55,000
6.	Electrical work	25,000
7.	Piping, valves, and fittings	10,000
8.	Reclaimed water force main to golf course	16,000
Construction Cost Subtotal		270,000
Contingencies @ 15%		40,000
	Estimated Construction Cost	310,000
Technical Services, Inspection, Legal, and Administrative @ 20%		60,000
	Total Project Cost	370,000

B. POWER REQUIREMENTS

Item	Description	Estimated Horsepower
1.	Reclaimed water pumping station 500 gpm @ 200' TDH Efficiency @ 80% Pumping time - 12 hr/day	20
2.	Miscellaneous (lights, etc.)	1
		21

Power consumption = (21 hp) (.746) = 384 kwh/day
(140,000 kwh/year)

6.6 EXPORTATION OF EFFLUENT

The effluent from the treatment plant could be exported out of the basin into the Borrego Sink to eliminate mixing with the groundwater in storage. It is anticipated that waste treatment discharge standards for disposal to the sink area would be the same as those for the percolation basins--i.e., an oxidized effluent.

Since the groundwater basin in the Borrego Sink is quite saline, there would probably be no mineral limitations on the effluent. However, the exported effluent would be a total loss to the Borrego Valley and would defeat the efforts to minimize water utilization of the basin.

Effluent would be conveyed to the Borrego Sink by a 5-mile-long gravity pipeline. The estimated cost of the pipeline is over $800,000. Thus, the cost of secondary treatment plus the pipeline is in excess of $1.67 million.

6.7 REGIONALIZATION OF FACILITIES

The development of property in the vicinity of BSPCWD should lead to consolidation of small treatment plants into a larger facility. This can result in substantial cost savings not only on the capital cost but also on the annual long-term operations and maintenance costs.

A draft EIR was recently completed for the "Rams Hill Country Club" for the Di Giorgio Development Corporation. A new sewage treatment plant with capacity to treat 0.224 mgd to serve this development was proposed in the report. The location of the proposed plant is approximately 3 miles from the site of the existing plantsite operated by BSPCWD; and it appears that sewage could gravity flow into the existing plantsite from Rams Hill.

The estimated cost of a single 0.45-mgd treatment facility (0.23 plus 0.22 for Borrego Springs Park and Rams Hill) is approximately $1.5 million. A gravity sewerline approximately 3 miles long would have to be constructed, but a reclaimed water pumping station and pipeline could also be eliminated in the Rams Hill Country Club plan. Effluent could be used on the lower elevation golf courses to eliminate its pumpage to higher elevations, thus resulting in reduced groundwater usage from the basin--a goal of both developments.

The long-term annual operating costs would be reduced since duplication of a very costly item--labor--would be eliminated. It would also make regulation of the effluent for compliance to the Regional Board's requirements easier since they would be monitoring one plant.

6.8 RECOMMENDED ALTERNATIVE

The regionalization of facilities is the most cost-effective alternative for the areas to be served. It provides for one small "regional" plant instead of two very small treatment plants, thus resulting not only in capital cost savings to the developers, but perhaps more importantly, long-term reduced operating expenses to the future population who have to pay the bills after the area is developed and the developers are gone.

The alternative to expand the existing plant is not feasible due to both its nonmodular construction and its deteriorated condition.

The alternative to only treat the effluent for disposal by percolation does not meet the Regional Board's goal to reclaim water when there is sufficient volume to work with (i.e., when flows are over 100,000 gpd).

The alternative to reclaim the effluent for irrigation of the golf course is a practical method to reduce groundwater demand and maximize the use of effluent. When the seasonal variation in effluent is below 100,000 gpd, it should probably be percolated to reduce treatment and laboratory testing costs; but, this alternative for the development only with BSPCWD is not as cost effective as combining the plant with the proposed facility to treat sewage from the Rams Hill Country Club project.

The alternative to dispose of effluent by exporting it to the Borrego Sink is effective in removing it out of the Borrego Valley Basin but wasteful of a valuable resource in an arid climate. This is not an economically viable alternative.

7.0 MITIGATION

7.1 CONSTRUCTION PROCEDURES

Where applicable, the following protective measures will be incorporated in construction contracts to reduce environmental degradation to a minimum. Specifications will be written into the contracts to limit definable impacts. All laws with regard to environmental conservation will be obeyed. Measures must be taken after construction to return the areas not built upon, as early as practicable, to the original state or better.

All roads must be kept open to traffic, as this is a requirement for emergency vehicles (e.g., fire departments, police, etc.).

Construction noise should be minimized by maximal use of muffled or quiet equipment and scheduling work to minimize noise intrusion. The state has legal restrictions on noise for internal combustion engines. Occupational Safety and Health Act noise exposure requirements will nt be exceeded as to residents, businesses, or workmen. Protective equipment will be used by workmen exposed to high noise levels.

Contractors' specifications should include measures to protect the public's health and safety during the construction phase. Safety is a major consideration, even though the site will not be accessible to the public. Safe construction procedures should be enforced. Equipment and machinery must be stored where children cannot gain ready access to it; thus, fencing and security measures will be required to preclude any injuries occurring on the project site.

free movement of wildlife. Further, the levees will be a source of high ground for resident species which might not be otherwise adapted to survival in the event of inundation. Preservation of wildlife in the Borrego Valley area is further provided for by the 470,000 acres of Anza-Borrego Desert State Park, the world's largest."

7.3 SOILS AND GEOLOGICAL CONSIDERATIONS

Design of the treatment plant expansion, water storage reservoir, and booster pumping station will require the following analysis by a qualified soils engineer and geologist:

1) Types of foundations and depths.
2) Soil bearing pressures.
3) Compaction and backfill requirements including erosion control for slopes.
4) Groundwater.
5) Expected cut slopes and embankment slopes.
6) Geologic-seismic factors with recommended seismic acceleration.
7) Slope stability for reservoir walls.

This analysis will provide design data to mitigate earthquake factors, soil factors, and geological considerations for the proposed project.

7.4 GROUNDWATER QUALITY

Mitigation of groundwater quality will be through a strict adherence to the discharge standards from the reclamation plant set forth by the CRWQCB, Colorado River Basin Region. The water quality objectives are documented in the board's basin plan and are implemented when discharge standards are set for each treatment plant facility. In general, the requirements for publicly owned facilities are to provide secondary treatment that meets the following Environmental Protection Agency (EPA) criteria:

Parameter	Unit of Measurement	30-Day Mean Value
BOD	mg/l	30
Suspended Solids	mg/l	30
Fecal Coliform Bacterial	No./100 ml	200
pH	pH units	Between 6.0 and 9.0

The primary emphasis on disposal is to return usable water to the usable water supply through reclamation or infiltration to the groundwater.

If the regional board sets standards similar to the Order No. 76 for the existing plant, it will not be necessary to provide any treatment beyond "secondary" to meet their requirements.

Prohibition of regenerative-type water softeners will be required to minimize the addition of salts to the effluent to maintain the allowed incremental increase in TDS in the new discharge permit.

Mitigation of nitrates in the domestic water supply due to migration from the northerly portion of the basin underlying the agricultural areas can be accomplished by pumping from the new well proposed on the southwesterly side of the water district's service area.

Urbanization of the area and diminishing agricultural activities will reduce groundwater pollution from the fertilizers and insecticides used on the various crops.

7.5 GROUNDWATER QUANTITY

Mitigation of the quantity of groundwater used is both the responsibility of the developer and the BSPCWD.

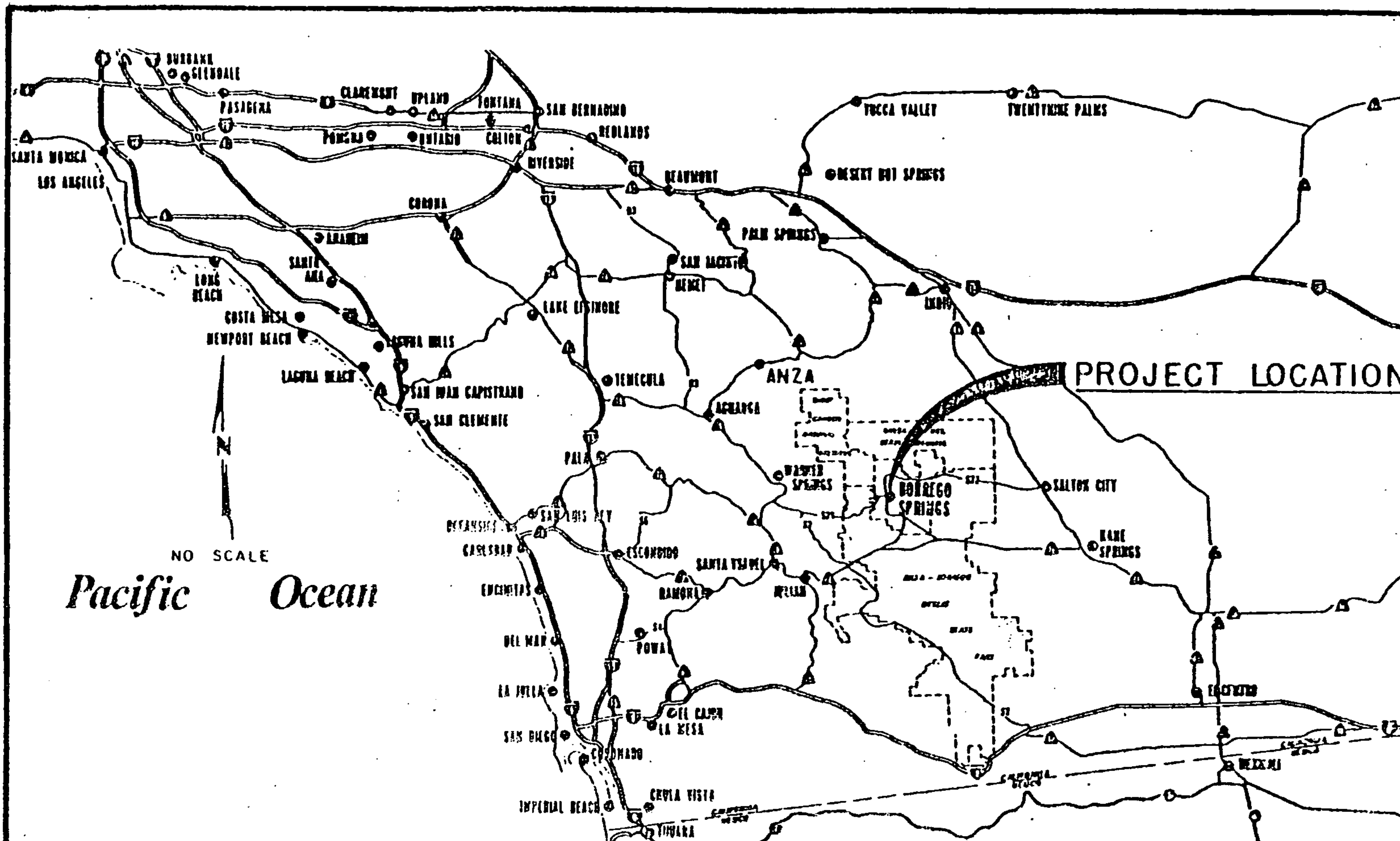
The developer can reduce the amount of groundwater used onsite to minimize the withdrawal of water from the basin by the following methods:

1) Toilets with 3.5-gallon tanks.
2) Shower with 3-gpm-maximum flow rate.
3) Faucets with 1.5-gpm-maximum flow rate.
4) Pressure-reducing valves set at 50 psi.
5) Automatic clothes washers and dishwashers.
6) Use of native plants in landscaping.
7) Time-controlled sprinklers for any exterior watering.

The installation of water conservation devices and careful exterior landscaping can reduce water use from 10 to 55 percent or more. This would result in a significant reduction in the historical per capita water usage rates found in similar desert communities. Deed restrictions prohibiting the use of water-consumptive plants can be placed on all single family lots with requirements that drought-resistant plants be used in landscaped areas.

The water district can reduce the amount of water by active pursual of the reclamation program to provide irrigation water to the golf course. In addition, the District can participate in basin-wide management and support recharge programs to capture storm water runoff.

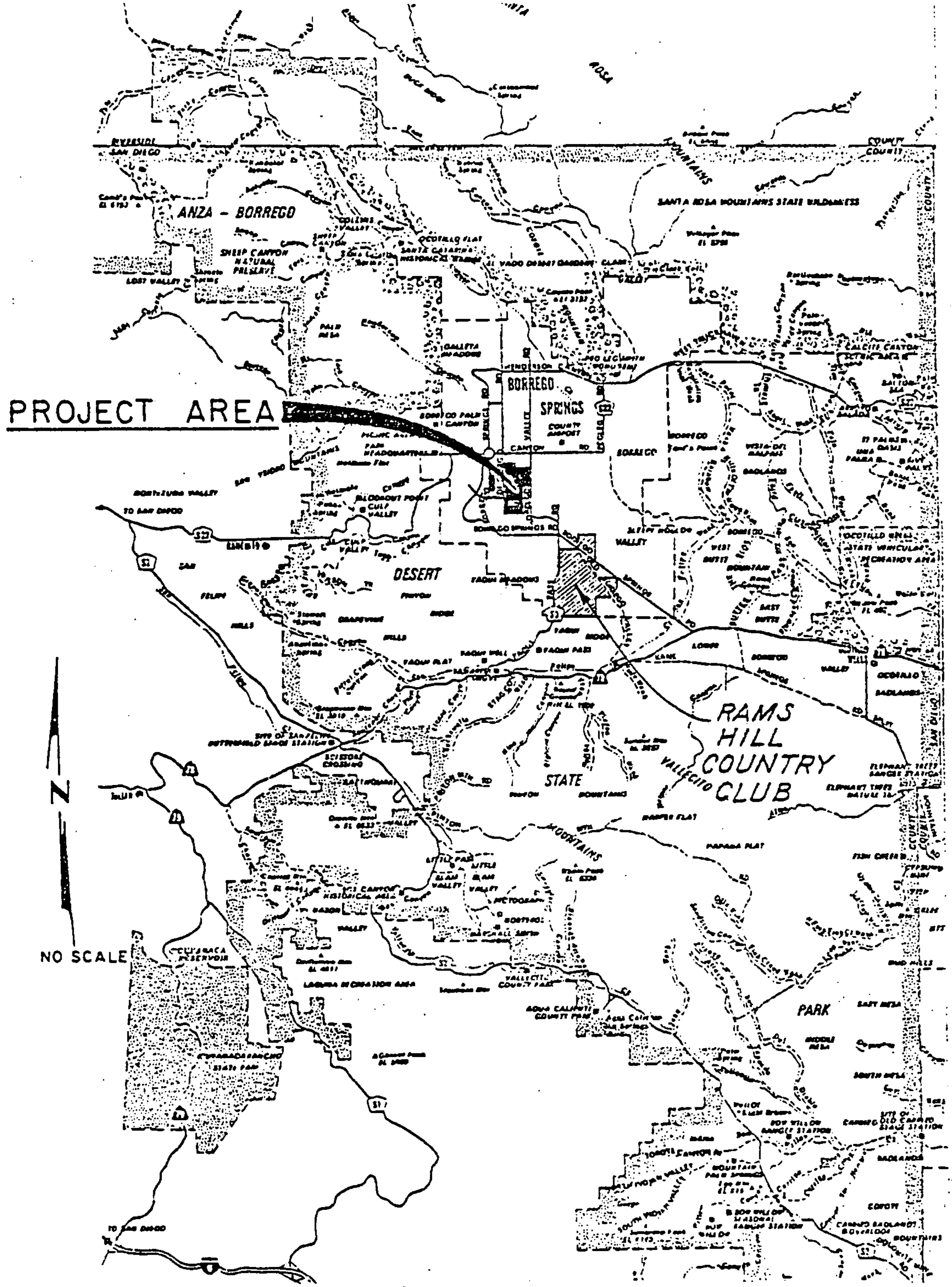
Mitigation of the long-term water supply to the Borrego Basin will involve regional planning that may require importation of water as proposed by the U.S. Department of the Interior's Bureau of Reclamation. It is estimated that this planning may be required in 50 to 100 years based on current forecasts for consumptive water use with and without urban development as a trade-off to agricultural development.



Boyle Engineering Corporation
consulting engineers / architects

REGIONAL VICINITY MAP

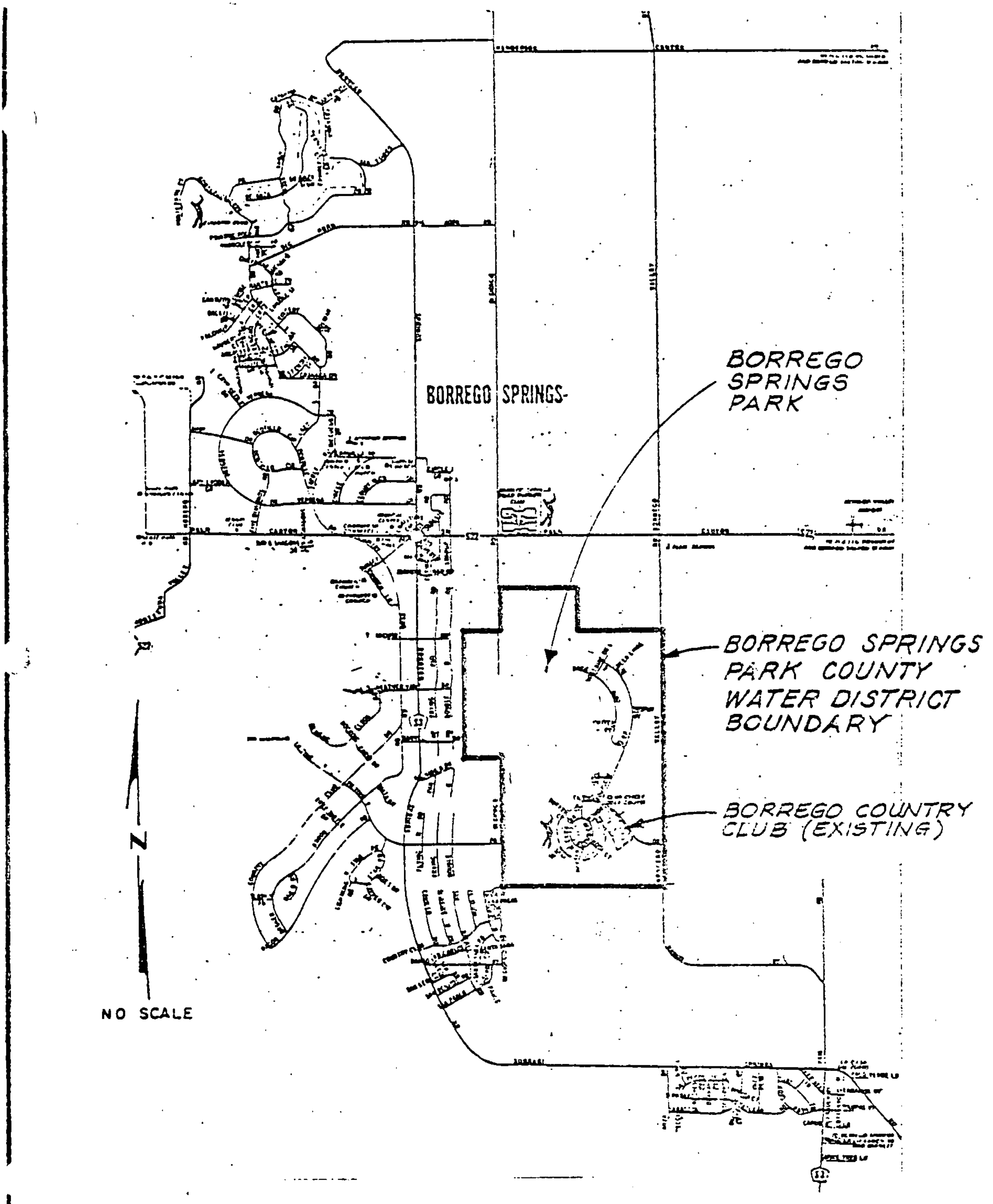
FIGURE I - I



Boyle Engineering Corporation
consulting engineers / architects

LOCATION MAP

FIGURE I - 2

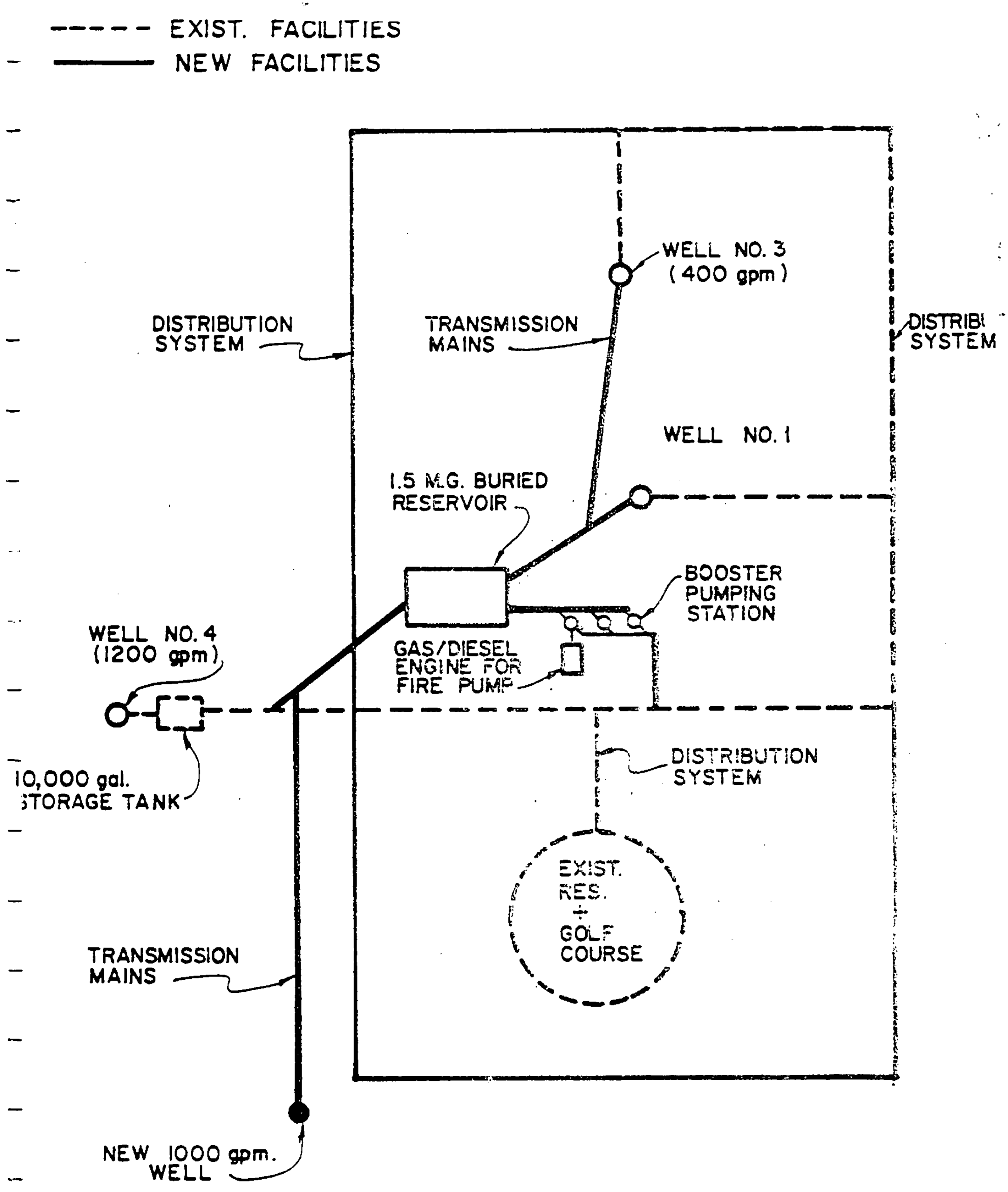


Boyle Engineering Corporation

BORREGO SPRINGS PARK COUNTY WATER DISTRICT

SERVICE AREA

FIGURE 2 - 1

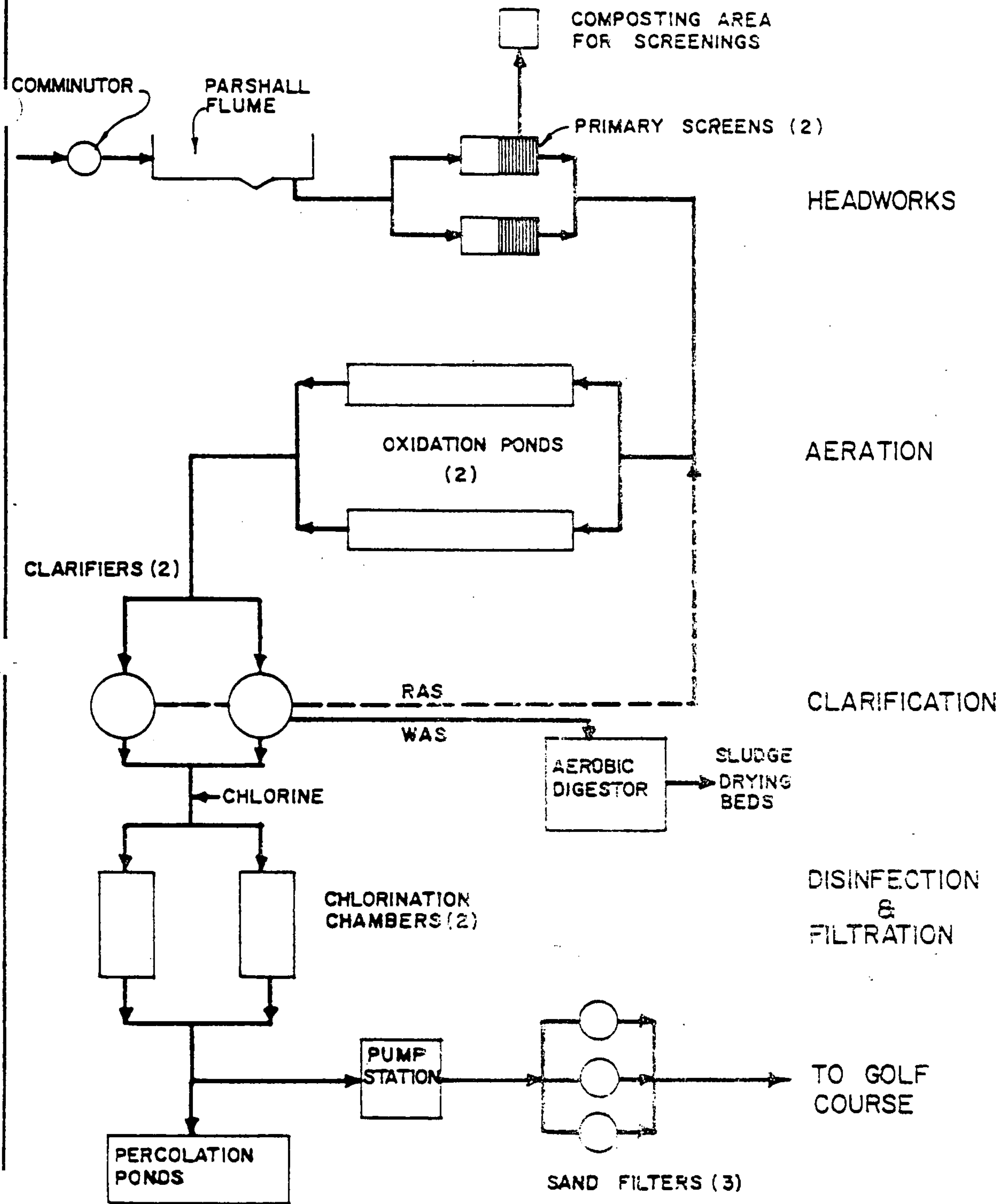


Boyle Engineering Corporation
consulting engineers / architects

BORREGO SPRINGS PARK COUNTY WATER DISTRICT

SCHEMATIC OF WATER SYSTEM AT

FIGU 5



Boyle Engineering Corporation
consulting engineers / architects

BORREGO SPRINGS PARK COUNTY WATER DISTRICT
SECONDARY TREATMENT FACILITIES

FIGURE 6-1

APPENDIX 1

FLOOD CONTROL COMPUTATIONS

- Alluvial Fan Special Flood Hazard Zone Mapping
  - Dry Canyon
  - Borrego-Palm Canyon
- Di Giorgio Road Drainage Ditch
- Onsite Runoff

1) ANALYSIS ; NOTE: SEE SHT 13, ANALYSIS SUMMARY

USE: "ALLUVIAL FAN SPECIAL FLOOD HAZARD ZONE MAPPING"

NOTE: A) DISCUSSED METHOD & APPROACH W/ BOB BROWN @ SAN DIEGO COUNTY DEPT OF SANITATION & FLOOD CONTROL TO CALCULATE DEPTH OF WATER AT PROPERTY

2) DATA

USE: USGS "MAP OF FLOOD PRONE AREAS" @ 1" = 400' SCALE

NOTES: A) U.S.G.S. MAP SHOWS ENTIRE VALLEY AS BEING "FLOOD PRONE AREA FROM SHEET FLOW AND FLOW IN UNDEFINED CHANNELS"
⇒ ALLUVIAL FAN ANALYSIS

B) USGS. MAP SHOWS "FLOOD PRONE AREA" WHICH DEFINES TERMINUS OF NORMAL FLOOD CHANNELS AND BEGINING OF "FLOW IN UNDEFINED CHANNELS"
⇒ APEX OF VALLEY ALLUVIAL FANS, SINCE FLOOD PEAK WILL IN THE WORSE CASE BE MAINTAINED IN CHANNEL

Boyle Engineering Corporation

BY______ DATE______ SUBJECT______ SHEET NO. 2 OF 12

CHKD. BY______ DATE______ JOB NO.______

3) CALCULATIONS:

A) BASE EQUATION:

CONTOUR WIDTH = 950 A C P

B) DEFINITIONS:

CONTOUR WIDTH — THAT WIDTH CORRESPONDING TO A SPECIFIC DEPTH OF WATER.

A — AVULSION COEFFICIENT; RECOMMEND TO BE 1.5 PER F.I.A. (PER GUIDELINES - P.7)

C — TRANSFORMATION CONSTANT; FOUND FROM THE MEAN OF THE LOGARITHM AND THE STANDARD DEVIATION FOR THE 100 YR AND 50 YR FLOOD FLOWS

P — PROBABILITY OF OCCURANCE; THE LOG-PEARSON TYPE III STANDARD DEVIATE IS CALCULATED AND CORRELATED FOR A DEPTH OF WA USING APPENDIX 3 OF THE U.S.W.R.C. (UNITED STATES WATER RESOURCES COUNCIL) "GUIDELINES FOR DETERMINING FLOOD FLOW FREQUENCY"; JUNE 1977 - BULLETIN 17A

c) COMPUTATIONS (DEPTH)

i) A (AVULSION COEFFICIENT) = 1.5

ii) C (TRANSFORMATION CONSTANT)

$$= e^{.92\bar{y} + .42S^2}$$

WHERE: $\bar{y}$ = LOG $\bar{Q}$ {THE MEAN OF THE LOGARITHM}

$$= \frac{\Sigma \text{LOG } Q_T - S\,\Sigma K_T}{N}$$

WHERE: Q_T = Q_{50} & Q_{100} PER TABLE 1, HYDROLOGY DATA, BORREGO VALLEY GENERAL PLAN FOR FLOOD CONTROL IMPROVEMENTS, JULY 1972

WHERE: N = 2 (Q_{50} & Q_{100})

WHERE: $$S = \frac{\text{LOG } Q_{100} - \text{LOG } Q_{50}}{K_{100} - K_{50}}$$

WHERE: $$K_T(K) = \frac{\text{LOG } Q - \bar{z}}{S_z}$$

Boyle Engineering Corporation

BY ______ DATE ______ SUBJECT ______

CHKD. BY ______ DATE ______ JOB NO. ______

WHERE: $S_z = S$ (STANDARD DEVIATION)

WHERE: z (LOG PEARSON TYPE III VARIABLE)

$= \bar{Y} + 0.92\ S^2$

DRY CANYON

THEN: USEING TABLE 1, HYDROLOGY DATA;

$Q_{100} = 1300$ CFS

$Q_{50} = 700$ CFS

THEN: USING APPENDIX 3, USWRC GUIDELINE THE SKEW COEFFICIENT (G) IS 0.0 PER USWRC GUIDELINE CHART;

$K_{100}\left(P\left\{\frac{1}{100} = 0.01\right\}\right) = 2.32635$

$K_{50} = 2.05375$

FINDING: $S = \dfrac{\text{LOG } 1300 - \text{LOG } 700}{2.32635 - 2.05375}$

$= \dfrac{0.2688}{0.2726} = 0.986 = S$

FINDING:

$$\bar{Y}(\text{LOG } Q) = \frac{(\text{LOG } 1300 + \text{LOG } 700) - [(0.986)(2.32635 + 2.05\ldots}{2}$$

$$\bar{y} = 0.82$$

FINDING:

$$C = e^{(0.92)(0.82) + (0.42)(0.986)^2}$$

$$= e^{1.1685}$$

$$C = 3.2$$

BORREGO PALM CANYON:

~~THEN~~: USING TABLE 1, HYDROLOGY DATA;

$$Q_{100} = 11700 \text{ CFS}$$

$$Q_{50} = 6300 \text{ CFS}$$

FINDING: $S = \dfrac{\text{LOG } 11700 - \text{LOG } 6300}{}$

~~2.32635 - 2.05375~~

Boyle Engineering Corporation

BY ______ DATE ______ SUBJECT ______ SHEET NO. 6 OF 15

CHKD. BY ______ DATE ______ JOB NO. ______

$$= \frac{0.2688}{0.2726}$$

$$S = 0.986$$

FINDING:

$$\bar{y} = \frac{(\log 11700 + \log 6300) - [(0.986)(2.32635 + 2.05}{2}$$

$$\bar{y} = \frac{(7.8675) - (4.3187)}{2}$$

$$\bar{y} = 1.77$$

FINDING:

$$C = e^{(0.92)(1.77) + (0.62)(0.986)^2}$$

$$= e^{2.04}$$

$$C = 7.67$$

TABLE 1. HYDROLOGY DATA

BORREGO VALLEY F.C. MASTER PLAN

Watershed	Area, Sq. Mi.	Peak Runoff, cfs 50 yr.	100 yr.	Prob. Max.	3-hour Rainfall, in.	Runoff Quantity, ac. ft. Debris	Runoff
COYOTE CREEK	137	12,500	23,200	-----	2.8	----	13,800
EL VADO	5.8	2,200	4,000	10,400	3.0	177	400
HENDERSON CANYON	8.2	3,400	6,300	15,100	3.0	458	600
BORREGO PALM CANYON	25.0	6,300	11,700	32,700	3.4	1,042	2,870
HELLHOLE CANYON	12.5	4,200	7,700	19,400	3.9	790	1,680
TUBB CANYON	12.2	4,200	7,700	20,200	3.8	788	1,640
DRY CANYON	1.6	700	1,300	3,500	3.0	75	100

TABLE A
ALLUVIAL FAN ANALYSIS SUMMARY

ITEM / CONTRIBUTING WATERSHED	Q_{100} (CFS)	MAX. DEPTH @ SITE	MAX VELOCITY @ SITE	ALLUVIAL FAN WIDTH @ SITE	ANALYSIS ALLUVIAL FAN CONTOUR WIDTH	A	C	S	$\bar{Y}$	P
DRY CYN	1300	0.5 FT	3.5 FPS	4300	2316 (< 4300)	1.5	3.2	0.986	0.82	0.508
BORREGO-PALM CYN	11700	1.5 FT.	5.5 FPS	10000	4503 (<10000)	1.5	7.67	0.986	1.77	0.412
TUBB CYN (1)	7700	1.5	5.5 FPS	4300	3029 (< 4300)	1.5	6.45	0.966	1.6	0.33

A - AVULSION CONSTANT
C - TRANSFORMATION CONSTANT
P - PROBABILITY OF OCCURRENCE

} CALCULATED ALLUVIAL FAN CONTOUR WIDTH = 950 A.C.P.

(1) NOTE THIS WATERSHED HAS BEEN DIVERTED FROM SITE — CALC'S ATTACHED

Boyle Engineering Corporation

CHKD. BY ____ DATE ____
DATE ____
SUBJECT ____
JOB NO. ____

Boyle Engineering Corporation

BY ______ DATE ______ SUBJECT ______ SHEET NO. 12 OF 12

CHKD. BY ______ DATE ______ JOB NO. ______

$$K_{5.5} = \frac{\log 654 - 2.664}{0.986}$$

$$= 0.1537$$

USE: APPENDIX 3; BULLETIN 17A

$$P = 0.439$$

$$P\{Q \geq 654\} = P\{K \geq 0.1537\} = 0.439$$

FINDING:

CONTOUR WIDTH = (950)(1.5)(5.67 (0.439))

= 4798'

$P\{Q \geq 68\} = P\{K \geq 0.120\} = 0.45236$

FINDING:

CONTOUR WIDTH = (950)(1.5)(3.20)(0.45236)

= 2063'

BORREGO - PALM CANYON

$$K_{4.5} = \frac{\text{LOG } 240 - [(1.77) + (0.92)(0.986)^2]}{0.986}$$

$$= \frac{2.38 - 2.664}{0.986} = -0.2878$$

USE: APPENDIX 3, BULLETIN 17A

$P = 0.6127$

$P\{Q \geq 240\} = P\{K \geq -0.2878\} = 0.6127$

FINDING:

CONTOUR WIDTH = (950)(1.5)(7.67)(0.6127)

= 6797'

D) COMPUTATIONS (VELOCITY)

i) BARE EQUATION:

$W = 950\ A\ C\ P$
(SEE SECTION 3 B, SHT 2)

FIND: P USING APPENDIX 3, BULLETIN 17A

WHERE: $K = \dfrac{\log Q - \bar{Z}}{S_z}$; $\bar{Z} = \bar{Y} + 0.92 S$

USE: RELATIONSHIP $Q = 0.13 V^5$ (PER SECT 5C)

DRY CANYON

$$K_{3.5} = \frac{\log 68 - [(0.82) + (0.92)(0.986)^2]}{0.986}$$

$$= \frac{1.832 - 1.714}{0.986}$$

$$= 0.120$$

USE: APPENDIX 3, BULLETIN 17A

$P = 0.45236$

Boyle Engineering Corporation

$P\{Q \geq 49.5\} = P\{K \geq -0.983\} = 0.832$

FINDING:

CONTOUR WIDTH (@ 0.5') = (950)(1.5)(7.74)(0.832)

= 9177'

USING: FIA. GUIDELINES (SEE SHEET 7)

FINDING:

$$K_{1.5} = \frac{\text{LOG } 772 - [(1.77) + (0.92)(0.936)]^2}{0.986}$$

$$= \frac{2.887 - 2.664}{0.986}$$

$$= 0.223$$

USING: APPENDIX 3 USWRC & INTERPOLATING TO FIND:

P = 0.412

$P\{Q \geq 772\} = P\{K \geq 0.223\} = 0.412$

FINDING:

CONTOUR WIDTH (@ 1.5')

= (950)(1.5)(7.67)(0.412)

= 4503'

Boyle Engineering Corporation

BY ______ DATE ______ SUBJECT ______ SHEET NO. 8 OF 1

CHKD. BY ______ DATE ______ JOB NO. ______

USING: FIGURE 4-1; 100 YEAR FLOOD LINE MAP FOR PROJECT AREA

FINDING: LIMITS OF DRY CANYON ALLUVIAL FAN, FIND A POINT WHERE THE WIDTH OF FAN PERPINDICULAR TO THE DIRECTION OF FLOW IS 2329 FEET WIDE WHICH WOULD CORRESPOND TO A DEPTH OF 0.5 FT PER GUIDELINE CALCULATIONS

FINDING: DEPTH OF WATER AT PROJECT SITE BOUNDRY LESS THAN 0.5 FEET PER GUIDELINES

BORREGO PALM CANYON

$$K_{0.5} = \frac{\text{LOG } 49.5 - \left[(1.77) + (0.92)(0.986)^2\right]}{0.986}$$

$$= -0.983$$

USING: APPENDIX 3 USWRC & INTERPOLATING TO FIND

Boyle Engineering Corporation

BY ______ DATE ______ SUBJECT ______ SHEET NO. 7 OF 13

CHKD. BY ______ DATE ______ JOB NO. ______

iii) P (PROBABILITY OF OCCURANCES)

WHERE: $K = \dfrac{\text{LOG } Q - \bar{z}}{S_z}$

$\bar{z} = \bar{y} + 0.92\, S^2$

USING: F.L.A. GUIDELINES ($Q = 280\, D^{2.5}$; PER SECTION 5a

Q (CFS)	49.5	772	2770	6420	120
D (FT)	0.5	1.5	2.5	3.5	4.5

DRY CANYON

$K_{0.5} = \dfrac{\text{LOG } 49.5 - [0.82 + (0.92)(0.986)^2]}{0.986}$

$= -0.02$

USING: APPENDIX 3 USWRC & INTERPOLATING TO FIND:

$P = 0.508$

$P\{Q \geq 49.5\} = P\{K \geq -0.02\} = 0.508$

FINDING: CONTOUR WIDTH = 950 ACP

$= (950)(1.5)(3.2)\ (.508)$

$= 2316$ @ 1/2' DEPTH

5. Determine Discharges for Depth and Velocity Zones

a. Discharges (Q) in cubic feet per second that correspond to the various depth zone boundaries should be selected using the following table. This table was derived from the relationship $Q = 280 D^{2.5}$ where D is the total depth in feet due to pressure head and velocity head.

Q	49.5	772	2770	6420	12000
D	0.5	1.5	2.5	3.5	4.5

b. Depth zones are designated from zone boundaries as follows:

Depth of Zone	Depth of Lower Boundary	Depth of Upper Boundary
1	0.5	1.5
2	1.5	2.5
3	2.5	3.5
4	3.5	4.5
etc.		

c. Discharges (Q) in cubic feet per second that correspond to the various velocity zone boundaries should be selected using the following table. This table was derived from the relationship $Q = 0.13V^5$, where V is velocity in feet per second.

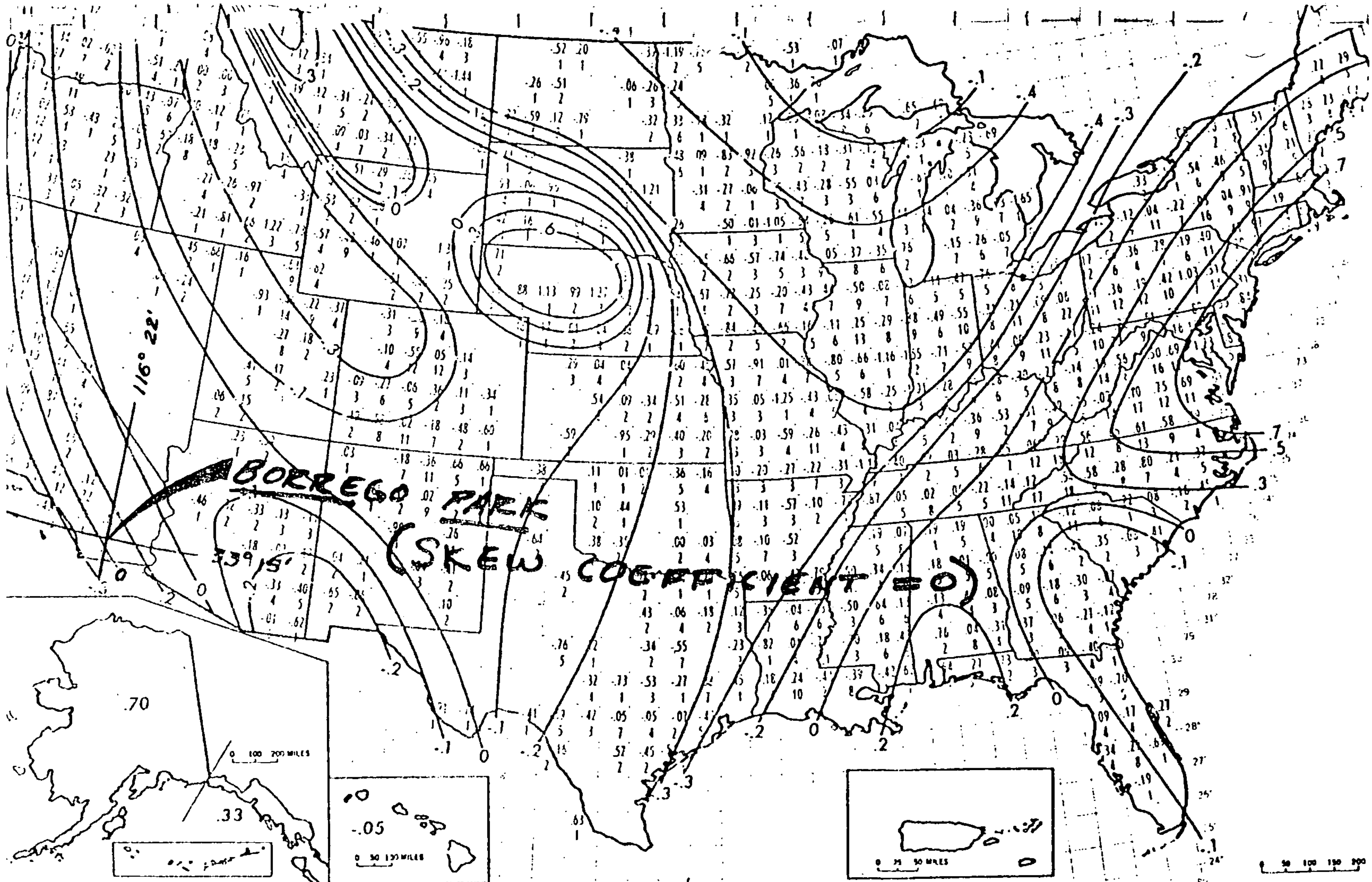
Q	68	240	654	1510	3080	5770
V	3.5	4.5	5.5	6.5	7.5	8.5

d. Velocity zones are designated from zone boundaries as follows:

Zone Velocity	Velocity of Lower Boundary	Velocity of Upper Boundary
4.0	3.5	4.5
5.0	4.5	5.5
6.0	5.5	6.5
7.0	6.5	7.5
8.0	7.5	8.5

APPENDIX 3, BULLETIN 17A

P	G =0.0	G =0.1	G =0.2	G =0.3	G =0.4	G =0.5	G =0.6
0.9999	-3.71902	-3.50703	-3.29921	-3.09631	-2.89907	-2.70836	-2.52507
0.9995	-3.29053	-3.12767	-2.96698	-2.80889	-2.65390	-2.50257	-2.35549
0.9990	-3.09023	-2.94834	-2.80786	-2.66915	-2.53261	-2.39867	-2.26780
0.9980	-2.87816	-2.75706	-2.63672	-2.51741	-2.39942	-2.28311	-2.16884
0.9950	-2.57583	-2.48187	-2.38795	-2.29423	-2.20092	-2.10825	-2.01644
0.9900	-2.32635	-2.25258	-2.17840	-2.10394	-2.02933	-1.95472	-1.88029
0.9800	-2.05375	-1.99973	-1.94499	-1.88959	-1.83361	-1.77716	-1.72033
0.9750	-1.95996	-1.91219	-1.86360	-1.81427	-1.76427	-1.71366	-1.66253
0.9600	-1.75069	-1.71580	-1.67999	-1.64329	-1.60574	-1.56740	-1.52830
0.9500	-1.64485	-1.61594	-1.58607	-1.55527	-1.52357	-1.49101	-1.45762
0.9000	-1.28155	-1.27037	-1.25824	-1.24516	-1.23114	-1.21618	-1.20028
0.8000	-0.84162	-0.84611	-0.84986	-0.85285	-0.85508	-0.85653	-0.85718
0.7000	-0.52440	-0.53624	-0.54757	-0.55839	-0.56867	-0.57840	-0.58757
0.6000	-0.25335	-0.26882	-0.28403	-0.29897	-0.31362	-0.32796	-0.34198
0.5704	-0.17733	-0.19339	-0.20925	-0.22492	-0.24037	-0.25558	-0.27047
0.5000	0.0	-0.01662	-0.03325	-0.04993	-0.06651	-0.08302	-0.09945
0.4296	0.17733	0.16111	0.14472	0.12820	0.11154	0.09478	0.07791
0.4000	0.25335	0.23763	0.22168	0.20552	0.18916	0.17261	0.15589
0.3000	0.52440	0.51207	0.49927	0.48600	0.47228	0.45812	0.44352
0.2000	0.84162	0.83639	0.83044	0.82377	0.81638	0.80829	0.79950
0.1000	1.28155	1.29178	1.30105	1.30936	1.31671	1.32309	1.32850
0.0500	1.64485	1.67279	1.69971	1.72562	1.75048	1.77428	1.79701
0.0400	1.75069	1.78462	1.81756	1.84949	1.88039	1.91022	1.93896
0.0250	1.95996	2.00688	2.05290	2.09795	2.14202	2.18505	2.22702
Q50 → 0.0200	2.05375	2.10697	2.15935	2.21081	2.26133	2.31084	2.35931
Q100 → 0.0100	2.32635	2.39961	2.47226	2.54421	2.61539	2.68572	2.75514
0.0050	2.57583	2.66965	2.76321	2.85636	2.94900	3.04102	3.13232
0.0020	2.87816	2.99978	3.12169	3.24371	3.36566	3.48737	3.60872
0.0010	3.09023	3.23322	3.37703	3.52139	3.66608	3.81090	3.95567
0.0005	3.29053	3.45513	3.62113	3.78820	3.95605	4.12443	4.29311
0.0001	3.71902	3.93453	4.15301	4.37394	4.59687	4.82141	5.04718



GENERALIZED SKEW COEFFICIENTS OF LOGARITHMS OF ANNUAL MAXIMUM STREAMFLOW

AVERAGE SKEW COEFFICIENT BY ONE DEGREE QUADRANGLES

Lower number in each quadrangle is number of stream gaging stations for which the average shown above it was computed

BULLETIN 17A

GENERALIZED SKEW COEFFICIENTS OF ANNUAL MAXIMUM STREAMFLOW LOGARITHMS

AUGUST 1975 EDITION

The generalized skew map was developed for those guide users who prefer not to develop their own generalized skew relationships. The map was developed from readily available data. Users are encouraged to make detailed studies for their region of interest using the procedures outlined in Section V,B-2. It is expected that Plate I will be revised as more data become available and more extensive studies are completed.

The map is of generalized logarithmic skew coefficients of annual peak discharge. It is based on skew coefficients at 2,972 stream gaging stations. These are all the stations available on USGS tape files with drainage areas equal to or less than 3,000 square miles that had 25 or more years of essentially unregulated annual peaks through water year 1973. Periods when the annual peak discharge likely differed from natural flow by more than about 15 percent were not used. At 144 stations the lowest annual peak was judged to be a low outlier by equation 5 using $\bar{G}$ from figure 14-1 and was not used in computing the skew coefficient. At 28 stations where the annual peak flow for one or more years was zero, only the remaining years were used in computing the low outlier test and in computing the logarithmic skew coefficients. No attempt was made to identify and treat high outliers, to use historic flood information, or to make a detailed evaluation of each frequency curve.

The generalized map of skew coefficients was developed using the averaging technique described in the guide. Preliminary attempts to determine prediction equations relating skew coefficients to basin characteristics indicated that such relations would not appreciably affect the isopleth position. Averages used in defining the isopleths were for groups of 15 or more stations in areas covering four or more one-degree quadrangles of latitude and longitude.

The average skew coefficients for all gaging stations in each one-degree quadrangle of latitude and longitude and the number of stations are also shown on the map. Average skew coefficients for selected groups of one-degree quadrangles were computed by weighting averages for one-degree quadrangles according to the number of stations. The averages for various groups of quadrangles were used to establish the maximum and minimum values shown by the isopleths and to position the intermediate lines.

Because the average skew for 15 or more stations with 25 or more years of record is subject to time sampling error, especially when the stations are closely grouped, the smoothed lines are allowed to depart a few tenths from some group averages. The standard deviation of station values of skew coefficient about the isopleth line is about 0.55 nationwide.

Only enough isopleths are shown to define the variations. Linear interpolation between isopleths is recommended.

The generalized skew coefficient of -0.05 shown for all of Hawaii is the average for 30 stream gaging stations. The generalized skew coefficient of 0.33 shown for southeastern Alaska is the average for the 10 stations in that part of the State. The coefficient of 0.70 shown for the remainder of Alaska is based on skew coefficients at nine stations in the Anchorage-Fairbanks area. The average skew of 0.85 for these nine stations was arbitrarily reduced to the maximum generalized skew coefficient shown for conterminous United States in view of the possibility that the average for the period sampled may be too large.

Boyle Engineering Corporation

BY RFK DATE 4/22/80 SUBJECT FEDERATED DEVEL. CO BORREGO SPRGS PK. SHEET NO. 1 OF 2
CHKD. BY ____ DATE ____ JOB NO. W F01 001 01

INCLUDE ALLUVIAL FAN ANALYSIS OF TUBB CYN (PER RECOMMENDATION OF GORDON LUTES)
(SEE 1/30/80 DRY CYN CALC'S)

CONTOUR WIDTH (FLOOD PLAIN) = 950 ACP

1) A (AVULSION COEFFICIENT) = 1.5

2) C (TRANSFORMATION CONSTANT) = $e^{.92\bar{y}+.42s^2}$

$Q_{100} = 7700$

$Q_{50} : 4200$

$$S = \frac{\text{LOG } 7700 - \text{LOG } 4200}{2.32635 - 2.05375}$$

S = 0.966

$$y = \frac{(\text{LOG } 7700 + \text{LOG } 4200) - [(0.966)(2.32635 + 2.0\ldots}{2}$$

y = 1.60

C = 6.45

Boyle Engineering Corporation

BY ____ DATE ____ SUBJECT ____ SHEET NO. 2 OF 2

CHKD. BY ____ DATE ____ JOB NO. ____

3) P (PROBABILITY OF OCCURANCE) - USE APPENDIX 3

a) FIND $K = \frac{\text{LOG } Q - z}{S}$

$z = \bar{Y} + 0.92\, S^2$

$$K_{0.5} = \frac{\text{LOG } 49.5 - [(1.6) + (.92)(.966)^2]}{.966}$$

$K_{0.5} = -.79$

$P_{0.5}\{Q \geq 49.5\} = P\{K \geq -0.79\} = .784$

$K_{1.5} = .44 \Rightarrow P_{1.5} = .33$

4) a) ALLUVIAL FLOOD PLAIN WIDTH = 7206 FT
@ 0.5' DEPTH

b) @ 1.5 DEPTH = 3029 FT

Boyle Engineering Corporation

BY RPK DATE 2/6/80 SUBJECT FEDERATED DEVEL CO BORREGO SPRINGS PK SHEET NO. 1 OF 2

CHKD. BY ____ DATE ____ JOB NO. ____

FIND: DIMENSIONS OF DIVERSION DITCH

USE: ALLUVIAL FAN ANALYSIS

1) $Q_{100} = 1300$ CFS

2) $D_{ANAL} = 0.5'$

3) $W_{ANAL} = 2329'$

4) $V_{ANAL} = 3.5$ FPS

w/ $V = \left(\frac{Q}{.13}\right)^{1/5}$ {PER ANALYSIS}

USE: $Q = VA$

w/ CONSTANT V

$$\frac{A_{CALC}}{A_{ANAL}} \propto \frac{Q_{CALC}}{Q_{100}} = \frac{A_{CALC}}{A_{ANAL}} = \frac{\left(\frac{1300}{3.5}\right)}{(0.5)(2329)} =$$

→ FIND THE Q_{CALC} AT THE INTERCEPTION POINT OF THE DIVERSION DITCH AND THE ALLUVIAL FAN FLOW

FIND: $Q_{CALC} = (.318)(1300) = 416$ CFS

Boyle Engineering Corporation

____ DATE ____	SUBJECT ____		SHEET NO. 2 OF 2
CHKD. BY ____ DATE ____			JOB NO. ____

FIND: $V = \left(\frac{416}{.13}\right)^{1/5} = 5.02$ FPS

USE: Q = 416
V = 5.02

FIND: $A = \frac{416}{5.02} = 82.9 \square'$

6' X 14 = 84 □' ✓ OK

Boyle Engineering Corporation

BY RPK DATE 4/24/80 SUBJECT FEDERATED BORREGO SPRINGS PARK SHEET NO. 1 OF 2
CHKD. BY ____ DATE __/__/__ JOB NO. W F01 001 01

A. FIND 100-YR FREQ. RUNOFF FROM SITE
COMPARE BEFORE & AFTER DEVELOPMENT

1) USE "COUNTY OF SAN DIEGO PROCEDURES FOR HYDROLOGIC COMPUTATIONS"

a) SOILS GROUP A (SECT I-A-3)
- TABLE I-A-1

⇒ PERVIOUSNESS @ 80% BEFORE (CN=46)
@ 55% AFTER (CN=70)

b) BASIN FACTOR (SECT I-B-2)

⇒ $n_{BEFORE} = 0.03$

$n_{AFTER} = 0.015$

2) USE UNIT HYDROGRAPH METHOD AS RECOMMENDED PER IV-A-2 FOR WATERSHEDS 0.5-15 MI^2
(PROJECT @ 1.5 MI^2)

a) USE 100-YR FREQ 2-6 HR DURATION

6 HR DURATION PER II-A-7
@ BORREGO VALLEY ZONE = 3-INCH

- APPROXIMATE TO 3 HR DURATION

Boyle Engineering Corporation

B.) ______ DATE ______ SUBJECT ______ SHEET NO. 2 OF 2

CHKD. BY ______ DATE ______ ______ JOB NO. ______

b) USE EXISTING POINT OF CONCENTRATION ALONG BORREGO VALLEY RD.

c) USE OC EMA COMPUTER PROGRAM.

BOYLE ENGINEERING CORPORATION
LOCAL 100-YEAR FLOOD CALCULATION
BASED UPON O.C.F.C.D. HYDROLOGY MANUAL METHOD

BORREGO SPGS PARK-DISCHARGE BEFORE DEV

DRAIN AREA (SQ MI)	1.500	UNIT PERIOD (HR) = T =	0.25	LOSS RATE (IN/HR)	0.20
PERVIOUS %	80.	BASE FLOW (CFS/SQ.MI.)	0.	ZONE:	VALLEY
UPPER ELEV (FT)	560.	LOWER ELEV (FT)	520.	DIFF IN ELEV (FT)	40.
L (MILES)	1.290	LCA (MILES)	.500	SLOPE(FT/MI) = S =	31.
BASIN FACTOR (N)	.030	LAG (HOURS)	.317	K=645(DR AREA)/T =	3870.
% LAG=100(T)/LAG=	78.8	100-YR 3-HR PT RAINFALL=	1.50	RAINFALL ADJ FAC	.455

R(180) = 3.290 R(60) = 2.675 R(30) = 1.855 R(15) = 1.370

RAINFALL(IN) PERIOD:	1	2	3	4	5	6	7	8	9	10	11	12
LOCAL PROJ- - - - - -	.043	.031	.068	.031	.123	.135	.086	.098	.394	.426	1.370	.485
LOCAL 100-YEAR- - - -	.020	.014	.031	.014	.056	.062	.039	.045	.179	.194	.623	.220
EFFECTIVE - - - - - -	.002	.001	.003	.001	.016	.022	.004	.005	.139	.154	.583	.180

% LAG	% Q	INCREM % Q	CFS
39.4	10.6	10.6	409.
118.2	59.6	49.0	1897.
196.9	77.6	18.0	696.
275.7	86.0	8.5	328.
354.5	90.6	4.6	177.
433.2	93.8	3.2	123.
512.0	96.1	2.3	88.
590.8	97.6	1.6	61.
669.5	98.6	1.0	39.
748.3	99.4	.8	29.
827.1	99.9	.5	18.
905.8	100.0	.1	6.

100-YEAR FLOOD HYDROGRAPH

BORREGO SPGS PARK-DISCHARGE BEFORE DEV

TIME (HR)	UNIT DISCH ORD (CFS)	- - - - E F F E C T I V E R A I N F A L L - I N C H E S - - - - - - .002	.001	.003	.001	.016	.022	.004	.005	.139	.154	.583	.180	PROJ FLOOD (CFS)	BASE FLOW (CFS)	TOTAL FLOOD (CFS)
.25	409.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	1.
.50	1897.	4.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.	0.	4.
.75	696.	1.	3.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	0.	5.
1.00	328.	1.	1.	6.	1.	0.	0.	0.	0.	0.	0.	0.	0.	8.	0.	8.
1.25	177.	0.	0.	2.	3.	7.	0.	0.	0.	0.	0.	0.	0.	12.	0.	17.
1.50	123.	0.	0.	1.	1.	30.	9.	0.	0.	0.	0.	0.	0.	41.	0.	41.
1.75	88.	0.	0.	1.	0.	11.	41.	2.	0.	0.	0.	0.	0.	55.	0.	55.
2.00	61.	0.	0.	0.	0.	5.	15.	7.	2.	0.	0.	0.	0.	30.	0.	30.
2.25	39.	0.	0.	0.	0.	3.	7.	3.	9.	57.	0.	0.	0.	79.	0.	79.
2.50	29.	0.	0.	0.	0.	2.	4.	1.	3.	264.	63.	0.	0.	337.	0.	337.
2.75	18.	0.	0.	0.	0.	1.	3.	1.	2.	97.	292.	238.	0.	633.	0.	633.
3.00	6.	0.	0.	0.	0.	1.	2.	0.	1.	46.	107.	1106.	74.	1336.	0.	1336.
3.25	0.	0.	0.	0.	0.	1.	1.	0.	1.	25.	50.	405.	342.	826.	0.	826.
3.50	0.	0.	0.	0.	0.	0.	1.	0.	0.	17.	27.	191.	126.	363.	0.	363.
3.75	0.	0.	0.	0.	0.	0.	1.	0.	0.	12.	19.	103.	59.	195.	0.	195.
4.00	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.	13.	72.	32.	126.	0.	126.
4.25	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	9.	51.	22.	88.	0.	88.
4.50	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.	6.	35.	16.	61.	0.	61.
4.75	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	4.	23.	11.	41.	0.	41.
5.00	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	3.	17.	7.	28.	0.	28.
5.25	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	11.	5.	17.	0.	17.
5.50	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	3.	7.	0.	7.
5.75	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.	1.

SUM = 3870.

PEAK FLOW = 1336.

BOYLE ENGINEERING CORPORATION
LOCAL 100-YEAR FLOOD CALCULATION
BASED UPON O.C.F.C.D. HYDROLOGY MANUAL METHOD

BORREGO SPGS PARK-DISCHARGE AFTER DEVEL

DRAIN AREA (SQ MI)	1.500	UNIT PERIOD (HR) = T =	0.25	LOSS RATE (IN/HR)	0.20
PERVIOUS %	55.	BASE FLOW (CFS/SQ.MI.)	0.	ZONE:	VALLEY
UPPER ELEV (FT)	560.	LOWER ELEV (FT)	520.	DIFF IN ELEV (FT)	40.
L (MILES)	1.290	LCA (MILES)	.500	SLOPE(FT/MI) = S =	31.
BASIN FACTOR (N)	.015	LAG (HOURS)	.159	K=645(DR AREA)/T =	3870.
% LAG=100(T)/LAG=	157.5	100-YR 3-HR PT RAINFALL=	1.50	RAINFALL ADJ FAC	.455

R(180) = 3.290　R(60) = 2.675　R(10) = 1.855　R(15) = 1.370

RAINFALL(IN) PERIOD:	1	2	3	4	5	6	7	8	9	10	11	12
LOCAL PROJ- - - - - -	.043	.031	.068	.031	.123	.135	.086	.098	.394	.426	1.370	.485
LOCAL 100-YEAR- - - -	.020	.014	.031	.014	.056	.062	.039	.045	.179	.194	.623	.220
EFFECTIVE - - - - - - -	.002	.001	.003	.001	.028	.034	.012	.017	.151	.166	.595	.193

% LAG	% Q	INCREM % Q	CFS
78.8	34.6	34.6	1338.
236.3	82.4	47.8	1850.
393.8	92.4	10.0	386.
551.4	96.9	4.6	177.
708.9	99.1	2.1	83.
866.5	99.9	.9	33.
1024.0	100.0	.1	3.

100-YEAR FLOOD HYDROGRAPH

BORREGO SPGS PARK-DISCHARGE AFTER DEVEL

TIME (HR)	UNIT DISCH ORD (CFS)	- - - - E F F E C T I V E R A I N F A L L - I N C H E S - - - - - - .002	.001	.003	.001	.028	.034	.012	.017	.151	.166	.595	.193	PROJ FLOOD (CFS)	BASE FLOW (CFS)	TOTAL FLOOD (CFS)
.25	1338.	3.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	0.	3.
.50	1850.	4.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	0.	5.
.75	386.	1.	3.	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.	0.	8.
1.00	177.	0.	1.	6.	2.	0.	0.	0.	0.	0.	0.	0.	0.	9.	0.	9.
1.25	83.	0.	0.	1.	3.	38.	0.	0.	0.	0.	0.	0.	0.	42.	0.	42.
1.50	33.	0.	0.	1.	1.	53.	45.	0.	0.	0.	0.	0.	0.	99.	0.	99.
1.75	3.	0.	0.	0.	0.	11.	63.	16.	0.	0.	0.	0.	0.	90.	0.	90.
2.00	0.	0.	0.	0.	0.	5.	13.	22.	23.	0.	0.	0.	0.	63.	0.	63.
2.25	0.	0.	0.	0.	0.	2.	6.	4.	32.	203.	0.	0.	0.	247.	0.	247.
2.50	0.	0.	0.	0.	0.	1.	3.	2.	7.	280.	223.	0.	0.	515.	0.	515.
2.75	0.	0.	0.	0.	0.	0.	1.	1.	3.	58.	308.	796.	0.	1168.	0.	1168.
3.00	0.	0.	0.	0.	0.	0.	0.	0.	1.	27.	64.	1101.	258.	1452.	0.	1452.
3.25	0.	0.	0.	0.	0.	0.	0.	0.	1.	13.	29.	230.	357.	629.	0.	629.
3.50	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	14.	105.	74.	199.	0.	199.
3.75	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.	49.	34.	90.	0.	90.
4.00	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	20.	16.	36.	0.	36.
4.25	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	6.	8.	0.	8.
4.50	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.	1.

SUM = 3870.

PEAK FLOW = 1452.

APPENDIX B

An Appraisal Of The Groundwater Resources In The Northern Subbasin Of The Borrego Valley Reservoir

David A. Phoenix

An appraisal of the groundwater resources in the northern subbasin of the Borrego Valley reservoir, San Diego County, with emphasis on the recovery of groundwater from the Borrego Park area.

For

FEDERATED DEVELOPMENT COMPANY

by

David A. Phoenix

July, 1979

PRELIMINARY

CONTENTS

* * * * *

ILLUSTRATIONS

* * * * *

1.0 INTRODUCTION

This report explores the influence that land developments have had upon water supplies in the Borrego Valley, and by so doing it evaluates the availability of water for additional developments, particularly in the Borrego Springs Park area, sections 4 and 9, T. 11 S., R. 6 E., in what is known as the Ensign Ranch area. The area is between 1 and 2 miles east of the base of the Peninsular Range and just south of the shopping center in Borrego Valley.

The only water available to homes and agriculture in the valley is that which comes from local sources. Inasmuch as the area is a desert, the supply is limited and almost entirely underground. It is within the reach of wells, some deeper and more costly than others, but available over most of the valley floor. The groundwater reservoir is large and it probably contains about 500,000 acre-feet or more of useable water, enough to provide a "standby" resource in periods of drought, and enough to last for many years if uncontaminated and used carefully in accordance with the natural supply. Unfortunately, land developments and management of water supplies do not often go hand-in-hand, and this is particularly true for groundwater supplies where the landowner is often in ignorance concerning the physical and hydrologic properties of the underlying reservoir, its reaction to climatic influences, to pumpage, and to land use practices as conceived by he or his neighbors. It is the purpose of this report to briefly describe the setting and the geology of the groundwater reservoir, i.e., those dimensions and features of the area that govern the availability of the groundwater; to introduce observations concerning the dynamic properties of the reservoir, its recharge and discharge, and to provide useful criteria for future use and management of the reservoir particularly as they apply to some 1,200 acres of land in the western part of the basin and in the vicinity of the Ensign Ranch (Sections 4 and 9, T. 11 S., R. 6 E).

2.0 GEOGRAPHIC SETTING AND HISTORIC DEVELOPMENTS

Borrego Valley, near sea level but about 60 miles due east of the Pacific Ocean, lies on the eastern side of the Peninsular Range in Southern California. It occupies a shallow indentation along the base of the northwesterly trending escarpment of these mountains (see Figure 1); it is about 17 miles long from the abraided channel of San Felipe creek in the south end of the valley to the mouth of Coyote Canyon in the north end, and in the central most populated part it is about 9 miles wide. The valley floor covers about 84 square miles.

Although the west side and north end of the valley are enclosed by steep escarpments and high mountains, in places arising to altitudes between 6,000 and 8,000 feet above sea level, the east side is enclosed by low-lying, somewhat aligned but poorly connected hills, Coyote Mountain, Clay Hills, and Borrego Mountain that are less than 1,200 feet above sea level and overlook the Salton Sea and Imperial Valley to the east. The area encompassed by the drainage divide encircling Borrego Valley is 280 square miles.

The valley is on the western edge of the most arid desert in North America and its western side and northern end yield the bulk of its water supply. Stream channels enter the valley from the west side and the north end. Coyote Creek on the north end is perennial, but those on the west side are all ephemeral. With the exception of San Felipe Creek, which enters the west central side of the valley and trends accurately across the valley to leave around the north end of Borrego Mountain, all channels from the north and west merge and eventually drain into Borrego Sink in the north central part of the valley.

Oiled highways connect the valley to the coast, San Diego on the southwest and Oceanside on the west, and to inland parts of Southern California, Imperial Valley and the Salton Sea and Palm Desert and Palm Springs in Coachella Valley to the east and northeast. All of the larger communities in Southern California are between one and one-half and two hours drive from the shopping center in Borrego Valley.

Since the 1920's, the valley has been a focal point for efforts in development. In the early 1930's, when the Ensign Ranch was operating in the central part of the valley, it was supporting hayfields and cattle and, for a time, considerable hope and expectation was placed in sizeable acreage devoted to dates. It is reported that the first irrigation well in the valley was constructed on this ranch in 1926. Later, in the mid-forties, attention was directed to the northern part of the valley; several thousand acres in this area were devoted to farming grapes, and for a time these were companion to colorful crops of gladiolus. Reportedly, the valley produced some of the finest table grapes in Southern California. By the late 1950's and early 1960's, attention was finally diverted to citrus, to specialty crops for desert landscaping, and to homes for people. Today the population of the area depends upon the season of the year. In summer it is between 1,500 and 1,800, but from October to May when the desert climate is comfortable, the population is between 7,000 and 8,000. Within the last 15 years it has become well known as a desert resort area with attendent recreational facilities, including golf courses and swimming pools, but also supports about 900 acres of lemon and grapefruit, about 250 acres of palm and related desert-specialty nursery stock, and about 320 acres of permanent pasture for livestock.

Over a 40-year-period the valley has changed from a thinly populated, remote and primitive desert, into an attractive resort and agricultural community. It has been accomplished by the pumpage of underlying groundwater. This water, subject to the limitations that first created a desert of the valley, has also been subject to changes and in some areas they are as dramatic as has been the transition from desert to farms and gardens.

3.0 HISTORICAL CHANGES IN THE GROUNDWATER AND RESUME

Well measurements made during the period 1952 to 1965 indicated that significant decline in water levels had occurred in the area north of Borrego Sink during that period (Moyle, 1968, page 10). Later in 1974 a contour map of the water table in Borrego Valley showed the decline to coincide with an area of extensive irrigation development. During the 12-year-period, in places, the decline was 30 to 40 feet. Further south it was from 20 to 44 feet, and in the vicinity of the old Ensign Ranch the decline was locally as much as 20 feet below the early period of water-level measurements (Moyle, 1974). Parallel to these changes and primarily in the area of agricultural development in the northern part of the valley, changes were also taking place in the chemical quality of the groundwater. In some wells in this area, total dissolved solids in the water more than doubled from 600 to 700 parts per million (ppm) to 1,200 to 1,500 ppm. The increase was accompanied by an increase in sodium and sulfate and by an alarming increase in nitrate, from 20 to 30 ppm to more than 200 ppm in places. These chemical changes were not going on in the more southern parts of the valley; the water remained suitable for domestic use in the vicinity of the Ensign Ranch and Borrego Sink, probably because the stress of pumping in these areas had not been sufficiently great to cause the nitrate-laden groundwater to migrate in these directions.

Today, 14 years after the first careful compilation of groundwater data had been completed, the author has revisited a number of the wells in Borrego Valley to remeasure water levels and to determine the amount of change in the groundwater since the previous studies. The results were meager, but interesting. About 40 wells were visited during the investigation at various localities throughout the central and northern part of the valley. Many of the irrigation and public water-supply wells were either abandoned and sealed, or enclosed by large turbine pumps and not constructed for water-level observation; the newer wells were in use and hence not suitable for measurements. However, water levels were measured in 10 wells, mainly used for domestic water supplies, for which previous observations had been made and in all these wells there was a decline in the water level over the earlier (1965) period of observation. As to be expected, the decline was not consistent from place to place. Ranging from an extreme of 28 feet for a well located near irrigated hayfields to about 6 feet at a U.S.G.S. observation well near the airport. The average annual decline over the 1965 to 1979 period was 0.7 foot and this decline is representative of the change in water levels that have occurred in the central part of the valley where most of the water used is for low-consumptive purposes.

Nitrates remain at dangerously high levels in the groundwater from the agricultural area at the north of the valley, and reportedly one or two of the public water-supply wells in the central part of the valley have been shut down or deepened to avoid the apparent migrating influence of nitrate.

Further south, nitrate in the groundwater of the Ensign Ranch and Borrego Sink areas has reportedly remained at low levels.

Both the decline in water levels and the adverse influence of nitrate in the groundwater are the result of pumpage in excess of groundwater recharge. In effect, a process that originated three decades ago, that of "mining" the underground reservoir for water, is still going on. The imbalance or depletion of the reservoir depends upon the method used for calculating groundwater inflow. One method derives an average annual inflow of 3,200 acre-feet from all measurable sources; a second method obtains about 9,500 acre-feet per year as an index to available recharge. Adjustments for error in both methods suggest that actual recharge may average 5,000 to 6,000 acre-feet per year.

Groundwater depletion has and will continue to have its greatest effect in the Borrego Valley groundwater reservoir north of San Felipe Creek where pumpage is localized. Greater use of the groundwater resource in this area will cause further depletion of a calculated available storage of about 565,000 acre-feet of water, unless a new source of water such as imported water is obtained for artificial recharge. Continued depletion will also be attendant to gradual chemical enrichment of the remaining groundwater as migratory routes are adjusted to lowered water tables and as new patterns of water usage are developed at the surface. Periodic basin wide and accurate measurements of water quality, pumpage, and water levels will clarify the relations discussed in this report.

4.0 CLIMATE AND STREAMFLOW

The climate in Borrego Valley is severely arid, abundant sunshine, little rainfall, little or no humidity with hot dry summers and cool dry winters; it is characteristic of the lowland desert regions of Southern California. It is also a climate where the extremes are highly noticeable. Diurnal changes in temperature exceeding 60° F are common summer and winter; severe rainfall originating from warm tropical storms in the summer are broadly cyclic in occurrence. They erode new steam channels in the mountains and create flood conditions over much of the valley.

It is an area where mean minimum temperatures in January are about 36° F but mean maximum temperatures in July are about 106° F;

the winters are comfortably cool, the summers uncomfortably hot. More importantly to its water supplies, it is also an area where potential evapo-transpiration far exceeds actual precipitation; the native vegetation is capable of using far more water than is supplied by precipitation and thus, it is an area of water deficiency (Piper, 1965, pp 3-5, pl. 2).

According to 20 years of record at Borrego Desert Park on the west side of the valley, the normal annual precipitation is about 8 inches and rainfall occurs mainly between November and March on the central and west side of the valley floor; in the mountains and elevated small valleys bordering the west side of Borrego Valley, temperatures are cooler and average annual precipitation is 16 inches or more, and perhaps very locally as high as 40 inches. The rocks in the mountains, mostly dense igneous and metamorphic types, are incapable of absorbing water readily and they are mantled only by a thin cover of soil; soil moisture from precipitation quickly returns to the dry atmosphere by evaporation and plant transpiration (evapo-transpiration), but in excess of these preemptive demands it combines to form streamflow. Very little water is stored as groundwater in the mountainous areas.

Precipitation that falls on the east side of the valley and over most of the valley floor is rarely believed to be sufficient to exceed the requirements for evapo-transpiration.

Surface water from perennial and intermittent streams enters the north end and west side of the valley. Coyote Creek at the north end of the valley and the only perennial steam in the area has a drainage area of 144 square miles. Streamflow past the mouth of the canyon where it enters the valley at the gaging station has been measured since 1950 and for the period 1950 to 1973 is unmodified by upstream diversions. Since 1973, an ungaged amount of water has been diverted above the gaging station to serve irrigation requirements in Borrego Valley. The annual discharge of Coyote Creek past the gaging station since 1963 is summarized as follows:

Calendar Year	Discharge (acre-feet)
1963	1,320
1964	1,100
1965	1,580
1966	1,190
1967	1,140
1968	888
1969	965
1970	1,110
1971	908
1972	980
1973	412
1974	1,110
1975	353
1976	448

Prior to 1973, the year at which diversions of streamflow were installed above the gaging station, the average annual discharge of Coyote Creek for 22 years of record was 1.99 cfs or 1,440 acre-foot per year.

Borrego Palm Creek on the northwest side of the valley is typical of the small desert drainage basins that contribute runoff to Borrego Valley; runoff occurs during the winter months and during periods of heavy unseasonal rain. Streamflow past the gaging station at the mouth of Borrego Palm Canyon originates from about 22 square miles of steep, rugged terrain; it is unhindered by diversions and it occurs primarily during the period December to May. The average discharge of Borrego Palm Creek for the 27-year-period 1950 to 1977 was 0.32 cfs or 232 acre-feet per year. The maximum discharge past the gaging station for the period 1955 to 1976 was 2,000 cfs and this was exceeded during a severe summer storm August 15, 1977 when maximum discharge was 2,160 cfs.

Henderson Canyon, Hellhole Canyon, and Culp Canyon, all desert-stream channels on the west side of Borrego Valley, also give rise to streamflow during periods of moderate-to-heavy rainfall. However, their combined drainage area is only about 28 square miles. They drain an environment similar to that for Borrego Palm Canyon and because of this the unit area runoff for these small basins is probably comparable to that for Borrego Palm Canyon. The annual discharge of all three of these ungaged drainage basins is probably no more than 250 acre-feet per year.

San Felipe Creek discharges into the southern and central part of Borrego Valley. Its drainage area above the mouth of its canyon covers about 180 square miles and tributaries of San Felipe Creek are all ephemeral except in a few places where they are fed by springs from the consolidated rocks or from shallow reservoirs of alluvium. Runoff from the upper one-half of the basin has been gaged in Sentenac Canyon since 1958 and at this station, surface water discharge occurs primarily during the months from mid-November to June; the average discharge for the period of record is 0.23 cfs or 167 acre-feet per year; whereas maximum discharge occurred August 22, 1927 and was 1,050 cfs.

The drainage basin of San Felipe Creek below the Sentenac gaging station is somewhere lower in average altitude than is the gaged portion above the canyon and hence, the lower portion probably receives less overall precipitation. An estimate of runoff based upon decreasing increments of evapo-transpiration and upon increasing increments of precipitation with greater altitude indicates that the lower basin probably contributes between 120 to 140 acre-feet per year to streamflow into Borrego Valley. It is believed that an average of about 300 acre-feet per year are contributed to Borrego Valley from San Felipe Creek.

The streams are the most important features in Borrego Valley with regard to its long-term water supply. Probably as much as 80 to 90 percent of their average annual flow enters the alluvium at the mouths of the canyons and reaches the groundwater reservoir beneath Borrego Valley. The extremes in streamflow - the occasional flood - add a valuable increment of water to the area, and this is reflected locally by the recovery (rise) of water levels in wells near and upon the alluvial fans on the west side of Borrego Valley following one of these short periods of heavy rainfall.

5.0 GEOLOGY AND WATER-BEARING PROPERTIES OF THE ROCKS

The rocks that occur in the mountains surrounding Borrego Valley and the sediments that underlie the valley present distinctly different geologic influences upon the area's water supplies. The rocks in the Peninsular Range on the western side of the valley are, for the most part, crystalline or they are highly compressed so that their porosity is very low. Although they are fractured and in places mantled by a thin veneer of alluvium, they are nearly impermeable and retain only small ephemeral amounts of groundwater. These properties are important because these mountains receive most of the precipitation that falls in the area.

The rocks are also transected by a major northwesterly trending fault (Caliente fault zone) and by several subparallel faults. The zones of fractured and sheared rock associated with them have had an influence upon the development of local landscape features in the Peninsular Range, but their influence upon the occurrence of groundwater in Borrego Valley is negligible.

The rocks on the eastern side of the valley include crystalline igneous rocks and metamorphosed limestone underlying Crystal Mountain, a large area of consolidated siltstone, sandstone, and clay southeast of Coyote Mountain and much younger deposits, the unconsolidated alluvium that blanket these latter deposits in many places. The deposits of siltstone, sandstone, and clay underlie deposits of alluvium beneath much of Borrego Valley, whereas the deposits of alluvium that cover these older sediments in Borrego Valley also extend into a smaller adjacent valley, Clark Valley, lying to the northeast of the central part of Borrego Valley. The northwesterly trending Coyote Canyon Creek fault transects all of these rocks and erosion and deplacement along this fault has controlled the development and trend of Coyote Creek and Coyote Canyon and to a large degree the northeastern boundary of the Borrego Valley groundwater reservoir. Displacement along this fault has been sufficient to interfere with the movement of groundwater between Clark and Borrego Valleys, but the degree of interference is not known.

In the mountains, precipitation is temporarily stored in alluvium; it evaporates and it is used by plants and, if it is sufficient to satisfy these requirements, it quickly gathers as streamflow and it eventually reaches the floor of the Borrego valley. The sharp fluctuations in streamflow in response to rainfall as measured at the gaging station in Borrego Palm Canyon, reflects the temporary absorptive influence that rocks in the mountains have upon the storage of precipitation during periods of heavy rainfall.*

SELECTED PERIODS OF STREAMFLOW
BORREGO PALM CREEK

Year	Period	Daily Discharge (cfs)
1977	August 13	0.0
	14	0.0
	15	89.0*
	16	3.1*
	17	45.0*
	18	4.1*
	19	0.32*
	20	0.01
	21	0.0
1970	December 20	0.0
	21	.25
	22	.96
	23	.26
	24	.04
	25	0.0

*This runoff accompanied the heavy tropical rain that seriously damaged and flooded parts of the desert regions in San Diego County in August, 1977.

The alluvium that underlies Borrego Valley has originated by erosion of rocks in the nearby mountainous areas; it is porous and permeable sand and gravel, particularly so near the mountains and opposite the mouths of canyons where it has been winnowed and sorted by streamflow and deposited as broad alluvial fans. Farther from the mountains in lower and more planar parts of the valley, the underlying sediments are less permeable, fine-grained sand, silt, and clay. The specific capacity of wells in Borrego Valley reflect the general physical and water-bearing properties of the sediments. In the northern and most western parts of the valley, specific capacities for most of the wells is between 40 to greater than 100 gallons of yield per foot of drawdown. In the central and planar parts of the valley near Borrego Sink, the specific capacity of wells is about 30 gallons yield or even much less. The geologic logs of wells in various parts of the valley (Moyle, 1968, pp D1 to D40) also indicate that the water-bearing strata underlying the valley are highly lenticular. In general, between adjacent wells, the deposits are uniform in their heterogeneity; extractions of water in one area will reflect upon water levels in nearby areas. Also, large extractions or additions of water over extended periods of time will be reflected by the lowering or raising of water levels in large parts of Borrego Valley.

6.0 GROUNDWATER IN THE ALLUVIUM

There are two procedures used for estimating the amount of available water in a groundwater reservoir. The first is a direct computation of the volume of available water in storage from the area covered by water-bearing sediments, the thickness of the sediments, and their porosity and specific yield.* The second method, the inflow-outflow method, uses the fact that under natural conditions and prior to the drilling of wells, a groundwater reservoir is in hydrologic balance because over a period of years the amount of water entering the reservoir will equal the amount leaving it.

For a developed groundwater reservoir such as Borrego Valley, the inflow-outflow method provides an assessment of the items in depletion or surplus in the water supply; whereas, the volumetric method provides guidance in evaluating changes in water level in a reservoir in terms of water added to or extracted from the reservoir. Both methods are subject to considerable latitude in interpretation.

6.1 VOLUMETRIC ESTIMATES OF AVAILABLE GROUNDWATER IN STORAGE

A groundwater reservoir the size of that underlying Borrego Valley, some 84 square miles, contains a large quantity of water in storage. It is therefore useful to determine the amount in storage, for it serves as a buffer in times of drought and in times when annual overdraft inadvertently exceeds the annual replenishment. The estimate of the amount of groundwater in storage makes many assumptions, for not only do the water-bearing properties of the sediments differ from place to place, but also the dynamic conditions

*The specific yield of a rock or soil is the ratio of (1) the volume of water, which after being saturated, it will yield by gravity to (2) its own volume.

in the aquifers differ; in places, the groundwater is unconfined and under water-table conditions; in others, it is semi-confined and under artesian pressure.

Subsurface data coming from well tests and geologic logs provide a good description of the water-bearing materials in a number of widely scattered parts of the valley (Moyle, 1968), but there is little information concerning the dynamic behavior of groundwater in the aquifers. However, using the available geologic data in a manner analogous to methods employed in designing a hydrologic model of a groundwater basin and assuming that water-table conditions prevail at least in the upper 100 feet of saturated sediments, it is then possible to compartmentalize the valley into areas of similar water-bearing properties and yield. For example, in the north end and along the west side of the valley where most of the large production wells have been drilled, water-bearing materials have a high permeability, probably between 10^3 and 10^4 gallons per day per foot, their porosity is moderate, probably about 25 percent, and judging from the specific capacity of more than 20 wells in this area (Moyle, 1969, pp E2-E9), the specific yield of the sediments is high, possibly as great as 25 percent. The area underlain by these kinds of water-bearing materials is about 42 square miles.

The central part of the valley, the area underlying Borrego Sink, the airport, and as far north as Oliver Ranch contains the least productive wells and here water-bearing materials are, for the most part, fine-grained sand interbedded with much thicker deposits of clay. These deposits have a correspondingly low overall permeability, probably on the order of 10 gallons per day per foot. Although their porosity is high, probably as great as 25 or 30 percent, the low specific capacity of the wells indicates that the specific yield of the sediments is low, probably no greater than 12 percent or less. About 12 square miles of Borrego Valley is underlain by these deposits. The remainder of the valley, about 30 square miles, is underlain by materials with overall water-bearing properties intermediate between these two extremes.

An additional source of water than simple gravity drainage is that which originates from compaction of the sediments.
For the purpose of calculation, it is assumed that subsidence under a theoretical basin-wide water level decline of 100 feet will be no more than 3 feet. It will take place in an area with a diameter of about 6 miles and this will be localized in the area where the sediments are mostly silt, fine sand, and clay and it will diminish to insignificant amounts where the sediments are mostly coarse sand and gravel. In other words, compaction of the sediments - the cause of subsidence - with an average porosity of 0.25, will yield water as a "one-shot deal," equal in amount to that occupying a shallow inverted cone with a maximum depth of 0.75 foot and a radius of 3 miles. The amount is about 4,500 acre-feet of recoverable storage for each 100 feet of water level decline in the Borrego Valley.

Using these assumptions, then it is possible to calculate the volume of water that must be extracted from the basin to effect a uniform lowering of 100 feet in the water table. The yield for a layer of sediment 1-foot-thick and 100-feet-thick is summarized as follows:

Area	Acres	Porosity	Specific Yield	Yield (acre-feet)
1 (margins)	26,880	0.25	0.25	1,680
2 (midsections)	19,200	0.25	0.17	816
3 (central)	7,680	0.30	0.12	277
Totals	68,480			2,773
				x 100
				277,300
			Yield By Compaction	4,500
				281,800

It is important to realize that this amount of water is available only under theoretical circumstances. In practice, the water table is a dimpled surface depending upon the number and location of wells as well as the amount of pumpage and water-bearing properties of the sediments. Costly or harmful groundwater conditions can develop, therefore, in some parts of a groundwater reservoir before they occur to other parts of the reservoir, and before this or greater amounts of idealized recoverable water are used. It is also to be noted that a previous estimate places the amount of recoverable water in storage in the first 200 feet of saturated alluvium as 1,000,000 acre-feet (California Department of Water Resources, 1975). This amount is more than double the amount estimated by the writer. No doubt both calculations are in error and will be adjusted as water management becomes a more urgent responsibility in the Borrego Valley and more information becomes available.

6.1.1 Inflow-Outflow Estimate

Inflow: The infiltration of precipitation falling on the valley floor and streamflow and associated underflow entering the valley are the primary sources of groundwater recharge in the Borrego Valley. The infiltration of precipitation is a consequence of the duration, intensity, and amount of precipitation that occurs during storms that envelope the floor of the valley and hence, the amount will differ from time to time. However, in valley areas of the desert southwest where elevations are low and where average annual precipitation is less than 10 inches, experience has shown that no more than one percent of the average annual precipitation moves downward and beyond the influence of evapotranspiration and becomes groundwater recharge (Heindl, 1965, P. 14). Thus, for the Borrego Valley with an area of about 85 square miles or 55,000 acres, an average altitude of about 700 feet above sea level and an average annual precipitation of about 7 inches, probably no more than about 320 acre-feet of water reaches the water table each year from precipitation that falls directly on the valley floor. This figure for recharge from direct precipitation on the valley is believed to be conservative.

A more generous source of recharge to the groundwater reservoir than direct precipitation comes by the infiltration of streamflow. Although some of this recharge is hidden from sight, for it enters the reservoir via the alluvium beneath the stream (underflow), much of it is measurable as streamflow. As it leaves the canyons, and within a short distance, it percolates into the permeable sand and gravel that underlies alluvial slopes of the valley and from here it disperses widely into the groundwater reservoir. Details of the discharge for Coyote Creek and Borrego Palm Creek are provided in the section of this report on climate and streamflow; the average unmodified discharge for Coyote Creek for 22 years of record (1951 to 1973) is 1,440 acre-feet per year; the average discharge for Borrego Palm Canyon for 27 years of record is 232 acre-feet; and the estimated annual average discharge for San Felipe Creek is 300 acre-feet per year. Other small drainage basins on the west side of the Borrego Valley have geologic and topographic characteristics similar to the Borrego Palm Canyon drainage basin, but their topographic relief and individual catchment areas are much less. It is unlikely that their total average discharge exceeds that for Borrego Palm Canyon; probably no more than 250 to 300 acre-feet of runoff per year originate in those small drainage basins. On the east side of the Borrego Valley, the western slopes of Coyote Mountain, Clay Hills and Borrego Mountain probably provide some runoff to the valley, but it occurs only during the rare heavy storm and it probably does not have a significant influence on groundwater underlying Borrego Valley.

Average annual runoff into the valley from the various streams itemized above is believed to be no less than 2,222 acre-feet per year and probably no more than 2,500 acre-feet per year, and of this water, probably as much as 2,200 acre-feet enters the groundwater reservoir as natural recharge each year.

Other sources of recharge to Borrego Valley include underflow through alluvium underlying each of the streams as well as water which may enter the sediments from deeply buried sources. As for the first item, underflow, the amount entering the valley depends upon the wetted cross-sectional area of alluvium beneath each stream, the transmissivity of the alluvium, and the hydraulic gradient. The alluvium underlying Coyote Canyon is probably the only significant perennial supply of underflow to the valley; underflow from the other canyons is probably ephemeral in somewhat the same pattern as is discharge from the ephemeral streams that occupy the canyons. The material underlying each channel is more than likely highly permeable sand and gravel. The wetted cross-sectional area for Coyote Creek is roughly triangular, 150 to 200 feet wide, and probably no more than 150 feet deep and the water-table gradient is about 100 feet per mile; therefore, using the formula Q=TIW where Q is underflow in gallons per day; T is the coefficient of transmissivity (permeability times thickness); I is the hydraulic gradient in feet per mile above the gaging station and W is the average width of the saturated alluviated section in miles; the underflow is calculated to be about 300,000 gallons per day or about 350 acre-feet per year. Using similar reasonable estimates for the cross-sectional area, the lithologic composition and the hydraulic gradient for subsurface conditions in other canyons that enter the west side of the Borrego Valley, it is estimated that probably no more than 600 acre-feet of water enters the Borrego Valley as underflow in the alluvium under average conditions of steam discharge each year.

Summarized below are the natural sources of groundwater in flow (recharge), the estimated average quantity for each source, and the estimated total in acre-feet per year for the Borrego Valley.

Infiltration from precipitation on the valley floor	320+
Infiltration from streamflow entering the valley	2,200
Underflow from alluviated canyons	600+
Upward percolation from deeply buried sources	Unknown
Total	3,200+

Another method of estimating potential groundwater recharge from mountain basins in Southern California has been described by Crippen (1965) for areas where streamflow data are not adequate. Application of this indirect method uses increments of rainfall and potential evapotranspiration corresponding to various altitudes in the drainage basin as an index to recoverable water. This and similar techniques designed for hydrologic studies in the lower basin of the Colorado River (Hely and Pecke, 1964) yield estimates of water available for recharge to the Borrego Valley of between 9,000 and 10,000 acre-feet per year. Both of these methods for analysis have been used as carefully as possible and they both have value in the determinations of water supplies for Southern California. For the Borrego Valley, however, the imbalance between the two methods of calculation is a large amount in acre-feet of water, and in terms of the valleys' water supply the amount is serious.

Errors inherent in the streamflow method include unknown and "extra" amounts of water that originate from ungaged drainage basins, uncalculated quantities that enter as underflow, and uncalculated quantities that occur by direct infiltration on the valley floor. The function of torrential rains is a serious element of uncertainty in the calculations of the hydrologic budget for the area. The method proposed by Crippen also has its uncertainties. Most of the data used in calculations for this method originate from streamflow records and climate records located on western slopes of the San Gabriel Mountains and on western slopes of the Peninsular Ranges, where values for precipitation and potential evapo-transpiration are quite unlike those that prevail on the easterly desert-facing slopes of these same ranges. A further uncertainty in the method, like all attempts to generalize, lies in the scarcity of representative data in the solution of local problems. Greater information is needed on rainfall, soil moisture, evapo-transpiration, and stream runoff at various altitudes and in various geologic settings in the desert, before this method can be used with confidence in the Borrego Valley area. It seems to the author of this report that a value for groundwater inflow to the Borrego Valley arising as runoff from the mountainous areas of the Peninsular Ranges probably lies somewhere between the two figures proposed as the result of this and other studies in the area, and that it would be prudent to use a conservative estimate of groundwater recharge in support of future water management for Borrego Valley.

Outflow: Outflow or discharge of groundwater from the Borrego Valley is by several means, each of which can be analyzed in a manner similar to the methods used for inflow. One of the important means of discharge is by lateral migration in the subsurface, and the geohydrologic map of Southern California (Moyle, 1974) indicates that groundwater movement easterly from the valley is hindered by the Coyote Canyon fault; its movement westerly is prevented by the crystalline rocks of the Peninsular Range, and its movement south toward Ocotillo Wells is the most obvious means of escape. However, movement in this direction from the northern part of the Borrego Valley is impeded, if not prevented, by a groundwater mound built up opposite the mouth of San Felipe Creek and lying athwart of the valley (see Figure 1). If groundwater escapes from the northern and central part of the Borrego Valley by subsurface migration and moves toward Ocotillo Wells, it does so by deep patterns of circulation not shown by the water level contours and it does so in such small quantities as to support only meager amounts of phreatophyte vegetation. Most of the water moving toward Ocotillo Wells is believed to originate by infiltration from San Felipe Creek in its reach across the valley.

There is a constant loss of groundwater from the valley as the result of transpiration by native vegetation. This loss is localized in areas where the capillary fringe above the water table is within the root zone of desert plants; hence, the loss by transpiration is dependent upon the species of plants. Willow, salt cedar, and palm are localized in Coyote Canyon and in small areas in Borrego Palm

Canyon and elsewhere in the vicinity of small springs in the Peninsular Range, but their total extent does not exceed about 30 or 40 acres. Water use by these plants is probably no more than 3 to 4 acre-feet of water per acre per year or about 90 to 120 acre-feet per year.

Other types of nonbeneficial vegetation that send their roots to the capillary fringe also occur in the valley. Tamarix (salt cedar) has been used extensively as windbreak, it is also in rare association with scattered clumps of mesquite and creosote bush surrounding Borrego Sink. Salt cedar and mesquite are both believed to extend their roots to great depths and they are therefore capable of transpiring groundwater from the capillary fringe and above the water table in parts of the Borrego Valley. In the aggregate, they probably cover about 200 acres where the water table is less than 40 feet below land surface, principally around the periphery of the Borrego Sink. The amount of water used by this type of vegetation is in the range of 3 to 4 acre-feet per year, and in the Borrego Valley transpiration from this community is probably about 600 acre-feet per year.

The greatest amount of groundwater is withdrawn from the Borrego Valley for the benefit of homes and agriculture. Irrigation wells are located chiefly in the central and north end of the valley and several large wells are used for public water supply to homes and small businesses located along the west side and in the central part of the valley. About 30 large turbine-pump-equipped wells have been used for irrigation or public water supply purposes, but of that number probably no more than eight or ten are now operating at any one time. The irrigation wells probably operate continuously during the summer and intermittently during the winter; those used for public water supplies operate intermittently, more so in the summer when the population is low, than in the winter when the population is greater. Wells servicing individual homes and small business establishments are scattered throughout the central part of the valley; most of these wells are connected to pressure tanks and most supply water to homes occupied by full-time residents in the valley. There are about 50 domestic wells in the valley and between 30 to 40 of these are believed to be in constant use.

For various reasons, it was not possible to determine the actual amount of water pumped from the valley. However, it is possible to estimate this quantity within a reasonable degree of accuracy by assessing the various purposes for which water is used according to (against) consumption use figures obtained from many years of water-management studies in the nearby Imperial and Coachella Valley areas (U.S. Soil Conservation Service, Indio, and El Centro, California). Acreages in the Borrego Valley devoted to various agricultural uses were estimated by field inspections and road traverses in the valley during June 1979, as was the number of wells used for irrigation; population of the valley, a highly seasonal variable, was provided by the Borrego Valley Chamber of Commerce. An estimate of the water furnished by wells to support agriculture is summarized on the following table.

TABLE_____

ESTIMATED USE OF GROUNDWATER FOR VARIOUS PURPOSES IN BORREGO VALLEY 1978 - 1979

Purpose

Irrigation

Crop	Method of Irrigation	Application Efficiency*	Consumptive Use	Adjusted Consumptive Use	Acreage	Annual Use (Acre-Feet)
Citrus	Drip and row	90	7	7.5	900	6,750
Palm (Nursery)	Drip and row	90	7-8	7.5	250	1,875
Permanent Pasture	Sprinkle	70	5.5	8	320	2,560
Golf Course	Sprinkle	35	5	14	200	2,800
Total						13,985

Home and Garden Unit	No. of Persons	Population (Summer)	Population (Winter)	Usage/Unit.	Annual Use (Acre-Feet)
Home	2	1,500	8,000	200 gpd	585
Overall Total					14,570

*Sandy loam soils, Coachella and Imperial Valleys.

Most of the water applied to the land for irrigation is consumed by plants to satisfy their growth requirements. However, a part of the water escapes the plants and is lost directly to evaporation or percolates downward and reaches the water table. This amount represented by the application efficiency differs for each method of irrigation and depends upon the permeability of the soil and climate. Judging from the established application efficiencies for crops in the Imperial and Coachella Valleys, and assuming that climate and soil conditions are similar for the Borrego Valley, it seems reasonable to assume that between 2,500 and 3,500 acre-feet of applied water is divided between evaporation and infiltration, and it is either returned to the atmosphere or eventually reaches the water table and becomes available for recycling back to the surface by pumpage. An arbitrary amount of 1,500 acre-feet is assigned to groundwater recharge by irrigation.

Summarized below are the methods of groundwater outflow (discharge), the estimated quantity for each method, and the estimated total in acre-feet for the Borrego Valley.

Transpiration (native vegetation)	600 acre-feet
Pumpage	
Consumptive use (irrigation, etc.)	13,985 acre-feet
(domestic use)	585 acre-feet
Underflow leaving the valley	Unknown
Subtotal	14,570 acre-feet
Less return seepage from applied irrigation	-1,500 acre-feet
	13,070 acre-feet
Less return seepage from domestic use	-300 acre-feet
Total	12,770 acre-feet

6.1.2 Summary of Inflow-Outflow Calculations

Inflow to the basin has been calculated from average annual runoff data measured at three stream-gaging stations in the Borrego Valley watershed from precipitation records for the valley, and from geologic and groundwater calculations for stream-channel underflow.

Two of the stream-gaging stations, Coyote Canyon and Borrego Palm Canyon, record discharge at or very near the point at which most of the runoff from their respective watersheds enter Borrego Valley. The third station measures runoff from the uplands and here reflects runoff conditions in the area of relatively high precipitation. The records of discharge at the Borrego Palm Canyon station reflect the nature and amount of runoff to be expected from ungaged, smaller basin watershed areas, on the west side of the Borrego Valley. Streamflow to the eastern side of the valley is insignificant to the inventory. The estimate for average annual underflow entering the valley is believed to be within the realm of permissive speculation as is the estimate for average annual recharge from direct precipitation on the valley floor. There are no disguised sources of water to the Borrego Valley from which supplies of groundwater can be derived, except contributions which may come from the unseasonal ungaged downpour associated with the occasional tropical storm, and by buried and undetected percolation such as Clark Valley.

The outflow from the groundwater reservoir, both natural and man induced, is based chiefly upon analogy with the results of studies and groundwater research during the last 50 or 60 years in the desert southwest. It seems quite certain that the amount of water extracted from the Borrego Valley groundwater reservoir each year, during the period 1954 to 1965, had annually exceeded the amount replenished by several fold; pumpage was largely for agricultural use (Bureau of Reclamation, 1969). The consequence was an annual lowering of the water table, greater in some areas than others, but still sufficient to reflect a decline of several feet per year over this period of development. During this period, an average of 22,400 acre-feet per year were being applied to about 2,500 acres of agriculture. Today it would appear that less than this amount of water, probably only one-half, is being used for mixed agriculture (golf courses included).

6.2 CHEMICAL QUALITY OF GROUNDWATER IN ALLUVIUM

The chemical quality of the groundwater is summarized by almost 200 complete and partial analyses of water collected from wells throughout the valley, mostly during the period 1952 to 1965 (Moyle, 1968, pp C1-C6). In the northern part of the valley opposite the mouth of Coyote Canyon, the groundwater is a calcium sulfate, bicarbonate type, with about 1-part per million (ppm) flouride, 3- to 5-ppm nitrate, and 670- to 725-ppm total dissolved solids. Further north in the valley, in the vicinity of most of the irrigated acreage, appreciable changes in the chemical composition of the water took place during the period from 1952 to 1965. In 1952, the groundwater from the area of irrigated land was like that nearer the mouth of Coyote Canyon. However, by 1965, the water was an interesting and complex combination of all the major cations and anions; it contained an unusual concentration of magnesium, and in most places, it contained greater than 100 ppm nitrate; the dissolved solids concentration exceeded 1,000 ppm in most places. It is interesting to compare the chemical character of this water from the northern end of the valley, with water collected from wells along the west side of the valley. In contrast to the complex composition of water in the north, with its high concentration of magnesium and nitrate, the water from along the west side of the valley, including the state park headquarters, the Ensign Ranch, and as far east as Desert Lodge, is a relatively dilute calcium or sodium-bicarbonate solution with smaller amounts of sulfate. Nitrate concentrations in the water are ordinarily less than 5 ppm and total dissolved solids concentration is between 300 and 400 ppm or less. Flouride is a characteristic constituent in those waters, but its concentration is less than 1 ppm. This water is of somewhat different chemical composition, and it is more dilute in total dissolved solids than that from directly below Coyote Canyon in the northern part of the valley. It has probably mostly originated as runoff from the ephemeral streams in the nearby Peninsular Ranges a short distance to the west.

No water samples were collected for chemical analysis during the brief period allotted to field work; however, it was interesting to learn from horticulturalists in the palm and desert plant nurseries in the agricultural area in the northern part of the valley, that the underlying groundwater used for irrigation was sufficiently concentrated in nitrate as to obviate the use of nitrate fertilizer on their nursery stock. Drinking water is obtained by reverse osmosis from the well water used by the ranches in this area. It was also reported that further south, several wells had been abandoned as a source of domestic water because of increasing amounts of nitrate in the water. All wells in Sections 4 and 9, T. 11 S., R. 6 E., provide water with less than 8-ppm nitrate, but these water supplies should be monitored at six-month intervals to detect possible lateral migration of nitrate away from the area of nitrate enrichment in the northern part of the valley.

6.3 CURRENT PATTERNS OF PUMPAGE AND EFFECTS

The heaviest pumpage in Borrego Valley takes place in the areas of irrigated acreage in the northern part of the valley and north of the east-west Palm Canyon Drive across the valley. This area contains large diameter irrigation wells used for the maintenance of citrus, nursery stock of palms, etc., hayfields, and a 9-hole and 18-hole golf course with landscaping and nearby gardens. The irrigation wells, although somewhat scattered, lie across the valley from the De Anza Country Club at the base of the Peninsular Range on the west side of the valley, to the Coyote Canyon Fault, on the east side. They are in position to intercept groundwater recharge coming from Coyote Creek Canyon, Hellhole Canyon, Borrego Palm Canyon, and Henderson Canyon on the west and from Coyote Mountain on the east. It was in this area that the decline in water level during the 1954 to 1965 period was most serious.

In June, 1965, depth-to-water measurements were successfully made in only two wells in the area. They were not sufficient to determine whether water levels were declining as the result of the current patterns of pumpage or had, in fact, stabilized or even recovered as reported by the Borrego Springs Water District. The water level in one well in June, 1979, 28 D1 (N.W. 1/4, N.W. 1/4, Sec. 28, T. 10 S., R. 6 E.), an unused Di Giorgio irrigation well was 8.7 feet above the water level measured in July, 1965. The only other well in which the depth to water could be measured in the northern part of the valley was 29 N1 (S.W. 1/4, S.W. 1/4, Sec. 29, T. 10 S., R. 6 E.). The water level in this well, an idle irrigation well, was 28.2 feet below a measurement made in July, 1965. Reportedly, the Borrego Springs Water Company well in the southwest 1/4 of Section 18, T. 10 S., R. 16 E. and near the outlet of Henderson Canyon, has not shown any decline despite its almost continuous usage as a source of domestic water (L. R. Burzell, personal communication, May, 1979).

Water levels were also measured in wells in the central part of the valley south of Palm Canyon Drive and in the vicinity of the Borrego Park Development area. The area is believed to receive groundwater recharge from the northern part of the valley and from the west side as far south as Culp Canyon, and wells in the area have penetrated water-bearing sediments to a depth of 600 feet. Most of the wells in the area yield no more than 1 or 2 acre-feet per year, primarily for domestic use, but Well 4M (N.W. 1/4, S.W. 1/4, Sec. 4, T. 11 S., R 6 E.) furnished about 25 acre-feet of water for the community of Club Circle and another Well 3D3 (N.W. 1/4, N.W. 1/4, Sec. 3, T. 11 S., R. 6 E.) has consistently provided water to the community school.

Fluctuations in water level in this area occur throughout the year as the result of natural influences, and they also occur as the result of pumpage from nearby wells.

Ordinarily, if water levels in wells are measured at the same time, the influence of natural events follows a similar annual pattern in each well. In addition, departures from the previous year's measurement if above, would indicate recharge or replenishment of the reservoir; if below, the previous year's measurement would indicate discharge or depletion of the underground reservoir. Water levels in nine idle wells about equally spaced and distributed over most of the central part of the valley were measured in June, 1979 (see Figure 1). The water level in each of the wells was below the water level measured at nearly the same time of year in 1965. The decline in water level in the various wells ranged from 4.6 feet to 17.13 feet and the average annual decline in water level was 0.7 foot (see Table_____). It is of further interest to note that during the 1953 to 1966 period when pumpage had created serious declines in water level in the northern part of the valley, that wells in the southern area underwent declines in water level from 10 to 43 feet during the period, and that the average decline in water level was 1.75 feet per year or more than double the rate that has occurred since that time.

The decline in water levels in the central part of the valley is believed to represent a general trend in depletion that has been established by pumpage in excess of groundwater replenishment. It may be the result of pumpage in the northern part of the valley, from individual wells in the south or a combination of these two influences. The change in the rate of decline is also difficult to clearly assess. Diminished irrigation and pumpage in the north is

TABLE____

MEASURED WATER LEVELS IN WELLS
BORREGO VALLEY, JUNE 20-27, 1979

Location and Number	Owner	Use	Date	Water Level Below Land Surface (feet)	Recovery (+) or Decline (-) Since 1965
T. 10 S., R 6 E., 16 D1	Di Georgio Well Co.	Idle	July 1965 June 1979	-163.1 -154.4	+8.7
T. 10 S., R 6 E., 29 N1	Pecoff Brothers	Idle 1	July 1965 June 1979	-133.83 -162.01	-28.2
T. 10 S., R. 6 E., 32 R1	Borrego Springs Water Co. No. 1	Idle	July 1965 May 1979	-240 -119 (Reported)	+35.4
T. 10 S., R. 6 E., 34 D1	--	D	Aug. 1965 June 1979	-78.74 -90.15	-11.41
T. 10 S., R. 6 E., 36 Q1	U.S.G.S. Observation Well	O	Aug. 1966 June 1979	-65.73 -70.20	-4.47
T. 11 S., R 6 E., [illegible] N4	U.S.G.S. Observation Well	O	Aug. 1965 Apr. 1979	-40.13 -52.30	-12.12
T. 11 S., R 6 E., 4 A2	Ward Hutton	D	Aug. 1965 June 1979	-63.44 -74.05	-10.6
T. 11 S., R 6 E., 4 M1	Borrego Springs Park	A	Aug. 1965 June 1979	-89.61 -92.00	-2.4
T. 11 S., R 6 E., 10 N1	Borrego Village Resort	D (Idle)	Aug. 1965 June 1979	-68.81 -73.40	-4.6
T. 11 S., R 6 E., 14 D3	A-1 Lodge	D (Idle)	Aug. 1965 June 1979	-32.29 -42.65	-10.36
T. 11 S., R. 6 E., 15 G1	State Highway Maintenance	D	Aug. 1965 June 1979	-45.00 -62.13	-17.13

probably the greatest change that has taken place in water use since 1965, and if this is true, then it is possible that this change is reflected by the diminished rate of decline in the central part of the valley. However, systematic measurements of water levels and pumping rates over long periods of time are necessary before these and similar changes can be properly evaluated.

6.4 RECOVERY OF GROUNDWATER BY PUMPAGE BORREGO SPRINGS PARK AREA

The Borrego Springs Park area is in the west-central part of Borrego Valley about 1-1/2 miles east of the base of the Peninsula Range. It is underlain by water-bearing sediments, interbedded clay and sand with lesser amounts of gravel, to a depth in excess of 600 feet.

Groundwater recharge to the area originates largely by infiltration into alluvial fans below the mouths of Tubb, Culp, and Henderson Canyons. Recharge from these canyons is therefore ephemeral and on the average not great, probably no more than 300 to 400 acre-feet per year. Unpredictable heavy rains occur in the area and probably help to replenish the groundwater reservoir, but their occurrence, although broadly cyclical, is unpredictable. Other sources of groundwater are in the northern part of the valley, but much of the recharge from this direction is intercepted by wells before it reaches the Borrego Springs Park area.

Groundwater discharge is by the pumpage from wells and the area has had a long history of groundwater development. The first well in the valley was drilled for the Ensign Ranch, now the Borrego Springs Park area, in 1913, and later in 1926 the first irrigation well in the valley was drilled on the same ranch. The park area, Sections 4 and 9, T. 11 S., R. 6 E., and the adjoining section of land to the north and east have been explored by almost 45 wells ranging in depth from 120 to 600 feet. Currently, groundwater discharge is taking place at no more than ten of these wells, seven of which are used for domestic purposes, and three for public water supply, one to the Roadrunner Club, one to the Club Circle area, and one to the public school. It is estimated that no more than 100 acre-feet of water is withdrawn from the underlying groundwater reservoir each year and that 70 or 80 acre-feet is withdrawn by the public water-supply wells. A small amount of this discharge, probably no more than 20 acre-feet per year, is returned to the reservoir by infiltration to the water table and it is later recycled back to the surface by pumpage.

The larger wells have reportedly sustained discharge rates of between 400 and 900 gallons per minute for several days' time and it would appear, therefore, with careful construction and development, that other large-capacity wells could be drilled in the area. However, the pumpage from such wells will cause the water level in the groundwater reservoir to decline, more so near the pumping well than at greater distance from the well. In all probability, it will also increase the annual rate of storage depletion (0.7 foot) in the central part of the Borrego Valley groundwater reservoir. The seriousness of these influences upon local areas in the groundwater reservoir and upon the reservoir at large cannot be calculated without pump tests of the aquifer and without systematic records of discharge and water levels in observation wells in Borrego Valley.

To avoid the interference effects between wells and to obtain the benefits of recharge from Tubb and Culp Canyons, it would be best if new wells in the Borrego Park area were placed near the southwest corner of Section 9 as far from other wells as possible.

6.5 ESTIMATED SAFE YIELD, BORREGO SPRINGS PARK AREA.

If no water is imported to Borrego Valley, water use must be maintained at a balance such that recharge and discharge are equal over the long term. Departures from this balance in the direction of water depletion can be tolerated, but only so much as can be remedied by periods of water surplus. Safe yield in the Borrego Park area is therefore dependent upon rates of recharge, rates of pumpage, rates of chemical enrichment, and rates of groundwater movement that occur locally as well as regionally in the valley and its tributaries.

It has been shown that average annual recharge as calculated from average annual precipitation and streamflow records is 3,200 acre-feet, and possibly more. Recharge based upon the most reliable of other methods is about 9,000 acre-feet; the difference of 5,800 feet is puzzling but not unexpected, for both methods of calculation have possibility in error. Actual recharge is within the realm of these two extremes and probably no more than 6,000 acre-feet per year.

Discharge from the valley calculated from consumptive demands for water by agriculture and people and extrapolated from nearby desert areas could be as great as 12,700 acre-feet per year. However, it could be less depending upon the extent of advanced irrigation techniques used in the valley, probably as little as 11,000 acre-feet per year.

The effects of overpumpage have been measured valley wide for the period 1953 to 1965 and they are represented by declines in water level as much as 40 feet in places. Since that time, in the Borrego Park area, the average annual decline has diminished from 1.7 to 0.7 feet. The amount of overpumpage believed to be about 5,000 acre-feet per year or more, represents the annual deficit that will be incurred if additional water is not forthcoming and present-day conditions of consumptive use continue in the valley. Pumping an additional 1,500 to 2,000 gpm from one or two wells in the Borrego Park area will cause water levels to further decline in the central part of Borrego Valley. In effect, the project will be additionally "mining" the underground reservoir for water, a process that originated more than three decades ago and is apparently still going on.

A further consideration upon the safe yield of the groundwater reservoir in the valley is the occurrence and migration of nitrate-enriched groundwater into areas of heavy pumpage. Nitrate-enriched groundwater is being pumped from wells in the areas of irrigated acreage and reportedly, in recent years, nitrate has become a problem in some of the wells south of the irrigated acreage of land. The general trend of groundwater movement is southerly and southeasterly toward Borrego Sink, and under the influence of increased water withdrawals in Borrego Park area; thus, southward movement could be accelerated. However, the rate of nitrate migration and the degree to which it has entered various aquifers north of Borrego Park area is not known. It could require many years of pumpage in Borrego Park area before it would appear in the groundwater from wells in the area.

Until the major uncertainties can be eliminated from the report, there is little purpose in forecasting the influence of usage or long-term safe yield for Borrego Valley.

6.6 ARTIFICIAL RECHARGE IN BORREGO VALLEY

Artificial recharge of floodwater is both feasible and desirable in Borrego Valley. The alluvial fans below the mouths of the several canyons on the west side of Borrego Valley offer excellent properties for the dispersion and infiltration of floodwater by the several methods that are used for this purpose, including the use of ponds, spreading ditches or furrows, and natural channels to collect and disperse water. The county of San Diego has explored these methods and prepared a general plan for flood control (1972) in Borrego Valley, that includes a system of levees designed to check the flow velocity of floods and disperse runoff into areas of least potential damage. Competion of this plan with some modifications to achieve greater dispersion of runoff over the slopes of the alluvial fans would probably add to the groundwater inflow reaching Borrego Valley, particularly in those areas that lie along the toe of the alluvial fans opposite the mouths of the canyons. The "modest" storms, that is, those that reoccur at intervals of less than 50-year frequency, are apt to do least damage to earthen flood control works and to provide maximum opportunity for groundwater recharge.

Of particular interest to artificial recharge will be the availability of the channel of Coyote Creek in transmittal of water from Anza in the north to the highly permeable alluvial sediments underlying the north end of Borrego Valley. This area and all others that lie along the base of the Peninsular Ranges on the west side of Borrego Valley contribute water that ultimately reaches the groundwater beneath Borrego Park

BIBLIOGRAPHY

Byerly, John R., 1979, Preliminary soils investigation, Proposed Borrego Springs Development, Borrego Valley, Borrego Springs, California: John R. Byerly, Inc., 2230 South Riverside Ave., Bloomington, California, 92316, rept. no. 8844; 4 pp., 16 figs.

California Department of Water Resources, 1975, California's groundwater: Department of Water Resources Bull. No. 118, 135 pp., 33 figs., 2 tables, 1 map.

County of San Diego, Department of Sanitation and Flood Control, 1972, General Plan for flood control improvements, Borrego Valley: Department of Sanitation and Flood Control, 5555 Overland Ave., San Diego, California, 92123, 44 pp., 3 tables, appendix.

Crippen, J. R., 1965, Natural water loss and recoverable water in mountain basins of Southern California: U. S. Geol. Survey Prof. Paper 417-E, 11 figs., 11 tables.

Cruff, R. W. and T. H. Thompson, 1967, A comparison of methods of estimating potential evapotranspiration from climatological data in arid and subhumid environments: U. S. Geol. Survey/Water-Supply Paper 1839-M; 27 pp., 4 figs., 10 tables.

Heindle, L.A., 1965, Groundwater in the southwest - a perspective in Ecology of Groundwater in the southwestern United States; Symposium, Arizona State University, American Association for the Advancement of Science, April 18 and 19, 1961; Arizona State University Bureau of Publication, pp. 4-28.

Helg, Allgen G. and E. L. Peck, 1964, Precipitation, Runoff and water loss in the Lower Colorado River - Salton Sea area: U.S. Geol. Survey Prof. Paper 486-B, 16 pp, 7 pls., 10 figs., 1 table.

Lough, C. F., 1974, Water Budget for Borrego Valley: County of San Diego, Office of Integrated Planning; 27 pp., 12 figs., with comments by R. L. Threet, Professor of Geology, San Diego State University.

Merifield, P. M., and D. L. Lamar, 1978, Report on two years of water level monitoring along San Andreas and San Jacinto Faults, Southern California: Lamar-Merifield Consultants, Geologists, 1318 Second Street, Suite 27, Santa Monica, California, 90401; Technical report 78-5, 89 pp., 71 figs., 7 tables.

Moyle, W. R. Jr., 1968, Water wells and springs in Borrego Carrizo and San Felipe Valley areas: California, Dept. of Water Resources, Bull. no. 91-15, figs. 3, tables 5, pgs. 119.

Moyle, W. R. Jr., 1974, Geohydrologic map of Southern California: U. S. Geol. Survey, Water Resources Inv. No. 48-73, Open file.

Rasmussen, Gary S., 1979, Geology of the Borrego Springs Park (Borrego Springs Country Club) for environmental impact report west of Borrego Valley Road and 1,300 feet south of Palm Canyon Drive, Borrego Springs, California: Gary S. Rasmussen and Associates, 1906 South Commercenter East, Suite 207, San Bernardino, California, 92408, project no. 1503; 14 pp., 4 figs.

Todd, David Keith, 1959, Groundwater Hydrology; John Wiley and Sons, Inc.

U. S. Bureau of Reclamation, 1968, Reconnaissance Investigations, Interim Rept., Inland Basins Projects, Borrego Valley, California: U. S. Bureau Rec., Region 3, Boulder City, Nevada, 89005, 60 pp., 2 figs., 16 tables.

Webb, H. A. and Associates, May, 1977, Draft, General plan amendment reports, Draft, Environmental Impact Report, Borrego Country Club: Albert A. Webb Associates, Consulting Engineers, Riverside, California; File No. 2364.2, 10 chapters, 18 figs., 8 appendices.

APPENDIX C

PRELIMINARY SOILS INVESTIGATION
JOHN R. BYERLY, INC.

MATERIALS LABORATORY, INC.

P. O. Box 3027 · 1526 No. "E" Street, San Bernardino, Calif. 92413 · Phone (714) 889-5714

January 22, 1979

Boyle Engineering
118 Airport Drive, Suite 210
San Bernardino, CA 92408

Attn: Wes Hyland

Subject: Observations and Conclusions
Borego Springs Park
Annex 1 and 2
Borego Springs, California

Dear Sir:

On January 16, 1979, a representative of this firm observed the conditions within the subdivisions known as Borego Springs Park, Annex 1 and 2, as these conditions relate to construction of individual dwellings within these subdivisions. Our observations and conclusions follow.

The subject subdivisions are known as Borego Springs Park, Annex 1 and 2. Annex No. 1 is 41 lots, Lot Nos. 30 through 70 inclusive, located along Foursome Drive while Annex No. 2 is a total of 104 lots, lots 90 through 193 inclusive, located generally along Back Nine Drive, Short Nine Drive, and Foursome Drive.

At the time of our observations, all of the lots within both subdivisions had previously been graded. The time of grading was not known to this firm. The lots are generally constructed by elevating the building pad areas themselves approximately 2 to 4 feet above street elevation. Each lot is separated by a drainage swale, approximately 2 to 3 feet in depth. At the time of our observations, none of the streets within the subject subdivisions had been paved. All of the subject lots were covered with grasses approximately 3 feet in height, making it nearly impossible to detect other than gross topographical differences.

Soil conditions within the subject properties generally consist of very fine to fine silty sands on the building pad areas. Soils other than the building pad areas generally consisted of silty sands, fine to medium, occasionally with traces of coarse sand. It would appear, based upon the topography and the soil conditions, that the subject pads themselves were built by removing dirt from the street and drainage areas and constructing the actual physical building pad. In general, it would appear that all building pads within both subdivisions contained approximately 2 to 4 feet of fill.

At the time of our observations, water lines were being installed within a portion of Annex No. 1.

Compaction tests were taken at random on Lots 93 and 189 of Annex No. 2. The number of lots which could be tested was limited by the vehicular access problems caused by the recent rains. The results of the compaction tests taken on these lots indicate that in general, the soils were in place in a state of compaction less than would be expected for adequate structural support.

In summary, the building pad areas within the subject projects have been graded. No streets are paved within the subject project. The building pad areas are apparently constructed of fill with the fill being approximately 2 to 4 feet in maximum depth. The lots generally are separated by sideyard swales approximately 3 feet deep. The soil conditions at the site consist of silty sands, very fine to fine in the building pad areas, while the original ground soils appear to be a silty sand, fine to medium with traces of coarse sands.

Based upon the observations made at the two subdivisions, it is the recommendation of this firm that before any construction proceed at the site, that an investigation be performed to determine the compaction of the on site soils in building pad areas. An investigation should be performed to determine if silt materials, possibly of a collapsible nature, are located at depth beneath the site.

C·H·J

The above conclusions are based upon a limited observation and investigation performed at the site, and are not intended to supercede any recommendations which might be determined after a more detailed investigation of the site conditions.

Should you have any questions or comments concerning this information, please feel free to contact this firm at your convenience.

Respectfully submitted,
C.H.J. MATERIALS LAB., INC.

Robert J. Johnson, R.E. 27060

RJJ/jp
Attachment: Test Data Summary Sheet

JN 79045-3

FIELD DENSITY TEST SUMMARY SHEET

Job No. 79045-3

Sh._____ of _____

PROJECT: Borego Springs Park, Annex 1 and 2, Borego Springs

Date	Test No.	Location Of Test	Depth Of Cut	Depth Of Fill	Depth Of Test	DENSITIES (lbs/cubic foot) Dry	Max.	Rel.	MC%	Soil Type	Remarks Retest C
1/16/79	FG-1	Lot 93, Center			0.1-0.6	98.3	123.0	80	11.0		
	FP-1	Lot 93, Center			1.0-1.5	87.7	121.5	72	11.0		
	FG-2	Lot 189, Center			0.1-0.6	91.2	121.5	75	12.0		
	FP-2	Lot 189, Center			1.0-1.5	86.3	121.5	71	9.5		

LEGEND: (SG) Tests on Subgrade Elevation; (BF) Tests on Backfill; (FP) Tests on Fill in Progress
(FG) Tests on Finish Grade Elevation; (Mc) Moisture Content; (REL) Relative; (*) Denotes Failure

JOHN R. BYERLY, INC.

2230 SOUTH RIVERSIDE AVENUE • BLOOMINGTON, CALIFORNIA 923

PHONES: BLOOMINGTON (714) 877-1324 • RIVERSIDE (714) 684-9775

PRELIMINARY SOILS INVESTIGATION

JUNE 1, 1979

PROPOSED BORREGO SPRINGS DEVELOPMENT

BORREGO VALLEY

BORREGO SPRINGS, CALIFORNIA

PREPARED AT THE REQUEST OF:

FEDERATED DEVELOPMENT COMPANY

1100 GLENDON AVENUE

LOS ANGELES, CALIFORNIA 90024

ATTN: MR. HERSCHEL BERKES

RPT. NO.: 8844
FILE NO.: S-4559

DISTRIBUTION:

(3) Client
(3) Boyle Engineering
Attn: Wesley Hylen

INTRODUCTION

During May of 1979, a field and laboratory investigation of the soil conditions underlying the proposed Borrego Springs Development located in Borrego Springs, California, was conducted by this firm. The purpose of our investigation was to explore and evaluate the surface and subsurface conditions at the site in order that we might provide geotechnical data for the project Environmental Impact Report. Of particular interest was a general definition of soil conditions, outlining major soils-related problems, and to review possible remedial construction, if needed. Concurrent with our investigation, the engineering geologic aspects of the site were explored and evaluated by Gary S. Rasmussen and Associates, Engineering Geologists. Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied.

DEVELOPMENT CONSIDERATIONS

Although development plans are still in the conceptual stage, we understand that the site is to be subdivided into lots varying in size from 0.5 acre to 10.0 acres. Each lot is to receive a single family residence. The development will include restoration of an existing golf course, construction of a hotel and community center and tennis courts. Construction of interior and access roads for the site will probably entail cuts and fills to a maximum depth of approximately 4 feet.

SITE CONDITIONS

The approximately 1100 acre site is located between Borrego Valley Road and Di Giorgio Road in the community of Borrego Springs. The project area lies along the eastern margin of coalescing alluvial fans that extend eastward from the mountains. In general the site slopes to the northeast at less than 1 percent. Currently the site contains a Club House, 2 nine hole golf courses, a sewer treatment plant, a date orchard, and numerous private residences. Vegetation consists of a moderate cover of desert flora over the majority of the area and numerous trees located around the residential portions of the site.

FIELD AND LABORATORY INVESTIGATION

The soils underlying the subject site were explored by means of 15 test pits excavated with a tractor-mounted backhoe to a maximum depth of 14.0 feet below the existing ground surface. The approximate locations of our test pits are indicated on Enclosure 1.

Rpt. No.: 8844
File No.: S-4559

The soils were examined and visually classified by one of our field engineers. The test pit logs are presented on Enclosure 2. The test pit logs show subsurface conditions at the dates and locations indicated, and may not be representative of subsurface conditions at other locations and times. The stratification lines presented on the test pit logs represent the approximate boundaries between soil types, and the transitions may be gradual. Undisturbed and bulk samples were obtained at selected levels within the test pits and returned to the laboratory for testing and evaluation. Included in the laboratory testing were moisture-density determinations on all undisturbed samples. Optimum moisture content-maximum dry density relationships were established for typical soil types so that the relative compaction of the subsoils might be determined. The laboratory test data are summarized on Enclosure 3.

SOIL CONDITIONS

Data from our test pits indicate that the site is underlain by loose sands and silty sands with varying amounts of cementation to the maximum depths penetrated. Neither free ground water nor significantly expansive soils were encountered during our investigation.

CONCLUSIONS

Based upon our field observations and test data, the soil conditions at the site appear to be compatible with the proposed development. However, the upper native soils are generally loose and will require precompaction to provide adequate support for the intended structures. We anticipate that conventional spread or continuous wall footings may be safely utilized. Detailed recommendations for foundation design, support of concrete slabs-on-grade and site preparation should be developed during a detailed soils investigation concducted after specific development plans are available. Generalized recommendations for site preparation are provided below.

SITE PREPARATION

Grading of the subject site should be performed in accordance with the provisions of Chapter 70 of the Uniform Building Code or applicable local ordinances. The following recommendations are presented for your assistance in establishing proper grading criteria.

All areas to be graded should be stripped of significant vegetation and other deleterious materials. These materials should be removed from the site for disposal.

Any existing man-made uncontrolled fills encountered during construction should be compeltely removed, cleaned of significant deleterious materials, and stockpiled pending replacement as compacted fill.

The cavities created by removal of trees of other subsurface obstructions should be thoroughly cleaned of loose soil, organic matter and other deleterious materials, shaped to provide access for construction equipment, and backfilled as recommended for site fill.

All surfaces to receive fill should be scarified to a depth of at least six (6) inches. The scarified soils should be moistened to a near optimum moisture content and compacted to a relative compaction of at least 90 percent (ASTM D 1557-70).

The on-site soils should provide adequate quality fill materials provided they are free from organic matter and other deleterious materials. Import fill should be inorganic, granular soils, free from rocks or lumps greater than eight (8) inches in maximum dimension. Sources for import fill should be inspected and approved by the Soils Engineers prior to their use.

Fill should be spread in 8-inch or less lifts, each lift moistened to a near optimum moisture content, and compacted to a relative compaction of at least 90 percent (ASTM D 1557-70).

Cut and fill slopes should be constructed no steeper than 2 horizontal to 1 vertical. Fill slopes should be overfilled during construction and then cut back to expose fully compacted soil. A suitable alternative would be to compact the slopes during construction and then roll the final slope to provide a dense, erosion-resistant surface.

EROSION CONTROL

Inasmuch as the native soils are highly susceptible to erosion by running water and wind, it is our recommendation that the following erosion control measures be provided.

Lot drainage should be by sheet flow or approved drainage structures. Runoff should not be permitted to concentrate.

Lots should be graded to drain away from the tops of slopes. Runoff over slope faces should not be permitted.

Slopes and yard areas should be planted as soon as possible after completion to provide maximum protection against erosion by wind or running water. The use of succulent ground covers such as iceplant or Sedum is not recommended for slopes.

The conclusions and recommendations presented in this report are based upon the field and laboratory investigaton described herein and represent our best engineering judgment. Should conditions be encountered in the field that appear different than those described in this report, we should be contacted immediately in order that appropriate recommendations might be prepared.

This report is intended to provide information necessary for the completion of the environmental impact study. Prior to construction, we recommend that a detailed soils investigation be conducted in order to provide specific design recommendations for the project.

The following enclosures are attached to and complete this report:

Enclosure 1:	Plot Plan
Enclosure 2:	Test Pit Logs
Enclosure 3:	Field and Laboratory Test Data
Enclosure 4:	Engineering Geology Report

Respectfully submitted,

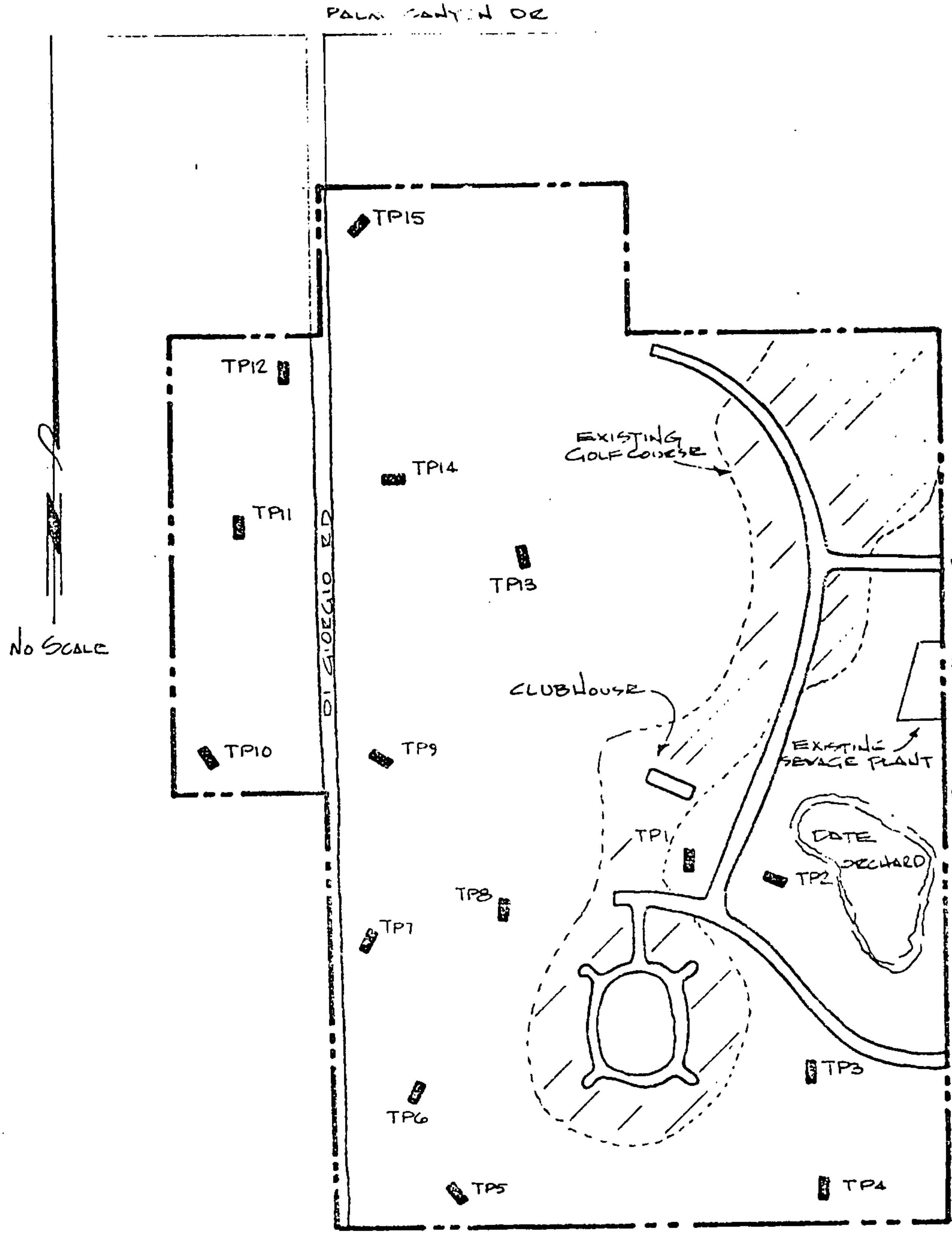
JOHN R. BYERLY, INC.

Kelvin L. Kaup, Staff Engineer

Roger A. Shervington, Civil Engineer

KLK/RAS:dr

Rpt. No.: 8844
File No.: S-4559



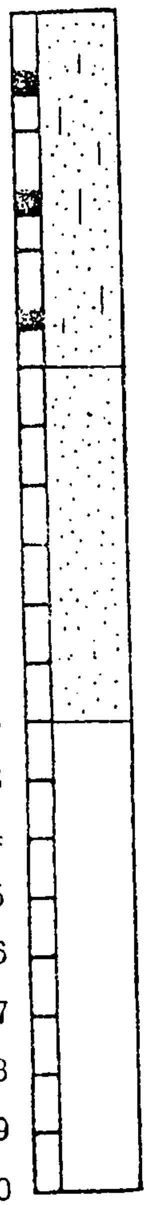
Enclosure 1
Rpt. No.: 8844
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Federated Development Company
Borrego Springs
Test Pit No. 1
Date tested May 29, 1979

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
				0
	92	2.0	76	1
				2
	88	2.0	73	3
				4
	92	2.6	76	5
				6
				7
				8
				9
				10
				11
				12
				13
				14
				15
				16
				17
				18
				19
				20



Lt. brown fine to coarse sand (SW)
(dry, loose w/some silty)

Grey medium to coarse sand (SW)
(dry, loose, w/occasional gravels)

Total depth 12.0 feet

No free ground water encountered

Caving below 6.0 feet

Enclosure 2, Page 1
Rpt. No.: 8844
File No.: S-4559

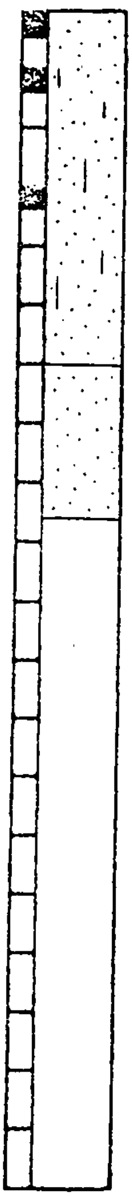
Form 8

JOHN R. BYERLY, INC.

Test Pit No. 2

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)
	87	1.0	75
	83	3.6	69
	105	2.0	89

DEPTH (FEET): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20



Lt. brown fine to coarse sand (SW) (porous, dry, loose w/some silt)

Grey fine to coarse sand (SW) (dry, loose, containing lenses of porous, cemented silt)

Total depth 9.5 feet

No free ground water encountered

Caving below 1.0 feet

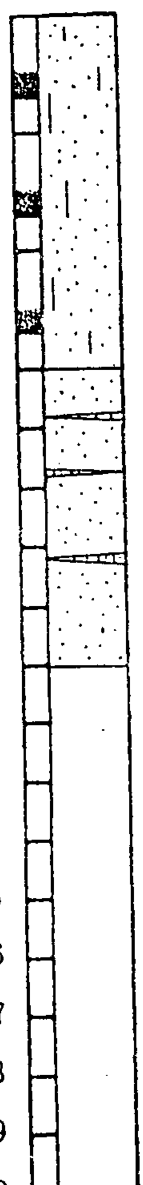
Enclosure 2, Page 2
Rpt. No.: 8844
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Test Pit No. 3

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
				0
	96	2.6	81	1
				2
	98	3.1	83	3
				4
	87	2.6	72	5
				6
				7
				8
				9
				10
				11
				12
				13
				14
				15
				16
				17
				18
				19
				20



Lt. brown fine to coarse sand (SW) (dry, slightly dense, w/some silt)

Grey fine to coarse sand (SW) (dry, loose, w/lenses of cemented silt)

Total depth 11.0 feet

No free ground water encountered

No caving

Enclosure 2, Page 3
Rpt. No.: 8844
File No.: S-4559

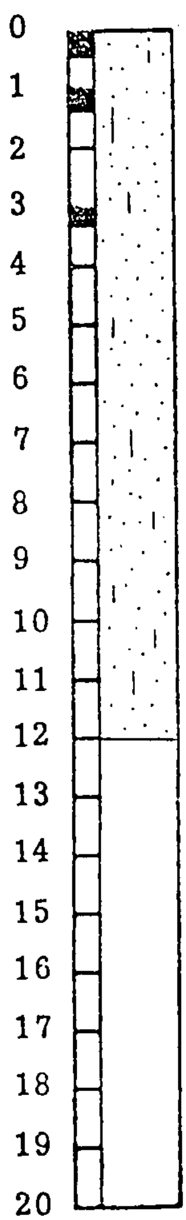
Form 8

JOHN R. BYERLY, INC.

Test Pit No. 4

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)
	93	1.0	80
	86	2.6	71
	97	4.2	80

DEPTH (FEET)



Lt. brown fine to coarse sand (SW)
(dry, loose, w/some silt)

Total depth 12.0 feet

No free ground water encounterd

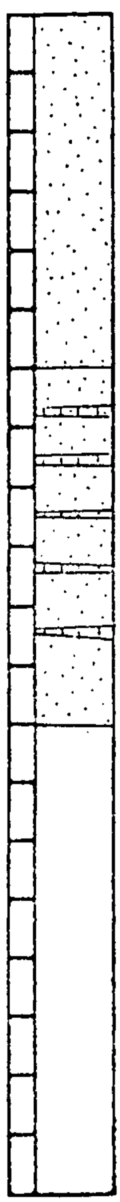
No caving

Enclosure 2, Page 4
Rpt. No.: 8844
File No.: S-4559

Form 6

JOHN R. BYERLY, INC.

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
				0
				1
				2
				3
				4
				5
				6
				7
				8
				9
				10
				11
				12
				13
				14
				15
				16
				17
				18
				19
				20



Test Pit No. 5

Brown fine to coarse sand (SW)
(dry, loose)

Grey to lt. brown interbedded fine to coarse sand (SW) & fine to coarse sand w/cemented silt, (loose)

Total depth 12.0 feet

No free ground water encountered

Caving below 6.0 feet

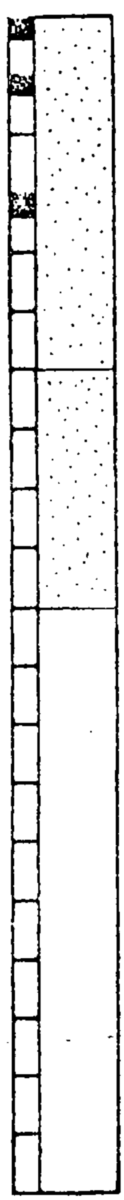
Enclosure 2, Page 5
Rpt. No.: 8844
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Test Pit No. 6

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
				0
	100	0.5	86	
	97	3.6	80	1
				2
	95	1.5	82	3
				4
				5
				6
				7
				8
				9
				10
				11
				12
				13
				14
				15
				16
				17
				18
				19
				20



Lt. brown fine to coarse sand (SW)
(dry, moderately dense)

Grey fine to coarse sand (SW)
(dry, loose)

Total depth 10.0 feet

No free ground water encountered

Caving below 6.0 feet

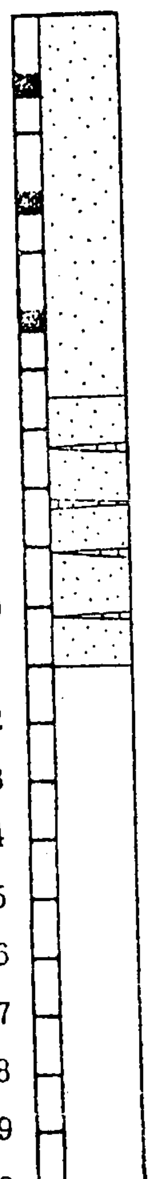
Form 8

JOHN R. BYERLY, INC.

Test Pit No. 7

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
	90	4.2	75	1
	90	5.3	74	3–4
	99	2.6	82	5

DEPTH (FEET): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20



Lt. brown fine to coarse sand (SW) (dry, loose, porous)

Grey, lt. brown fine to coarse sand w/lenses of silt, (dry & loose)

Total depth 11.0 feet

No free ground water encountered

No caving

Enclosure 2, Page 7
Rpt. No.: 8844
File No.: S-4559

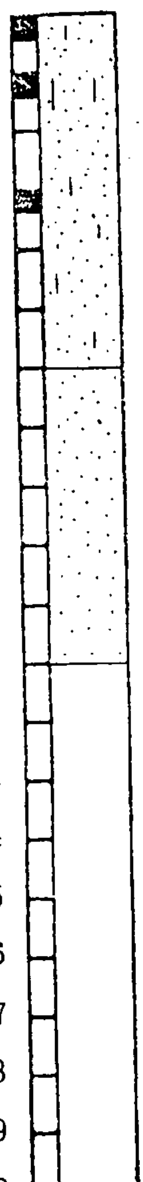
Form 8

JOHN R. BYERLY, INC.

Test Pit No. 8

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)
	91	1.5	77
	94	2.0	82
	92	2.0	80

DEPTH (FEET): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20



Lt. brown fine to coarse sand (SW)
(dry, slightly dense, w/some silt)

Lt. brown to grey interbedded fine to coarse sands, (dry, loose)

Total depth 11.0 feet

No free ground water encountered

No caving

Enclosure 2, Page 8
Rpt. No.: 8844
File No.: S-4559

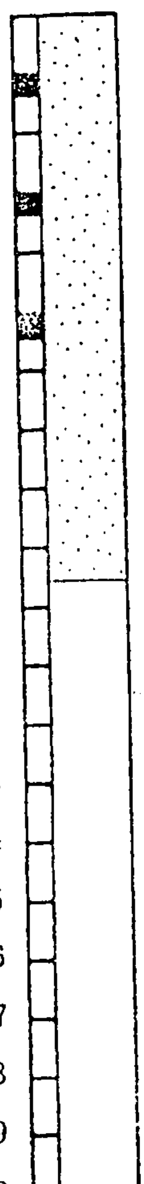
Form 8

JOHN R. BYERLY, INC.

Test Pit no. 9

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)
	101	2.6	87
	99	2.0	83
	100	1.5	85

DEPTH (FEET): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20



Grey fine to coarse sand (SW)
(dry, moderately dense)

Total depth 9.5 feet

No free ground water encountered

Caving below 3.0 feet

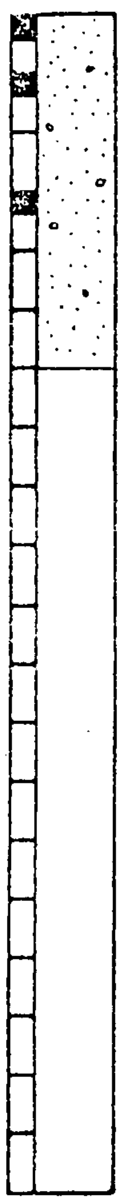
Enclosure 2, Page 9
Rpt. No.: 8844
File No.: S-4559

Form 8

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)
	94	1.0	80
	95	1.0	80
	91	1.0	77

DEPTH (FEET)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20



Test Pit No. 10

Grey fine to coarse sand (SW)
(dry & slightly dense w/some silt and gravel)

Total depth 6.0 feet

No free ground water encountered

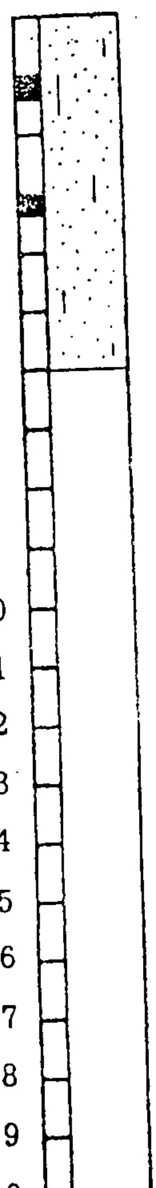
Caving below 1.0 feet

Form 8

JOHN R. BYERLY, INC.

Test Pit No. 11

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
				0
				1
	96	3.6	82	
				2
	102	3.6	87	3
				4
				5
				6
				7
				8
				9
				10
				11
				12
				13
				14
				15
				16
				17
				18
				19
				20



Lt. brown fine to coarse sand (SW)
(dry, mod. dense w/some silt)

Total depth 6.0 feet

No free ground water encountered

Caving below 1.0 feet

Form 8

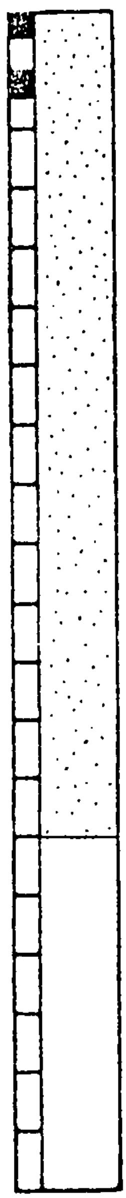
JOHN R. BYERLY, INC.

Test Pit No. 12

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)
	80	2.0	70
	77	2.5	67

DEPTH (FEET)

0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20



Grey to lt. brown fine to coarse sand (SW) (dry, loose, w/some silt)

Total depth 14.0 feet

No free ground water encountered

Caving below 3.0 feet

Enclosure 2, Page 12
Rpt. No.: 8844
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Test Pit No. 13

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)	
				0	Lt. brown fine to coarse sand (SW) (dry, loose w/some silt)
	88	2.0	76	1	
				2	
	85	4.2	73	3	Lt. brown fine to coarse sand (SW) (dry, loose)
				4	
				5	Lt. brown silty fine to coarse sand (S (dry, loose)
				6	
				7	
				8	
				9	
				10	Total depth 10.0 feet
				11	No free ground water encountered
				12	No caving
				13	
				14	
				15	
				16	
				17	
				18	
				19	
				20	

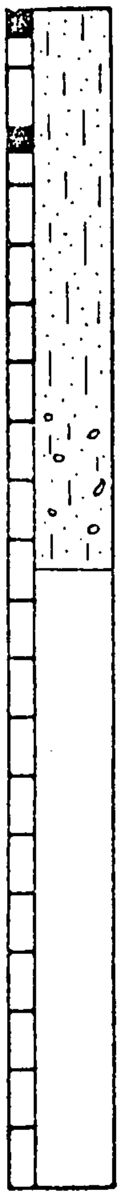
Enclosure 2, Page 13
Rpt. No.: 8844
File No.: S-4559

Form.5

JOHN R. BYERLY, INC.

Test Pit No. 14

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
				0
	87	2.6	75	1
	94	1.0	79	2
				3
				4
				5
				6
				7
				8
				9
				10
				11
				12
				13
				14
				15
				16
				17
				18
				19
				20



Lt. brown silty fine to coarse sand (S
(dry, loose)

Occasional gravels at 7.0 feet

Total depth 9.5 feet

No free ground water encountered

No caving

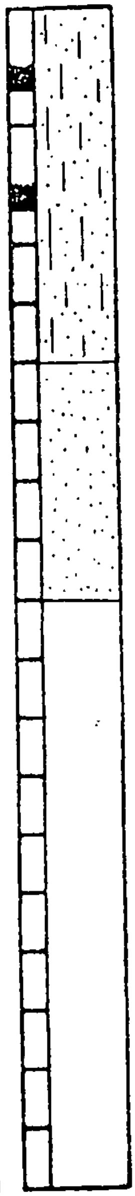
Enclosure 2, Page 14
Rpt. No.: 8844
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Test Pit No. 15

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)	
				0	Lt. brown silty fine to coarse sand (S (dry, loose)
	82	0.5	71	1	
				2	
	87	1.5	75	3	
				4	
				5	Occasional gravels at 5.0 feet
				6	Lt. brown fine to coarse sand (SW)
				7	
				8	
				9	
				10	Total depth 10.0 feet
				11	No free ground water encountered
				12	No caving
				13	
				14	
				15	
				16	
				17	
				18	
				19	
				20	



Enclosure 2, Page 15
Rpt. No.: 8844
File No.: S-4559

TEST DATA

LABORATORY STANDARD: ASTM D 1557-70, Mehtod A: 4-Inch Diamter Mold; 1/30 Cubic Foot Volume; 5 Layers; 25 Blows Per Layer; 10 Pound Hammer; 18 Inch Fall; -No. 4 Material.

Type	Classification	Optimum Moisture(%)	Maximum Density(PCF)
A	Lt. brown fine to coarse sand (SW)	12.0	115.5
B	Lt. brown fine to coarse sand (SW)	12.5	118.0
C	Lt. brown silty fine to coarse sand (SM)	11.0	121.5

Enclosure 3
Rpt. No.: 8844
File No.: S-4559

GARY S. RASMUSSEN & ASSOCIATES / ENGINEERING GEOLOGY
1906 SO. COMMERCENTER EAST, SUITE 207 • SAN BERNARDINO, CA 92408 • (714) 888-2422 • (714) 825-9052

GEOLOGY OF BORREGO SPRINGS PARK (BORREGO SPRINGS COUNTRY CLUB) FOR ENVIRONMENTAL IMPACT REPORT WEST OF BORREGO VALLEY ROAD AND 1,300 FEET SOUTH OF PALM CANYON DRIVE BORREGO SPRINGS, CALIFORNIA

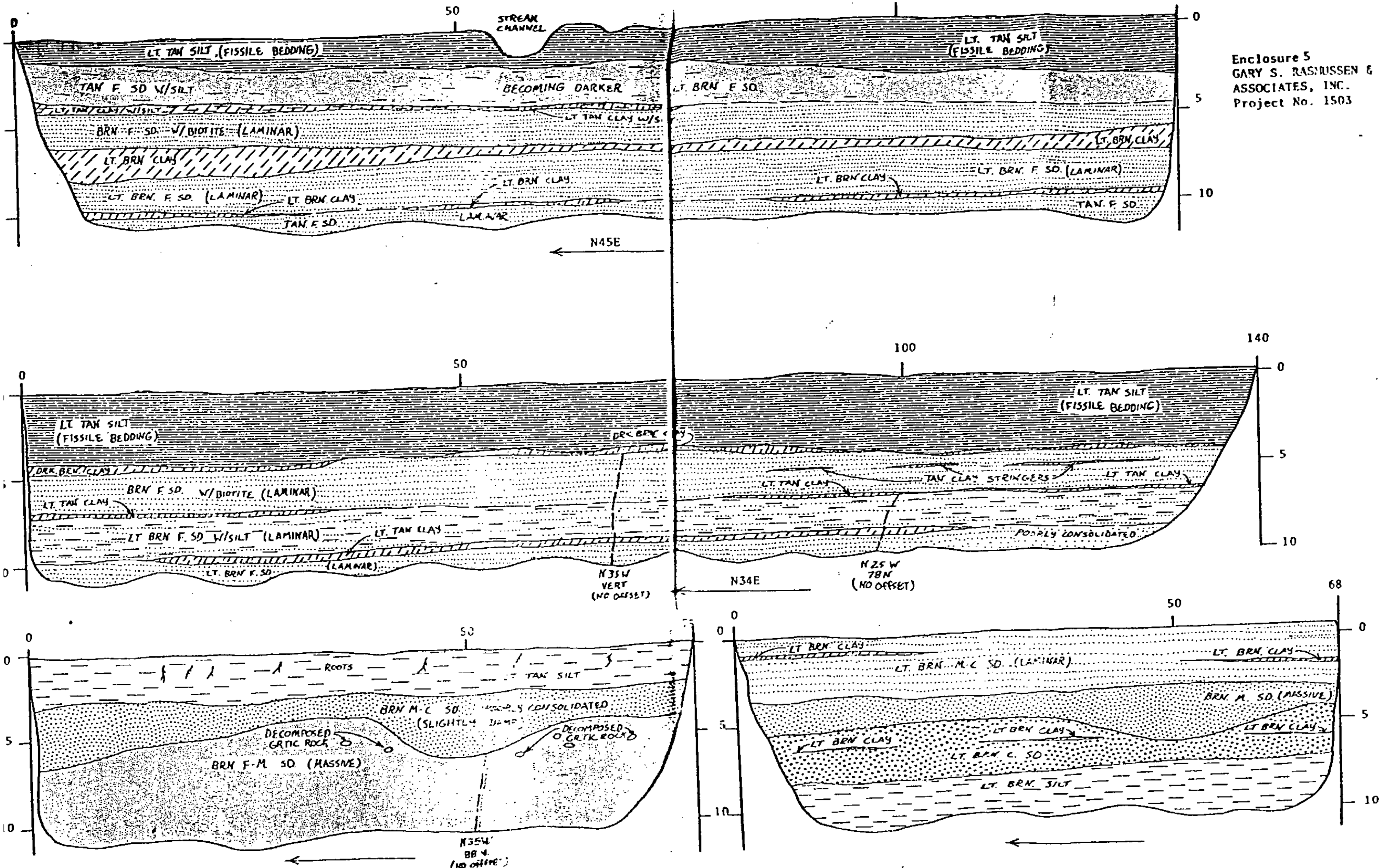
June 13, 1979

Project No. 1503

Prepared for

John R. Byerly, Inc.
2230 South Riverside Avenue
Bloomington, California 92316

Enclosure 5
GARY S. RASMUSSEN & ASSOCIATES, INC.
Project No. 1503



JOHN R. BYERLY, INC.

2230 SOUTH RIVERSIDE AVENUE · BLOOMINGTON, CALIFORNIA 92316

PHONES: BLOOMINGTON (714) 877-1324 · RIVERSIDE (714) 684-97..

June 20, 1979

Federated Development Company
1100 Glendon Avenue
Los Angeles, California 90024

Rpt. No.: 8883
File No.: S-4559

Attention: Mr. Hershel Berkes

Subject: Proposed Borrego Springs Development, Borrego Springs, California

Reference: Preliminary Soils Investigation, Rpt. No. 8844, June 1, 1979

Gentlemen:

The referenced report presents our conclusions and recommendations concerning soil conditions encountered during an investigation at the subject site. Enclosure 4 to the referenced report presents an engineering geology report prepared for the subject development by Gary S. Rasmussen and Associates, of San Bernardino. In the geology report, Mr. Rasmussen discussed the existence of a soil formation known as the Indio Silts. This soil formation is shown on USDA Soil Maps and is indicated as having a significant settlement potential. Mr. Rasmussen concluded that these soils should be specifically addressed by the Soils Engineer.

Porous, compressible silts similar to the Indio silt formation were not encountered in any of our test pits during our preliminary soils investigation. However, inasmuch as the soil formation is indicated as existing in an area of the site not heavily explored during our investigation, we are currently conducting an additional investigation in that area. Our additional investigation will involve the exploration of several test pits at selected locations utilizing hand equipment. The soils encountered will be examined and visually classified by one of our staff engineers. Should compressible silts be encountered, undisturbed samples will be obtained and returned to the laboratory for testing and evaluation. Based upon our field observations and laboratory test data, an addendum to the referenced report will be prepared providing specific recommendations concerning the Indio silts. Our field investigation should be completed by the end of this week and our recommendations available within 2 or 3 da-- thereafter.

GARY S. RASMUSSEN & ASSOCIATES / ENGINEERING GEOLOGY
1906 SO. COMMERCENTER EAST, SUITE 207 • SAN BERNARDINO, CA 92408 • (714) 888-2422 • (714) 825-9052

June 13, 1979

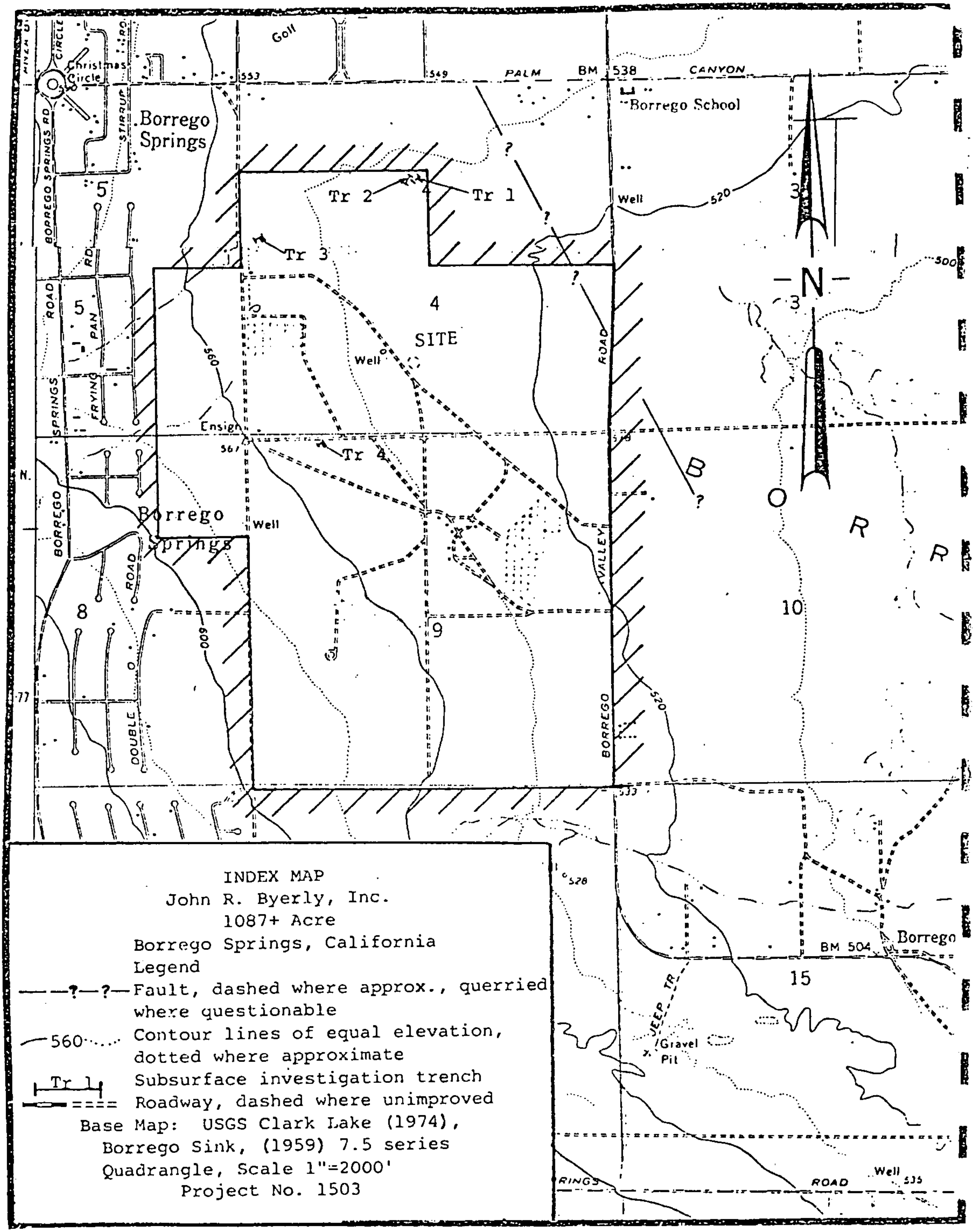
John R. Byerly, Inc.
2230 South Riverside Avenue
Bloomington, California 92316

Project No. 1503

Subject: Geology of Borrego Springs Park (Borrego Springs Country Club) for Environmental Impact Report, West of Borrego Valley Road and 1,300 Feet South of Palm Canyon Drive, Borrego Springs, California.

A geology investigation of the Borrego Springs Park Development also referred to as Borrego Springs Country Club, Borrego Springs, California has been conducted at your request. The purpose of our investigation was to determine the existing geologic setting and assess the probable impact of the geology on the proposed development. The 1087 acre site is located approximately 1/2 mile southeast of the Borrego Springs Christmas Circle. It is our understanding that the site will be developed in five stages and will contain a golf course, clubhouse, community center, sewage treatment plant, single family residences, patio homes, attached single family residential units, 5-acre ranchettes, 10-acre ranches, and open space. The site contains 1,087.3 acres with a total of 835 residential units planned, resulting in 0.77 units per acre. A majority of the site has previously been graded, with the golf course, clubhouse facilities, sewer treatment plant, and occasional residences already in existence. A 400-scale plat map, drawn by Richardson, Nagy, Martin Architecture/Planning of Newport Beach, California, dated September 22, 1978, was used for our investigation. Proposed grading plans were not available at the time of our investigation, but additional grading of those areas previously graded is anticipated to be minimal, with those areas not previously graded probably requiring maximum cut and fill slope heights of the order of 3± feet. The location of the site and property boundaries are shown on the index map on page 2, as well as on the safety element, soil survey, and the geologic maps included as Enclosures 1, 2, and 3.

A geologic field reconnaissance of the site and surrounding area was conducted during May, 1979. In addition to the field work, our investigation included



INDEX MAP
John R. Byerly, Inc.
1087+ Acre
Borrego Springs, California

Legend

—?—?— Fault, dashed where approx., querried where questionable

560 Contour lines of equal elevation, dotted where approximate

Tr 1 Subsurface investigation trench

==== Roadway, dashed where unimproved

Base Map: USGS Clark Lake (1974), Borrego Sink, (1959) 7.5 series Quadrangle, Scale 1"=2000'

Project No. 1503

review of stereoscopic pairs of aerial photographs flown in 1953; review of pertinent geologic literature and maps, including previous reports on the site and surrounding area by other firms; excavation of four short backhoe trenches at selected locations; and review of significant seismic information, including recorded, historic earthquakes. A list of references is enclosed (Enclosure 4).

SITE TOPOGRAPHY

The index map on page 2, a composite 2,000-scale topographic map of the Clark Lake, Borrego Springs Quadrangles, shows a gradual 1 to 2 percent slope of the ground surface to the northeast. Localized, southeast trending swales (minor depressions) were observed on the northwest portion of the site and indicate drainage from this area previously flowed towards the Borrego Sink. No classical topographic evidence of faults (scarps) was found on the site during our investigation or on aerial photographs. Three vegetational lineaments were observed on the aerial photographs, one of which was associated with a linear drainage. Due to the relative close proximity and parallel trend to known faults in the area, plus the observed trend of plotted epicenters (all northwest trending), the possibility existed that these lineaments could be fault related. Therefore, trenches, with a total lineal footage of 414 feet, were excavated across these features, as shown on the index map, to determine if they were in fact caused by active faulting. No faults were found.

The procedure utilized for conducting the subsurface portion of our investigation was to excavate trenches perpendicular to the trend of the lineaments and known faults in the area, to a depth of 10-12 feet. Trenching of sediments to $10^{\pm}$ feet is consistent with the current state-of-the-art for investigating recency of faulting for the type of use intended for the site. Trenching enables a detailed visual inspection of subsurface materials for faults, fault related features, and other near surface geologic features. The exact age of sediments at depths of 10-12 feet is not known but is estimated to be late Holocene. The trench logs are enclosed (Enclosure 5).

The undeveloped portions of the site contained natural vegetation in the form of mesquite and sage with the developed portions of the site containing mature date palm trees and occasional grass, as well as a variety of trees. Previously, the northern portion of the site had been used for agricultural purposes, grain and cotton, while the southern portion reportedly has remained in its natural state.

A northwest trending scarp (bench) is located approximately 1300 feet northeast of the northerneasternmost portion of the site. This scarp may be the surface expression of a fault, or alternatively, it may be the remnant of an old stream bank or dune deposit. This scarp, if extended to the southeast, would cross a portion of the golf course not containing any human occupancy structures and no structures are proposed in the area on the development plan. If the scarp is fault related and continues to the southeast, it would run through the extreme northeast portion of the golf course (index map on page 2).

SITE GEOLOGY

The Borrego Springs Park Development is located in Borrego Valley, which lies within the Salton Trough. The Salton Trough is defined by a linear and narrow depression which encompasses the low-lying areas of the Colorado River Delta Region in Mexico and the Imperial and Coachella Valley Regions of southern California, comprising a physiographic province 1400 kilometers (875 miles) long. The land surface in the north-central section of the Salton Trough is below sea level, having been cut off from the Gulf of California by the deposition of a delta cone of the Colorado River within the last 11,000 years (Holocene) This Salton Trough Basin has been periodically inundated by bodies of water, the latest having formed the Salton Sea in 1905 (Mendenhall, 1909). The present geographic limits of the Salton Trough correspond approximately to the boundaries of the San Andreas fault system (San Andreas, San Jacinto, Agua Caliente and Elsinore fault zones). Intermittent, right-lateral movement along the southeast fault zones within this system have continued to change the shape of the basin with vertical displacement forming the dominant physiographic elements (mountains) within the Trough and bordering areas. These mountain masses include the Borrego Mountains, Fish Creek Mountains, Superstition Mountains, and the Coyote Mountains (Sharp, 1972).

Sediments in the Salton Trough range from older gravel (or its consolidated fanglomerate equivalents) through predominately sandy flood-plain and deltaic deposits including marine silts and clays. Deposition through the erosion of continental materials may have prevailed in some marginal parts of the trough throughout its history, although much of the deposition has alternately been marine and non-marine. Other lithology found within the trough included bedded gypsum deposits (Ver Planck, 1952) and Matric volcanic rocks (Allen, 1957). Widespread and various source areas around the Salton Trough have contributed clastic material at various times.

The entire site lies on Quaternary alluvium (Rogers, 1965) as shown on the geologic map (Enclosure 3). Data from water wells drilled on-site indicates that this alluvium continues to a minimum depth of 600 feet below the surface and consists of sands, clays, fine gravel and gravels (Department of Water Resources, January, 1968). This alluvium is underlain by crystalline rock (metamorphic and granitic) which rises to the west and forms the San Ysidro Mountains.

SEISMIC SETTING

The principal fault zones in the Salton Trough consist of the San Andreas, located near the northeast margin; a group of unnamed boundary faults that are concealed along the southwest edge of Coachella Valley; the widely branching San Jacinto fault zone, which crosses the southwest portion of the Trough; and the Aqua Caliente and the Elsinore fault zones located along the southwest edge of the Trough. All of these fault zones are considered part of the San Andreas fault system and display the surficial features characteristic of this system: linearity, northwest-southeast trends, evidence of Holocene activity, and right-laterial, strike-slip offset.

San Andreas Fault Zone

The San Andreas fault zone consists of two principal faults in the northern

Coachella Valley, the Mission Creek and Banning faults. The Mission Creek fault, an eastern branch of the San Andreas fault zone, extends along a nearly straight line to the Little San Bernardino Mountains from Indio (Allen, 1957, Proctor, 1968). The Banning fault, the western branch, curves to a nearly east-west trend at the north end of the Salton Trough and mergeswith the Mission Creek fault near Indio. Near the City of Indio, the San Andreas fault zone includes a number of subsidiary breaks that lie along the northeast side of the main fault. Southeast of Indio, the San Andreas zone is relatively straight and continues to the northeast shore of the Salton Se (Allen, 1957). Throughout most of the Coachella Valley, the fault zone is well defined in alluvium by scarps and by ground water and/or vegetational lineaments. Geophysical data indicates that the basement rocks have been vertically displaced a minimum of 3.2 kilometers (2 miles) along the southwest side of the San Andreas fault zone in Coachella Valley (Biehler, Kovack and Allen, 1964).

Southeast of the Salton Sea, the surficial expression of the San Andreas fault zone is not readily apparent. Following the fault trace of the San Andreas fault zone from the northwest to the southeast results in an intermittent surficial expression of the fault evident in the northern part of the Imperial Valley (Babcock, 1971). Historic movement on the San Andreas fault zone within the Salton Trough has not been recorded in conjunction with any earthquakes, prior to the Borrego Mountain event in 1968 (Sharp, 1972).

San Jacinto Fault Zone

The San Jacinto fault zone, trending northwest-southeast, enters the Salton Trough through the Santa Rosa mountains and cuts diagonally into the basin. The San Jacinto fault zone, in the vicinity of the Salton Trough, consists of three recognizable faults forming a zone of approximately 10 kilometers wide (6.25 miles). The northern fault (Clark) extends through Clark Valley and along the southern tip of the Santa Rosa Mountains, with the middle fault lying along the west edge of Clark Valley and extending southward from the Clark fault into the Borrego Badlands, where it possibly dies out (Sharp, 1967).

The southwesternmost fault within the San Jacinto fault zone is the Coyote Creek fault, located approximately 5.75 kilometers (3.6 miles) northeast of the site. The Coyote Creek fault experienced substantial movement during the 1968 Borrego Mountain earthquake. This fault is an en echelon feature with fault splays that generally follow the northeast edge of the Borrego Valley and traverse along the margins of the Borrego Mountains and the Borrego Badlands to a point near the easternmost Fish Creek Mountains. Other faults lying farther southeast and extending into Mexico have also been regarded as part of the San Jacinto fault zone (Beal, 1915; Dibblee, 1954; Biehler, et.al., 1964; Merriam, 1965; Sharp, 1968). These include the Superstition Mountain fault and the Superstition Hills fault as well as a fault extending southeastward from the Cerro Prieto in Baja California.

The Imperial fault, as defined by the 1940 Imperial Valley earthquake, may also belong to the San Jacinto fault zone. The Imperial fault lies nearly along the projection of the Clark fault and may join at depth (Sharp, 1968). Alternatively, it has also been suggested that the movement on the Imperial fault is partially transferred northeastward to the San Andreas fault by crustal spreading near the southern portions of the Salton Sea (Lomnitz, et. al., 1970).

Elsinore Fault Zone

The Elsinore fault zone, as described in this report, includes the Aqua Caliente fault and is a discontinuous zone of fractures extending southeastward from the Peninsular Ranges into the Salton Trough near the Terra Blanca Mountains, approximately 16 kilometers (10 miles) southwest of the site. Continuity between many individual faults within the Elsinore fault zone are concealed by alluvium within the Imperial Valley. The total strike-slip displacement along the Elsinore fault zone is relatively small when compared with the San Jacinto and San Andreas fault zones (Sharp, 1968; Baird, et.al. 1970). Historic movement has not been documented within the Salton Trough along the Elsinore fault zone, with only the southern section of this zone characterized by appreciable seismicity in recent times (Sharp, 1972).

SEISMIC HISTORY

The Salton Trough region is considered to be one of the most seismically active areas of tectonicism in California (Enclosure 3). The Salton Trough has been dominated in this century by earthquakes of intermediate magnitudes (Richter magnitudes 3-6) originating along two members of the San Andreas system, the San Jacinto fault zone and the Imperial fault. Nine or more earthquakes of Richter magnitude 6+ have occurred along these faults since 1915 (Sharp, R.V., 1972). Of these nine historic earthquakes of Richter magnitude 6 or greater, six were located within 88 kilometers (55 miles) of the site, with eight of these earthquakes having occurred on or near fault breaks within the San Jacinto fault zone (Sharp. R.V., 1972). These earthquakes have caused relatively little damage, mainly because they were centered in sparsely settled desert regions. The most important of these earthquakes, in relation to the proposed development,was the 1968 Borrego Mountain earthquake of Richter magnitude 6.4, which occurred along the Coyote Creek fault within the San Jacinto fault zone. This earthquake resulted in horizontal (right-lateral) surface displacement along the Coyote Creek fault approximately 4 miles northeast of the site, as well as along several other faults within the complex San Jacinto fault zone. This Richter magnitude 6.4 earthquake ranks among the larger shocks recorded in southern California since the establishment of modern seismographic stations, and resulted in faulting along a 33 kilometer (20 mile) segment of the Coyote Creek fault (Clark,1972). The Borrego Mountain earthquake triggered a small displacement along a number of distant faults far outside the aftershock area (Allen, 1972) with these aftershocks lasting for several months after the main shock. The San Jacinto fault zone, of which the Coyote Creek fault is a member, has been the location of repeated moderate seismic activity within the entire historic record (Allen, 1965). This fault zone has been well delineated by seismic activity, with no one location along the San Jacinto fault zone in the Salton Trough seeming more prone to earthquake faulting. Many of the epicenters of these earthquakes have been about equidistant along the fault, with the 1968 Borrego Mountain epicenter lying approximately midway between the epicenters of the lower Borrego Valley earthquake (Richter magnitude 6.5) and the Santa Rosa earthquake (Richter magnitude 6.2) of 1954. The 1968 Borrego Mountain earthquake resulted in visible surface waves which caused anchored objects (utility poles, buildings) to move at the proposed developmental site (Sharp, R.V., 1972, Plate 4).

The location of the site, in relation to earthquake epicenters between 1934 and 1968 in San Diego County, is shown on Enclosure 3 (Seismic Safety Element to the County of San Diego). Two epicenters between Richter magnitudes 2.0 to 3.0 have been plotted as having occurred at depth below the site.

SOIL SURVEY

The entire site is located on alluvium, part of a large bajada (nearly flat surface of confluent alluvial fans) which skirts the mountains to the west. The barren slopes of these mountains provide runoff from precipitation which has deposited the alluvium in the valley.

The soils of the area and on-site are divided into two associations (Mecca-Indio, Rositas-Carrizo) and four series (Enclosures 2 and 2A). These soils (alluvium) may be generally characterized as loosely consolidated, highly permeable, and susceptible to wind and water erosion, with one of these series (Indio Silt Lome) being subject to settling (See Enclosure 2A for detailed description).

HYDROLOGIC SETTING

The Borrego Valley is a structural depression created by the Coyote Creek fault and is a desert basin located in the northeast portion of San Diego County. The area contributing water to the Borrego Valley consists of approximately 280 square miles, of which 195 square miles are steep rocky slopes (Lough, C.F., 1974). The remaining portion of the Borrego Valley watershed consists of approximately 85 square miles (55,000 acres) and is the valley portion of Borrego Valley. The basin is filled to an unknown depth with alluvium and based on water well data on-site, is a minimum of 600 feet in structures and roadways on the site.

RECOMMENDATIONS

A maximum probable earthquake of Richter magnitude 7.0 is expected along the San Jacinto fault zone in the Salton Trough, 3.6 miles from the site; therefore, we recommend human occupancy structures be designed accordingly.

No human occupancy structures should be placed across the possible fault through the extreme northeast portion of the golf course unless trenching proves the possible fault to be non-existent or inactive.

The potential for flooding on site should be evaluated and mitigated by the design engineer.

That portion of the site shown on Enclosure 2 as containing the Indio Silt (IoA) series should be investigated by the Soils Engineer for possible special foundation recommendations.

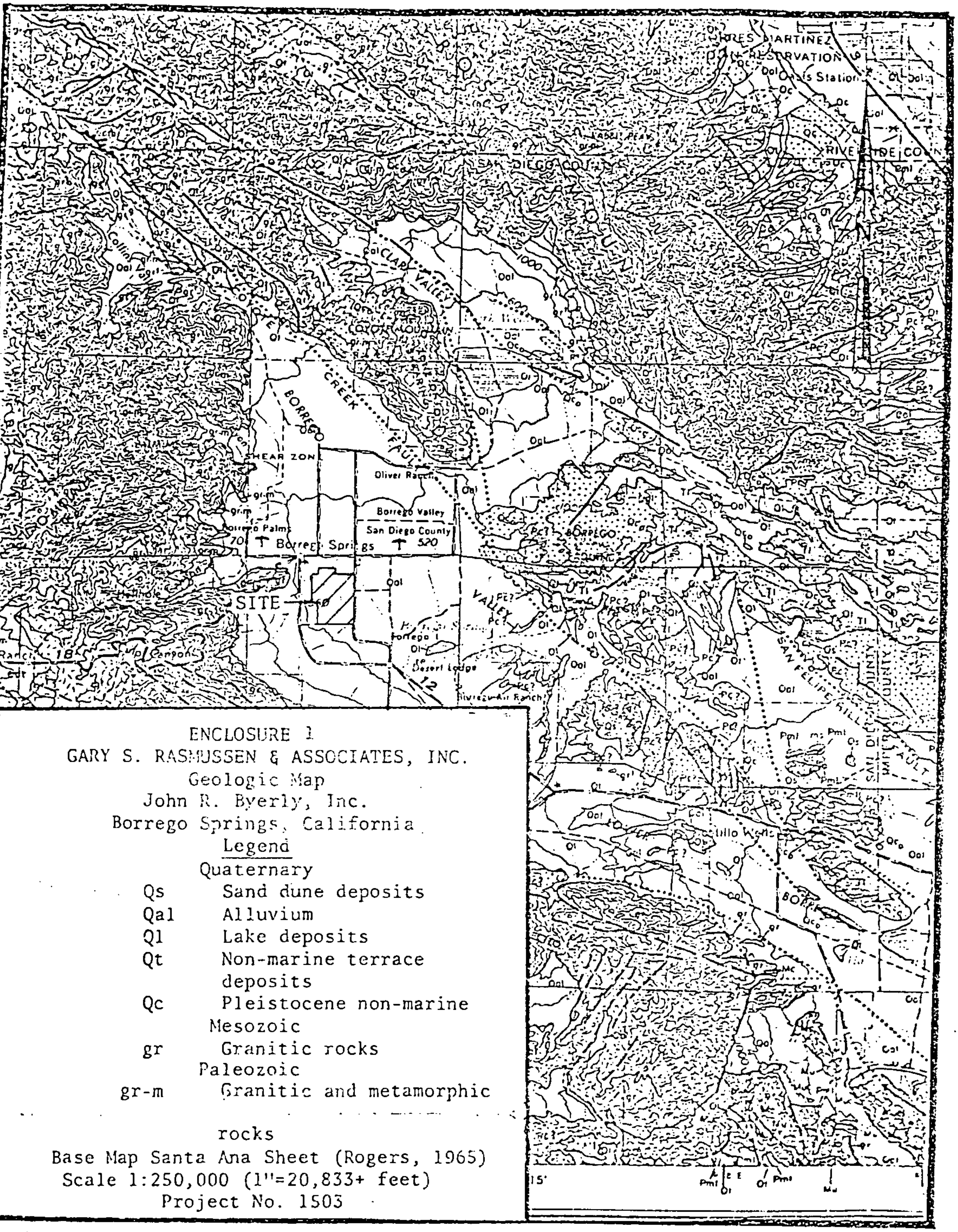
Respectfully submitted,
GARY S. RASMUSSEN & ASSOCIATES

Daniel D. Bush,
Staff Geologist

Gary S. Rasmussen
Engineering Geologist, EG 925

DDB:GSR/rc
Enclosures: 1-Geologic Map
2, 2A-Soil Survey and Description
3-Seismic Safety Element
4-References
5-Trench Logs

Distribution-John R. Byerly, Inc. (8)



ENCLOSURE 1
GARY S. RASMUSSEN & ASSOCIATES, INC.
Geologic Map
John R. Byerly, Inc.
Borrego Springs, California

Legend

Quaternary

Qs	Sand dune deposits
Qal	Alluvium
Ql	Lake deposits
Qt	Non-marine terrace deposits
Qc	Pleistocene non-marine

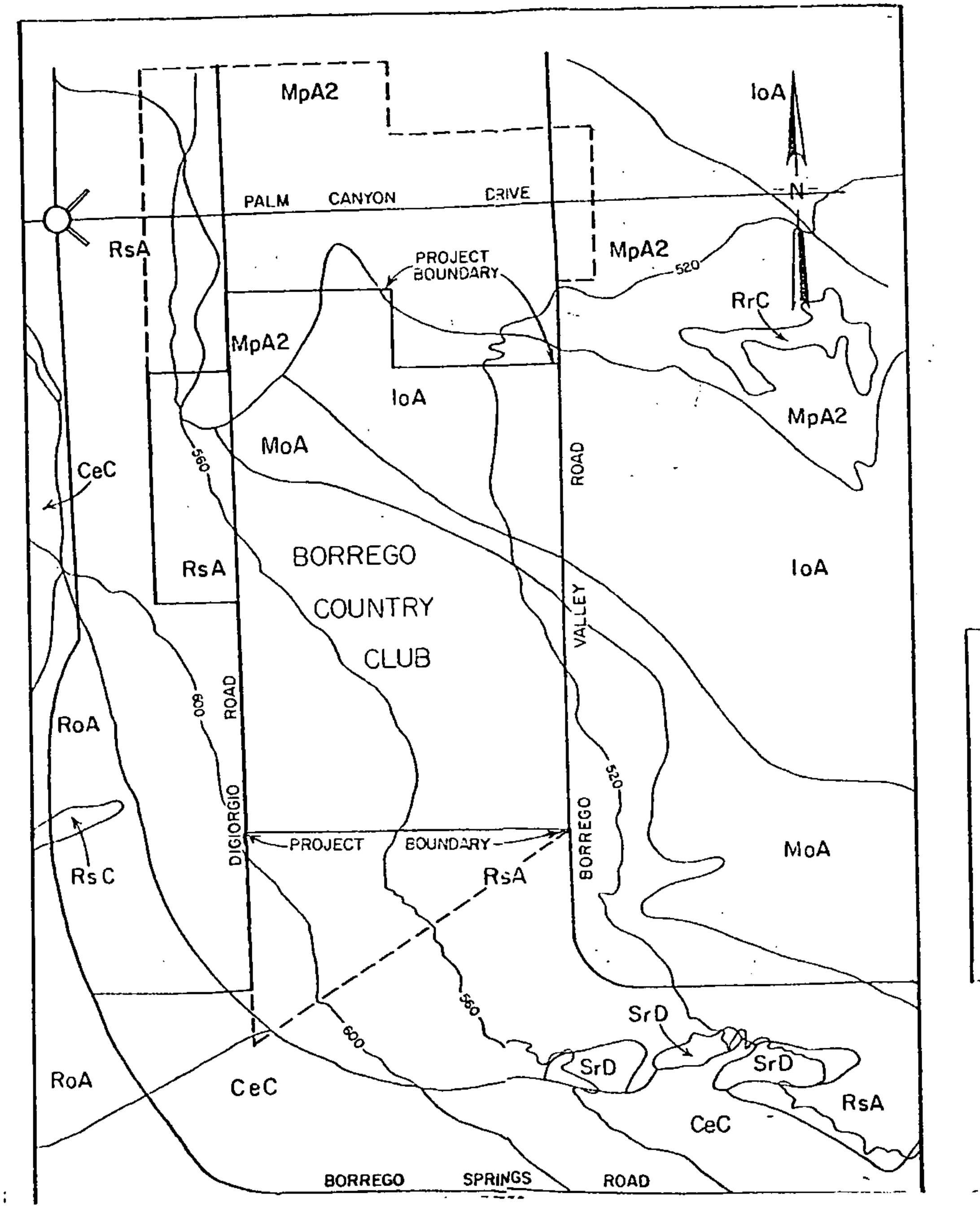
Mesozoic

gr	Granitic rocks

Paleozoic

gr-m	Granitic and metamorphic rocks

Base Map Santa Ana Sheet (Rogers, 1965)
Scale 1:250,000 (1"=20,833+ feet)
Project No. 1503



ENCLOSURE 2
GARY S. RASMUSSEN & ASSOCIATES, INC.
John R. Byerly, Inc.
Borrego Springs, California

<u>Legend</u>

IoA	Indio Silt Loam
MoA	Mecca Sandy Loam
MpA2	Mecca Fine Sandy Loam
RsA	Rositas Loamy Coarse Sand

Base Map: USDA Soil Conservation Service Soils Classification
Scale 1"=2000'
Project No. 1503

Enclosure 2A
Gary S. Rasmussen & Associates
John R. Byerly, Inc.
Borrego Springs, California

SOIL CAPABILITY AND CHARACTERISTICS

Individual Soils	Slope	Land Capability	Characteristics	Erodibility	Suitability as Topsoil
Indio Silt Loam (IoA)	0-2%	IIIs-6	Subject to flooding, ponding or overflow, slow infiltration rate, settlable	Severe	Poor
Mecca Sandy Loam (MoA)	0-2%	IIIs-6	Subject to flooding, ponding or overflow, moderate infiltration rate	Severe	Fair
Mecca Fine Sandy Loam (MpA2)	0-2%	IIe-4	Moderate infiltration rate, subject to wind erosion and abrasion	Severe	Good
Rositas Loamy Coarse Sand (RsA)	0-2%	IVs-4	High infiltration rate, well drained	Severe	Poor

*Notes

- e - Main limitation is risk of erosion
- s - Limited because it is shallow, droughty, or stony
- 4 - Coarse texture or excessive gravel
- 6 - Salts or alkali
- II - Moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- III - Severe limitations that reduce the choice of plants, require special conservation practices, or both.
- IV - Very severe limitations that reduce the choice of plants, require very careful management, or both.

REFERENCES

Advance Planning and Research Associates, August, 1978, Draft Environmental report, Rodgriquez Borrow Pit, p. 77-64, EAD Log No. 77-5-4, Borrego Springs, California, Report No. 78-0704.

Allen, C.R. 1957, San Andreas fault zone in San Gorgonio Pass, southern California: Geol. Soc. America Bull., v. 68, no. 3, pp 315-350

Allen, C.R., Saint Amand, P., Richter, C.F., and Hordquist, J.M., 1965, Relationship between seismicity and geologic structure in southern California region: Seismological Society of America Bulletin, v. 55, no. 4, pp. 753-797.

Babcock, E.A., 1971, Detection of active faulting using oblique infarred aerial photography in the Imperial Valley, California, Geol. Soc. America Bull., v. 82, p 3189-3196.

Baird, A.K., Welday, E.E., and Baird, K.W., 1970, Chemical variations in batholithic rock of southern California: Geologic Society of America, abstracts with programs, v. 2, no. 2, p. 69.

Beal, C.H., 1915, The earthquake in Imperial Valley, California, June 22, 1915: Seismological Society of America Bulletin, vol. 5, pp 130-149.

Bennett, J.H., & Rodgers, D.A., 1975, Crustal movement investigations along the San Andreas fault in southern California, in Crowell, J.C., ed., 1975, San Andreas fault in southern California, a guide to San Andreas fault from Mexico to Carrizo Plain: Calif. Div. Mines & Geol. Special Report 118, pp 53-60.

Biehler, S., Kovach, R.L., and Allen, C.R., 1964, Geophysical framework of northern end of Gulf of California structural province, in Van Andel T.H., and Shor, G.G., Jr., Marine Geology of Gulf of California; American Association of Petroleum Geologist, Mem. 3, p. 126-143.

Bonilla, 1970, Surface faulting and related effects in Earthquake engineering, Prentice-Hall, Englewood Cliffs, Ch. 3, pp 47-74.

California Department of Water Resources, 1964, Crustal strain and fault movement investigation-faults and earthquakes in California: Department of Water Resources Bulletin 116-2.

California Department of Water Resources, 1968, Water Wells and springs in Borrego, Corrizo and San Felipe Valley areas; Dept. of Water Resources Bulletin 91-15.

Clark, M.M., Grantz, A., and Rubin, M., 1972, Holocene activity of the Coyote Creek fault as recorded in sediments of Lake Coahuila, Professional Paper 787, pp 112-130, U.S. Geological Survey, Washington, D.C.

Dibblee, T.W., Jr., 1968, Displacement of the San Andreas fault system in the San Gabriel, San Bernardino, and San Jacinto Mountains, southern California, in Dickinson, W.R., and Grantz, A., eds., Conference of geologic problems of San Andreas fault system, Stanford, California, 1967, Proceedings, Stanford University Publications, Dept. of Geol. Sciences, v. II, pp 260-276.

Dibblee, T.W., Jr., 1970, Regional geologic map of the San Andreas and related faults in eastern San Gabriel Mountains, San Bernardino Mountains, western San Jacinto Mountains and vicinity, Los Angeles, San Bernardino, and Riverside Counties, CA: U.S. Geological Survey Open-file report.

Dibblee, T.W., Jr., 1975, Late Quaternary uplift of the San Bernardino Mountains on the San Andreas and related faults, in Crowell, J.C., ed., 1975, San Andreas fault in southern California, a guide to San Andreas fault from Mexico to Carrizo Plain: California Division of Mines and Geology Special Report 118, p. 127-135.

Dickinson, W.R., and Grantz, A., 1968, Indicated cumulative offsets along the San Andreas fault in the California coast ranges; proceedings, Conference on Geological Problems of San Andreas fault system, Stanford University Publications, Geological Sciences, Publisher, Stanford, California, Vol. 11, pp 117-119.

Friedman, M.E., Whitcomb, J.H., Allen, C.R., and Hileman, J.A., 1976. Seismicity of the southern California region, 1 January 1972, to 31 December 1974, Seismological laboratory, California Institute of Technology.

Greensfelder, R.W., 1972, Crustal movement investigations in California, their history, data, and significance: California Division of Mines and Geology, Special Publication 37.

Greensfelder, R.W., 1974, Maximum credible rock acceleration from earthquakes in California: California Division of Mines and Geology Map Sheet 23.

Hart, E.W., 1976, Fault hazard zones in California: California Division of Mines and Geology Special Publication 42, Revised Edition.

Heaton, T.H., Helmberger, D.V., April 1977, A study of strong ground motion of the Borrego Mountain California earthquake, in Bulletin of the Seismol. Soc. of America, v. 67, no. 2.

Hileman, J.A., Allen, C.R., and Nordquist, J.M., 1973, Seismicity of the southern California region, 1 Jan 1932 to 31 Dec 1972: Seismol. Lab. California Institute of Technology, Pasadena, California, p. 404.

Hope, R.A., 1969, Maps showing recently active breaks along the San Andreas and related faults between Cajon Pass and Salton Sea, California: U.S. Geological Survey Open-file report, 1:24,000.

Jennings, C.W., 1975, Fault map of California with locations of volcanoes, thermal springs and thermal wells: California Division of Mines and Geology, 1:750,000.

Lamar, D.L., Merifield, P.M., and Proctor, R.J., 1973, Earthquake recurrence intervals on major faults in southern California, in Moran, D.E., and others, eds., 1973, Geology, seismicity and environmental impact: Assoc. Engineering Geologist, Spec. Pub., pp 265-276.

Lomnitz, et. al., 1970, Seismicity and tectonics of the norther Gulf of California region, Mexico, Preliminary results. Geofisica Internacional, vol. 10, no. 2, pp 37-48.

Lough, C.F., November 1974, Water budget for Borrego Valley, San Diego County Planning Div., San Diego County, California.

McEven, Robert, Piuckney, C.J., Seismic Risk in San Diego, Studies on the geology and geological hazards in greater San Diego Area, California and San Diego Society National History Transactions, v. 17, p. 33-62, 1972.

Mendenhall, W.C., 1909, Ground water of the Indio region, California: U.S. Geological Survey Water Supply Paper 225, p 56.

Ploessel, M.R., & Slossen, J.E., 1974, September, Repeatable high ground accelerations from earthquakes; from California Geology, vol. 27, no. 9, pp 195-199.

Proctor, R.J., 1968, Geology of the Desert Hot Springs-Upper Coachella Valley area, California: California Division of Mines and Geology Special Report 94.

Richter, C.F., Allen, C.R., and Nordquist, J.M., 1958, The Desert Hot Springs earthquakes and their tectonic environment: Seismol. Soc. America Bulletin, pp 315-337.

Rogers, T.H., 1965, Geologic map of California, Olaf P. Jenkins edition, Santa Ana Sheet: California Division of Mines and Geology.

Rogers Engineering Company, August 1977, Non-electric applications of geothermal resources at Desert Hot Springs, California, quarterly report for period May 23, 1977-August 12, 1977: Prepared for the Energy Research and Development Administration, Div. of Geothermal Energy.

San Diego County Seismic Safety Element to the General Plan, Part V, 1975.

Schnabel, P.B., and Seed, H.M., 1973, Accelerations in rock for earthquakes in the western United States: Seismol. Soc. America Bull., v. 63, no. 2, pp 501-516.

Sharp, R.V., 1967, San Jacinto fault zone in the Peninsular Ranges of southern California, Geological Society of America Bulletin, v. 78, pp 705-730.

Sharp, R.V., 1972, Map showing recently active breaks along the San Jacinto fault zone between the San Bernardino area and Borrego Valley, Calif: U.S. Geological Survey Misc. Geologic Investigations Map I-675, Scale 1:24,000.

Sharp, R.V., 1972, The Borrego Mountain earthquake of April 9, 1968, Geologic Survey Professional Papers 787.

Slemmons, D.B., 1977, State-of-the-art for assessing earthquake hazards in the United States: U.S. Army Engineer Waterways Experiment Station Report 6

Tyler, S.J., 1974, Analog model study of the ground water basin of the Upper Coachella Valley, California: USGS Water Supply Paper 2027.

U.S.D.A. Stereoscopic aerial photographs, May 12, 1953, photo numbers AXN 12M 130-133, AXN 13M 69-72, AXN 14M 171-174, AXN 17M 20-23, Nominal scale 1"=1,667'.

Ver Planck, W.E., 1952, Gypsum in California: Calif. Div. of Mines and Geology Bulletin 163, p 151.

Wallace R.E., 1970, Earthquake recurrence intervals on the San Andreas fault: Geological Society of America Bulletin, v. 81, pp 2875-2889.

Woodward, Clyde, Sherard & Associates, Soil investigation for the proposed Borrego Springs Park Development, San Diego, California, April, 1962.

JOHN R. BYERLY, INC.

2230 SOUTH RIVERSIDE AVENUE • BLOOMINGTON, CALIFORNIA 9231[illegible]

PHONES: BLOOMINGTON (714) 877-1324 • RIVERSIDE (714) 684-97[illegible]

PRELIMINARY SOILS INVESTIGATION

PROPOSED BORREGO SPRINGS DEVELOPMENT

FEDERATED DEVELOPMENT COMPANY

We trust this information is sufficient for your needs at this time. Should questions arise, please do not hesitate to contact this office.

Respectfully submitted,

JOHN R. BYERLY, INC.

Roger A. Shervington, Civil Engineer

RAS:lw

Copies: (3) Client
(3) Boyle Engineering
Attention: Wesley Hylen

Rpt. No.: 8883
File No.: S-4559

JOHN R. BYERLY, INC.

2250 SOUTH RIVERSIDE AVENUE • BLOOMINGTON, CALIFORNIA 923

PHONES: BLOOMINGTON (714) 877-1324 • RIVERSIDE (714) 684-9775

July 26, 1979

Federated Development Company
1100 Glendon Avenue
Los Angeles, California 90024

Rpt. No.: 8977
File No.: S-4559

Attention: Mr. Hershel Berkes

Subject: Proposed Borrego Springs Development, Borrego Springs, California; Addendum to Preliminary Soils Investigation

Reference: Preliminary Soils Investigation, Report No. 8844, June 1, 1979

Gentlemen:

The referenced report presents our conclusions and recommendations concerning soil conditions encountered during an investigation at the subject site. Enclosure 4 to the referenced report presents an engineering geology report prepared for the subject development by Gary S. Rasmussen & Associates of San Bernardino. In the geology report, Mr. Rasmussen discussed the existence of a soil formation known as the Indio Silts. This soil formation is shown on USDA soil maps and is indicated as having significant settlement potential. Mr. Rasmussen concluded that these soils should be specifically addressed by the Soils Engineer.

Inasmuch as our initial investigation did not heavily explore areas believed to be underlain by the Indio Silt formation, additional investigation was performed by this firm. Our additional investigation involved the excavation of 3 additional test pits excavated to a maximum depth of 7.0 feet utilizing hand equipment. The soils encountered were examined and visually classified by one of our field engineers. Undisturbed samples of the Indio Silts were obtained at selected levels within the test pits and returned to the laboratory for testing and evaluation. Included in our laboratory testing were moisture-density determinations on all undisturbed samples. In addition, selected samples were tested in consolidation in order that we might evaluate the settlement potential of this soil formation. Our test pit logs, together with our moisture density data, is presented on Enclosure 2. The test pit logs show the subsurface conditions at the locations and date indicated and may not be representative of subsurface conditions at other locations and times. The stratification lines presented on the test pit logs represent the approximate boundaries between soil types and the transitions may be gradual. Summaries of our consolidation tests are presented on Enclosure 3.

Our laboratory test data indicates that the Indio Silts are subject to significant consolidation under the anticipated foundation loads, especially upon saturation. To provide adequate foundation support, residential structures placed in areas known to be underlain by the Indio Silts should be founded on a compacted fill mat. A compacted fill mat will provide a uniform, dense, high strength soil area layer to distribute the foundation loads over the compressible underlying soils. In addition, a compacted fill mat will provide a relatively impermeable soil layer to inhibit percolation of surface water to the collapsible underlying soils. We anticipate that conventional spread or continuous wall footings may be safely utilized in conjunction with a compacted fill mat. Additional measures to minimize settlement would be positive drainage away from the structures. In addition, residences in these areas should be provided with eave gutters and downspouts.

We trust this information is sufficient for your needs at this time. If we may be of further assistance or should questions arise, please do not hesitate to contact this office.

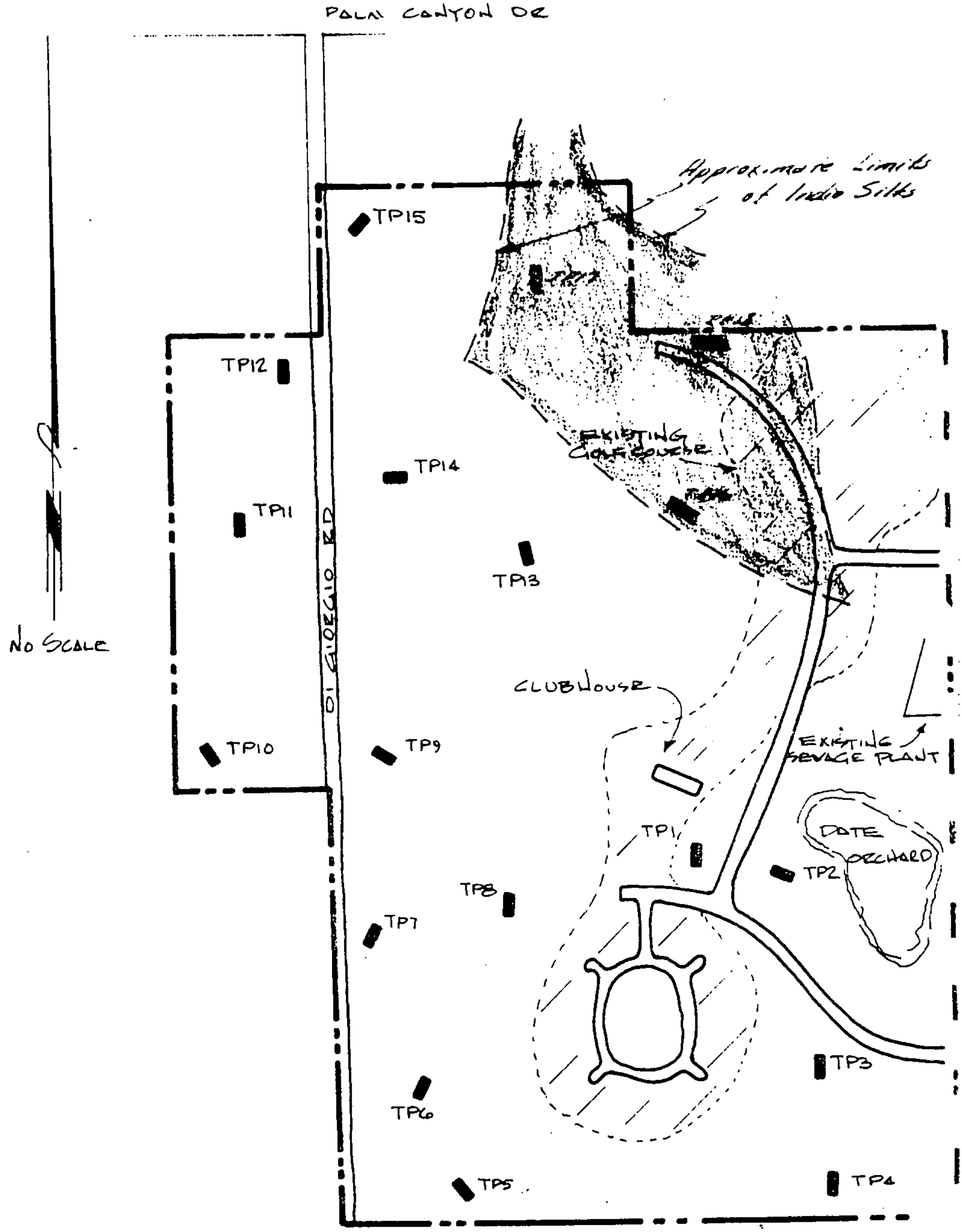
Respectfully submitted,

JOHN R. BYERLY, INC.

Roger A. Shervington, Civil Engineer

Enclosures: (1) Plot Plan
(2) Test Pit Logs
(3) Consolidation Test Data

cc: (3) Boyle Engineering
Attn: Wesley Hylen



Enclosure 1
Rpt. No.: 8977
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Test Pit No. 16

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
				0
	77	1.8		
				1
	80	5.4		
				2

Grey fine sandy silt (ML) (dry & firm) (porous)

Total depth 1.5 feet

No free ground water encountered

Test Pit No. 17

DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)
	78	2.2		0
	78	2.5		1
				2
	91	1.7		3
				4

Grey fine sandy silt (ML) (dry & firm) (porous)

Total depth 3.0 feet

No free ground water encountered

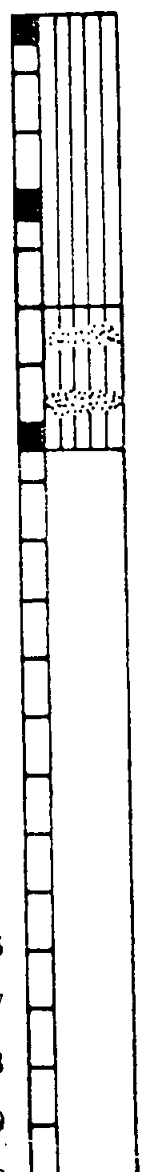
Enclosure 2, Page 1
Rpt. No.: 8977
File No.: S-4559

Form 8

JOHN R. BYERLY, INC.

Federated Development Company
Proposed Borrego Springs Development
Test Pit No. 18

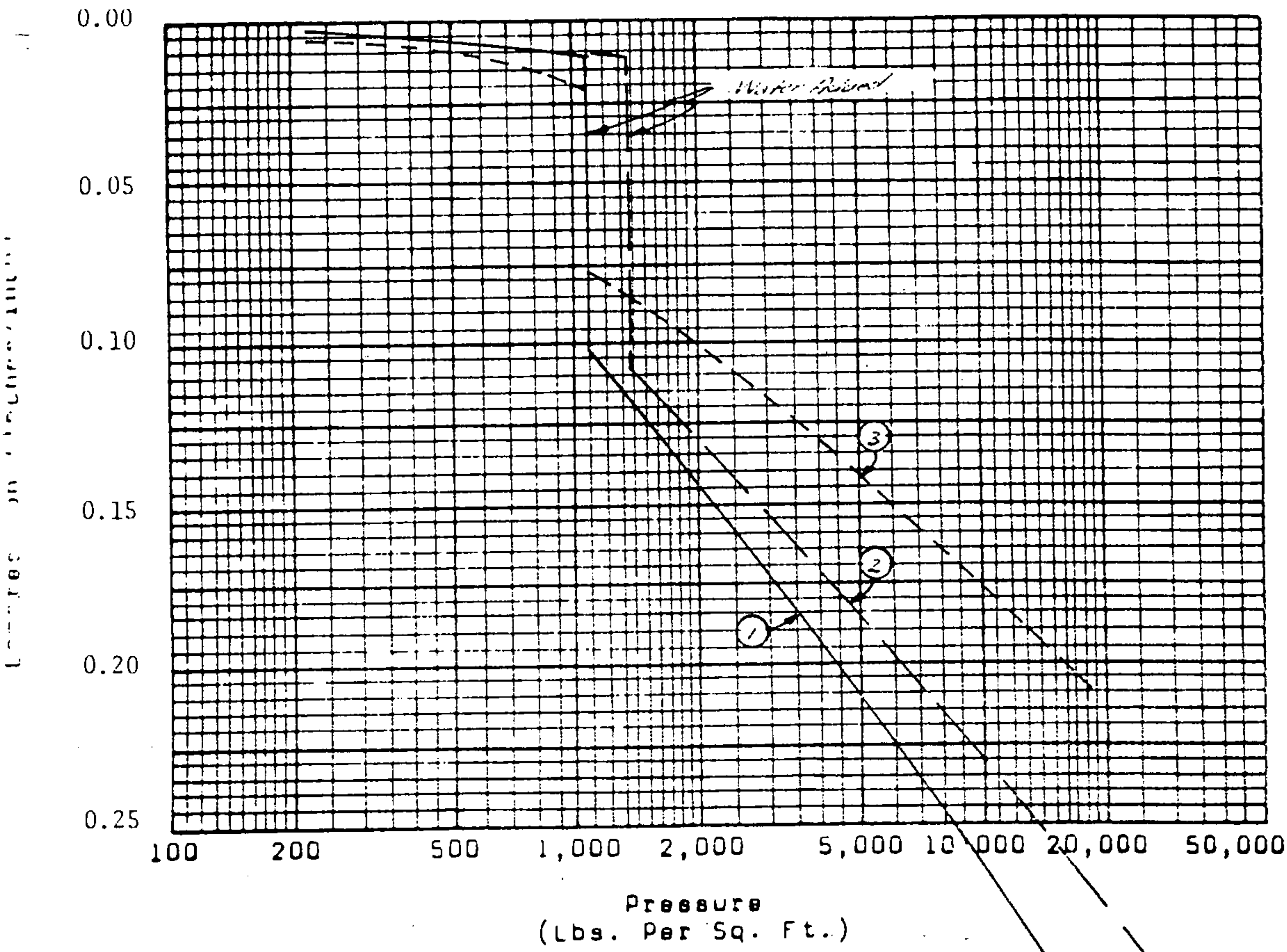
DRIVING ENERGY (KIP-FT/FT)	DRY DENSITY (PCF)	MOISTURE CONTENT (PERCENT)	RELATIVE COMPACTION (PERCENT)	DEPTH (FEET)	
				0	Grey fine sandy silt (ML) (dry and firm) (porous)
	92	1.7		1	
				2	
				3	
	80	4.5		4	
				5	As above, w/inclusions of fine sand (
				6	
				7	Total depth 7.5 feet
	87	4.1		8	No free ground water encountered
				9	
				10	
				11	
				12	
				13	
				14	
				15	
				16	
				17	
				18	
				19	
				20	



Enclosure 2, Page 2
Rpt. No.: 8977
File No.: S-4559

PROJECT: BORREGO SPRINGS

CONSOLIDATION TEST DATA



Curve	Boring	Depth	Soil	Moisture Content Before	Moisture Content After	Dry Density Lbs./Cu.Ft.
1	16	0.0	Grey fine sandy silt (ML)	1.8		77.1
2	16	1.0	Grey fine sandy silt (ML)	5.4		79.9
3	18	7.0	Grey fine sandy silt (ML)	4.7		87.1

Enclosure 3
Rpt. No.: 8977

SOIL INVESTIGATION FOR THE PROPOSED BORREGO SPRINGS PARK DEVELOPMENT

San Diego, California

by

WOODWARD-CLYDE-SHERARD AND ASSOCIATES
Consulting Soil and Foundation Engineers

San Diego, California

BORREGO SPRINGS PARK

3010 Cowley Way
San Diego, California

WOODWARD • CLYDE • SHERARD & ASSOCIATES Consulting Civil Engineers

3467 KURTZ STREET • SAN DIEGO 10, CALIFORNIA • TELEPHONE ACADEMY 2-1187
Soil and Foundation Engineering

DENVER, COLO.
KANSAS CITY, MO.
OAKLAND, CALIF.
OMAHA, NEB.
MONTCLAIR, N. J.
SAN DIEGO, CALIF.
NEW YORK, N. Y.

April 13, 1962
Job No. 62-164

Borrego Springs Park
3010 Cowley Way
San Diego, California

Attention: Mr. Vince Mattingly

Gentlemen:

At the requst of Mr. Vince Mattingly of your organization, we have made an investigation of the underlying soil conditions at the site of the proposed Borrego Springs Park development.

The accompanying report gives our conclusions and recommendations as well as the results of the subsurface exploration and laboratory tests upon which these recommendations are based.

Very truly yours,

WOODWARD-CLYDE-SHERARD & ASSOCIATES

By Gerald L. Baker
Gerald L. Baker, R. E. 12112

Reviewed by
Douglas C. Moorhouse, R. E. 9027

Lewis Lee

22-1-291

(8 cc)

TABLE OF CONTENTS

SCOPE

This report describes an investigation of the underlying soil conditions at the site of the proposed Borrego Springs Park development, located in portions of Sections 4, 5, 8, and 9, T11S, R6E SBBM, near Borrego Springs, California. The study is intended to determine the most suitable foundation type, required footing depths and allowable soil bearing pressures for residential construction, as well as to make recommendations regarding site grading. In addition, the requirements of the Federal Housing Administration and the San Diego Department of Public Health regarding sewage disposal are presented.

FIELD INVESTIGATION

Fourteen test borings were made with a 6-inch diameter power auger at the locations shown on the Site Plan, Figure 1. The drilling was done on March 29, 30 and 31, 1962, under the supervision of a staff engineering geologist. Field boring logs were prepared by the geologist on the basis of an examination of the samples secured and the excavated material. The Logs of Borings presented on Figures 1 through 4, are based on an inspection of the samples, on the laboratory test results, and on the field boring logs. The vertical position of each sample is shown on the Logs of Borings.

In addition to the work done to determine the soil conditions, twelve percolation tests and four field permeability tests were performed to aid in estimating the requirements for sewage disposal systems. The percolation tests were made at a depth of 3 feet and in accordance with the procedure outlined on page 4 of "Manual of Septic Tank Practice" published by the U.S. Department of Health, Education and Welfare. The field permeability tests were performed in accordance with test Designation E-19, as described in the "Earth Manual" published by the U. S. Department of the Interior, Bureau of Reclamation. The results of these tests are given in Tables 1 and 2.

LABORATORY TESTS

The soils encountered were visually classified and evaluated with respect to strength, compressibility characteristics, dry density and moisture content. The classification was substantiated by grain size analyses on representative samples of the soils. Fill suitability tests, including compaction tests, direct shear tests, and grain size analyses were performed on representative samples of the on-site soils. The strength of the soils was evaluated by consideration of the density and moisture content of the samples and the penetration resistance of the sampler. Compressibility characteristics were evaluated by confined compression tests on undisturbed samples and consideration of the density of the samples and the penetration resistance of the sampler.

The results of tests on undisturbed samples, except for the confined compression tests, are shown with the penetration resistance of the sampler at the corresponding sample location on the Logs of Borings. The confined compression tests are reported in Table 3, and the fill suitability tests are reported on Figures 5, 6 and 7.

SITE AND SOIL CONDITIONS

The site is located in the western portion of Borrego Valley along the eastern margin of the alluvial fans extending eastward from the mountains. The ground surface slopes gradually toward the northeast at a maximum grade of about 1 percent. As indicated on the site plan, a portion of the site is used for date orchards. An unpaved airstrip and three high capacity wells also exist on the property. The northern portion of the property has been used in the past to raise various grains and cotton; however according to long-time residents of the area, the southern portion has always remained dormant.

The soils encountered at the site consist of sands and silts varying in consistency from loose to dens. In general, the soils become finer in texture and slightly lower in density in a northeast direction. Above an elevation of approximately 560 feet, the soils are loose silty sands to a depth of 1 to 2 feet, and are underlain by medium dense to dense silty sands. Below an elevation of approximately 560 feet, the soils are loose silty sands and sandy silts to depths varying from 3 to 13 feet; these soils are underlain by medium-dense to dense silty sands and sandy silts.

The maximum depth of the alluvial material is not known, although the logs of the wells on the property indicate that they extend below a depth of 630 feet. Ground water was not encountered in any of the borings, and the soils, except for some of the underlying silt layers were very low in moisture content.

DISCUSSION

Two requirements must be fulfilled by any foundation material. First, it must be safe against shear failure, which would result in lateral movement of soil from under the load. Second, the settlement must not exceed the amount permissible for the particular type of structure.

Sandy soils, such as those encountered at the site, have good shear strengths when properly confined. Settlement on such soils is not excessive if the bearing capacity is governed by the compactness of the material. Compactness is best measured by the dry density of the sample and the resistance to penetration of the sampler. As mentioned previously, below an elevation of approximately 560 feet, the soils tend to be low in density to greater depths. In their present condition, some of these soils could densify under normal residential footing loads, resulting in undesirable settlements of the structures. Additional densification could take place if the soils became saturated at a later date, for example, from lawn watering. It is anticipated that this condition can be alleviated by surface compaction with a heavy vibrating sheepsfoot roller, although the type and extent of treatment necessary can best be determined when development plans showing the location and type of structures and any proposed grading are available.

The percolation and permeability test data indicate that the soils at the site are capable of readily accepting water, and for the most part, the minimum acceptable lengths of disposal trenches will be satisfactory. However, we have discussed this project with Mr. Edwin Heimlich, Chief Land Planner for the San Diego office of the Federal Housing Administration and Mr. J. H. Whitman, Assistant Chief, Division of Sanitation, San Diego Department of Public Health, and Mr. Arthur Swajian, Chairman, Water Pollution Control Board, Colorado River Basin, Region 7. These gentlemen indicate that if multiple family dwellings on large lots are proposed, a sewage treatment plant must be constructed. It appears, though, that if the development consists of single family residences on individual lots, individual septic tanks and disposal fields will be acceptable. For this case, the other agencies have indicated that the requirements of the San Diego Department of Public Health will govern. For the types of soils encountered, the publications of the San Diego Department of Public Health (Ordinance 1258 New Series, and SAN 88) indicate that two-compartment septic tanks having a minimum capacity of 960 gallons will be required and two 100 foot long disposal trenches will probably suffice for each lot. The Department of Public Health does not encourage the use of seepage pits (rather than disposal trenches), however, according to local residents standard practice in the Borrego Springs area appears to be the use of a horizontal seepage pit 4 feet wide, 6 feet deep, and 10 feet long. The Department of Public Health also requires that at least twenty percent of the lots in a subdivision be tested to determine the rate of percolation.

If the proposed development consists of multiple family living units on large lots, the requirements for sewage treatment and disposal will be determined by the Federal Housing Administration and the State Water Pollution Control Board. Both of these agencies have indicated that the requirements for treatment and disposal can be determined only after a study of the proposed development. The normal procedure is to submit plans for the proposed development, including plans showing the method of sewage treatment and disposal. These agencies will then study the plans to determine if the proposed treatment is satisfactory and recommend modifications where necessary.

CONCLUSIONS

1. Footings for residential structures placed on the underlying medium-dense undisturbed native soils (above elevation 560 feet) or properly compacted fill may be designed for a bearing pressure of 1500 psf at a depth of 8 inches or 2000 psf at a depth of 12 inches below rough lot grade.

2. When development plans for the northeast portion of the site (below elevation (560 feet) are available, additional study should be made of this area to determine the possible effects of saturation of the loose soils under the load. The study should include field plate bearing tests on saturated areas and laboratory tests on both undisturbed and compacted samples.

3. The soils expected to be used in fills have low volume change characteristics.

4. If single family residences on individual lots are planned for this development, two-compartment septic tanks having a minimum capacity of 960 gallons will be required for each residence. Disposal of the effluent can probably be accomplished by two 100 foot long disposal trenches or one seepage pit 4 feet wide 6 feet deep and 10 feet long. At least twenty percent of the lots in a subdivision must be tested to determine the rate of percolation.

5. If the proposed development consists of multiple family living units on large lots, a sewage treatment plant will be required by the San Diego Department of Public Health and the Federal Housing Administration. The design of the treatment plant and the means of disposal of effluent must be approved by the Federal

Housing Administration and the State Water Pollution Control Board, Colorado River Basin, Region 7.

RECOMMENDATIONS

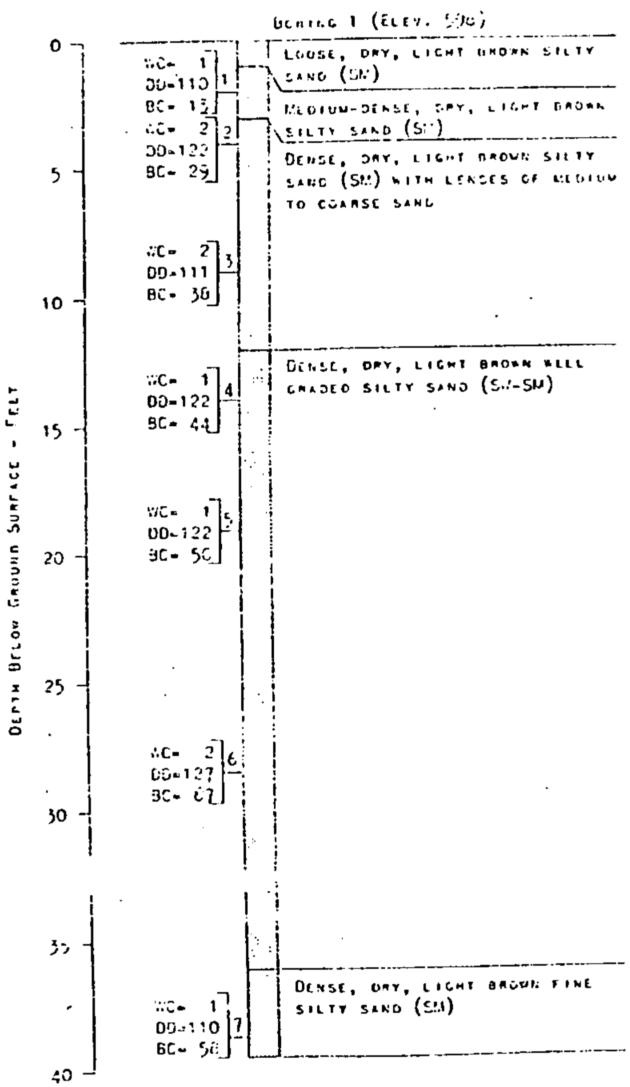
1. It is recommended that the loose surface soils not removed by grading operations be compacted before footings or slabs are placed.

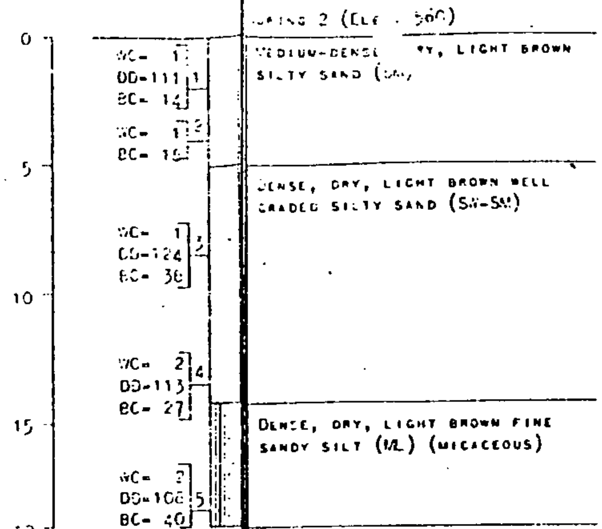
2. It is recommended that a study of the disposition of the loose material in the northeast portion of the site be made when development plans are available. It is anticipated that compaction from the surface by heavy compaction equipment will densify the soils sufficiently, although it may be necessary to remove part of these materials and replace them as compacted fill.

3. A set of earthwork specifications is attached. The recommendations made as a part of this preliminary soils report shall become a part of the earthwork specifications.

LIMITATIONS

The recommendations made in this report are based on the assumption that the soil conditions do not deviate appreciably from those disclosed by the borings. If variations are encountered during construction, we should be notified so we may make supplemental recommendations if this should be required.





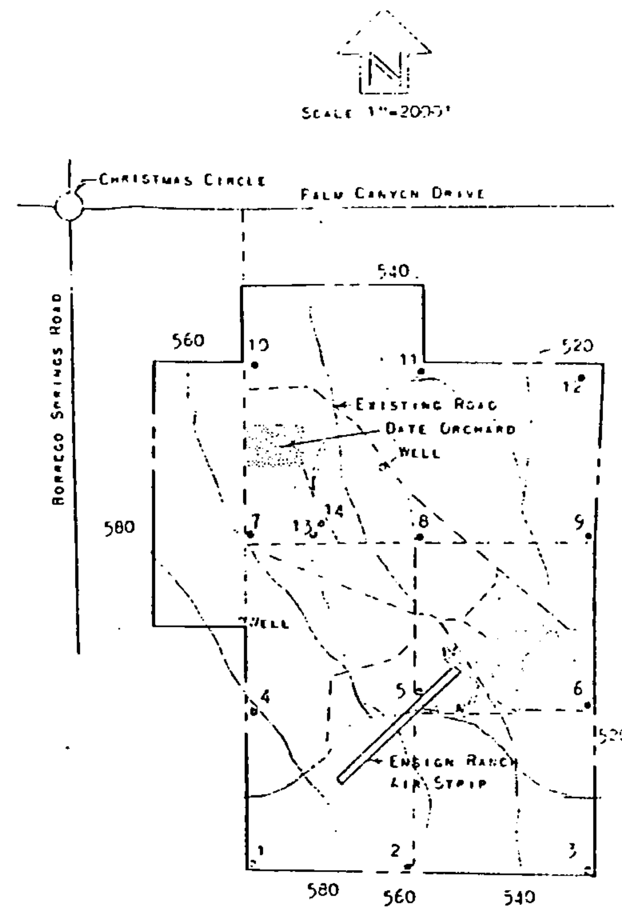
LEGEND

WC - Water Content in percent of dry weight.

DD - Dry Density in Lbs./Cu.Ft.

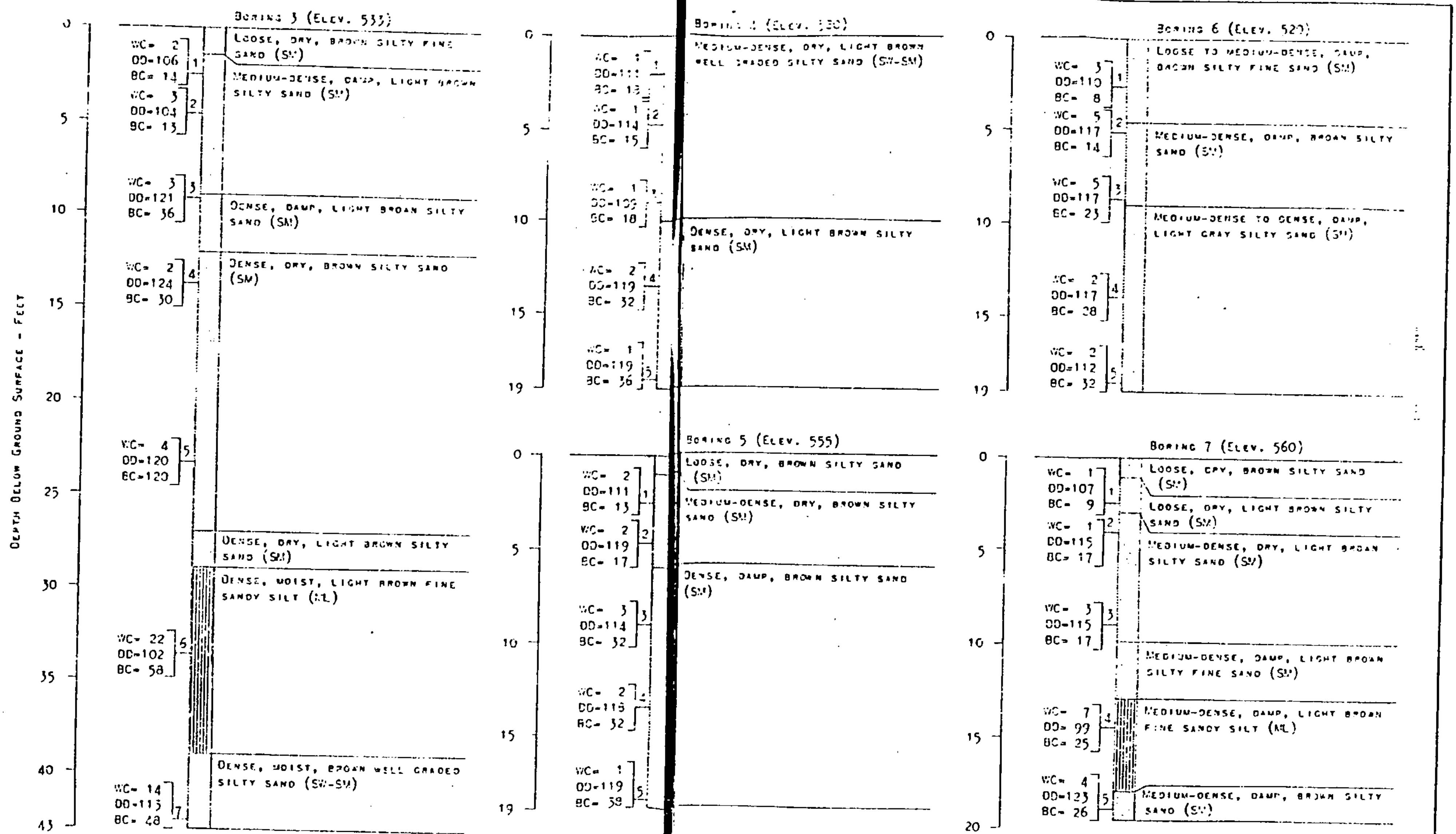
BC - Number of blows by 140-Lb. hammer falling 30 inches to drive sampler 12 inches. Sampler Data: ID = 2.0", OD = 2.5".

(SM) - Group classification symbol in accordance with the Unified Soil Classification System.



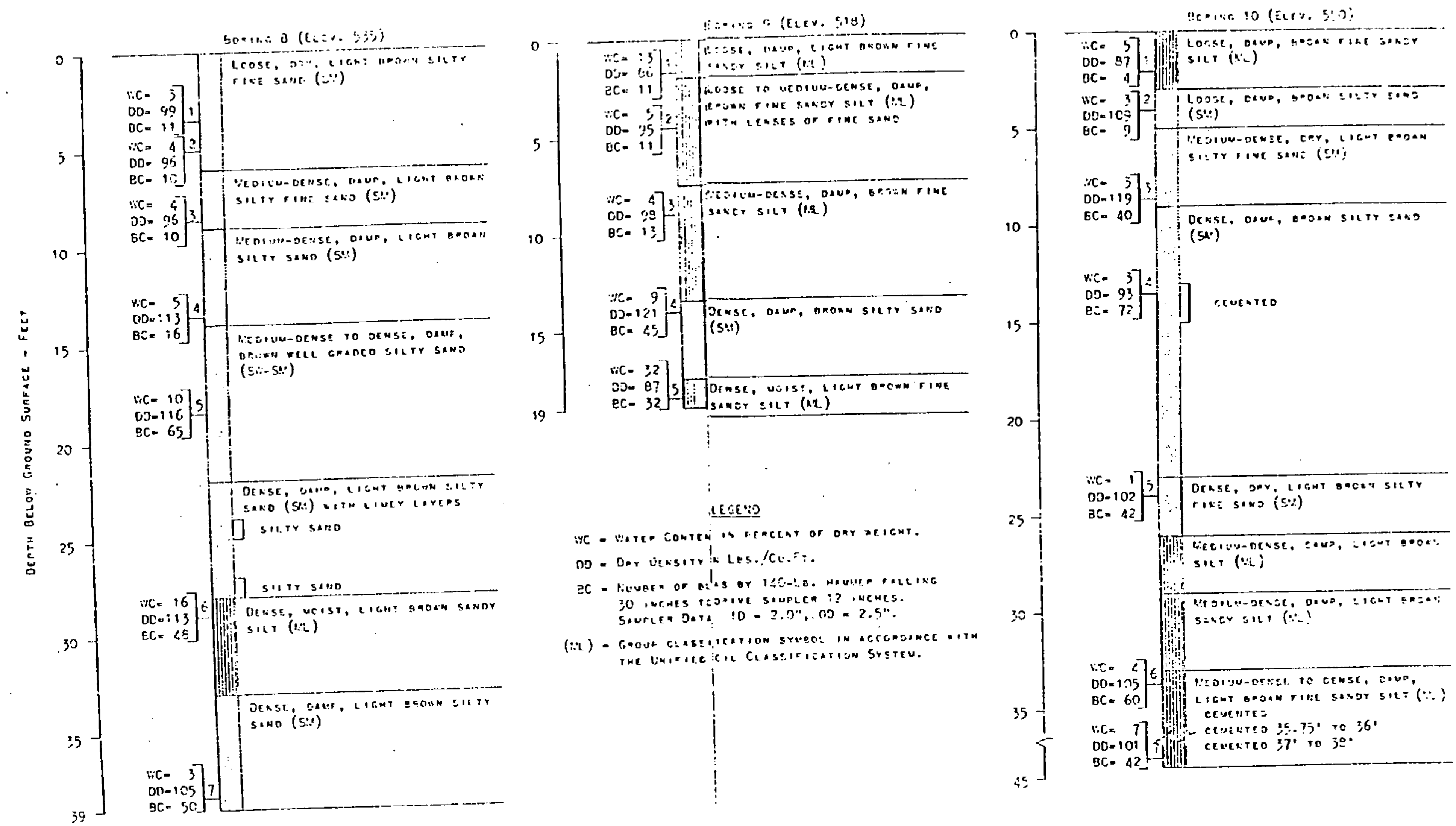
SITE PLAN
AND
LOGS OF TEST BORINGS 1 & 2
BORREGO SPRINGS PARK
JOB NO. 62-164

FIG. 2



Note: For Legend see Fig. 1

LOGS OF TEST BORINGS
3 THROUGH 7
BORREGO SPRINGS PARK
JOB NO. 62-15[illegible]



LEGEND

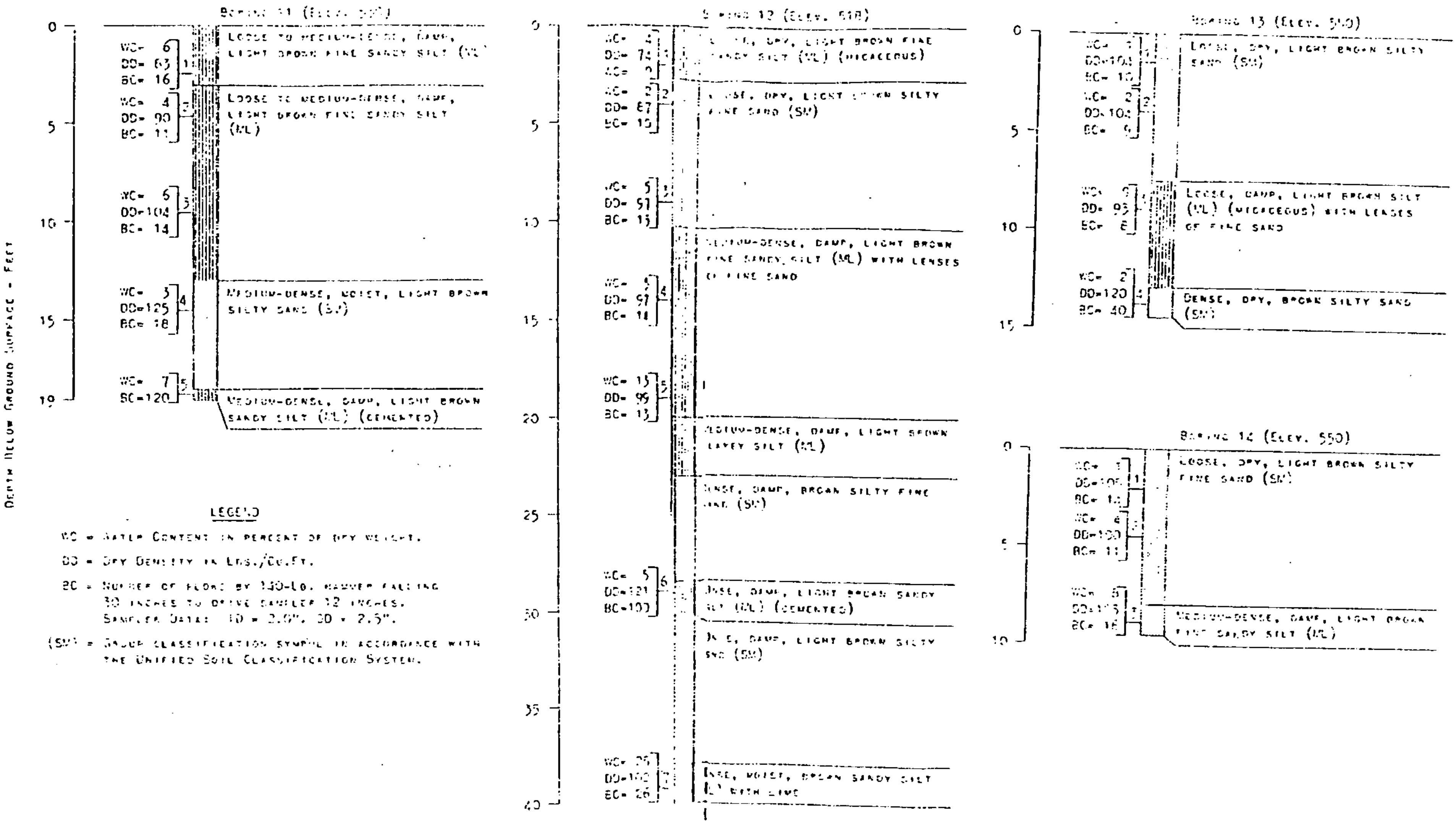
WC = Water content in percent of dry weight.

DD = Dry density in Lbs./Cu.Ft.

BC = Number of blows by 140-Lb. hammer falling 30 inches to drive sampler 12 inches. Sampler Data: ID = 2.0", OD = 2.5".

(ML) = Group classification symbol in accordance with the Unified Soil Classification System.

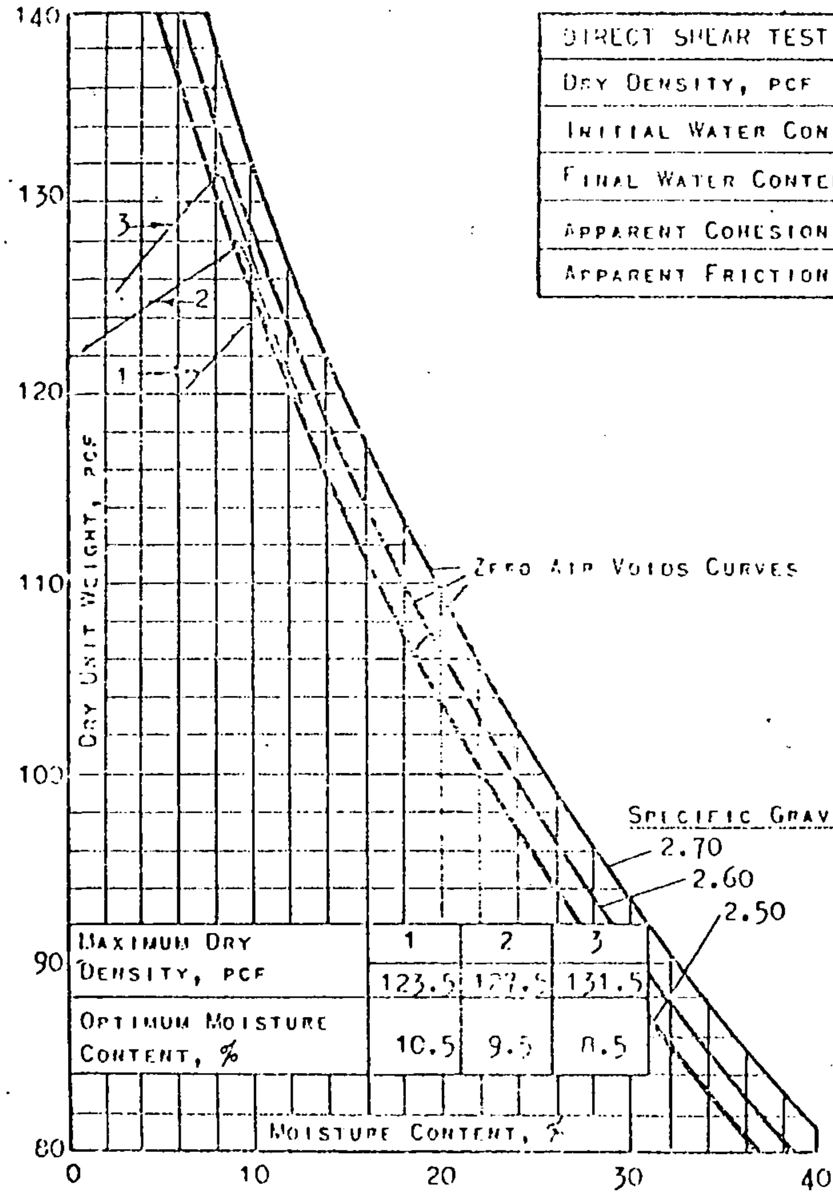
LOGS OF TEST BORINGS
8 THROUGH 10
BORREGO SPRINGS PARK
JOB NO. 62-164



LOGS OF TEST BORINGS
11 THROUGH 14
BORREGO SPRINGS PARK
JOB NO. 62-164

DIRECT SHEAR TEST

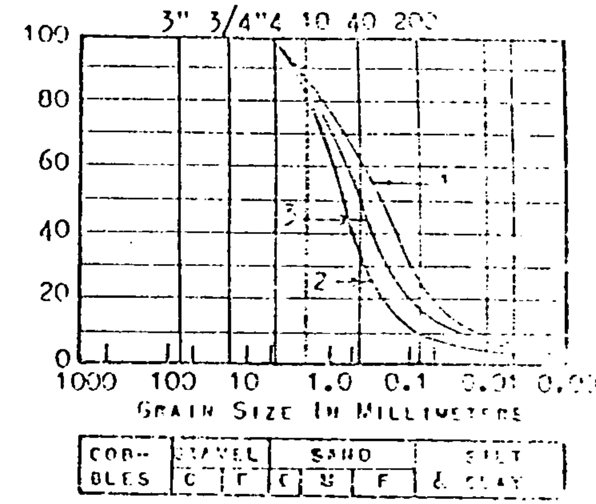
DIRECT SHEAR TEST DATA	1	2	3
Dry Density, pcf	111	115	118
Initial Water Content, %	11.1	6.9	7.5
Final Water Content, %	16.4	14.5	13.5
Apparent Cohesion, pcf	250	200	210
Apparent Friction Angle, °	28	36	34



Maximum Dry Density, pcf	1	2	3
	123.5	127.5	131.5
Optimum Moisture Content, %	10.5	9.5	8.5

LABORATORY COMPACTION TEST

MECHANICAL ANALYSIS



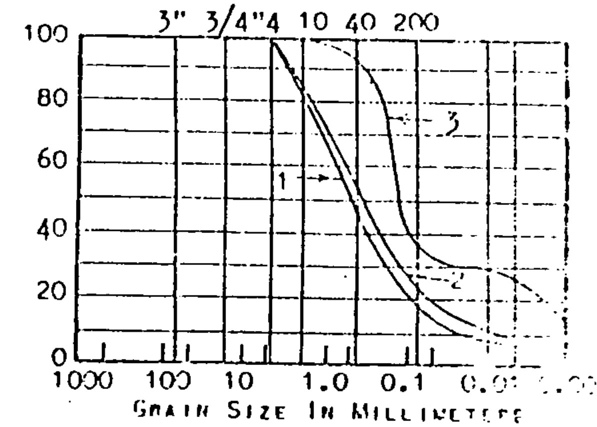
EXPANSIBILITY CHARACTERISTICS	1	2	3
Liquid Limit, %			
Plasticity Index, %			
Shrinkage Limit, %			
Colloidal Content, %			
Potential Expansibility:			

Woodward-Clyde-Sherard & Associates
FILL SUITABILITY TESTS
BORREGO SPRINGS [illegible]
JOB NO. 62-164
Specimen 1: Sample 3-1
Specimen 2: Sample 4-1
Specimen 3: Sample 5-1

DIRECT SHEAR TEST

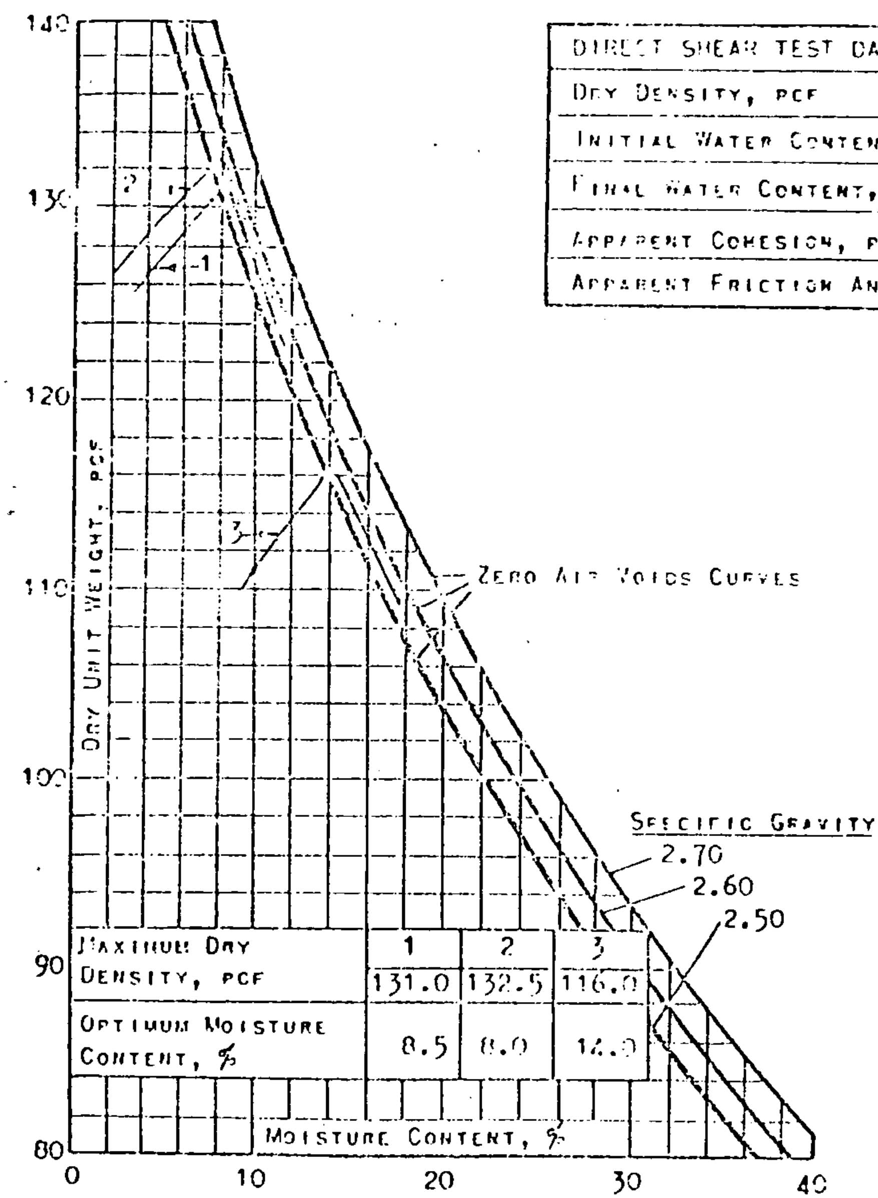
DIRECT SHEAR TEST DATA	1	2	3
Dry Density, pcf	118	119	104
Initial Water Content, %	8.1	8.8	16.2
Final Water Content, %	15.2	13.8	21.4
Apparent Cohesion, pcf	210	240	370
Apparent Friction Angle, °	34	33	25

MECHANICAL ANALYSIS



COBBLES	GRAVEL		SAND			SILT & CLAY
	C	F	C	M	F	

EXPANSIBILITY CHARACTERISTICS	1	2	3
Liquid Limit, %			
Plasticity Index, %			
Shrinkage Limit, %			
Colloidal Content, %			
Potential Expansibility:			



Maximum Dry Density, pcf	1	2	3
	131.0	132.5	116.0
Optimum Moisture Content, %	8.5	8.0	14.0

LABORATORY COMPACTION TEST

WOODWARD-CLYDE-SHERARD & ASSOCIATES

FILL SUITABILITY TESTS

BORREGO SPRINGS PARK

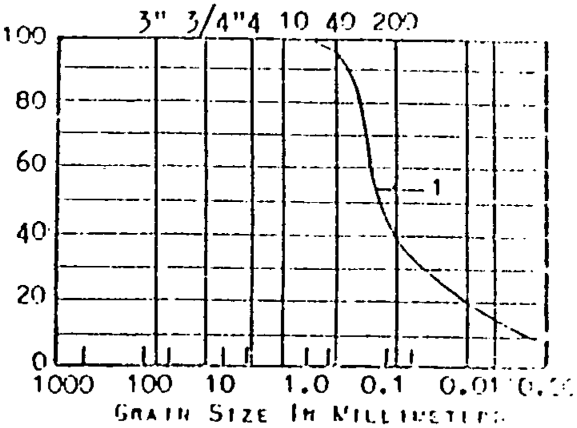
JOB NO. 62-164

Specimen 1: Sample 6-3
Specimen 2: Sample 10-4
Specimen 3: Sample 11-1

DIRECT SHEAR TEST

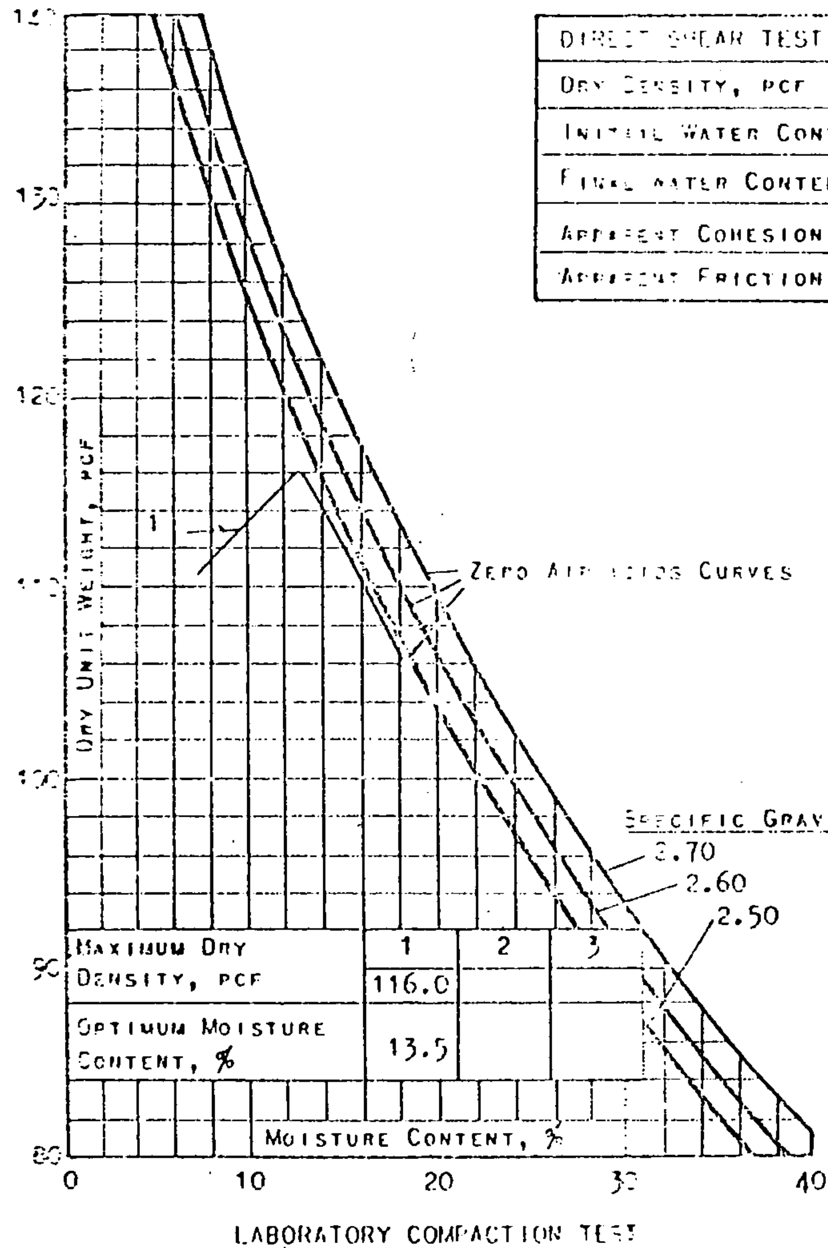
DIRECT SHEAR TEST DATA	1	2	3
DRY DENSITY, PCF	104		
INITIAL WATER CONTENT, %	14.2		
FINAL WATER CONTENT, %	21.2		
APPARENT COHESION, PCF	290		
APPARENT FRICTION ANGLE, °	26		

MECHANICAL ANALYSIS



COBBLES	GRAVEL		SAND			SILT & CLAY
	C	F	C	M	F	

EXPANSIBILITY CHARACTERISTICS	1	2	3
LIQUID LIMIT, %			
PLASTICITY INDEX, %			
SHRINKAGE LIMIT, %			
COLLOIDAL CONTENT, %			
POTENTIAL EXPANSIBILITY:			



	1	2	3
MAXIMUM DRY DENSITY, PCF	116.0		
OPTIMUM MOISTURE CONTENT, %	13.5		

LABORATORY COMPACTION TEST

WOODWARD-CLYDE-SHERARD & ASSOCIATES

FILL SUITABILITY TESTS

BORREGO SPRINGS PARK

JOB NO. 62-164

SPECIMEN 1: SAMPLE 12-3

TABLE 2 - RESULTS OF FIELD PERMEABILITY TESTS

Test No.	Location	Depth of Well feet	Radius of Well feet	Depth of Water feet	Rate of Flow Ft^3/Min.	Permeability * Ft/Year
1	Boring 1	5.0	0.25	4.0	.122	17,000
2	Boring 3	5.0	0.25	4.0	.030	410
3	Boring 10	5.0	0.25	4.0	.030	410
4	Boring 12	5.0	0.25	4.0	.070	950

* Permeability determined from Figure 19-6 "Earth Manual" U.S. Department of Interior, Bureau of Reclamation.

TABLE 1 - RESULTS OF PERCOLATION TESTS

Test No.*	Time	Depth of Water Inches	Percolation Rate ** Minutes/Inch
1	8:00	7.0	
	8:10	3.0	
	8:20	0	
	8:20	7.0	
	8:30	3.0	
	8:40	0	0.30
2	8:15	6.0	
	8:25	0	
	8:25	6.0	
	8:35	0	0.60
3	8:43	6.0	
	8:53	1.8	
	8:55	6.5	
	9:25	2.2	0.43
4	3:02	8.0	
	3:12	1.8	
	3:15	6.5	
	3:25	1.7	0.48
5	1:35	7.5	
	1:45	6.25	
	1:55	4.75	
	2:05	3.5	
	2:15	2.5	
	2:25	1.25	
	2:35	0	0.12
6	1:39	7.0	
	1:49	5.75	
	2:00	4.5	
	2:10	3.25	
	2:20	2.0	
	2:30	1.0	0.10

Test No.*	Time	Depth of Water Inches	Percolation Rate Minutes/Inch
7	10:54	6.0	
	11:04	4.5	
	11:04	6.0	
	11:14	4.5	0.15
8	10:51	6.0	
	11:07	4.5	
	11:07	6.0	
	11:17	4.5	0.15
9	11:00	6.5	
	11:10	5.5	
	11:10	7.0	
	11:20	6.0	0.10
10	1:47	8.0	
	1:47	4.0	
	2:10	0	
	2:11	7.0	
	2:21	3.5	
	2:31	0	0.35
11	8:30	7.0	
	8:40	5.0	
	8:50	2.0	
	9:00	1.0	0.10
12	7:45	8.0	
	7:55	4.0	
	8:05	1.0	
	8:15	6.0	
	8:25	3.0	
	8:35	0	0.30

* Tests were performed adjacent to Borings with same number

** Computed for the last 10 minutes

RESULTS OF CONFINED COMPRESSION TESTS

Sample Number	Initial Dry Density	Initial Water Content	Degree of Saturation Initial	Degree of Saturation Final	Load	Deformation Percent of Initial Height Before Saturation	Deformation Percent of Initial Height After Saturation
	PCF	Percent of Dry Weight	Percent	Percent	PSF		
6-1	101.9	3.4	13	88	500	1.0	1.4
6-1	102.2	3.3	14	89	1000	2.0	2.1
8-2	90.5	4.4	13	89	500	0.7	0.8
8-2	91.4	3.9	12	94	1000	1.7	0.7
9-1	80.0	12.7	31	94	500	0.7	0.9
9-1	78.4	16.1	38	98	1000	1.1	1.7
10-1	71.0	7.0	13	94	500	1.3	6.2
10-1	78.7	5.0	12	91	1000	2.4	7.9

EARTHWORK SPECIFICATIONS

GENERAL REQUIREMENTS

This specifications covers the method of control and supervision, and preparation of existing surfaces to receive fill; the type of soil suitable; the control of compaction and methods of testing compacted fills.

SCOPE

The earthwork shall consist of performing all operations necessary to excavate earth and rock from the cut areas, as designated on the plans; to excavate ditches, including ditches at the top of cut slopes, channels, and borrow pits; to build fills in the locations and to the elevations and form shown on the plans; to dispose of all unsuitable material and excess excavation as shown on the plans or as directed by the Soil Engineer; and to perform all incidental work of whatsoever nature which may be required for cutting, filling, and grading as shown on the plans; and to maintain the finished products in the form specified until the completion and acceptance of the contract.

EXCAVATION

Excavation shall be made to the elevations and the form planned, with finish grades and slopes cut true and straight in conformity with the plans and specifications.

Select material from the excavations shall be placed and compacted as hereinafter specified in the "filled areas" and as shown on the plans.

COMPACTED FILLS

General

Fills shall be constructed to the depth and elevations as shown on the grading plan by placing and compacting select soil, as hereinafter specified, with finished grades and slopes true and straight in conformity with the plans.

Clearing, Grubbing and Preparing Areas to be Filled

(a) All timber, logs, trees, brush and other rubbish shall be removed, piled and burned or otherwise disposed of so as to leave the areas that have been disturbed with a neat and finished appearance free from unsightly debris.

(b) All vegetable matter shall be removed from the surface upon which the fill is to be placed and the full depth of loose soils shall be removed. The surface shall then be plowed or scarified to a depth of six inches (6"), and until the surface is free from ruts, hummocks or other uneven features which would tend to prevent uniform compaction by the equipment to be used.

(c) Where fills are made on hillsides or slopes, the slope of the original ground upon which the fill is to be placed shall be plowed or scarified deeply or where the slope ratio of the original ground is steeper than 6 horizontal to 1 vertical, the bank shall be stepped or benched.

(d) After the foundation for the fill has been cleared, plowed or scarified, it shall be disced or bladed until it is uniform and free from large clods brought to the proper moisture content and compacted to not less than ninety percent (90%) of maximum density in accordance with AASHO test No. T180-57 Method A., or other density test methods which will obtain equivelent results.

<u>Select Materials</u>

Select material shall be any soil excavated from the cut areas which, in the opinion of the Soil Engineer, is suitable for use in constructing fills, and which contains no rocks or hard lumps six inches or over in diameter, and which contains at least 40% of material smaller than one-quarter inch (¼") in diameter. The material used within two feet of rough lot grade shall be nonexpansive select material. For the purpose of this specification nonexpansive materials are defined as those materials which have a liquid limit less than 30 percent, a plasticity index less than 10 percent and which swell less than one percent when compacted as hereinafter specified for compacted fill and when subjected to an axial pressure of 150 pounds per square foot.

No material of a perishable, spongy, or otherwise of an improper nature shall be used in filling.

<u>Placing, Spreading, and Compacting Fill Material</u>

(a) The selected fill material shall be placed in layers which when compacted shall not exceed six inches (6"). Each layer shall be spread evenly and shall be thoroughly blade mixed during the spreading to insure uniformity of material in each layer.

(b) When the moisture content of the fill material is below that specified by the Soil Engineer, water shall be added until the moisture content is as specified to assure thorough bonding during the compacting process.

(c) When the moisture content of the fill material is above that specified by the Soil Engineer, the fill material shall be aerated by blading or other satisfactory methods until the moisture content is as specified.

(d) After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted to not less than ninety percent (90%) of maximum density in accordance with the AASHO Test No. T180-57 Method A, or other density tests which will obtain equivalent results. Compaction shall be accomplished by sheepsfoot rollers, multiple-wheel pneumatic-tired rollers or other types of acceptable rollers. Rollers shall be of such design that they will be able to compact the fill to the specified density. Rolling shall be continuous over its entire area and the roller shall make sufficient trips to insure that the desired density has been obtained.

(e) Fill slopes shall be compacted by means of sheepsfoot rollers or other suitable equipment. Compacting operations shall be continued until the slopes are stable but not too dense for planting and there is no appreciable amount of loose soil on the slopes. Compacting of the slopes may be done progressively in increments of 3 to 5 feet in fill height or after the fill is brought to its total height.

(f) Field density tests shall be made in accordance with A.S.T.M. Test No. D1556-5ST by the Soil Engineer for each layer of fill. Density tests may be made at intervals not exceeding 2 feet of fill height provided all layers are tested. Where sheepsfoot rollers are used the soil may be disturbed to a depth of several inches. Density tests shall be made in the compacted materials below the disturbed surface. When these tests indicate that the density of any layer of fill or portion thereof is below the required (90%) density, the particular layer or portion shall be reworked until the required density has been obtained.

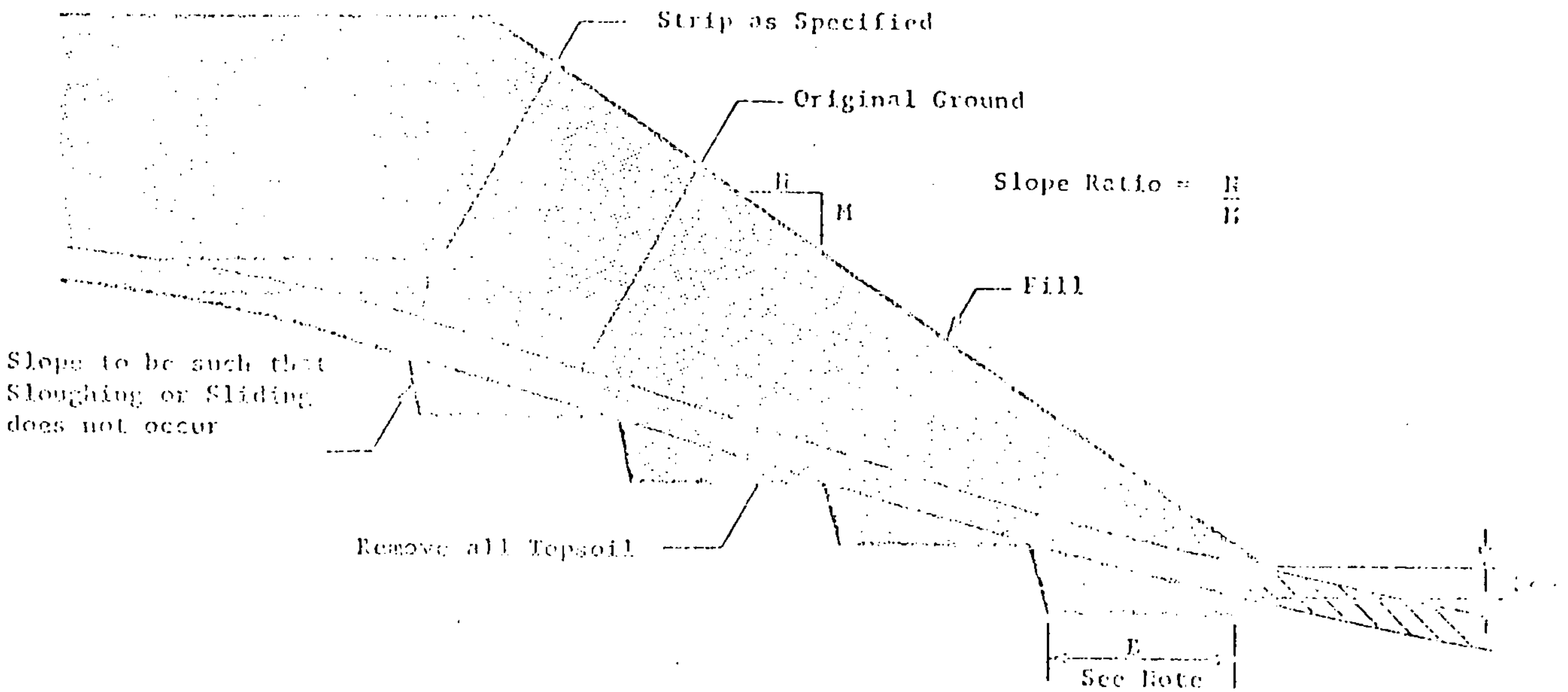
Supervision

Supervision by the Soil Engineer shall be made during the filling and compacting operations so that he can certify that the fill was made in accordance with accepted specifications.

Tests

During grading operations, soil types other than those analyzed in the preliminary soils report may be encountered. The Soil Engineer shall decide the suitability of these soils. Any special treatment recommended by the Soil Engineer in the preliminary and subsequent suitability soil reports, which is not covered in the Earthwork Specifications, shall become an addendum to the Earthwork Specifications.

Representative samples of material to be used for fill and/or sub-base shall be tested in the laboratory in order to determine the maximum density, optimum water content, and classification. In addition, the laboratory shall determine the approximate bearing value of a recompacted, saturated sample by direct shear or other method applicable to the particular soil.



NOTES

The minimum width "B" of key shall be 2 feet wider than the compaction equipment, and not less than 10 feet.

The outside edge of bottom key shall be below topsoil or loose surface material.

Keys are required where the natural slope is steeper than 6 horizontal to 1 vertical, or where specified by Soil Engineer.

WOODWARD · CLYDE · SHERARD & ASSOCIATES
CONSULTING SOIL ENGINEERS AND GEOLOGISTS

3467 Kurtz Street
San Diego
California 92110
(714) 224-2911

December 21, 1967
Project 67-103-115

Federal Mortgage Investors
10889 Wilshire Boulevard
Suite 1040
Los Angeles, California

Attention: Mr. Keith A. Miller

BORREGO SPRINGS PARK, CALIFORNIA

In accordance with your request, we have obtained two representative samples of soil from the area of the proposed lake at the subject site. Chemical and grain size analyses were performed on these materials in order to determine their general characteristics in relation to possible reaction with the proposed lining materials. The test results are presented on the attached forms.

Louis J. Lee
Louis J. Lee/R. E. 14129
Chief Engineer

LJL/jsk

(4) Federal Mortgage Investors
(2) Campbell, Miller & Associates

MEMBER OF:
AMERICAN SOCIETY FOR METALS
INSTITUTE OF ENVIRONMENTAL SCIENCES
SOCIETY OF APPLIED SPECTROSCOPY
SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS

MEMBER OF:
AMERICAN WELDING SOCIETY
SOCIETY FOR NONDESTRUCTIVE TESTING
AMER. ASSN. FOR THE ADV. OF SCIENCE
NATIONAL RIFLE ASSN. OF AMERICA

CHEM-MET ASSOCIATES

MITCHELL P. CHRISTENSEN
E. Met. O. E. Dmk

2661 REYNARD WAY SAN DIEGO, CALIFORNIA 92103 298-5062

REPORT NO: CM-1519: December 20,1967

Woodward,Clyde Sherard & Associates
3467 Kurtz Street
San Diego,California 92110

JOB.NO: 67-103-115
Borrego SpringsPark
2-Samples Rec'd:12-19-67AM

REPORT OF DETERMINATIONS OF SOLUBLE SALTS IN TWO SOIL SAMPLES:

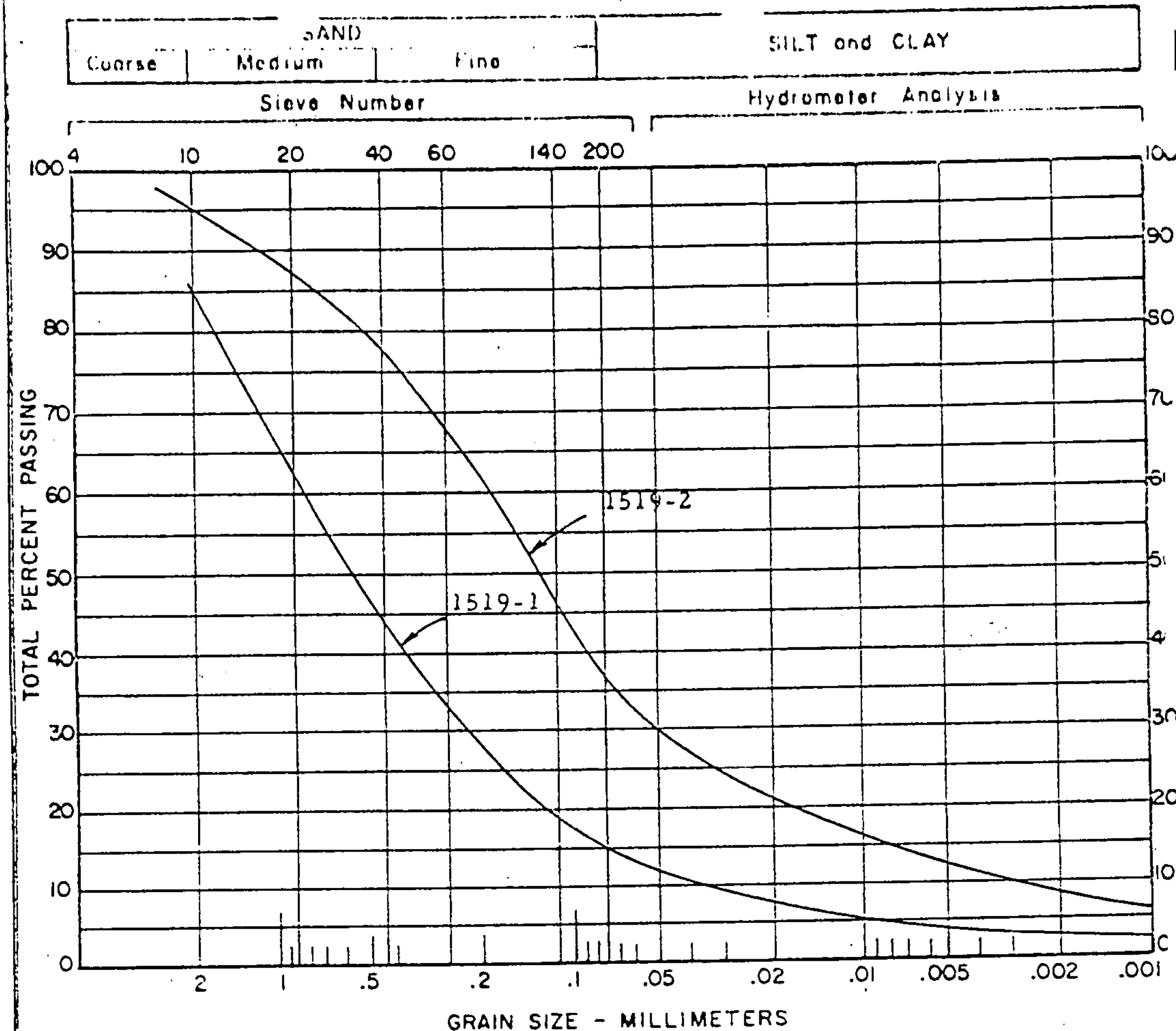
At your request we made the following determinations on two soil samples which you submitted,prepared for extraction,from test drillings:

DETERMINATIONS:	MARK:	SAMPLE 1519-1 "Borrego Springs Park Well #3 @6'7":"	SAMPLE 1519-2 "Borrego Springs Park@6'7", 300'South of Green #26:"
pH Value=		8.12 (Alkaline)	9.35(VERY ALKALINE)
Nitrate:	(NO_3)=	0.0004% = 4 ppm	0.0006%= 6 ppm
Phosphate:	(P_2O_5)=	Nil	Nil
Potash:	(K_2O^5)=	0.0005%	0.0012%
Calcium:	(Ca) =	0.0210%	0.0365%
Magnesium:	(Mg) =	0.0014%	0.0045%
Sodium:	(Na) =	0.1550%	0.2240%
Iron:	(Fe) =	Nil	Nil
Manganese:	(Mn) =	Nil	Nil
Chloride:	(Cl)	0.1860%	0.2940%
Sulfate:	(SO_4)	0.0440%	0.0620%
Carbonates:	(CO_3)	Present LARGE AMOUNTS	Present Large Amounts

These are both definitely "Alkalie" soils and the presence of the high sulfate content would indicate deleterious reactions with Concrete,buried structures even if Low Alkalie Cement were used.This might also be true of certain plastic membrane materials,but a well graded,Asphaltic Concrete with a chlorinated-rubber sealant to protect against Ultra Violet degredation of the bitumins, should be satisfactory in contact with this caustic soil.

CHEM-MET ASSOCIATES,
By M. P. Christensen
M.P.Christensen-Ch.E.#2452 Calif.

(5) w/invoices Attn:L.Lee



SAMPLE	CLASSIFICATION AND SYMBOL
1519-1	Silty Sand (SM-SW)
1519-2	Silty Sand (SM)

WOODWARD, CLYDE, SHERARD & ASSOCIATES

GRAIN SIZE DISTRIBUTION CURVES

Borrego Springs Park

67-103-115

APPENDIX E

BIOLOGICAL DATA

ULTRASYSTEMS, INC.

APPENDIX E

TABLE 1

PLANTS OBSERVED* ON THE PROJECT SITE

CREOSOTE BUSH SCRUB/CREOSOTE - MESQUITE ASSOCIATION

Common Name	Scientific Name	Occurrence**
Asteraceae - Sunflower Family		
Arrowweed	Pulchea sericea	O
Burrobrush	Ambrosia dumosa	C
Cheesebush	Hymenoclea salsola	D
Desert Baccharis	Baccharis sergiloides	I
Desert Dandelion	Malacothrix glabrata	I
Pincushion Flower	Chaenactis stevioides	I
Spanish Needle	Palafoxia linearis	I
Sweetbush	Bebbia juncea	I
Cactaceae - Cactus Family		
Beavertail Cactus	Opuntia basilaris	I
Silver Cholla	O. echinocarpa	I
Pencil Cactus	O. ramosissima	I
Caryophyllaceae - Pink Family		
Frost Mat	Achyronychia cooperi	I
Cucurbitaceae - Gourd Family		
NCN	Cucurbita palmata	I
Euphorbiaceae - Spurge Family		
Croton	Croton californicus	I
Rattlesnake Weed	Euphorbia albomarginata	O
NCN	Euphorbia setiloba	

---

* Nomenclature Munz (1974)

** Occurrence

D = Dominant S = Scattered R = Restricted

I = Infrequent O = Occasional

NCN = No Common Name

APPENDIX E CONTINUED

PLANTS OBSERVED* ON THE PROJECT SITE

CREOSOTE BUSH SCRUB CONTINUED

Common Name	Scientific Name	Occurrence**
Fabaceae - Pea Family		
Palo Verde	Cercidium floridum	I
Mesquite	Prosopis juliflora	I
Smoke Tree	Dalea spinosa	I
Krameriaceae - Krameria Family		
Krameria	Krameria grayi	O
Nyctaginaceae - Four-O'Clock Family		
Wish bone	Mirabilis bigelovii	I
Onagraceae - Evening Primrose Family		
Evening Primrose	Camissonia claviformis	O
Evening Primrose	C. refracta	I
Dune Primrose	Oenothera deltoides	I
Plantaginaceae - Plantain Family		
Woody Plantain	Plantago insularis	C
Poaceae - Grass Family		
Abu Mashi	Schismus barbatus	D
Gallita Grass	Hilaria rigida	O
Polemoniaceae - Phlox Family		
NCN	Langloisia setosissima	I
Polygonaceae - Buckwheat Family		
Buckwheat	Eriogonium thomasii	I
Desert Trumpet	E. inflatum	I

* Nomenclature Munz (1974)

** Occurrence
D = Dominant S = Scattered R = Restricted
I = Infrequent O = Occasional

APPENDIX E CONTINUED

PLANTS OBSERVED* ON THE PROJECT SITE

CREOSOTE BUSH SCRUB CONTINUED

Common Name	Scientific Name	Occurrence**
Zygophyllaceae - Caltrap Family		
Creosote Bush	Larrea tridentata	C
NCN	Kallstroemia californica	I
SALTBUSH SCRUB/DISTRUBED		
Amaranthaeceae - Pigweed Family		
Fringed Pigweed	Amaranthus fimbriatus	O
Arecaceae - Palm Family		
Date Palm	Phoenix dactylfer	C
Asteraceae - Sunflower Family		
Alkali Goldenbush	Haplopappus acradenius	I
Annual African Daisy	Dimorphotheca sinuata	I
Brittle Bush	Encelia farinosa	I
Cheesebush	Hymenoclea salsola	O
Desert Sunflower	Geraea canescens	O
Mule Fat	Baccharis glutinosa	I
Sow Thistle	Sonchus oleraceus	O
Telegraph Weed	Heterotheca grandiflora	O
Boraginaceae - Borage Family		
Comb-Bur	Pectocarya penicillata	I
Fiddleneck	Amsinckia tessellata	I
Popcorn Flower	Cryptantha augustifolia	D
Brassicaceae - Mustard Family		
London Rocket	Sisymbrium irio	C
Oriental Mustard	Sisymbrium orientale	I
Pepper Grass	Brassica tournefortii	O
Pepper Grass	Lepidium lasiocarpum	O
Pepper Grass	L. virginicum	O
Short Pudded Mustard	Brassica geniculata	I
NCN	Tropidocarpum gracile	I

* Nomenclature Munz (1974)

** Occurrence

D = Dominant S = Scattered R = Restricted

I = Infrequent O - Occasional

NCN = No Common Name

ultrasystems

APPENDIX E CONTINUED

PLANTS OBSERVED* ON THE PROJECT SITE

SALTBUSH SCRUB/DISTURBED

Common Name	Scientific Name	Occurrence**
Poaceae - Grass Family Continued)		
Foxtail Chess	Bromus rubens	O
Ripgut Grass	B. diandrus	I
Salt Grass	Distichlis spicata	O
Sand Dropseed	Sporobolus cryptandrus	C
Stinkgrass	Eragrostis cilianensis	I
Salicaceae - Willow Family		
Fremont Cottonwood	Populus fremontii	I
Solanaceae - Nightshade Family		
Desert Datura	Datura discolor	I
Ground Cherry	Physalis acutifolia	I
Silverleaf Nettle	Solanum elaeagnifolium	O
Tamaricaceae - Tamarisk Family		
Athel Tree	Tamarix aphylla	O
Salt Cedar	T. ramosissima	O
Typhaceae - Cat-Tail Family		
Cat-Tail	Typha domingensis	I
Zygophyllaceae - Caltrap Family		
Puncture Vine	Tribulus terrestris	O

---

* Nomenclature Munz (1974)

** Occurrence

D = Dominant   S = Scattered   R = Restricted

I = Infrequent   O = Occasional

APPENDIX E

TABLE 2

BIRDS OBSERVED ON THE PROJECT SITE

COMMON NAME*	SCIENTIFIC NAME*	NUMBER OBSERVED	STATUS**	HABITAT***
Red-tailed Hawk	_Buteo jamaicensis_	1	N,R	CS
American Kestrel	_Falco sparverius_	1	N,R	CS
Gambel's Quail	_Lophortyx gambellii_	25	N,R	CS
Mourning Dove	_Zenaida macroura_	42	N,R	DIS
Roadrunner	_Geococcyx californianus_	5	N,R	CS
White-throated Swift	_Aeronautes saxatalis_	6	N,R	CS
Common Flicker	_Colaptes auratus_	2	R	R
Common Crow	_Corvus brachyrhynchos_	22	R	DIS
Common Raven	_Corvus corax_	2	N,R	DIS
Le Conte's Thrasher	_Toxostoma lecontei_	1	R	CS
Mockingbird	_Mimus polyglottos_	5	R	CS, DIS
Loggerhead Shrike	_Lanius ludovicianus_	3	N,R	DIS
Starling	_Sturnis vulgaris_	19	N,R	DIS
Verdin	_Auriparus flaviceps_	1	R	CS
House Finch	_Carpodacus mexicanus_	20	N,R	DIS
Song Sparrow	_Melospiza melodia_	1	R	DIS
White-crowned Sparrow	_Zonotrichia leucophrys_	25	M,Sp.,FW	CS
Anna's Hummingbird	_Calypte anna_	2	N,R	CS, DIS

* Nomenclature: American Orinthologists' Union (1957, 1973).

** Status Designation from Sams and Stott (1959) and the Anza-Borrego Desert Natural History Association - Birds of Anza-Borrego Desert State Park:

R = Resident M = Migrant Sp = Spring F = Fall
V = Visitant N = Nests S = Summer W = Winter

*** Habitat Key
CS = Creosote Bush Scrub
DIS= Disturbed Area
R = Riparian

APPENDIX E

TABLE 3

BIRDS EXPECTED* ON PROJECT SITE

COMMON NAME**	SCIENTIFIC NAME**	STATUS**
Violet-Green Swallow	Tachycineta thalassina	M,Sp
Barn Swallow	Hirundo rustica	M,Sp
Cliff Swallow	Petrochelidon pyrrhonota	M,S,F
Purple Martin	Progne subis	V,Sp
Bewick's Wren	Thryomanes bewickii	R
Cactus Wren	Campylorhynchus brunneicapills	R
Canyon Wren	Catherpes mexicanus	R
Rock Wren	Salpinctes bsoletus	R
Crissal Thrasher	Toxostoma dorsale	Sp,S,F
Western Bluebird	Sialia mexicana	M,Sp,F,W
Blue-gray Gnatcatcher	Polioptila caerulea	Sp,F
Black-tailed Gnatcatcher	Polioptila melanura	R
Cedar Waxwing	Bombycilla cedrorum	Sp,F,W
Phainopepla	Phainopepla nitens	R
Western Meadowlark	Sturnella neglecta	R
Scott's Oriole	Icterus parisorum	R,Sp,S,F,W
Lesser Goldfinch	Carduelis psattria	N,R
Lark Sparrow	Chondestes grammacus	N,R
Black-throated Sparrow	Amphispiza belineata	F,W
Sage Sparrow	Amphispiza belli	F,W
Brewer's Sparrow	Spizella breweri	S,F,W

* Compiled from Anza-Borrego Natural History Association Birds in the Anza-Borrego Desert State Park Area.

** Nomenclature: American Ornithologists' Union (1957, 1973)

*** Status Key

R = Resident V = Visitant S = Summer W = Winter

M = Migrant Sp = Spring F = Fall

TABLE 3 CONTINUED

BIRDS EXPECTED* ON PROJECT SITE

COMMON NAME**	SCIENTIFIC NAME	STATUS***
Turkey Vulture	Cathartes aura	R
Sharp Shinned Hawk	Accipiter striatus	M,Sp,F,W
Cooper's Hawk	Accipiter cooperii	R,Sp,F,W
Red Shouldered Hawk	Buteo lineatus	V,Sp,F,W
Rough Legged Hawk	Buteo lagopus	M,F,W
Ferruginous Hawk	Buteo regalis	R
Golden Eagle	Aquila chrysaetos	R
Prairie Falcon	Falco mexicanus	R
Peregrine Falcon	Falco peregrinus	M,Sp,S,W
Killdeer	Charadrius vociferus	M,Sp,F
Rock Dove	Columba livia	R
Ground Dove	Columbina passerina	R
Barn Owl	Tyto alba	R
Great Horned Owl	Bubo virginianus	R
Burrowing Owl	Athene cunicularia	R
Long Eared Owl	Asio otus	R
Poor-Will	Phalaenoptilus nuttallii	R
Lesser Nighthawk	Chordeiles acutipennis	Sp,S,F
White-throated Swift	Aeronautes saxatalis	R
Costa's Hummingbird	Calypte costae	M,Sp,W
Yellow-bellied Sapsucker	Sphyrapicus varius	V,F
Ash-throated Flycatcher	Myiarchus cinerascens	R
Black Phoebe	Sayornis nigricans	R
Say's Phoebe	Sayornis saya	R

* Compiled from Anza-Borrego Natural History Association, Birds in the Anza-Borrego Desert State Park Area.

** Nomenclature: American Ornithologists' Union (1957, 1973)

*** Status Key

R = Resident V = Visitant S = Summer W = Winter
M = Migrant Sp = Spring F = Fall

TABLE 4

MAMMALS OBSERVED AND EXPECTED ON PROJECT SITE

COMMON NAME	SCIENTIFIC NAME*	DETECTION**	HABITAT
Desert Cottontail	Sylvilagus audubonii arizonae	O	CS
Black-tailed Jack Rabbit	Lepus californicus deserticola	O	CS
White-tailed Antelope Squirrel	Ammospermophilus leucurus leucurus	O	CS
Round-tailed Ground Squirrel	Spermophilus tereticaudus tereticaudus	O	DIS
Southern Pocket Gopher	Thomomys bottae boregoensis	B	DIS
Coyote	Canis latrans	O, S	CS, DIS
EXPECTED			
Merriam's Kangaroo Rat	Dipodomys merriami arenivagus		
Desert Kangaroo Rat	Dipodomys deserti deserti		
Desert Woodrat	Neotoma lepida lepida		
Western Pipestrel	Pipistrellus hesperus hesperus		
Pallid Bat	Antrozous pallidus pallidus		
California Myotis	Myotis californicus californicus		
Brazilian (Mexican) Free-tailed Bat	Tadarida brasiliensis mexicana		
Little Pocket Mouse	Perognathus longimembris bangi		
Desert Pocket Mouse	Perognathus penicillatus angustirostris		
Spiny Pocket Mouse	Perognathus spinatus rufescens		
Cactus Mouse	Peromyscus eremicus eremicus		
Deer Mouse	Peromyscus maniculatus sonoriensis		
Southern Grasshopper Mouse	Onychomys torridus pulcher		

* Nomenclature Bond (1977)
** O = Observed; B = Burrow; S = Scat
*** Habitat
CS = Creosote Bush Scrub
DIS = Disturbed

TABLE 5

AMPHIBIANS AND REPTILES OBSERVED OR EXPECTED*

COMMON NAME	SCIENTIFIC NAME	NUMBER OBSERVED
Leopard Lizard	Crotaphytus wislizeni	1
Western Fence Lizard	Sceloporus occidentalis	8
Desert Spiny Iguana	Sceloporus magister	1
Desert Side Blotched Lizard	Uta stansburiana stejnegeri	2
Long-tailed Brush Lizard	Urosaurus graciosus	3
Expected**		
Desert Iguana	Dipsosaurus dorsalis dorsalis	
Zebra-tailed Lizard	Callisaurus draconoides	
Collard Lizard	Crotaphytus collaris	
Flat-tailed Horned Lizard	Phrynosoma m'callii	
Desert Banded Gecko	Coleonyx variegatus variegatus	
Western Brush Lizard	Urosaurus graciosus	
Desert Horned Lizard	Phrynosoma platyrhinos	
Gilbert Skink	Eumeces gilberti	
Sonora Gopher Snake	Pituophis melanoleucus affinis	
Common King Snake	Lampropeltis getulus	
Colorado Desert Sidewinder	Crotalus cerastes laterorepens	
Colorado Desert Shovel-Nosed Snake	Chionactis occipitalis annulata	
Red Racer	Masticophis flagellum piceus	
Southwestern Speckled Rattlesnake	Crotalus mitchelli pyrrhus	
Red Diamond Rattlesnake	Crotalus ruber ruber	
Desert Night Snake	Hypsiglena torquata deserticola	

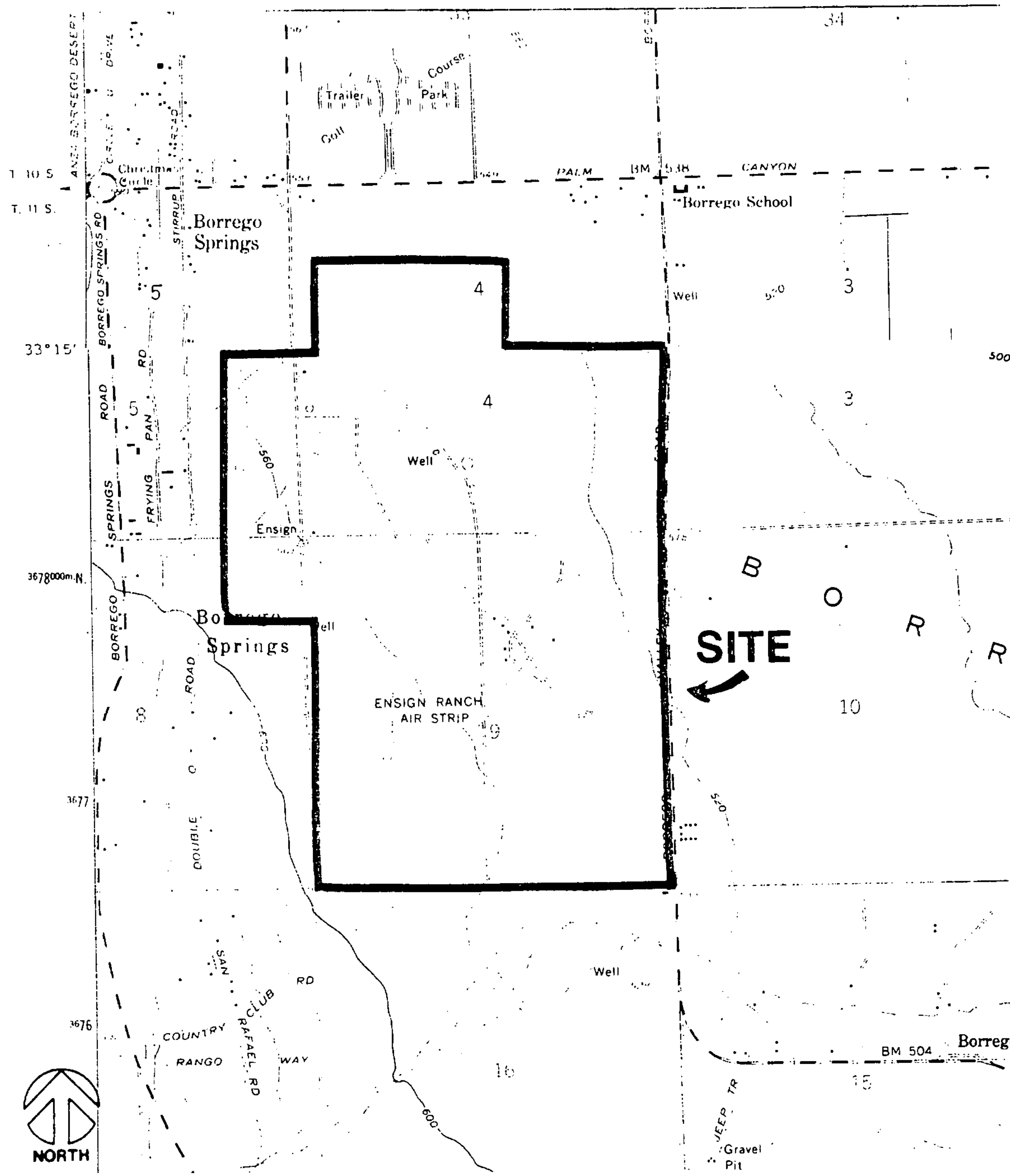
* Nomenclature from Stebbins (1966) and Sloan (1964).

** Anza-Borrego Desert Natural History Association. The Reptiles and Amphibians of Anza-Borrego State Park.

TABLE 5 (CONTINUED)

AMPHIBIANS AND REPTILES OBSERVED OR EXPECTED

COMMON NAME	SCIENTIFIC NAME
Western Long-nosed Snake	*Rhinocheilus lecontei lecontei*
Desert Patchnosed Snake	*Salvadora hexalepis*
Southern Pacfic Rattle-snake	*Crotalus viridis helleri*
Pacific Tree Frog	*Hyla regilla*
Great Basin Whiptail	*Cnemidophorus tigris tigris*
Western Spadefoot Toad	*Scaphiopus hammondii*
California Toad	*Bufo boreas halophilus*



Source: ULTRASYSTEMS, INC.

Title: U.S.G.S. MAP

APPENDIX E

THE RARITY-ENDANGERMENT-VIGOR-DISTRIBUTION CODE*

R (RARITY)

1 - Rare, but found in sufficient numbers and distributed widely enough that the potential for extinction or extirpation is low at this time.

2 - Occurrence confined to several populations or to one extended population.

3 - Occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported.

E (ENDANGERMENT)

1 - Not endangered.

2 - Endangered in a portion of its range.

3 - Endangered throughout its range.

V (VIGOR)

1 - Increasing or stable in number.

2 - Declining in number.

3 - Approaching extinction or extirpation.

D (DISTRIBUTION)

1 - More or less widespread outside California.

2 - Rare outside Calfiornia.

3 - Endemic to California.

* California Native Plant Society, Inventory of Rare and Endangered Vascular Plants, Special Publication NO. 1 (2nd Edition) April 1980.

Literature Cited

Anza-Borrego Desert National History Association - The Birds of Anza-Borrego Desert State Park: The Mammals of Anza-Borrego Desert State Park; The Reptiles and Amphibians of Anza-Borrego Desert State Park.

Burt, W. H. and Grossenheider R. P. 1976. A Field Guide to Mammals. Hougton Mifflin Company, Boston. 189 pp.

California Native Plant Society: Inventory of Rare and Endangered Vascular Plants of California. California Native Plant Society Special Publication No. 1. (2nd Edition) April, 1980.

Higgins, E.B. 1949. Annotated Distributional List of the Ferns and Flowering Plants of San Diego County. California. Occ. Pap. S.D. Soc. Nat. Hist. No.8. 174 pp.

McMinin, H.E. 1974. An Illustrated Manual of California Shrubs. Univ. Calif. Press. 663 pp.

Munz, P.A. 1974. A Flora of Southern California. Univ. Calif. Press 1085 pp.

Sams, J.R. and Stott, K. 1959. Birds of San Diego County, California. An Annotated Checklist. Occ. Pap. S.D. Soc. Nat. Hist. No.10. 49 pp.

Sloan, A.J. 1964. Amphibians of San Diego County. Occ. Pap. S.D. Soc. Nat. Hist. No.13. 40 pp.

Stebbins, R.C. 1966. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Co. Boston. 179 pp.

Udvardy, M.D.F. 1977. The Audubon Society Field Guide to North American Birds: Western Region. Alfred A. Knoph, Inc. 855 pp.

PROJECT BIOLOGISTS

David Clark

Ultrasystems, Inc.
(714) 752-7500
Survey: January 30, 1981

Ted L. Hanes, Ph.D.

California State University, Fullerton
(714) 773-3614
Survey: April 9, and April 14, 1981

Oscar F. Clark

University of Calfiornia, Riverside
(714) 686-3746
Survey: February 18, 1981
(Report incorporated by reference from Borrego
Country Club General Plan Amendment EIR)

DR. TED L. HANES

Dr. Hanes is Associate Professor of Biology at California State University, Fullerton. He teaches courses in plant ecology, general ecology, botany, biology, crisis biology, ecological internship and graduate seminars in ecology and environmental assessment. His current research interests are in fire ecology of California chaparral and the inventory of natural areas in Southern California.

Dr. Hanes holds three degrees in plant sciences from UCLA, a Master's degree from Claremont Graduate School in Science Education, and has done graduate work on various subjects in biology at Indiana University, California Institute of Technology, University of Iowa, and Oak Ridge Institute of Nuclear Studies. He has received research grants from the National Science Foundation and the National Park Service to carry out work on fire ecology, pollution problems, and natural areas. He has been resident ecologist and naturalist several summers at the National Audubon Camp of the West, Dubois, Wyoming. He is active in several local, state and national ecology and conservation organizations and is a consultant to Ultrasystems, Inc. on environmental planning, wildland management, and ecological impact studies.

His professional memberships include:

National:
- Sigma Xi
- Ecological Society of America
- American Institute of Biological Sciences
- American Association for the Advancement of Science
- American Scientific Affiliation
- The National Audubon Society
- The National Geographic Society

State:
- California Native Plant Society
- Southern California Botanists (1961-present; Board Member 1968-present; President 1969-1971)
- The Nature Conservancy, Southern California Chapter (1963-1972; board member, past treasurer and vice chairman 1967-1971)
- Tri-County Conservation League
- Southern California Academy of Sciences
- California Natural Areas Coordinating Council (Director and Regional Chairman)
- California Native Plant Society. President of the Southern California Botanists Chapter (1972).

DR. HANES (Continued)

Dr. Hanes has recieved honors from:

W. Atlee Burpee Award - UCLA, 1950
National Science Foundation Faculty Fellowship - UCLA, 1961-1962
N.S.F. Research Grant - Chaparral Succession, 1966-1968
California State College, Fullerton Faculty Grant, 1969-1970
National Park Service Grant - UC Davis, 1971-1972
Consultant: Thorne Ecological Institute, Boulder, Colorado 1971-1972

Dr. Hanes' publications include:

Hanes, T.L., 1973. Chaparral ecology of the San Gabriel Mts., California

In preparation:

______________. 1973. The vegetation called chaparral. Proceedings Symposium on Living with the Chaparral, Univ. Calif. Riverside, Calif. (in press)

______________. 1971. Succession after fire in the chaparral of southern California. Ecol. Monogr. 41. (1): 27-52

______________. 1970. California sage and chaparral. Grizzly - Bul. Tucker Wildlife Sanc. 1 (2): 7-10

______________. 1967. Problems related to biology in the junior college. Amer. Bio. Teacher 29 (8): 639-640

Hanes, T.L. and H.W. Jones. 1967. Postfire chaparral succession in southern California. Ecology 48 (2): 259-264

Hanes, T.L. et al. 1966. General Biology laboratory manual. Brown Book Co., Iowa. 295 pp.

Hanes, T.L. 1965. Ecological Studies on two closely related chaparral shrubs in southern California. Ecol. Monogr. 34: 213-235

Patric, J.H. and T.L. Hanes. 1964. Chaparral succession in a San Gabriel Mountain area of California. Ecology 45 (2): 353-360.

David D. Clark

Mr. Clark is a Project Manager at Ultrasystems, Inc., and is primarily responsible for the preparation of environmental impact reports (EIR's), environmental assessments (EA's) and related special studies.

Mr. Clark received his Master of Science Degree in Ecology and Bachelor of Arts Degree in Biology from California State University, Fullerton. Mr. Clark has augmented his educational background with additional study in Environmental Impact Analysis, Statistical Analysis, Urban Planning Problems, etc. He is currently pursuing a Master of Business Administration Degree from California Polytechnic University, Pomona.

Prior to joining the professional staff at Ultrasystems, Inc., Mr. Clark was employed as an Environmental Systems Analyst and Proposal Manager with Systems Control, Inc. (formerly Olson Laboratories). During this period, he was actively involved with a number of U.S. E.P.A. Inspection/Maintenance programs for the control of automotive emissions at the State level.

Mr. Clark has conducted a number of biological assessments under the sponsorship of the Bureau of Land Management (BLM). His most recent effort has included an exhaustive analysis of utility construction impacts on the vegetation and soils of arid environments. Project emphasis was placed on vegetational inventories, soil dynamics and computer modeling.

He has taught environmental and ecological courses at California State University, Fullerton, and Cerritos College. He holds a Teaching Credential in California.

Mr. Clark has numerous publications in both the engineering and environmental fields. Recent publications include:

1. "Resource Allocation Patterns in Two Annuals of the California-Sonoron Desert." Submitted to Ecologia, 1979.

David D. Clark - (Continued)

2. "An Analysis of Construction Effects on Vegetation and Soils of the Colorado Desert." Bureau of Land Management (BLM), Riverside.

3. "Xylem Anatomy Variation in Creosote Bush (Larrea tridentata) of the Southwest Deserts." In preparation.

4. "Evaluation of Motor Vehicle Inspection/Maintenance Programs for the Control of Automotive Emissions." U.S. E.P.A.

TABLE 5 (CONTINUED)

AMPHIBIANS AND REPTILES OBSERVED OR EXPECTED

COMMON NAME	SCIENTIFIC NAME
Western Long-nosed Snake	Rhinocheilus lecontei lecontei
Desert Patchnosed Snake	Salvadora hexalepis
Southern Pacfic Rattle-snake	Crotalus viridis helleri
Pacific Tree Frog	Hyla regilla
Great Basin Whiptail	Cnemidophorus tigris tigris
Western Spadefoot Toad	Scaphiopus hammondii
California Toad	Bufo boreas halophilus

Hubbs, C.L., G.S. Bien, and H.E. Suess
1960 La Jolla Natural Radiocarbon Measurements I. Radiocarbon 2:197-223.

Kroeber, A.L.
1925 Handbook of the Indians of California. Washington, D.C.: Smithsonian Institute, Bureau of American Ethnology Bulletin, 78: 1-995.

Kroeber, Alfred L. and M.J. Harner
1955 Mojave Pottery. U.C. Anthropological Records 16(1). Berkeley.

May, Ronald V.
1975 A Brief Survey of Kumeyaay Ethnography: Correlations Between Environmental Land-Use Patterns, Material Culture, and Social Organization. PCAS 11:4: 1-25.

1977 No Title. Unpublished Manuscript Draft.

Meighan, Clement W.
1959 Archaeological Resources of Borrego State Park. Archaeological Survey Annual Report. 1958-1959, pp. 185-216. UCLA.

1965 Pacific Coast Archaeology. In The Quarternary of the United States, Wright and Frey, Eds.

1954 "A Late Complex in Southern California Prehistory." Southwestern Journal of Anthropology, Vol. 10, No. 2, pp. 215-227. University of New Mexico Press, Albuquerque.

Michelsen, Ralph C.
1967 "Pecked Metates of Baja California." The Masterkey Southwest Museum Publications.

Moratto, M.J.
1972 A Study of Prehistory in the Southern Sierra Nevada Foothills, California. Unpublished Ph.D. dissertation presented to the Dept. of Anthropology, University of Oregon.

O'Brian, T.P.
1973 Ceramic Artifacts in Perris Reservoir Archaeology: Late Prehistoric Demographic Change in Southeastern Calif. J.F. O'Connell et al., Eds. Archaeological Report 14, California Dept. of Parks and Recreation, Sacramento.

Rogers, Malcom J.

1936 "Yuman Pottery Making." San Diego Museum Papers, No. 2, San Diego.

1945 "An Outline of Yuman Prehistory" Southwestern Journal of Anthropology No. (2): 167-198.

Schroeder, Albert H.

1958 Lower Colorado Buff Ware in Pottery Types in the Southwest. Museum of Northern Arizona Ceramic Series. 31.

Spier, Leslie

1923 "Southern Digueno Customs". University of California Publications in American Archaeology and Ethnology. Vol. 20, No. 16, pp. 297-360. Berkeley.

Strong, W.D.

1929 "Aboriginal Society in Southern California." University of California Publications in American Archaeology and Ethnology 26. Berkeley

True, D.L.

1970 "Investigation of a Late Prehistoric Complex in Cuyamaca Rancho State Park, San Diego, California." Archaeological Survey Monograph, University of Calif., Los Angeles.

Wallace, W.J. and E.S. Taylor

1960 The Indian Hill Rockshelter: Preliminary Excavations. The Masterkey Vol. 34, pp. 66-82.

Wilke, Phillip J.

1974 Settlement and Subsistence at Perris Reservoir: A Summary of Archaeological Investigations. Perris Reservoir Archaeology, Late Prehistoric Demographic Change in Southeastern California. S.F. O'Connel, et al., eds. Archaeological Report 14. Sacramento Dept. of Parks and Recreation.

APPENDIX F

ARCHAEOLOGICAL DATA

DR. DAVID M. VAN HORN

BIBLIOGRAPHY

Bean, L.J. and K.S. Saubel
1961 "Cahuilla Ethnobotanical Notes. The Aboriginal Uses of The Mesquite and Screwbean." UCLA Archaeological Survey Annual Report.

Bean, John Lowel
1972 Mukat's People. Banning: Malki Museum Press.

Bean, L.J. and K.S. Saubel
1972 Temalpakh: Cahuilla Indian Knowledge and Usage of Plants. Malki Museum Press, Banning.

1961 Cahuilla Ethnobotanical Notes: The Aboriginal Uses of The Oak, UCLA Archaeological Survey Annual Report.

Bean, Lowell, J. and Shipek, Florence C.
1978 Luiseno. In the Handbood of North American Indians, v. 8, 550ff. Washington, D.C.

Bettinger, Robert L.
1974 Dating the Perris Reservoir Assemblages. Perris Reservoir Archaeology. Archaeological Report 14, Cal. Dept. of Parks and Recreation. Sacramento.

1974 Environment and Ethnography at Perris Reservoir. Perris Reservoir Archaeology. Archaeological Report 14, Cal. Dept. of Parks and Recreation. Sacramento.

Colton, H.S.
1939 An Archaeological Survey of Northwestern Arizona, Including the Descriptions of Fifteen new Pottery Types. Bulletin of the Museum of Arizona. 16

1956 Pottery Types of the Southwest. Ceramic Series 3C, Museum of Northern Arizona.

Euler, Robert C. & Henry Dobyns
1958 Tizon Brown Ware in Pottery Types of the Southwest. Edited by H.S. Colton. Museum of Northern Arizona Ceramic Series No. 3D. Flagstaff.

Heizer, R.F. and Whipple, M.A.
1951 The California Indians. University of California
1973 Press, Berkeley

List of Figures

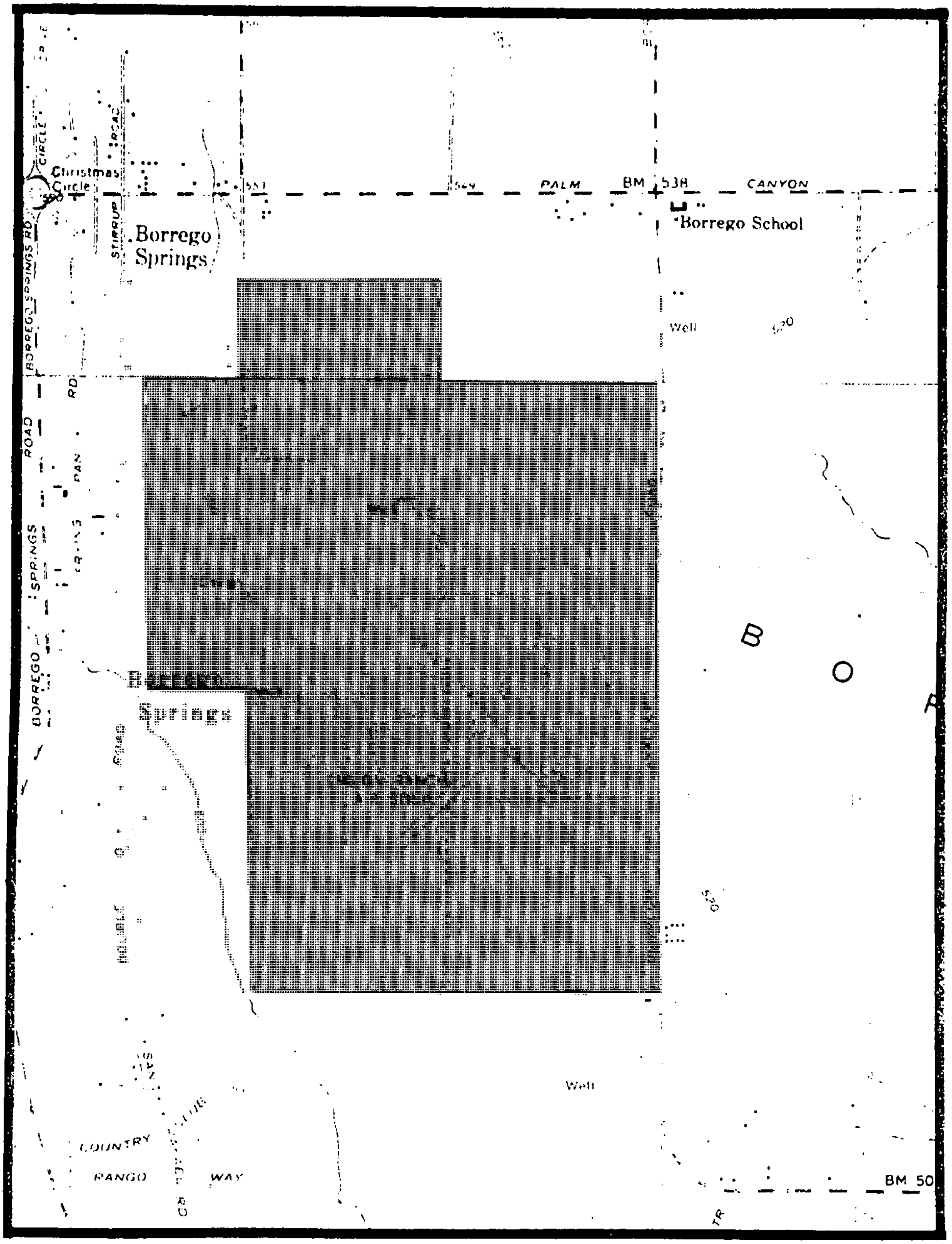


Figure 1. Property Surveyed Plotted on 7.5' USGS Clark Lake and Borrego Sink Topographic Quadrangles.

FIGURE 2

A large scale map depicting the location of the archaeological sites on the project site is available for review by qualified archaeologists at the County of San Diego Environmental Analysis Division.

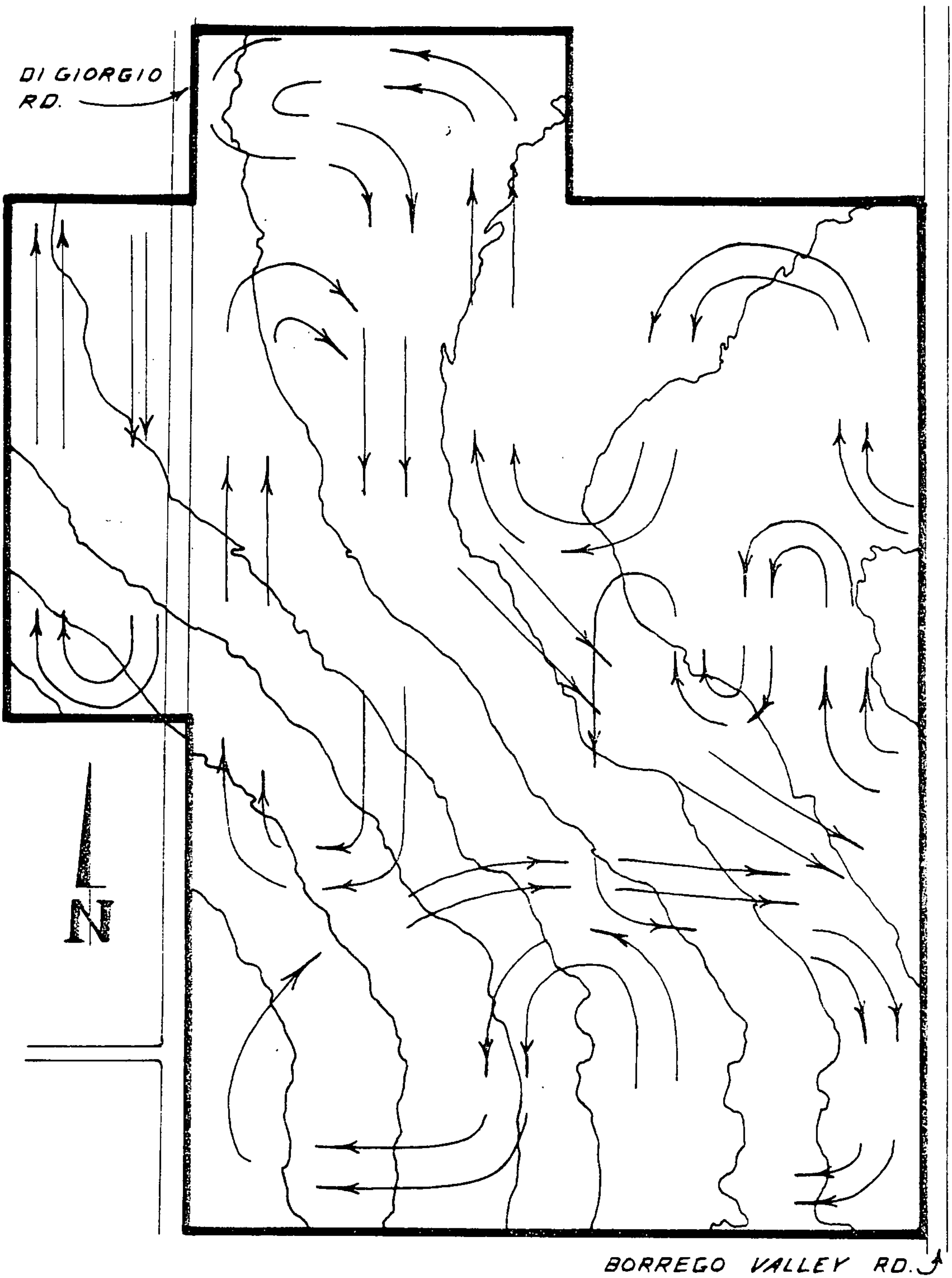


Figure 3. Survey Route Map.

00012

A. Southern portion of subject property looking northwest.

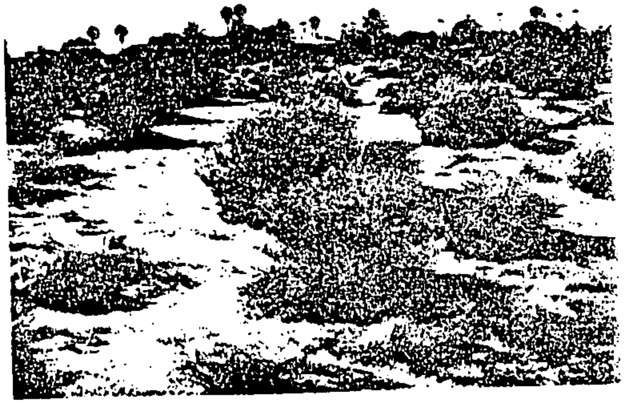
00012

B. Northern portion of subject property looking northwest. Area shown is part of the abandoned golf course now overgrown with weeds.

Fig.4

00012

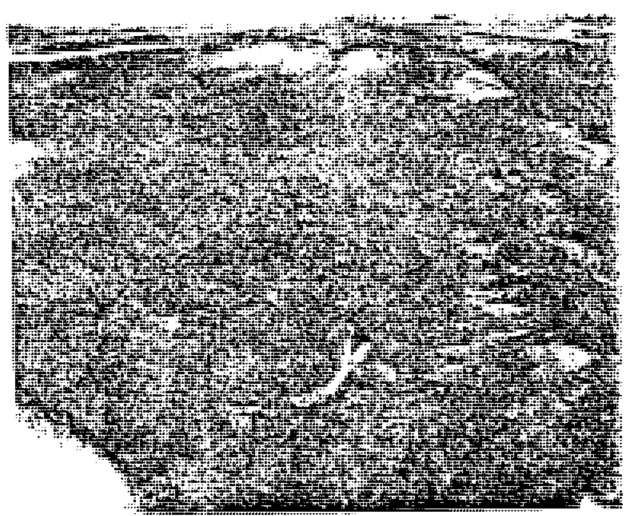
00012



A. Modern development in south-central portion looking northwest.

B. Golf course on perimeter of modern development

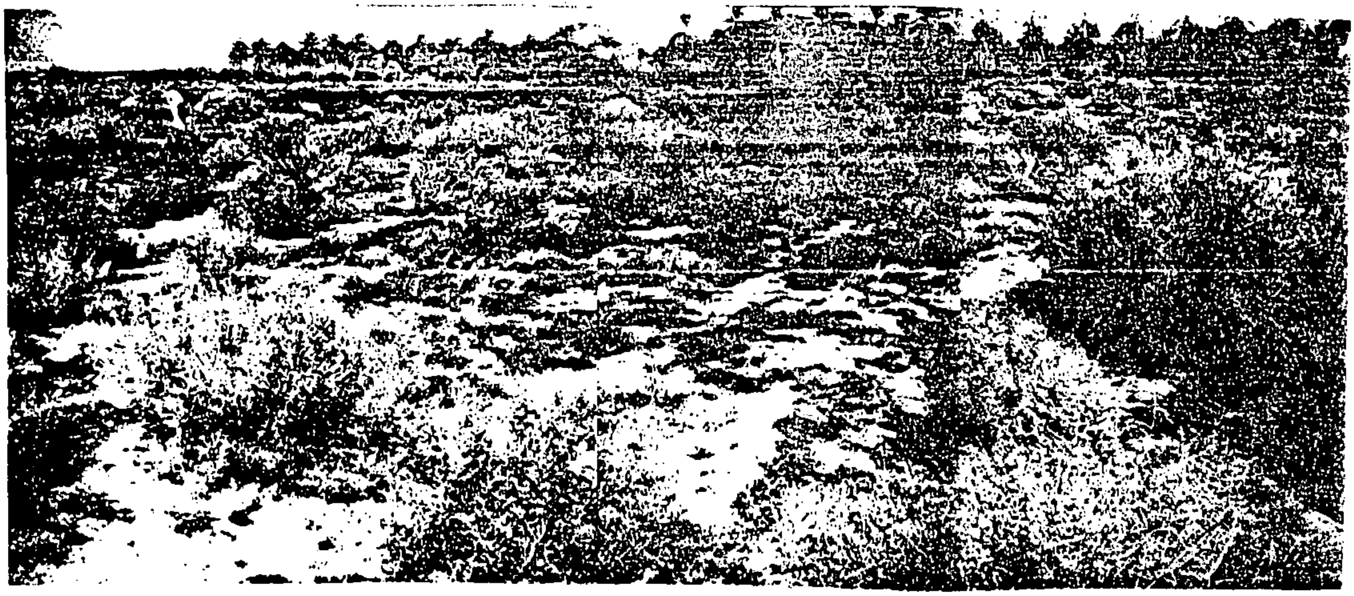
00012



C. Old irrigation ditch in northern portion of property looking east.

Fig.5

00011



A. Site A looking north.
Northern boundary of site is approximately 50 yds. in front of the date palms.

00011

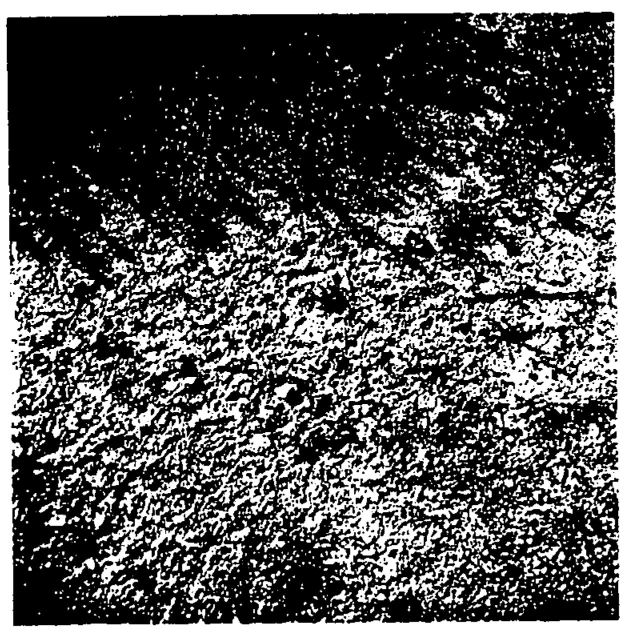
B. Tizon Brown Ware sherd (just right of stake) at Site A.

Fig.6

00011

A. Site B looking southwest. Note trailer park beyond site.

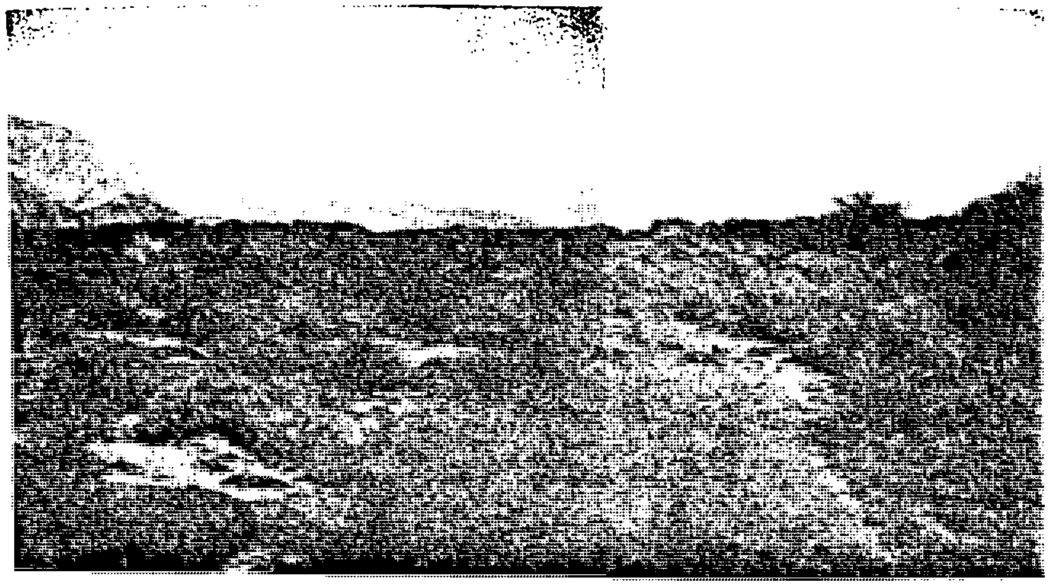
00011



B. Sherds at Site B.

Fig.7

00011



A. Vicinity of light sherd scatter designated on Site C. Looking northwest.

00011

B. Sherds at the site shown above.

Fig.8

8622 B Victoria
Costa Mesa, Ca. 9262

State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
ARCHEOLOGICAL SITE SURVEY RECORD

SITE No. ____________

1. Previous Site Designation None 2. Temporary Field No. Borrego Site A
3. USGS Quad Borrego Sink 7½' x 15' Year 1959
4. UTM Coordinates 3678,400 N ; 559.280 E
5. Twp. 11S Range 6E ; SW ¼ of SW ¼ of Sec. 4
6. Location 50 to 100 meters south of a date palm orchard and 50 meters east of DiGiorgio Road about 1 mile southeast of Borrego Springs.
7. Contour 560 8. Owner & Address Federated Development Co.
9. Prehistoric x Ethnographic ____ Historic ____ 10. Site Description Light scatter of Tizon Brown Ware
11. Area 70 x 70 meters 4900 square meters. 12. Depth of Midden None observed
13. Site Vegetation Creosote Surrounding Vegetation Same
14. Location & Proximity of Water Well for date palm orchard, no perennial water in vicin...
15. Site Soil dry sandy loam Surrounding Soil Same
16. Previous Excavation None
17. Site Disturbance None
18. Destruction Possibility Property scheduled for development
19. Features None
20. Burials None
21. Artifacts Tizon Brown Ware sherds - no other cultural materials observed.
22. Faunal Remains None
23. Comments Probably a gathering site where a vessel was accidentally broken
24. Accession No. ____ 25. Sketch Map x by A.A. where attached
26. Date Recorded 3/13/79 27. Recorded By Van Horn
28. Photo Roll No. 00011 Frame No. ____ Film Type(s) B/W Taken By Van Horn

DPR 422 (Rev. 9/76)

[illegible] 0 [illegible] % of [illegible]

National Register Status: Listed ____ Potential ____ No Determination ____ Nominated ____ Ineligible X

State Historical Landmark (No.) ________ Point of Historical Interest ________

SPECIAL ATTRIBUTES (Place an X in only those spaces which pertain to the site)

Midden/Habitation Debris ______ Lithic and/or Ceramic Scatter X

Bedrock Mortars/Milling Surfaces ______ Petroglyphs/Pictographs ______, Stone Features ______

Burials ______ Caches ______, Hearths/Roasting Pits ______, Housepits ______, Structure Remains ______

Underwater ______, Open Air ______ Rockshelter ______, Cave ______ Quarry ______, Trails ______

REMARKS probably no depth - a very light sherd scatter

SKETCH LOCATION MAP (Include permanent reference markers, North Arrow, and Scale)

Attached

SKETCH SITE MAP (Same criteria as above)

Attached

1032-B Victoria ...
Costa Mesa, Ca. 926..

State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
ARCHEOLOGICAL SITE SURVEY RECORD

SITE No. ________

1. Previous Site Designation None 2. Temporary Field No. Borrego Site B
3. USGS Quad Borrego Sink 7½' x 15' Year 1959
4. UTM Coordinates ^{36}77,800 - ^{36}78,200N; ^{5}58,760 - ^{5}59,100E
5. Twp. 11S Range 6E ; eastern ½ of NE ¼ of Sec. 8
6. Location One mile SSE of Borrego Springs just west of DiGiorgio Rd. and north of a modern trailer park (not shown on Quad).
7. Contour 580 8. Owner & Address Federated Development Co.
9. Prehistoric x Ethnographic ___ Historic ___ 10. Site Description
Expansive light scatter of Tizon Brown Ware sherds (see item 21 below)
11. Area 400 x 340 meters, 136,000 square meters. 12. Depth of Midden None observed
13. Site Vegetation Creosote Surrounding Vegetation Same
14. Location & Proximity of Water Well for date palm orchard, no perennial water in vicinity
15. Site Soil dry sandy loam Surrounding Soil Same
16. Previous Excavation None
17. Site Disturbance Uncertain
18. Destruction Possibility Property scheduled for development
19. Features None
20. Burials None
21. Artifacts Tizon Brown Ware sherds, several Lower Colorado River Buff Ware sherds on northern periphery. No other cultural materials observed.
22. Faunal Remains ~~None observed~~
23. Comments Probably a gathering site. No indications of occupation.
24. Accession No ________ 25. Sketch Map x by A.A. where attached
26. Date Recorded 3/13/79 27. Recorded By Van Horn
28. Photo Roll No. 00011 Frame No ____ Film Type(s) B/W Taken By Van Horn

DPR 422 (Rev. 9/76)

[illegible]

National Register Status: Listed ____ Potential ____ No Determination ____ Nominated ____ Ineligible X

State Historical Landmark (No.) ________ Point of Historical Interest ________

SPECIAL ATTRIBUTES (Place an X in the spaces which pertain to the site)

Midden/Habitation Debris ______ Lithic and/or Ceramic Scatter X

Bedrock Mortars/Milling Surfaces ______ Petroglyphs/Pictographs ______ Stone Features ______

Burials ______ Caches ______ Hearths/Roasting Pits ______, Housepits ______, Structure Remains ______

Underwater ______, Open Air ______ Rockshelter ______, Cave ______, Quarry ______, Trails ______

REMARKS Probably no depth.

SKETCH LOCATION MAP (Include permanent reference markers, North Arrow, and Scale)

Attached

SKETCH SITE MAP (Same criteria as above)

Attached

Costa Mesa, Ca 92...

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
ARCHEOLOGICAL SITE SURVEY RECORD

SITE No. ______

1. Previous Site Designation ______ 2. Temporary Field No. Borrego Site C
3. USGS Quad Clark Lake 7.5' x 15' Year 1959
4. UTM Coordinates 3679,320N ; 559,160E
5. Twp. 11S Range 6E ; SW ¼ of NW ¼ of Sec. 4
6. Location Adjacent to east side of DiGiorgio Rd., one and ½ miles ESE of Borrego springs.
7. Contour 520 8. Owner & Address Federated Development Co.
9. Prehistoric x Ethnographic ___ Historic ___ 10. Site Description Small light sherd scatter
11. Area 20 x 20 meters. 400 square meters. 12. Depth of Midden None observed
13. Site Vegetation Creosote Surrounding Vegetation Same
14. Location & Proximity of Water Only modern wells in vicinity
15. Site Soil dry sandy loam Surrounding Soil Same
16. Previous Excavation None
17. Site Disturbance Construction of DiGiorgio Rd.
18. Destruction Possibility Property scheduled to be developed
19. Features None
20. Burials None
21. Artifacts Tizon Brown Ware sherds – no other cultural material observed.
22. Faunal Remains None observed
23. Comments Historic sherds also present. Road destroyed unknown percentage of site
24. Accession No. ______ 25. Sketch Map x by A.A. where attached
26. Date Recorded 3/13/79 27. Recorded By Van Horn
28. Photo Roll No. 00011 Frame No. ___ Film Type(s) B/W Taken By Van Horn

[illegible] ? [illegible] Road construction [illegible] If known

National Register Status: Listed ___ Potential ___ No Determination ___ Nominated ___ Ineligible x

State Historical Landmark (No.) ___ Point of Historical Interest ___

SPECIAL FEATURES (Place an X in any of the following which pertain to the site)

Midden or Habitation Debris ___ Lithic and/or Ceramic Scatter x

Bedrock Mortars/Milling Surfaces ___ Petroglyphs/Pictographs ___, Stone Features ___

Burials ___ Caches ___ Hearths/Roasting Pits ___ Housepits ___, Structure Remains ___

Underwater ___, Open Air ___ Rockshelter ___, Cave ___ Quarry ___, Trails ___

REMARKS Much of site probably destroyed by DiGiorgio Road. More of the site may be present on the west side of the road -- this area was not surveyed as it was not a part of the subject property.

SKETCH LOCATION MAP (Include permanent reference markers, North Arrow, and Scale)

Attached

SKETCH SITE MAP (Same criteria as above)

Attached

1350 El Prado, Balboa Park, San Diego, California 92101, Telephone (714) 239-2001

REPORT ON ARCHAEOLOGICAL SITE FILES RECORD SEARCH

Source of Request: Archaeological Associates - David M. Van Horn

Date of Request: 29 January 1979 (X)Letter ( )Telephone ( ) In Person

Date Request Received: 30 January 1979 (X)Map Received (X)Map Returned

Name of Project: Borrego Springs area

( ) The Museum of Man files show no recorded sites for the project area.

(X) The Museum of Man files show the following sites ( )within (X)in the vicinity of the project area.

Site No. C-131 Culture(s): Cahuilla

Description: General site number for Borrego Valley; many campsites with cobble hearths, cremations, sherds, etc. No specific locations.

Recorded by: M.J.Rogers

Site No. C-490 Culture(s): Late Pre-historic

Description: Camp site; hearths; stacked rock circle; hammerstones; cores; flakes/debitage; scrapers; metates; manos; sherds; shell; retouched tools; milling slabs.

Recorded by: R.May 1977

Site No. Culture(s):

Description:

Recorded by:

Site No. Culture(s):

Description:

Recorded by:

Site No. Culture(s):

Description:

Recorded by:

Site No. Culture(s):

Description:

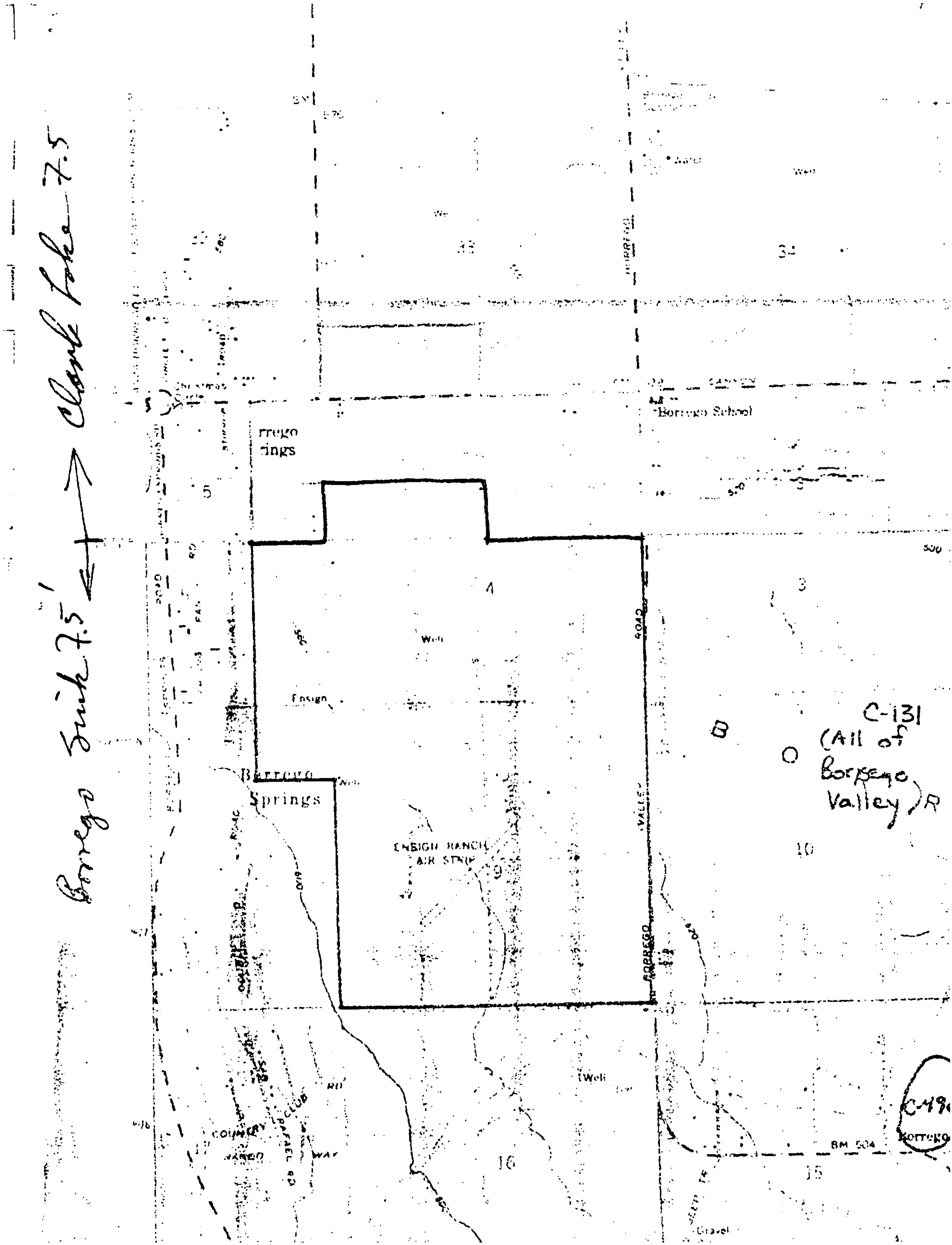
Recorded by:

Please note: The project area may contain archaeological resources in addition to those noted above. This report is made from San Diego Museum of Man files only and may not include data pertaining to localities other than those covered in previous Museum of Man surveys or gathered by other institutions or by individuals.

Record check by: Grace Johnson

Date: 31 January 1979

Signed: Lowell E. English



Borrego Sink 7.5' ↔ Clark Lake 7.5
Borrego School
Borrego Springs
Ensign
Well
ENSIGN RANCH AIR STRIP
BORREGO VALLEY ROAD
C-131 (All of Borrego Valley) R
COUNTRY CLUB
RANCHO
RAFAEL RD
WAY
BM 504
Gravel
33
34
5
4
3
9
10
16
15

SAN DIEGO STATE UNIVERSITY
SAN DIEGO, CALIFORNIA 92182
Department of Anthropology

REPORT ON ARCHAEOLOGICAL SITE FILES RECORD SEARCH

Source of Request— ARCHAEOLOGICAL ASSOCIATES, LTD

Date of Request—January 29, 1979

Date Request Received— January 30, 1979

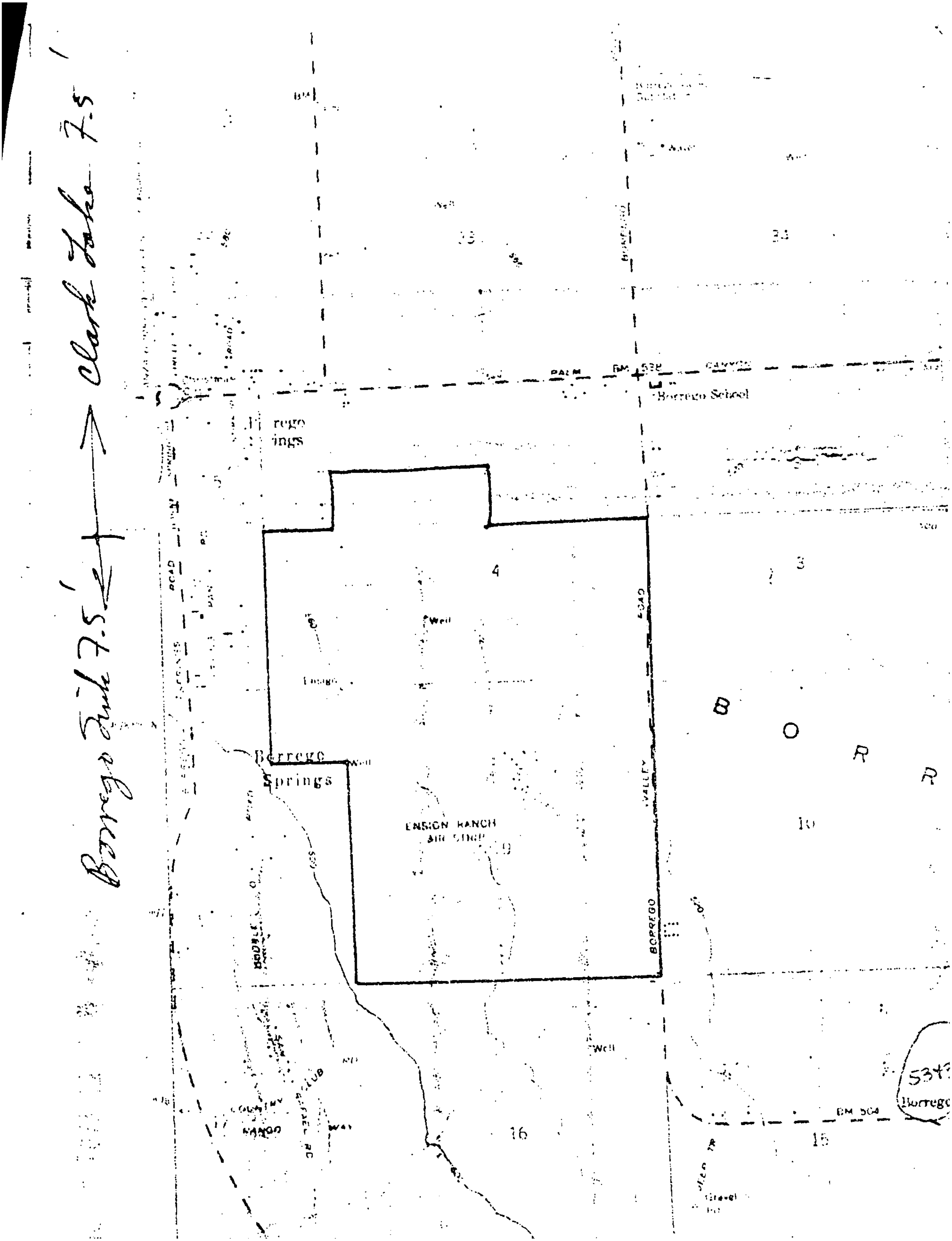
Project Identification— Clark Lake, Borrego Sink

(X) The San Diego State University files show no recorded site for the Project area.

( ) The files show positive site locations in the vicinity/on the project area. Site forms are included.

Record check by— Melissa Johnson Date— Feb 1, 1979

Signed— Larry L. Leach



Borrego Sink 7.5'
Clark Lake 7.5'
Borrego Springs
Borrego School
PALM
BM 538
CANYON
BORREGO
VALLEY
ROAD
ENSIGN RANCH
AIR STRIP
Well
BM 504
Gravel
COUNTRY CLUB
33
34
4
3
10
16
15
B
O
R
R

SAN DIEGO MUSEUM OF MAN

1350 El Prado, Balboa Park, San Diego, California 92101, Telephone (714) 239-2001

REPORT ON ARCHAEOLOGICAL SITE FILES RECORD SEARCH

Source of Request: Archaeological Associates - David M. Van Horn

Date of Request: 29 January 1979 (X)Letter ( )Telephone ( ) In Perso

Date Request Received: 30 January 1979 (X)Map Received (X)Map Returned

Name of Project: Borrego Springs area

( ) The Museum of Man files show no recorded sites for the project area.

(X) The Museum of Man files show the following sites ( )within (X)in the vicinity of the project area.

Site No. C-131 Culture(s): Cahuilla

Description: General site number for Borrego Valley; many campsites with cobble hearths, cremations, sherds,etc. No specific locations.

Recorded by: M.J.Rogers

Site No. C-490 Culture(s): Late Pre-historic

Description: Camp site; hearths; stacked rock circle; hammerstones; cores; flakes/debitage; scrapers; metates; manos; sherds; shell; retouched tools; milling slabs.

Recorded by: R.May 1977

Site No.____ Culture(s):

Description:

Recorded by:

Site No. Culture(s):

Description:

Recorded by:

Site No. Culture(s):

Description:

Recorded by:

Site No. Culture(s):

Description:

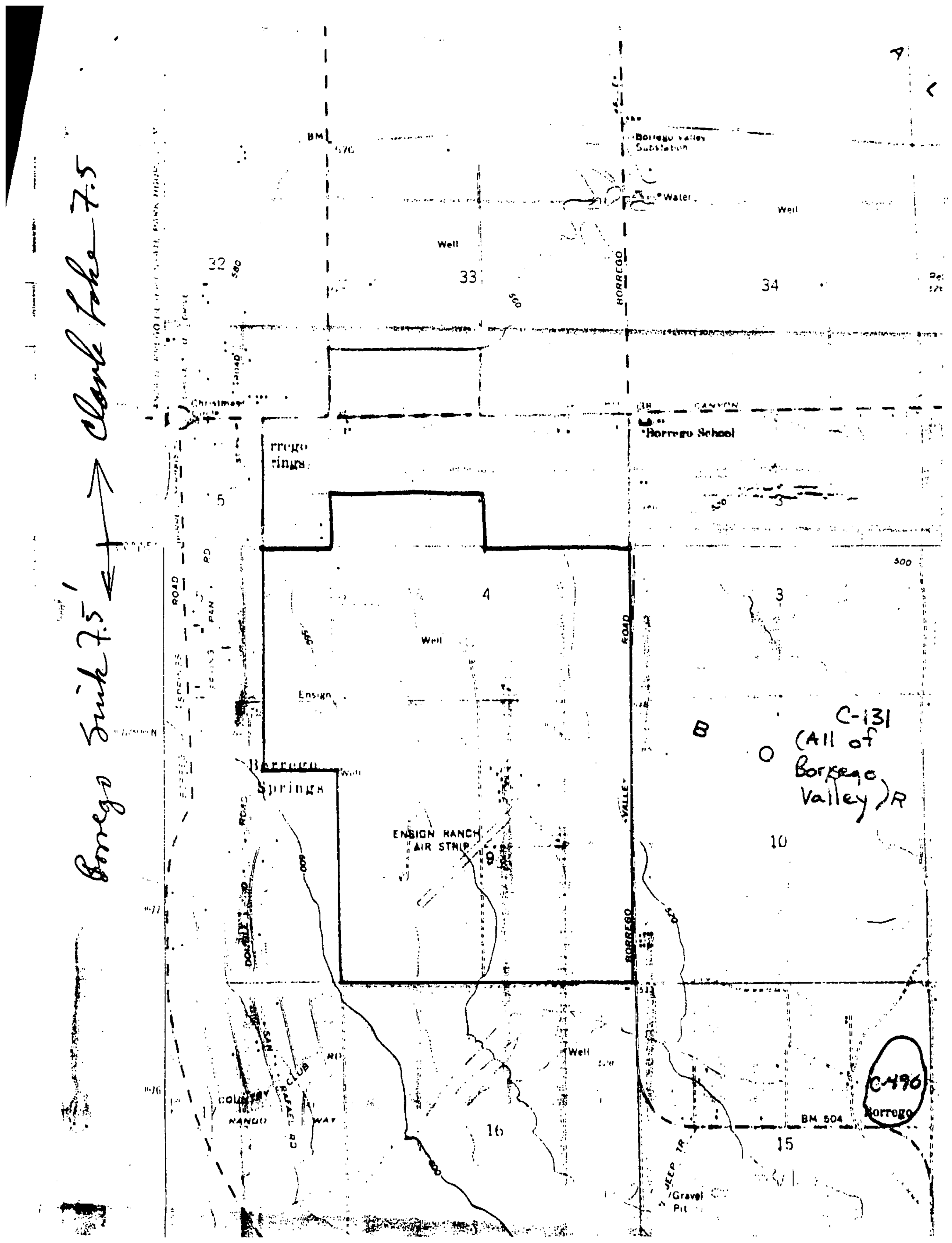
Recorded by:

Please note: The project area may contain archaeological resources in addition to those noted above. This report is made from San Diego Museum of Man files only and may not include data pertaining to localities other than those covered in previous Museum of Man surveys or gathered by other institutions or by individuals.

Record check by: Grace Johnson

31 January 1979

Signed: Lowell E. Endish



Borrego Sink 7.5' ←→ Clark Lake 7.5
BM
Borrego Valley Substation
Water
Well
Well
32
33
34
BORREGO
Christmas Circle
CANYON
Borrego School
rrego
rings
5
3
500
4
3
ROAD
Well
Ensign
C-131 (All of Borrego Valley) R
B
O
Borrego Springs
Well
VALLEY
ENSIGN RANCH AIR STRIP
9
10
BORREGO
Well
CLUB
RD
COUNTRY
SAN RAFAEL RD
RANCHO
WAY
16
C-496
Borrego
BM 504
15
JEEP TR
Gravel Pit
600

SAN DIEGO STATE UNIVERSITY
SAN DIEGO, CALIFORNIA 92182

Department of Anthropology

REPORT ON ARCHAEOLOGICAL SITE FILES RECORD SEARCH

Source of Request— ARCHAEOLOGICAL ASSOCIATES, LTD

Date of Request—January 29, 1979

Date Request Received— January 30, 1979

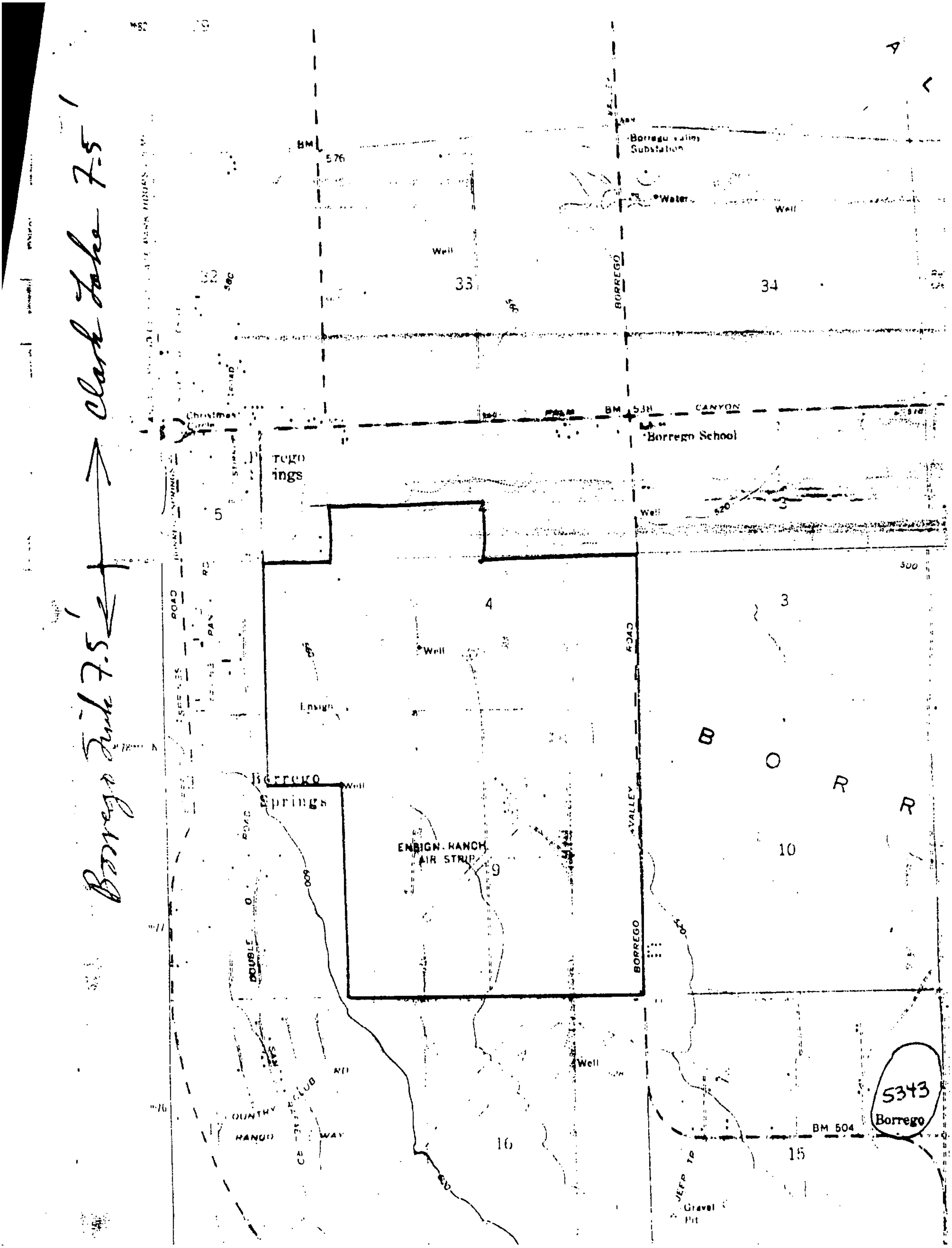
Project Identification— Clark Lake, Borrego Sink

(X) The San Diego State University files show no recorded site for the Project ar

(   ) The files show positive site locations in the vicinity/on the project area. Site forms are included.

Record check by— Melissa Johnson   Date— Feb 1, 1979

Signed— Larry L. Leach



Borrego Sink 7.5' ← → Clark Lake 7.5'
BM 576
Borrego Valley Substation
Water
Well
32
33
34
BORREGO
Christmas Circle
CANYON
BM 538
Borrego School
Borrego Springs
5
Well
520
3
500
4
Well
Ensign
ROAD
PAN
BORR
Borrego Springs
Well
ENSIGN RANCH AIR STRIP
9
10
VALLEY
BORREGO
DOUBLE O
600
COUNTRY CLUB
RANCHO
WAY
RD
Well
16
15
BM 504
5343
Borrego
JEEP TR
Gravel Pit

APPENDIX G

TABLE 1

TRAFFIC CHARACTERISTICS/TILTING T DRIVE

Average Daily Traffic	7300.
Percent Medium Trucks	.5
Percent Heavy Trucks	.5
Speed-Autos (MPH)	40.
Speed-Trucks (MPH)	40.
CNEL Criteria (dB)	55.

Distribution of Traffic

	Percent Daytime	Percent Evening	Percent Night Time
Autos	77.5	12.9	9.6
M-Trucks	84.8	4.9	10.3
H-Trucks	86.5	2.7	10.8

Noise Barrier Geometry

Horizontal Distance from Source to Barrier (Ft.)	65.0
Height of Barrier Base Above Roadway Base (Ft.)	0.0
Horizontal Distance From Source to Receptor (Ft.)	80.0
Height of Receptor Above Roadway Base (Ft.)	5.0

Traffic Noise Levels and Noise Barrier Heights

Traffic Noise Level (CNEL) Without Noise Barrier	59.9
Noise Barrier Height to Meet CNEL Criteria	6.0
Height of Top of Barrier Above Roadway Base	6.0
Attenuated Noise Level (CNEL) Achieved With Barrier	54.9

APPENDIX G

TABLE 2

TRAFFIC CHARACTERISTICS/BORREGO VALLEY ROAD

Average Daily Traffic	16000.
Percent Medium Trucks	1.5
Percent Heavy Trucks	.5
Speed-Autos (MPH)	45.
Speed-Trucks (MPH)	40.
CNEL Criteria (dB)	55.

Distribution of Traffic

	Percent Daytime	Percent Evening	Percent Night Time
Autos	77.5	12.9	9.6
M-Trucks	84.8	4.9	10.3
H-Trucks	86.5	2.7	10.8

Noise Barrier Geometry

Horizontal Distance From Source to Barrier (Ft.)	65.0
Height of Barrier Base Above Roadway Base (Ft.)	0.0
Horizontal Distance From Source to Receptor (Ft.)	80.0
Height of Receptor Above Roadway Base (Ft.)	5.0

Traffic Noise Levels and Noise Barrier Heights

Traffic Noise Level (CNEL) Without Noise Barrier	64.7
Noise Barrier Height to Meet CNEL Criteria	10.0
Height of Top of Barrier Above Roadway Base	10.0
Attenuated Noise Level (CNEL) Achieved With Barrier	54.9

APPENDIX G

TABLE 3

TRAFFIC CHARACTERISTICS/DI GIORGIO ROAD

Average Daily Traffic	6000.
Percent Medium Trucks	.5
Percent Heavy Trucks	.5
Speed-Autos (MPH)	40.
Speed-Trucks (MPH)	35.
CNEL Criteria (dB)	55.

Distribution of Traffic

	Percent Daytime	Percent Evening	Percent Night Time
Autos	77.5	12.9	9.6
M-Trucks	84.8	4.9	10.3
H-Trucks	86.5	2.7	10.8

Noise Barrier Geometry

Horizontal Distance From Source to Barrier (Ft.)	65.0
Height of Barrier Base Above Roadway Base (Ft.)	0.0
Horizontal Distance From Source to Receptor (Ft.)	80.0
Height of Receptor Above Roadway Base (Ft.)	5.0

Traffic Noise Levels and Noise Barrier Heights

Traffic Noise Level (CNEL) Without Noise Barrier	58.8
Noise Barrier Height to Meet CNEL Criteria	6.0
Height of Top of Barrier Above Roadway Base	6.0
Attenuated Noise Level (CNEL) Achieved With Barrier	53.8