3. Data Collection

Sufficient manpower resources shall be provided to collect the data necessary to determine the effectiveness of sand dune arrays at reducing PM-10 emissions. In addition to PM-10 related data, data shall also be collected to determine the effect of sand dune arrays on the shallow groundwater table using piezometers within the dune array. A data collection protocol shall be provided that addresses, in detail, the procedures for collecting the data discussed above. This protocol shall be presented for review and comments to GBUAPCD prior to any construction. GBUAPCD may request raw data for review at any time.

4. Data Analysis

The proper type and amount of data analysis necessary to determine the effectiveness of sand dune arrays at reducing PM-10 emissions shall be conducted. Data analysis shall be conducted as per a data analysis protocol to be developed by SLC or its Contractor and presented for review and comment to GBUAPCD prior to any data collection. Drafts of all data analyses shall be submitted to GBUAPCD for review and comment.

5. Maintenance

All approved sand fence materials and data collection equipment shall be maintained in working order. All materials and equipment shall be adequately anchored and secured. Upon completion of the test all equipment and material shall be removed from the lake bed and properly disposed of. This includes all sand fence materials if required by SLC.

6. Environmental Mitigation

A Negative Declaration (ND) under the provisions of the California Environmental Quality Act (CEQA) has been issued for this project by SLC. The mitigation measures called for in the approved ND that affect the sand dune project shall be implemented by SLC. Mitigation measure monitoring shall occur as per a monitoring plan to be adopted by SLC. The agency responsible for monitoring shall be decided at a later date.

7. Schedule

The small-scale array fences shall be in place by October 31, 1992. All monitoring equipment for the small-scale test shall be in place and operational by October 31, 1992. Data collection on the small-scale array will continue at least until January 1, 1994. The large-scale array fences and monitoring equipment shall be in place and operational by October 1, 1993. Data collection on the large-scale arrays

will continue at least until April 30, 1994. For the small-scale array, the quarterly project status reports will be prepared and submitted to GBUAPCD on October 1, 1992; January 1, 1993; April 1, 1993; July 1, 1993; and October 1, 1993. A draft data analysis report will be submitted on November 1, 1993 and draft final report will be submitted on January 1, 1994. For the large-scale array, the quarterly reports will be submitted on the same schedule, but in 1993 and 1994. A draft data analysis report for the large-scale arrays will be submitted on November 1, 1994, and the final report will be submitted on January 1, 1995.

TASK 2 - OPTIMIZED AND ENGINEERING OF SAND FENCE MATERIALS AND DESIGN

1. Analysis of Field Acquired Meteorological Data

   All field acquired meteorological data shall be properly reduced and estimates of surface friction speed and surface roughness shall be provided.

2. Sand Fence Design - Conceptual

   All previous field installations of sand fences on Owens Lake will be examined and reported on. Wind tunnel tests to be conducted per a separate contract will be used to develop the optimum parameters for the sand fence manufacturers, and other sand fence investigators will be conducted.

3. Sand Fence Design - Engineering

   Field and laboratory tests necessary to establish the principle sand fence engineering parameters will be conducted and a sand fence design will be generated. The design parameters to be developed will include: fence height, distance between support posts, post embedment depth, fence porosity, fence post, guy and anchor materials, fence orientation, and fence shape. The location of any field testing to be performed shall be submitted for review and comment to GBUAPCD prior to any field work.

4. Lake Bed Access

   Preliminary investigations regarding provision of all-weather access to all mitigation areas on the lake will be conducted. This will include collection of representative samples of the native soils found on Owens Lake and laboratory stabilization testing.

5. Schedule

The work described in this task shall be completed by October 15, 1993. All raw data collected can be requested by GBUAPCD at any time. Drafts of all data analysis shall be submitted to GBUAPCD for review and comment.

TASK 3 - NATIVE VEGETATION, SOIL AND WATER SURVEY

1. Study Site Selection

Study areas will be selected and will include natural dune areas and artificial dune areas. These sites will be submitted to GBUAPCD for review and comment prior to initiation of any field work.

2. Species Inventory

A species list will be made for each dune or dune system according to micro habitants present (dune top, dune margin, and interdune depressions). Quantitative data on species present will be developed. This will include, but is not limited to, cross section profiles, percentage cover, and species frequency.

3. Dune Morphology and Composition

Dune height, length, width, and shape will be recorded for each study area. Core samples of selected dunes will be collected and analyzed. Analyses will include, but are not limited to, particle size, pH, electrical conductivity, moisture content, organic matter and sulfate, carbonate, and nitrate levels.

4. Vegetation Composition Analysis

Representative plant samples will be collected and analyzed. Analyses will include, but are not limited to, ions of sodium, calcium, magnesium, chloride, boron, sulfate, and carbonate.

5. Seed Dispersal Study

Seasonal variability of seeds between the barren playa and dune sites and between open areas and beneath vegetation canopies will be compared. Random soil samples will be collected from each type of area of interest. Seeds present in the samples will be germinated and identified.

6. Report Preparation

A report will be prepared that addresses the study's main objectives. These include, but are not limited to, qualitative and quantitative descriptions of dune vegetation on and around the playa, and comparisons of these species compositions with the surrounding non-dune salt bush communities. The report will also describe the physical and chemical characteristics of sand dunes as they bear upon vegetation, and determine any correlation between species composition and dune characteristics. The report will also investigate the seeds and seed dispersal on and around the playa.

7. Schedule

The work described in this task shall be completed by October 15, 1993. All raw data collection may be requested at any time by the GBUAPCD. Drafts of all data analyses shall be submitted to GBUAPCD for review and comment.

COST BY TASK

Large and Small Scale

Task 1 - Sand Dune Array Field Test

1. Personnel	$34,315
2. Equipment**	$ 5,200
3. Subcontractors	
a. Fencing materials	$43,000
b. Construction labor	$27,000
4. Travel	$11,315
5. Supplies, Dust analysis	$ 8,332
Total	$132,252

Task 2 - Optimization and Engineering

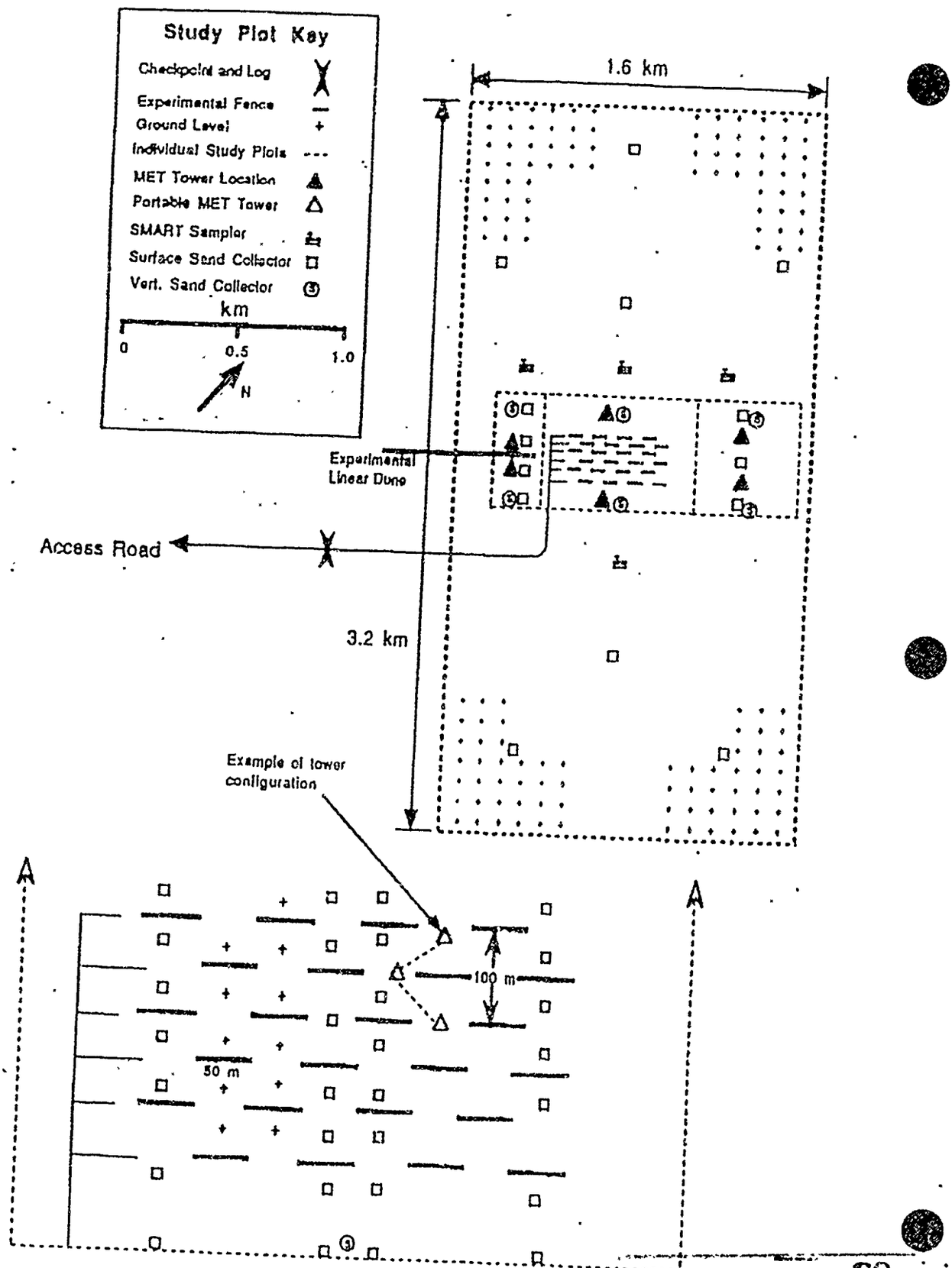
1. Personnel	$20,986
2. Equipment	-0-
3. Subcontractors	
a. Fencing materials	$ 3,000
b. Construction labor	$ 2,910
4. Travel	$ 3,182
5. Supplies	$ 3,288
Total, Task 2	$33,366

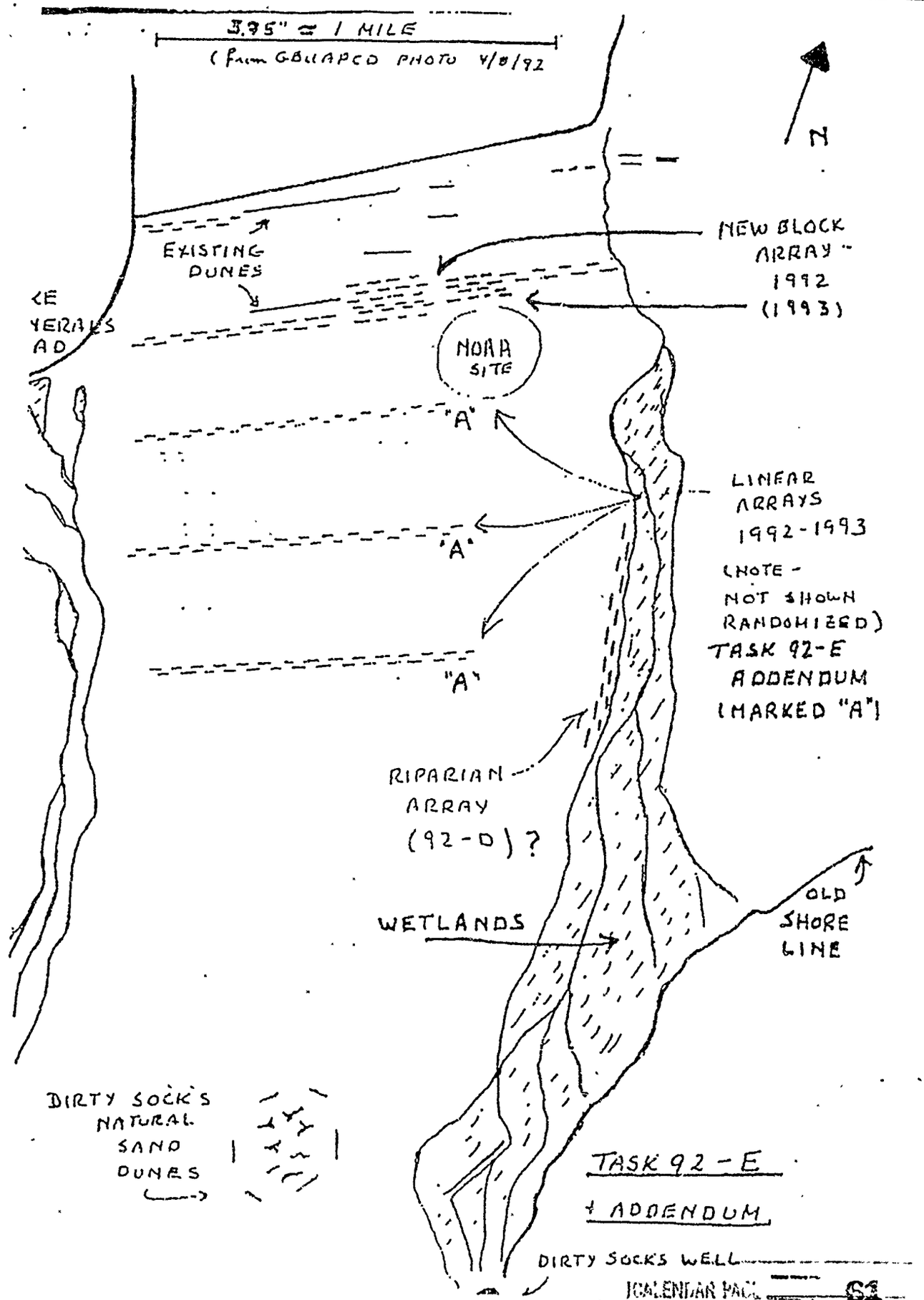
Task 3 - Nature Vegetation

1. Personnel	$ 5734
2. Travel	$ 3182
3. Supplies	$ 2,652
Total, Task 3	$11,568

Indirect Costs
(Items ** not subject to Indirect Costs)

10% of $163,138 =	16,314
PROJECT TOTAL	$193,500





BUDGET SUMMARY

DIRECT COSTS:

1.	Labor	$40,389
2.	Subcontractors/Consultants	30,000
3.	Equipment	5,200
4.	Travel & Subsistence	17,680
5.	Electronic Data Processing	
6.	Reproduction & Publication	1,500
7.	Mail & Telephone	1,000
8.	Materials & Supplies	58,501
9.	Analyses	2,300
10.	Micscellaneous	8,848
	Total Direct Cost	$175,018

INDIRECT COSTS:

11.	Employee Fringe Benefits	2,168
12.	Other Indirect Costs	16,314
	Total Indirect Cost	$15,482

TOTAL PROJECT COST $193,500

BUDGET DETAIL

Direct Costs:

1. Labor Charges

Direct Labor	Monthly Salary	No.Months	Total Salary
A. T.A. Cahill	$2,175./wk	1 week	$ 2,175
B. M. Taylor	1,950./wk	6 weeks	11,700
C. T.E. Gill	2,185./mo	6 months	6,555
D. J.S. Reid	2,185./mo	6 months	6,555
E. M.L. Yau	2,185./mo	6 months	6,555
F. Research Asst.	2,072./mo	7 months	9,324
G. Student Asts.	4.75./hr	1500 hours	7,125
	SUBTOTAL		$49,989

2. Subcontractors & Consultants — Estimated Cost

A. Contractor - Fence Construction — $30,000

1. Local Contractor must have California Contractor's License.

   a. Maintain secure area(s) for storage of fences, etc.

   b. Supply vehicle suitable for:

      (1). Work on lake bed
      (2). Capable of carrying fence, tools and personnel.

   c. Supply operator for vehicle:

      (1). Estimated days: 180 days
      (2). Work hours: 1,440 hours

   d. Supply safety equipment, communications equipment, etc.

   e. Superisor of operator - 20% time

      (1). Estimated days: 180 days
      (2). Work hours: 288 hours

	SUBTOTAL	$30,000

3. Equipment — Estimated Cost

A.	All Terrain Vehicle - 4 wheel	$ 1,300
B.	Trailer For ATV	600
C.	Electric Winch, etc. - On Lake	400
D.	Meterorological Equipment (add-on to equipment on loan to project. See also ARB contract #132-105)	2,400
	SUBTOTAL	$ 5,200

4.	Travel & Subsistence	Estimated Cost
A.	Air Transportation (none)	
B.	Ground Transportation	
	1. Round trips to Owens Lake 600 miles @ 0.24/mi -$144 x 15 trips	$ 2,160
	2. Transportation at Owens Lake UC car rental for 6 months.	2,600
C.	Per Diem or Subsistence 160 days @ $26/day	5,920
D.	Other - Rental of housing (replaces housing)	7,000
	SUBTOTAL	$17,680

5.	Electronic Data Processing	Estimated Cost
A.	Computer Usage	$ 0
	SUBTOTAL	$ 0

6.	Reproduction & Publication	Estimated Cost
A.	Progress Reports/Final Report	$ 1,500
	SUBTOTAL	$ 1,500

7.	Mail & Telephone	Estimated Cost
A.	Telephone At Lone Pine	$ 800
B.	Mail Costs	200
	SUBTOTAL	$ 1,000

8.	Materials & Supplies	Estimated Cost
A.	Sand Fencing, Posts, Cable, etc.	$50,000
B.	Film, Optical Support	800
C.	Hardware, etc.	900

D.	Materials For Sand Traps, Vehicle Tow	2,105
E.	Safety Equipment (Helmets, etc.)	200
F.	Miscellaneous Supplies	4,496
	SUBTOTAL	$58,501

9.	Analyses	Estimated Cost
A.	Compositional Analysis - Aerosols	$ 1,700
B.	Compositional Analysis - Water, etc.	600
	SUBTOTAL	$ 2,300

10.	Miscellaneous	Estimated Cost
A.	Graduate Student Fee Remission	$ 8,848
	SUBTOTAL	$ 8,848
	TOTAL DIRECT COSTS	$175,018

Indirect Costs:

11.	Employee Fringe Benefits	Estimated Cost
A.	Employee Benefits	$ 2,168
	SUBTOTAL	$ 2,168

12. Indirect Costs

(Based on modified total direct costs [MTDC] basis where MTDC = direct cost less equipment and Graduate Student Fees.

Rate 0.10 x MTDC 163,138.* = $16,314

*Overhead does not apply to items 3 (Equipment) and 10 (Graduate Student Fee Remission).

SUBTOTAL	$16,314
TOTAL INDIRECT COST	$18,482
TOTAL PROJECT COST	$193,500

ATTACHMENT b

AGREEMENT BETWEEN
GREAT BASIN UNIFIED AIR POLLUTION CONTROL DISTRICT
AND STATE OF CALIFORNIA, STATE LANDS COMMISSION
FOR THE PROVISION OF
RESEARCH AND DEVELOPMENT SERVICES

TERM:

FROM: May 1, 1992 TO: April 30, 1995

SCHEDULE OF FEES AND PAYMENT:

Great Basin Unified Air Pollution Control District shall pay the State of California, State Lands Commission the sum of fifty thousand dollars ($50,000) for the final data analysis reports resulting from the work described in Attachment A. Payment shall be made in a lump sum and will be paid within thirty (30) days of receipt of the funds from the City of Los Angeles Department of Water and Power

EXHIBIT C

MITIGATION OF WINDBLOWN DUSTS AND RECLAMATION OF PUBLIC TRUST VALUES, OWENS LAKE, CALIFORNIA, 1992-1993

Owens Lake Task Group
University of California, Davis

Partial Mitigation of PM-10 Dust Episodes Through Control of Saltating Particles and Reduction of Wind Shear, 1992-1993

Thomas A. Cahill: Principal Investigator
Robert G. Flocchini: Meteorology and Aerosols
Bruce White: Wind Field Diagnostics
Mike Taylor: Civil Engineering
Don Nielsen: Hydrology
Cathy Toft, Susan Ustin: Ecology
Tom Gill, Jeff Reid, Mee-Ling Yau: Air Quality Group

April 28, 1992

WORK PLAN: 1992-1993

The central thrust of this program is to test the hypothesis that control of saltating coarse particles is an effective and efficient way to control PM-10 dusts on the Owens Lake playas and surrounding countryside.

It will not be possible in this first phase to test this hypothesis completely, since the scale of the pilot scale mitigation is too small to give more than a few percent reduction of PM-10 dusts over a relatively small area. But it will be possible to test our second hypothesis: that a critical and effective way to control saltating coarse particles is through carefully-designed, properly-tested sand fences (which work by interacting directly with the saltation process) placed in "corridors" that cut the major wind fetches and areas of high sand movement.

Further, such sand fences can be placed in an array that, while it appears random and natural, provides effective control as it leads to a quasi-natural dune structure that is consistent with the public trust values of the Owens Lake area. In some cases, when water is available, these "dune corridors' could eventually become "riparian corridors" with native vegetation supported by naturally occurring and pumped water sources.

In addition, geophysical monitoring of the saltation process itself and its associated processes - upwind of, downwind of, on and around the sand fences - must be done if a mitigation effort is to be made successful. By better understanding the saltation phenomenon, as well as the physicochemical properties and processes characterizing the saltating particles (with respect to momentum transfer, fine particulate generation, etc.) we can optimize our mitigation strategy. Even a small improvement in our knowledge of the saltation process and how saltating particles create Pm-10 dusts at Owens Lake could lead to great reductions in the ultimate cost of mitigation.

After consultation with the State Land Commission (SLC) and the GBUAPCD, the original proposal of January 1992 (derived from the proposal of August 1991) has been focussed into tasks: a dry dune field, array sand fence dunes associated with either the array or the GBUAPCD wetlands tests, and a small riparian corridor vegetation test, and fence engineering and design. The wind tunnel testing is being prepared in a separate proposal.

It is important to realize that, although some mitigation will be accomplished by this summer's work, the essence of this proposal is a test of all aspects of field emplacement of dune arrays, aiming to optimize designs and engineering, reduce costs of future work, and get the greatest benefit per dollar spent. As such, it must be considered a research project on a pilot scale.

Nevertheless, the emplacement of more extensive fence arrays in summer 1993, pending satisfactory results of the test array of 1992-1993 and the detailed model/wind-tunnel/test fence studies, could be the initiation of mitigation efforts on the Owens Lake Bed.

CB

SUMMARY OF TASKS

NOTE: Task numbers derived from January 1992 Proposal. Listed in order of present priority.

1) TASK 92-E: Task 92-E instrumented dry dune field on the south Owens Lake area, has been expanded to incorporate some of the objectives from Task 92-A and Task 92-C from the January 1992 proposal. Appended.

2) TASK 92-F: Optimization for costs and materials, mechanical design and civil engineering of sand fence array placement. This will involve test fences at Davis and the existing south Owens Lake test area near the WESTEC fences. Implementation of this task will be submitted in a separate proposal. Appended.

3) TASK 92-A: Task 92-A from the January 1992 proposal for the emplacement of dry dune fields in the sand-dominated corridor north and west of Keeler has been deleted due to conflict with the GBUAPCD wetlands tests. Significant aspects have been incorporated into Task 92-E on the southern sand sheet near Olanch.

4) TASK 92-A: Alternate: Sand Fence array in corporation with the GBUAPCD wetlands tests. (New to this proposal). Appended.

5) TASK 92-B: Task 92-B from the January 1992 proposal for the initial tests of the Swansea Riparian Corridor has been deleted due to conflict with the GBUAPCD wetlands tests. Some of the information desired from Task 92-B can be obtained from Task 92-A: Alternate.

6) TASK 92-C: Task 92-C from the January 1992 proposal for the widening and extension of the One Mile Dune to the salt plan north and west of Keeler (an area heavily involved in the dust storms of November 1992), has been deleted due to conflicts with the GBUAPCD wetlands tests. Significant aspects of Task 92-C have been incorporated into Task 92-A: Alternate and Task 92-E.

7) TASK 92-D: Task 92-D has been retained as a small-scale test riparian corridor vegetation focussed on the Sulfate Well and Dirty Socks Well wetlands. Appended.

TASK 92-G: Design and optimization of sand fences and sand fence arrays for sand capture using computer models, wind tunnel tests and the experience of other projects around the world. This task will include the analysis of wind field of individual fences and fence arrays. Implementation of this task will be submitted in a separate proposal and part of which is covered by the companion ARB contract.

C9

I) TASK 92-E

Description:

Project 92-E involves construction of a test block array on the south area sand-dominated area near the 1981-1982 WESTEC sites. Access is via Lake Minerals Road. this area was significantly involved in the November 1992 dust storm.

Project 92-E has as its main purposes:

1. The measurement of transportal sand and saltating particles through a series of fences and to find the removal rate factor per staggered fence array. (Also see Plot 92-A.1). Such an array is one aspect of the riparian corridors or dry fence/dune arrays.

2. To measure the rate of entrainment of sand and saltating particles.

3. To measure the rate of dune buildup in the array.

4. To make measurements of wind speed in, around, and above the extended array (also data for wind tunnel model verification.)

5. To measure changes in surface, water levels, etc., in the array.

Project 92-E shall involve:*

1. Construction of 24 sand fences of the preliminary optimum design (Figure 1) in a block array of 3 staggered rows (Figure 2) placed across the prevailing direction of sand migration on the south sand sheet (Figure 3), ideally next to an existing filled linear dune. These are scheduled for completion in October 1992. Estimated fence - 4,000 feet.

2. Continuation of the array across the sand sheet, with the intent of blocking all N/S migration of sand, by Summer 1993. Estimated fence - 12,000 feet.

* All figures are present "best estimates" depending on local conditions and advances in design and materials.

3. Test arrays will have detailed meteorological and physical measurements designed to evaluate the effectiveness of the array. These are shown in Figure 2 and detailed in the protocols, but include:

   a. Sand Level Monitors (~600)
   b. Surface Sand Collectors (~50)
   c. Permanent Instrumented Meteorological Tower
   d. Portable 5-Tower Meteorological Array
   e. Vertical Sand Collectors (6)
   f. PM-10 Aerosol Collectors (4 to 6)
   g. Several Surface Moisture Level Sensors [not shown]

4. All data will be collected and reduced as a component of this contract and in collaboration with the companion Air Resources Board contract #A-132-105.

5. Further detail and operational protocols are found below in "General Protocols for Tasks.

92-E (addendum)
(If 92-A: Alternate is not chosen)

The purpose of these arrays is to start to set the parameters for spacing arrays at Owens Lake to optimize sand capture per dollar.

1. Four linear, staggered arrays will be constructed at locations upwind, downwind, and beside the block array. Each array will be approximately 4,000 feet long with adequate randomization in length and placement to present a quasi-natural dune field when filled. The spacing between arrays will be ~2,600 feet. Estimated fence - 16,000 feet.

2. Test arrays will have detailed instrumentation on ground level and sand migration, with occasional surveys of meteorology and aerosols and other parameters of 92-E.

FIGURE 2

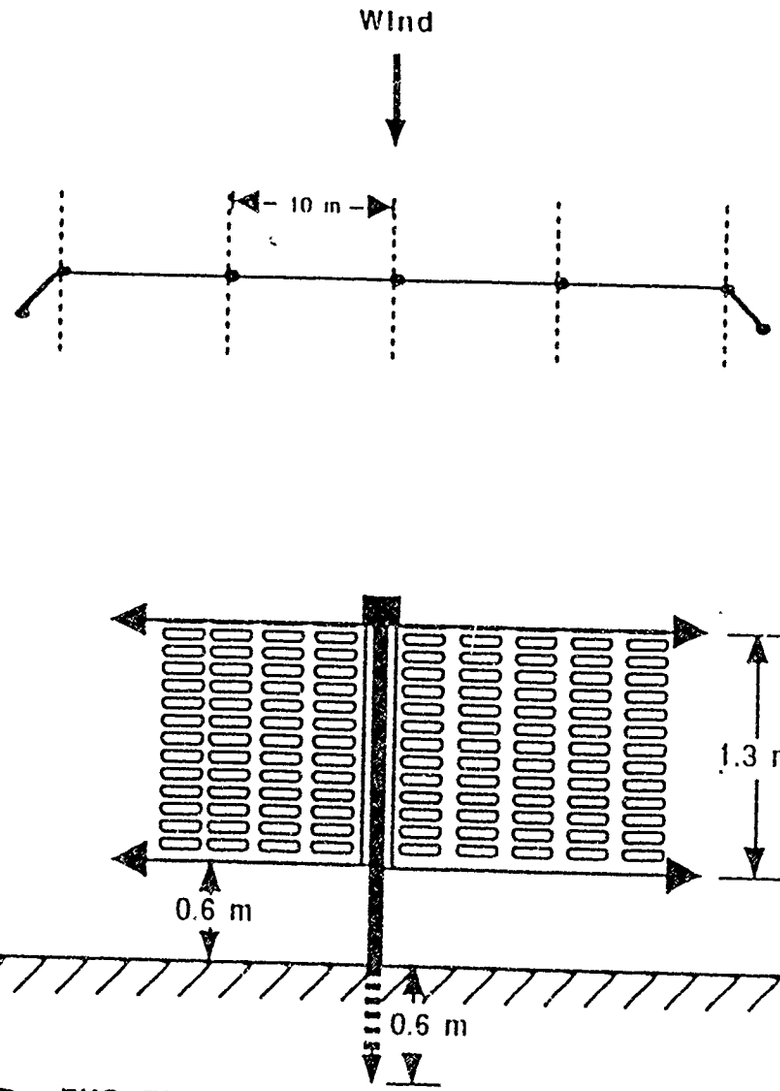
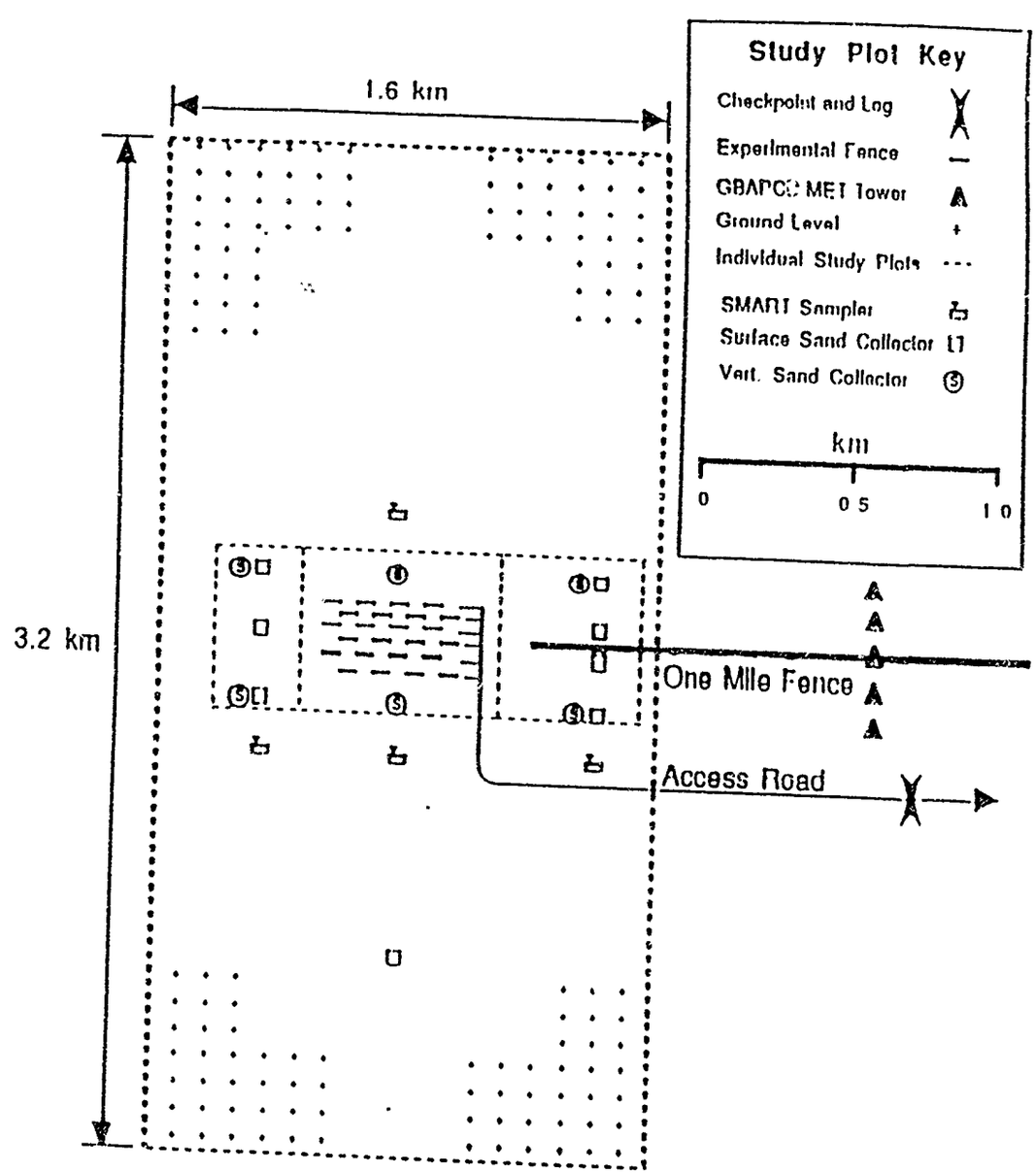
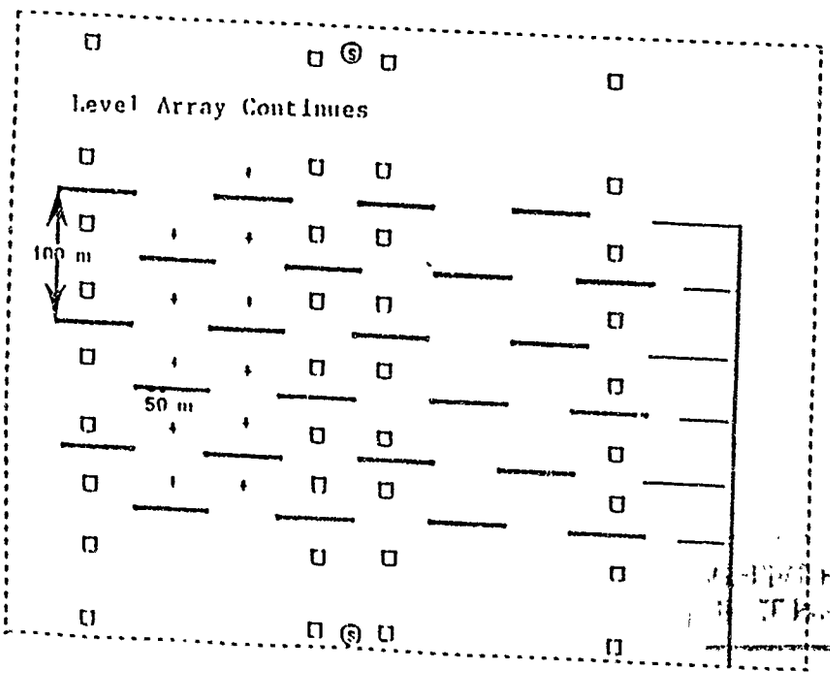
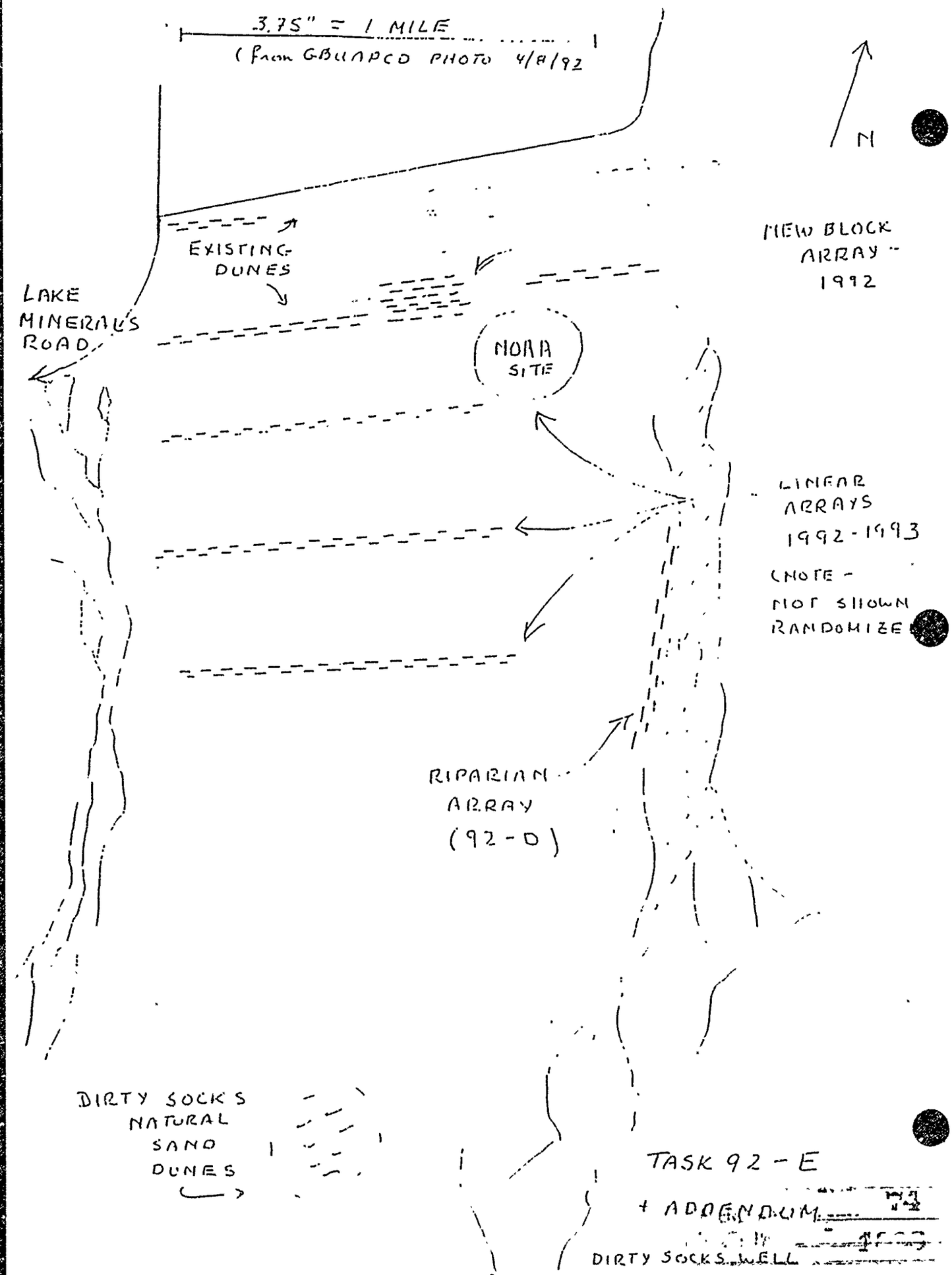

Wind
10 m
1.3 m
0.6 m
0.6 m
PVC Pipe
Plastic Fence
Manila Rope
PVC Pipes

FIGURE 1.


Study Plot Key
Checkpoint and Log
Experimental Fence
GBAPCS MET Tower
Ground Level
Individual Study Plots
SMART Sampler
Surface Sand Collector
Vert. Sand Collector
km
0
0.5
1.0
1.6 km
3.2 km
One Mile Fence
Access Road


Level Array Continues
100 m
50 m


3.75" = 1 MILE
(From GBUAPCD PHOTO 4/8/92
N
EXISTING DUNES
NEW BLOCK ARRAY - 1992
LAKE MINERALS ROAD
NOAA SITE
LINEAR ARRAYS 1992-1993
(NOTE - NOT SHOWN RANDOMIZED
RIPARIAN ARRAY (92-D)
DIRTY SOCKS NATURAL SAND DUNES
TASK 92-E
+ ADDENDUM
DIRTY SOCKS WELL

2) Task 92-F. Mike Taylor, Investigator

Optimization of costs and materials, mechanical design, and civil engineering of sand fence array placement. This will involve test fences at both Davis and the existing south test area.

This work is greatly aided by the simultaneous efforts of ARB contract of Tom Cahill that focusses on the nature and origins of the saltating particles, their motions across the lake bed, the connection between saltating particles and PM-10 dusts, the origins and transport of PM-10 dusts, and their detection through high altitude and satellite photography.

As the project is presently envisaged, this particular sub-project involves the following tasks which are listed in approximate chronological order.

(a) Fence Design - Conceptual
(b) Fence Design - Engineering
(c) Installation Methods for Fences
(d) Economies of Fence Design and Installation
(e) Logistics of Accessing the Lake Bed

(a) Fence Design - Conceptual

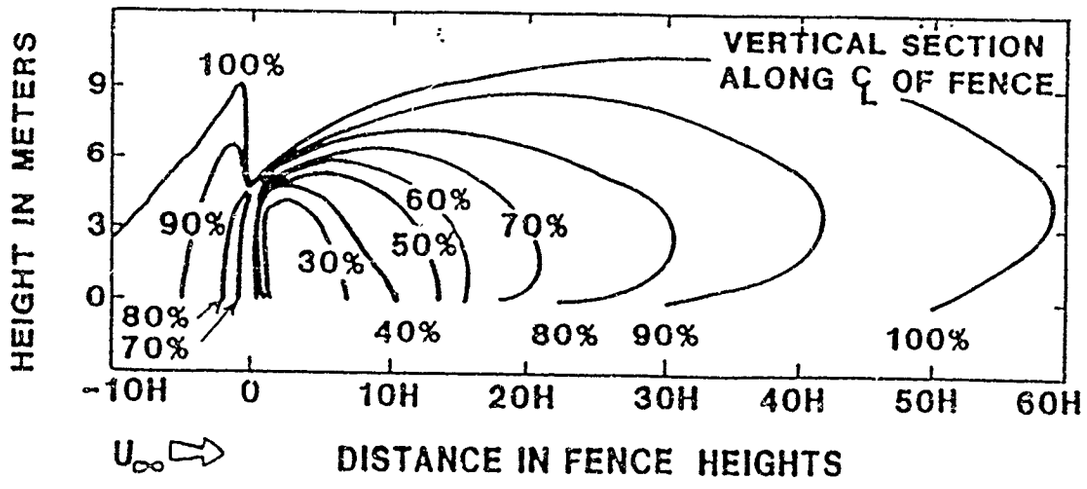
The detailed design of the fence(s) will be based upon the results of the following research.

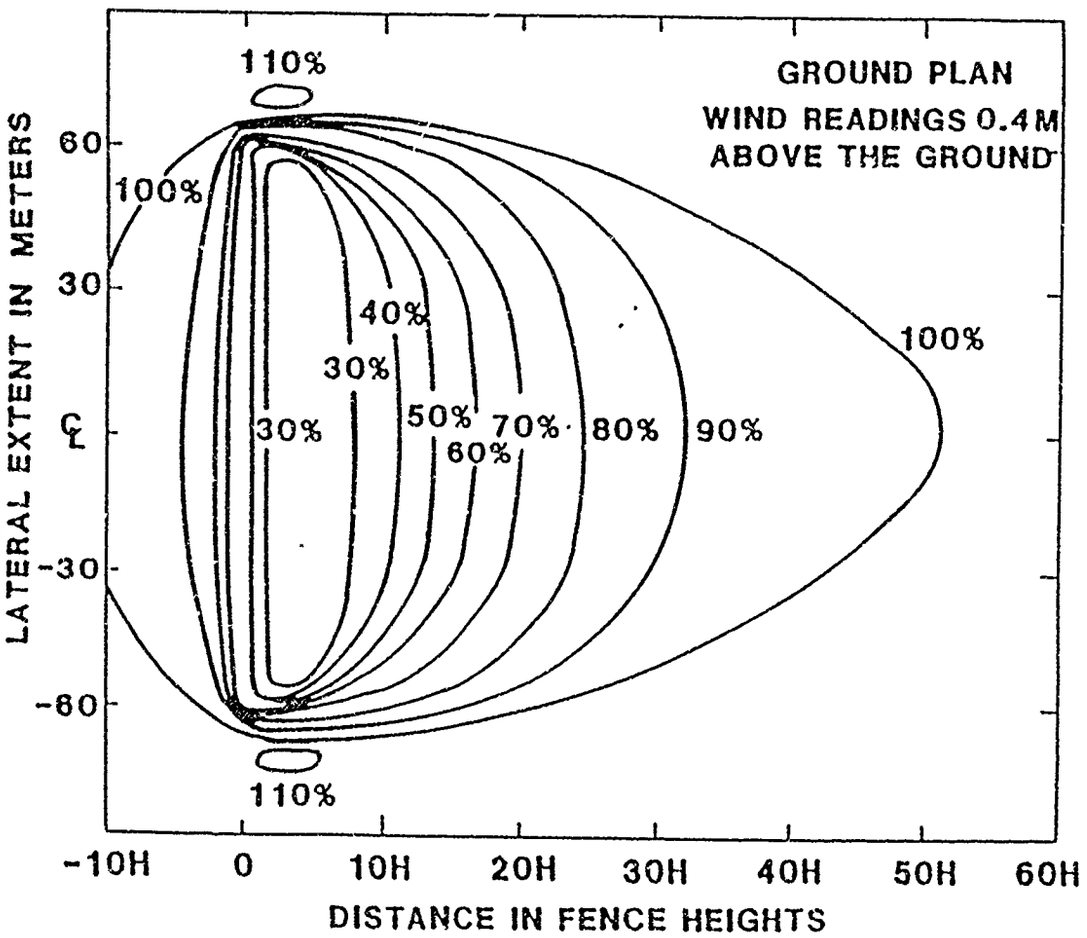
First, the experiences of all previous field installations of fences will be examined. A compilation of the successful and unsuccessful features of these prior installations will be made and, wherever possible, interviews with participants will be conducted to obtain first-hand accounts of both problems and successes. Considerable field experience has already been acquired by members of the Great Basin Unified Air Pollution Control District for fences subjected to the conditions at Owens Lake. Some sources of problems have also been identified - these include the effects of ultraviolet radiation and some failures initiated by the interaction of dissimilar materials in the fence components.

Second, the wind tunnel tests conducted by Dr. Bruce White will be used to predict the optimum parameters of each fence. Note that there may well be different design objectives for different fences, e.g. (i) maximization of storage capacity for sand, (ii) maximum life (stability) of created dune (iii) reduction of windshear (iv) suitability for (chosen) vegetation, etc. The detailed parameters are discussed hereinafter.

Third, a survey of the literature will be made to obtain the experiences of other investigators with fence designs, materials, and installation.

Fourth, UCD has personal communications with some of the worlds foremost experts on topic closely related to the Owens Project. Wherever possible the advice of these experts will be incorporated in the design process (Figure 4).





NOTE: VELOCITIES ARE % OF UPSTREAM VELOCITY AT THE SAME HEIGHT