SWRHL-36r

STATUS OF THE NEVADA TEST SITE EXPERIMENTAL FARM

Summary Report for July 1964 - December 1965

by
Richard L. Douglas
Bioenvironmental Research Program
Southwestern Radiological Health Laboratory
U. S. Public Health Service
Department of Health, Education, and Welfare
Las Vegas, Nevada

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This work performed under Memorandum of Understanding (No. SF 54 373)
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I. INTRODUCTION

On July 1, 1963, the U. S. Atomic Energy Commission (AEC) awarded a contract to the U. S. Public Health Service, Southwestern Radiological Health Laboratory (SWRHL) to study the transport of radioiodine from the environment to man. The most pressing problem was the determination of the passage of radioiodine through the air-forage-dairy cow-milk-man food chain. In order to initiate this program, the Bioenvironmental Research Program (BRP) was established within SWRHL for the sole purpose of developing a field and laboratory research program which would answer the questions posed by the AEC.

In addition to this research on radioiodine, the Research Branch of the Division of Radiological Health, U. S. Public Health Service, was seeking answers to questions about the uptake by plants of long-lived fission products and neutron activation products in fallout and subsequent passage of these products through man's food chains. Since much of the data and information collected in one of these programs would also be required by the other, it seemed logical to combine the two to avoid unnecessary duplication of equipment, facilities, and effort. Therefore, the Aged Radionuclide Program was formed as a sub-section of the BRP with Public Health Service funding. The Aged Radionuclide Program officially came into being on July 1, 1965, although its requirements had been considered earlier along with those for the BRP.

Because an extensive effort was to be devoted to the passage of radioiodine through the human food chain, and because this research was to be conducted under field conditions, an experimental farm facility was required. The Nevada Test Site (NTS), with its sources of radioactive materials resulting from various nuclear detonations and tests, seemed to be an excellent area in which to develop this experimental farm. The original concept of the farm included about 30 acres of irrigated land, facilities for a 24-cow dairy herd, and a laboratory building.

Criteria for the farm site were drawn up and the search for a specific location on the NTS was begun in 1963. Personnel from several organizations provided helpful consultation and advice regarding site selection. These organizations included the U. S. Weather Bureau, the U. S. Geological Survey, the Clark County Agricultural Extension Service of the University of Nevada, and Reynolds Electric and Engineering Co. (REECo), the prime contractor at the NTS. Six different areas were evaluated in terms of the following criteria:

1. A land area of about 30 acres
2. An adequate and dependable water supply for irrigation of this acreage
3. Accessability
4. Availability of electrical power
5. Construction cost (largely influenced by 2, 3, and 4)
6. The presence of significant levels of fallout activity which would allow field research by the Aged Radionuclide Program
7. Soil type and growing season which would permit a simulation of current farming practices in the southwestern United States

One site was finally selected as providing the best compromise with all these criteria. This site was located at Well UE 15d in Area 15, near the north end of the NTS (see Figure 1). Although some problems were anticipated in developing the well for our needs, it seemed to be

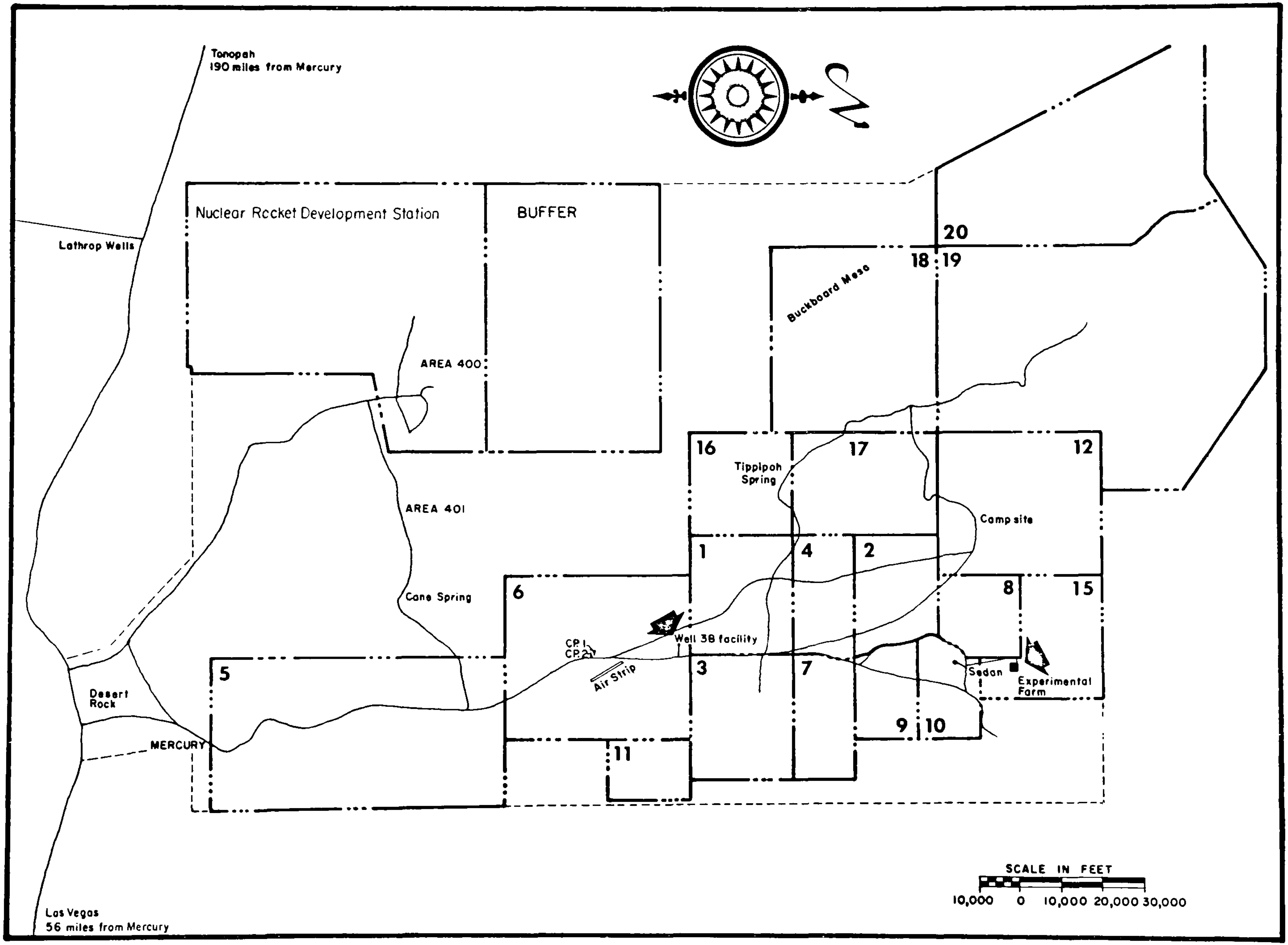

Figure 1. Location of PHS facilities on the Nevada Test Site.

the best overall choice among the water supplies available. A paved road approached to within one-quarter mile of the site, and an electrical power line was located within one mile of the site. Temperature data collected over several years indicated that the growing season was adequate for forage and grain crops. This site, located about three miles downwind from the Sedan crater, was contaminated with considerable radioactivity from this 1962 Plowshare event.

Design and construction of the facility began in the spring of 1964. The land clearing and reservoir construction was completed and the first crop was planted that fall. However, the laboratory and dairy facilities were not completed in time for occupancy before the end of this report period.

Seventeen Holstein cows were purchased in April 1964 for use in field studies that spring. Since the Experimental Farm was not completed then, they were housed in a temporary barn and corral at Well 3B, NTS, (see Figure 1), and fed forage purchased on a contract basis.

II. DESCRIPTION OF THE EXPERIMENTAL FARM FACILITY

A. Specific Site Characteristics

The site is located on a gently sloping alluvial fan in a high desert valley surrounded by mountains on the east, north, and west. The average elevation is 4560 feet and the average land slope is 2-4% to the southeast. The soil is a gravelly sandy loam with some cobbles and stones scattered throughout. The area has a dense desert cover of natural vegetation, predominately black brush (*Coleogyne ramosissima*), wolf berry (*Lycium andersonii*), small rabbit brush (*Chrysothamnus viscidiflorus*), desert needle grass (*Stipa speciosa*), four-wing saltbush (*Atriplex canescens*), and Indian rice grass (*Oryzopsis hymenoides*).

Prevailing winds during the spring, summer and fall are from the south-southwest during the daytime. Northerly drainage winds predominate during summer nights. During the winter, the winds are predominately from the north with some tendency to reverse during daytime, but less so than in summer. General weather conditions in Area 15, averaged over a four-year period, are presented in Table 1.

B. Cultivated Area

A roughly square area of about 29 acres lying to the southeast of the well was graded to remove native vegetation and to smooth a few small natural drainage channels. The contractor was asked to disturb the soil as little as possible consistent with achieving the desired results. Some of the larger rocks were removed with a tractor and front-end loader. The clearing job was completed about the end of August 1964, and the area was fenced with woven wire fence and three strands of barbed wire on steel posts.

Table 1. Summer weather conditions in Area 15, NTS (four-year average).

Month	Apr	May	Jun	Jul	Aug	Sep	Oct
Average Wind Speed: (miles per hour)							
Average Speed	10	9	9	9	8	7	8
Relative Humidity: (percent)							
Mean maximum	51	44	35	31	40	50	53
Mean minimum	11	10	9	8	11	14	17
Temperature: (degrees Fahrenheit)							
Mean maximum	72	76	89	95	92	87	72
Mean minimum	43	47	58	64	62	55	47

Average annual precipitation: 4.5 inches

C. Well and Reservoir

Well UE 15d was originally drilled as an exploratory water well. It had a seven-inch (outside diameter) casing from the ground surface to a depth of 1784 feet. A 4-1/2 inch lining started at 1667 feet and went down to 5400 feet. The static water level was at 670 feet, with 80% of the water coming from an aquifer between 5200 and 5300 feet. The well was test pumped at a rate of 78 gallons per minute.

When the well was drilled, considerable trouble was encountered with lost circulation of drilling mud because the casing was ruptured at several points. In an attempt to remedy this situation, large quantities of cottonseed hulls, redwood bark, cement, ground rubber tires, and cellophane were pumped down the well to try to plug the ruptures. This material was to be flushed out when the well was pumped, but REECo engineers were afraid that it would ruin a pump. Therefore, they recommended developing the well by jetting it with an air compressor to clean the well out and test its capacity.

Accordingly, a compressor was set up and jetting began in May, 1964. The flow rate ranged from 100 to 150 gpm. After several weeks of testing, some drilling material was still being flushed out. The engineers concluded that so much of this material had been injected that it would probably never be completely flushed out. However, since compressor jetting would not be a practical method for routinely producing water, they decided to install a special pump designed to handle the drilling material.

A 73-stage Byron Jackson submersible pump (Model D225B) with a 180 horsepower, 1040 volt motor was installed at the 1700-foot level during September 1964. This pump has a rating of 200 gpm at 2000-foot head. Although this pump was designed to handle small amounts of this type of material, the amount pumped out exceeded the capacity of the pump and caused pump failure on two occasions. The pump was replaced in June and again in August 1965.

A flow rate of 550 gpm for about eight hours per day were desired for the irrigation system. Since a maximum flow rate of about 200 gpm was anticipated from the well, a storage reservoir was necessary to keep an adequate water supply available for the irrigation pump. A reservoir of about one million gallons capacity was designed and constructed in the summer of 1964. The reservoir, of trapezoidal cross section, was approximately 120 feet square at the top with a design water depth of 13 feet. The porosity of the soil at this site required sealing the sides and bottom of the reservoir. Bentonite clay was used as a sealant.

The reservoir was filled in the fall of 1964, just prior to the planting of the first crop. After filling, it was apparent that the reservoir leaked badly and it was doubtful if an adequate water supply for corp irrigation could be maintained during the summer months. In the spring of 1965, the water in the reservoir was pumped out and the sides were coated with cement grout applied over 2-inch mesh screen. The bottom of the reservoir was not grouted because the REECo engineers felt that the thick layer of bentonite on the bottom (which had washed off the sides) had sealed it. However, the leakage losses were still apparent after the grouting.

Data collection was started in June of 1965 so that the actual reservoir losses could be determined. Since only approximate values were desired, the leakage losses were calculated as the difference between what was pumped into and out of the reservoir during a given period of time. If there was a difference in the water level in the reservoir between the beginning and end of the period, this was accounted for in the calculations.

The following table indicates average losses over periods of approximately one month duration.

Table 2. Average reservoir leakage losses.

Period Covered in 1965	Losses in Gallons per day
June 14 to July 14	60,000
July 14 to August 13	44,500
August 13 to September 20*	32,000
September 20 to October 20	38,000
October 20 to November 8	33,000
November 8 to December 7	26,000

*Reservoir nearly empty 30% of the period due to failure of the well pump.

The trend of the data indicates a substantial decrease in losses due to leakage. This probably resulted from a gradual expansion of the bentonite with the passage of time, which provided a better seal of the bottom of the reservoir.

D. Irrigation System

In the original planning for the irrigation system both sprinkler and surface flooding methods were considered. A sprinkler system was chosen because: (1) the soil is too porous for a flooding system to operate efficiently, (2) a flooding system would require extensive grading and land leveling, and (3) a sprinkler system allows greater flexibility.

The irrigation system was installed in the fall of 1964. It consisted of a centrifugal pump mounted on the north bank of the reservoir, a 900-foot main line, and sixteen 767-foot laterals connected to the main line at right angles (see Figure 2). This system provided irrigation coverage of approximately 16.5 acres.

The pump (Peerless Mfg. Co., Type "A" Size 6A-13) delivers 550 gpm at 140 feet of head and is powered by a 30 hp - 1750 rpm - 480 volt electric motor. At the pump, a water meter (Sparling Model CF-115) indicates both the flow rate and the total gallons of water which have passed through the meter. The main line is 6-inch O.D., 12 gauge cement-coated steel pipe, buried 18 inches below grade. The laterals are 3-inch O.D., 12 gauge, asphalt dipped, steel pipe, installed on the ground surface and spaced approximately 60 feet apart. Each lateral has 20 Rainbird Model 40B sprinkler heads which at 50 psi deliver 7.2 gpm and cover a circle of about 40 feet. The heads are spaced approximately 40 feet apart and are mounted 21 inches

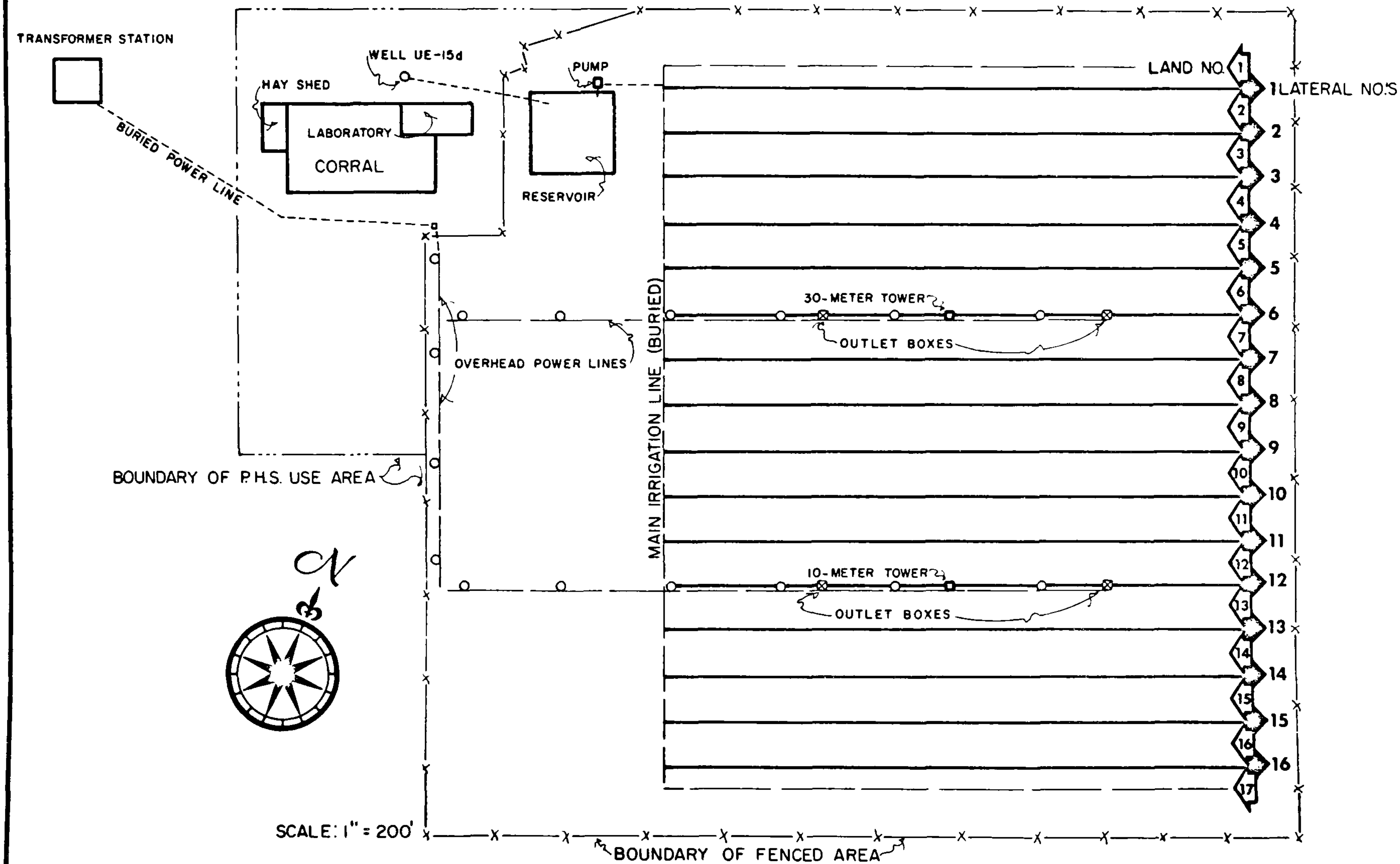

Figure 2. Plan of experimental farm.

above the lateral on 3/4" galvanized pipe risers. The water flow through each lateral is controlled by a gate valve located just off the main line.

The system was originally installed with every second lateral 20 feet shorter than the adjacent one and the heads on alternate laterals staggered. Theoretically, this method of spacing should have given optimum distribution of the water. However, in our case it did not, as there were areas in the middle of the field which did not receive adequate water. In addition, the edges of the field were ragged and hard to farm. Therefore, in late 1965 the short laterals were lengthened 20 feet so that the heads on all the laterals are now the same distance from the main line.

As originally constructed, the first three laterals joined the main line at the base of the reservoir bank. This setup did not leave room to turn farm machinery without running up on the bank. To correct this situation, in December of 1965 the first 20-foot section of each of these three laterals was buried to allow turning space.

E. Other Agricultural Equipment

The following basic pieces of farm machinery were purchased during the summer of 1964:

Tractor	- Massey-Ferguson Model 35
Grain drill	- Massey-Ferguson Model 33
Forage chopper	- Massey-Ferguson Model Super 60
Self-unloading wagon	- Gehl Model 85
Disc	- Massey-Ferguson Model 25
Manure spreader	- Massey-Ferguson Model 18
Manure loader	- Massey-Ferguson Model 38
Rear-mounted scraper blade	- Massey-Ferguson Model 17
Fertilizer spreader	- Lely Whirlwind

F. Laboratory and Animal Facilities

The original concept of the building complex included a 40'x 90' laboratory building with milking parlor; an attached 30'x 48' holding barn; a 120'x 130' corral with feed bunks, water tanks, shade, and loading chute; a 26'x 60' hay storage shed and a 26'x 60' machine shed. Such a complex was too expensive, however, and in the final design the laboratory building was reduced to 40'x 74' and the holding barn and machine shed were deleted.

Sierra Construction Company began construction of the building complex in May 1965. Figure 3 shows an area plan of the building complex.

Disposal of the milk from the herd of 24 cows presented a problem. Government regulations and possible radioactive contamination prohibited human consumption. Disposal to a septic tank was judged undesirable because of the possible adverse effects the milk might have on the biochemical activity in the tank. It was decided to use a liquid manure handling system to take care of both the milk and the manure which was washed from the barn. A commercially-available liquid manure system designed especially for dairy operations (Easy-Way Disposal System, manufactured by the Vaughn Co., Inc.) was chosen. This system consists of an 18,000-gallon underground concrete tank which collects the manure and milk. A clock-operated agitator in the tank keeps the solids in suspension, and a special chopper pump empties the tank into a 1100-gallon tank wagon. The tank wagon has a spreader with which the contents can be emptied on the field.

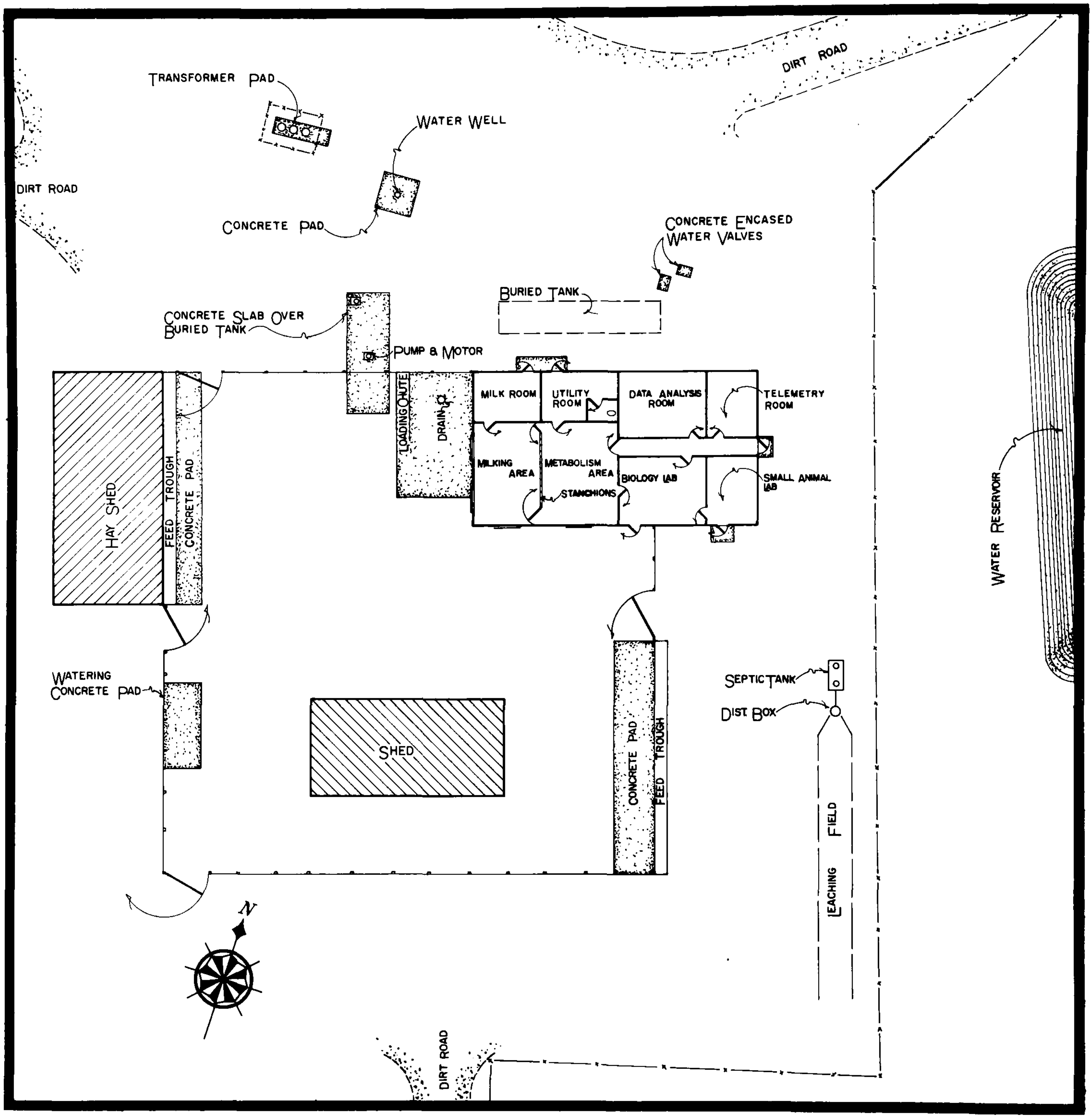

Figure 3. Area plan of the experimental farm building complex.

G. Permanent Research and Support Equipment

It was recognized from the beginning of this research project that weather conditions affect the passage of radioiodine through the food chain, particularly in the deposition of an aerosol on the ground or crops. Therefore, it was desired to have a complete record of the micrometeorology of the Experimental Farm. An agreement was made with the U. S. Weather Bureau personnel assigned to the AEC Nevada Operations Office to obtain such a record.

The approach used was to install two permanent instrumentation towers in the crop area, from which data could be transmitted by line to readout and recording equipment in the telemetry room of the laboratory. During 1965, a 30-meter tower was erected at the midpoint of the No. 6 lateral, a 10-meter tower at the midpoint of the No. 12 lateral, and two electrical outlet boxes were installed on each of these laterals (see Figure 2). Portable one-meter towers can be plugged into the outlet boxes and placed anywhere in the crop area. Sensors on the towers are capable of making the following measurements:

<u>30-meter tower</u>

Wind speed and direction at one, ten and thirty meters

Ambient temperature at one meter

Temperature difference between one and ten meters

Temperature difference between one and thirty meters

Dew point at one meter

Soil temperature two inches below surface

<u>10-meter tower</u>

Wind speed and direction at one and ten meters

Ambient temperature at one meter

Temperature difference between one and ten meters

One-meter towers (portable)

Wind speed and direction

Ambient temperature

Dew point

Soil temperature

At the end of 1965, the meteorology towers and associated power and telemetry lines were the only equipment permanently installed in the field. Installation of the system was essentially complete, but problems were still being encountered with the telemetry equipment.

Other meteorological equipment was set up near the laboratory to measure insolation, precipitation, and evaporation rate. Precipitation data from October 1, 1964 through December 1965 are tabulated in Appendix I. Insolation and evaporation data for this reporting period have not been completely processed.

III. AGRONOMY PRACTICES

For convenience of operating the farm machinery, the entire strip of land between adjacent irrigation laterals was planted to the same crop. The laterals were numbered one through sixteen, with lateral No. 1 being the northernmost one. (See Figure 2.) The area between adjacent laterals is called a land, and the lands are numbered as shown. Lands Nos. 1 and 17, being on the ends of the system, are slightly smaller than the others. Each of the 15 full-sized lands (Nos. 2 through 16) is about one acre in area.

The cropping pattern used is based on the capacity of the irrigation system. The pump was designed to provide a sufficient flow rate and pressure to handle a set of four laterals at once, i.e., laterals 1-4, 5-8, etc. Each crop type is planted in adjacent lands which are irrigated simultaneously by one set of laterals.

When development of the farm site was begun in the spring of 1964, it was hoped that construction would be finished in time to allow planting a fall crop in September. However, due to various delays we were not able to begin planting until late October. The local Agricultural Extension Service agent gave advice pertaining to suitable forage varieties, seeding rates, and fertilizer application rates for this area. Because of the late season, he advised seeding Brevor wheat and Alpine barley at the rate of 100 pounds of seed per acre. Hopefully, these varieties would germinate and become established before cold weather set in, and then make good growth in the spring. He also advised that we apply 100 pounds each of nitrogen (N) and phosphorus (P_2O_5) per acre.

The phosphorus fertilizer was applied on October 21 and 22, 1964, with the grain drill, the only piece of equipment available at that time. Treble superphosphate (45% P_2O_5) was used as a source of phosphorus. An application of 220 pounds of fertilizer per acre provided the desired 100 pounds of P_2O_5 per acre. The entire field was disced to cover the fertilizer on October 27.

On October 28, the lower half of the field (lands 9-17) was irrigated with 1/4 inch of water prior to planting. On the same day, lands 1-4 were seeded to Ramona wheat (Brevor wheat seed was not available locally) and fertilized with 220 pounds of urea (45% nitrogen) per acre. This application rate gave 100 pounds of N per acre. Lands 5-8 were seeded to Alpine barley and fertilized with nitrogen at the same rate as lands 1-4. On October 29, the area seeded the previous day was irrigated with 1/2 inch of water. Lands 9-12 were seeded to barley and lands 12-17 seeded to wheat, and then fertilized with 220 pounds of urea (100 pounds of N) per acre.

The seed planted in the fall of 1964 did not provide a good crop in 1965. Apparently, the main reason for the failure was the fact that the seed was planted so late that seedlings did not become well established before winter. Consequently, the entire field was replanted in the spring of 1965. On May 27, the upper half of the field (lands 1-9) was seeded with 100 pounds per acre of Alpine barley. At the same time, 220 pounds of urea (100 pounds of N) were applied per acre. The lower half of the field (lands 10-17) was fertilized at the same rate and seeded with 30 pounds per acre of Piper Sudan grass.

A heavy infestation of aphids was noticed in mid-June. On June 28, the entire field was sprayed with 4-1/2 gallons of 56.5% Malathion, applied at the rate of one quart per acre.

Approximately 32 tons of surplus ammonium nitrate (33.5% nitrogen) was obtained from REECo for use as a top dressing. On July 13, 1965, the entire field was top dressed with 340 pounds of ammonium nitrate (110 pounds of N) per acre. On August 13, the Sudan grass was fertilized with 85 pounds of nitrogen per acre, and on August 18 the barley was fertilized with 105 pounds of nitrogen per acre. On September 12, the Sudan grass was fertilized with an additional 50 pounds of nitrogen per acre, applied as urea.

The Sudan grass planted on the lower half of the field germinated well and produced a good stand. However, the barley planted at the same time on the upper half of the field did not make a good crop. The exact reason or reasons for this poor crop is not known, but apparently it was due to at least two factors. It seemed to have been damaged more by the aphids, and was also hurt by the lack of water when the well pump failed in June.

On September 16, 1965, the barley in the first nine lands was disced under. This area was then fertilized with 300 pounds of treble superphosphate (135 pounds P_2O_5) per acre and seeded with a mixture of Kanota oats and Lahontan alfalfa. The oats were seeded at the rate of 35 pounds per acre, and the alfalfa at 25 pounds per acre. Thirty pounds of nitrogen per acre were applied at the time of planting. On September 25, the Sudan grass in lands 10-17 was fertilized with 25 pounds of nitrogen per acre.

During October the Sudan grass was harvested with the forage chopper. An amount that the dairy cows could eat was chopped each day, and this "green chop" was taken to the barn at Well 3B and fed to the cows. About nine tons of green chop were cut from lands 10-13 (approximately four acres). Lands 14-17 were not harvested because they were heavily infested with Russian thistle.

When the green chopping was completed in late October, the Sudan stubble in lands 10-13 was disced three times and the area was seeded to rye grain. The area was fertilized prior to planting with 200 pounds of treble superphosphate (90 pounds of P_2O_5) and 300 pounds of ammonium nitrate (100 pounds of N) per acre. On November 4, rye grain was seeded at the rate of 100 pounds per acre. An additional 55 pounds of urea (25 pounds of N) per acre was applied at the time of planting. The last four lands (14-17) were disced and left fallow.

Appendix II shows the amount of water applied by date and the total amount during the report period. It should be recognized that all areas under irrigation did not receive exactly the amount of water stated. Some of the factors which cause non-uniform water application are evaporation losses, wind drift of the spray, damaged or improperly adjusted sprinkler heads, irregular spacing of laterals and heads, and leaks in the system.

The types and amounts of fertilizer applied by date and the total amount applied during the report period are summarized in Appendix III.

IV. RESEARCH PROJECTS - PAST AND FUTURE

Only one major experiment, designated Project Hayseed, was performed at the Experimental Farm during the reporting period. On October 4, 1965, a diatomaceous earth aerosol tagged with ^{131}I was released over a section of growing Sudan grass, a stack of spread hay, and a stack of spread green chop. The growing Sudan grass was cut as green chop, and each of the three types of contaminated forage were fed to groups of lactating dairy cows. An additional group of cows was placed in the aerosol cloud for an inhalation study. The levels of ^{131}I in the milk were related to ^{131}I concentrations in forage and air. Further details of this study have been published in References 1 and 2.

Two major experiments are planned for 1966. In the early summer, a dry aerosol tagged with ^{131}I is to be released over a mixed stand of oats and alfalfa (Project Alfalfa) in a study very similar to Project Hayseed. A study is planned for late summer where a ^{131}I tagged solution will be sprayed over a portion of the field to simulate the "rainout" of radioiodine (Project Rainout).

Experiments will be started within the Aged Radionuclide Program to study the movement in the soil and the uptake by plants of the long-lived radionuclides from Sedan fallout. An auxilliary irrigation system is planned which will allow irrigation of small plots of undisturbed soil. These micro plots will be used for experiments and pilot studies which could not conveneintly be conducted in the main crop area.

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2. Barth, D.S., and Seal, M., "Radioiodine Transport Through the Ecosystem, Air-Forage-Cow-Milk Using a Synthetic Dry Aerosol", Radioecological Concentration Processes, Proceedings of an International Symposium held in Stockholm, April 25-29, 1966.

APPENDICES

APPENDIX I

PRECIPITATION DATA

The precipitation gauge was set up at the Experimental Farm on October 1, 1964. The daily precipitation (in inches) is tabulated by months during the report period.

DATE	INCHES
October 29, 1964	0.06
Total:	0.06
November 9, 1964	0.10
10	0.05
13	0.03
15	0.04
16	0.27
17	0.02
Total:	0.51
December 2, 1964	0.01
11	0.02
19	0.02
28	0.03
31	0.02
Total:	0.10
January 7, 1965	0.09
19	0.02
Total:	0.11
February 6, 1965	0.01
Total:	0.01
March 12, 1965	0.69
13	0.20
27	0.08
31	0.17
Total:	1.14
April 1, 1965	1.09
2	0.09
3	0.58
4	0.50
6	0.01
8	0.17
9	0.15
10	0.15
11	0.02
12	0.27
13	0.12
Total:	3.15
May 2, 1965	0.01
3	0.03
14	0.05
22	0.05
24	0.02
Total:	0.16
June 3, 1965	0.13
16	0.01
25	0.01
Total:	0.15
July 15, 1965	0.01
16	0.08
17	0.04
18	0.01
19	0.01
24	0.10
25	0.04
31	0.10
Total:	0.39
August 10, 1965	0.07
11	0.01
12	0.11
13	0.02
15	0.30
16	0.34
17	0.01
18	0.12
Total:	0.98
September, 1965	0
October, 1965	0

DATE	INCHES	DATE	INCHES
November 14, 1965	0.15	December 9, 1965	1.13
15	0.13	10	0.02
16	0.64	11	0.03
17	0.48	12	0.05
18	0.06	13	0.01
22	1.08	29	1.40
23	0.06	31	0.04
24	0.03	Total:	2.68
25	0.03		
Total:	2.66		

Total precipitation for report period

October 1, 1964 to December 31, 1965

= 12.10 inches

APPENDIX II

IRRIGATION DATA

The water applied during the reporting period is tabulated by date of application and by four sets of laterals. The figures recorded are gallons of water applied, as determined by the difference between the irrigation pump meter readings before and after irrigation. The gallons of water applied through each set of laterals is totaled for the period of October 28, 1964 to May 31, 1965, and monthly thereafter to the end of 1965. Each of these totals is converted to inches of water applied, using the conversion factor of 28,000 gallons through four laterals being approximately equal to one-quarter inch of water over the area covered. The water depths are rounded to the nearest one-quarter inch. The total depth of water applied through each set is summarized at the end of the Appendix.

Gallons Applied

DATE	Lateral Numbers 1 - 4	5 - 8	9 -12	13-16	TOTAL
Oct 28, 1964	----	----	28,000	28,000	56,000
Oct 29	57,000	57,000	----	----	114,000
Oct 31	44,000	45,000	44,000	45,000	178,000
Nov 2	57,000	57,000	57,000	57,000	228,000
Nov 6	28,000	28,000	28,000	28,000	112,000
Dec 11	28,000	28,000	28,000	28,000	112,000
Dec 17	28,000	28,000	28,000	28,000	112,000
Mar 2, 1965	28,000	28,000	5,000	----	61,000
Mar 8	28,000	28,000	----	----	56,000
*	47,000	47,000	47,000	47,000	188,000
May 24	----	----	----	6,000	6,000

*No record of how this water was applied since it was done by REECo personnel testing irrigation system. Assumed to be applied uniformly over the field.

DATE	Lateral Numbers 1 - 4	5 - 8	9 -12	13-16	TOTAL
May 26, 1965	57,000	57,000	57,000	57,000	228,000
May 28	57,000	57,000	14,000	57,000	185,000
May 31	57,000	57,000	57,000	57,000	228,000
Total gallons applied during period	516,000	517,000	393,000	438,000	1,864,000
Inches of water applied during period	4-1/2"	4-1/2"	3-1/2"	3-3/4"	
June 2, 1965	57,000	57,000	57,000	57,000	228,000
June 4	28,000	28,000	28,000	28,000	112,000
June 7	28,000	28,000	28,000	28,000	112,000
June 9	28,000	28,000	28,000	28,000	112,000
June 11	28,000	28,000	28,000	28,000	112,000
June 14	28,000	28,000	28,000	28,000	112,000
June 16	28,000	28,000	28,000	29,000	113,000
June 18	28,000	28,000	28,000	28,000	112,000
June 21	36,000	28,000	28,000	28,000	120,000
June 23	28,000	34,000	----	28,000	90,000
Total gallons applied in June	317,000	315,000	281,000	310,000	1,223,000
Inches of water applied in June	2-3/4"	2-3/4"	2-1/2"	2-3/4"	
July 1, 1965	57,000	56,000	28,000	28,000	169,000
July 6	29,000	29,000	29,000	29,000	116,000
July 9	58,000	58,000	58,000	60,000	234,000
July 12	58,000	58,000	58,000	58,000	232,000
July 13	58,000	58,000	58,000	58,000	232,000

DATE	Lateral Numbers 1 - 4	5 - 8	9 - 12	13-16	TOTAL
July 14, 1965	29,000	29,000	29,000	29,000	116,000
July 16	58,000	58,000	58,000	58,000	232,000
July 19	58,000	58,000	58,000	58,000	232,000
July 21	58,000	58,000	58,000	58,000	232,000
July 23	29,000	34,000	29,000	29,000	121,000
July 26	58,000	58,000	58,000	59,000	233,000
July 28	58,000	58,000	58,000	58,000	232,000
July 30	29,000	29,000	29,000	29,000	116,000
Total gallons applied in July	637,000	641,000	608,000	611,000	2,497,000
Inches of water applied in July	5-1/2"	5-1/2"	5-1/4"	5-1/4"	
Aug 2, 1965	58,000	58,000	58,000	58,000	232,000
Aug 4	67,000	58,000	58,000	73,000	256,000
Aug 6	58,000	58,000	58,000	58,000	232,000
Aug 9	58,000	58,000	61,000	58,000	235,000
Aug 11	63,000	58,000	58,000	58,000	237,000
Aug 13	66,000	58,000	48,000	74,000	246,000
Aug 18	58,000	58,000	----	----	116,000
Aug 26	----	----	----	58,000	58,000
Aug 27	----	----	58,000	----	58,000
Aug 30	52,000	51,000	58,000	58,000	219,000
Total gallons applied in August	480,000	457,000	457,000	495,000	1,889,000
Inches of water applied in August	4-1/4"	4"	4"	4-1/2"	

DATE	Lateral Numbers 1 - 4	5 - 8	9 -12	13-16	TOTAL
Sept 1, 1965	29,000	----	87,000	87,000	203,000
Sept 2	----	58,000	----	----	58,000
Sept 3	58,000	58,000	87,000	87,000	290,000
Sept 6	58,000	58,000	58,000	58,000	232,000
Sept 9	29,000	29,000	58,000	58,000	174,000
Sept 10	58,000	58,000	----	----	116,000
Sept 12	----	----	87,000	87,000	174,000
Sept 17	58,000	58,000	58,000	58,000	232,000
Sept 20	46,000	46,000	58,000	58,000	208,000
Sept 21	36,000	36,000	----	----	72,000
Sept 22	39,000	39,000	58,000	----	136,000
Sept 23	29,000	29,000	----	----	58,000
Sept 25	58,000	58,000	58,000	58,000	232,000
Sept 26*	30,000	30,000	30,000	30,000	120,000
Sept 27	73,000	35,000	58,000	62,000	228,000
Total gallons applied in September	601,000	592,000	697,000	643,000	2,533,000
Inches of water applied in September	5-1/4"	5-1/4"	6-1/4"	5-3/4"	

*Between September 25 and September 27, the records on 120,000 gallons of water were lost. It was assumed to be applied uniformly over the entire field on September 26.

*Sept 28 - Oct 4, 1965	200,000	200,000	200,000	200,000	800,000
Oct 5	30,000	58,000	74,000	58,000	220,000
Oct 6	36,000	46,000	29,000	29,000	140,000
Oct 7	32,000	29,000	70,000	29,000	160,000

*During this period, the records on 798,000 gallons of water were lost. However, this water was known to be applied approximately uniformly over the entire field.

DATE	Lateral Numbers 1 - 4	5 - 8	9 -12	13-16	TOTAL
Oct 8, 1965	35,000	29,000	58,000	94,000	216,000
Oct 9	94,000	29,000	58,000	39,000	220,000
Oct 11	29,000	29,000	70,000	42,000	170,000
Oct 12	29,000	29,000	29,000	----	87,000
Oct 13	29,000	60,000	72,000	15,000	176,000
Oct 14	42,000	51,000	----	----	93,000
Oct 15	34,000	51,000	53,000	58,000	196,000
Oct 16	29,000	29,000	----	30,000	88,000
Oct 18	29,000	29,000	----	48,000	106,000
Oct 20	29,000	29,000	----	21,000	79,000
Oct 21	29,000	29,000	----	----	58,000
Oct 23	29,000	29,000	----	29,000	87,000
Oct 25	15,000	16,000	----	29,000	60,000
Oct 26	29,000	29,000	----	----	58,000
Oct 29	58,000	95,000	53,000	----	206,000
Total gallons applied in October	837,000	896,000	766,000	721,000	3,220,000
Inches of water applied in October	7-1/2"	8"	6-3/4"	6-1/2"	
Nov 1, 1965	48,000	48,000	----	----	96,000
Nov 3	----	----	68,000	----	68,000
Nov 4	----	58,000	84,000	----	142,000
Nov 5	29,000	29,000	29,000	----	87,000
Nov 8	66,000	29,000	29,000	----	124,000
Nov 10	----	----	18,000	----	18,000
Nov 12	23,000	29,000	29,000	29,000	110,000
Nov 18	18,000	----	----	----	18,000
Total gallons applied in November	184,000	193,000	257,000	29,000	645,000
Inches of water applied in Nov	1-1/2"	1-3/4"	2-1/4"	1/4"	

DATE	Lateral Numbers 1 - 4	5 - 8	9 -12	13-16	TOTAL
Dec 7, 1965	29,000	29,000	58,000	----	116,000
Total gallons applied in December	29,000	29,000	58,000	----	116,000
Inches of water applied in December	1/4"	1/4"	1/2"	0	

SUMMARY OF INCHES OF WATER APPLIED

DATE	Lateral Numbers 1 - 4	5 - 8	9 -12	13-16
Oct, 1964 thru May, 1965	4-1/2"	4-1/2"	3-1/2"	3-3/4"
June, 1965	2-3/4"	2-3/4"	2-1/2"	2-3/4"
July, 1965	5-1/2"	5-1/2"	5-1/4"	5-1/4"
August, 1965	4-1/4"	4"	4"	4-1/2"
Sept, 1965	5-1/4"	5-1/4"	6-1/4"	5-3/4"
Oct, 1965	7-1/2"	8"	6-3/4"	6-1/2"
Nov, 1965	1-1/2"	1-3/4"	2-1/4"	1/4"
Dec, 1965	1/4"	1/4"	1/2"	0
Total for period:	31-1/2"	32"	31"	28-3/4"

APPENDIX III

FERTILIZER APPLICATIONS

Nitrogen was applied as urea (45% nitrogen) or ammonium nitrate (33.5% nitrogen). Phosphorus was applied as treble superphosphate (45% P_2O_5). Fertilizer applications are expressed as units, or pounds, of actual nutrient per acre.

DATE	Form of NITROGEN	Lands 1 - 4		5 8		9 - 12		13 - 17	
		N	P_2O_5	N	P_2O_5	N	P_2O_5	N	P_2O_5
10/21-22/64	Urea	100	100	100	100	100	100	100	100
5/27/65	Urea	100	---	100	---	100	---	100	---
7/13/65	Ammonium Nitrate	110	---	110	---	110	---	110	---
8/13-18/65	Ammonium Nitrate	105	---	105	---	85	---	85	---
9/12/65	Urea	---	---	---	---	50	---	50	---
9/16/65	Urea	30	135	30	135	---	---	---	---
9/25/65	Urea	---	---	---	---	25	---	25	---
10/28/65	Ammonium Nitrate	---	---	---	---	100	90	100	90
11/04/65	Urea	---	---	---	---	25	---	25	---
	TOTALS:	445	235	445	235	595	190	595	190

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