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LAKE WATER QUALITY ASSESSMENT SURVEYS

PLAYA LAKES

1992

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PLAYA LAKE WATER QUALITY ASSESSMENT SURVEYS COMPLETED IN 1992

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A FORWARD TO THE SOUTHEAST NEW MEXICO HYPERSALINE PLAYA LAKES

Special circumstances surrounding the first eight playa basins surveyed by the Surveillance and Standards Section during 1992 require explanation. These eight lakes are located in Eddy and Lea counties of southeast New Mexico and are assumed to be naturally ephemeral and hypersaline. Five of the eight lakes have received industrial discharges for various periods of time. Evidence indicating a decrease in avian populations, both aquatic and terrestrial, led to a cooperative survey effort by teams from the Surface Water Quality Bureau and the U.S. Fish and Wildlife Service. These joint investigations were conducted to determine what, if any, differences exist between basins receiving discharges and those not receiving discharges that might account for the decreasing bird populations. The initial findings of these surveys have engendered considerable controversy.

Three separate geological settings were chosen based on location, history and duration of effluent discharges. Each of the three areas had playa basins with a history of discharges from potash mining or oil and gas extraction, and each included a reference lake believed to have not received recent effluent discharges.

The following abstracts of eight playa lakes present information required for work commitments under the Lake Water Quality Assessment Grant (CL-006980-01-0), as well as additional data gathered to fulfill the needs of the Surface Water Quality Bureau and U.S. Fish and Wildlife Service's cooperative investigations.

INTRODUCTION

In 1992, the Surveillance and Standards Section began a two-year study of the State's playa lakes and related closed basin wetlands. Playa lakes are defined as waters of the State (see Section 3-100.SS of the New Mexico water quality standards), thus they are afforded protection for any attainable use as set out in section 3-101 of the water quality standards. The Lake Water Quality Assessment Grant was amended in 1993 to extend funding from two to three years, resulting in a commitment to survey a total of 40 playa lakes. Data collected from these surveys, representing varying playa lake types throughout the State, will provide the background information needed to develop designated uses and numeric standards necessary for the protection of these wetland resources.

New Mexico has many playa-like basins, which share general morphologic features, but may differ in geologic origin and hydrologic characteristics. Though playa lakes are commonly associated with the arid high plains of the Llano Estacado in eastern New Mexico, playa-like closed basins are also common in many pleistocene lake beds, dissolution basins and erosional depressions. Water quality and biological sampling efforts have focused on groups from all of these playa lake types throughout the State. Water chemistry based categories of playa lakes will probably be needed to facilitate development of water quality standards sufficient to protect the full range of playa lake types and associated water quality conditions.

The study and classification of New Mexico's estimated 2,460 playa lakes is a new effort stemming from the understanding that these wetland habitats are important resources for both wildlife and human uses (Bolen et al. 1989). Their presence along major flyways offers resting, feeding and nesting habitat for migratory and resident birds. Vegetation typical of playa lake basins also provides much needed forage and cover for terrestrial vertebrates and invertebrates. Though the majority of playa lakes are typically ephemeral, their presence in the arid Southern High Plains region of the U.S. makes them an important resource for many human activities.

It is generally accepted that playa basins often serve as recharge points to ground-water aquifers, particularly the Oglalla (Osterkamp and Wood 1987). Though historically playa lakes have been considered obstacles to efficient agricultural land use, they are now recognized for their usefulness in storing seasonal precipitation as well as for irrigation return flow. As these beneficial uses of playa lakes have become more widely recognized, it has also become apparent that mismanagement has, in many cases, eroded the capability of these unique and fragile waters to support such uses.

Hydrologic modification, in particular deepening of the basin to increase storage capacity and decrease evaporation, subjects the major portion of the playa basin to premature and prolonged drying, thus impeding the growth and development of associated wetland vegetation needed by wildlife. Further, sediment, fertilizer, pesticide and herbicide residues from irrigation tail waters, runoff and spray drift may threaten the quality of surface and ground waters associated with playa lake basins.

It is not uncommon for playa lakes to serve as catchment basins for various point and non-point source discharges. In the southeast corner of New Mexico, potash process water and oil extraction wastes have been discharged to playa lake basins for many years. Several communities use playa basins as waste water effluent ponds, and city storm water runoff is often diverted to playa lake basins. Cattle feedlot operators have diverted waste ladened runoff to playa lakes, increasing the potential for outbreaks of avian cholera and botulism.

Cattle have also impacted playa lakes in rangeland environments. In some heavily grazed areas there are indications that increased sediment input to playa basins from runoff has reduced basin depth, facilitated the recruitment of non-wetland vegetation and severely decreased water holding capacity. These water quality problems represent some of the major impacts to New Mexico's playa lake resources and threaten their continued usefulness to people and wildlife.

Due to the unique and often extreme conditions inherent to many playa or closed basin waters, certain chemical analysis are subject to significant interference. High concentrations of major cations and anions often necessitate considerable dilution of sample waters prior to laboratory analyses. Thus, the usefulness of analytical results are often severely compromised by detection limits that are far in excess of numeric water quality standards applicable to more dilute freshwater systems. Similarly, high levels of naturally occurring suspended solids have occasionally rendered filtration impossible, thereby precluding analyses for dissolved materials. The effects of anthropogenic impacts further serve to complicate water quality analyses. Partially as a consequence of these analytical difficulties, playa surveys have incorporated wildlife and macroinvertebrate observations, not previously gathered for lake studies, to aid in determination of biotic integrety and wildlife use.

Playa lakes are not only individually unique, but also present different characteristics over time as chemical and biotic components respond to seasonal and hydrologic variables. While this variability increases the difficulty of data analysis, it serves to highlight the great need for further study of playa systems. Without a comprehensive understanding of the nature of playa lakes and other closed-basin systems, future management decisions will of necessity be made in ignorance and will risk damaging the resource they are designed to protect.

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WATER QUALITY SURVEY OF LAGUNA GATUNA IN LEA COUNTY, NEW MEXICO, MARCH 31, 1992

Introduction

During 1992 the Surveillance and Standards Section conducted a water quality assessment of Laguna Gatuna in Lea County, New Mexico (Fig. 1). The field team visited the playa on March 31, 1992.

Laguna Gatuna, possibly named after the "catclaw mesquite" which surrounds the playa, is a 121 hectare (300 acre) collapsed basin, and is located approximately 26 miles northeast of Carlsbad, New Mexico via State highways 62 and 180. The basin is located in the arid, high desert part of the Western High Plains ecoregion at an elevation of 1,070 meters (3,510 ft) above mean sea level. Precipitation and rainfall deficit data for Laguna Gatuna, Williams Sink, Laguna Uno, Laguna Tres, Laguna Quatro and "Laguna Walden" were estimated by averaging historical data for six surrounding stations located in Eddy and Lea counties, New Mexico (Gaben and Lesperance 1977). Mean annual precipitation and mean water deficit, which reflect the conditions in the study area, are 33.7 cm/year (13.3 in/yr), and 98.7 cm/year (38.9 in/yr), respectively. Stations chosen for their relative proximity to the study area are Maljamar 4SE, Lovington 1WNW, Jal, Lake Avalon, Hobbs, and Hobbs FAA Airport.

Soils associated with Laguna Gatuna are of the Badlands, Jal association and Largo-Pajarito complex. Badlands is made up of barren areas of wind and water deposited sediments, and is usually associated with local salt lake areas of the San Simon Sink. Erosion potential is extreme with these soils. The Jal association soils are typically found on eastern sides of playa lakes and are extremely susceptible to wind erosion when plant cover is lacking. The Largo-Pajarito complex derived from Triassic red-bed materials, is also subject to severe wind and water erosion when plant cover has been removed (Soil Conservation Service 1974).

The formation of Laguna Gatuna, as with many playa basins in the Nash Draw and Clayton basin region of southeastern New Mexico, was caused by the dissolution of underlying salt beds which resulted in the collapse of overlying formations. Additional basin formation of these playas through eolian processes is indicated by the presence of sand dunes on their leeward sides.

Laguna Gatuna received produced water from the oil extraction activities of Gatuna, Inc. for a period of 12 years. Gatuna Inc., a brine disposal facility, was ordered by EPA Region VI to cease discharge in May of 1992. The EPA's order followed the documentation of migratory waterfowl use of the lake resulting in the classification of Laguna Gatuna as a "Water of the United States." This decision was hastened by the discovery at Laguna Gatuna of 49 dead migratory waterfowl consisting of ruddy ducks, shovelers, green winged teals, blue winged teals, pie-billed grebes and American coots.

There is no recorded surface discharge of potash mine process effluent to Laguna Gatuna, however, Laguna Toston, a playa basin located five miles southwest of Laguna Gatuna continues to receive a discharge from the New Mexico Potash Company. The discharge to Laguna Toston, which has resulted in a significant enlargement of the playa, may contribute saline ground-water

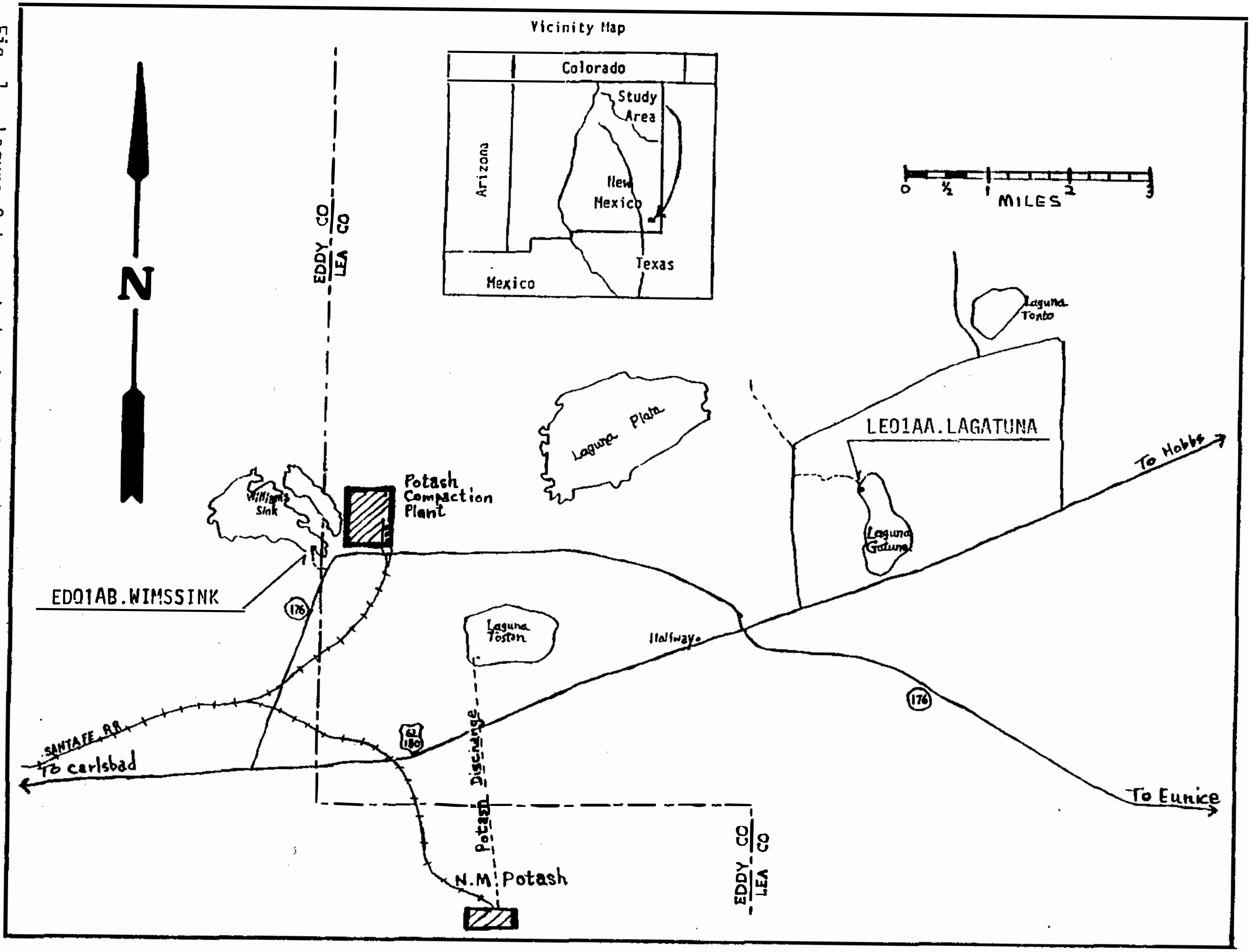


Fig. 1. Laguna Gatuna study site, 1992.

flow to the surrounding playa basins including Laguna Gatuna (Nicholson and Clebsch 1961). The historical shift from ephemeral to perennial conditions in the playa basins of the southern Nash Draw area supports this possibility. In an assessment of hydrologic conditions in the Nash Draw area, Geohydrology Associates, Inc., (1986) assert that "although there is no surface connection between Laguna Uno and this chain of lakes, it is likely that a subsurface connection exists." If Laguna Toston is contributing saline ground water to Laguna Gatuna, then effluent from the New Mexico Potash Company is indirectly altering the Laguna Gatuna basin and adding to its levels of dissolved salts.

Laguna Gatuna was compared with another playa basin known as Williams Sink, located approximately seven miles due west of the Gatuna Basin (see Williams Sink report). Though Williams Sink is immediately adjacent to the Mississippi Chemical Potash Compaction Plant and tailings piles consisting of sodium chloride and clay, the basin no longer receives direct discharge from potash processing. Some runoff from these tailings piles, however, probably reaches the playa. We designated this playa basin as a reference lake due to its apparent lack of recent impact by potash milling discharges. The chemical, physical and biological differences between Laguna Gatuna and Williams Sink are readily apparent.

Water Quality Standards

Water quality standards for Laguna Gatuna are set forth in section 1-102 of the New Mexico water quality standards (NMWQCC 1991). Water quality standards specific to playa lakes have not been adopted. The principal objective of studying the diverse playa lakes of New Mexico is to develop numeric and narrative water quality standards that will support and protect the attainable uses of these waters of the State.

Methods

Water quality sampling methods were in accordance with the "New Mexico Clean Lakes Program: Lake Water Quality Assessment for FY 92-93" (NMED 1992) and the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 1992).

Water Quality Assessment

Water quality data for playa lake station LE01AA.LAGATUNA are available on STORET and can be retrieved using the selector A=21NMEX and restrictor IS=923507. Parametric coverage, water quality and biological data are provided in tables 1 through 6.

The investigators computed Likens' (1975) phytoplankton community composition index and Carlson's (1977) chlorophyll a, total phosphorus and Secchi disk depth indices. These trophic state indices were evaluated for their applicability in comparisons between the hypersaline playa lakes under investigation. The investigators concluded that these indices have no applicability or usefulness in comparisons between hypersaline lakes. Further, since these trophic state indices were developed using data from temperate freshwater lakes, they were not expected to be useful in comparisons between hypersaline lakes.

Values for unionized ammonia are presented here as an expression of the relationship between total ammonia, pH and temperature. It is estimated that algorithms incorporating ionic strength and total alkalinity in addition to the above would yield results of approximately one-half the concentrations given here (Emerson et al, 1975. B. Zander, EPA Region 8, pers. comm.).

Review of the EPA's guidance literature for both fresh and saltwater ammonia criteria shows that while ammonia toxicity increases with both temperature and pH, a decrease in toxicity occurs with increasing salinity. The EPA did not publish criteria for un-ionized ammonia in saline environments beyond thirty parts per thousand, while salinity levels in the hypersaline playas studied in 1992 ranged from 140 to 390 parts per thousand. Further, the accuracy of the method used to calculate the un-ionized fraction of total ammonia is questionable when used in conditions of high ionic strength. In light of the above, it is worthy of note that the lake with the highest calculated un-ionized ammonia level (Middle Lake) among the hypersaline systems studied during 1992, also supported the second highest benthic standing crop ($3897/m^2$) and greatest number of taxa (4) of all these lakes.

As mentioned earlier, Laguna Gatuna is hypersaline as shown by a total dissolved solids concentration of 330,250 mg/l. Sodium and chloride ions were dominant with values of 99,330 and 223,000 mg/l, respectively. Ion analysis of Williams Sink, the reference playa, showed a total dissolved solids concentration of 169,270 mg/l with sodium and chloride concentrations at 37,210 mg/l and 88,500 mg/l respectively. This means that Laguna Gatuna is about twice as saturated with dissolved solids as Williams Sink (Figs. 2-4).

Total and dissolved metal analyses of water and sediments showed no levels of concern except for boron (36 mg/l), which exceeded the numeric standard for livestock and wildlife watering. Laguna "Walden", one of the reference playas, was the only playa sampled where boron values were within acceptable limits. This suggests that increased boron concentrations may exist in those playa basins where oil and potash industry discharges have taken place.

Radioactivity analysis for radium 226 and 228 resulted in a combined value of 103 pCi/l, which is an exceedance of the numeric standard for livestock and wildlife watering. Conversely, radium 226 and 228 results from Williams Sink were 5.6 pCi/l, well within acceptable limits. Potassium 40 was also analyzed to determine if potash mining discharge could be linked to increased levels of K-40. Values for K-40 were within acceptable limits based on the concentrations of potassium measured in sediment and water samples, and fell within the natural isotopic distribution. Analyses for aromatic and halogenated purgeables were performed. Results of this scan yielded no detectable concentrations of the 62 synthetic organic compounds analyzed for.

Biological analyses of phytoplankton, diatoms and macroinvertebrates were performed at Laguna Gatuna. Planktonic algae were scarce except for one green alga Dunaliella (Table 3). This single celled flagellate is distinctive in that it is one of two green algae known to persist in waters saturated with salts. Cole (1983) points out that few algal species can survive in waters with greater than 10% salinity except for specific bluegreens and diatoms that will tolerate what green algae cannot. Cole further states that "exceptions are the branched green alga Ctenocladus circinnatus and the green flagellate Dunaliella ..., which thrive in water saturated with NaCl."

Qualitative diatom analyses of composited surface sediment samples were performed (Table 4). Only four species were identified totaling four individuals in 130 microscope fields. Tentative identification of four other diatom genera were noted though not included in the formal taxonomic assessment. These results may be compared with the diatom analysis for Williams Sink, where five species totaling 215 individuals were counted after the analysis of only 40 fields.

Sediment samples were collected for diatom analyses using a "Lexan" piston corer insert fitted with an eggshell core catcher to hold the sediment in place. We believed that analyses of core sections might yield information on the historic diatom communities found in Laguna Gatuna, but highly alkaline and saline conditions has caused the dissolution of diatom frustules (Rushforth pers. comm.), thus precluding chronological core-section analyses.

Macroinvertebrates were collected from both the eastern and western shores of Laguna Gatuna. Only the western shore sample yielded the two macroinvertebrates found in the playa. Artemia salina (brine shrimp) and Hydropyrus near cinearea (brine fly) were found, and these were in poor condition. Many were "mummified," but some were found alive beneath the salt crust that coats the bottom of the lake. Table 5 provides a comparison between macroinvertebrates identified from Laguna Gatuna and Williams Sink.

Acute toxicity tests were conducted by the U.S. Fish and Wildlife Service using Artemia salina and Hydropyrus sp., where organisms collected from the reference playa were exposed to water and sediment collected from the test playa. No Artemia survived exposure to water collected from Laguna Gatuna, while 56 percent of Hydropyrus exposed to lake sediments were alive after 48 hours (Tables 6a and 6b).

There are important differences between Laguna Gatuna and the reference playa Williams Sink. As was shown previously, dissolved solids concentrations in Laguna Gatuna is double that of Williams Sink. Phytoplankton, benthic algae and macroinvertebrate species richness and standing crops were dramatically lower in Laguna Gatuna. Although both playa depressions were observed to have loafing waterfowl during the spring migration , only Laguna Gatuna produced the 49 dead and salt encrusted ducks. U.S. Fish and Wildlife Service pathologists examined these specimens, and strongly suspected that these ducks had succumbed to salt toxicosis (Tables 6c-6d).

Table 1. Water quality data for Laguna Gatuna, 1992.

LE01AA.LAGATUNA LE01AALAGUNAGAT LAGUNAGATUNA
32 34 51.0 103 42 00.0 4
LAGUNA GATUNA MID-DEEP CENTER OF N 1/3 OF LAKE
35025 NEW MEXICO LEA
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 13060011
0000 METERS DEPTH 907 METERS ELEVATION
24G SOUT

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00010 WATER TEMP CENT	00400 PH SU	00095 CNDUCTVY AT 25C MICROMHO	00300 DO MG/L	82205 SPECIFIC GRAVITY GM/L	00480 SALINITY PPTH	00031 INCDT LT REMNING PERCENT	82079 TURBIDTY LAB NTU	00608 NH3+NH4- N DISS MG/L	00612 UN-IONZD NH3-N MG/L
92/03/31	0910	WATER	0	16.0		456896J	1.8		308.0J	100.0			0.6J
92/03/31	0910	VERT	0		7.32						14.0	101.0	

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00078 TRANSP SECCHI METERS	00079 COLOR FORL-ULE SCALE	00204 DEPTH-M 1% LIGHT REMAINS	00410 T ALK CACO3 MG/L	00440 HCO3 ION HCO3 MG/L	00530 RESIDUE TOT NFLT MG/L	70300 RESIDUE DISS-180 C MG/L	00600 TOTAL N N MG/L	00605 ORG N N MG/L	00053 SURFACE AREA ACRES
92/03/31	0910	VERT	0	1.00L	3	1.0L	43	52	101	330250	109.30	6.000	392

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00610 NH3+NH4- N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00631 NO2&NO3 N-DISS MG/L	00640 T INORG. NITROGEN MG/L N	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P	00671 PHOS-DIS ORTHO MG/L P	00900 TOT HARD CACO3 MG/L	00915 CALCIUM CA,DISS MG/L
92/03/31	0910	VERT	0	103.000	109.000	.30	.4	103.30	.200	.060	.010K	30720J	2710.0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00925 MGNSIUM MG,DISS MG/L	00930 SODIUM NA,DISS MG/L	00935 PTSSIUM K,DISS MG/L	00940 CHLORIDE TOTAL MG/L	00945 SULFATE SO4-TOT MG/L	71870 BROMIDE BR MG/L	32210 CHLRPHYL A UG/L	32211 CHLRPHYL A UG/L CORRECTD	32212 CHLRPHYL B UG/L	32214 CHLRPHYL C UG/L
92/03/31	0910	VERT	0	5820.0	99330.00	1800.00	223000	2855	.88	.55	.57	.00	.00

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	32218 PHEOPHTN A UG/L	32221 % CHL A OF PHE A + CHL A
92/03/31	0910	VERT	0	.00	100

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 1 cont.

LEO1AA.LAGATUNA LEO1AALAGUNA GATLAGUNAGAT UNA
32 34 51.0 103 42 00.0 4
LAGUNA GATUNA MID-DEEP CENTER OF N 1/3 OF LAKE
35025 NEW MEXICO LEA
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 92071B 13060011
0000 METERS DEPTH 907 METERS ELEVATION
24G SOUT

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81552 ACETONE TOT UG/L	78124 BENZENE HOH VOL UG/L	81555 BROMO BENZENE TOT UG/L	73085 CLBRMETH TOTAL WTR UG/L	32101 DICLBRMT TOTUG/L	32104 BROMOFRM WHL-WTR UG/L	81595 MTH ETH KETONE TOT UG/L	77342 N-BUTLBZ TOTAL UG/L	77350 SEC-BUTB TOTAL UG/L	77353 T-BUTLBZ TOTAL UG/L
92/03/31	0910	VERT	0	50.000K	10.00K	10.000K	10.0K	10.0K	10.0K	50.000K	10.000K	10.000K	10.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	46491 MTBE WATER TOT UG/L	32102 CARBNTET TOTUG/L	34301 CHLOROBE NZENE TOTWUG/L	32106 CHLRFORM TOTUG/L	38680 CHLOROTO LUENEWTR TOT UG/L	77277 P-CLTOLU TOTAL UG/L	82625 DIBRCLRO PRPN TOT REC UG/L	32105 CLDIBRMT TOTUG/L	30203 ETHAN12 WTR,WHL REC UG/L	77596 DBRMETHA TOTAL UG/L
92/03/31	0910	VERT	0	50.00K	10.0K	10.000K	10.0K	10.000K	10.000K	10.0K	10.0K	10K	10.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	34536 12DICHLO ROBENZEN TOTWUG/L	34567 13DICHLO ROBENZEN DISSUG/L	34572 14DICHLO ROBENZEN DISSUG/L	34668 DICHLORO DIFLUORO TOTWUG/L	34496 11DICHLO ROETHANE TOTWUG/L	34531 12DICHLO ROETHANE TOTWUG/L	34501 11DICHLO ROETHYLE TOTWUG/L	77093 C-1,2DCE TOTAL UG/L	34546 12DICHLO ROETHENE TOTWUG/L	34541 12DICHLO ROPROPAN TOTWUG/L
92/03/31	0910	VERT	0	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77173 1,3DCLPR TOTAL UG/L	77170 2,2DCLPR TOTAL UG/L	77168 1,1DCLPR TOTAL UG/L	34704 C1,3-DCP TOT WAT UG/L	34699 T1,3-DCP TOT WAT UG/L	34371 ETHYLBEN ZENE TOTWUG/L	34391 HEXACHLO ROBUTADI TOTWUG/L	77223 IPROPBNZ TOTAL UG/L	30341 BNZ1MTHL RECOVER WTR UG/L	34423 METHYLEN ECHLORID TOTWUG/L
92/03/31	0910	VERT	0	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K	10.00K	10.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77418 1MNAPTHA TOTAL UG/L	77416 2MNAPTHA TOTAL UG/L	34696 NAPTHALE NE T OTWUG/L	77224 N-PRPBNZ TOTAL UG/L	77128 STYRENE TOTAL UG/L	77562 1112TCLE TOTAL UG/L	34516 1122TETR ACHLOROE TOTWUG/L	34475 TETRACHL OROETHYL TOTWUG/L
92/03/31	0910	VERT	0	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 1 cont.

LE01AA.LAGATUNA LE01AALAGUNA GATLAGUNAGATUNA
32 34 51.0 103 42 00.0 4
LAGUNA GATUNA MID-DEEP CENTER OF N 1/3 OF LAKE
35025 NEW MEXICO LEA
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 13060011
0000 METERS DEPTH 907 METERS ELEVATION
24G SOUT

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81807 TETRAHYD FURAN TOT UG/L	78131 TOLUENE WHL HOH VOLUG/L	77613 123TCLBZ TOTAL UG/L	34551 124TRICH LOROBENZ TOTWUG/L	34506 111TRICH LOROETHA TOTWUG/L	34511 112TRICH LOROETHA TOTWUG/L	39180 TRICHLOR ETHYLENE TOT UG/L	34488 TRICHLOR OFLUOROM TOTWUG/L	77443 1,2,3TCP TOTAL UG/L	77222 1,2,4TMB TOTAL UG/L
92/03/31	0910	VERT	0	50.000K	10.00K	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K	10.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77226 1,3,5TMB TOTAL UG/L	39175 VINYLCHL ORIDE TOT UG/L	77135 O-XYLENE TOTAL UG/L	85795 XYLENE M&P WTR WHL UG/L
92/03/31	0910	VERT	0	10.000K	10.000K	10.000K	10.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	09501 RA-226 TOTAL PC/L	09502 RA-226 ERROR PC/L	11501 RA-228 TOTAL PC/L	11502 RA-228 ERROR PC/L	11503 RA-226 + RA-228 PC/L	11504 RA-226 + 228 ERR PC/L	75038 K-40 TOTAL PC/L	75037 K-40 ERROR PC/L	09507 RA-226 SEDIMENT PC/G	09508 RA-226 SED-ERR PC/G
92/03/31	0910	VERT	0	86.0J	5.0J	17.0J	4.0J	103.0J	6.4J	1500.00J	100.00J	1.5J	.3J

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	75977 RA 228 DRY WT SED PC/G	75948 RA228SUS 1 SIGMA SED PC/G	22300 K-40 SEDIMENT PCI/G	22301 K-40 SED-ERR PCI/G
92/03/31	0910	VERT	0	.0J	.60J	8.100J	1.200

0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01108 AL MUD DRY WGT MG/KG-AL	01008 BA MUD DRY WGT MG/KG-BA	01013 BERYLIUM SEDMG/KG DRY WGT	01023 B MUD DRY WGT MG/KG-B	01028 CD MUD DRY WGT MG/KG-CD	00917 CA MUD DRY WGT MG/KG-CA	01029 CHROMIUM SEDMG/KG DRY WGT	01038 CO MUD DRY WGT MG/KG-CO	01043 COPPER SEDMG/KG DRY WGT	01170 FE MUD DRY WGT MG/KG-FE
92/03/31	0910	WATER	0	7950.00	126.00	6.00K	43.00	.06K	22578.00	11.20	3.20K	6.00K	5620.00

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 1 cont.

LEO1AA.LAGATUNA LEO1AALAGUNAGAT LAGUNAGATUNA
32 34 51.0 103 42 00.0 4
LAGUNA GATUNA MID-DEEP CENTER OF N 1/3 OF LAKE
35025 NEW MEXICO LEA
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 13060011
0000 METERS DEPTH 907 METERS ELEVATION
24G SOUT

0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00010 WATER TEMP CENT	00924 MG MUD DRY WGT MG/KG-MG	01053 MN MUD DRY WGT MG/KG-MN	01063 MO MUD DRY WGT MG/KG-MO	01068 NICKEL SEDMG/KG DRY WGT	01144 SI MUD DRY WGT MG/KG-SI	01078 SILVER SEDMG/KG DRY WGT	01083 SR MUD DRY WGT MG/KG-SR	01103 TIN MUD DRY WGT MG/KG-SN	01088 V MUD DRY WGT MG/KG-V
92/03/31	0910	WATER	0	16.0	8366.00	83.00	8.20	6.00K	567.00	6.00K	570.00	6.00K	21.00

0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01093 ZINC SEDMG/KG DRY WGT	00010 WATER TEMP CENT	71921 MERCURY SEDMG/KG DRY WGT	01148 SELENIUM SEDMG/KG DRY WGT
92/03/31	0910	WATER	0	15.00	16.0	.3K	.25K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01106 ALUMINUM AL,DISS UG/L	01000 ARSENIC AS,DISS UG/L	01010 BERYLIUM BE,DISS UG/L	01020 BORON B,DISS UG/L	01025 CADMIUM CD,DISS UG/L	82036 CALCIUM DISS CA UG/L	82037 MG DISS MG UG/L	01030 CHROMIUM CR,DISS UG/L	01035 COBALT CO,DISS UG/L	01040 COPPER CU,DISS UG/L
92/03/31	0910	VERT	0	100K	50K	100.00K	36000	100K	2390000	575000	8	50K	100K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01046 IRON FE,DISS UG/L	01049 LEAD PB,DISS UG/L	01056 MANGNESE MN,DISS UG/L	71890 MERCURY HG,DISS UG/L	01060 MOLY MO,DISS UG/L	01065 NICKEL NI,DISS UG/L	01145 SELENIUM SE,DISS UG/L	01140 SILICON SI,DISS UG/L	01075 SILVER AG,DISS UG/L	01080 STRONTUM SR,DISS UG/L
92/03/31	0910	VERT	0	100K	250K	50.0K	.5K	100K	100K	1000K	1600	100.0K	120000

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01100 TIN SN,DISS UG/L	01085 VANADIUM V,DISS UG/L	01090 ZINC ZN,DISS UG/L	71900 MERCURY HG,TOTAL UG/L	01147 SELENIUM SE,TOT UG/L
92/03/31	0910	VERT	0	100K	100K	100K	.5K	1000K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 2. Limiting nutrient and Carlson Trophic State indices computed by SAS.

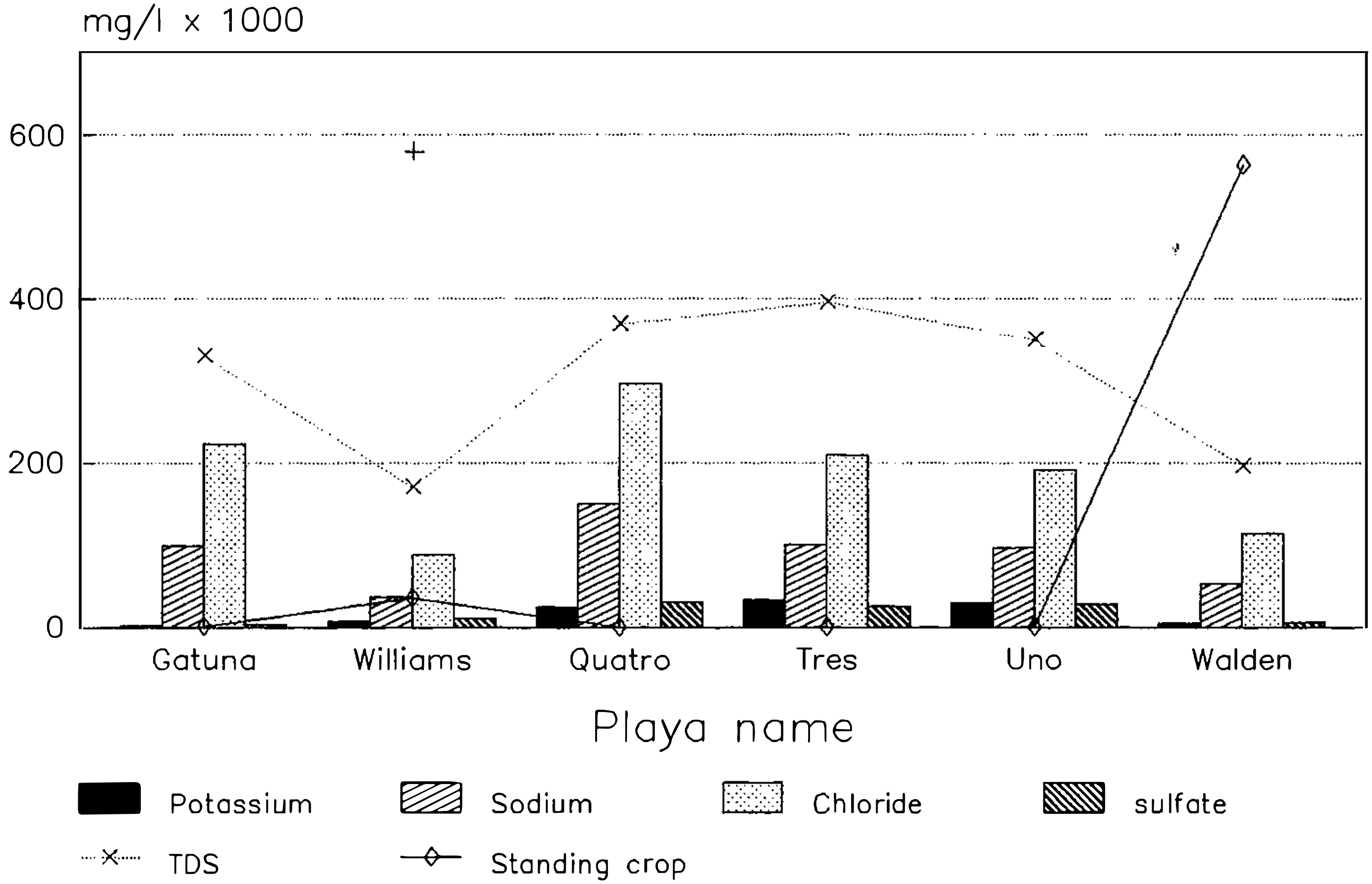
LIMITING NUTRIENT FOR PLAYA LAKES, CALCULATED BY SAS
TN/TP > 17 INDICATES P-LIMITATION
TN/TP 10 - 17 INDICATES N AND/OR P LIMITATION
TN/TP < 10 INDICATES N-LIMITATION

OBS	STATION		DATE	TN	TP	RATIO	LIMITING
1	21NMEX	LE01AA.LAGATUNA	31MAR92	109.30	0.20	546.500	P
2	21NMEX	ED01AB.WLMSSINK	01APR92	4.33	0.18	24.056	P
3	21NMEX	LE03AC.LANSALLK	14APR92	17.85	0.38	46.974	P
4	21NMEX	LE04AD.MIDDLELK	14APR92	14.54	0.11	132.182	P
5	21NMEX	ED01AE.LAGUNUNO	04MAY92	40.65	0.25	162.600	P
6	21NMEX	ED02AF.LAG-WALD	04MAY92	1.67	0.89	1.876	N
7	21NMEX	ED03AG.LGQUATRO	05MAY92	23.39	0.96	24.365	P
8	21NMEX	ED04AH.LAG-TRES	05MAY92	19.14	0.06	319.000	P
9	21NMEX	MO01AIWMSALTLKE	09JUN92	3.53	0.13	27.154	P
10	21NMEX	HA01AJ.CHICOSAL	26AUG92	7.40	0.64	11.562	N &/OR P

CARLSON TROPHIC STATE INDICES COMPUTED BY SAS
TSI <42 OLIGOTROPHIC, 42-47 MESOTROPHIC, >47 EUTROPHIC

OBS	STATION		DATE	CARLCHL	TSICHL	CARLSDD	TSISDD	CARLTP	TSITP
1	21NMEX	LE01AA.LAGATUNA	920331	25.0470	OLIGOTRO	60.0000	EUTRO	80.593	EUTRO
2	21NMEX	ED01AB.WLMSSINK	920401	32.4332	OLIGOTRO	54.1491	EUTRO	79.073	EUTRO
3	21NMEX	LE03AC.LANSALLK	920414	41.9761	OLIGOTRO	77.3733	EUTRO	89.855	EUTRO
4	21NMEX	LE04AD.MIDDLELK	920414	.	--	77.3733	EUTRO	71.967	EUTRO
5	21NMEX	ED01AE.LAGUNUNO	920504	.	--	77.3733	EUTRO	83.813	EUTRO
6	21NMEX	ED02AF.LAG-WALD	920504	28.7344	OLIGOTRO	77.3733	EUTRO	102.136	EUTRO
7	21NMEX	ED03AG.LGQUATRO	920505	55.7913	EUTRO	60.0000	EUTRO	103.228	EUTRO
8	21NMEX	ED04AH.LAG-TRES	920505	45.6853	MESOTRO	83.2242	EUTRO	63.220	EUTRO
9	21NMEX	MO01AIWMSALTLKE	920609	32.2697	OLIGOTRO	66.2162	EUTRO	74.377	EUTRO
10	21NMEX	HA01AJ.CHICOSAL	920826	85.9582	EUTRO	93.2263	EUTRO	97.378	EUTRO

Fig. 2. Playa biota x 100 vs major ions.
Numbers of invertebrates relative to concentrations of selected major ions.



+ = number of invertebrates per square meter x 100 taken at Williams Sink, February 26, 1992.

Fig. 3a. Stiff diagrams: Williams, Gatuna meq/l x .1

Chemical Constituents in Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl
Williams Snk	31/ 3/1692	179.76	6.44	27.89	0.00	0.00	23.27	0.33	249.66
L. Gatuna	30/ 3/1682	436.69	13.62	47.88	0.00	0.00	5.94	0.09	629.08

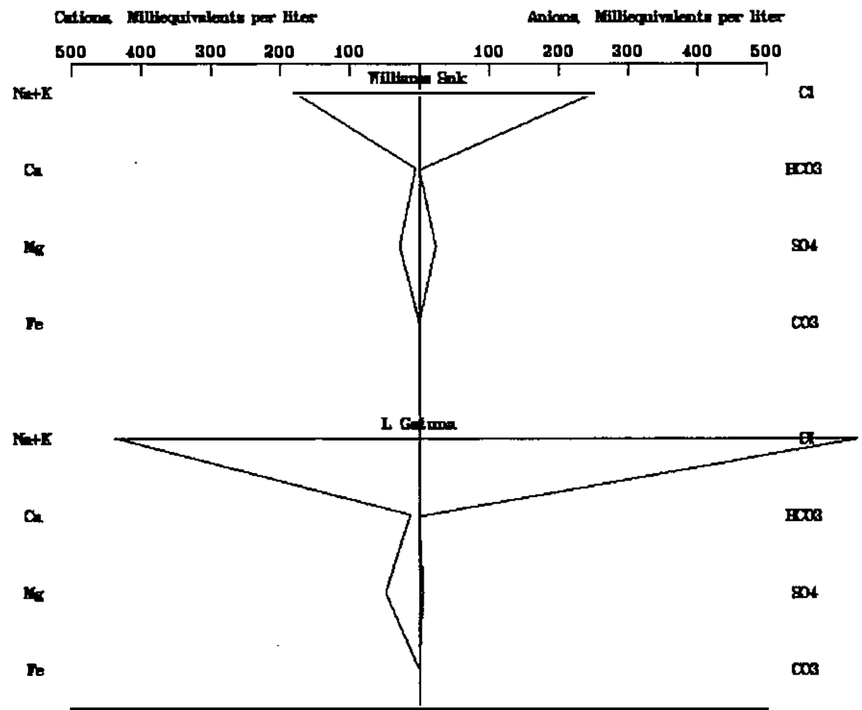


Fig. 3b. Stiff diagrams: Williams, Gatuna % meq/l

Chemical Constituents in % Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl	SAR	ESP	RSC
Williams Snk	31/ 3/1692	83.97	3.01	13.03	0.00	0.00	8.51	0.12	91.37	39.07	36.05	-34.00
L. Gatuna	30/ 3/1692	87.67	2.71	9.61	0.00	0.00	0.94	0.01	99.05	77.98	63.22	-61.31

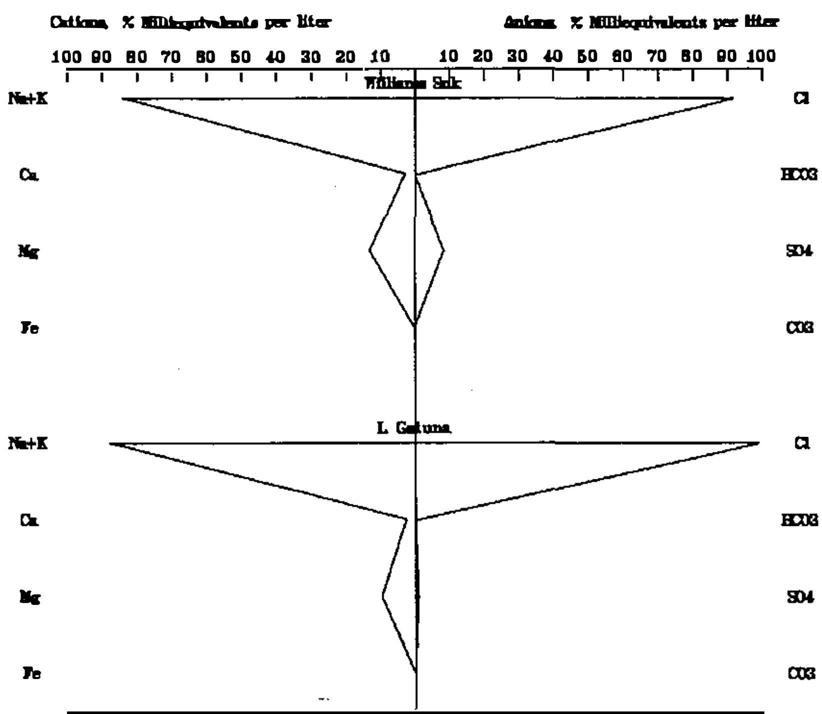
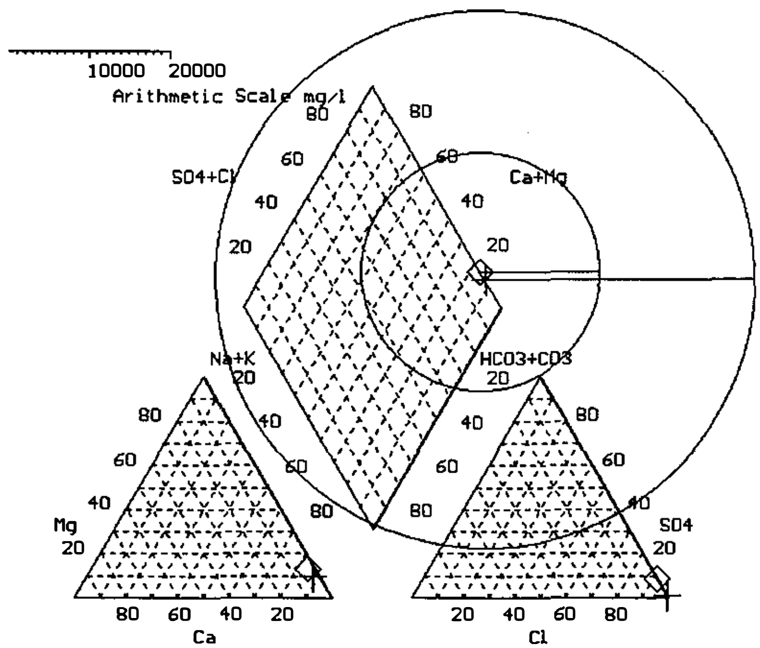


Fig. 4. Piper Trilinear diagram: Williams, Gatuna mg/l x .1



Diamond=«» Square=■ Circle=°

Williams Snk 03/31/1692-«» L. Gatuna 03/30/1692-+

Table 3. Phytoplankton collected from Laguna Gatuna and Williams Sink, Eddy and Lea Counties, New Mexico, March 31-April 1, 1992.

Lake	Station	Date	Taxon	Count (%)
Laguna Gatuna	LE01AA.LAGATUNA	92/03/31	none found*	0 (100)

* NOTE: During a preliminary survey of Laguna Gatuna conducted on 2/25/92, 510 Dunaliella /ml were counted in a phytoplankton sample.

Lake	Station	Date	Taxon	Count (%)
Williams Sink	ED01AB.WLMSSINK	92/04/01	Dunaliella	60 (80)
			Stephanoptera	15 (20)
		Total		75
		Taxa Richness		2
		Shannon - Wiener Diversity		0.72
		Evenness		0.72

Table 4.

QUALITATIVE DIATOM ANALYSIS OF LAGUNA GATUNA, N.M.: 1992
Surface sediment sample

	NAME	# CELLS
1.	*Amphora* sp. prob. *coffeiformis* Agardh.	1
2.	*Nitzschia palea* var. *debilis* (Kutz.) Grun.	1
3.	*Surirella* sp.	1
4.	*Synedra* sp. (poss.)	1
	Total =	4

SHANNON-WIENER INDEX OF DIVERSITY

Total number of fields viewed for formal count = 130
Total species per formal count = 4
Total species identified = 8

H = 2.0
Hmax = 2.0
Equitability = 1.0

Other diatoms observed, but not included in formal count:

A. *Fragilaria* sp. (poss.)

B. *Navicula* sp.

C. *Nitzschia* sp. poss. *communis* Rabenhorst

D. *Nitzschia* sp. prob. *dissipata* Grun.

Note: The Shannon-Wiener Diversity Index calculated for this playa is of no use due to the sparsity of diatoms present in the sample. What is noteworthy is that this apparently barren and salt encrusted playa does have diatoms present, which suggests that under natural conditions a more enriched diatom community would exist (see Williams Sink diatom results for comparison).

Table 5. **1992 PLAYA SURVEY MACROINVERTEBRATE ABUNDANCES**

	Williams Sink 920401 (ref.)	**Laguna Gatuna** 920331
	26° station	East Shore
Artemia salina ‡	275	0
Hydropyrus sp., near *cinearea*	50	0
Dasyhelea sp.	21	0
Stratiomys sp.	1	0
	240° station	West shore
Artemia salina	69	4
Hydropyrus sp., near *cinearea*	268	11
Dasyhelea sp.	11	0

	Middle Lake 920414 (ref.)	**Lane Salt Lake** 920414
	N side of island	inlet channel
Artemia salina	3890	0
Hydropyrus sp., near *cinearea*	1	541
Culicidae, prob. *Aedes sp.*	5	0
Stratiomys sp.	1	0
Muscidae	0	6
	S. shore	½ mi. N. of S. end
Artemia salina	3507	0
Hydropyrus sp., near *cinearea*	15	0

	"Laguna Walden" 920504 (ref.)	**Laguna Uno** 920504
	S. end	W. end
Artemia salina	2201	0
Hydropyrus sp., near *cinearea*	3436	0
Nemotelus sp.	1	0

Laguna Tres 920505
near Murchison Nash #3
none found

Laguna Quatro 920505
W. end
none found

Table 5. cont.

Wagon Mound Salt Lk. 920609

qualitative, deep station, Eckman dredge, sediment grab

Cladocera	
poss. Sididae	rare
Chironomidae	
Chironomus sp.	abundant
Tanypodinae	present

Wagon Mound Salt Lk.
qualitative, littoral, "D" net

Cladocera poss. Sididae	common
Libellulidae	
poss. *Belonia sp.*	rare (decayed specimen)
Coenagrionidae	
Enellagma sp.	abundant
Corixidae	
Trichocorixa sp.	rare
Tenagobia sp.	rare
Corisella sp.	common
Notonectidae	
Buenoa sp.	present
Hydrophilidae	
Berosus sp.	present
Hydraenidae	
poss. *Ochtebius sp.*	rare
Stratiomyidae	
Stratiomys sp.	present
Dolichopodidae	rare
Chironomidae	
Tanypodinae	abundant
Orthocladiinae	abundant
Chironominae	abundant

Chicosa Lake 920826

quantitative, benthic sweep, "D" net

Hydrophilidae	
Berosus sp.	1
Corixidae	
Corisella sp.	1

Note also presence of cast ephydrid (Diptera) puparia and very numerous Gastropod tests in sample.

Table 6a. Results of adult *Artemia salina* 48 hr acute toxicity tests (100% test and control water).

Test Site	% Survival	Control site	% Survival
Laguna Gatuna	0*	Williams Sink	97.8
Lane Salt Lake	0*	Middle Lake	100.0
Burro Pipeline effl.	0*	Middle Lake	100.0
Laguna Uno	0	Laguna Walden	96.0
Laguna Tres	0*	Laguna Walden	96.0
Laguna Quatro	0	Laguna Walden	96.0

* 100% mortality/immobility after 24 hrs.

Table 6b. Results of larval *Hydropyrus sp.* 48 hr acute toxicity tests (100% test and control sediment).

Test Site	% Survival	Control Site	% Survival
Laguna Gatuna	56[1]	Williams Sink	80
Lane Salt Lake[2]	No sediment toxicity tests were conducted		
Laguna Uno	36[1]	Laguna Walden	96
Laguna Tres	58[1]	Laguna Walden	96
Laguna Quatro	12[1]	Laguna Walden	96

[1] Survival = individual larvae that were not dead or immobile.

[2] Too few *Hydropyrus* larvae were collected from Middle Lake for comparative toxicity testing.

Table 6c. Migratory bird species of Williams Sink, Eddy County, New Mexico, March 31, 1992

Species	Number	Activiey
American shoveler	9	Loafing
Black-necked stilt	9	Feeding
American avocet	6	Feeding
American coot	1	--
Great blue heron	4	Perching
Killdeer	4	Flying
American shoveler/ teal species	25	Loafing
Diving ducks (readheads/scaup)	10	Loafing
Total	68	

Table 6d. Migratory bird species of Laguna Gatuna, Lea County, New mexico, March 31, 1992

Species	Number	Activity
Long-billed curlew	6	Fly over
Killdeer	1	Along shore
Canvasback	1	Loafing
American shoveler/ teal species	26	Loafing
Least sandpiper	1	Along shore
Swallow species	1	Fly over
American avocet	1	Along shore
Total	37	

WATER QUALITY SURVEY OF WILLIAMS SINK IN EDDY COUNTY, NEW MEXICO, APRIL 1, 1992

Introduction

In 1992 the Surveillance Standards Section conducted a water quality survey of Williams Sink in Eddy County, New Mexico. The field team completed its sampling run on April 1, 1992. Williams Sink was selected as a study site because of its proximity to Laguna Gatuna and the fact that it was not currently receiving a direct industrial discharge.

Williams Sink is a large, shallow basin probably formed by the collapse of underlying material due to dissolution and the subsequent removal of further material by wind. The basin has an altitude of 1,045 m (3,430 ft) and lies on the boundary of the Southern Desert and Western High Plains ecoregions. Wetted surface area at the time of sampling was estimated at 350 acres. Mean annual precipitation for the area is 35.5 cm (13.2 in) and the mean water deficit is 85.4 cm (34.0 in).

The wetted area of Williams Sink is comprised of four major ephemeral subbasins and several small, shallow pools. Only the southeastern-most of the major subbasins was sampled. That this basin has only recently begun filling regularly with water is evidenced by the fact that a water well, windmill tower and two water tanks were submerged in two meters of brine near its eastern end. Although Williams Sink is not currently receiving direct industrial discharge, National Potash Co. (NPC) conducted potash refining operations on the site from 1957 to 1982. During NPC's production period approximately 3,200 tons per day of brine slurry, composed of water, sodium chloride, potassium salts and clays were pumped to the tailings disposal area, which drains, in part, to Williams Sink. At the time of sampling, runoff from the east side of the tailings pile was reaching the southeastern subbasin via the State Road 243 bar ditch.

In the spring of 1992 Williams Sink supported a robust, if simple, population of aquatic macroinvertebrates. This invertebrate population supported migratory and resident waterfowl and shorebirds, a number of which were observed feeding or loafing in the basin (Table 12c). Other wildlife included numerous raptors, especially northern harriers, *Circus cyanus*. A large population of cottontail rabbits, *Sylvilagus* sp., was evident both from the extensive system of trails and numerous sightings.

The soils in Williams Sink are of the Reeves-Gypsumland complex with Reeves loam occupying the lowlands and Gypsumland on the high ground. These soils are light in color, well drained and resistant to erosion. Soil cover consisted of a vigorous growth of hummocky short and mid grasses interspersed with mesquite. It should be noted that revegetation of these soils is difficult once they are denuded. There was no evidence of recent livestock grazing activity and almost no erosion except on the lake's shore. Growth of shrubs was commonly heaviest in areas between the subbasins, but much of this had recently been drowned or poisoned by salt. This brush was predominantly tamarisk (*Tamarix pentandra*) and extended into the water, providing cover sufficient to make location and identification of waterfowl difficult.

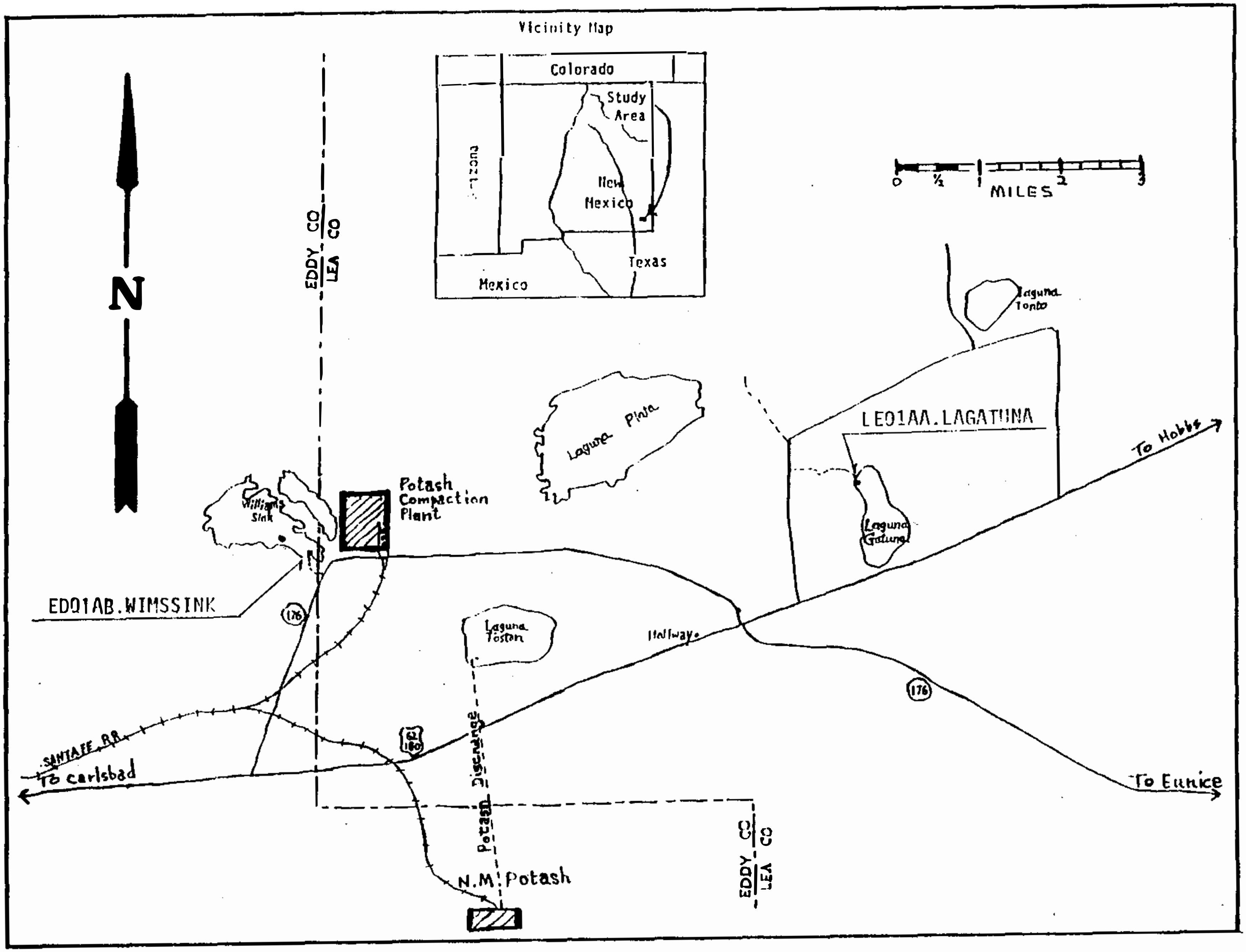


Fig. 5 Williams Sink study area, 1992.

The floor of the wetted portion of the basin was comprised of a thin layer of fine, yellow-grey gypsiferous sand overlying an indurated pan of sufficient integrity as to render penetration by "Lexan" coring tubes nearly impossible. Deposits of crystalline salts were visible only on vegetation and debris above the waterline.

Water Quality Standards

Water quality standards for Williams Sink are set forth in section 1-102 of the New Mexico water quality standards (NMWQCC 1991). Water quality standards specific to playa lakes have not been adopted. The principal objective of studying the diverse playa lakes of New Mexico is to develop numeric and narrative water quality standards that will support and protect the attainable uses of these waters of the State.

Methods

Water quality sampling methods were in accordance with the "New Mexico Clean Lakes Program: Lake Water Quality Assessment for FY 92-93" (NMED 1992) and the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 1992).

Water Quality Assessment

Water quality data for playa lake station ED01AB.WLMSSINK are available on STORET and can be retrieved using the selector A=21NMEX and restrictor IS=923508. Parametric coverage, water quality and biological data are provided in tables 7 through 12.

The investigators computed Likens' (1975) phytoplankton community composition index and Carlson's (1977) chlorophyll a, total phosphorus and Secchi disk depth indices (Table 8). These trophic state indices were evaluated for their applicability in comparisons between the hypersaline playa lakes under investigation. The investigators concluded that these indices have no applicability or usefulness in comparisons between hypersaline lakes. Further, since these trophic state indices were developed using data from temperate freshwater lakes, they were not expected to be useful in comparisons between hypersaline lakes.

Williams Sink is a sodium chloride water with significant concentrations of potassium, magnesium and sulfate. Total dissolved solids (TDS) at the time of sampling was 169,270 mg/l with a hardness of 17,180 mg/l. As highly concentrated as the dissolved solids fraction of the water in Williams Sink was at the time of sampling, the TDS value is still approximately one half that of Laguna Gatuna.

Scans for aromatic hydrocarbons yielded no results above detection limits. Analyses for radium 226 and 228 found no levels of concern. Results of potassium 40 analysis were consistent, assuming normal isotopic distribution, with levels of potassium found in the lake water. Due to the need for considerable dilution prior to analyses, results for metals are presented with extremely high detection limits. Unusually high results obtained for strontium, tin and vanadium appear to be typical of these hypersaline systems and may be due to concentration by evaporation of naturally occurring levels of these elements. Boron levels in Williams Sink (8500 ug/l), exceed livestock and wildlife watering standards. Note that this level of boron is, roughly, one third that of Laguna Gatuna (36,000 ug/l) and twice that of Laguna Walden (3,900 ug/l), the other regional reference lake. Given that Laguna Gatuna was receiving oil brines in April of 1992, Williams Sink had received potash effluent until 1982 and Laguna Walden has received no known industrial discharges, it appears that brines of deep subsurface origin may be a source for boron in excess of local background levels. Nutrient analyses yielded no levels of concern.

The value for un-ionized ammonia (0.01mg/l) is presented here as an expression of the relationship between total ammonia, pH and temperature. It is estimated that algorithms incorporating ionic strength and total alkalinity in addition to the above would yield results of approximately one half the concentrations given here (Emerson et al, 1975. B. Zander, EPA Region 8, pers. comm.). Review of the EPA's guidance literature for both fresh and saltwater ammonia criteria shows that while ammonia toxicity increases with both temperature and pH, a decrease in toxicity occurs with increasing salinity. The EPA did not publish criteria for un-ionized ammonia in saline environments beyond thirty parts per thousand, while salinity levels in the hypersaline playas studied in 1992 ranged from 140 to 390 parts per thousand. Further, the accuracy of the method used to calculate the un-ionized fraction of total ammonia is questionable when used in conditions of high ionic strength. In light of the above, it is worthy of note that the lake with the highest calculated un-ionized ammonia level (Middle Lake) among the hypersaline systems studied during 1992, also supported the second highest benthic standing crop (3897/m^2) and greatest number of taxa (4) of all these lakes.

Phytoplankton density was 75 cells per ml with two taxa represented (Table 9). Shannon-Wiener diversity would normally be considered low, but may not be relevant in so specialized a community. Qualitative diatom analysis from multi-substrate periphyton scrapes yielded a total of five taxa for 121 cells per 40 fields counted (Table 10). Shannon-Wiener diversity for the diatom community was good. Benthic macroinvertebrate sweeps at two locations in the southeastern subbasin yielded 347 and 348 individuals of three and four taxa per m^2, respectively (Table 11). Shannon-Wiener diversity for the macroinvertebrate community was poor at both locations, but community structure appears to be typical for such hypersaline systems.

While Williams Sink is known to have received NPC's brine slurry for the 1957-1982 production period, the biotic community of the southeastern subbasin compares favorably to other hypersaline systems studied in 1992. However, data collected by BLM in April of 1975 for sodium (12,000 mg/l), potassium (3,500 mg/l) and chloride (22,000 mg/l) are one third, one half and one quarter, respectively, of those returned during the Surveillance and Standards survey of 1992 (BLM 1975a, Fig. 6). If these discrepancies represent a trend in the dissolved constituents of Williams Sink water and not natural variability, then there is some other source of salts supplying the basin.

The only surface inflow to Williams Sink observed during the 1992 survey was the small flow entering the south east end of the lake via the SR 243 bar ditch. While this flow originates on the east side of the old NPC tailings pile, it is unlikely that it would be sufficient to increase the dissolved fraction of the lake water by a factor of two to four when the direct discharge of the NPC refinery did not. No obvious explanation for the increase in Na, K and Cl was seen. Neither has the historically unprecedented occurrence of significant quantities of water in Williams Sink been explained. Since direct discharges are lacking and indirect discharges via the State Road 243 bar ditch amount to a trickle in fair weather, we assume that Williams Sink should return to a dry condition. Williams Sink contained much water in February and April of 1992, however, and still contained some water in April of 1993 when most other basins in the area were dry. The only playa basins in this part of the Querecho Plains that had water in April of 1993 were Lagunas Plata, Gatuna and Toston, and Williams Sink.

While there is evidence indicating the probability of a hydrologic connection between Laguna Toston and the Plata/Gatuna basin (Nicholson and Clebsch 1961), the case for such a connection between Laguna Toston and Williams Sink is tenuous. Laguna Toston, as mapped by the New Mexico Bureau of Mines (1961) is hydrologically down-gradient from Williams Sink. The surface elevation of Laguna Toston, however, is significantly higher than Williams Sink and the possibility exists that water infiltrating from Laguna Toston could reach Williams Sink. Whether or not this is the case is not known at this time, but Laguna Toston is the only known supply available to maintain the water level in Williams Sink.

Table 7. Water Quality Data for Williams Sink

EDO1AB.WLMSSINK EDO1ABWILLMS WILLIAMSSINK
32 34 16.0 103 49 11.0 4
WILLIAMS SINK ACCESSED FROM RD. 243, SE PART OF BASIN
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920905 13060011
0002 METERS DEPTH 1045 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00010 WATER TEMP CENT	00400 PH SU	00095 CNDUCTVY AT 25C MICROMHO	00300 DO MG/L	00612 UN-IONZD NH3-N MG/L	00480 SALINITY PPTH	00031 INCDT LT REMNING PERCENT	82079 TURBIDTY LAB NTU	00608 NH3+NH4- N DISS MG/L	00053 SURFACE AREA ACRES
92/04/01	0900	WATER	1.5	14.0		199592J	3.8	0.01J	140.0J	100.0			
92/04/01	0900	VERT	1.5		7.77						2.6	.490	350J

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00078 TRANSP SECCHI METERS	00079 COLOR FORL-ULE SCALE	00204 DEPTH-M 1% LIGHT REMAINS	00410 T ALK CACO3 MG/L	00440 HCO3 ION HCO3 MG/L	00530 RESIDUE TOT NFLT MG/L	70300 RESIDUE DISS-180 C MG/L	00600 TOTAL N N MG/L	00605 ORG N N MG/L	00608 NH3+NH4- N DISS MG/L
92/04/01	0900	VERT	1.5	1.50		1.5L	164	200	406	169270	4.33	1.880	.490

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00610 NH3+NH4- N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00631 NO2&NO3 N-DISS MG/L	00640 T INORG. NITROGEN MG/L N	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P	00671 PHOS-DIS ORTHO MG/L P	00900 TOT HARD CACO3 MG/L	00915 CALCIUM CA,DISS MG/L
92/04/01	0900	VERT	1.5	.660	2.540	1.79	1.7	2.45	.180	.100	.010K	17180J	1290.0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00925 MGNSIUM MG,DISS MG/L	00930 SODIUM NA,DISS MG/L	00935 PTSSIUM K,OISS MG/L	00940 CHLORIDE TOTAL MG/L	00945 SULFATE SO4-TOT MG/L	71870 BROMIDE 8R MG/L	32210 CHLRPHYL A UG/L	32211 CHLRPHYL A UG/L CORRECTO	32212 CHLRPHYL 8 UG/L	32214 CHLRPHYL C UG/L
92/04/01	0900	VERT	1.5	3390.0	37210.00	7000.00	88500	11175	.44	1.42C	1.21C	.00C	.04C

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	32218 PHEOPHTN A UG/L	32221 % CHL A OF PHE A + CHL A	09501 RA-226 TOTAL PC/L	09502 RA-226 ERROR PC/L	11501 RA-228 TOTAL PC/L	11502 RA-228 ERROR PC/L	11503 RA-226 + RA-228 PC/L	11504 RA-228 + 228 ERR PC/L	75038 K-40 TOTAL PC/L	75037 K-40 ERROR PC/L
92/04/01	0900	VERT	1.5	.31C	85C	5.6J	.4C	.0J	2.0C	5.6C	2.0C	5380.00	250.00C

Remark codes: C= calculated value, O= field measurement, J= value estimated, K= less than, L= greater than

Table 7. cont.

ED01AB.WLMSSINK ED01ABWILLMS WILLIAMSSINK
32 34 16.0 103 49 11.0 4
ACCESSED FROM RD. 243, SE PART OF BASIN
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920905 13060011
0002 METERS DEPTH 1045 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01106 ALUMINUM AL,DISS UG/L	01000 ARSENIC AS,DISS UG/L	01005 BARIUM BA,DISS UG/L	01010 BERYLIUM BE,DISS UG/L	01020 BORON B,DISS UG/L	01025 CADMIUM CD,DISS UG/L	82036 CALCIUM DISS CA UG/L	82037 MG DISS MG UG/L	01030 CHROMIUM CR,DISS UG/L	01035 COBALT CO,DISS UG/L
92/04/01	0900	VERT	1.5	100K	50K	200	100.00K	8500	25K	1310000	3510000	5K	50K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01040 COPPER CU,DISS UG/L	01046 IRON FE,DISS UG/L	01049 LEAD PB,DISS UG/L	01056 MANGNESE MN,DISS UG/L	71890 MERCURY HG,DISS UG/L	01060 MOLY MO,DISS UG/L	01065 NICKEL NI,DISS UG/L	01145 SELENIUM SE,DISS UG/L	01140 SILICON SI,DISS UG/L	01075 SILVER AG,DISS UG/L
92/04/01	0900	VERT	1.5	100K	100K	130K	50.0K	.5K	3300	100	1000K	2700	100.0K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01080 STRONTUM SR,DISS UG/L	01100 TIN SN,DISS UG/L	01085 VANADIUM V,DISS UG/L	01090 ZINC ZN,DISS UG/L	71900 MERCURY HG,TOTAL UG/L	01147 SELENIUM SE,TOT UG/L
92/04/01	0900	VERT	1.5	24000	200	100	100K	.5K	500K

Remark Codes: K= less than

Table 7. cont.

EDO1AB.WLMSSINK EDO1ABWILLMS WILLIAMSSINK
32 34 16.0 103 49 11.0 4
ACCESSED FROM RD. 243, SE PART OF BASIN
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920905 13060011
0002 METERS DEPTH 1045 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00917 CA MUD DRY WGT MG/KG-CA	00924 MG MUD DRY WGT MG/KG-MG	01003 ARSENIC SEDMG/KG DRY WGT	01008 BA MUD DRY WGT MG/KG-BA	01013 BERYLIUM SEDMG/KG DRY WGT	01019 CD MUD WET WGTM G/KG-CD	01023 B MUD DRY WGT MG/KG-B	01029 CHROMIUM SEDMG/KG DRY WGT	01038 CO MUD DRY WGT MG/KG-CO	01043 COPPER SEDMG/KG DRY WGT
92/04/01	0900	WATER	1.5	129658.0	20739.00	12.00	61.00	7.00K		35.00	8.00	3.60K	7.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01053 MN MUD DRY WGT MG/KG-MN	01063 MO MUD DRY WGT MG/KG-MO	01068 NICKEL SEDMG/KG DRY WGT	01078 SILVER SEDMG/KG DRY WGT	01083 SR MUD DRY WGT MG/KG-SR	01088 V MUD DRY WGT MG/KG-V	01093 ZINC SEDMG/KG DRY WGT	01103 TIN MUD DRY WGT MG/KG-SN	01108 AL MUD DRY WGT MG/KG-AL
92/04/01	0900	WATER	1.5	140.00	22.00	7.00K	7.00K	2223.00	87.00	14.00	7.00K	4921.00

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01144 SI MUD DRY WGT MG/KG-SI	01170 FE MUD DRY WGT MG/KG-FE	71921 MERCURY SEDMG/KG DRY WGT
92/04/01	0900	WATER	1.5	462.00	3565.00	.4K

Table 7. cont.

EDO1AB.WLMSSINK EDO1ABWILLMS WILLIAMSSINK
32 34 16.0 103 49 11.0 4
WILLIAMS SINK, SE PART OF BASIN
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920905 13060011
0002 METERS DEPTH 1045 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81552 ACETONE TOT UG/L	78124 BENZENE HOH VOL UG/L	81555 BROMO BENZENE TOT UG/L	73085 CLBRMETH TOTAL WTR UG/L	32101 DICLBRMT TOTUG/L	32104 BROMOFRM WHL-WTR UG/L	81595 MTH ETH KETONE TOT UG/L	77342 N-BUTLBZ TOTAL UG/L	77350 SEC-BUTB TOTAL UG/L	77353 T-BUTLBZ TOTAL UG/L
92/04/01	0900	VERT	1.5	5.000U	1.00U	1.000U	1.0U	1.0U	1.0U	5.000U	1.000U	1.000U	1.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	46491 MTBE WATER TOT UG/L	32102 CARBNTET TOTUG/L	34301 CHLOROBE NZENE TOTWUG/L	32106 CHLRFORM TOTUG/L	38680 CHLOROTO LUENEWTR TOT UG/L	77277 P-CLTOLU TOTAL UG/L	82625 DIBRCLRO PRPN TOT REC UG/L	32105 CLDIBRMT TOTUG/L	30203 ETHAN12 WTR,WHL REC UG/L	77596 DBRMETHA TOTAL UG/L
92/04/01	0900	VERT	1.5	5.00U	1.0U	1.000U	1.0U	1.000U	1.000U	1.0U	1.0U	1.0U	1.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	34536 12DICHLO ROBENZEN TOTWUG/L	34567 13DICHLO ROBENZEN DISSUG/L	34572 14DICHLO ROBENZEN DISSUG/L	34668 DICHLORO DIFLUORO TOTWUG/L	34496 11DICHLO ROETHANE TOTWUG/L	34531 12DICHLO ROETHANE TOTWUG/L	34501 11DICHLO ROETHYLE TOTWUG/L	77093 C-1,2DCE TOTAL UG/L	34546 12DICHLO ROETHENE TOTWUG/L	34541 12DICHLO ROPROPAN TOTWUG/L
92/04/01	0900	VERT	1.5	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77173 1,3DCLPR TOTAL UG/L	77170 2,2DCLPR TOTAL UG/L	77188 1,1DCLPR TOTAL UG/L	34704 C1,3-DCP TOT WAT UG/L	34699 T1,3-DCP TOT WAT UG/L	34371 ETHYLBEN ZENE TOTWUG/L	34391 HEXACHLO ROBUTADI TOTWUG/L	77223 IPROPBNZ TOTAL UG/L	30341 BNZ1MTHL RECOVER WTR UG/L	34423 METHYLEN ECHLORID TOTWUG/L
92/04/01	0900	VERT	1.5	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.00U	1.000U

Remark codes: U= undetected

Table 7. cont.

ED01AB.WLMSSINK ED01ABWILLMS WILLIAMSSINK
32 34 16.0 103 49 11.0 4
WILLIAMS SINK, SE PART OF BASIN
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920905 13060011
0002 METERS DEPTH 1045 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77418 1MNAPTHA TOTAL UG/L	77416 2MNAPTHA TOTAL UG/L	34696 NAPTHALE NE T OTWUG/L	77224 N-PRPBNZ TOTAL UG/L	77128 STYRENE TOTAL UG/L	77562 1112TCLE TOTAL UG/L	34516 1122TETR ACHLOROE TOTWUG/L	34475 TETRACHL OROETHYL TOTWUG/L
92/04/01	0900	VERT	1.5	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81607 TETRAHYD FURAN TOT UG/L	78131 TOLUENE WHL HOH VOLUG/L	77613 123TCLBZ TOTAL UG/L	34551 124TRICH LOROBENZ TOTWUG/L	34506 111TRICH LOROETHA TOTWUG/L	34511 112TRICH LOROETHA TOTWUG/L	39180 TRICHLOR ETHYLENE TOT UG/L	34488 TRICHLOR OFLUOROM TOTWUG/L	77443 1,2,3TCP TOTAL UG/L	77222 1,2,4TMB TOTAL UG/L
92/04/01	0900	VERT	1.5	5.000U	1.00U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77226 1,3,5TMB TOTAL UG/L	39175 VINYLCHL ORIDE TOT UG/L	77135 O-XYLENE TOTAL UG/L	85795 XYLENE M&P WTR WHL UG/L
92/04/01	0900	VERT	1.5	1.000U	1.000U	1.000U	1.00U

Remark codes: U= undetected

Table 8. Limiting nutrient and Carlson Trophic State indices computed by SAS.

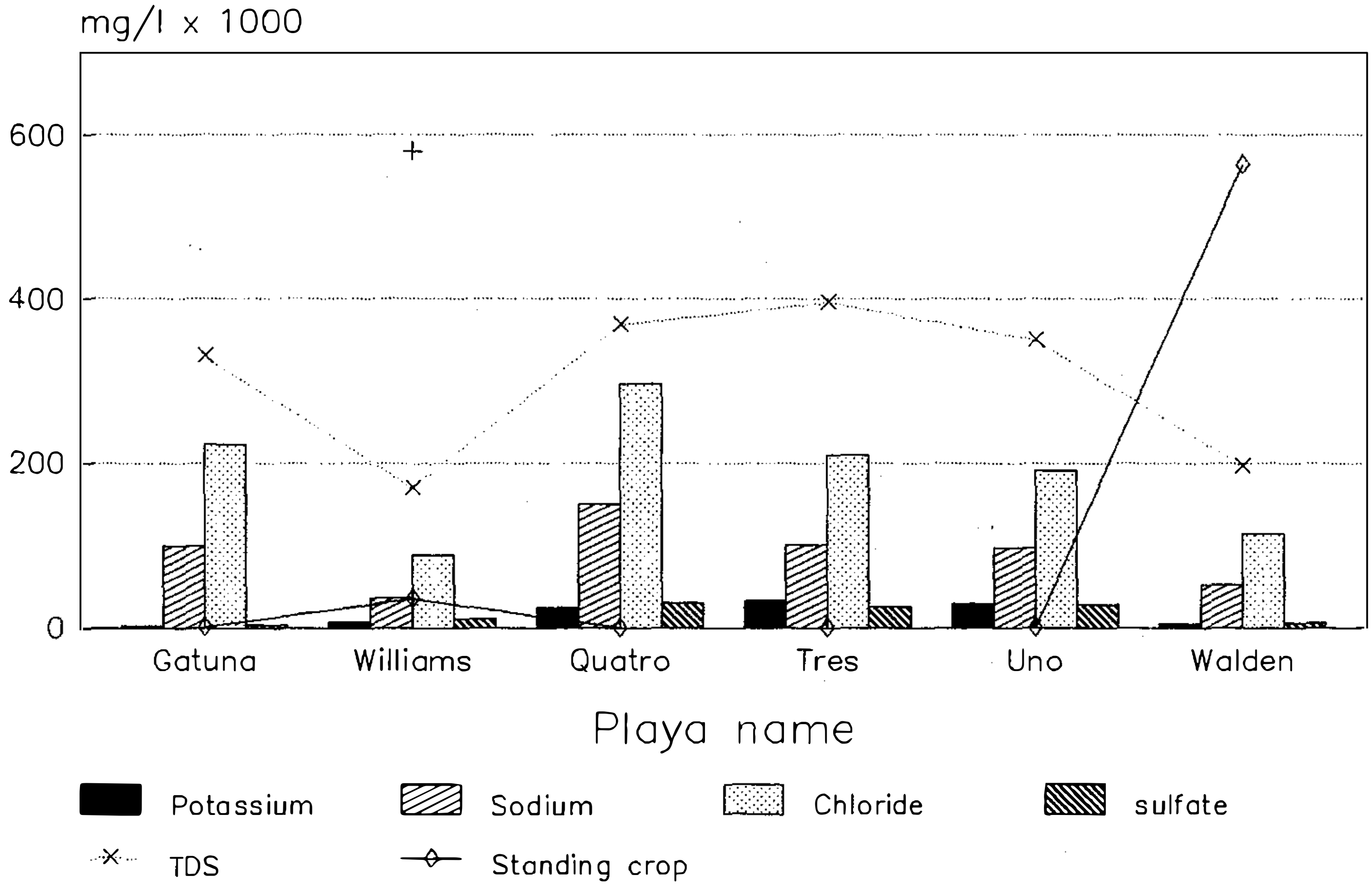
LIMITING NUTRIENT FOR PLAYA LAKES, CALCULATED BY SAS
TN/TP > 17 INDICATES P-LIMITATION
TN/TP 10 - 17 INDICATES N AND/OR P LIMITATION
TN/TP < 10 INDICATES N-LIMITATION

OBS	STATION		DATE	TN	TP	RATIO	LIMITING
1	21NMEX	LE01AA.LAGATUNA	31MAR92	109.30	0.20	546.500	P
2	21NMEX	ED01AB.WLMSSINK	01APR92	4.33	0.18	24.056	P
3	21NMEX	LE03AC.LANSALLK	14APR92	17.85	0.38	46.974	P
4	21NMEX	LE04AD.MIDDLELK	14APR92	14.54	0.11	132.182	P
5	21NMEX	ED01AE.LAGUNUNO	04MAY92	40.65	0.25	162.600	P
6	21NMEX	ED02AF.LAG-WALD	04MAY92	1.67	0.89	1.876	N
7	21NMEX	ED03AG.LGQUATRO	05MAY92	23.39	0.96	24.365	P
8	21NMEX	ED04AH.LAG-TRES	05MAY92	19.14	0.06	319.000	P
9	21NMEX	MO01AIWMSALTLKE	09JUN92	3.53	0.13	27.154	P
10	21NMEX	HA01AJ.CHICOSAL	26AUG92	7.40	0.64	11.562	N &/OR P

CARLSON TROPHIC STATE INDICES COMPUTED BY SAS
TSI <42 OLIGOTROPHIC, 42-47 MESOTROPHIC, >47 EUTROPHIC

OBS	STATION		DATE	CARLCHL	TSICHL	CARLSDD	TSISDD	CARLTP	TSITP
1	21NMEX	LE01AA.LAGATUNA	920331	25.0470	OLIGOTRO	60.0000	EUTRO	80.593	EUTRO
2	21NMEX	ED01AB.WLMSSINK	920401	32.4332	OLIGOTRO	54.1491	EUTRO	79.073	EUTRO
3	21NMEX	LE03AC.LANSALLK	920414	41.9761	OLIGOTRO	77.3733	EUTRO	89.855	EUTRO
4	21NMEX	LE04AD.MIDDLELK	920414	.	--	77.3733	EUTRO	71.967	EUTRO
5	21NMEX	ED01AE.LAGUNUNO	920504	.	--	77.3733	EUTRO	83.813	EUTRO
6	21NMEX	ED02AF.LAG-WALD	920504	28.7344	OLIGOTRO	77.3733	EUTRO	102.136	EUTRO
7	21NMEX	ED03AG.LGQUATRO	920505	55.7913	EUTRO	60.0000	EUTRO	103.228	EUTRO
8	21NMEX	ED04AH.LAG-TRES	920505	45.6853	MESOTRO	83.2242	EUTRO	63.220	EUTRO
9	21NMEX	MO01AIWMSALTLKE	920609	32.2697	OLIGOTRO	66.2162	EUTRO	74.377	EUTRO
10	21NMEX	HA01AJ.CHICOSAL	920826	85.9582	EUTRO	93.2263	EUTRO	97.378	EUTRO

Fig. 6 Playa biota x 100 vs major ions.
Numbers of invertebrates relative to concentrations of selected major ions.



+ = number of invertebrates per square meter x 100 taken at Williams Sink, February 26, 1992.

Fig. 7 Williams Sink/Laguna Gatuna: meq per liter.

Chemical Constituents in Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl
Williams Snk	31/ 3/1692	179.76	6.44	27.89	0.00	0.00	23.27	0.33	249.66
L. Gatuna	30/ 3/1692	436.69	13.52	47.88	0.00	0.00	5.94	0.09	629.08

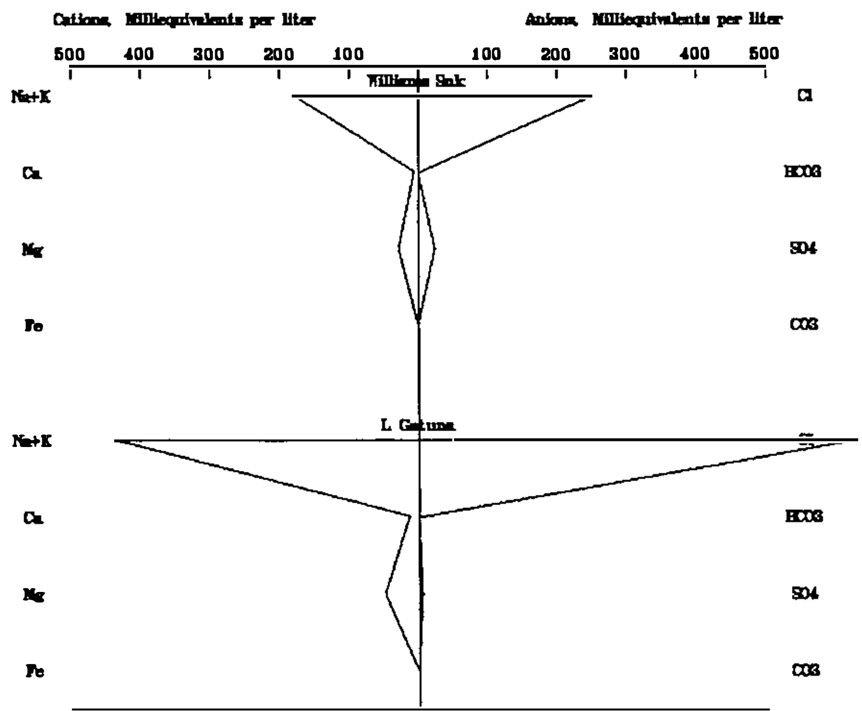


Fig. 8 Williams Sink/Laguna Gatuna: % meq per million

Chemical Constituents in % Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl	SAR	ESP	RSC
Williams Snk	31/ 3/1692	83.97	3.01	13.03	0.00	0.00	8.51	0.12	81.37	38.07	36.06	-34.00
L. Gatuna	30/ 3/1692	87.67	2.71	9.61	0.00	0.00	0.94	0.01	99.06	77.98	68.22	-61.31

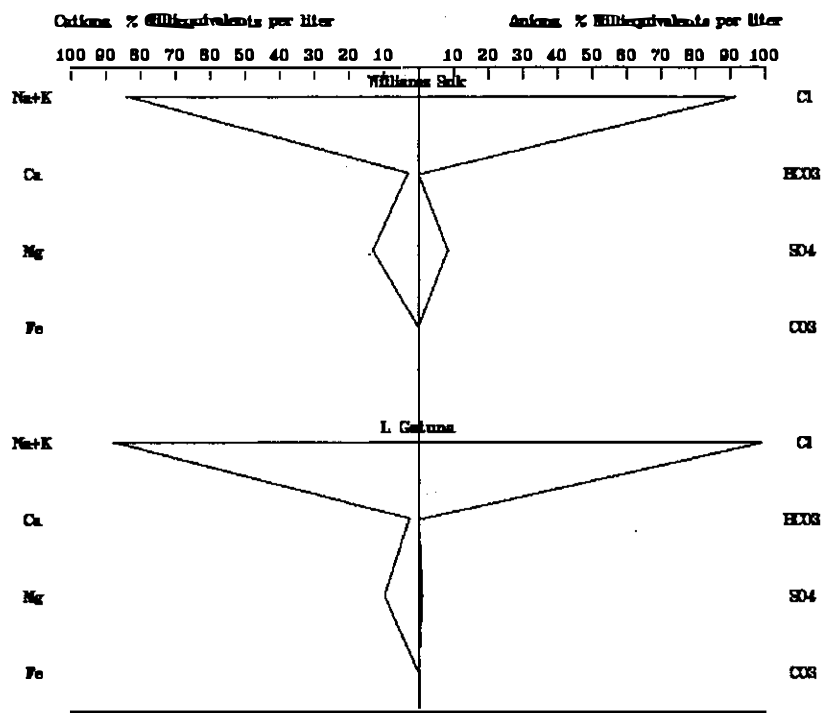
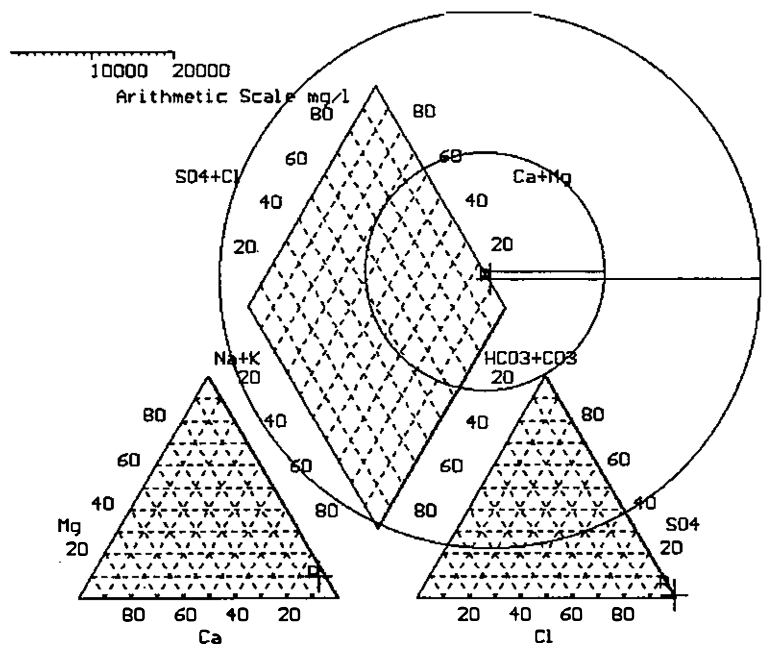


Fig. 9 Trilinear diagram: Williams/Gatuna. mg/l x 0.1



Diamond=«» Square=■ Circle=°

Williams Snk 03/31/1692-R L. Gatuna 03/30/1692-+

Table 9. Phytoplankton collected from Laguna Gatuna and Williams Sink, Eddy and Lea Counties, New Mexico, March 31-April 1, 1992.

Lake	Station	Date	Taxon	Count (%)
Laguna Gatuna	LE01AA.LAGATUNA	92/03/31	none found*	0 (100)
Williams Sink	ED01AB.WLMSSINK	92/04/01	*Dunaliella*	60 (80)
			Stephanoptera	15 (20)
		Total		75
		Taxa Richness		2
		Shannon - Wiener Diversity		0.72
		Evenness		0.72

* **NOTE: During a preliminary survey of Laguna Gatuna conducted on 2/25/92, 510 *Dunaliella* /ml were counted in a phytoplankton sample.**

Table 10.

QUALITATIVE DIATOM ANALYSIS OF WILLIAMS SINK, N.M.: April, 1992
Multiple substrate periphyton scrapes:

	NAME	# CELLS
1.	Amphora coffeiformis (Ag.) Kutz. var. coffeiformis	4
2.	Navicula cincta (Ehr.) Ralfs. var. cincta	31
3.	Nitzschia communis Rabh. var. communis	31
4.	N. epithemioides Grun.	44
5.	Pinnularia gracillima Gregory	11
	Total	= 121

SHANNON-WIENER INDEX OF DIVERSITY

Total number of fields viewed for formal count = 150
Total species per formal count = 5
Total species identified = 5

H = 2.02
Hmax = 2.32
Equitability = 0.87

Table 10, cont.

QUALITATIVE DIATOM ANALYSIS OF WILLIAMS SINK, N.M.: February, 1992
Surface sediment sample:

	NAME	# CELLS
1.	*Amphora coffeiformis* (Ag.) Kutz. var. *coffeiformis*	12
2.	*Navicula cincta* (Ehr.) Ralfs. var. *cincta*	115
3.	*Navicula* sp. #2 (poss.) *sclesvicensis* Grun.	35
4.	*Nitzschia communis* Rabh.	45
5.	*N. epithemioides* Grun.	8
	Total =	215

SHANNON-WIENER INDEX OF DIVERSITY

Total number of fields viewed for formal count = 40
Total species per formal count = 5
Total species identified = 6

H = 1.8
Hmax = 2.3
Equitability = 0.78

Other diatoms observed, but not included in formal count:

A. *Navicula dulcus* Patr. var. *dulcus*

B. Poss. *Pinnularia* sp.

Table 11. 1992 PLAYA SURVEY MACROINVERTEBRATE ABUNDANCES

	Williams Sink 920401 (ref.)	Laguna Gatuna 920331
	26° station	East Shore
Artemia salina ‡	275	0
Hydropyrus *sp.*, near *cinearea*	50	0
Dasyhelea *sp.*	21	0
Stratiomys *sp.*	1	0
	240° station	West shore
Artemia *salina*	69	4
Hydropyrus *sp.*, near *cinearea*	268	11
Dasyhelea *sp.*	11	0

	Middle Lake 920414 (ref.)	Lane Salt Lake 920414
	N side of island	inlet channel
Artemia *salina*	3890	0
Hydropyrus *sp.*, near *cinearea*	1	541
Culicidae, prob. *Aedes* *sp.*	5	0
Stratiomys *sp.*	1	0
Muscidae	0	6
	S. shore	½ mi. N. of S. end
Artemia *salina*	3507	0
Hydropyrus *sp.*, near *cinearea*	15	0

	"Laguna Walden" 920504 (ref.)	Laguna Uno 920504
	S. end	W. end
Artemia *salina*	2201	0
Hydropyrus *sp.*, near *cinearea*	3436	0
Nemotelus *sp.*	1	0

Laguna Tres 920505	Laguna Quatro 920505
near Murchison Nash #3	W. end
none found	none found

Table 12a. Results of adult *Artemia salina* 48 hr acute toxicity tests (100% test and control water).

Test Site	% Survival	Control site	% Survival
Laguna Gatuna	0*	Williams Sink	97.8
Lane Salt Lake	0*	Middle Lake	100.0
Burro Pipeline effl.	0*	Middle Lake	100.0
Laguna Uno	0	Laguna Walden	96.0
Laguna Tres	0*	Laguna Walden	96.0
Laguna Quatro	0	Laguna Walden	96.0

* 100% mortality/immobility after 24 hrs.

Table 12b. Results of larval *Hydropyrus sp.* 48 hr acute toxicity tests (100% test and control sediment).

Test Site	% Survival	Control Site	% Survival
Laguna Gatuna	56[1]	Williams Sink	80
Lane Salt Lake[2]	No sediment toxicity tests were conducted		
Laguna Uno	36[1]	Laguna Walden	96
Laguna Tres	58[1]	Laguna Walden	96
Laguna Quatro	12[1]	Laguna Walden	96

[1] Survival = individual larvae that were not dead or immobile.

[2] Too few *Hydropyrus* larvae were collected from Middle Lake for comparative toxicity testing.

Table 12c. Migratory bird species of Williams Sink, Eddy County, New Mexico, March 31, 1992

Species	Number	Activiey
American shoveler	9	Loafing
Black-necked stilt	9	Feeding
American avocet	6	Feeding
American coot	1	--
Great blue heron	4	Perching
Killdeer	4	Flying
American shoveler/ teal species	25	Loafing
Diving ducks (readheads/scaup)	10	Loafing
Total	68	

Table 12d. Migratory bird species of Laguna Gatuna, Lea County, New mexico, March 31, 1992

Species	Number	Activity
Long-billed curlew	6	Fly over
Killdeer	1	Along shore
Canvasback	1	Loafing
American shoveler/ teal species	26	Loafing
Least sandpiper	1	Along shore
Swallow species	1	Fly over
American avocet	1	Along shore
Total	37	

WATER QUALITY SURVEY OF LANE SALT LAKE IN LEA COUNTY, NEW MEXICO, APRIL 14, 1992

Introduction

In 1992 the Surveillance and Standards Section conducted a water quality survey of Lane Salt Lake in Northern Lea County, New Mexico (Fig. 10). The field team completed its survey on April 14, 1992. Lane Salt Lake was first permitted by the New Mexico Oil Conservation Division as a receiving basin in May of 1967, and since then has received produced brines more or less continuously. Lane Salt Lake currently receives the discharge of produced brines from a disposal facility operated by Burro Pipeline Corporation. The New Mexico Oil Conservation Division issued a permit to Burro Pipeline to operate this facility until Nov. 30, 1993.

Lane Salt Lake, covering approximately 400 ac, was probably formed by dissolution of underlying materials and further removal of material by deflation. The lake's elevation is approximately 1,265 m (4,150 ft) above mean sea level. Lane Salt Lake lies within the Western High Plains ecoregion. Mean annual rainfall is 37.8 cm (14.9 in) and the area is subject to an annual water deficit of 78.5 cm (30.9 in).

In April of 1992 no benthic organisms were found in Lane Salt Lake proper, although numbers of brine fly larvae, *Hydropyrus* sp. possibly *cinearea*, were found in the effluent channel from Burro Pipeline. Interestingly, many more recently dead brine fly larvae were observed on the surface sediments of the effluent channel than were taken alive during the sampling effort. Many more were dead in mineralized puparia. Numerous bird species were seen near or on Lane Salt Lake (Table 18 c-d), but were observed feeding only in the effluent channel. Only resting birds were seen on the lake itself. A local rancher reports that great blue herons, *Ardea herodius*, nested at the north end of the lake until the time that the discharge commenced. Some wading birds were seen to exhibit behavior consistent with nesting activities in the vicinity of the effluent channel, but no nests were observed during the course of the survey. Examination of stomach contents of American avocets, *Recurvirostra americana*, taken by U. S. Fish and Wildlife personnel near the effluent channel indicates that the birds were feeding primarily on *Hydropyrus* larvae. No other wildlife was seen.

Soils in the immediate vicinity of the lake shore are of the Arch-Drake association. These are light colored, calcareous soils of moderate permeability. Wind erosion hazard is severe. Land use in the area is grazing, but range conditions on the east side of the lake were generally good. The range on the west side of the lake was mostly hummocky brush. Some gullying exists on steep banks at the north end of the lake. The floor of the wetted portion of the basin consisted of a layer of white, crystalline salts overlying a grey, indurated sandy pavement near shore. The grey pavement gave way to black, reduced muck beneath the salt layer. In some areas near shore large pillars of crystallized salt were found on remnant vegetation. The presence of this now dead vegetation on the basin floor is an indication that either the water level has risen dramatically, or the salt content of the soil has increased beyond the tolerance of the local vegetation or both.

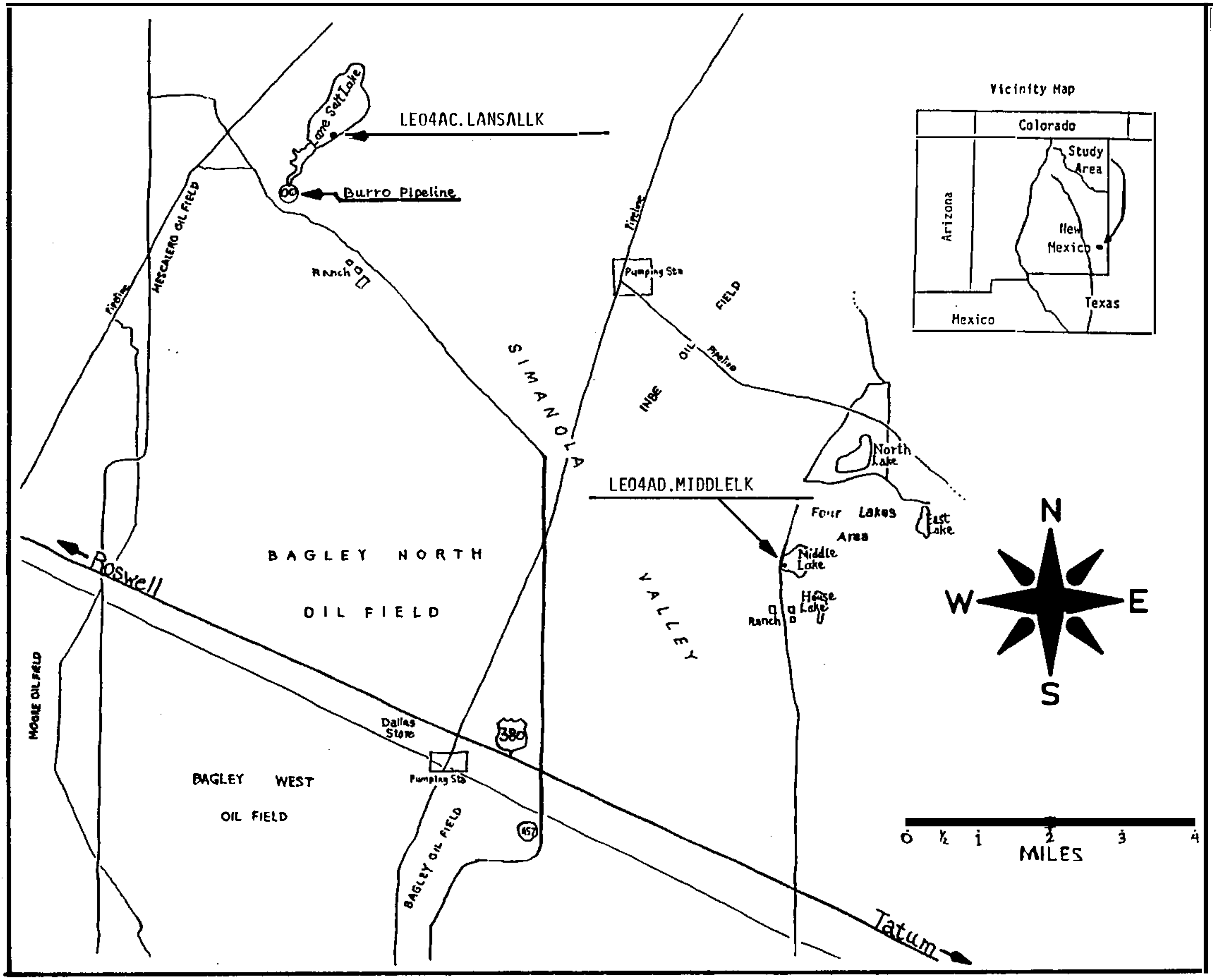


Fig. 10 Lane Salt Lake study area, 1992.

Water Quality Standards

Water quality standards for Lane Salt Lake are set forth in section 1-102 of the New Mexico water quality standards (NMWQCC 1991). Water quality standards specific to playa lakes have not been adopted. The principal objective of studying the diverse playa lakes of New Mexico is to develop numeric and narrative water quality standards that will support and protect the attainable uses of these waters of the State.

Methods

Water quality sampling methods were in accordance with the "New Mexico Clean Lakes Program: Lake Water Quality Assessment for FY 92-93" (NMED 1992) and the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 1992).

Water Quality Assessment

Water quality data for playa lake station LE03AC.LANSALLK are available on STORET and can be retrieved using the selector A=21NMEX and restrictor IS=923509. Parametric coverage, water quality and biological data are provided in tables 13 through 18d.

The investigators computed Likens' (1975) phytoplankton community composition index and Carlson's (1977) chlorophyll a, total phosphorus and Secchi disk depth indices. These trophic state indices were evaluated for their applicability in comparisons between the hypersaline playa lakes under investigation. The investigators concluded that these indices have no applicability or usefulness in comparisons between hypersaline lakes. Further, since these trophic state indices were developed using data from temperate freshwater lakes, they were not expected to be useful in comparisons between hypersaline lakes.

Lane Salt Lake is a Na-Cl water with a significant contribution of calcium (Figs. 11-14). Total dissolved solids was 333,730 mg/l with a hardness of 43,500 mg/l. The TDS value at Lane Salt Lake is over twice that of Middle Lake, the other system studied in the Tatum area. Scans for aromatic hydrocarbons in Lane Salt Lake water yielded no results above detection limits despite the presence of benzene, toluene and xylenes in Burro effluent water (Rick Roy, U.S. Fish and Wildlife Service, pers. comm.).

Analysis for radium 226 and 228 yielded 256 pCi/l. This value is in exceedence of the livestock and wildlife standard for combined radium of 30 pCi/l. Comparison to Middle Lake combined radium results (11.4 pC/l) suggests that levels of radium in excess of local background levels are the result of anthropogenic inputs associated with oil brine discharge. Analysis for potassium 40 yielded a value of 1,980 pCi/l, consistent with results expected from the potassium concentration in the lake water of 2,600 mg/l. Analyses for dissolved metals yielded no levels of concern for any metal subject to standards except boron which was found at the level of 150,000 ug/l. Comparison of Lane Salt Lake boron levels with those obtained at nearby Middle Lake (18,000 ug/l) suggests that the normally occuring level of boron is substantially lower than that found in Lane Salt Lake and that the difference is probably attributable to allocthonous inputs from oil field brines.

Magnesium and strontium were also elevated, as seems typical for hypersaline playas.

Phytoplankton density was 3 cells/ml with one taxon, Dunaliella, represented (Table 15). Shannon-Wiener Diversity is inapplicable in this case. No benthic macroinvertebrates could be found in the lake basin, although as mentioned above, numbers of Hydropyrus sp. were found in the Burro effluent channel (Table 17). Qualitative diatom analysis from multi-substrate periphyton scrapes taken from the Burro Pipeline effluent stream yielded 218 cells for 12 taxa per 20 fields counted. Shannon-Wiener diversity was excellent. Forty one diatom frustules of nine taxa per 205 fields viewed were found in the top two centimeters of bottom sediment cores taken through the salt pan. No diatoms were identified from above the salt layer in the lake basin proper (Tables 16a-16b). While no identifiable bird carcases have been found in Lane Salt Lake, feather piles have been located on or near the shore. It is not known at this time what, if any, influence the lake environment has had on this bird mortality. When exposed to Lane Salt Lake water 100% of Artemia salina, collected from nearby Middle Lake, were dead or otherwise immobilized within 24 hours (Table 18a). It is not known if this mortality is due to some unidentified toxin in the lake water or is simply the result of electrolytic stress due to the very high salinity of Lane Salt Lake.

Table 13. Water Quality Data for Lane Salt Lake.

LE03AC.LANSALLK LE03ACLANSAL LANESALT LK
33 27 28.0 103 36 48.0 4
LANE SALT LAKE E SHORE .5 MI. NORTH OF SOUTH END
35025 NEW MEXICO LEA
WESTERN GULF 120500
COLORADO RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 12080001
0001 METERS DEPTH 1266 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00010 WATER TEMP CENT	00400 PH SU	00095 CNDUCTVY AT 25C MICROMHO	00300 DO MG/L	82205 SPECIFIC GRAVITY GM/L	00480 SALINITY PPTH	00031 INCDT LT REMNING PERCENT	82079 TURBIDTY LAB NTU	00612 UN-IONZD NH3-N MG/L	00053 SURFACE AREA ACRES
92/04/14	1100	WATER	0.3	24.0		453900J	1.5		328.0	100.0			400
92/04/14	1100	VERT	0.3		6.94			1.20D			5.0	0.1	

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00078 TRANSP SECCHI METERS	00079 COLOR FORL-ULE SCALE	00204 DEPTH-M 1% LIGHT REMAINS	00410 T ALK CACO3 MG/L	00440 HCO3 ION HCO3 MG/L	00530 RESIDUE TOT NFLT MG/L	70300 RESIDUE DISS-180 C MG/L	00600 TOTAL N N MG/L	00605 ORG N N MG/L	00608 NH3+NH4- N DISS MG/L
92/04/14	1100	VERT	0.3	.30	2J	.3	251	306	192	333730	17.85	3.600	13.400

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00610 NH3+NH4- N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00631 NO2&NO3 N-DISS MG/L	00640 T INORG. NITROGEN MG/L N	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P	00671 PHOS-DIS ORTHO MG/L P	00900 TOT HARD CACO3 MG/L	00915 CALCIUM CA,DISS MG/L
92/04/14	1100	VERT	0.3	14.000	17.600	.25	.3	14.25	.380	.830	.410	43500J	10270.0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00925 MGNSIUM MG,DISS MG/L	00930 SODIUM NA,DISS MG/L	00935 PTSSIUM K,DISS MG/L	00940 CHLORIDE TOTAL MG/L	00945 SULFATE SO4-TOT MG/L	71870 BROMIDE BR MG/L	32210 CHLRPHYL A UG/L	32211 CHLRPHYL A UG/L CORRECTD	32212 CHLRPHYL B UG/L	32214 CHLRPHYL C UG/L
92/04/14	1100	VERT	0.3	4340.0	162900.0	2600.00	216000	585	86.10	1.16J	3.20J	.60J	.00J

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	32218 PHEOPHTN A UG/L	32221 % CHL A OF PHE A + CHL A	09501 RA-226 TOTAL PC/L	09502 RA-226 ERROR PC/L	11501 RA-228 TOTAL PC/L	11502 RA-228 ERROR PC/L	11503 RA-226 + RA-228 PC/L	11504 RA-226 + 228 ERR PC/L	75038 K-40 TOTAL PC/L	75037 K-40 ERROR PC/L
92/04/14	1100	VERT	0.3	.00J	276J	250.0J	15.0C	6.0J	4.0C	256.0C	16.0C	1980.00	200.00C

Remark codes: C= calculated value, D= field measurement, J= value estimated, K= less than, L= greater than

Table 13. cont.

LEO3AC.LANSALLK LEO3ACLANSAL LANESALT LK
33 27 28.0 103 36 48.0 4
LANE SALT LAKE E SHORE .5 MI. NORTH OF SOUTH END
35025 NEW MEXICO LEA
WESTERN GULF 120500
COLORADO RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 120B0001
0001 METERS DEPTH 1266 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01106 ALUMINUM AL,DISS UG/L	01000 ARSENIC AS,DISS UG/L	01005 BARIUM BA,DISS UG/L	01010 BERYLIUM BE,DISS UG/L	01020 BORON B,DISS UG/L	01025 CADMIUM CD,DISS UG/L	82036 CALCIUM DISS CA UG/L	82037 MG DISS MG UG/L	01030 CHROMIUM CR,DISS UG/L	01035 COBALT CO,DISS UG/L
92/04/14	1100	VERT	0	100K	50K	400	100.00K	150000	25K	9630000	4330000	250K	50K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01040 COPPER CU,DISS UG/L	01046 IRON FE,DISS UG/L	01049 LEAD PB,DISS UG/L	01056 MANGNESE MN,DISS UG/L	71890 MERCURY HG,DISS UG/L	01060 MOLY MO,DISS UG/L	01065 NICKEL NI,DISS UG/L	01145 SELENIUM SE,DISS UG/L	01140 SILICON SI,DISS UG/L	01075 SILVER AG,DISS UG/L
92/04/14	1100	VERT	0	100K	100K	250K	920.0	5.0K	100K	100K	1000K	5400	100.0K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01080 STRONTUM SR,DISS UG/L	01100 TIN SN,DISS UG/L	01085 VANADIUM V,DISS UG/L	01090 ZINC ZN,DISS UG/L	71900 MERCURY HG,TOTAL UG/L	01147 SELENIUM SE,TOT UG/L
92/04/14	1100	VERT	0	570000	100K	100K	100K	.5K	2000K

Remark Codes: K= less than

Table 13, cont.

LE03AC.LANSALLK LE03ACLANSAL LANESALT LK
33 27 28.0 103 36 48.0 4
LANE SALT LAKE E SHORE .5 MI. NORTH OF SOUTH END
35025 NEW MEXICO LEA
WESTERN GULF 120500
COLORADO RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 12080001
0001 METERS DEPTH 1266 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00917 CA MUD DRY WGT MG/KG-CA	00924 MG MUD DRY WGT MG/KG-MG	01003 ARSENIC SEDMG/KG DRY WGT	01008 BA MUD DRY WGT MG/KG-BA	01013 BERYLLIUM SEDMG/KG DRY WGT	01019 CD MUD WET WGTM G/KG-CD	01023 B MUD DRY WGT MG/KG-B	01029 CHROMIUM SEDMG/KG DRY WGT	01038 CO MUD DRY WGT MG/KG-CO	01043 COPPER SEDMG/KG DRY WGT
92/04/14	1100	WATER	0.3	33366.00	12981.00	10.00	47.00	6.00K		272.00	5.00	3.00K	6.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01053 MN MUD DRY WGT MG/KG-MN	01063 MO MUD DRY WGT MG/KG-MO	01068 NICKEL SEDMG/KG DRY WGT	01078 SILVER SEDMG/KG DRY WGT	01083 SR MUD DRY WGT MG/KG-SR	01088 V MUD DRY WGT MG/KG-V	01093 ZINC SEDMG/KG DRY WGT	01103 TIN MUD DRY WGT MG/KG-SN	01108 AL MUD DRY WGT MG/KG-AL
92/04/14	1100	WATER	0.3	48.00	6.00K	6.00K	6.00K	3993.00	23.00	8.00	6.00K	2819.00

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01144 SI MUD DRY WGT MG/KG-SI	01170 FE MUD DRY WGT MG/KG-FE	71921 MERCURY SEDMG/KG DRY WGT
92/04/14	1100	WATER	0.3	383.00	2262.00	.3K

Table 13, cont.

LEO3AC.LANSALLK LEO3ACLANSAL LANESALT LK
33 27 28.0 103 36 48.0 4
LANE SALT LAKE E SHORE .5 MI. NORTH OF SOUTH END
35025 NEW MEXICO LEA
WESTERN GULF 120500
COLORADO RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 12080001
0001 METERS DEPTH 1266 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81552 ACETONE TOT UG/L	78124 BENZENE HOH VOL UG/L	81555 BROMO BENZENE TOT UG/L	73085 CLBRMETH TOTAL WTR UG/L	32101 DICLBRMT TOTUG/L	32104 BROMOFRM WHL-WTR UG/L	81595 MTH ETH KETONE TOT UG/L	77342 N-BUTLBZ TOTAL UG/L	77350 SEC-BUTB TOTAL UG/L	77353 T-BUTLBZ TOTAL UG/L
92/04/14	1100	VERT	0.3	250.000U	50.00U	50.000U	50.0U	50.0U	50.0U	250.000U	50.000U	50.000U	50.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	46491 MTBE WATER TOT UG/L	32102 CARBNTET TOTUG/L	34301 CHLOROBE NZENE TOTWUG/L	32106 CHLRFORM TOTUG/L	38680 CHLOROTO LUENEWTR TOT UG/L	77277 P-CLTOLU TOTAL UG/L	82625 DIBRCLRO PRPN TOT REC UG/L	32105 CLDIBRMT TOTUG/L	30203 ETHAN12 WTR,WHL REC UG/L	77596 DBRMETHA TOTAL UG/L
92/04/14	1100	VERT	0.3	250.00U	50.0U	50.000U	50.0U	50.000U	50.000U	50.0U	50.0U	50.0U	50.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	34536 12DICHLO ROBENZEN TOTWUG/L	34567 13DICHLO ROBENZEN DISSUG/L	34572 14DICHLO ROBENZEN DISSUG/L	34668 DICHLORO DIFLUORO TOTWUG/L	34496 11DICHLO ROETHANE TOTWUG/L	34531 12DICHLO ROETHANE TOTWUG/L	34501 11DICHLO ROETHYLE TOTWUG/L	77093 C-1,2DCE TOTAL UG/L	34546 12DICHLO ROETHENE TOTWUG/L	34541 12DICHLO ROPROPAN TOTWUG/L
92/04/14	1100	VERT	0.3	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77173 1,3DCLPR TOTAL UG/L	77170 2,2DCLPR TOTAL UG/L	77168 1,1DCLPR TOTAL UG/L	34704 C1,3-DCP TOT WAT UG/L	34699 T1,3-DCP TOT WAT UG/L	34371 ETHYLBEN ZENE TOTWUG/L	34391 HEXACHLO ROBUTADI TOTWUG/L	77223 IPROPBNZ TOTAL UG/L	30341 BNZ1MTHL RECOVER WTR UG/L	34423 METHYLEN ECHLORID TOTWUG/L
92/04/14	1100	VERT	0.3	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U	50.00U	50.000U

Remark codes: U= undetected

Table 13, cont.

LE03AC.LANSALLK LE03ACLANSAL LANESALT LK
33 27 28.0 103 36 48.0 4
LANE SALT LAKE E SHORE .5 MI. NORTH OF SOUTH END
35025 NEW MEXICO LEA
WESTERN GULF 120500
COLORADO RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 12080001
0001 METERS DEPTH 1266 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77418 1MNAPTHA TOTAL UG/L	77416 2MNAPTHA TOTAL UG/L	34696 NAPTHALE NE T OTWUG/L	77224 N-PRPBNZ TOTAL UG/L	77128 STYRENE TOTAL UG/L	77562 1112TCLE TOTAL UG/L	34516 1122TETR ACHLOROE TOTWUG/L	34475 TETRACHL OROETHYL TOTWUG/L
92/04/14	1100	VERT	0.3	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81607 TETRAHYD FURAN TOT UG/L	78131 TOLUENE WHL HOH VOLUG/L	77613 123TCLBZ TOTAL UG/L	34551 124TRICH LOROBENZ TOTWUG/L	34506 111TRICH LOROETHA TOTWUG/L	34511 112TRICH LOROETHA TOTWUG/L	39180 TRICHLOR ETHYLENE TOT UG/L	34488 TRICHLOR OFLUOROM TOTWUG/L	77443 1,2,3TCP TOTAL UG/L	77222 1,2,4TMB TOTAL UG/L
92/04/14	1100	VERT	0.3	250.000U	50.00U	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U	50.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77226 1,3,5TMB TOTAL UG/L	39175 VINYLCHL ORIDE TOT UG/L	77135 O-XYLENE TOTAL UG/L	85795 XYLENE M&P WTR WHL UG/L
92/04/14	1100	VERT	0.3	50.000U	50.000U	50.000U	50.00U

Remark codes: U= undetected

Table 14. Limiting nutrient and Carlson Trophic State indices computed by SAS.

LIMITING NUTRIENT FOR PLAYA LAKES, CALCULATED BY SAS
TN/TP > 17 INDICATES P-LIMITATION
TN/TP 10 - 17 INDICATES N AND/OR P LIMITATION
TN/TP < 10 INDICATES N-LIMITATION

OBS		STATION	DATE	TN	TP	RATIO	LIMITING
1	21NMEX	LE01AA.LAGATUNA	31MAR92	109.30	0.20	546.500	P
2	21NMEX	ED01AB.WLMSSINK	01APR92	4.33	0.18	24.056	P
3	21NMEX	LE03AC.LANSALLK	14APR92	17.85	0.38	46.974	P
4	21NMEX	LE04AD.MIDDLELK	14APR92	14.54	0.11	132.182	P
5	21NMEX	ED01AE.LAGUNUNO	04MAY92	40.65	0.25	162.600	P
6	21NMEX	ED02AF.LAG-WALD	04MAY92	1.67	0.89	1.876	N
7	21NMEX	ED03AG.LGQUATRO	05MAY92	23.39	0.96	24.365	P
8	21NMEX	ED04AH.LAG-TRES	05MAY92	19.14	0.06	319.000	P
9	21NMEX	MO01AIWMSALTLKE	09JUN92	3.53	0.13	27.154	P
10	21NMEX	HA01AJ.CHICOSAL	26AUG92	7.40	0.64	11.562	N &/OR P

CARLSON TROPHIC STATE INDICES COMPUTED BY SAS
TSI <42 OLIGOTROPHIC, 42-47 MESOTROPHIC, >47 EUTROPHIC

OBS		STATION	DATE	CARLCHL	TSICHL	CARLSDD	TSISDD	CARLTP	TSITP
1	21NMEX	LE01AA.LAGATUNA	920331	25.0470	OLIGOTRO	60.0000	EUTRO	80.593	EUTRO
2	21NMEX	ED01AB.WLMSSINK	920401	32.4332	OLIGOTRO	54.1491	EUTRO	79.073	EUTRO
3	21NMEX	LE03AC.LANSALLK	920414	41.9761	OLIGOTRO	77.3733	EUTRO	89.855	EUTRO
4	21NMEX	LE04AD.MIDDLELK	920414	.	--	77.3733	EUTRO	71.967	EUTRO
5	21NMEX	ED01AE.LAGUNUNO	920504	.	--	77.3733	EUTRO	83.813	EUTRO
6	21NMEX	ED02AF.LAG-WALD	920504	28.7344	OLIGOTRO	77.3733	EUTRO	102.136	EUTRO
7	21NMEX	ED03AG.LGQUATRO	920505	55.7913	EUTRO	60.0000	EUTRO	103.228	EUTRO
8	21NMEX	ED04AH.LAG-TRES	920505	45.6853	MESOTRO	83.2242	EUTRO	63.220	EUTRO
9	21NMEX	MO01AIWMSALTLKE	920609	32.2697	OLIGOTRO	66.2162	EUTRO	74.377	EUTRO
10	21NMEX	HA01AJ.CHICOSAL	920826	85.9582	EUTRO	93.2263	EUTRO	97.378	EUTRO

Fig. 11 Playa biota x 100 vs major ions.
Numbers of invertebrates relative to concentrations of selected major ions.

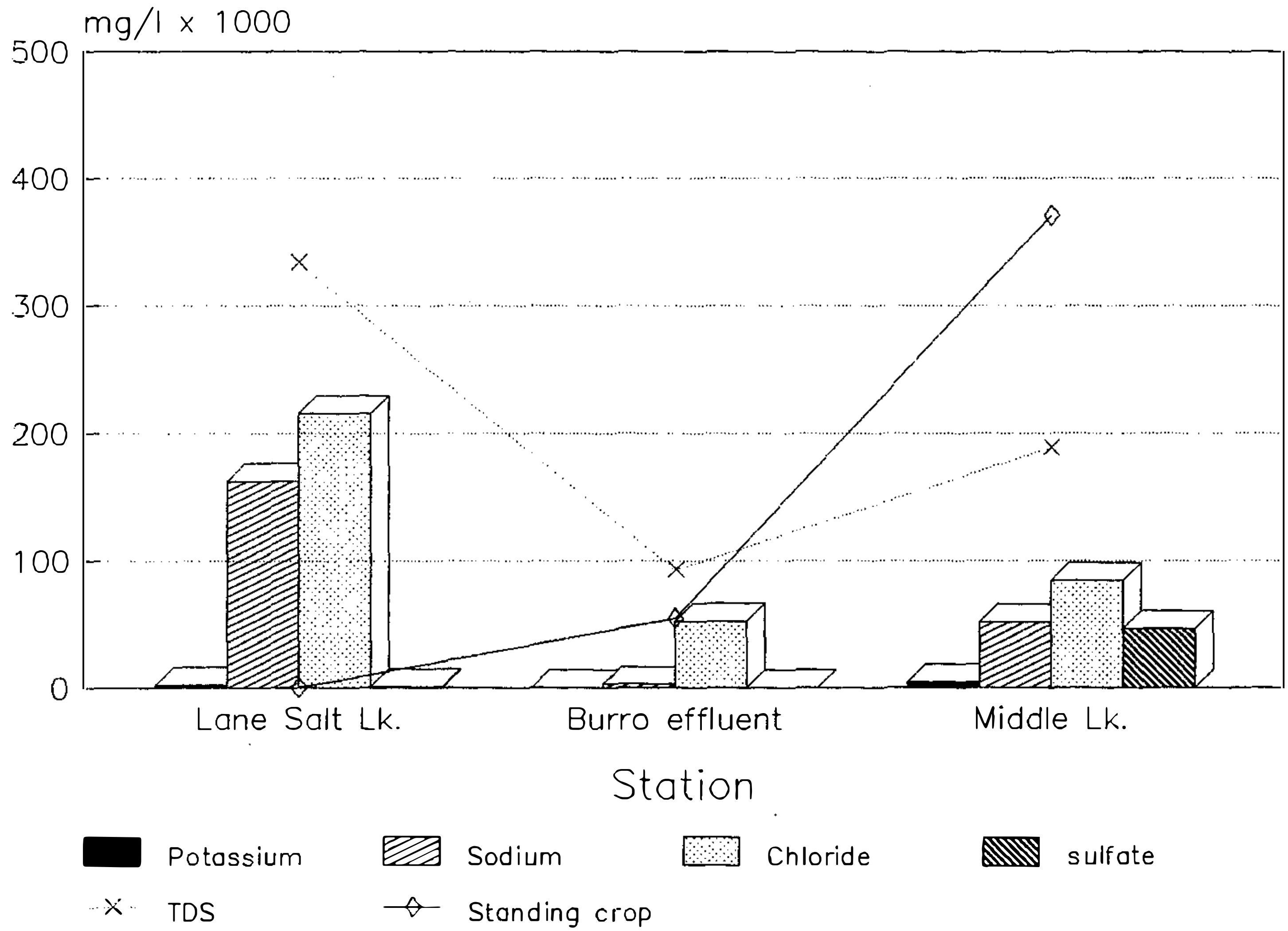


Fig. 12 Stiff diagrams: Four Lakes area. meq/liter

Chemical Constituents in Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl
Lane Salt Lk	13/ 5/1692	715.26	51.25	35.70	0.00	0.00	1.22	0.50	609.34
Burro Eflunt	14/ 5/1692	12.04	20.11	6.33	0.00	0.00	0.81	0.78	148.38
Middle Lk.	13/ 5/1692	237.44	2.99	60.01	0.00	0.00	96.81	0.41	238.37

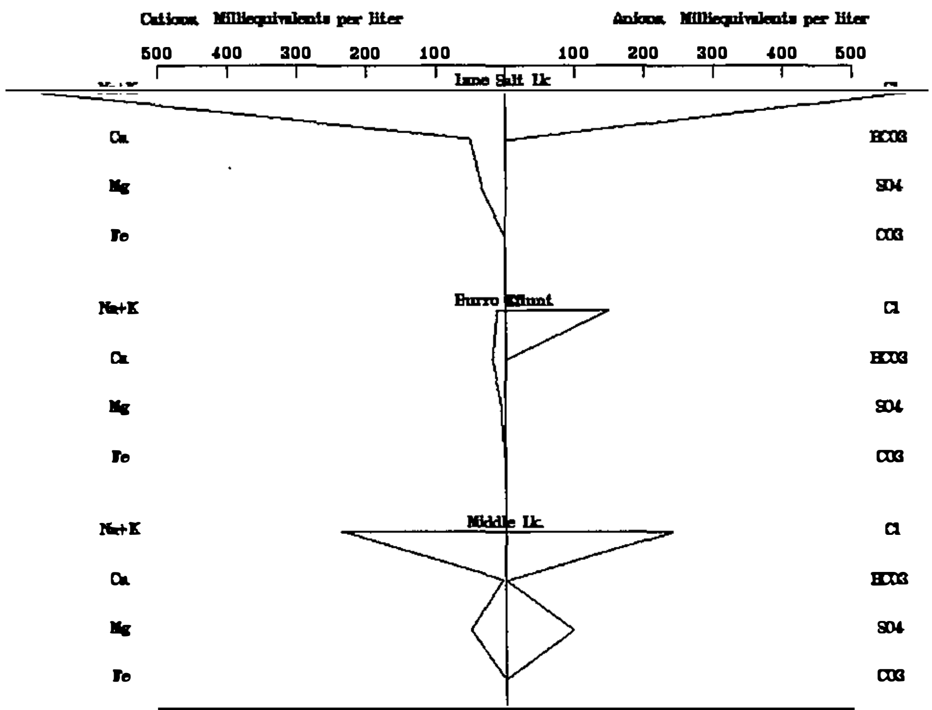


Fig. 13 Stiff diagrams: Four Lakes area. % meq/liter

Chemical Constituents in % Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl	SAR	ESP	RSC
Lane Salt Lk	13/ 5/1692	89.16	6.39	4.45	0.00	0.00	0.20	0.08	99.72	107.47	61.13	-96.45
Burro Eflunt	14/ 5/1692	31.28	52.26	16.46	0.00	0.00	0.54	0.52	98.94	3.17	3.30	-25.67
Middle Lk.	13/ 5/1692	81.75	1.03	17.22	0.00	0.00	28.85	0.12	71.03	43.84	38.80	-62.69

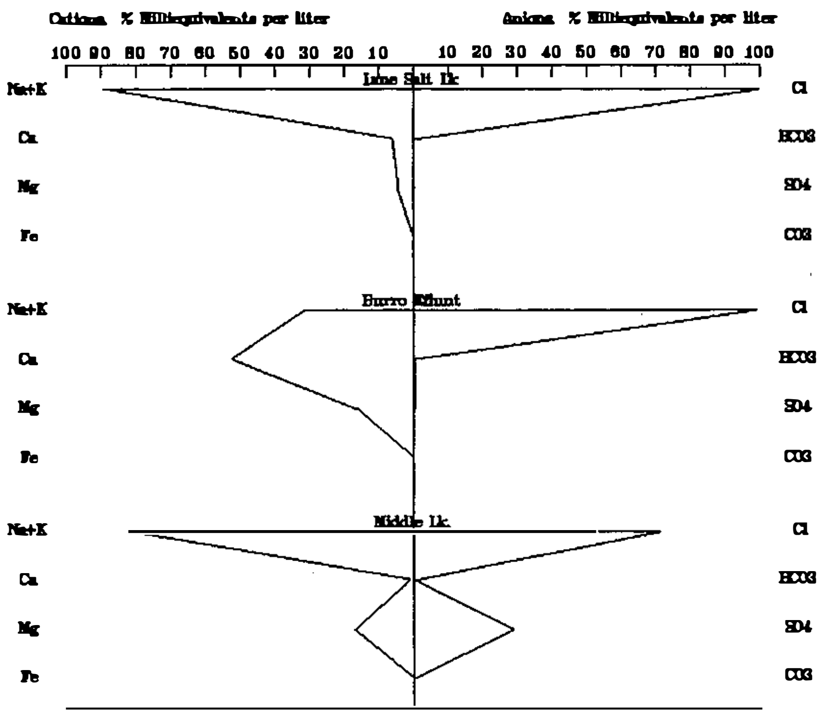
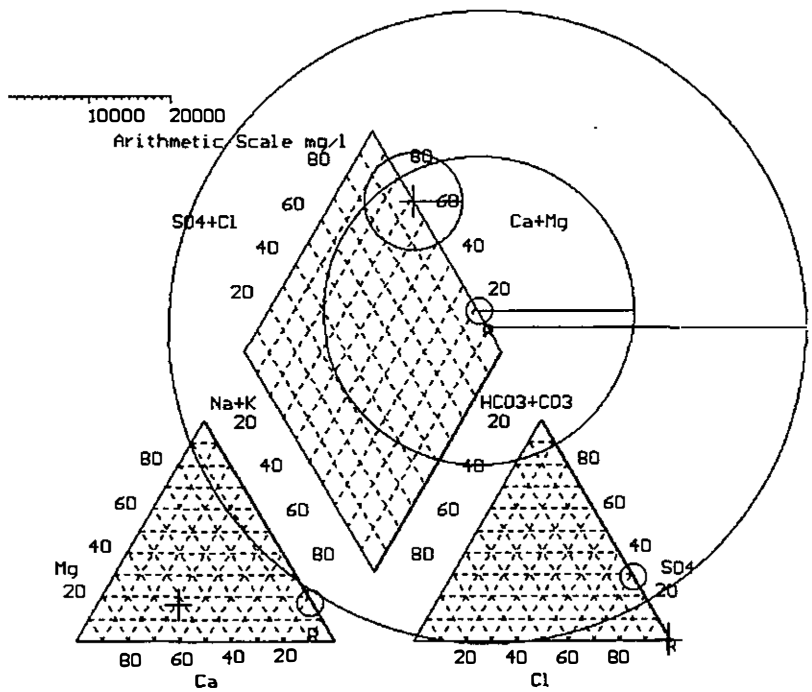


Fig. 14 Trilinear diagram: Four Lakes area. mg/l x 0.1



Diamond=«» Square=■ Circle=°

Lane Salt Lk 05/13/1692-R Burro Eflunt 05/14/1692-+ Middle Lk. 05/13/1692-°

Table 15. Phytoplankton collected from Lane Salt Lake and Middle Lake, Lea County, New Mexico, April 14, 1992.

Lake	Station	Date	Taxon	Count (%)
Lane Salt Lake	LE03AC.LANSALLK	92/04/14	*Dunaliella*	3 (100)
		Total		3
		Taxa Richness		1
		Shannon - Wiener Diversity		0.00
		Evenness		0.00
Middle Lake	LE04AD.MIDDLELK	92/04/14	*Pennales*	12 (100)
		Total		12
		Taxa Richness		1
		Shannon - Wiener Diversity		0.00
		Evenness		0.00

Table 16a.

QUALITATIVE DIATOM ANALYSIS OF LANE SALT LAKE, N.M.: 1992
Main inlet channel below Burro Pipeline near springs.

Multiple substrate periphyton mix.

	NAME	# CELLS
1.	Amphora coffeiformis (Ag.) Kutz. var. coffeiformis	9
2.	Cymbella minuta Hilse ex. Rabh. var. minuta	4
3.	C. minuta var. silesiaca (Bleisch ex. Rabh.) Reim. comb. nov.	8
4.	Denticula elegans var. kittoniana (Grun.) Del.	55
5.	Navicula graciloides A. Mayer var. graciloides	9
6.	N. odiosa Wallace var. odiosa	6
7.	Nitzschia communis Rabh. var. communis	27
8.	N. intermedia Hantzsch var. intermedia	18
9.	N. pusilla Kutz.	48
10.	N. vermicularis (Kutz.) Grun.	7
11.	Mastogloia elliptica var. danseii (Thwaites) Cl.	11
12.	Rhopalodia musculus (Kutz.) O. Mull. var. musculus	16
	Total =	218

SHANNON-WIENER INDEX OF DIVERSITY

Total number of fields viewed for formal count = 20
Total species per formal count = 12
Total species identified = 18

H = 3.11
Hmax = 3.59
Equitability = 0.87

Table 16a. (Cont.)

QUALITATIVE DIATOM ANALYSIS OF LANE SALT LAKE, N.M.: 1992
Main inlet channel below Burro Pipeline near springs.

Other diatoms observed, but not included in formal count:

A. Navicula scoliopleuroides (Quint.) Hust.

B. Nitzschia denticula Grun.

C. Nitzschia dissipata (Kutz) Grun.

D. N. palea (Kutz.) W. Sm. var. palea

E. N. triblionella Hantzsch

F. Rhopalodia gibberula (Ehr.) O. Mull. var. gibberula

Table 16b.

QUALITATIVE DIATOM ANALYSIS OF LANE SALT LAKE, N.M.: 1992
Surface sediment sample #15 (0 - 2cm depth):

	NAME	# CELLS
1.	Amphora coffeiformis (Ag.) Kutz. var. coffeiformis	12
2.	Prob. Coscinodiscus sp. poss. fothii var. normani (Greg.) V.H.	1
3.	Denticula sp. prob. elegans Kutz.	3
4.	Navicula mutica var. cohnii (Hilse) Grun.	5
5.	Prob. Navicula tripunctata var. schizonemoides (V.H.) Patr.	2
6.	Navicula sp. #3	3
7.	Nitzschia communis Rabenhorst	4
8.	N. subcapitellata Hustedt	5
9.	Rhopalodia musculus (Kutz.) O. Mull. var. musculus	6
	Total =	41

SHANNON-WIENER INDEX OF DIVERSITY

Total number of fields viewed for formal count = 205
Total species per formal count = 9
Total species identified = 9

H = 2.89
Hmax = 3.17
Equitability = 0.91

Table 17. 1992 PLAYA SURVEY MACROINVERTEBRATE ABUNDANCES

	Williams Sink 920401 (ref.)	**Laguna Gatuna 920331**
	26° station	East Shore
Artemia salina ‡	275	0
Hydropyrus sp., near *cinearea*	50	0
Dasyhelea sp.	21	0
Stratiomys sp.	1	0
	240° station	West shore
Artemia salina	69	4
Hydropyrus sp., near *cinearea*	268	11
Dasyhelea sp.	11	0

	Middle Lake 920414 (ref.)	**Lane Salt Lake 920414**
	N side of island	inlet channel
Artemia salina	3890	0
Hydropyrus sp., near *cinearea*	1	541
Culicidae, prob. *Aedes sp.*	5	0
Stratiomys sp.	1	0
Muscidae	0	6
	S. shore	½ mi. N. of S. end
Artemia salina	3507	0
Hydropyrus sp., near *cinearea*	15	0

	"Laguna Walden" 920504 (ref.)	**Laguna Uno 920504**
	S. end	W. end
Artemia salina	2201	0
Hydropyrus sp., near *cinearea*	3436	0
Nemotelus sp.	1	0

Laguna Tres 920505	**Laguna Quatro 920505**
near Murchison Nash #3	W. end
none found	none found

Table 18a. Results of adult *Artemia salina* 48 hr acute toxicity tests (100% test and control water).

Test Site	% Survival	Control site	% Survival
Laguna Gatuna	0[‡]	Williams Sink	97.8
Lane Salt Lake	0[‡]	Middle Lake	100.0
Burro Pipeline effl.	0[‡]	Middle Lake	100.0
Laguna Uno	0	Laguna Walden	96.0
Laguna Tres	0[‡]	Laguna Walden	96.0
Laguna Quatro	0	Laguna Walden	96.0

‡ 100% mortality/immobility after 24 hrs.

Table 18b. Results of larval *Hydropyrus sp.* 48 hr acute toxicity tests (100% test and control sediment).

Test Site	% Survival	Control Site	% Survival
Laguna Gatuna	56[1]	Williams Sink	80
Lane Salt Lake[2]	No sediment toxicity tests were conducted		
Laguna Uno	36[1]	Laguna Walden	96
Laguna Tres	58[1]	Laguna Walden	96
Laguna Quatro	12[1]	Laguna Walden	96

1 Survival = individual larvae that were not dead or immobile.

2 Too few *Hydropyrus* larvae were collected from Middle Lake for comparative toxicity testing.

Table 18c. Migratory bird species from Middle Lake, Lea County, New Mexico, April 15, 1992.

Species	Number	Activity
American avocet	11	Feeding
Killdeer	2	Feeding
Total	13	

Table 18d. Migratory bird species from Lane Salt Lake, Lea County, New Mexico, April 13, 1992.

Species	Number	Activity
American shoveler/ teal species/divers	333	Loafing
American coot	4	Loafing
American avocet	11	Feeding*
Yellowlegs	6	Feeding*
Bufflehead	2	Feeding*
Least sandpiper	80	Feeding*
Blue-winged teal	19	Feeding*
Snowy plover	14	Feeding*
Killdeer	2	Feeding*
Total	471	

*Birds encountered in area below Burro Pipeline facility outfall.

WATER QUALITY SURVEY OF MIDDLE LAKE IN LEA COUNTY, NEW MEXICO
APRIL 14, 1992

INTRODUCTION

During 1992 the Surveillance and Standards Section conducted a water quality assessment of Middle Lake in Lea County, New Mexico (Fig. 15). The field team visited the playa on April 14, 1992.

Middle Lake is located in southeastern New Mexico approximately 12 miles northwest of Tatum, New Mexico. Its location is known as the Four Lakes Area as three other playa basins, North Lake, East Lake and House Lake are in close proximity to each other. Middle Lake has a 16 hectare (40 acre) surface area at an elevation of 1,256 meters (4,120 ft) above mean sea level. The basin formation appears to be from the dissolution and collapse of underlying materials as well as eolian processes, both considered primary factors in the creation of playa basins (Osterkamp and Wood 1987). The basin is located in the arid Western High Plains ecoregion with mean annual precipitation of 37.8 cm/yr (14.9 in/yr) and a mean annual water deficit of about 78.5 cm/yr (30.9 in/yr)(Gabin and Lesperance 1977). We followed the procedure of Nicholson and Clebsch (1961) to derive these estimated values by averaging 37.5 years of data from four weather stations in the vicinity of the study area. The stations used for the estimations were Tatum, Crossroads, Pep A and Elida.

Soils associated with Middle Lake are of the Arch-Drake association, Portales and Gomez fine sandy loams and Reeves loam types. The Arch-Drake association consists mostly of Arch loam and Drake loamy fine sand, which is generally found as concave benches along playa lakes. Soil loss through wind and water erosion is a severe hazard when plant cover is removed. The Portales and Gomez fine sandy loams are well drained, but severely susceptible to wind erosion. The Reeves loam is typically found in smooth concave areas near large playa lakes. This soil is susceptible to moderate water and wind erosion (Soil Conservation Service 1974).

Playa basins in the region of Middle Lake are normally ephemeral though exceptions occur. One such exception is Lane Salt Lake, a large dissolution basin located about 17 km (10 miles) northwest of Middle Lake. Lane Salt Lake is currently a perennial water body because it has received produced water from a brine disposal facility associated with oil extraction activities during a period of more than 25 years.

Middle Lake was chosen as a reference lake because it is relatively undisturbed, is not known to have received point-source discharges, is in a similar geologic setting and is close to Lane Salt Lake. Though cattle owned by the Four Lakes Ranch are grazed on the State lands surrounding Middle Lake, the cattle are apparently rotated often, as indicated by the thickly grassed pasture surrounding the playa.

Water Quality Standards

Water quality standards for Middle Lake are set forth in section 1-102 of the New Mexico water quality standards (NMWQCC 1991). Water quality standards specific to playa lakes have not been adopted. The principal objective of studying the diverse playa lakes of New Mexico is to develop numeric and

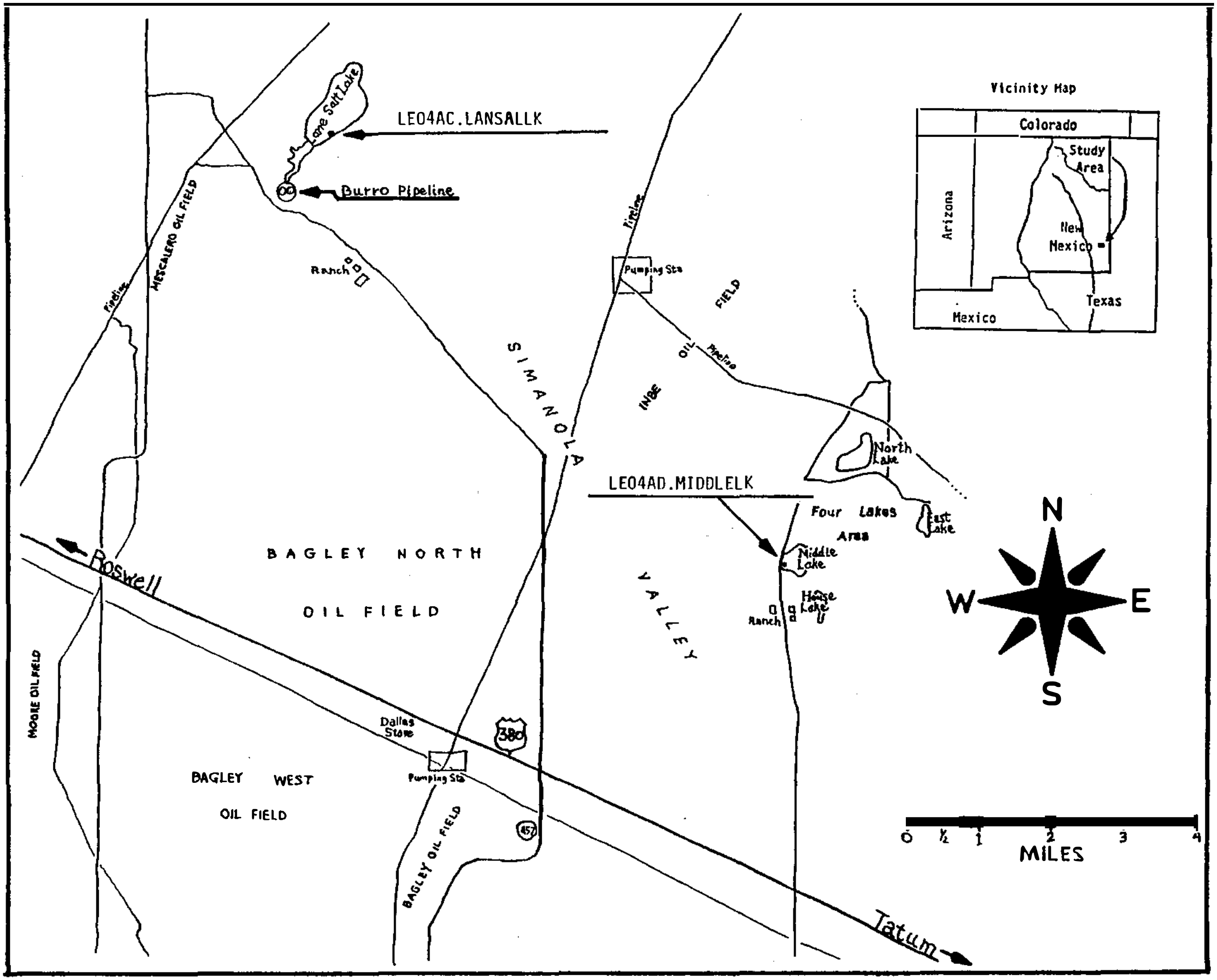


Fig. 15. Middle Lake study site, 1992.

narrative water quality standards that will support and protect the attainable uses of these waters of the State.

Methods

Water quality sampling methods were in accordance with the "New Mexico Clean Lakes Program: Lake Water Quality Assessment for FY 92-93" (NMED 1992) and the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 1992).

Water Quality Assessment

Water quality data for playa lake station LE04AD.MIDDLELK are available on STORET and can be retrieved using the selector A=21NMEX and restrictor IS=923510. Parametric coverage, water quality and biological data are provided in tables 19 through 24.

The investigators computed Likens' (1975) phytoplankton community composition index and Carlson's (1977) chlorophyll a, total phosphorus and Secchi disk depth indices (Table 20). These trophic state indices were evaluated for their applicability in comparisons between the hypersaline playa lakes under investigation. The investigators concluded that these indices have no applicability or usefulness in comparisons between hypersaline lakes. Further, since these trophic state indices were developed using data from temperate freshwater lakes, they were not expected to be useful in comparisons between hypersaline lakes.

Values for unionized ammonia are presented here as an expression of the relationship between total ammonia, pH and temperature. It is estimated that algorithms incorporating ionic strength and total alkalinity in addition to the above would yield results of approximately one-half the concentrations given here (Emerson et al, 1975. B. Zander, EPA Region 8, pers. comm.).

Review of the EPA's guidance literature for both fresh and saltwater ammonia criteria shows that while ammonia toxicity increases with both temperature and pH, a decrease in toxicity occurs with increasing salinity. The EPA did not publish criteria for un-ionized ammonia in saline environments beyond thirty parts per thousand, while salinity levels in the hypersaline playas studied in 1992 ranged from 140 to 390 parts per thousand. Further, the accuracy of the method used to calculate the un-ionized fraction of total ammonia is questionable when used in conditions of high ionic strength. In light of the above, it is worthy of note that the lake with the highest calculated un-ionized ammonia level (Middle Lake) among the hypersaline systems studied during 1992, also supported the second highest benthic standing crop (3897/m^2) and greatest number of taxa (4) of all these lakes.

Total dissolved solids of 188,950 mg/l, and sodium and chloride ion concentrations of 51,880 and 84,500 mg/l, respectively, place Middle Lake in a hypersaline classification. Sulfate concentration was also high with a value of 46,500 mg/l. We compared the ion concentrations of Middle Lake, the reference playa, with those of Lane Salt Lake, the playa basin which has received produced water discharge for 25 years. Figure 16 shows ion comparisons between those survey playas receiving or having received some type of discharge and playas treated as reference playas. Lane Salt Lake has a total dissolved solids concentration almost twice that of Middle Lake with sodium and chloride concentrations approaching three times that of the reference playa. Figures 16 through 19 give a graphical comparison of Middle Lake and Lane Salt Lake.

Total and dissolved metal analyses of water and sediments showed no levels of concern, though strontium and magnesium concentrations were noticeably high. Radiochemical analyses of water and sediment for radium 226, 228 and potassium 40 were less than the standards applicable to livestock and wildlife watering. Analyses for aromatic and halogenated purgeables were performed. Results of this scan yielded no detectable concentrations of the 62 synthetic organic compounds analyzed for.

Biological analyses of phytoplankton, diatoms and macroinvertebrates were performed on Middle Lake. Planktonic algae were scarce in the sample collected and resulted in only 12 diatom frustules of the order Pennales (Table 21). In contrast, benthic diatom sample composites were collected and analyzed (Table 22). Seven species totaling 209 individuals were observed in 15 microscope fields. One additional genus was observed during an informal scan of the herbarium slide. We found it difficult to compare Middle Lake's diatom community with that of Lane Salt Lake because the latter lacked suitable substrate in the main body of the playa.

A sediment sample, however, was collected in Lane Salt Lake using a Lexan piston corer insert fitted with an eggshell core catcher to hold the sediment in place. Though deeper sections of this core lacked diatom frustules, probably because of dissolution of the frustules (Rushforth pers. comm.), the uppermost section yielded 41 frustules representing nine species counted in 205 microscope fields. Analyses were also performed on periphyton scrapes from a channel which drains relatively fresh spring water directly below the brine disposal facility. We are uncertain what contribution this area has made to the diatom community of the core sample, but we do assume that diatom frustules are dispersed throughout the lake by wind. Thus we find that it is difficult to make comparisons between Middle Lake and Lane Salt Lake diatom communities.

Macroinvertebrate populations were dominated by <u>Artemia</u> <u>salina</u> (brine shrimp) throughout Middle Lake. <u>Ephydra</u> <u>salina</u> (brine fly) was also common with <u>Culicidae</u> prob. <u>Aedes</u> sp. (mosquitoes) found in lesser amounts. Two 15 ft^2 sections of the lake bed were sampled using a one-foot wide "D" net. Captured organisms were preserved in 70% ethanol and later sorted to the lowest practicable taxonomic level. Table 23 provides the macroinvertebrate results and interpretation of data.

We found important differences between Middle Lake and Lane Salt Lake. As shown previously, Lane Salt Lake has twice the dissolved solids concentration as Middle Lake. Radium concentrations are far lower than in Lane Salt Lake, which receives produced waters from oil and gas extraction activities. Phytoplankton, benthic algae, and macroinvertebrate species richness and standing crops were dramatically lower in the main body of Lane Salt Lake. Although ducks and shorebirds in both playa basins were observed (Tables 24c-24d), only Lane Salt Lake reportedly yielded dead birds (Tom Lane, USFWS pers. comm.). The discovery of dead birds on some of the playas of this area has led to concern by federal and state agencies as well as industry and the general public.

Table 19. Water quality data for Middle Lake, 1992.

LE04AD.MIDDLELK LE04ADMIDLLK MIDDLELAKE
33 22 27.0 103 29 59.0 4
MIDDLE LAKE SHORE STATION- W SIDE -S OF INLET
35025 NEW MEXICO LEA
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 12080001
0000 METERS DEPTH 1258 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00010 WATER TEMP CENT	00400 PH SU	00095 CNDUCTVY AT 25C MICROMHO	00300 DO MG/L	82205 SPECIFIC GRAVITY GM/L	00480 SALINITY PPTH	00031 INCDT LT REMNING PERCENT	82079 TURBIDTY LAB NTU	00608 NH3+NH4- N DISS MG/L	00612 UN-IONZD NH3-N MG/L
92/04/14	1430	WATER	0	23.5		239475J	3.3		156.0J	100.0			.40J
92/04/14	1430	VERT	0		8.45			1.13J			4.2	.950	

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00078 TRANSP SECCHI METERS	00079 COLOR FORL-ULE SCALE	00204 DEPTH-M 1% LIGHT REMAINS	00410 T ALK CACO3 MG/L	00440 HCO3 ION HCO3 MG/L	00530 RESIDUE TOT NFLT MG/L	70300 RESIDUE DISS-180 C MG/L	00600 TOTAL N N MG/L	00605 ORG N N MG/L	00053 SURFACE AREA ACRES
2/04/14	1430	VERT	0	.30L	3	.3L	271	252	323	188950	14.54C	11.420C	40

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00610 NH3+NH4- N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00631 NO2&NO3 N-DISS MG/L	00640 T INORG. NITROGEN MG/L N	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P	00671 PHOS-DIS ORTHO MG/L P	00900 TOT HARD CACO3 MG/L	00915 CALCIUM CA,DISS MG/L
92/04/14	1430	VERT	0	3.080	14.500	.04	.04K	3.12C	.110	2.630	1.190	26530J	599.0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00925 MGNSIUM MG,DISS MG/L	00930 SODIUM NA,DISS MG/L	00935 PTSSIUM K,DISS MG/L	00940 CHLORIDE TOTAL MG/L	00945 SULFATE SO4-TOT MG/L	71870 BROMIDE BR MG/L	32210 CHLRPHYL A UG/L	32211 CHLRPHYL A UG/L CORRECTD	32212 CHLRPHYL B UG/L	32214 CHLRPHYL C UG/L
92/04/14	1430	VERT	0	6080.0	51880.00	4600.00	84500	46500	35.50	HYPERSALINE INTERFERENCE PREVENTED ANALYSIS			

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81552 ACETONE TOT UG/L	78124 BENZENE HOH VOL UG/L	81555 BROMO BENZENE TOT UG/L	73085 CLBRMETH TOTAL WTR UG/L	32101 DICLBRMT TOTUG/L	32104 BROMOFRM WHL-WTR UG/L	81595 MTH ETH KETONE TOT UG/L	77342 N-BUTLBZ TOTAL UG/L	77350 SEC-BUTB TOTAL UG/L	77353 T-BUTLBZ TOTAL UG/L
92/04/14	1430	VERT	0	250.000K	50.00K	50.000K	50.0K	50.0K	50.0K	250.000K	50.000K	50.000K	50.000K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 19, cont.

LEO4AD.MIDDLELK LEO4ADMIDLLK MIDDLELAKE
33 22 27.0 103 29 59.0 4
MIDDLE LAKE SHORE STATION- W SIDE -S OF INLET
35025 NEW MEXICO LEA
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 12080001
0000 METERS DEPTH 1256 METERS ELEVATION
25G WEST

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	46491 MTBE WATER TOT UG/L	32102 CARBNTET TOTUG/L	34301 CHLOROBE NZENE TOTWUG/L	32106 CHLRFORM TOTUG/L	38680 CHLOROTO LUENEWTR TOT UG/L	77277 P-CLTOLU TOTAL UG/L	82625 DIBRCLRO PRPN TOT REC UG/L	32105 CLDIBRMT TOTUG/L	30203 ETHAN12 WTR,WHL REC UG/L	77596 DBRMETHA TOTAL UG/L
92/04/14	1430	VERT	0	250.00K	50.0K	50.000K	50.0K	50.000K	50.000K	50.0K	50.0K	50K	50.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	34536 12DICHLO ROBENZEN TOTWUG/L	34567 13DICHLO ROBENZEN DISSUG/L	34572 14DICHLO ROBENZEN DISSUG/L	34668 DICHLORO DIFLUORO TOTWUG/L	34496 11DICHLO ROETHANE TOTWUG/L	34531 12DICHLO ROETHANE TOTWUG/L	34501 11DICHLO ROETHYLE TOTWUG/L	77093 C-1,2DCE TOTAL UG/L	34546 12DICHLO ROETHENE TOTWUG/L	34541 12DICHLO ROPROPAN TOTWUG/L
92/04/14	1430	VERT	0	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77173 1,3DCLPR TOTAL UG/L	77170 2,2DCLPR TOTAL UG/L	77168 1,1DCLPR TOTAL UG/L	34704 C1,3-DCP TOT WAT UG/L	34699 T1,3-DCP TOT WAT UG/L	34371 ETHYLBEN ZENE TOTWUG/L	34391 HEXACHLO ROBUTADI TOTWUG/L	77223 IPROPBNZ TOTAL UG/L	30341 BNZ1MTHL RECOVER WTR UG/L	34423 METHYLEN ECHLORID TOTWUG/L
92/04/14	1430	VERT	0	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K	50.00K	50.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77418 1MNAPTHA TOTAL UG/L	77416 2MNAPTHA TOTAL UG/L	34696 NAPTHALE NE T OTWUG/L	77224 N-PRPBNZ TOTAL UG/L	77128 STYRENE TOTAL UG/L	77562 1112TCLE TOTAL UG/L	34516 1122TETR ACHLOROE TOTWUG/L	34475 TETRACHL OROETHYL TOTWUG/L
92/04/14	1430	VERT	0	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81607 TETRAHYD FURAN TOT UG/L	78131 TOLUENE WHL HOH VOLUG/L	77613 123TCLBZ TOTAL UG/L	34551 124TRICH LOROBENZ TOTWUG/L	34506 111TRICH LOROETHA TOTWUG/L	34511 112TRICH LOROETHA TOTWUG/L	39180 TRICHLOR ETHYLENE TOT UG/L	34488 TRICHLOR OFLUOROM TOTWUG/L	77443 1,2,3TCP TOTAL UG/L	77222 1,2,4TMB TOTAL UG/L
92/04/14	1430	VERT	0	250.000K	50.00K	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K	50.000K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 19, cont.

LE04AD.MIDDLELK LE04ADMIDLLK MIDDLELAKE
33 22 27.0 103 29 59.0 4
MIDDLE LAKE SHORE STATION- W SIDE -S OF INLET
35025 NEW MEXICO LEA
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 12080001
0000 METERS DEPTH 1256 METERS ELEVATION
25G WEST

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77226 1,3,5TMB TOTAL UG/L	39175 VINYLCHL ORIDE TOT UG/L	77135 O-XYLENE TOTAL UG/L	85795 XYLENE M&P WTR WHL UG/L
92/04/14	1430	VERT	0	50.000K	50.000K	50.000K	50.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	09501 RA-226 TOTAL PC/L	09502 RA-226 ERROR PC/L	11501 RA-228 TOTAL PC/L	11502 RA-228 ERROR PC/L	11503 RA-226 + RA-228 PC/L	11504 RA-226 + 228 ERR PC/L	75038 K-40 TOTAL PC/L	75037 K-40 ERROR PC/L	09507 RA-226 SEDIMENT PC/G	09508 RA-226 SED-ERR PC/G
92/04/14	1430	VERT	0	.4J	.3J	11.0J	7.0J	11.4J	7.0J	3490.00	250.00	1.2J	.2J

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	75977 RA 228 DRY WT SED PC/G	75948 RA228SUS 1 SIGMA SED PC/G	22300 K-40 SEDIMENT PCI/G	22301 K-40 SED-ERR PCI/G	01100 TIN SN,DISS UG/L	01085 VANADIUM V, DISS UG/L	01090 ZINC ZN,DISS UG/L	71900 MERCURY HG,TOTAL UG/L	01147 SELENIUM SE,TOTAL UG/L
92/04/14	1430	VERT	0	2.0J	.80J	6.400	1.600	100K	100K	100K	.5K	500K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01106 ALUMINUM AL,DISS UG/L	01000 ARSENIC AS,DISS UG/L	01010 BERYLIUM BE,DISS UG/L	01020 BORON B,DISS UG/L	01025 CADMIUM CD,DISS UG/L	82036 CALCIUM DISS CA UG/L	82037 MG DISS MG UG/L	01030 CHROMIUM CR,DISS UG/L	01035 COBALT CO,DISS UG/L	01040 COPPER CU,DISS UG/L
92/04/14	1430	VERT	0	100K	50K	100.00K	18000	10K	550000	6530000	50K	50K	100K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01046 IRON FE,DISS UG/L	01049 LEAD PB,DISS UG/L	01056 MANGNESE MN,DISS UG/L	71890 MERCURY HG,DISS UG/L	01060 MOLY MO,DISS UG/L	01065 NICKEL NI,DISS UG/L	01145 SELENIUM SE,DISS UG/L	01140 SILICON SI,DISS UG/L	01075 SILVER AG,DISS UG/L	01080 STRONTUM SR,DISS UG/L
92/04/14	1430	VERT	0	100K	130	50.0K	.5K	200	100K	2000K	100K	100.0K	31000

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 19, cont.

LEO4AD.MIDDLELK LEO4ADMIDLLK MIDDLELAKE
33 22 27.0 103 29 59.0 4
MIDDLE LAKE SHORE STATION- W SIDE -S OF INLET
35025 NEW MEXICO LEA
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 12080001
0000 METERS DEPTH 1256 METERS ELEVATION
25G WEST

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01108 AL MUD DRY WGT MG/KG-AL	01008 BA MUD DRY WGT MG/KG-BA	01013 BERYLIUM SEDMG/KG DRY WGT	01023 B MUD DRY WGT MG/KG-B	01028 CD MUD DRY WGT MG/KG-CD	00917 CA MUD DRY WGT MG/KG-CA	01029 CHROMIUM SEDMG/KG DRY WGT	01038 CO MUD DRY WGT MG/KG-CO	01043 COPPER SEDMG/KG DRY WGT	01170 FE MUD DRY WGT MG/KG-FE
92/04/14	1430	WATER	0	9630.00	80.00	6.70K	56.00	.07K	80700.00	13.00	3.40K	6.70K	6590.00

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00924 MG MUD DRY WGT MG/KG-MG	01053 MN MUD DRY WGT MG/KG-MN	01063 MO MUD DRY WGT MG/KG-MO	01068 NICKEL SEDMG/KG DRY WGT	01144 SI MUD DRY WGT MG/KG-SI	01078 SILVER SEDMG/KG DRY WGT	01083 SR MUD DRY WGT MG/KG-SR	01103 TIN MUD DRY WGT MG/KG-SN	01088 V MUD DRY WGT MG/KG-V	01093 ZINC SEDMG/KG DRY WGT
92/04/14	1430	WATER	0	16340.00	121.00	6.70K	6.70K	857.00	6.70K	830.00	6.70K	48.00	24.00

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	71921 MERCURY SEDMG/KG DRY WGT	01148 SELENIUM SEDMG/KG DRY WGT
92/04/14	1430	WATER	0	.4K	.34K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 20. Limiting nutrient and Carlson Trophic State indices computed by SAS.

LIMITING NUTRIENT FOR PLAYA LAKES, CALCULATED BY SAS
TN/TP > 17 INDICATES P-LIMITATION
TN/TP 10 - 17 INDICATES N AND/OR P LIMITATION
TN/TP < 10 INDICATES N-LIMITATION

OBS	STATION		DATE	TN	TP	RATIO	LIMITING
1	21NMEX	LE01AA.LAGATUNA	31MAR92	109.30	0.20	546.500	P
2	21NMEX	ED01AB.WLMSSINK	01APR92	4.33	0.18	24.056	P
3	21NMEX	LE03AC.LANSALLK	14APR92	17.85	0.38	46.974	P
4	21NMEX	LE04AD.MIDDLELK	14APR92	14.54	0.11	132.182	P
5	21NMEX	ED01AE.LAGUNUNO	04MAY92	40.65	0.25	162.600	P
6	21NMEX	ED02AF.LAG-WALD	04MAY92	1.67	0.89	1.876	N
7	21NMEX	ED03AG.LGQUATRO	05MAY92	23.39	0.96	24.365	P
8	21NMEX	ED04AH.LAG-TRES	05MAY92	19.14	0.06	319.000	P
9	21NMEX	MO01AIWMSALTLKE	09JUN92	3.53	0.13	27.154	P
10	21NMEX	HA01AJ.CHICOSAL	26AUG92	7.40	0.64	11.562	N &/OR P

CARLSON TROPHIC STATE INDICES COMPUTED BY SAS
TSI <42 OLIGOTROPHIC, 42-47 MESOTROPHIC, >47 EUTROPHIC

OBS	STATION		DATE	CARLCHL	TSICHL	CARLSDD	TSISDD	CARLTP	TSITP
1	21NMEX	LE01AA.LAGATUNA	920331	25.0470	OLIGOTRO	60.0000	EUTRO	80.593	EUTRO
2	21NMEX	ED01AB.WLMSSINK	920401	32.4332	OLIGOTRO	54.1491	EUTRO	79.073	EUTRO
3	21NMEX	LE03AC.LANSALLK	920414	41.9761	OLIGOTRO	77.3733	EUTRO	89.855	EUTRO
4	21NMEX	LE04AD.MIDDLELK	920414	.	--	77.3733	EUTRO	71.967	EUTRO
5	21NMEX	ED01AE.LAGUNUNO	920504	.	--	77.3733	EUTRO	83.813	EUTRO
6	21NMEX	ED02AF.LAG-WALD	920504	28.7344	OLIGOTRO	77.3733	EUTRO	102.136	EUTRO
7	21NMEX	ED03AG.LGQUATRO	920505	55.7913	EUTRO	60.0000	EUTRO	103.228	EUTRO
8	21NMEX	ED04AH.LAG-TRES	920505	45.6853	MESOTRO	83.2242	EUTRO	63.220	EUTRO
9	21NMEX	MO01AIWMSALTLKE	920609	32.2697	OLIGOTRO	66.2162	EUTRO	74.377	EUTRO
10	21NMEX	HA01AJ.CHICOSAL	920826	85.9582	EUTRO	93.2263	EUTRO	97.378	EUTRO

Fig. 16. Playa biota x 100 vs major ions.
Numbers of invertebrates relative to concentrations of selected major ions.

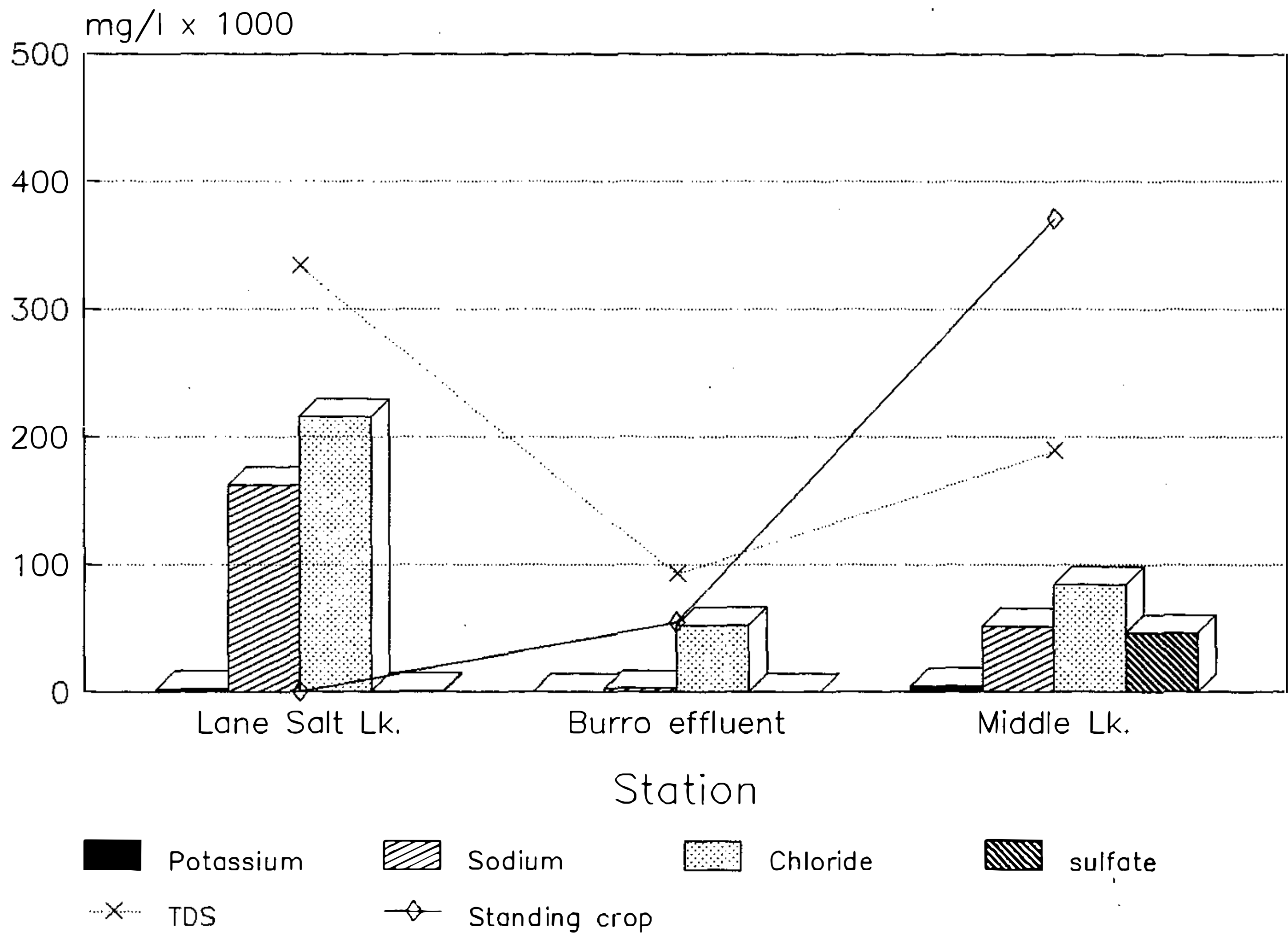


Fig. 17 Stiff diagrams: Four Lakes area meq/l

Chemical Constituents in Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl
Lane Salt Lk	13/5/1692	715.26	51.25	36.70	0.00	0.00	1.22	0.60	609.34
Burro Eflunt	14/ 5/1692	12.04	20.11	6.33	0.00	0.00	0.81	0.78	148.38
Middle Lk.	13/ 5/1692	237.44	2.99	50.01	0.00	0.00	96.81	0.41	238.37

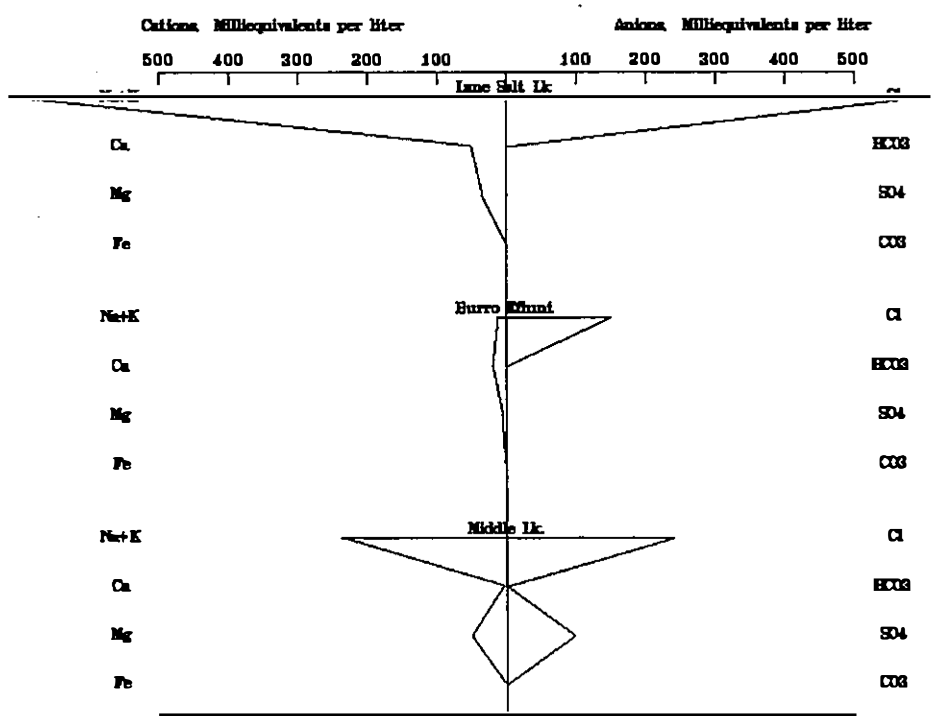


Fig. 18 Stiff diagrams: Four Lakes area % meq/l

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl	SAR	ESP	RSC
	Chemical Constituents in % Equivalents per Million											
Halden	3/ 5/1692	76.42	6.02	17.56	0.00	0.00	3.62	0.09	96.29	37.58	35.14	-74.01
Laguna Uno	3/ 5/1692	87.42	2.82	9.76	0.00	0.00	9.91	0.06	90.03	70.69	80.70	-71.02
Laguna Tres	4/ 5/1692	89.85	0.40	9.75	0.00	0.00	8.26	0.07	91.67	80.74	64.09	-68.65

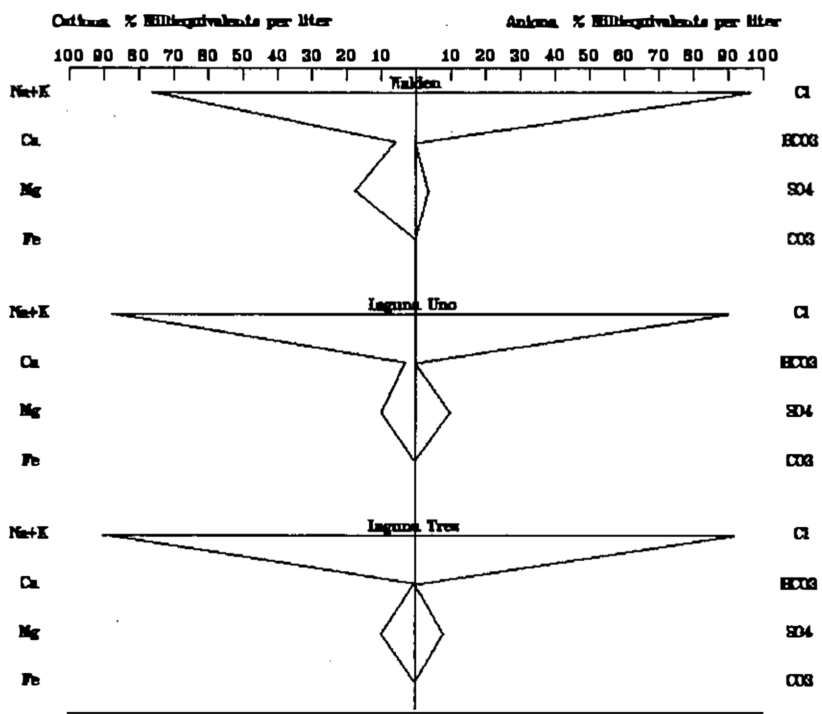
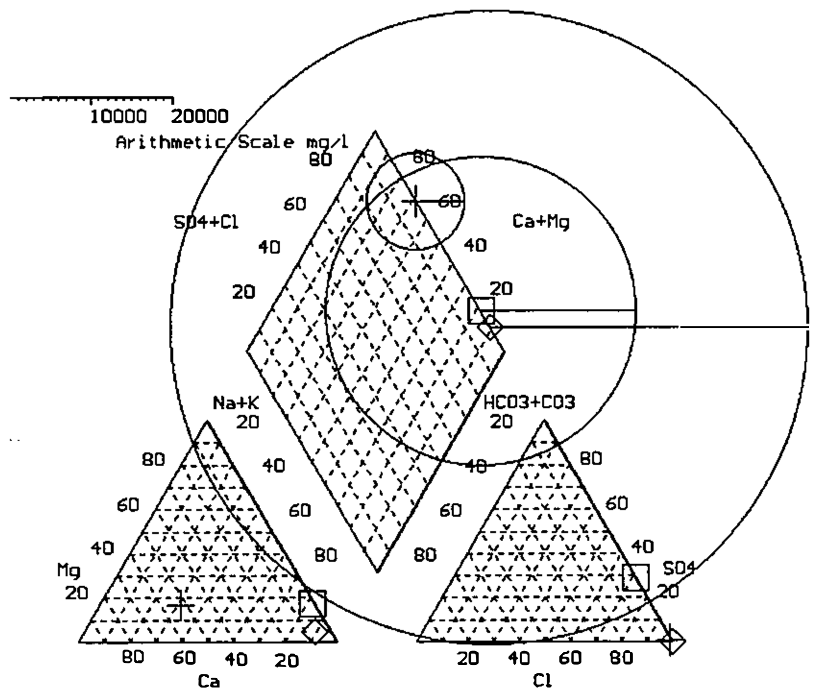


Fig. 19. Piper Trilinear diagram: Four Lakes area mg/l x 0.1



Diamond=«» Square=■ Circle=°

Lane Salt Lk 05/13/1692-«» Burro Eflunt 05/14/1692-+ Middle Lk. 05/13/1692-■

Table 21. Phytoplankton collected from Lane Salt Lake and Middle Lake, Lea County, New Mexico, April 14, 1992.

Lake	Station	Date	Taxon	Count (%)
Lane Salt Lake	LE03AC.LANSALLK	92/04/14	Dunaliella	3 (100)
		Total		3
		Taxa Richness		1
		Shannon - Wiener Diversity		0.00
		Evenness		0.00
Middle Lake	LE04AD.MIDDLELK	92/04/14	Pennales	12 (100)
		Total		12
		Taxa Richness		1
		Shannon - Wiener Diversity		0.00
		Evenness		0.00

Table 22.

QUALITATIVE DIATOM ANALYSIS OF MIDDLE LAKE, N.M.: 1992
Multiple substrate periphyton scrapes:

	NAME	# CELLS
1.	*Amphora acutiuscula* Kutz. var. *acutiuscula*	5
2.	*A. coffeiformis* (Ag.) Kutz. var. *coffeiformis*	8
3.	*Navicula graciloides* A. Mayer var. *graciloides*	5
4.	*N. latissima* Greg. var. *latissima*	6
5.	*N. tripunctata* (O.F. Mull.) Bory var. *tripunctata*	12
6.	*Nitzschia communis* Rabenhorst.	170
7.	*N. palea* var. *debilis* (Kutz.) Grun.	3
	Total =	209

SHANNON-WIENER INDEX OF DIVERSITY

Total number of fields viewed for formal count = 15
Total species per formal count = 7
Total species identified = 8

H = 1.15
Hmax = 2.81
Equitability = 0.41

Other diatoms observed, but not included in formal count:

A. *Rhopalodia musculus* (Kutz.) O. Mull. var. *musculus*

Table 23. 1992 PLAYA SURVEY MACROINVERTEBRATE ABUNDANCES.

	Williams Sink 920401 (ref.)	**Laguna Gatuna 920331**
	26° station	East Shore
Artemia salina	275	0
Hydropyrus sp.,* near *cinearea*	50	0
Dasyhelea sp.	21	0
Stratiomys sp.	1	0
	240° station	West shore
Artemia salina	69	4
Hydropyrus sp., near *cinearea*	268	11
Dasyhelea sp.	11	0

	Middle Lake 920414 (ref.)	**Lane Salt Lake 920414**
	N side of island	inlet channel
Artemia salina	3890	0
Hydropyrus sp., near *cinearea*	1	541
Culicidae, prob. *Aedes sp.*	5	0
Stratiomys sp.	1	0
Muscidae	0	6
	S. shore	½ mi. N. of S. end
Artemia salina	3507	0
Hydropyrus sp., near *cinearea*	15	0

	"Laguna Walden" 920504 (ref.)	**Laguna Uno 920504**
	S. end	W. end
Artemia salina	2201	0
Hydropyrus sp., near *cinearea*	3436	0
Nemotelus sp.	1	0

	Laguna Tres 920505	**Laguna Quatro 920505**
	near Murchison Nash #3	W. end
	none found	none found

Table 24a. Results of adult *Artemia salina* 48 hr acute toxicity tests (100% test and control water).

Test Site	% Survival	Control site	% Survival
Laguna Gatuna	0*	Williams Sink	97.8
Lane Salt Lake	0*	Middle Lake	100.0
Burro Pipeline effl.	0*	Middle Lake	100.0
Laguna Uno	0	Laguna Walden	96.0
Laguna Tres	0*	Laguna Walden	96.0
Laguna Quatro	0	Laguna Walden	96.0

* 100% mortality/immobility after 24 hrs.

Table 24b. Results of larval *Hydropyrus sp.* 48 hr acute toxicity tests (100% test and control sediment).

Test Site	% Survival	Control Site	% Survival
Laguna Gatuna	56[1]	Williams Sink	80
Lane Salt Lake[2]	No sediment toxicity tests were conducted		
Laguna Uno	36[1]	Laguna Walden	96
Laguna Tres	58[1]	Laguna Walden	96
Laguna Quatro	12[1]	Laguna Walden	96

[1] Survival = individual larvae that were not dead or immobile.

[2] Too few *Hydropyrus* larvae were collected from Middle Lake for comparative toxicity testing.

Table 24c. Migratory bird species from Middle Lake, Lea County, New Mexico, April 15, 1992.

Species	Number	Activity
American avocet	11	Feeding
Killdeer	2	Feeding
Total	13	

Table 24d. Migratory bird species from Lane Salt Lake, Lea County, New Mexico, April 13, 1992.

Species	Number	Activity
American shoveler/ teal species/divers	333	Loafing
American coot	4	Loafing
American avocet	11	Feeding*
Yellowlegs	6	Feeding*
Bufflehead	2	Feeding*
Least sandpiper	80	Feeding*
Blue-winged teal	19	Feeding*
Snowy plover	14	Feeding*
Killdeer	2	Feeding*
Total	471	

*Birds encountered in area below Burro Pipeline facility outfall.

WATER QUALITY SURVEY OF LAGUNA UNO IN EDDY COUNTY, NEW MEXICO, MAY 4, 1992

Introduction

During 1992 the Surveillance and Standards Section conducted a water quality assessment of Laguna Uno in Eddy County, New Mexico (Fig. 20). The field team visited the playa on May 4, 1992.

Laguna Uno is located in southeastern New Mexico, approximately 12 miles northeast of Loving, via State highways 31 and 128. It is one of many playa basins located in the "potash district" of Eddy and Lea Counties, New Mexico, which is the largest potash mining area in the U.S. (New Mexico Bureau of Mines and Mineral Resources 1977). The playa was determined to have a surface area of 245 hectares (606 ac) as calculated through digitized analysis of 7.5 minute quadrangle maps by personnel of the Bureau of Land Management, and is at an elevation of 914 meters (3,000 ft) above mean sea level. This basin is located in the arid Southern Deserts ecoregion where mean annual precipitation is 33.5 cm/yr (13.2 in/yr), and annual moisture deficit is 86.4 cm/yr (34 in/yr) (Gabin and Lesperance 1977).

Soils associated with Laguna Uno are of the Reeves-Gypsum land complex. Typical characteristics for the Reeves series are light-colored, well drained, calcareous soils over gypsiferous earths and rocks. This complex is generally suitable for native pasture and wildlife habitat. Soil erodibility is slight, though it is suggested that "good range management is needed to maintain a cover of desirable forage" (Soil Conservation Service 1971).

It is reasonable to assume that playa basins in this region are generally ephemeral, however, Laguna Uno and other playas in lower Nash Draw appear to be permanent due to the hydrologic effect of years of discharges from the International Minerals and Chemical Corporation. This facility began operation in 1936 and by 1948 potassium-rich ore was being extracted from five shafts and associated tunnels (ICF 1988). Process water used in the extraction and refinement of the potassium ore is pumped from wells in the Capitan Limestone of the Carlsbad underground water basin. The IMC operation uses an estimated 3,500 gal/min of water to process the ore. Though some of this water is lost through evaporation during processing, an estimated 5,000 acre-feet of brine is discharged annually to lower Nash Draw. Sodium and Chloride are the most abundant ions present in Laguna Quatro. The IMC facility discharges a conservatively estimated amount of 1.8×10^6 metric tons per year of NaCl to Nash Draw. This discharge certainly accounts for much of the thick salt incrustation on the bottom of most Nash Draw playas.

Assuming that a portion of this water is lost during processing through evaporation, and that only 3,000 gal/min of sodium chloride and clay enriched brine reach the outfall, the resulting contribution to Laguna Uno is considerable. A 3,000 gal/min discharge is equal to 13.3 ac-ft per day or 4,840 ac-ft per year. Using a surface area of 606 acres and multiplying by the average annual evaporation rate for brine lakes in the Nash Draw area of 4.4 ft/yr (Sandia National Labs 1985) provides an estimated evaporation of 2,670 ac-ft per year. The 2,170 ac-ft provides an estimated depth of 3.6 ft in the 606 ac playa lake. These estimates do not include normal precipitation, spring flow or ground water contributions, if any. These figures support the premise that Nash Draw playa lake volumes have increased

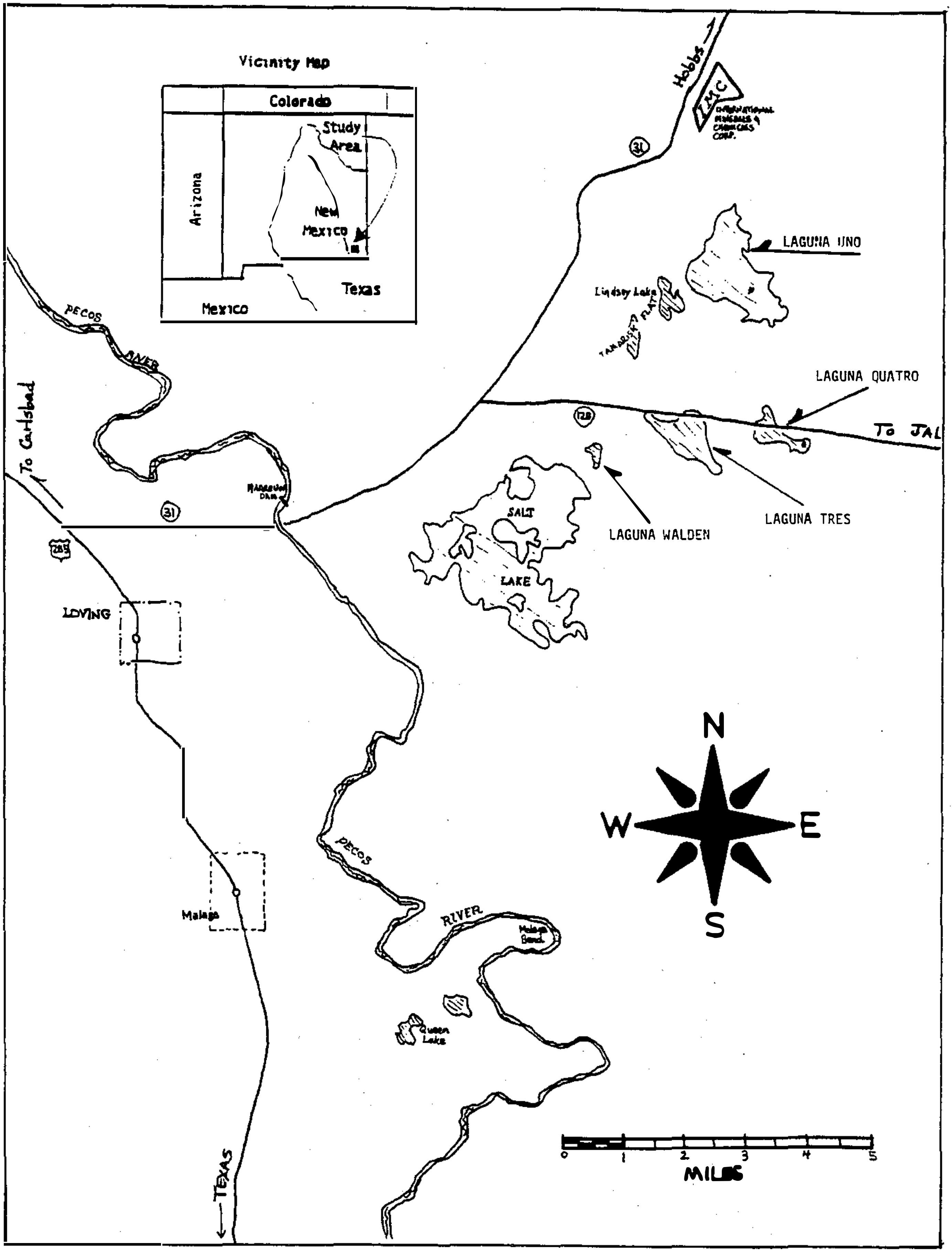


Fig. 20. Laguna Uno study area, 1992.

over the years (U.S.D.I. 1975), resulting in the need to elevate State highway 128 to protect the roadways from rising water levels.

Effluent concentrations for IMC, as analyzed by the U.S. Geological Survey yielded sodium and chloride concentrations of 100,000 mg/l and 190,000 mg/l, respectively from samples collected in April of 1975. If these concentrations are applied to IMC effluent discharge at 3,000 gal/min, the rate of sodium chloride loading is 1.73 x 10^6 metric tons per year. This is the solids portion of the slurried waste, which originates as an ore from hundreds of feet below ground.

It is generally accepted that surface and ground water flows connect the Nash Draw playas. As mentioned in the BLM report "Potash Leasing in Southeastern New Mexico" (1975),

> It is shown by Cooper (1962, Table 2), that Nash Well, Sec. 6, T. 23S., R.30E., was 30 feet deep and the water level was 6.5 feet below land surface. This well is now flooded by Laguna Quatro, hence the aquifer below this lake has risen at least 7 feet since August 19, 1958. If the reported depth is correct, the aquifer may have risen 30 feet since the time it was drilled, because presumably it did not pump brine when drilled.

One well in a similar circumstance also exists at the southeast end of the now enlarged Laguna Uno basin. The J-Bar-F well was slightly over 130 feet deep in the 1930s (T.M. McClure 1938), but now the well lies submerged beneath the main body of Laguna Uno.

Laguna Uno is the first in a series of playa basins which stretch from just beneath IMC and extend to the southwest edge of Nash Draw near Malaga Bend on the Pecos River. As mentioned earlier, surface channels connecting many of the playa basins have been constructed to equalize water levels during wet periods, and reduce high water threat to roadways. Further, the shallow aquifer connecting many of the Nash Draw playas provides another pathway for industrial discharges to move through the system. To test this premise an unnamed reference playa, unofficially called Laguna Walden, was chosen to compare with Laguna Uno and two other playa basins within Nash Draw, Laguna Tres, and Laguna Quatro. Laguna Walden is located southwest of Laguna Tres, and east of Laguna Grande de Sal (Salt Lake). Laguna Walden was chosen as a reference playa because of its apparent undisturbed condition.

Water Quality Standards

Water quality standards for Laguna Uno are set out in section 1-102 of the New Mexico water quality standards (NMWQCC 1991). Water quality standards specific to playa lakes have not been adopted. The principal objective of studying the diverse playa lakes of New Mexico is to develop numeric and narrative water quality standards that will support and protect the attainable uses of these waters of the State.

Methods

Water quality sampling methods were in accordance with the "New Mexico Clean Lakes Program: Lake Water Quality Assessment" work plan (NMED 1992) and the

"Quality Assurance Project Plan for Water Quality Management Programs" (NMED 1992).

Water Quality Assessment

Water quality data for playa lake station ED01AE.LAGUNUNO are available on STORET and can be retrieved using the selector A=21NMEX and restrictor IS=923511. Parametric coverage, water quality and biological data are provided in tables 25 through 29.

The investigators computed Likens' (1975) phytoplankton community composition index and Carlson's (1977) chlorophyll a, total phosphorus and Secchi disk depth indices (Table 26). These trophic state indices were evaluated for their applicability in comparisons between the hypersaline playa lakes under investigation. The investigators concluded that these indices have no applicability or usefulness in comparisons between hypersaline lakes. Further, since these trophic state indices were developed using data from temperate freshwater lakes, they were not expected to be useful in comparisons between hypersaline lakes.

Values for unionized ammonia are presented here as an expression of the relationship between total ammonia, pH and temperature. It is estimated that algorithms incorporating ionic strength and total alkalinity in addition to the above would yield results of approximately one-half the concentrations given here (Emerson et al. 1975; B. Zander, EPA Region 8, pers. comm.).

Review of the EPA's guidance literature for both fresh and saltwater ammonia criteria shows that while ammonia toxicity increases with both temperature and pH, a decrease in toxicity occurs with increasing salinity. The EPA did not publish criteria for un-ionized ammonia in saline environments beyond thirty parts per thousand, while salinity levels in the hypersaline playas studied in 1992 ranged from 140 to 390 parts per thousand. Further, the accuracy of the method used to calculate the un-ionized fraction of total ammonia is questionable when used in conditions of high ionic strength. In light of the above, it is worthy of note that the lake with the highest calculated un-ionized ammonia level (Middle Lake) among the hypersaline systems studied during 1992, also supported the second highest benthic standing crop ($3897/m^2$) and greatest number of taxa (4) of all these lakes.

Total dissolved solids of 349,800 mg/l with sodium and chloride ion concentrations of 96,900 and 191,000 mg/l, respectively, place Laguna Uno in a hypersaline category. Potassium and sulfate concentrations were 29,000 and 28,500 mg/l, respectively. The total dissolved solids for Laguna Uno were almost twice that of Laguna Walden, the reference playa, and potassium concentration was over six times higher in Laguna Uno than the reference playa. Turbidity was greater in Laguna Uno than the other playa lakes of Nash Draw. The orange colored foam and water observed in and around the lake strongly suggest that fine particulate residue contained in the IMC effluent is largely responsible. Figure 21 gives comparisons of ionic concentrations between those playa lakes receiving or having received some type of discharge and those playas considered reference playas. Figures 22 through 24 provide a graphical comparison of Laguna Uno and Laguna Walden.

Total and dissolved metals analyses of water and sediment showed no levels of concern except for boron (7,700 ug/l), which exceeded the numeric standard for livestock and wildlife watering. Radioactivity analyses of water and sediment for radium 226 + 228 and potassium 40 were less than livestock and wildlife watering standards. Analytical scans for aromatic and halogenated purgeables yielded no detectable concentrations of 62 substances. A sample of a thick grease or paraffin-like material found along the shore at the sampling station was submitted for base neutral extractable analysis. Though this waxy substance was not identified, the analyst suspected that it was a remnant of the material used to protect equipment surfaces within the IMC potash processing facility. Results indicated that long carbon chain hydrocarbons (20 to 28 carbon atoms) were present. Total petroleum hydrocarbons were detected at 21 mg/l. Traces of acenaphthene, di-n-butylphthalate, and pyrene were also detected from this sample, but were below the minimum quantification level.

Biological examinations of phytoplankton, sediment and epiphytic diatoms and macroinvertebrates were performed, but yielded no organisms from Laguna Uno. These results should be compared with those of Laguna Quatro, Laguna Tres, and the reference playa, Laguna Walden, all of which are included in this compendium (Table 27 and 28).

Acute toxicity tests were conducted using Artemia salina and Hydropyrus sp., where organisms collected from the reference playa were exposed to water and sediment collected from the test playa. No Artemia survived exposure to water collected from Laguna Uno, but 36 percent of Hydropyrus exposed to Laguna Uno lake sediments were alive after 48 hours (Tables 29a and 29b).

Migratory bird species observed on both Laguna Uno and Laguna Walden during the sampling surveys are located in Table 29c. Notice that only two teal were observed loafing on Laguna Uno, while at least three species of shorebirds were nesting and feeding at Laguna Walden. Literature and field reports from birders support the premise that greater use by migratory waterfowl was normal in the past for all of the playa basins within the Nash Draw (Steve West pers. comm.).

Table 25. Water quality data for Laguna Uno, 1992.

ED01AE.LAGUNUNO ED01AELAGUNO LAGUNAUNO
32 22 21.0 103 56 05.0 4
LAGUNA UNO SHORE STATION SW END NEAR POWER LINES
35015 NEW MEXICO EDDY
WESTERN GULF 120600
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920716 13060011
0000 METERS DEPTH 914 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00010 WATER TEMP CENT	00400 PH SU	00095 CNDUCTVY AT 25C MICROMHO	00300 DO MG/L	82205 SPECIFIC GRAVITY GM/L	00480 SALINITY PPTH	00031 INCDT LT REMNING PERCENT	82079 TURBIDTY LAB NTU	00608 NH3+NH4- N DISS MG/L	00612 UN-IONZD NH3-N MG/L
92/05/04	0900	WATER	0	19.6		510050J	.6		334.0J	100.0			
92/05/04	0900	VERT	0		7.35			2.24J			23.6	10.50J	0.1J

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00078 TRANSP SECCHI METERS	00079 COLOR FORL-ULE SCALE	00204 DEPTH-M 1% LIGHT REMAINS	00410 T ALK CACO3 MG/L	00440 HCO3 ION HCO3 MG/L	00530 RESIDUE TOT NFLT MG/L	70300 RESIDUE DISS-180 C MG/L	00600 TOTAL N N MG/L	00605 ORG N N MG/L	00053 SURFACE AREA ACRES
92/05/04	0900	VERT	0	.30L	4	.3L	155	189	351	349600	40.65J	.000	600

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00610 NH3+NH4- N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00631 NO2&NO3 N-DISS MG/L	00640 T INORG. NITROGEN MG/L N	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P	00671 PHOS-DIS ORTHO MG/L P	00900 TOT HARD CACO3 MG/L	00915 CALCIUM CA,DISS MG/L
92/05/04	0900	VERT	0	14.600J	9.600	26.05	24.0	40.65J	.250	.220	.010K	35696J	3200.0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00925 MGNSIUM MG,DISS MG/L	00930 SODIUM NA,DISS MG/L	00935 PTSSIUM K,DISS MG/L	00940 CHLORIDE TOTAL MG/L	00945 SULFATE SO4-TOT MG/L
92/05/04	0900	VERT	0	6730.0	96900.00	29000.00	191000	26500

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	79537 ACENAPH THENE WASMG/KG	79536 ACENAPH THYLENE WASMG/KG	79546 ANTHRA CENE WASMG/KG	79509 1,2-BENZ ANTHRACN WASMG/KG	03645 BNZBFLRN ELUTRIAT UG/L	03646 BNZKFLRN ELUTRIAT UG/L	03647 BNZGHIPL ELUTRIAT UG/L	79532 3,4BENZO PYRENE WASMG/KG	30160 BNZLALCH SOIL,REC MG/KG	79559 BIS(2CLR ETXY)MTH WASMG/KG
92/05/04	0900	VERT	0	2.00K	2.00K	2.00K	2.00K	4000.000K	4000.000K	4000.000K	4.00K	2K	2.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	79560 BIS(2CLR ETH)ETH WASMG/KG	79561 BIS(2CLR IPRP)ETH WASMG/KG	79562 BIS(2ETH HEX)PHTH WASMG/KG	79534 4BRPHNYL PHNYLETH WASMG/KG	79565 BUTBNZYL PHTHLATE WASMG/KG	78547 CLBNZENA MINE UG/KG	79527 2-CHLORO NAPTHALN WASMG/KG	79535 4CLPHNYL PHNYLETH WASMG/KG	79592 CHRYSENE WASMG/KG	79508 1256DIBZ ANTHRACN WASMG/KG
92/05/04	0900	VERT	0	2.00K	2.00K	2.00K	2.00K	2.00K	4000.00K	2.00K	2.00K	2.00K	2.00K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 25. cont.

EDO1AE.LAGUNUNO EDO1AELAGUNO LAGUNAUNO
32 22 21.0 103 56 05.0 4
LAGUNA UNO SHORE STATION SW END NEAR POWER LINES
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 13060011
0000 METERS DEPTH 914 METERS ELEVATION
24G SOUT

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	30168 DIBNZOFR SOIL,REC MG/KG	79599 DINBUTYL PHTHLATE WASMG/KG	79511 12DICLBZ WASMG/KG	79516 13DICLBZ WASMG/KG	79517 14DICLBZ WASMG/KG	79530 3,3DICLR BNZIDINE WASMG/KG	79608 DIETHYL PHTHLATE WASMG/KG	79611 DIMETHYL PHTHLATE WASMG/KG	79524 24DINIT TOLUENE WASMG/KG	79525 26DINIT TOLUENE WASMG/KG
92/05/04	0900	VERT	0	2K	2.00K	2.00K	2.00K	2.00K	2.00K	2.00K	2.00K	2.00K	2.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	79600 DINOCTYL PHTHLATE WASMG/KG	79625 FLUORAN THENE WASMG/KG	79626 FLUORENE WASMG/KG	79633 HEXACLOR BENZENE WASMG/KG	79634 HEXACLOR BUTADIEN WASMG/KG	79635 HXCLCYCL PENTDIEN WASMG/KG	79636 HEXACLOR ETHANE WASMG/KG	79644 IND(123-CD)PYRNE WASMG/KG	79646 ISPHRONE WASMG/KG	79666 METHPHEN ANTHRENE WASMG/KG
92/05/04	0900	VERT	0	4.00K	2.00K	2.00K	2.00K	10.00K	10.00K	2.00K	2.00K	2.00K	2.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	79670 NAPHTHA-LENE WASMG/KG	30186 ANILIN2N SOIL,REC MG/KG	30187 ANILIN3N SOIL,REC MG/KG	30189 ANILIN4N SOIL,REC MG/KG	79672 NITRO BENZENE WASMG/KG	79669 N-NITRSO DIPHYLAM WASMG/KG	79668 N-NITRSO DI-NPRAM WASMG/KG	79692 PHENAN THRENE WASMG/KG	79702 PYRENE WASMG/KG	79507 124TRICL BNZ WASMG/KG
92/05/04	0900	VERT	0	2.00K	2K	20K	10K	2.00K	2.00K	2.00K	2.00K	2.00K	2.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81552 ACETONE TOT UG/L	78124 BENZENE HOH VOL UG/L	81555 BROMO BENZENE TOT UG/L	73085 CLBRMETH TOTAL WTR UG/L	32101 DICLBRMT TOTUG/L	32104 BROMOFRM WHL-WTR UG/L	81595 MTH ETH KETONE TOT UG/L	77342 N-BUTLBZ TOTAL UG/L	77350 SEC-BUTB TOTAL UG/L	77353 T-BUTLBZ TOTAL UG/L
92/05/04	0900	VERT	0	125.000K	25.00K	25.000K	25.0K	25.0K	25.0K	125.000K	25.000K	25.000K	25.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	46491 MTBE WATER TOT UG/L	32102 CARBNTET TOTUG/L	34301 CHLOROBE NZENE TOTWUG/L	32106 CHLRFORM TOTUG/L	38680 CHLOROTO LUENEWTR TOT UG/L	77277 P-CLTOLU TOTAL UG/L	82625 DIBRCLRO PRPN TOT REC UG/L	32105 CLDIBRMT TOTUG/L	30203 ETHAN12 WTR,WHL REC UG/L	77596 DBRMETHA TOTAL UG/L
92/05/04	0900	VERT	0	125.00K	25.0K	25.000K	25.0K	25.000K	25.000K	25.0K	25.0K	25K	25.000K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 25. cont.

ED01AE.LAGUNUNO ED01AELAGUNO LAGUNAUNO
32 22 21.0 103 56 05.0 4
LAGUNA UNO SHORE STATION SW END NEAR POWER LINES
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 13060011
0000 METERS DEPTH 914 METERS ELEVATION
24G SOUT

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	34536 12DICHLO ROBENZEN TOTWUG/L	34567 13DICHLO ROBENZEN DISSUG/L	34572 14DICHLO ROBENZEN DISSUG/L	34668 DICHLORO DIFLUORO TOTWUG/L	34496 11DICHLO ROETHANE TOTWUG/L	34531 12DICHLO ROETHANE TOTWUG/L	34501 11DICHLO ROETHYLE TOTWUG/L	77093 C-1,2DCE TOTAL UG/L	34546 12DICHLO ROETHENE TOTWUG/L	34541 12DICHLO ROPROPAN TOTWUG/L
92/05/04	0900	VERT	0	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77173 1,3DCLPR TOTAL UG/L	77170 2,2DCLPR TOTAL UG/L	77168 1,1DCLPR TOTAL UG/L	34704 C1,3-DCP TOT WAT UG/L	34699 T1,3-DCP TOT WAT UG/L	34371 ETHYLBEN ZENE TOTWUG/L	34391 HEXACHLO ROBUTADI TOTWUG/L	77223 IPROPBNZ TOTAL UG/L	30341 8NZ1MTHL RECOVER WTR UG/L	34423 METHYLEN ECHLORID TOTWUG/L
92/05/04	0900	VERT	0	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.00K	25.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77418 1MNAPTHA TOTAL UG/L	77416 2MNAPTHA TOTAL UG/L	34696 NAPTHALE NE T OTWUG/L	77224 N-PRP8NZ TOTAL UG/L	77128 STYRENE TOTAL UG/L	77562 1112TCLE TOTAL UG/L	34516 1122TETR ACHLOROE TOTWUG/L	34475 TETRACHL OROETHYL TOTWUG/L
92/05/04	0900	VERT	0	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81607 TETRAHYD FURAN TOT UG/L	78131 TOLUENE WHL HOH VOLUG/L	77613 123TCL8Z TOTAL UG/L	34551 124TRICH LOROBENZ TOTWUG/L	34506 111TRICH LOROETHA TOTWUG/L	34511 112TRICH LOROETHA TOTWUG/L	39180 TRICHLOR ETHYLENE TOT UG/L	34488 TRICHLOR OFLUOROM TOTWUG/L	77443 1,2,3TCP TOTAL UG/L	77222 1,2,4TMB TOTAL UG/L
92/05/04	0900	VERT	0	125.000K	25.00K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77226 1,3,5TMB TOTAL UG/L	39175 VINYLCHL ORIDE TOT UG/L	77135 O-XYLENE TOTAL UG/L	85795 XYLENE M&P WTR WHL UG/L
92/05/04	0900	VERT	0	25.000K	25.000K	25.000K	25.00K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 25. cont.

EDO1AE.LAGUNUNO EDO1AELAGUNO LAGUNAUNO
32 22 21.0 103 56 05.0 4
LAGUNA UNO SHORE STATION SW END NEAR POWER LINES
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 13060011
0000 METERS DEPTH 914 METERS ELEVATION
24G SOUT

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	09501 RA-226 TOTAL PC/L	09502 RA-226 ERROR PC/L	11501 RA-228 TOTAL PC/L	11502 RA-228 ERROR PC/L	11503 RA-226 + RA-228 PC/L	11504 RA-226 + 228 ERR PC/L	75038 K-40 TOTAL PC/L	75037 K-40 ERROR PC/L
92/05/04	0900	VERT	0	2.5	.3	10.0K	8.0	12.5K	8.0C	26.20	.40

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01106 ALUMINUM AL,DISS UG/L	01000 ARSENIC AS,DISS UG/L	01010 BERYLIUM BE,DISS UG/L	01020 BORON B,DISS UG/L	01025 CADMIUM CD,DISS UG/L	82036 CALCIUM DISS CA UG/L	82037 MG DISS MG UG/L	01030 CHROMIUM CR,DISS UG/L	01035 COBALT CO,DISS UG/L	01040 COPPER CU,DISS UG/L
92/05/04	0900	VERT	0	100K	50K	100.K	7700	25K	330000	6980000	40K	50K	100K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01046 IRON FE,DISS UG/L	01049 LEAD PB,DISS UG/L	01058 MANGNESE MN,DISS UG/L	71890 MERCURY HG,DISS UG/L	01060 MOLY MO,DISS UG/L	01065 NICKEL NI,DISS UG/L	01145 SELENIUM SE,DISS UG/L	01140 SILICON SI,DISS UG/L	01075 SILVER AG,DISS UG/L	01080 STRONTUM SR,DISS UG/L
92/05/04	0900	VERT	0	100K	2500K	70.0	.5K	100K	100K	500K	1600	100.0K	2800

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01100 TIN SN,DISS UG/L	01085 VANADIUM V,DISS UG/L	01090 ZINC ZN,DISS UG/L	71900 MERCURY HG,TOTAL UG/L	01147 SELENIUM SE,TOT UG/L
92/05/04	0900	VERT	0	100K	100K	100K	.5K	2000K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 26. Limiting nutrient and Carlson Trophic State indices computed by SAS.

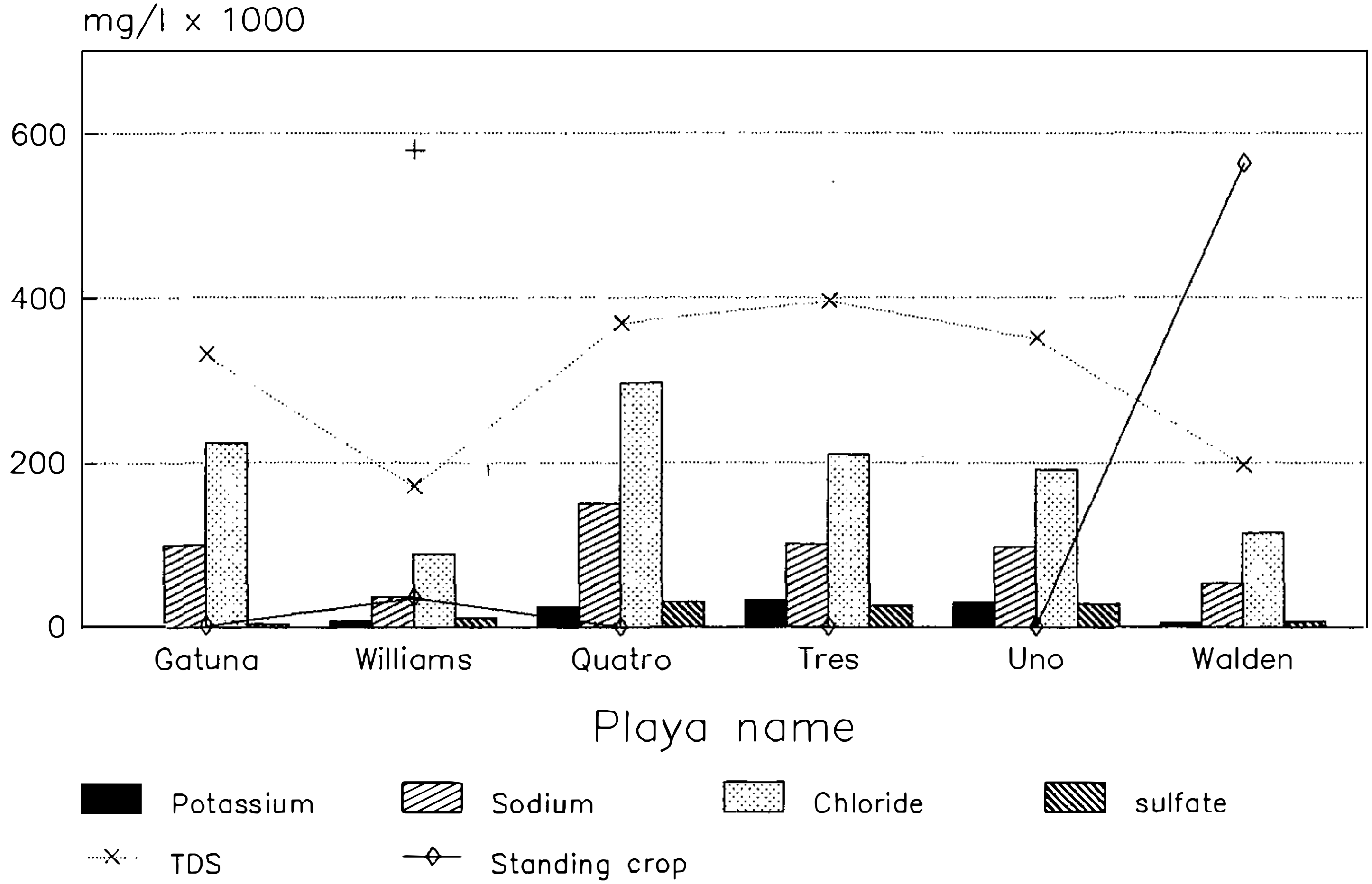
LIMITING NUTRIENT FOR PLAYA LAKES, CALCULATED BY SAS
TN/TP > 17 INDICATES P-LIMITATION
TN/TP 10 - 17 INDICATES N AND/OR P LIMITATION
TN/TP < 10 INDICATES N-LIMITATION

OBS	STATION		DATE	TN	TP	RATIO	LIMITING
1	21NMEX	LE01AA.LAGATUNA	31MAR92	109.30	0.20	546.500	P
2	21NMEX	ED01AB.WLMSSINK	01APR92	4.33	0.18	24.056	P
3	21NMEX	LE03AC.LANSALLK	14APR92	17.85	0.38	46.974	P
4	21NMEX	LE04AD.MIDDLELK	14APR92	14.54	0.11	132.182	P
5	21NMEX	ED01AE.LAGUNUNO	04MAY92	40.65	0.25	162.600	P
6	21NMEX	ED02AF.LAG-WALD	04MAY92	1.67	0.89	1.876	N
7	21NMEX	ED03AG.LGQUATRO	05MAY92	23.39	0.96	24.365	P
8	21NMEX	ED04AH.LAG-TRES	05MAY92	19.14	0.06	319.000	P
9	21NMEX	MO01AIWMSALTLKE	09JUN92	3.53	0.13	27.154	P
10	21NMEX	HA01AJ.CHICOSAL	26AUG92	7.40	0.64	11.562	N &/OR P

CARLSON TROPHIC STATE INDICES COMPUTED BY SAS
TSI <42 OLIGOTROPHIC, 42-47 MESOTROPHIC, >47 EUTROPHIC

OBS	STATION		DATE	CARLCHL	TSICHL	CARLSDD	TSISDD	CARLTP	TSITP
1	21NMEX	LE01AA.LAGATUNA	920331	25.0470	OLIGOTRO	60.0000	EUTRO	80.593	EUTRO
2	21NMEX	ED01AB.WLMSSINK	920401	32.4332	OLIGOTRO	54.1491	EUTRO	79.073	EUTRO
3	21NMEX	LE03AC.LANSALLK	920414	41.9761	OLIGOTRO	77.3733	EUTRO	89.655	EUTRO
4	21NMEX	LE04AD.MIDDLELK	920414	.	--	77.3733	EUTRO	71.967	EUTRO
5	21NMEX	ED01AE.LAGUNUNO	920504	.	--	77.3733	EUTRO	83.813	EUTRO
6	21NMEX	ED02AF.LAG-WALD	920504	28.7344	OLIGOTRO	77.3733	EUTRO	102.136	EUTRO
7	21NMEX	ED03AG.LGQUATRO	920505	55.7913	EUTRO	60.0000	EUTRO	103.228	EUTRO
8	21NMEX	ED04AH.LAG-TRES	920505	45.8853	MESOTRO	83.2242	EUTRO	63.220	EUTRO
9	21NMEX	MO01AIWMSALTLKE	920609	32.2697	OLIGOTRO	66.2162	EUTRO	74.377	EUTRO
10	21NMEX	HA01AJ.CHICOSAL	920826	85.9582	EUTRO	93.2263	EUTRO	97.378	EUTRO

Fig. 21. Playa biota x 100 vs major ions.
Numbers of invertebrates relative to concentrations of selected major ions.



+ = number of invertebrates per square meter x 100 taken at Williams Sink, February 26, 1992.

Fig. 22 Stiff diagrams: Nash Draw playas meq/l

Chemical Constituents in Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl
Walden	3/ 5/1692	240.88	18.96	55.36	0.00	0.00	12.08	0.31	321.59
Laguna Uno	3/ 5/1692	495.67	15.97	55.36	0.00	0.00	69.34	0.31	538.81
Laguna Tres	4/ 5/1692	523.30	2.35	66.76	0.00	0.00	63.09	0.45	689.69
Lag. Quatro	4/ 5/1692	716.04	2.35	66.76	0.00	0.00	63.50	0.37	837.84

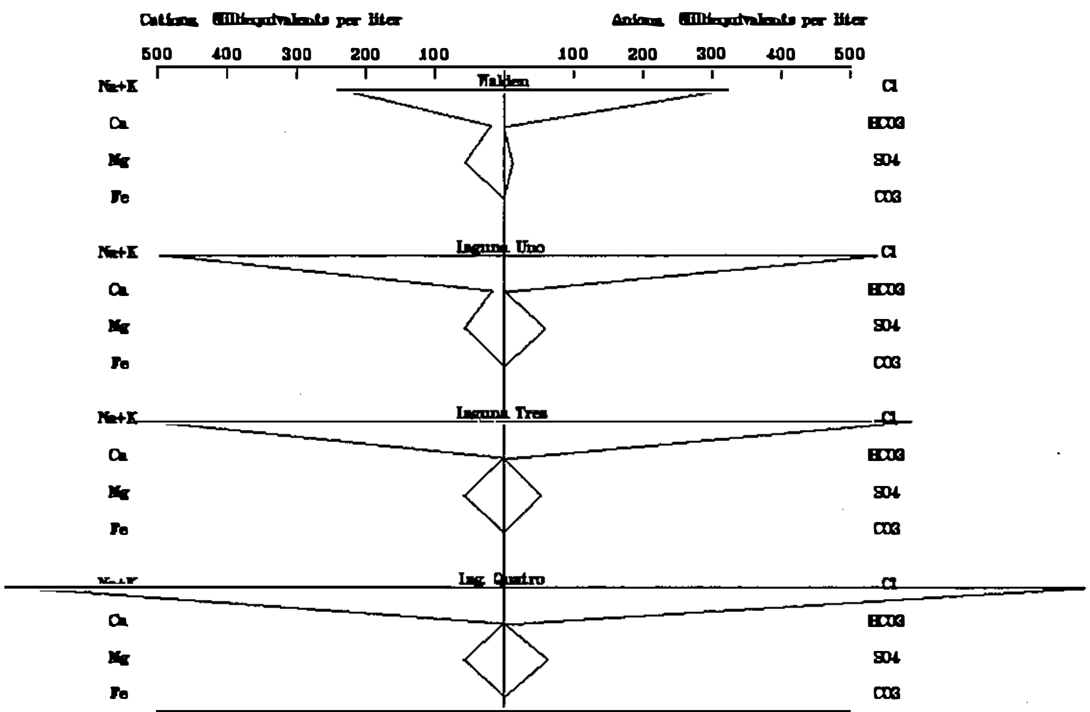


Fig. 23 Stiff diagrams: Nash Draw playas % meq/l

Chemical Constituents in % Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl	SAR	ESP	RSC
Walden	3/ 5/1692	76.42	6.02	17.56	0.00	0.00	3.62	0.09	96.29	37.58	36.14	-74.01
Laguna Uno	3/ 5/1692	87.42	2.82	9.76	0.00	0.00	9.91	0.06	90.03	70.68	50.70	-71.02
Laguna Tres	4/ 5/1692	89.85	0.40	9.75	0.00	0.00	8.26	0.07	91.67	80.74	54.09	-58.65
Lag. Quatro	4/ 5/1692	92.38	0.30	7.32	0.00	0.00	7.04	0.04	92.92	120.43	63.82	-58.73

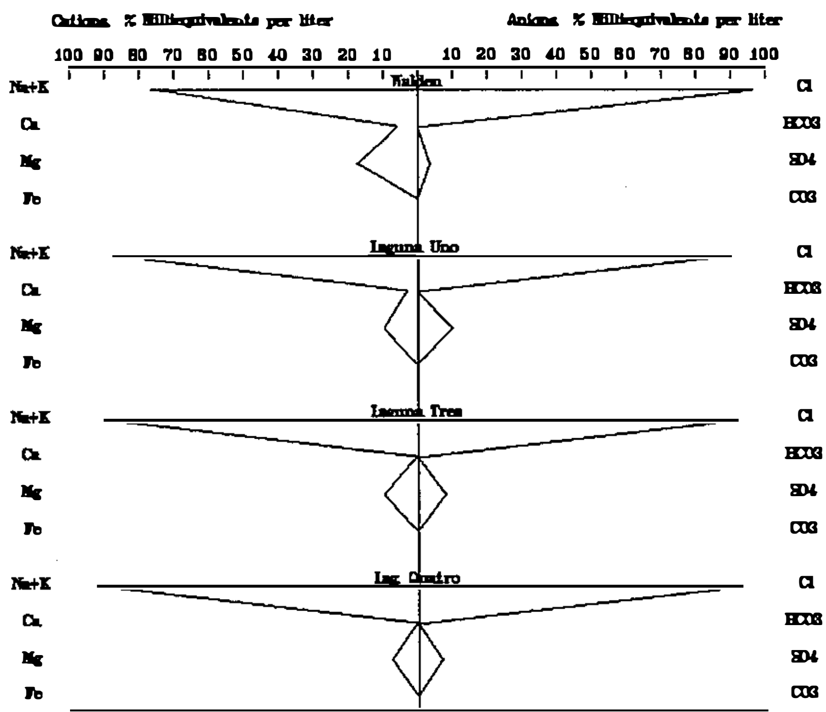
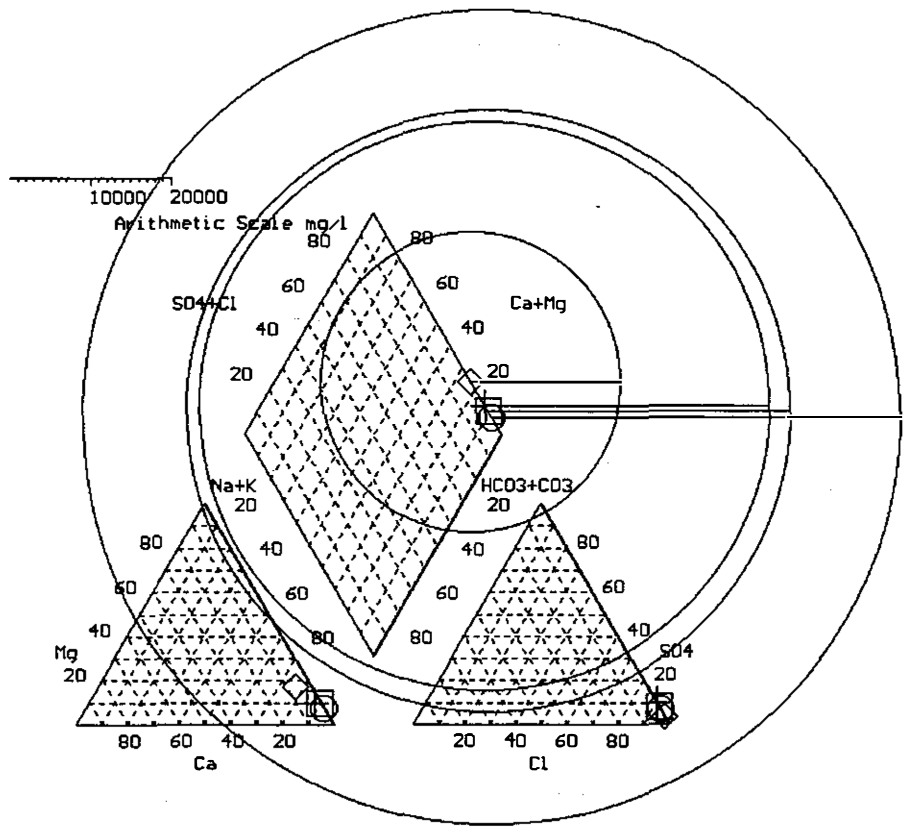


Fig. 24. Tri-linear diagram: Nash Draw Playas mg/l x 0.1



Diamond=«» Square=■ Circle=°

Walden 04/04/1992-«» Laguna Uno 04/04/1992-+ Laguna Tres 05/04/1992-■ Lag. Quatro 05/04/1992-°

Table 27. Phytoplankton collected from Nash Draw playas, Eddy County, New Mexico, April 4-5, 1992.

Lake	Station	Date	Taxon	Count (%)
Laguna Walden	ED02AF.LAG-WALD	92/05/04	*Fragilaria*	395 (56.2)
			Synedra	169 (24.0)
			Achnanthes	29 (4.1)
			Cymbella	57 (8.1)
			Nitzschia	29 (4.1)
			Dunaliella	18 (2.5)
			Crucigenia	3 (0.4)
			Gleocystis	3 (0.4)
			Total	703
			Taxa Richness	8
			Shannon - Wiener Diversity	1.84
			Evenness	0.61
Laguna Uno	ED01AE.LAGUNUNO	92/05/04	none found	0 (100)
Laguna Tres	ED04AH.LAG-TRES	92/05/05	none found	0 (100)
Laguna Quatro	ED03AG.LGQUATRO	92/05/05	*Dunaliella*	1848 (100)
			Total	1848
			Taxa Richness	1
			Shannon - Wiener Diversity	0.00
			Evenness	0.00

Table 28. 1992 PLAYA SURVEY MACROINVERTEBRATE ABUNDANCES

	Williams Sink 920401 (ref.)	Laguna Gatuna 920331
	26° station	East Shore
Artemia salina	275	0
Hydropyrus sp.,* near *cinearea*	50	0
Dasyhelea sp.	21	0
Stratiomys sp.	1	0
	240° station	West shore
Artemia salina	69	4
Hydropyrus sp., near *cinearea*	268	11
Dasyhelea sp.	11	0

	Middle Lake 920414 (ref.)	Lane Salt Lake 920414
	N side of island	inlet channel
Artemia salina	3890	0
Hydropyrus sp., near *cinearea*	1	541
Culicidae, prob. *Aedes sp.*	5	0
Stratiomys sp.	1	0
Muscidae	0	6
	S. shore	½ mi. N. of S. end
Artemia salina	3507	0
Hydropyrus sp., near *cinearea*	15	0

	"Laguna Walden" 920504 (ref.)	Laguna Uno 920504
	S. end	W. end
Artemia salina	2201	0
Hydropyrus sp., near *cinearea*	3436	0
Nemotelus sp.	1	0

Laguna Tres 920505	Laguna Quatro 920505
near Murchison Nash #3	W. end
none found	none found

Table 29a. Results of adult _Artemia salina_ 48 hr acute toxicity tests (100% test and control water).

Test Site	% Survival	Control site	% Survival
Laguna Gatuna	0[‡]	Williams Sink	97.8
Lane Salt Lake	0[‡]	Middle Lake	100.0
Burro Pipeline effl.	0[‡]	Middle Lake	100.0
Laguna Uno	0	Laguna Walden	96.0
Laguna Tres	0[‡]	Laguna Walden	96.0
Laguna Quatro	0	Laguna Walden	96.0

‡ 100% mortality/immobility after 24 hrs.

Table 29b. Results of larval _Hydropyrus sp._ 48 hr acute toxicity tests (100% test and control sediment).

Test Site	% Survival	Control Site	% Survival
Laguna Gatuna	56[1]	Williams Sink	80
Lane Salt Lake[2]	No sediment toxicity tests were conducted		
Laguna Uno	36[1]	Laguna Walden	96
Laguna Tres	58[1]	Laguna Walden	96
Laguna Quatro	12[1]	Laguna Walden	96

1 Survival = individual larvae that were not dead or immobile.

2 Too few _Hydropyrus_ larvae were collected from Middle Lake for comparative toxicity testing.

Table 29c. Migratory bird species of Laguna Uno, Eddy County, New Mexico, May 4, 1992.

Species	Number	Activity
Blue-winged/cinnamon teal	2	Loafing
Swallow species	1	Fly over
Duck species	1	Fly over
Peregrine falcon	1	Chasing duck
Total	5	

Table 29d. Migratory bird species of Laguna Walden, Eddy County, New Mexico, May 4, 1992.

Species	Number	Activity
Black-necked stilt	14	Feeding/nesting
Wilson's phalarope	9	Feeding
Greater yellowlegs	1	Feeding
Killdeer	5	Vocalizing
Snowy egret	11	Fly over/nesting?
Total	40	

Table 29e. Migratory bird species of Laguna Tres, Eddy County, New Mexico, May 5, 1992.

Species	Number	Activity
Wilson's phalarope	10	Feeding/Loafing*
Snowy plover	10	Feeding*
Yellowlegs	2	Feeding*
Snowy plover	1	Along shore
Total	23	

Important note: There were no birds observed on Laguna Quatro during the survey.

* Birds encountered in a cut-off portion of Laguna Tres

WATER QUALITY SURVEY OF LAGUNA WALDEN IN EDDY COUNTY, NEW MEXICO, MAY 4, 1992

Introduction

In 1992 the Surveillance and Standards Section conducted a water quality survey at an unnamed depression or swale at T23S R29E S3 W/2 SE/4. in Eddy County, New Mexico. This basin was informally named "Laguna Walden" for convenience. The field team completed its survey on May 4, 1992. Laguna Walden was chosen as a study site because of its proximity to Lagunas Uno, Quatro and Tres and the fact that it has no known surface connection to any industrial discharge (Fig. 25).

Laguna Walden is a 40-60 ac depression that lies on a terrace 5 m above Laguna Grande de la Sal near the south end of Nash Draw. This depression is at an altitude of 904 m (2,960 ft) above mean sea level and lies within the Southern Desert ecoregion. The area has a mean annual rainfall of 33.5 cm (13.2 in) and suffers an annual water deficit of 86.4 cm (34 in). The basin appears to be primarily eolian in origin. Water depth at the time of sampling was measured at 0.3 m (1 ft).

Laguna Walden was sampled at its southern-most end. The basin was well vegetated with a vigorous growth of mid grasses (1 to 3 feet tall) on hummocky soil. Mesquite, _Prosopis glandulosa_, and tamarisk, _Tamarix pentandra_, were abundant in the near-shore area. The lake supported a robust community of brine flies, _Hydropyrus_ sp. possibly _cinearea_, and brine shrimp, _Artemia salina_. A number of wading birds were seen feeding and nesting in the sample area (Table 35d). There were no signs of excessive grazing pressure at the time of sampling, but the presence of pedestalled bunch grasses indicates the possibility of historic overgrazing.

Soils in the Laguna Walden area are Pajarito loamy fine sand and Cottonwood-Reeves association. Pajarito soils are deep, well drained and moderately dark colored. Wind and water erosion hazard for these soils is severe. Cottonwood-reeves soils are light colored, well drained and shallow. They occur over gypsum and are subject to severe erosion if exposed (Soil Conservation Service 1971).

Extensive areas of brush had been inundated recently and provided considerable cover for both terrestrial and aquatic birds. The floor of the basin consisted of a somewhat brittle, dark colored surface layer over reduced muck. This substrate, which appeared to consist of calcarious or gypsiferous material and the blue-green alga _Microcoleus_ sp. possibly _chthonoplastes_ provided an excellent substrate for larval brine flies. The brine flies in turn provided a food source for the wading birds. Salt deposits were seen only on debris and grasses above the waterline. Large numbers of brine fly larvae and brine shrimp were collected at Laguna Walden for use in toxicity tests of Lagunas Uno, Tres and Quatro waters and sediments (Tables 35a-b).

Water Quality Standards

Water quality standards for Laguna Walden are set forth in section 1-102 of the New Mexico water quality standards (NMWQCC 1991). Water quality standards specific to playa lakes have not been adopted. The principal objective of

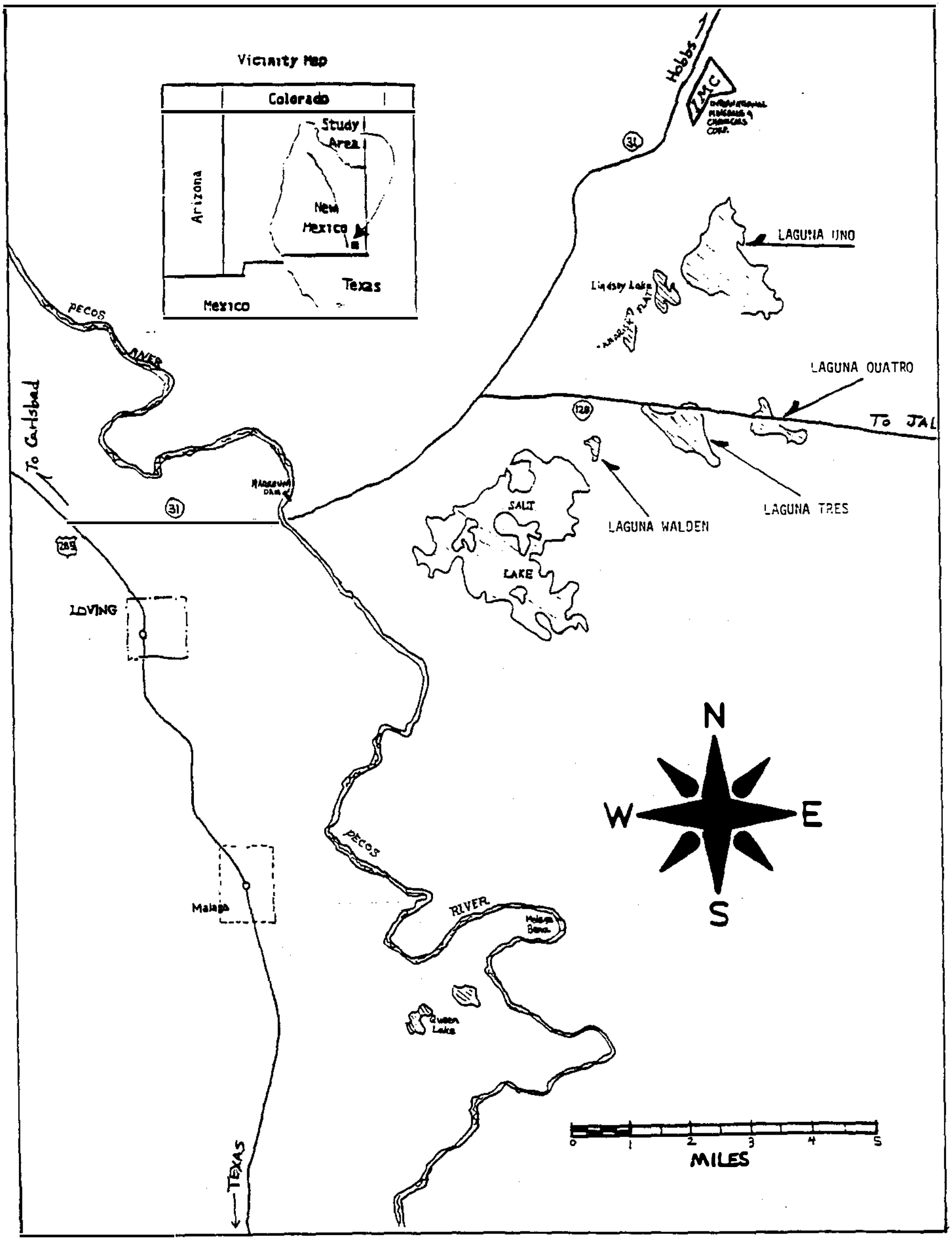


Fig. 25 Laguna "Walden" study area, 1982.

studying the diverse playa lakes of New Mexico is to develop numeric and narrative water quality standards that will support and protect the attainable uses of these waters of the State.

Methods

Water quality sampling methods were in accordance with the "New Mexico Clean Lakes Program: Lake Water Quality Assessment" Work Plan (NMED 1992) and the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 1992).

Water Quality Assessment

Water quality data for playa lake station ED02AF.LAG-WALD are available on STORET and can be retrieved using the selector A=21NMEX and the restrictor IS=923512. Parametric coverage, water quality and biological data are provided in tables 30 through 35.

The investigators computed Likens' (1975) phytoplankton community composition index and Carlson's (1977) chlorophyll a, total phosphorus and Secchi disk depth indices (Table 31). These trophic state indices were evaluated for their applicability in comparisons between the hypersaline playa lakes under investigation. The investigators concluded that these indices have no applicability or usefulness in comparisons between hypersaline lakes. Further, since these trophic state indices were developed using data from temperate freshwater lakes, they were not expected to be useful in comparisons between hypersaline lakes.

Laguna Walden is a Na-Mg-Cl water with a total dissolved solids concentration of 195,902 mg/l at the time of sampling. This value is one-half to one-third that of Lagunas Uno, Tres and Quatro (Table 30).

Scans for aromatic hydrocarbons yielded trace amounts of chloroform of 9.1 µg/l. Consultation with analytical staff at the Scientific Laboratory Division lead to the conclusion that chloroform was present in the sample only as a laboratory contaminant introduced during the extensive series of dilutions required prior to analysis. No other aromatic hydrocarbon was reported for Laguna Walden. Analyses for radium 226 and 228 showed no levels of concern. Results of potassium 40 analysis yielded a value of 3,500 pCi/l, consistent with assumed normal isotopic distribution of the lake's potassium concentration of 4,600 mg/l. Analyses for dissolved metals returned values above detection levels for eight metals. Of these, strontium (99,000 µg/l) and boron (3900 µg/l) appear to be elevated beyond the level expected in water subject to the evaporative concentration of Laguna Walden. Results of strontium and boron analyses of sediments taken from Laguna Walden, 560 µg/g and 33 µg/g respectively, suggest that high ambient concentrations in soil may account for the observed level in water. Nutrient analyses yielded no levels of concern. Total ammonia in Laguna Walden (0.10 mg/l) was considerably lower than levels encountered in other Nash Draw playas. This is probably due to the generally lower levels of nitrogen compounds available in Laguna Walden. Unionized ammonia calculations, reflecting the relationship between temperature, pH and total ammonia, indicate that no significant level of unionized ammonia existed at the time of sampling.

Phytoplankton density was 703 cells/ml with eight taxa represented (Table 32). Shannon-Wiener diversity was good, but may not be relevant in systems so specialized to deal with high salinity. Qualitative diatom analysis from multi-substrate periphyton scrapes yielded 212 cells for eight taxa per 50 fields counted. Shannon-Wiener diversity was good (Table 33). A benthic macroinvertebrate sweep resulted in 5,638 individuals per m^2 in three taxa, one of which was represented by a single individual (Table 34). Shannon-Wiener diversity was poor with Hydropyrus sp. constituting 61% of the sample. It should be noted that this community structure is typical of the hypersaline systems studied that have not received industrial discharge (see reports for Middle Lake and Williams Sink).

Laguna Walden appears to be the least impacted system studied in the Carlsbad area. The contrast between Laguna Walden and Lagunas Uno, Tres and Quatro is striking. Despite the presence of much recently dead brush in the vicinity of the lake shore, there are signs of life everywhere about Laguna Walden, whereas many other lakes in the vicinity are nearly devoid of life. The dead brush on the perimeter of Laguna Walden raises the question of the extent of ground-water elevation in Nash Draw. If Laguna Walden, like the other lakes in Nash Draw, is a ground-water level lake and if the dead brush, which is greater than 10 ft on height and four inches in diameter, was either drowned or poisoned by salt, then water levels at Laguna Walden must have recently risen considerably.

Since the water carrying capacity of the shallow permeable rock beneath the floor of the Draw is largely occupied (BLM 1975a, Geohydrology Associates 1986), any contribution to the system will find an alternative route down gradient by surface or ground-water flow. Since total dissolved solids levels in Laguna Walden are well below those lakes of Nash Draw receiving effluent, its water level is probably not directly related to effluent discharges. But given the dissolved solids concentration difference between Laguna Walden and Laguna Tres (Figs. 26-29), the nearest up-gradient lake, it is probable that local groundwater is literally floating on a deeper reservoir of highly mineralized water from Laguna Tres. Whatever the source of water in Laguna Walden, it is a valuable resource to waterfowl and other wildlife in an area where habitat is scarce. Hypersaline groundwater moving down from the upper part of Nash Draw, however, may eventually contaminate Laguna Walden as it has other lakes in the area, and render it unfit for use by wildlife.

Table 30. Water Quality Data for Laguna Walden

EDO2AF.LAG-WALD EDO2AFLAGWAL LAGUNAWALDEN
32 19 34.0 103 58 12.0 4
LAGUNA WALDEN NW NE S10 T23S R29E
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 13060011
0001 METERS DEPTH 904 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00010 WATER TEMP CENT	00400 PH SU	00095 CNDUCTVY AT 25C MICROMHO	00300 DO MG/L	82205 SPECIFIC GRAVITY GM/L	00480 SALINITY PPTH	00031 INCDT LT REMNING PERCENT	82079 TURBIDTY LAB NTU	00612 UN-IONZD NH3-N MG/L	00053 SURFACE AREA ACRES
92/05/04	1300	VERT	0.3	26.0	7.30	286748J	2.0		182.0J	100.0	7.3	0.00	60

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00078 TRANSP SECCHI METERS	00079 COLOR FORL-ULE SCALE	00204 DEPTH-M 1% LIGHT REMAINS	00410 T ALK CACO3 MG/L	00440 HCO3 ION HCO3 MG/L	00530 RESIDUE TOT NFLT MG/L	70300 RESIDUE DISS-180 C MG/L	00600 TOTAL N N MG/L	00605 ORG N N MG/L	00608 NH3+NH4- N DISS MG/L
92/05/04	1300	VERT	0.3	.30		.3	154	188	152	195902	1.67C	1.530C	.100

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00610 NH3+NH4- N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00631 NO2&NO3 N-DISS MG/L	00640 T INORG. NITROGEN MG/L N	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P	00671 PHOS-DIS ORTHO MG/L P	00900 TOT HARD CACO3 MG/L	00915 CALCIUM CA,DISS MG/L
92/05/04	1300	VERT	0.3	.100	1.630	.04K	.04K	.14C	.890	.380	.010K	32297J	3800.0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00925 MGNSIUM MG,DISS MG/L	00930 SODIUM NA,DISS MG/L	00935 PTSSIUM K,DISS MG/L	00940 CHLORIDE TOTAL MG/L	00945 SULFATE SO4-TOT MG/L	71870 BROMIDE BR MG/L	32210 CHLRPHYL A UG/L	32211 CHLRPHYL A UG/L CORRECTD	32212 CHLRPHYL B UG/L	32214 CHLRPHYL C UG/L
92/05/04	1300	VERT	0.3	6730.0	52670.00	4600.00	114000	5800	130.00	.95C	.83C	.00C	.00C

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	32218 PHEOPHTN A UG/L	32221 % CHL A OF PHE A + CHL A	09501 RA-226 TOTAL PC/L	09502 RA-226 ERROR PC/L	11501 RA-228 TOTAL PC/L	11502 RA-228 ERROR PC/L	11503 RA-226 + RA-228 PC/L	11504 RA-226 + 228 ERR PC/L	75038 K-40 TOTAL PC/L	75037 K-40 ERROR PC/L
92/05/04	1300	VERT	0.3	.16C	87C	4.5J	.3C	15.0J	10.0C	19.5J	10.0C	3500.00	150.00C

Remark codes: C= Calculated value, J= Estimated value, K= Less than, L= Greater than, U= Undetected

Table 30. cont.

EDO2AF.LAG-WALD EDO2AFLAGWAL LAGUNAWALDEN
32 19 34.0 103 58 12.0 4
LAGUNA WALDEN NW NE S10 T23S R29E
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 13060011
0001 METERS DEPTH 904 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01106 ALUMINUM AL,DISS UG/L	01000 ARSENIC AS,DISS UG/L	01005 BARIUM BA,DISS UG/L	01010 BERYLIUM BE,DISS UG/L	01020 BORON B,DISS UG/L	01025 CADMIUM CD,DISS UG/L	82036 CALCIUM DISS CA UG/L	82037 MG DISS MG UG/L	01030 CHROMIUM CR,DISS UG/L	01035 COBALT CO,DISS UG/L
92/05/04	1300	VERT	0	100K	50K	100	100.00K	3900	10K	3890000	5440000	5K	50K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01040 COPPER CU,DISS UG/L	01046 IRON FE,DISS UG/L	01049 LEAD PB,DISS UG/L	01056 MANGNESE MN,DISS UG/L	71890 MERCURY HG,DISS UG/L	01060 MOLY MO,DISS UG/L	01065 NICKEL NI,DISS UG/L	01145 SELENIUM SE,DISS UG/L	01140 SILICON SI,DISS UG/L	01075 SILVER AG,DISS UG/L
92/05/04	1300	VERT	0	100K	100K	50K	390.0	.5K	100K	100K	1000K	11000	100.0K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01080 STRONTUM SR,DISS UG/L	01100 TIN SN,DISS UG/L	01085 VANADIUM V,DISS UG/L	01090 ZINC ZN,DISS UG/L	71900 MERCURY HG,TOTAL UG/L	01147 SELENIUM SE,TOT UG/L
92/05/04	1300	VERT	0	99000	100K	100K	100K	.5K	1000K

Remark Codes: K= less than

Table 30, cont.

EDO2AF.LAG-WALD EDO2AFLAGWAL LAGUNAWALDEN
32 19 34.0 103 56 12.0 4
LAGUNA WALDEN NW NE S10 T23S R29E
35015 NEW MEXICO EDDY
WESTERN GULF 120600
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920622 13060011
0001 METERS DEPTH 904 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00917 CA MUD DRY WGT MG/KG-CA	00924 MG MUD DRY WGT MG/KG-MG	01003 ARSENIC SEDMG/KG DRY WGT	01006 BA MUD DRY WGT MG/KG-BA	01013 BERYLIUM SEDMG/KG DRY WGT	01019 CD MUD WET WGTM G/KG-CD	01023 B MUD DRY WGT MG/KG-B	01029 CHROMIUM SEDMG/KG DRY WGT	01036 CO MUD DRY WGT MG/KG-CO	01043 COPPER SEDMG/KG DRY WGT
92/05/04	1300	WATER	0	90061.00	5731.00	.10	16.00	6.00K		33.00	1.60	6.00K	6.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01053 MN MUD DRY WGT MG/KG-MN	01063 MO MUD DRY WGT MG/KG-MO	01066 NICKEL SEDMG/KG DRY WGT	01076 SILVER SEDMG/KG DRY WGT	01063 SR MUD DRY WGT MG/KG-SR	01066 V MUD DRY WGT MG/KG-V	01093 ZINC SEDMG/KG DRY WGT	01103 TIN MUD DRY WGT MG/KG-SN	01106 AL MUD DRY WGT MG/KG-AL
92/05/04	1300	WATER	0	164.00	6.00K	6.00K	6.00K	917.00	6.00K	6.00	6.00K	2620.00

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01144 SI MUD DRY WGT MG/KG-SI	01170 FE MUD DRY WGT MG/KG-FE	71921 MERCURY SEDMG/KG DRY WGT
92/05/04	1300	WATER	0	276.00	2292.00	.3K

Table 30, cont.

EDO2AF.LAG-WALD EDO2AFLAGWAL LAGUNAWALDEN
32 19 34.0 103 58 12.0 4
LAGUNA WALDEN NW NE S10 T23S R29E
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 13060011
0001 METERS DEPTH 904 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81552 ACETONE TOT UG/L	78124 BENZENE HOH VOL UG/L	81555 BROMO BENZENE TOT UG/L	73085 CLBRMETH TOTAL WTR UG/L	32101 DICLBRMT TOTUG/L	32104 BROMOFRM WHL-WTR UG/L	81595 MTH ETH KETONE TOT UG/L	77342 N-BUTLBZ TOTAL UG/L	77350 SEC-BUTB TOTAL UG/L	77353 T-BUTLBZ TOTAL UG/L
92/05/04	1300	VERT	0.3	5.000U	1.00U	1.000U	1.0U	1.0U	1.0U	5.000U	1.000U	1.000U	1.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	46491 MTBE WATER TOT UG/L	32102 CARBNTET TOTUG/L	34301 CHLOROBE NZENE TOTWUG/L	32106 CHLRFORM TOTUG/L	38680 CHLOROTO LUENEWTR TOT UG/L	77277 P-CLTOLU TOTAL UG/L	82625 DIBRCLRO PRPN TOT REC UG/L	32105 CLDIBRMT TOTUG/L	30203 ETHAN12 WTR,WHL REC UG/L	77596 DBRMETHA TOTAL UG/L
92/05/04	1300	VERT	0.3	5.00U	1.0U	1.000U	9.1T	1.000U	1.000U	1.0U	1.0U	1.0U	1.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	34536 12DICHLO ROBENZEN TOTWUG/L	34567 13DICHLO ROBENZEN DISSUG/L	34572 14DICHLO ROBENZEN DISSUG/L	34668 DICHLORO DIFLUORO TOTWUG/L	34496 11DICHLO ROETHANE TOTWUG/L	34531 12DICHLO ROETHANE TOTWUG/L	34501 11DICHLO ROETHYLE TOTWUG/L	77093 C-1,2DCE TOTAL UG/L	34546 12DICHLO ROETHENE TOTWUG/L	34541 12DICHLO ROPROPAN TOTWUG/L
92/05/04	1300	VERT	0.3	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77173 1,3DCLPR TOTAL UG/L	77170 2,2DCLPR TOTAL UG/L	77168 1,1DCLPR TOTAL UG/L	34704 C1,3-DCP TOT WAT UG/L	34699 T1,3-DCP TOT WAT UG/L	34371 ETHYLBEN ZENE TOTWUG/L	34391 HEXACHLO ROBUTADI TOTWUG/L	77223 IPROPBNZ TOTAL UG/L	30341 8NZ1MTHL RECOVER WTR UG/L	34423 METHYLEN ECHLORID TOTWUG/L
92/05/04	1300	VERT	0.3	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.00U	1.000U

Remark codes: U= undetected, T= less than criterion of detection

Table 30, cont.

EDO2AF.LAG-WALD EDO2AFLAGWAL LAGUNAWALDEN
32 19 34.0 103 58 12.0 4
LAGUNA WALDEN NW NE S10 T23S R29E
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 13060011
0001 METERS DEPTH 904 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77418 1MNAPTHA TOTAL UG/L	77416 2MNAPTHA TOTAL UG/L	34696 NAPTHALE NE T OTWUG/L	77224 N-PRPBNZ TOTAL UG/L	77128 STYRENE TOTAL UG/L	77562 1112TCLE TOTAL UG/L	34516 1122TETR ACHLOROE TOTWUG/L	34475 TETRACHL OROETHYL TOTWUG/L
92/05/04	1300	VERT	0.3	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81607 TETRAHYD FURAN TOT UG/L	78131 TOLUENE WHL HOH VOLUG/L	77613 123TCLBZ TOTAL UG/L	34551 124TRICH LOROBENZ TOTWUG/L	34506 111TRICH LOROETHA TOTWUG/L	34511 112TRICH LOROETHA TOTWUG/L	39180 TRICHLOR ETHYLENE TOT UG/L	34488 TRICHLOR OFLUOROM TOTWUG/L	77443 1,2,3TCP TOTAL UG/L	77222 1,2,4TMB TOTAL UG/L
92/05/04	1300	VERT	0.3	5.000U	1.00U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U	1.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77226 1,3,5TMB TOTAL UG/L	39175 VINYLCHL ORIDE TOT UG/L	77135 O-XYLENE TOTAL UG/L	85795 XYLENE M&P WTR WHL UG/L
92/05/04	1300	VERT	0.3	1.000U	1.000U	1.000U	1.00U

Remark codes: U= undetected, T= less than criterion of detection

Table 31. Limiting nutrient and Carlson Trophic State indices computed by SAS.

LIMITING NUTRIENT FOR PLAYA LAKES, CALCULATED BY SAS
TN/TP > 17 INDICATES P-LIMITATION
TN/TP 10 - 17 INDICATES N AND/OR P LIMITATION
TN/TP < 10 INDICATES N-LIMITATION

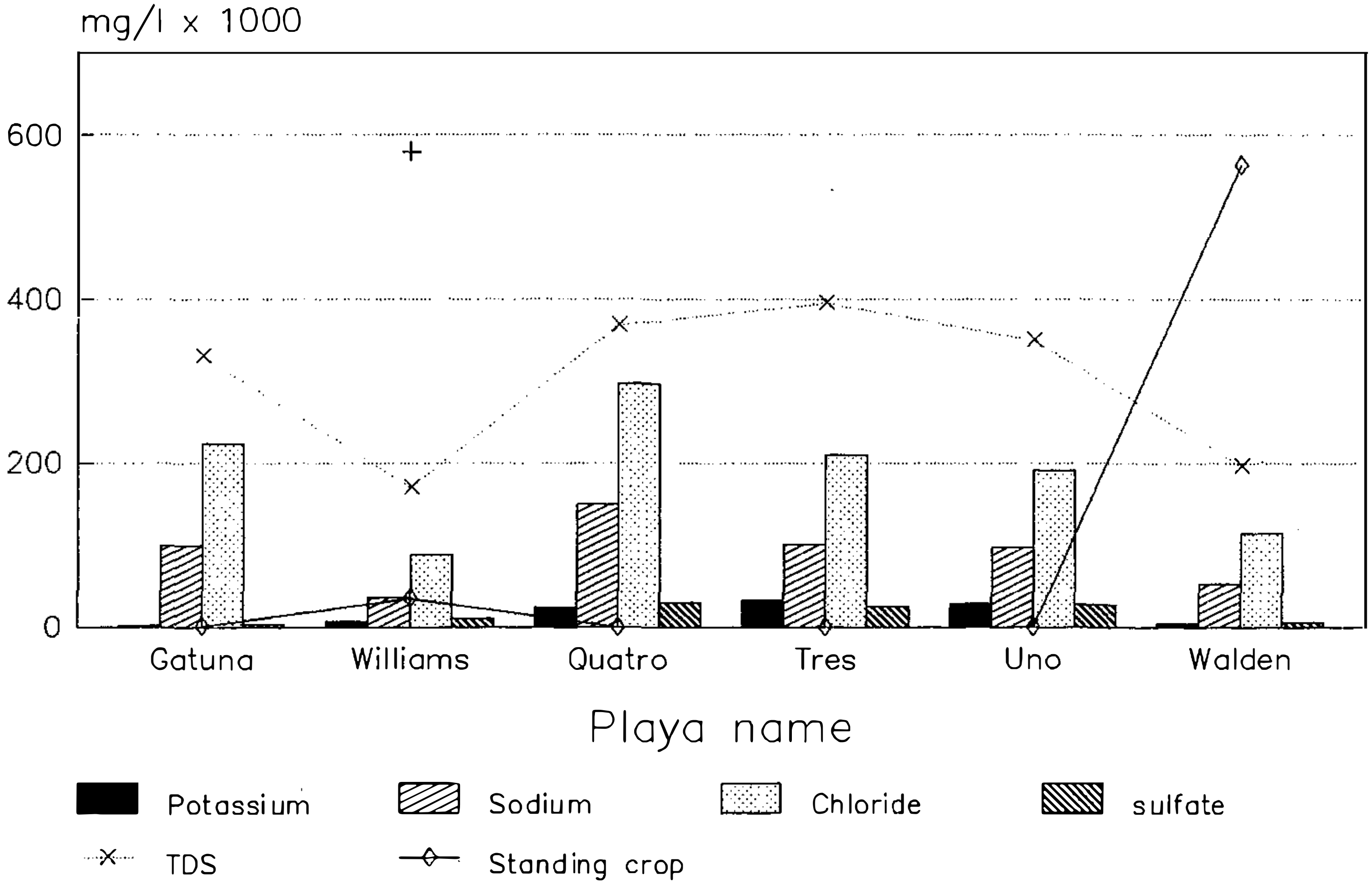
OBS	STATION		DATE	TN	TP	RATIO	LIMITING
1	21NMEX	LE01AA.LAGATUNA	31MAR92	109.30	0.20	546.500	P
2	21NMEX	ED01A8.WLMSSINK	01APR92	4.33	0.18	24.056	P
3	21NMEX	LE03AC.LANSALLK	14APR92	17.85	0.38	46.974	P
4	21NMEX	LE04AD.MIDDLELK	14APR92	14.54	0.11	132.182	P
5	21NMEX	ED01AE.LAGUNUNO	04MAY92	40.65	0.25	162.600	P
6	21NMEX	ED02AF.LAG-WALD	04MAY92	1.67	0.89	1.876	N
7	21NMEX	ED03AG.LGQUATRO	05MAY92	23.39	0.96	24.365	P
8	21NMEX	ED04AH.LAG-TRES	05MAY92	19.14	0.06	319.000	P
9	21NMEX	MO01AIWMSALTLKE	09JUN92	3.53	0.13	27.154	P
10	21NMEX	HA01AJ.CHICOSAL	26AUG92	7.40	0.64	11.562	N &/OR P

CARLSON TROPHIC STATE INDICES COMPUTED BY SAS
TSI <42 OLIGOTROPHIC, 42-47 MESOTROPHIC, >47 EUTROPHIC

OBS	STATION		DATE	CARLCHL	TSICHL	CARLSDD	TSISDD	CARLTP	TSITP
1	21NMEX	LE01AA.LAGATUNA	920331	25.0470	OLIGOTRO	60.0000	EUTRO	80.593	EUTRO
2	21NMEX	ED01A8.WLMSSINK	920401	32.4332	OLIGOTRO	54.1491	EUTRO	79.073	EUTRO
3	21NMEX	LE03AC.LANSALLK	920414	41.9761	OLIGOTRO	77.3733	EUTRO	89.855	EUTRO
4	21NMEX	LE04AD.MIDDLELK	920414	.	--	77.3733	EUTRO	71.967	EUTRO
5	21NMEX	ED01AE.LAGUNUNO	920504	.	--	77.3733	EUTRO	83.813	EUTRO
6	21NMEX	ED02AF.LAG-WALD	920504	28.7344	OLIGOTRO	77.3733	EUTRO	102.136	EUTRO
7	21NMEX	ED03AG.LGQUATRO	920505	55.7913	EUTRO	60.0000	EUTRO	103.228	EUTRO
8	21NMEX	ED04AH.LAG-TRES	920505	45.6853	MESOTRO	83.2242	EUTRO	63.220	EUTRO
9	21NMEX	MO01AIWMSALTLKE	920609	32.2697	OLIGOTRO	66.2162	EUTRO	74.377	EUTRO
10	21NMEX	HA01AJ.CHICOSAL	920826	85.9582	EUTRO	93.2263	EUTRO	97.378	EUTRO

Fig. 26 Playa biota x 100 vs major ions.

Numbers of invertebrates relative to concentrations of selected major ions.



+ = number of invertebrates per square meter x 100 taken at Williams Sink, February 26, 1992.

Fig. 27 Stiff diagrams: Nash Draw playas meq/liter

Chemical Constituents in Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl
Walden	3/ 5/1692	240.88	18.96	55.36	0.00	0.00	12.08	0.31	321.59
Laguna Uno	3/ 5/1692	495.67	15.97	55.36	0.00	0.00	59.34	0.31	538.81
Laguna Tres	4/ 5/1692	583.30	2.35	56.76	0.00	0.00	53.09	0.45	589.59
Lag. Quatro	4/ 5/1692	716.04	2.35	56.76	0.00	0.00	63.50	0.37	837.84

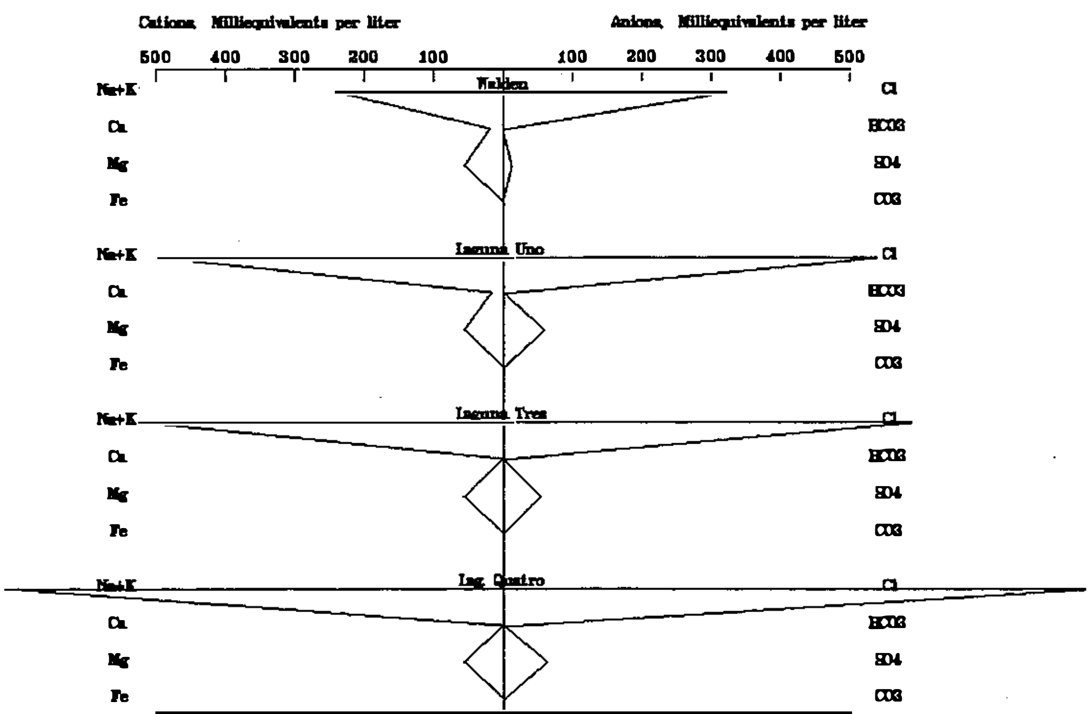


Fig. 28 Stiff diagrams: Nash Draw playas % meq/liter

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl	SAR	ESP	RSC
	Chemical Constituents in % Equivalents per Million											
Walden	3/ 5/1692	76.42	6.02	17.56	0.00	0.00	3.62	0.09	96.29	37.58	35.14	-74.01
Laguna Uno	3/ 5/1692	87.42	2.82	9.76	0.00	0.00	9.91	0.05	90.03	70.58	50.70	-71.02
Laguna Tres	4/ 5/1692	89.85	0.40	9.75	0.00	0.00	8.26	0.07	91.67	80.74	54.09	-58.65
Lag. Quetro	4/ 5/1692	92.38	0.30	7.32	0.00	0.00	7.04	0.04	92.92	120.43	63.82	-58.73

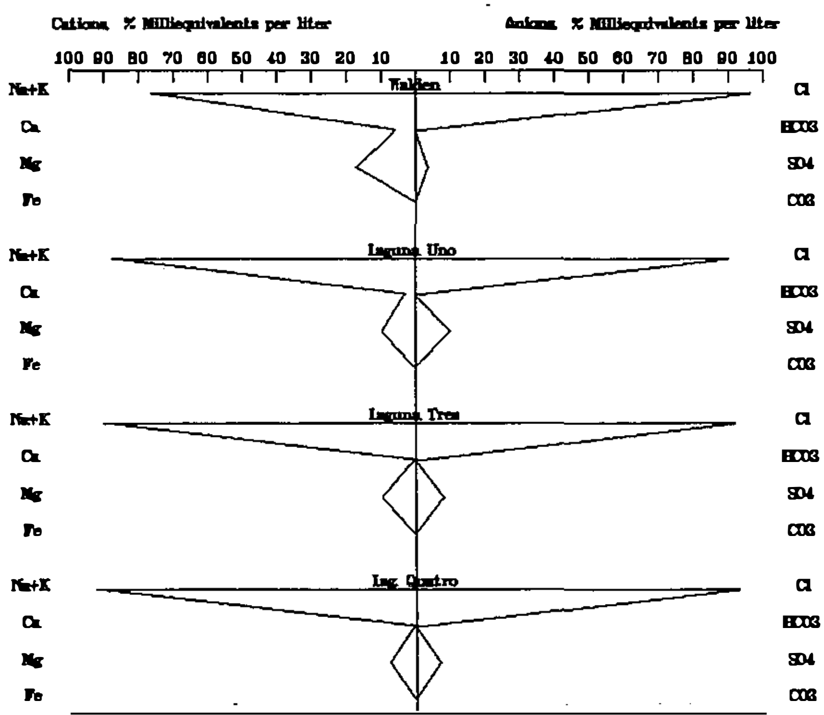
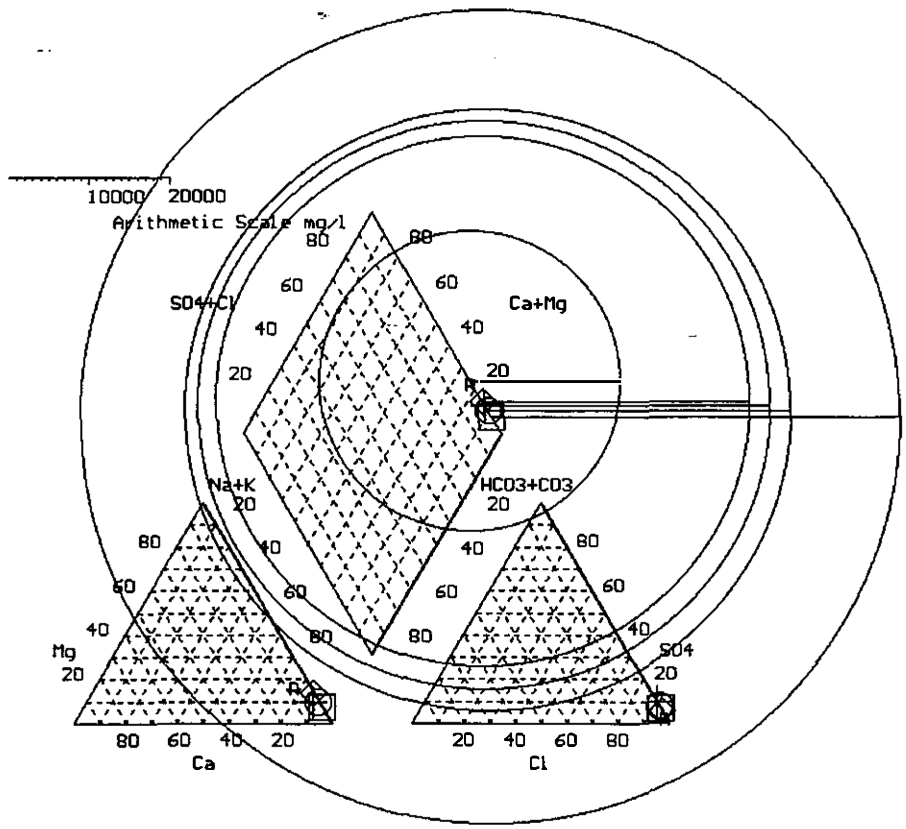


Fig. 29 Trilinear diagram: Nash Draw playas mg/l x 0.1



Diamond=«» Square=■ Circle=°

Walden 05/04/1992-R Laguna Uno 05/04/1992-+ Laguna Tres 05/05/1992-° Lag. Quatro 05/05/1992-■
Cutoff basin 05/05/1992-«»

Table 32. Phytoplankton collected from Nash Draw playas, Eddy County, New Mexico, April 4-5, 1992.

Lake	Station	Date	Taxon	Count (%)
Laguna Walden	ED02AF.LAG-WALD	92/05/04	*Fragilaria*	395 (56.2)
			Synedra	169 (24.0)
			Achnanthes	29 (4.1)
			Cymbella	57 (8.1)
			Nitzschia	29 (4.1)
			Dunaliella	18 (2.5)
			Crucigenia	3 (0.4)
			Gleocystis	3 (0.4)
			Total	703
			Taxa Richness	8
			Shannon - Wiener Diversity	1.84
			Evenness	0.61
Laguna Uno	ED01AE.LAGUNUNO	92/05/04	none found	0 (100)
Laguna Tres	ED04AH.LAG-TRES	92/05/05	none found	0 (100)
Laguna Quatro	ED03AG.LGQUATRO	92/05/05	*Dunaliella*	1848 (100)
			Total	1848
			Taxa Richness	1
			Shannon - Wiener Diversity	0.00
			Evenness	0.00

Table 33.

QUALITATIVE DIATOM ANALYSIS OF LAGUNA WALDEN, N.M.: 1992
Multiple substrate periphyton scrapes:

	NAME	# CELLS
1.	Amphora coffeiformis (Ag.) Kutz. var. coffeiformis	56
2.	Entomoneis paludosa (W. Sm.) Reim. comb. nov. var. paludosa	1
3.	Nitzschia acuta Hantzsch.	26
4.	N. communis Rabenhorst	19
5.	N. epithemioides Grun.	2
6.	N. linearis W. Smith	98
7.	N. palea (Kutz.) W. Sm.	2
8.	Rhopalodia musculus (Kutz.) O. Mull. var. musculus	8
	Total =	212

SHANNON-WIENER INDEX OF DIVERSITY

Total number of fields viewed for formal count = 50
Total species per formal count = 8
Total species identified = 11

H = 2.05
Hmax = 3.00
Equitability = 0.68

Other diatoms observed, but not included in formal count:

1. Eunotia Sp.
2. Navicula sp. #1 (prob. dulcus patr. var. dulcus)
3. Navicula sp. #2

Table 34. 1992 PLAYA SURVEY MACROINVERTEBRATE ABUNDANCES

Williams Sink 920401 (ref.)		Laguna Gatuna 920331
26° station		East Shore
Artemia salina	275	0
Hydropyrus sp.,* near *cinearea*	50	0
Dasyhelea sp.	21	0
Stratiomys sp.	1	0
240° station		West shore
Artemia salina	69	4
Hydropyrus sp., near *cinearea*	268	11
Dasyhelea sp.	11	0

Middle Lake 920414 (ref.)		Lane Salt Lake 920414
N side of island		inlet channel
Artemia salina	3890	0
Hydropyrus sp., near *cinearea*	1	541
Culicidae, prob. *Aedes sp.*	5	0
Stratiomys sp.	1	0
Muscidae	0	6
S. shore		½ mi. N. of S. end
Artemia salina	3507	0
Hydropyrus sp., near *cinearea*	15	0

"Laguna Walden" 920504 (ref.)		Laguna Uno 920504
S. end		W. end
Artemia salina	2201	0
Hydropyrus sp., near *cinearea*	3436	0
Nemotelus sp.	1	0

Laguna Tres 920505	Laguna Quatro 920505
near Murchison Nash #3	W. end
none found	none found

Table 35a. Results of adult *Artemia salina* 48 hr acute toxicity tests (100% test and control water).

Test Site	% Survival	Control site	% Survival
Laguna Gatuna	0[‡]	Williams Sink	97.8
Lane Salt Lake	0[‡]	Middle Lake	100.0
Burro Pipeline effl.	0[‡]	Middle Lake	100.0
Laguna Uno	0	Laguna Walden	96.0
Laguna Tres	0[‡]	Laguna Walden	96.0
Laguna Quatro	0	Laguna Walden	96.0

‡ 100% mortality/immobility after 24 hrs.

Table 35b. Results of larval *Hydropyrus sp.* 48 hr acute toxicity tests (100% test and control sediment).

Test Site	% Survival	Control Site	% Survival
Laguna Gatuna	56[1]	Williams Sink	80
Lane Salt Lake[2]	No sediment toxicity tests were conducted		
Laguna Uno	36[1]	Laguna Walden	96
Laguna Tres	58[1]	Laguna Walden	96
Laguna Quatro	12[1]	Laguna Walden	96

1 Survival = individual larvae that were not dead or immobile.

2 Too few *Hydropyrus* larvae were collected from Middle Lake for comparative toxicity testing.

Table 35c. Migratory bird species of Laguna Uno, Eddy County, New Mexico, May 4, 1992.

Species	Number	Activity
Blue-winged/cinnamon teal	2	Loafing
Swallow species	1	Fly over
Duck species	1	Fly over
Peregrine falcon	1	Chasing duck
Total	5	

Table 35d. Migratory bird species of Laguna Walden, Eddy County, New Mexico, May 4, 1992.

Species	Number	Activity
Black-necked stilt	14	Feeding/nesting
Wilson's phalarope	9	Feeding
Greater yellowlegs	1	Feeding
Killdeer	5	Vocalizing
Snowy egret	11	Fly over/nesting?
Total	40	

Table 35e. Migratory bird species of Laguna Tres, Eddy County, New Mexico, May 5, 1992.

Species	Number	Activity
Wilson's phalarope	10	Feeding/Loafing*
Snowy plover	10	Feeding*
Yellowlegs	2	Feeding*
Snowy plover	1	Along shore
Total	23	

Important note: There were no birds observed on Laguna Quatro during the survey.

* Birds encountered in a cut-off portion of Laguna Tres

WATER QUALITY SURVEY OF LAGUNA QUATRO IN EDDY COUNTY, NEW MEXICO
MAY 5, 1992

INTRODUCTION

During 1992 the Surveillance and Standards Section conducted a water quality assessment of Laguna Quatro in Eddy County, New Mexico (Fig. 30). The field team visited the playa on May 5, 1992.

Laguna Quatro is located in southeastern New Mexico approximately 10 miles east of Loving, New Mexico, via State highways 31 and 128. It is one of many playa basins located in the "potash district" of Eddy and Lea counties, New Mexico, which is the largest potash mining area in the U.S. (New Mexico Bureau of Mines & Mineral Resources 1977). The playa was determined to have a surface area of 77 hectares (191 ac) as calculated through digitized analysis of 7.5 minute quadrangle maps by personnel of the Bureau of Land Management, and is at an elevation of 909 meters (2,982 ft) above mean sea level. This basin is located in the arid Southern Deserts ecoregion where mean annual precipitation is 33.5 cm/yr (13.2 in/yr), and annual moisture deficit is 86.4 cm/yr (34 in/yr) (Gabin and Lesperance 1977).

Soils associated with Laguna Uno are of the Reeves-Gypsum land complex. Typical characteristics for the Reeves series are light-colored, well drained, calcareous soils over gypsiferous earths and rocks. This complex is generally suitable for native pasture and wildlife habitat. Soil erodibility is slight, though it is suggested that "good range management is needed to maintain a cover of desirable forage" (Soil Conservation Service 1971).

Laguna Quatro is one of many playa basins within Nash Draw that historically were ephemeral except where springs provided a continuous water supply. This playa, however, and others in lower Nash Draw, now appear to be permanent due to hydrologic changes after years of receiving the discharges of the potash industry. The closest and largest potash mine and mill, the International Minerals and Chemical Corporation (IMC), began operation in 1936. By 1948 potassium bearing ore was being extracted from five shafts and associated tunnels (ICF 1988). Process water used in the extraction and refinement of the potassium ore is pumped from wells in the Capitan Limestone of the Carlsbad underground water basin. The IMC operation uses an estimated 3,500 gal/min of water to process the ore. Though some of this water is lost through evaporation during processing, an estimated 5,000 acre-feet of brine is discharged annually to lower Nash Draw. Sodium and Chloride are the most abundant ions present in Laguna Quatro. The IMC facility discharges a conservatively estimated amount of 1.8×10^6 metric tons per year of NaCl to Nash Draw. This discharge certainly accounts for much of the thick salt incrustation on the bottom of most Nash Draw playas.

Information published by the Bureau of Land Management (1975b) indicates that surface and ground water levels in lower Nash Draw playa basins have risen considerably since at least 1958. For example, the BLM states that New Mexico Highway 128 was elevated to protect the roadbed from the rising water levels of Laguna Quatro and Laguna Tres.

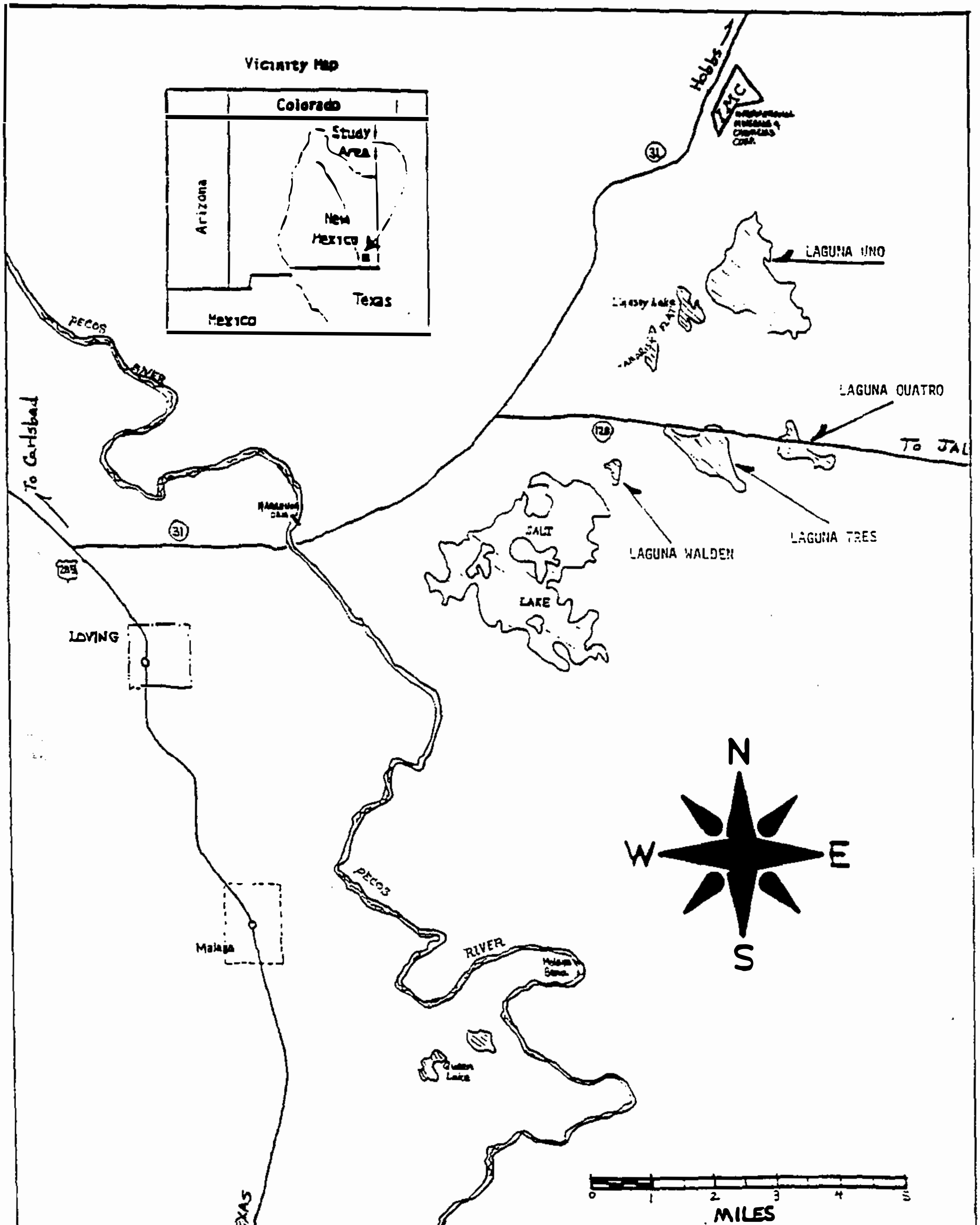


Fig. 30. Laguna Quatro study site, 1992.

Further, surface and ground-water flows apparently connect the Nash Draw playa basins as indicated by the following quotation from BLM (1975b):

> It is shown by Cooper (1962, table 2), that Nash Well, Sec. 6, T. 23S., R.30E., was 30 feet deep and the water level was 6.5 feet below land surface. This well is now flooded by Laguna Quatro, hence the aquifer below this lake has risen at least 7 feet since August 19, 1958. If the reported depth is correct, the aquifer may have risen 30 feet since the time it was drilled, because presumably it did not pump brine when drilled.

Another past contributor of brine effluent discharged directly to Laguna Quatro was B&E Incorporated. The Bureau of Land Management allowed this facility to discharge produced water from oil and gas extraction activities directly into Laguna Quatro. Concern shared by federal, state and public agencies and organizations eventually lead to the determination by EPA that Laguna Quatro is a "Water of the United States," and thus is subject to point source regulations under the Clean Water Act. The net result of this determination has been the halt of produced brine discharged by B&E Incorporated.

Laguna Quatro is one of four playa basins studied in Nash Draw and is approximately 2 miles down gradient from Laguna Uno, which receives direct discharge from IMC. Laguna Tres is located below and to the west of Laguna Quatro and has a man made channel connecting it with Laguna Quatro. The fourth lake is the reference playa Laguna Walden, which was considered free of impacts due to direct potash or produced water discharges.

Water Quality Standards

Water quality standards for Laguna Quatro are set forth in section 1-102 of the New Mexico water quality standards (NMWQCC 1991). Water quality standards specific to playa lakes have not been adopted. The principal objective of studying the diverse playa lakes of New Mexico is to develop numeric and narrative water quality standards that will support and protect the attainable uses of these waters of the State.

Methods

Water quality sampling methods were in accordance with the "New Mexico Clean Lakes Program: Lake Water Quality Assessment" work plan (NMED 1992) and the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 1992).

Water Quality Assessment

Water quality data for playa lake station ED03AG.LGQUATRO are available on STORET and can be retrieved using the selector A=21NMEX and restrictor IS=923513. Parametric coverage, water quality and biological data are provided in tables 36 through 40.

The investigators computed Likens' (1975) phytoplankton community composition index and Carlson's (1977) chlorophyll a, total phosphorus and Secchi disk depth indices (Table 37). These trophic state indices were evaluated for their applicability in comparisons between the hypersaline playa lakes under investigation. The investigators concluded that these indices have no applicability or usefulness in comparisons between hypersaline lakes. Further, since these trophic state indices were developed using data from temperate freshwater lakes, they were not expected to be useful in comparisons between hypersaline lakes.

Values for unionized ammonia are presented here as an expression of the relationship between total ammonia, pH and temperature. It is estimated that algorithms incorporating ionic strength and total alkalinity in addition to the above would yield results of approximately one-half the concentrations given here (Emerson et al. 1975; B. Zander, EPA Region 8, pers. comm.).

Review of the EPA's guidance literature for both fresh and saltwater ammonia criteria shows that while ammonia toxicity increases with both temperature and pH, a decrease in toxicity occurs with increasing salinity. The EPA did not publish criteria for un-ionized ammonia in saline environments beyond thirty parts per thousand, while salinity levels in the hypersaline playas studied in 1992 ranged from 140 to 390 parts per thousand. Further, the accuracy of the method used to calculate the un-ionized fraction of total ammonia is questionable when used in conditions of high ionic strength. In light of the above, it is worthy of note that the lake with the highest calculated un-ionized ammonia level (Middle Lake) among the hypersaline systems studied during 1992, also supported the second highest benthic standing crop (3897/m^2) and greatest number of taxa (4) of all these lakes.

Total dissolved solids of 368,540 mg/l with dominant sodium and chloride ion concentrations of 150,500 and 297,000 mg/l, respectively, place Laguna Quatro in a hypersaline category. Potassium and sulfate concentrations were also notable with values of 24,000 and 30,500 mg/l, respectively. It is important to point out that the total dissolved solids for Laguna Quatro were about twice that of Laguna Walden, the reference playa, and potassium and sulfate concentrations were over five times higher in Laguna Quatro than in the reference playa. Figure 31 compares those playa basins receiving or having received some type of discharge and those considered reference playas. Figures 32 through 34 provide a graphical comparison of Laguna Quatro and Laguna Walden.

Total and dissolved metal analyses of water and sediment showed no levels of concern. Mercury was detected (2.6 ug/l) in the filtered sample while results from analyses of total mercury were below detection limits. This discrepancy may by due to laboratory error. Radiological analyses of water for radium 226 and 228 and potassium 40 were below livestock and wildlife watering criteria. Analyses of water samples for aromatic and halogenated purgeables were performed. Results of these scans yielded no detectable concentrations of the 62 compounds analyzed except for chloroform. Laboratory personnel, however, believe that the presence of chloroform is most likely due to laboratory contamination. Analyses for base/neutral extractables were performed on sediment collected at the sampling station. As discussed in the introduction, the minimum detection limits were high due to the dilution necessary for successful analyses of the sample. These analyses yielded no detectable concentrations for 50 specific organic compounds. The analyst also reported, however, that the sample contained a series of petroleum hydrocarbons in the six-carbon atom to greater range at a total concentration of approximately

1,100 mg/l. This suggests that residue from produced water discharge and documented petroleum spills persists in the sediment.

Biological examination of phytoplankton, sediment and epiphytic diatoms, and macroinvertebrates were performed. Phytoplankton analysis yielded one species of the green alga Dunaliella, which is a single celled flagellate distinctive as one of two soft bodied algae known to persist in waters saturated with salts (Table 38). Cole (1983) states that few algal species can survive in waters with greater than 10% salinity, except for specific bluegreens and diatoms that tolerate high salinity. Cole further states that exceptions are the branched green alga Ctenocladus circinnatus and the green flagellate Dunaliella, which thrive in waters saturated with NaCl.

Qualitative diatom analysis of composited substrate periphyton scrapes were performed. There were no diatoms found in the highly concentrated microscope slide mount. Sediment samples were also collected for diatom analysis using a Lexan piston corer insert fitted with an eggshell core catcher to hold the sediment in place. Analyses of core sections might have yielded information on the historic diatom communities of Laguna Quatro, but highly alkaline and saline conditions caused the dissolution of diatom frustules (Dr. Sam Rushforth pers. comm.) to the extent that chronological core section analysis was not possible.

Macroinvertebrates were collected from the western end of Laguna Quatro. There were no organisms found during formal D-net sweeps. The analyst, however, found a few (4 or 5) Hydropyrus sp. when the salt pan substrate of the lake was broken with a shovel. Table 39 provides a comparison between macroinvertebrates identified from Laguna Quatro and the reference playa, Laguna Walden, where substantial populations of Artemia salina and Hydropyrus sp. were counted.

An important finding of these playa surveys is that differences between Laguna Quatro and Laguna Walden are substantial. Data show that Laguna Quatro has twice the dissolved solids as Laguna Walden. Laguna Quatro was devoid of algal and macroinvertebrate communities except for one green algal species and four brine fly individuals gathered from beneath the lake bottom salt pan.

Acute toxicity tests were conducted using Artemia salina and Hudropyrus sp., where organisms collected from the reference playa were exposed to water and sediment collected from the test playa. No Artemia survived exposure to water collected from Laguna Quatro, and only 12 percent of Hydropyrus exposed to Laguna Quatro lake sediments were alive after 48 hours (Tables 40a and 40b).

Wildlife use was much more prevalent at the reference playa than at Laguna Quatro. No migratory waterfowl or shore birds were observed on Laguna Quatro, however, migratory birds were observed loafing, feeding and nesting at Laguna Walden (Tables 40c-e). This strongly suggests that past conditions at many other Nash Draw playa basins including Laguna Quatro, may once have provided migratory waterfowl with a more hospitable habitat.

Table 36. Water quality data for Laguna Quatro, 1992.

ED03AG.LGQUATRO ED03AGQUATRO LAGUNAQUATRO
32 20 01.0 103 55 10.0 4
LAGUNA QUATRO SHORE STATION E OF IMC SHAFT #5
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 13060011
0000 METERS DEPTH 909 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00010 WATER TEMP CENT	00400 PH SU	00095 CNDUCTVY AT 25C MICROMHO	00300 DO MG/L	82205 SPECIFIC GRAVITY GM/L	00480 SALINITY PPTH	00031 INCDT LT REMNING PERCENT	82079 TURBIDTY LAB NTU	00608 NH3+NH4- N DISS MG/L	00612 UN-IONZD NH3-N MG/L
92/05/05	0900	WATER	0	25.2		495210J	1.1		341.0J	100.0			
92/05/05	0900	VERT	0		7.34			2.21J			14.0	20.300	0.2J

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00078 TRANSP SECCHI METERS	00079 COLOR FORL-ULE SCALE	00204 DEPTH-M 1% LIGHT REMAINS	00410 T ALK CACO3 MG/L	00440 HCO3 ION HCO3 MG/L	00530 RESIDUE TOT NFLT MG/L	70300 RESIDUE DISS-180 C MG/L	00600 TOTAL N N MG/L	00605 ORG N N MG/L	00053 SURFACE AREA ACRES
92/05/05	0900	VERT	0	1.00L	4	1.0L	185	226	306	368540	23.39C	.000C	150

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00610 NH3+NH4- N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00631 NO2&NO3 N-DISS MG/L	00640 T INORG. NITROGEN MG/L N	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P	00671 PHOS-DIS ORTHO MG/L P	00900 TOT HARD CACO3 MG/L	00915 CALCIUM CA,DISS MG/L
92/05/05	0900	VERT	0	20.500	20.500	2.89	3.0	23.39C	.960	.570	.010K	29580J	470.0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00925 MGNSIUM MG,DISS MG/L	00930 SODIUM NA,DISS MG/L	00935 PTSSIUM K,DISS MG/L	00940 CHLORIDE TOTAL MG/L	00945 SULFATE SO4-TOT MG/L	00680 TOT ORG CARBON MG/L	32210 CHLRPHYL A UG/L	32211 CHLRPHYL A UG/L CORRECTD	32212 CHLRPHYL B UG/L	32214 CHLRPHYL C UG/L
92/05/05	0900	VERT	0	6900.0	150500.0	24000.00	297000	30500	200K	12.71J	13.08J	2.02J	.00J

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	32218 PHEOPHTN A UG/L	32221 % CHL A OF PHE A + CHL A
92/05/05	0900	VERT	0	.00J	100J

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 36, cont.

EDO3AG.LGQUATRO EDO3AGQUATRO LAGUNAQUATRO
32 20 01.0 103 55 10.0 4
LAGUNA QUATRO SHORE STATION E OF IMC SHAFT #5
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 13060011
0000 METERS DEPTH 909 METERS ELEVATION
24G SOUT

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	79537 ACENAPH THENE WASMG/KG	79538 ACENAPH THYLENE WASMG/KG	79546 ANTHRA CENE WASMG/KG	79509 1,2-BENZ ANTHRACN WASMG/KG	03645 BNZBFLRN ELUTRIAT UG/L	03646 BNZKFLRN ELUTRIAT UG/L	03647 BNZGHIPL ELUTRIAT UG/L	79532 3,4BENZO PYRENE WASMG/KG	30180 BNZLALCH SOIL,REC MG/KG	79559 BIS(2CLR ETXY)MTH WASMG/KG
92/05/05	0900	VERT	0	2.00K	2.00K	2.00K	2.00K	4000.0K	4000.0K	4000.0K	4.00K	2K	2.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	79560 BIS(2CLR ETH)ETH WASMG/KG	79561 BIS(2CLR IPRP)ETH WASMG/KG	79562 BIS(2ETH HEX)PHTH WASMG/KG	79534 4BRPHNYL PHNYLETH WASMG/KG	79565 BUTBNZYL PHTHLATE WASMG/KG	78547 CLBNZENA MINE UG/KG	79527 2-CHLORO NAPTHALN WASMG/KG	79535 4CLPHNYL PHNYLETH WASMG/KG	79592 CHRYSENE WASMG/KG	79508 1256DIBZ ANTHRACN WASMG/KG
92/05/05	0900	VERT	0	2.00K	2.00K	2.00K	2.00K	2.00K	4000.0K	2.00K	2.00K	2.00K	2.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	30188 DIBNZOFR SOIL,REC MG/KG	79599 DINBUTYL PHTHLATE WASMG/KG	79511 12DICLBZ WASMG/KG	79516 13DICLBZ WASMG/KG	79517 14DICLBZ WASMG/KG	79530 3,3DICLR BNZIDINE WASMG/KG	79608 DIETHYL PHTHLATE WASMG/KG	79611 DIMETHYL PHTHLATE WASMG/KG	79524 24DINIT TOLUENE WASMG/KG	79525 26DINIT TOLUENE WASMG/KG
92/05/05	0900	VERT	0	2K	2.00K	2.00K	2.00K	2.00K	2.00K	2.00K	2.00K	2.00K	2.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	79600 DINOCTYL PHTHLATE WASMG/KG	79625 FLUORAN THENE WASMG/KG	79626 FLUORENE WASMG/KG	79633 HEXACLOR BENZENE WASMG/KG	79634 HEXACLOR BUTADIEN WASMG/KG	79635 HXCLCYCL PENTDIEN WASMG/KG	79636 HEXACLOR ETHANE WASMG/KG	79844 IND(123- CD)PYRNE WASMG/KG	79646 ISPHRONE WASMG/KG	79666 METHPHEN ANTHRENE WASMG/KG
92/05/05	0900	VERT	0	4.00K	2.00K	2.00K	2.00K	10.0K	10.0K	2.00K	2.00K	2.00K	2.00K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 36, cont.

EDO3AG.LGQUATRO EDO3AGQUATRO LAGUNAQUATRO
32 20 01.0 103 55 10.0 4
LAGUNA QUATRO SHORE STATION E OF IMC SHAFT #5
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 13060011
0000 METERS DEPTH 909 METERS ELEVATION
24G SOUT

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	79670 NAPHTHA- LENE WASMG/KG	30186 ANILIN2N SOIL,REC MG/KG	30187 ANILIN3N SOIL,REC MG/KG	30189 ANILIN4N SOIL,REC MG/KG	79672 NITRO BENZENE WASMG/KG	79669 N-NITRSO DIPHYLAM WASMG/KG	79668 N-NITRSO DI-NPRAM WASMG/KG	79692 PHENAN THRENE WASMG/KG	79702 PYRENE WASMG/KG	79507 124TRICL BNZ WASMG/KG
92/05/05	0900	VERT	0	2.00K	2K	20.0K	10.0K	2.00K	2.00K	2.00K	2.00K	2.00K	2.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81552 ACETONE TOT UG/L	78124 BENZENE HOH VOL UG/L	81555 BROMO BENZENE TOT UG/L	73085 CLBRMETH TOTAL WTR UG/L	32101 DICLBRMT TOTUG/L	32104 BROMOFRM WHL-WTR UG/L	81595 MTH ETH KETONE TOT UG/L	77342 N-BUTLBZ TOTAL UG/L	77350 SEC-BUTB TOTAL UG/L	77353 T-BUTLBZ TOTAL UG/L
92/05/05	0900	VERT	0	125.000K	25.00K	25.000K	25.0K	25.0K	25.0K	125.000K	25.000K	25.000K	25.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	46491 MTBE WATER TOT UG/L	32102 CARBNTET TOTUG/L	34301 CHLOROBE NZENE TOTWUG/L	32106 CHLRFORM TOTUG/L	38680 CHLOROTO LUENEWTR TOT UG/L	77277 P-CLTOLU TOTAL UG/L	82625 DIBRCLRO PRPN TOT REC UG/L	32105 CLDIBRMT TOTUG/L	30203 ETHAN12 WTR,WHL REC UG/L	77596 DBRMETHA TOTAL UG/L
92/05/05	0900	VERT	0	125.00K	25.0K	25.000K	9.7J	25.000K	25.000K	25.0K	25.0K	25K	25.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	34536 12DICHLO ROBENZEN TOTWUG/L	34567 13DICHLO ROBENZEN DISSUG/L	34572 14DICHLO ROBENZEN DISSUG/L	34668 DICHLORO DIFLUORO TOTWUG/L	34496 11DICHLO ROETHANE TOTWUG/L	34531 12DICHLO ROETHANE TOTWUG/L	34501 11DICHLO ROETHYLE TOTWUG/L	77093 C-1,2DCE TOTAL UG/L	34546 12DICHLO ROETHENE TOTWUG/L	34541 12DICHLO ROPROPAN TOTWUG/L
92/05/05	0900	VERT	0	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 36, cont.

EDO3AG.LGQUATRO EDO3AGQUATRO LAGUNAQUATRO
32 20 01.0 103 55 10.0 4
LAGUNA QUATRO SHORE STATION E OF IMC SHAFT #5
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 13060011
0000 METERS DEPTH 909 METERS ELEVATION
24G SOUT

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77173 1,3DCLPR TOTAL UG/L	77170 2,2DCLPR TOTAL UG/L	77168 1,1DCLPR TOTAL UG/L	34704 C1,3-DCP TOT WAT UG/L	34699 T1,3-DCP TOT WAT UG/L	34371 ETHYLBEN ZENE TOTWUG/L	34391 HEXACHLO ROBUTADI TOTWUG/L	77223 IPROPBNZ TOTAL UG/L	30341 BNZ1MTHL RECOVER WTR UG/L	34423 METHYLEN ECHLORID TOTWUG/L
92/05/05	0900	VERT	0	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.00K	25.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77418 1MNAPTHA TOTAL UG/L	77416 2MNAPTHA TOTAL UG/L	34696 NAPTHALE NE T OTWUG/L	77224 N-PRPBNZ TOTAL UG/L	77128 STYRENE TOTAL UG/L	77562 1112TCLE TOTAL UG/L	34516 1122TETR ACHLOROE TOTWUG/L	34475 TETRACHL OROETHYL TOTWUG/L
92/05/05	0900	VERT	0	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81607 TETRAHYD FURAN TOT UG/L	78131 TOLUENE WHL HOH VOLUG/L	77613 123TCLBZ TOTAL UG/L	34551 124TRICH LOROBENZ TOTWUG/L	34506 111TRICH LOROETHA TOTWUG/L	34511 112TRICH LOROETHA TOTWUG/L	39180 TRICHLOR ETHYLENE TOT UG/L	34488 TRICHLOR OFLUOROM TOTWUG/L	77443 1,2,3TCP TOTAL UG/L	77222 1,2,4TMB TOTAL UG/L
92/05/05	0900	VERT	0	125.000K	25.00K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K	25.000K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77226 1,3,5TMB TOTAL UG/L	39175 VINYLCHL ORIDE TOT UG/L	77135 O-XYLENE TOTAL UG/L	85795 XYLENE M&P WTR WHL UG/L
92/05/05	0900	VERT	0	25.000K	25.000K	25.000K	25.00K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 36, cont.

ED03AG.LGQUATRO ED03AGQUATRO LAGUNAQUATRO
32 20 01.0 103 55 10.0 4
LAGUNA QUATRO SHORE STATION E OF IMC SHAFT #5
WESTERN GULF 120800
35015 NEW MEXICO EDDY
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 13060011
0000 METERS DEPTH 909 METERS ELEVATION
24G SOUT

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	09501 RA-226 TOTAL PC/L	09502 RA-226 ERROR PC/L	11501 RA-228 TOTAL PC/L	11502 RA-228 ERROR PC/L	11503 RA-226 + RA-228 PC/L	11504 RA-226 + 228 ERR PC/L	75038 K-40 TOTAL PC/L	75037 K-40 ERROR PC/L
92/05/05	0900	VERT	0	8.5	.4	10.0K	4.0	18.5K	.6	20.60	.40

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01106 ALUMINUM AL,DISS UG/L	01000 ARSENIC AS,DISS UG/L	01010 BERYLIUM BE,DISS UG/L	01020 BORON B,DISS UG/L	01025 CADMIUM CD,DISS UG/L	82036 CALCIUM DISS CA UG/L	82037 MG DISS MG UG/L	01030 CHROMIUM CR,DISS UG/L	01035 COBALT CO,DISS UG/L	01040 COPPER CU,DISS UG/L
92/05/05	0900	VERT	0	100K	25K	100K	5500	5K	380000	5790000	10K	50K	100K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01046 IRON FE,DISS UG/L	01049 LEAD PB,DISS UG/L	01056 MANGNESE MN,DISS UG/L	71890 MERCURY HG,DISS UG/L	01060 MOLY MO,DISS UG/L	01065 NICKEL NI,DISS UG/L	01145 SELENIUM SE,DISS UG/L	01140 SILICON SI,DISS UG/L	01075 SILVER AG,DISS UG/L	01080 STRONTUM SR,DISS UG/L
92/05/05	0900	VERT	0	100K	25K	140.0	2.6	100K	100K	500K	3900	100.0K	18000

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01100 TIN SN,DISS UG/L	01085 VANADIUM V,DISS UG/L	01090 ZINC ZN,DISS UG/L	71900 MERCURY HG,TOTAL UG/L	01147 SELENIUM SE,TOT UG/L
92/05/05	0900	VERT	0	100K	100K	100K	.5K	2000K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 36, cont.

EDO3AG.LGQUATRO EDO3AGQUATRO LAGUNAQUATRO
32 20 01.0 103 55 10.0 4
LAGUNA QUATRO SHORE STATION E OF IMC SHAFT #5
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 13060011
0000 METERS DEPTH 909 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01108 AL MUD DRY WGT MG/KG-AL	01008 BA MUD DRY WGT MG/KG-BA	01013 BERYLIUM SEDMG/KG DRY WGT	01023 B MUD DRY WGT MG/KG-B	01028 CD MUD DRY WGT MG/KG-CD	00917 CA MUD DRY WGT MG/KG-CA	01029 CHROMIUM SEDMG/KG DRY WGT	01038 CO MUD DRY WGT MG/KG-CO	01043 COPPER SEDMG/KG DRY WGT	01170 FE MUD DRY WGT MG/KG-FE
92/05/05	0900	WATER	0	362.00	39.00	7.20K	14.50	.12	130208.0	.85	7.20K	7.20K	405.00

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00924 MG MUD DRY WGT MG/KG-MG	01053 MN MUD DRY WGT MG/KG-MN	01063 MO MUD DRY WGT MG/KG-MO	01068 NICKEL SEDMG/KG DRY WGT	01144 SI MUD DRY WGT MG/KG-SI	01078 SILVER SEDMG/KG DRY WGT	01083 SR MUD DRY WGT MG/KG-SR	01103 TIN MUD DRY WGT MG/KG-SN	01088 V MUD DRY WGT MG/KG-V
92/05/05	0900	WATER	0	3472.00	7.20	7.20K	7.20K	87.00	7.20K	3762.00	7.20K	11.60

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01093 ZINC SEDMG/KG DRY WGT	71921 MERCURY SEDMG/KG DRY WGT	01148 SELENIUM SEDMG/KG DRY WGT
92/05/05	0900	WATER	0	7.20K	.3K	.36K

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 37. Limiting nutrient and Carlson Trophic State indices computed by SAS.

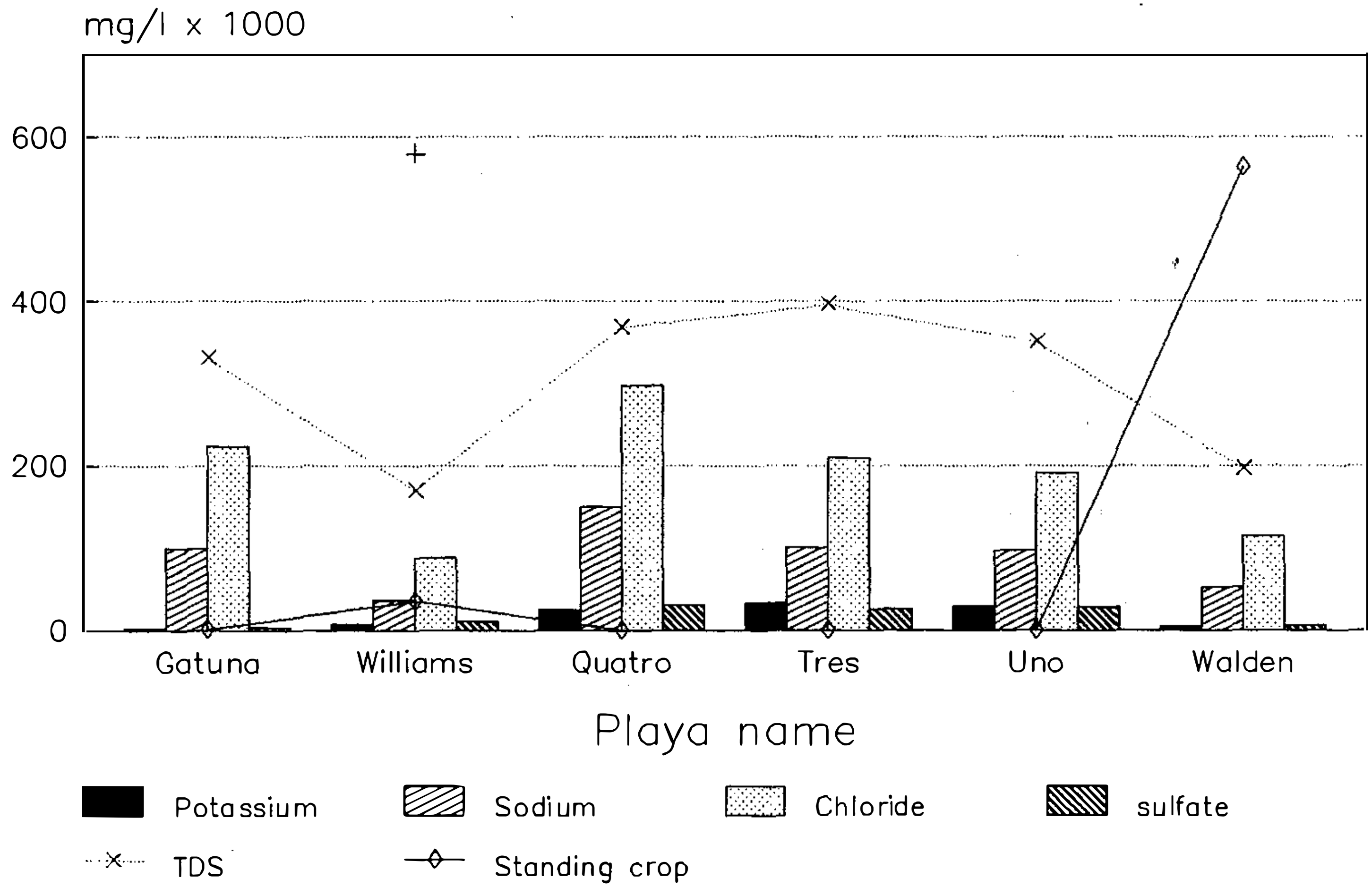
LIMITING NUTRIENT FOR PLAYA LAKES, CALCULATED BY SAS
TN/TP > 17 INDICATES P-LIMITATION
TN/TP 10 - 17 INDICATES N AND/OR P LIMITATION
TN/TP < 10 INDICATES N-LIMITATION

OBS	STATION		DATE	TN	TP	RATIO	LIMITING
1	21NMEX	LE01AA.LAGATUNA	31MAR92	109.30	0.20	546.500	P
2	21NMEX	ED01AB.WLMSSINK	01APR92	4.33	0.18	24.056	P
3	21NMEX	LE03AC.LANSALLK	14APR92	17.85	0.38	46.974	P
4	21NMEX	LE04AD.MIDDLELK	14APR92	14.54	0.11	132.182	P
5	21NMEX	ED01AE.LAGUNUNO	04MAY92	40.65	0.25	162.600	P
6	21NMEX	ED02AF.LAG-WALD	04MAY92	1.67	0.89	1.876	N
7	21NMEX	ED03AG.LGQUATRO	05MAY92	23.39	0.96	24.365	P
8	21NMEX	ED04AH.LAG-TRES	05MAY92	19.14	0.06	319.000	P
9	21NMEX	MO01AIWMSALTLKE	09JUN92	3.53	0.13	27.154	P
10	21NMEX	HA01AJ.CHICOSAL	26AUG92	7.40	0.64	11.562	N &/OR P

CARLSON TROPHIC STATE INDICES COMPUTED BY SAS
TSI <42 OLIGOTROPHIC, 42-47 MESOTROPHIC, >47 EUTROPHIC

OBS	STATION		DATE	CARLCHL	TSICHL	CARLSDD	TSISDD	CARLTP	TSITP
1	21NMEX	LE01AA.LAGATUNA	920331	25.0470	OLIGOTRO	60.0000	EUTRO	80.593	EUTRO
2	21NMEX	ED01AB.WLMSSINK	920401	32.4332	OLIGOTRO	54.1491	EUTRO	79.073	EUTRO
3	21NMEX	LE03AC.LANSALLK	920414	41.9761	OLIGOTRO	77.3733	EUTRO	89.855	EUTRO
4	21NMEX	LE04AD.MIDDLELK	920414	.	--	77.3733	EUTRO	71.967	EUTRO
5	21NMEX	ED01AE.LAGUNUNO	920504	.	--	77.3733	EUTRO	83.813	EUTRO
6	21NMEX	ED02AF.LAG-WALD	920504	28.7344	OLIGOTRO	77.3733	EUTRO	102.136	EUTRO
7	21NMEX	ED03AG.LGQUATRO	920505	55.7913	EUTRO	60.0000	EUTRO	103.228	EUTRO
8	21NMEX	ED04AH.LAG-TRES	920505	45.6853	MESOTRO	83.2242	EUTRO	63.220	EUTRO
9	21NMEX	MO01AIWMSALTLKE	920609	32.2697	OLIGOTRO	66.2162	EUTRO	74.377	EUTRO
10	21NMEX	HA01AJ.CHICOSAL	920826	85.9582	EUTRO	93.2263	EUTRO	97.378	EUTRO

Fig. 31. Playa biota x 100 vs major ions.
Numbers of invertebrates relative to concentrations of selected major ions.



+ = number of invertebrates per square meter x 100 taken at Williams Sink, February 26, 1992.

Fig. 32 Stiff diagrams: Nash Draw playas meq/l

Chemical Constituents in Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl
Walden	3/ 5/1692	240.88	18.96	55.36	0.00	0.00	12.08	0.31	321.59
Laguna Uno	3/ 5/1692	495.67	15.97	55.36	0.00	0.00	59.34	0.31	588.81
Laguna Tres	4/ 5/1692	523.30	2.35	56.76	0.00	0.00	53.09	0.45	583.59
Lag. Quatro	4/ 5/1692	716.04	2.35	56.76	0.00	0.00	63.50	0.37	837.84

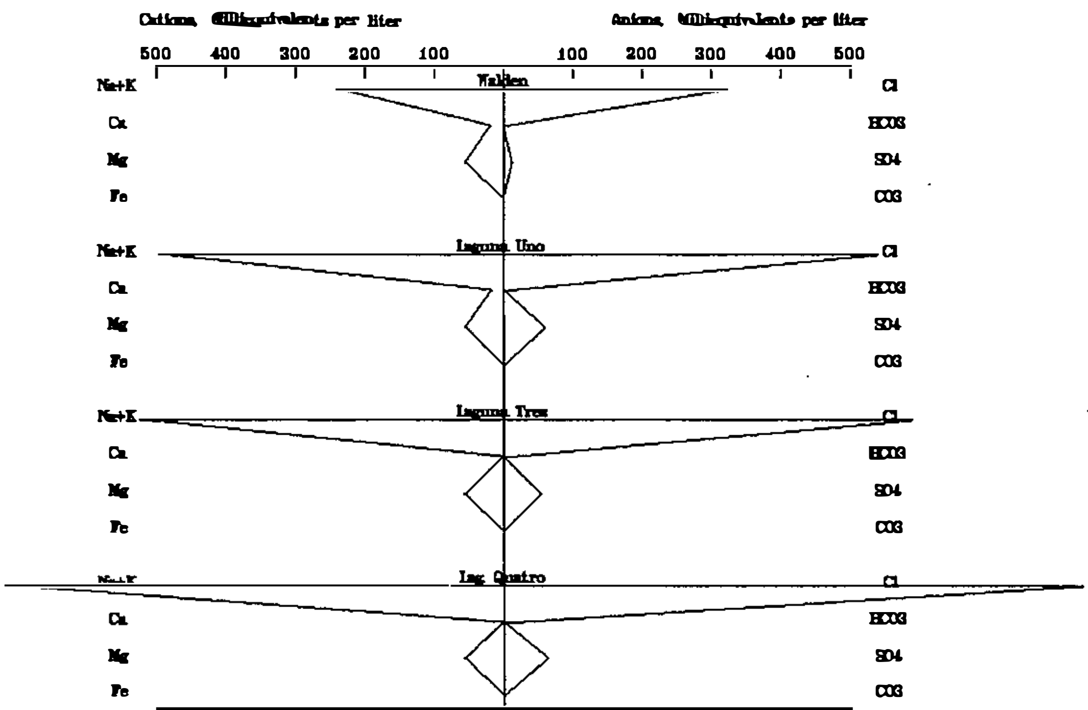


Fig. 33 Stiff diagrams: Nash Draw playas % meq/l

Chemical Constituents in % Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl	SAR	ESP	RSC
Walden	3/ 5/1992	76.42	6.02	17.56	0.00	0.00	3.62	0.09	96.29	37.58	36.14	-74.01
Laguna Uno	3/ 5/1992	87.42	2.82	9.76	0.00	0.00	9.91	0.06	90.03	70.58	50.70	-71.02
Laguna Tres	4/ 5/1992	89.85	0.40	9.75	0.00	0.00	8.26	0.07	91.67	80.74	54.09	-58.65
Lag. Quatro	4/ 5/1992	92.38	0.30	7.32	0.00	0.00	7.04	0.04	92.92	120.43	63.82	-58.73

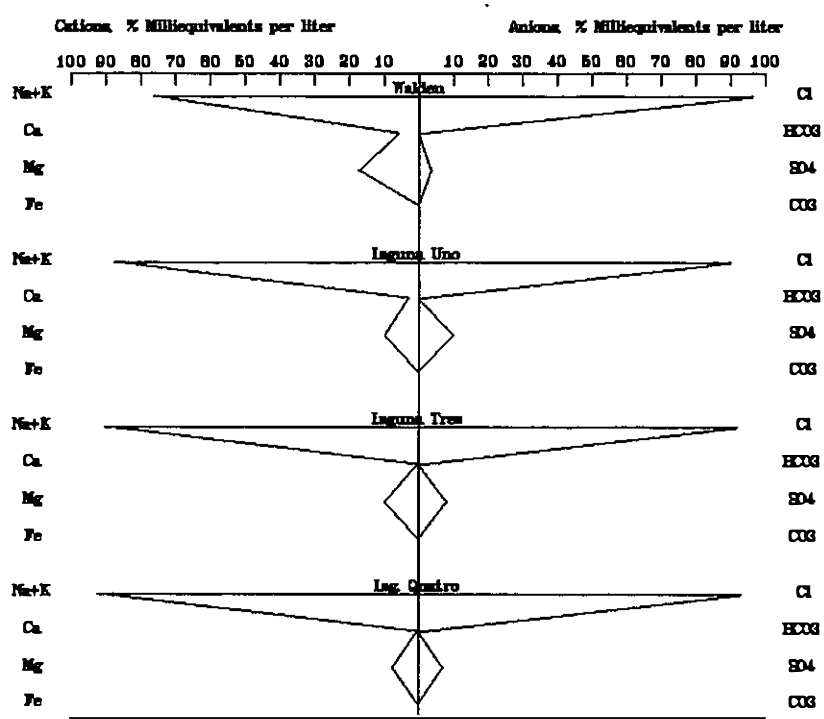
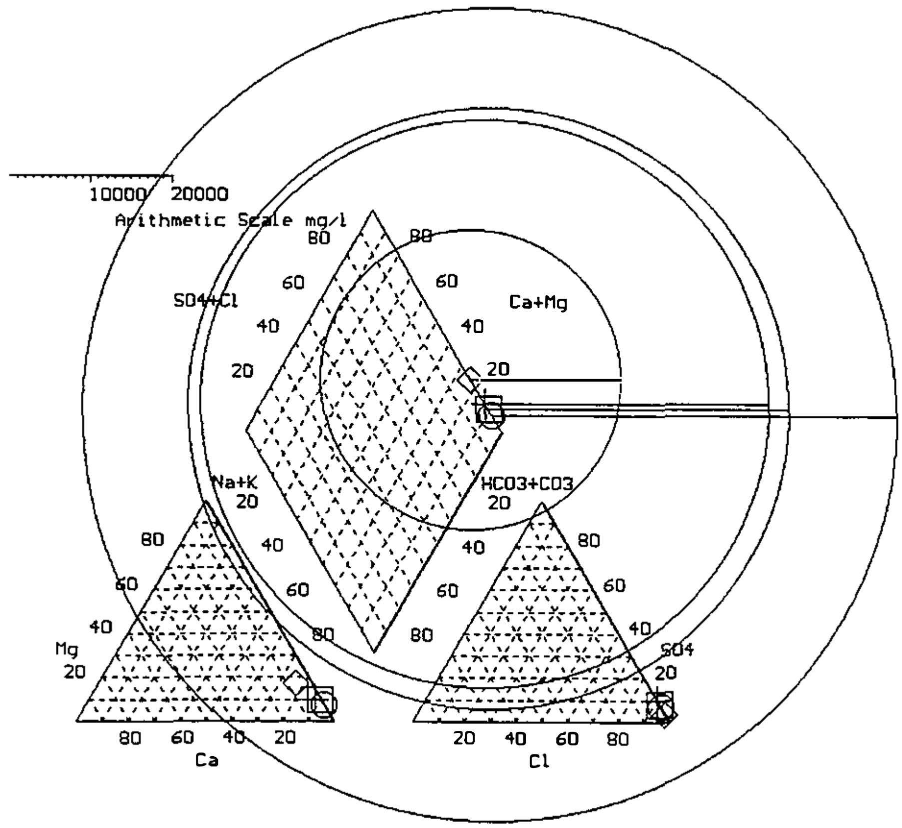


Fig. 34. Tri-linear diagram: Nash Draw Playas mg/l x 0.1



Diamond=«» Square=■ Circle=°

Walden 04/04/1992-«» Laguna Uno 04/04/1992-+ Laguna Tres 05/04/1992-■ Lag. Quatro 05/04/1992-°

Table 38. Phytoplankton collected from Nash Draw playas, Eddy County, New Mexico, April 4-5, 1992.

Lake	Station	Date	Taxon	Count (%)
Laguna Walden	ED02AF.LAG-WALD	92/05/04	*Fragilaria*	395 (56.2)
			Synedra	169 (24.0)
			Achnanthes	29 (4.1)
			Cymbella	57 (8.1)
			Nitzschia	29 (4.1)
			Dunaliella	18 (2.5)
			Crucigenia	3 (0.4)
			Gleocystis	3 (0.4)
		Total		703
		Taxa Richness		8
		Shannon - Wiener Diversity		1.84
		Evenness		0.61
Laguna Uno	ED01AE.LAGUNUNO	92/05/04	none found	0 (100)
Laguna Tres	ED04AH.LAG-TRES	92/05/05	none found	0 (100)
Laguna Quatro	ED03AG.LGQUATRO	92/05/05	*Dunaliella*	1848 (100)
		Total		1848
		Taxa Richness		1
		Shannon - Wiener Diversity		0.00
		Evenness		0.00

Table 39. 1992 PLAYA SURVEY MACROINVERTEBRATE ABUNDANCES

	Williams Sink 920401 (ref.)	**Laguna Gatuna 920331**
	26° station	East Shore
Artemia salina	275	0
Hydropyrus sp., near *cinearea*	50	0
Dasyhelea sp.	21	0
Stratiomys sp.	1	0
	240° station	West shore
Artemia salina	69	4
Hydropyrus sp., near *cinearea*	268	11
Dasyhelea sp.	11	0

	Middle Lake 920414 (ref.)	**Lane Salt Lake 920414**
	N side of island	inlet channel
Artemia salina	3890	0
Hydropyrus sp., near *cinearea*	1	541
Culicidae, prob. *Aedes sp.*	5	0
Stratiomys sp.	1	0
Muscidae	0	6
	S. shore	½ mi. N. of S. end
Artemia salina	3507	0
Hydropyrus sp., near *cinearea*	15	0

	"Laguna Walden" 920504 (ref.)	**Laguna Uno 920504**
	S. end	W. end
Artemia salina	2201	0
Hydropyrus sp., near *cinearea*	3436	0
Nemotelus sp.	1	0

Laguna Tres 920505	**Laguna Quatro 920505**
near Murchison Nash #3	W. end
none found	none found

Table 40a. Results of adult *Artemia salina* 48 hr acute toxicity tests (100% test and control water).

Test Site	% Survival	Control site	% Survival
Laguna Gatuna	0*	Williams Sink	97.8
Lane Salt Lake	0*	Middle Lake	100.0
Burro Pipeline effl.	0*	Middle Lake	100.0
Laguna Uno	0	Laguna Walden	96.0
Laguna Tres	0*	Laguna Walden	96.0
Laguna Quatro	0	Laguna Walden	96.0

* 100% mortality/immobility after 24 hrs.

Table 40b. Results of larval *Hydropyrus sp.* 48 hr acute toxicity tests (100% test and control sediment).

Test Site	% Survival	Control Site	% Survival
Laguna Gatuna	56[1]	Williams Sink	80
Lane Salt Lake[2]	No sediment toxicity tests were conducted		
Laguna Uno	36[1]	Laguna Walden	96
Laguna Tres	58[1]	Laguna Walden	96
Laguna Quatro	12[1]	Laguna Walden	96

[1] Survival = individual larvae that were not dead or immobile.

[2] Too few *Hydropyrus* larvae were collected from Middle Lake for comparative toxicity testing.

Table 40c. Migratory bird species of Laguna Uno, Eddy County, New Mexico, May 4, 1992.

Species	Number	Activity
Blue-winged/cinnamon teal	2	Loafing
Swallow species	1	Fly over
Duck species	1	Fly over
Peregrine falcon	1	Chasing duck
Total	5	

Table 40d. Migratory bird species of Laguna Walden, Eddy County, New Mexico, May 4, 1992.

Species	Number	Activity
Black-necked stilt	14	Feeding/nesting
Wilson's phalarope	9	Feeding
Greater yellowlegs	1	Feeding
Killdeer	5	Vocalizing
Snowy egret	11	Fly over/nesting?
Total	40	

Table 40e. Migratory bird species of Laguna Tres, Eddy County, New Mexico, May 5, 1992.

Species	Number	Activity
Wilson's phalarope	10	Feeding/Loafing*
Snowy plover	10	Feeding*
Yellowlegs	2	Feeding*
Snowy plover	1	Along shore
Total	23	

Important note: There were no birds observed on <u>Laguna Quatro</u> during the survey.

* Birds encountered in a cut-off portion of Laguna Tres

WATER QUALITY SURVEY OF LAGUNA TRES IN EDDY COUNTY, NEW MEXICO, MAY 5, 1992

Introduction

In 1992 the Surveillance and Standards Section conducted a water quality survey of Laguna Tres in Eddy County, New Mexico (Fig. 35). The field team completed its sampling run on May 5, 1992. Laguna Tres was selected as a study lake in part because it received overland flow from Laguna Quatro via a drainage ditch dug to relieve State Road 128, and because it recieved the discharge from Unichem International's Rattlesnake facility from October of 1982 to April of 1991.

The Laguna Tres basin is comprised of three major subbasins that connect in times of high water. Historically, the two larger subbasins have remained separated by a narrow isthmus and were named individually by the BLM during the 1970s. At the time of sampling the two major subbasins, Lagunas Tres and Cinco, (after BLM), were completely contiguous. The third subbasin remained distinct. Sampling was conducted in what would have been Laguna Cinco in times of lower water. Elevation taken from the USGS Nash Draw Quadrangle map is about 905 m (2,970 ft) above mean sea level. BLM has computed the area of Laguna Tres as 430.5 ac and that of Laguna Cinco as 185.0 ac. The actual area of the wetted portion of the basin during the sampling run was greater than the 616.4 ac total of the two lakes combined. Laguna Tres lies near the eastern edge of the Southern Deserts ecoregion and was probably formed by the dissolution of underlying material and removal of some surface material by wind. Mean annual rainfall for the Nash Draw is 35.5 cm (13.2 in) and the annual water deficit is about 85.4 cm (34 in). Water depth at the sampling site was measured at 20 cm (7.9 in).

In May of 1992 the combined Tres-Cinco basin was nearly devoid of life. Despite the presence of a few dipteran larvae in seeps draining to the lake, no macroinvertebrates were found in the main basin. While a few diatoms were found along the lake shore, no phytoplankters were identified from the water column. The third, southern-most subbasin was found to support large numbers of invertebrates and birds, mostly phalarope, which were actively feeding in the water (Table 46e). We conclude that the water of the the third subbasin was biologically active and the main basin abiotic because no salts were precipitating in the water column of the biologically active subbasin. Any particulate material in the water column of the main basin would rapidly become encrusted with salt crystals and fall to the floor of the lake where it would be incorporated in the salt substrate.

With respect to the apparent growth of the wetted area of the Tres/Cinco basin complex, the USDA-SCS soil maps, developed from aerial photographs taken between 1946 and 1964, identify two small, separate basins in the northern and western portions of the BLM's Laguna Tres basin as being ephemeral waterbodies. No other area is designated as wetted. The USGS 15-minute Nash Draw Quadrangle, photo-revised in 1965, identifies a continuous band along the northern and eastern boundaries of Laguna Tres and two small areas in the Cinco basins as ephemeral water bodies. The 1992 Surveillance and Standards survey found Lagunas Tres and Cinco to be fully contiguous and saw evidence of recent submersion of the isthmus between the main basin and the third, biologically active minor basin. A cursory examination of the 1992 sample

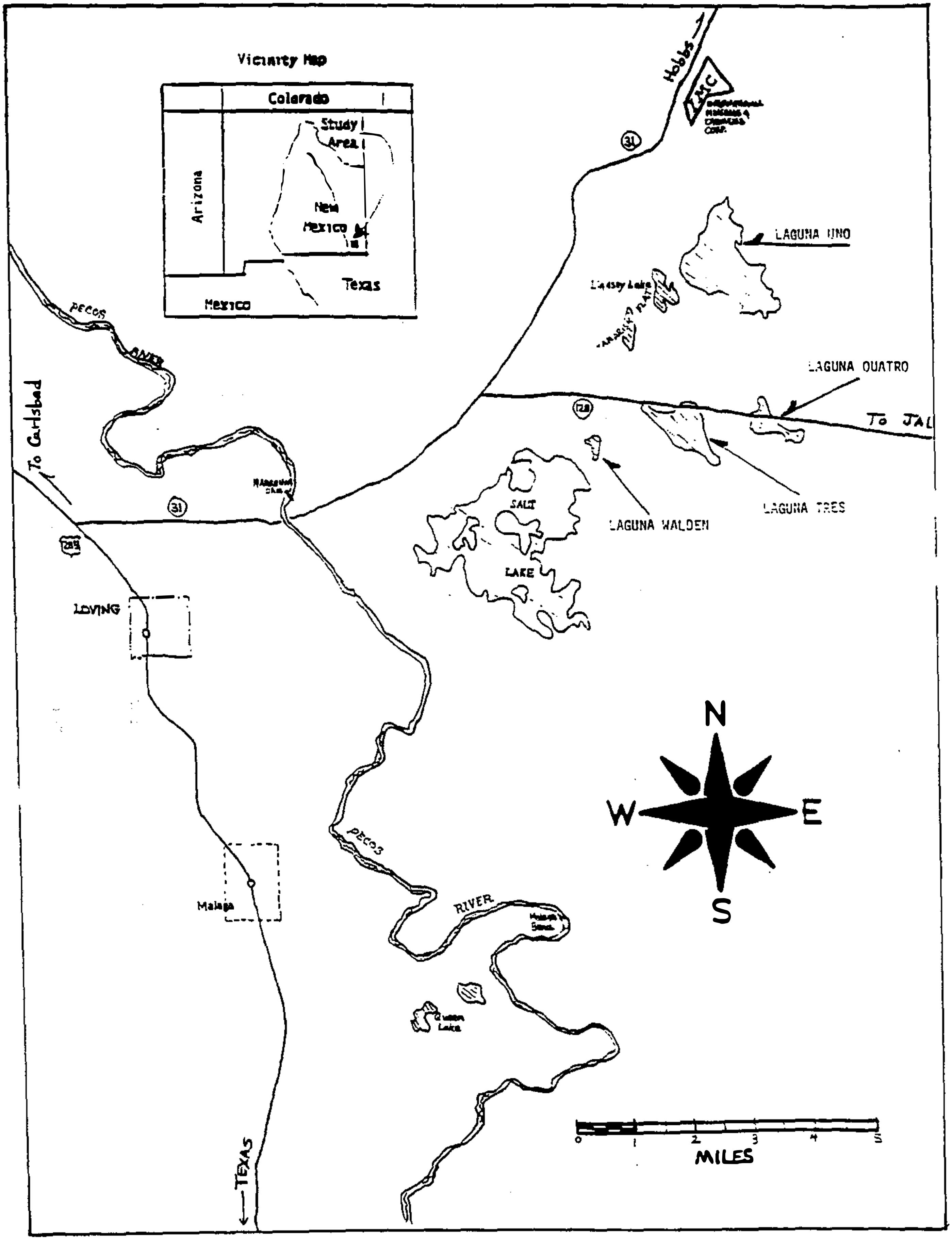


Fig. 35. Laguna Tres study area, 1992.

site in the spring of 1993 found water levels similar to those of the previous year in Laguna Tres, but the detached minor basin was now salt encrusted beneath the water's surface and non-supportive of biotic activity. Discharge in the drainage canal from Laguna Quatro to Laguna Tres was estimated at 3 to 5 cfs.

Soils in the Laguna Tres basin are Cottonwood-Reeves loams. These are light colored, calcareous soils occurring over gypsum. If ground cover is eliminated, these soils are subject to serious water erosion. Soil cover consisted of some short and mid grasses dominated by shrubs. There was much bare soil in the sampled area, presumably due to the removal of ground cover and the subsequent erosion of topsoil.

The floor of the wetted portion of the basin was comprised of a thick layer of coarsely crystalline sodium chloride. That this deposit is of fairly recent origin is evidenced by the absence of large salt deposits in any Nash Draw basin, except for Laguna Grande de la Sal in the Eddy Area Soil Survey aerial photographs, which were produced between 1946 and 1964.

Water Quality Standards

Water quality standards for Laguna Tres are set forth in section 1-102 of the New Mexico water quality standards (NMWQCC 1991). Water quality standards specific to playa lakes have not been adopted. The principal objective of studying the diverse playa lakes of New Mexico is to develop numeric and narrative water quality standards that will support and protect the attainable uses of these waters of the State.

Methods

Water quality sampling methods were in accordance with the "New Mexico Clean Lakes Program: Lake Water Quality Assessment" work plan (NMED 1992) and the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 1992).

Water Quality Assessment

Water quality data for playa lake station ED04AH.LAG-TRES are available on STORET and can be retrieved using the selector A=2INMEX and the restrictor IS=923114. Parametric coverage, water quality and biological data are provided here in Tables 41 through 46.

The investigators computed Likens' (1975) phytoplankton community composition index and Carlson's (1977) chlorophyll a, total phosphorus and Secchi disk depth indices (Table 42). These trophic state indices were evaluated for their applicability in comparisons between the hypersaline playa lakes under investigation. The investigators concluded that these indices have no applicability or usefulness in comparisons between hypersaline lakes. Further, since these trophic state indices were developed using data from temperate freshwater lakes, they are not expected to be useful in comparisons between hypersaline lakes.

Laguna Tres is a Na-Cl water with significant contributions made by potassium, magnesium and sulfate. (Figs. 36-39). Laguna Quatro surpassed Laguna Tres in terms of eq/l NaCl, but Laguna Tres yielded the highest total dissolved solids of any Nash Draw playa sampled, with 395,584 mg/l and a hardness of 29,580 mg/l. Scans for a total of 62 aromatic and halogenated hydrocarbons identified only one compound, chloroform, that was present in trace amounts. Staff of the Scientific Laboratory Division have indicated that the chloroform present in this sample was a laboratory contaminant. Analyses for radium 226 and 228 (11.0 pC/l) reflect no levels of concern. Potassium 40 analysis produced a result of (28,900 pCi/l) which was consistent with the level of potassium (33,000 mg/l) found in lake water.

Due to the need for extreme dilution of sample water, results for metals analyses are presented with very high detection limits. The results of analyses for priority metals indicates that the water of Laguna Tres is free of quantifiable levels of these metals. The laboratory's method detection limit of 100 µg/l, however, does not allow the conclusion that the metal is not present. Quantifiable results were obtained for B, Ca, Mg, Si and Sr in water. These results appear consistent with those of other hypersaline systems studied. Metals analyses of sediments taken from below the salt pan gave quantifiable levels of V, Zn, As, Cd, Cr and Pb. While these levels are consistent with those of other basins in the area, it is not known whether they are due solely to evaporative concentration of naturally occurring levels in soils or whether they are due partly to allocthonous inputs from industrial discharges.

Nutrient analyses of Laguna Tres gave elevated results for total ammonia and total Kjeldahl. This is consistent with the reduced environment beneath the salt layer. Nitrogenous compounds derived from crude oil contamination of Laguna Quatro may also have contributed to these results. Review of the EPA's guidance literature for both fresh and saltwater ammonia criteria shows that while ammonia toxicity increases with both temperature and pH, a decrease in toxicity occurs with increasing salinity. The EPA did not publish criteria for un-ionized ammonia in saline environments beyond thirty parts per thousand, while salinity levels in the hypersaline playas studied in 1992 ranged from 140 to 390 parts per thousand. Further, the accuracy of the method used to calculate the un-ionized fraction of total ammonia is questionable when used in conditions of high ionic strength. In light of the above, it is worthy of note that the lake with the highest calculated un-ionized ammonia level (Middle Lake) among the hypersaline systems studied during 1992, also supported the second highest benthic standing crop (3897/m^2) and greatest number of taxa (4) of all these lakes. Results for analyses for total phosphorus and dissolved phosphorus are anomalous in that dissolved phosphorus is reported at three orders of magnitude greater than total phosphorus. This discrepancy is attributed to sample contamination in the field, laboratory error, or both.

Phytoplankton could not be found in Laguna Tres (Table 43). Qualitative diatom analyses from periphyton scrapes of substrates in seeps flowing to the lake resulted in a total of three taxa comprising 12 cells in over 100 fields counted (Table 44). Shannon-Wiener diversity was poor, although conventional indices of diversity are probably inapplicable to this hypersaline system.

Sweeps made for benthic macroinvertebrates yielded no organisms in the lake, although some _Hydropyrus_ sp. and larval Muscidae were taken from seeps flowing to the lake (Table 45). Toxicity studies conducted by personnel of the U.S.

Fish and Wildlife Service resulted in the mortality or immobility of 100% of Artemia salina in water within 24 hours and 42% of Hydropyrus sp. larvae in sediment within 48 hours. While the cause of this mortality or immobility has not been positively identified, electrolytic stress induced by high salinity is thought to be sufficient explanation (Tables 46a-b).

In the absence of definitive data, no final conclusions can be drawn as to what has rendered this basin virtually abiotic. Comparison with Laguna Walden, however, demonstrates that the potential for life in lakes in this area is very high, and that some factor or combination of factors is suppressing both the flora and the fauna of Laguna Tres. Despite the net gain in surface area the abiotic nature of Laguna Tres serves only to reduce the system's usefulness to migrating and resident waterfowl.

Review of BLM water quality data for April 1975 shows sodium at 53,000 mg/l, potassium at 8800 mg/l and chloride at 97,000 mg/l (BLM 1975). These concentrations compare favorably with results obtained for Laguna Walden during this set of surveys 17 years after the BLM study. Sodium concentration at the time of sampling in Laguna Tres was 100,900 mg/l, potassium was measured at 33,000 mg/l and chloride was 209,000 mg/l. These findings indicate that Laguna Tres in 1975 probably was a biologically active basin capable of supporting numerous shorebirds and other waterfowl.

At this time it is not known whether the increase in salinity in the small cutoff subbasin, evidenced by the development of a thick salt crust on the basin floor by April of 1993, represents a trend related to changes in the rest of the basin, or if this is a periodic occurrence typical of this basin. A critical question is raised by a comparison of ion analyses for Laguna Tres and the adjacent, cutoff subbasin (Fig. 39). Results of analyses for major ions sampled in May of 1992 showed the two waters to be similar in the composition of their dissolved constituents, but with one important difference. The total dissolved solids value for the cutoff subbasin was 23,000 mg/l less than that of the Tres/Cinco basin. Examination of the lakes themselves showed the cutoff basin to have a floor of fine sand and to support a large population of brine shrimp, while the Tres/Cinco basin had a 0.3 m layer of coarse, crystalline salt and was virtually abiotic. While it is possible that the two basins were defining opposite sides of a biologically limiting osmotic threshold, it is obvious that a water that is actively crystallizing and dissolving salt in a state of saturation equilibrium would be nearly incapable of supporting a significant biotic community for reasons of simple mechanics. Consequently, if the postulated trend towards the movement of highly concentrated industrial brines into the basins of Nash Draw continues, these basins will be rendered unfit for biotic activity.

Table 41. Water Quality Data for Laguna Tres

EDO4AH.LAG-TRES EDO4AHL-TRES LAGUNA TRES
32 19 46.0 103 56 33.0 4
LAGUNA TRES NE/4 SW/4 S12 T23S R29E
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 13060011
0001 METERS DEPTH 906 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00010 WATER TEMP CENT	00400 PH SU	00095 CNDUCTVY AT 25C MICROMHO	00300 DO MG/L	82205 SPECIFIC GRAVITY GM/L	00480 SALINITY PPTH	00031 INCDT LT REMNING PERCENT	82079 TURBIDTY LAB NTU	00612 UN-IONZD NH3-N MG/L	00053 SURFACE AREA ACRES
92/05/05	1300	WATER	0.2	28.2		570674J	.8		390.0J	100.0			
92/05/05	1300	VERT	0.2		7.80			2.20D			14.0	0.7	616L

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00078 TRANSP SECCHI METERS	00079 COLOR FORL-ULE SCALE	00204 DEPTH-M 1% LIGHT REMAINS	00410 T ALK CACO3 MG/L	00440 HCO3 ION HCO3 MG/L	00530 RESIDUE TOT NFLT MG/L	70300 RESIDUE DISS-180 C MG/L	00600 TOTAL N N MG/L	00605 ORG N N MG/L	00608 NH3+NH4- N DISS MG/L
92/05/05	1300	VERT	0.2	.20	2J	.2	227	277	293	395584	19.14	.800	16.300

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00610 NH3+NH4- N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00631 NO2&NO3 N-DISS MG/L	00640 T INORG. NITROGEN MG/L N	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P	00671 PHOS-DIS ORTHO MG/L P	00900 TOT HARD CACO3 MG/L	00915 CALCIUM CA,DISS MG/L
92/05/05	1300	VERT	0.2	15.700	16.500	2.64	2.1	18.34	.060	1.400	.010K	29560J	470.0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00925 MGNSIUM MG,DISS MG/L	00930 SODIUM NA,DISS MG/L	00935 PTSSIUM K,DISS MG/L	00940 CHLORIDE TOTAL MG/L	00945 SULFATE SO4-TOT MG/L	71870 BROMIDE BR MG/L	32210 CHLRPHYL A UG/L	32211 CHLRPHYL A UG/L CORRECTD	32212 CHLRPHYL B UG/L	32214 CHLRPHYL C UG/L
92/05/05	1300	VERT	0.2	6900.0	100900.0	33000.00	209000	25500	82.30	4.69C	4.67C	.41C	.00C

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	32218 PHEOPHTN A UG/L	32221 % CHL A OF PHE A + CHL A	09501 RA-226 TOTAL PC/L	09502 RA-226 ERROR PC/L	11501 RA-228 TOTAL PC/L	11502 RA-228 ERROR PC/L	11503 RA-226 + RA-228 PC/L	11504 RA-226 + 228 ERR PC/L	75038 K-40 TOTAL PC/L	75037 K-40 ERROR PC/L
92/05/05	1300	VERT	0.2	.00	100C	11.0J	.4C	0.0	6.0C	11.0J	6.0C	28900.0	500.0C

Remark codes: C= calculated value, D= field measurement, J= estimated value, K= less than, L= greater than, U= undetected

Table 41, cont.

EDO4AH.LAG-TRES EDO4AHL-TRES LAGUNA TRES
32 19 46.0 103 56 33.0 4
LAGUNA TRES NE SW S12 T23S R29E
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 13060011
0001 METERS DEPTH 906 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01106 ALUMINUM AL,DISS UG/L	01000 ARSENIC AS,DISS UG/L	01005 BARIUM BA,DISS UG/L	01010 BERYLIUM BE,DISS UG/L	01020 BORON B,DISS UG/L	01025 CADMIUM CD,DISS UG/L	82036 CALCIUM DISS CA UG/L	82037 MG DISS MG UG/L	01030 CHROMIUM CR,DISS UG/L	01035 COBALT CO,DISS UG/L
92/05/05	1300	VERT	0	100K	25K	100K	100.00K	7400	25K	190000	8530000	25K	50K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01040 COPPER CU,DISS UG/L	01046 IRON FE,DISS UG/L	01049 LEAD PB,DISS UG/L	01056 MANGNESE MN,DISS UG/L	71890 MERCURY HG,DISS UG/L	01060 MOLY MO,DISS UG/L	01065 NICKEL NI,DISS UG/L	01145 SELENIUM SE,DISS UG/L	01140 SILICON SI,DISS UG/L	01075 SILVER AG,DISS UG/L
92/05/05	1300	VERT	0	100K	100K	100K	50.0K	.5K	100K	100K	500K	600	100.0K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01080 STRONTUM SR,DISS UG/L	01100 TIN SN,DISS UG/L	01085 VANADIUM V,DISS UG/L	01090 ZINC ZN,DISS UG/L	71900 MERCURY HG,TOTAL UG/L	01147 SELENIUM SE,TOT UG/L
92/05/05	1300	VERT	0	6000	100K	100K	100K	.5K	2000K

Remark Codes: K= less than

Table 41, cont.

ED04AH.LAG-TRES ED04AHL-TRES LAGUNA TRES
32 19 46.0 103 56 33.0 4
LAGUNA TRES NE SW S12 T23S R29E
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/SIO/PLAYA
21NMEX 920822 13060011
0001 METERS DEPTH 906 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00917 CA MUD DRY WGT MG/KG-CA	00924 MG MUD DRY WGT MG/KG-MG	01003 ARSENIC SEDMG/KG DRY WGT	01008 BA MUD DRY WGT MG/KG-BA	01013 BERYLIUM SEDMG/KG DRY WGT	01019 CD MUD WET WGTM G/KG-CD	01023 B MUD DRY WGT MG/KG-B	01029 CHROMIUM SEDMG/KG DRY WGT	01038 CO MUD DRY WGT MG/KG-CO	01043 COPPER SEDMG/KG DRY WGT
92/05/05	1300	WATER	0	46337.00	9412.00	2.20	145.00	7.00K		26.00	6.50	7.00K	7.00K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01053 MN MUD DRY WGT MG/KG-MN	01063 MO MUD DRY WGT MG/KG-MO	01068 NICKEL SEDMG/KG DRY WGT	01078 SILVER SEDMG/KG DRY WGT	01083 SR MUD DRY WGT MG/KG-SR	01088 V MUD DRY WGT MG/KG-V	01093 ZINC SEDMG/KG DRY WGT	01103 TIN MUD DRY WGT MG/KG-SN	01108 AL MUD DRY WGT MG/KG-AL
92/05/05	1300	WATER	0	78.00	7.00K	7.00K	7.00K	767.00	10.00	12.00	7.00K	4634.00

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01144 SI MUD DRY WGT MG/KG-SI	01170 FE MUD DRY WGT MG/KG-FE	71921 MERCURY SEDMG/KG DRY WGT
92/05/05	1300	WATER	0	319.00	3620.00	.3K

Table 41, cont.

EDO4AH.LAG-TRES EDO4AHL-TRES LAGUNA TRES
32 19 46.0 103 56 33.0 4
LAGUNA TRES NE SW S12 T23S R29E
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 13060011
0001 METERS DEPTH 906 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81552 ACETONE TOT UG/L	78124 BENZENE HOH VOL UG/L	81555 BROMO BENZENE TOT UG/L	73085 CLBRMETH TOTAL WTR UG/L	32101 DICLBRMT TOTUG/L	32104 BROMOFRM WHL-WTR UG/L	81595 MTH ETH KETONE TOT UG/L	77342 N-BUTLBZ TOTAL UG/L	77350 SEC-BUTB TOTAL UG/L	77353 T-BUTLBZ TOTAL UG/L
92/05/05	1300	VERT	0.2	125.00U	25.00U	25.000U	25.0U	25.0U	25.0U	125.000U	25.000U	25.000U	25.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	46491 MTBE WATER TOT UG/L	32102 CARBNTET TOTUG/L	34301 CHLOROBE NZENE TOTWUG/L	32106 CHLRFORM TOTUG/L	38680 CHLOROTO LUENEWTR TOT UG/L	77277 P-CLTOLU TOTAL UG/L	82625 DIBRCLRO PRPN TOT REC UG/L	32105 CLDIBRMT TOTUG/L	30203 ETHAN12 WTR,WHL REC UG/L	77596 DBRMETHA TOTAL UG/L
92/05/05	1300	VERT	0.2	125.00U	25.0U	25.000U	8.2T	25.000U	25.000U	25.0U	25.0U	25.0U	25.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	34536 12DICHLO ROBENZEN TOTWUG/L	34567 13DICHLO ROBENZEN DISSUG/L	34572 14DICHLO ROBENZEN DISSUG/L	34868 DICHLORO DIFLUORO TOTWUG/L	34496 11DICHLO ROETHANE TOTWUG/L	34531 12DICHLO ROETHANE TOTWUG/L	34501 11DICHLO ROETHYLE TOTWUG/L	77093 C-1,2DCE TOTAL UG/L	34546 12DICHLO ROETHENE TOTWUG/L	34541 12DICHLO ROPROPAN TOTWUG/L
92/05/05	1300	VERT	0.2	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77173 1,3DCLPR TOTAL UG/L	77170 2,2DCLPR TOTAL UG/L	77168 1,1DCLPR TOTAL UG/L	34704 C1,3-DCP TOT WAT UG/L	34699 T1,3-DCP TOT WAT UG/L	34371 ETHYLBEN ZENE TOTWUG/L	34391 HEXACHLO ROBUTADI TOTWUG/L	77223 IPROPBNZ TOTAL UG/L	30341 BNZ1MTHL RECOVER WTR UG/L	34423 METHYLEN ECHLORID TOTWUG/L
92/05/05	1300	VERT	0.2	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U	25.00U	25.000U

Remark codes: U= undetected, T= less than criterion of detection

Table 41, cont.

EDO4AH.LAG-TRES EDO4AHL-TRES LAGUNA TRES
32 19 46.0 103 56 33.0 4
LAGUNA TRES NE SW S12 T23S R29E
35015 NEW MEXICO EDDY
WESTERN GULF 120800
PECOS RIVER /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920822 13060011
0001 METERS DEPTH 906 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77418 1MNAPTHA TOTAL UG/L	77416 2MNAPTHA TOTAL UG/L	34696 NAPTHALE NE T OTWUG/L	77224 N-PRPBNZ TOTAL UG/L	77128 STYRENE TOTAL UG/L	77562 1112TCLE TOTAL UG/L	34516 1122TETR ACHLOROE TOTWUG/L	34475 TETRACHL OROETHYL TOTWUG/L
92/05/05	1300	VERT	0.2	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	81607 TETRAHYD FURAN TOT UG/L	78131 TOLUENE WHL HOH VOLUG/L	77613 123TCLBZ TOTAL UG/L	34551 124TRICH LOROBENZ TOTWUG/L	34506 111TRICH LOROETHA TOTWUG/L	34511 112TRICH LOROETHA TOTWUG/L	39180 TRICHLOR ETHYLENE TOT UG/L	34488 TRICHLOR OFLUOROM TOTWUG/L	77443 1,2,3TCP TOTAL UG/L	77222 1,2,4TMB TOTAL UG/L
92/05/05	1300	VERT	0.2	125.000U	25.00U	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U	25.000U

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	77226 1,3,5TMB TOTAL UG/L	39175 VINYLCHL ORIDE TOT UG/L	77135 O-XYLENE TOTAL UG/L	85795 XYLENE M&P WTR WHL UG/L
92/05/05	1300	VERT	0.2	25.000U	25.000U	25.000U	25.00U

Remark codes: U= undetected, T= less than criterion of detection

Table 42. Limiting nutrient and Carlson Trophic State indices computed by SAS.

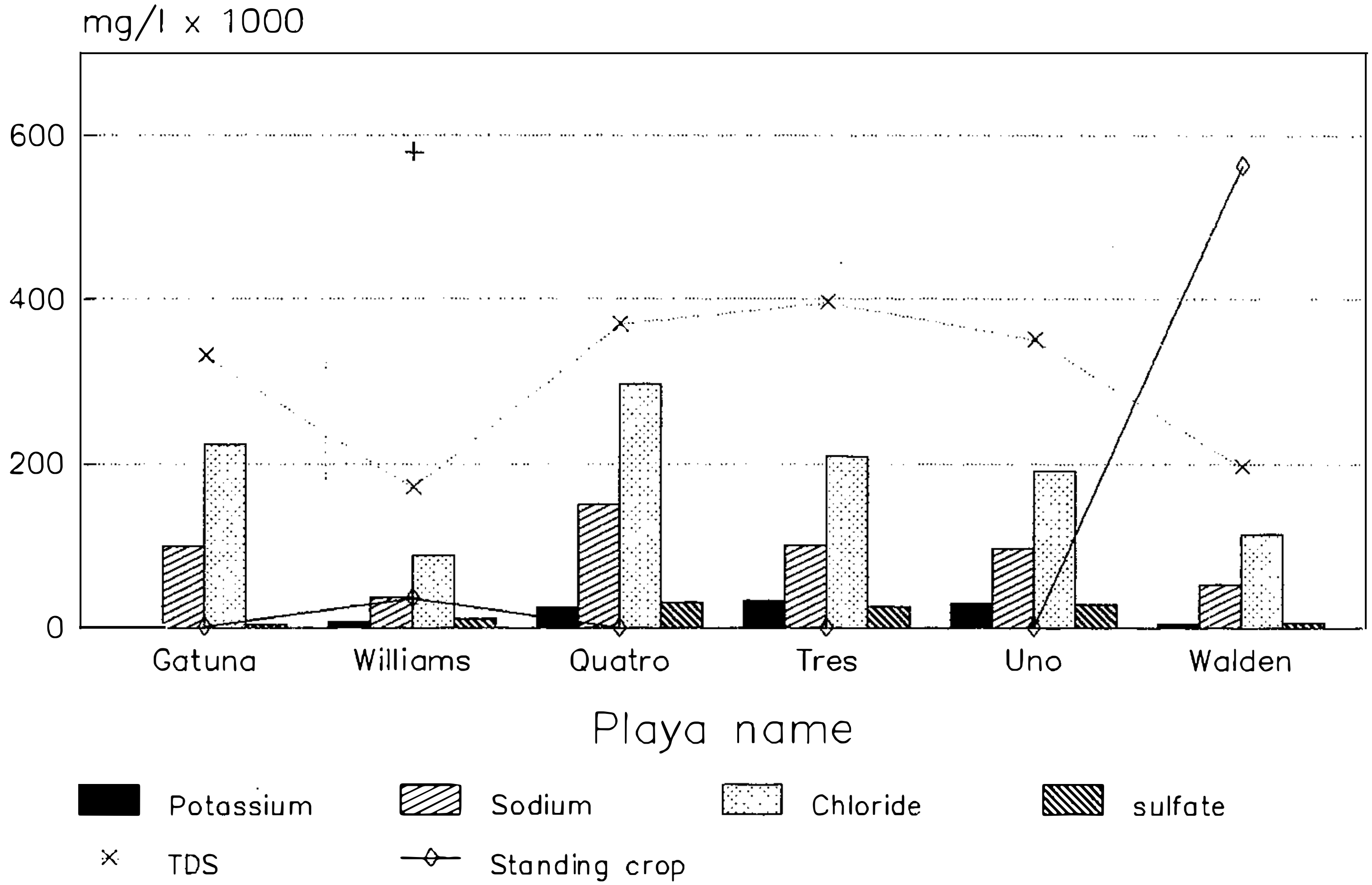
LIMITING NUTRIENT FOR PLAYA LAKES, CALCULATED BY SAS
TN/TP > 17 INDICATES P-LIMITATION
TN/TP 10 - 17 INDICATES N AND/OR P LIMITATION
TN/TP < 10 INDICATES N-LIMITATION

OBS		STATION	DATE	TN	TP	RATIO	LIMITING
1	21NMEX	LE01AA.LAGATUNA	31MAR92	109.30	0.20	546.500	P
2	21NMEX	ED01AB.WLMSSINK	01APR92	4.33	0.18	24.056	P
3	21NMEX	LE03AC.LANSALLK	14APR92	17.85	0.38	46.974	P
4	21NMEX	LE04AD.MIDDLELK	14APR92	14.54	0.11	132.182	P
5	21NMEX	ED01AE.LAGUNUNO	04MAY92	40.65	0.25	162.600	P
6	21NMEX	ED02AF.LAG-WALD	04MAY92	1.67	0.89	1.876	N
7	21NMEX	ED03AG.LGQUATRO	05MAY92	23.39	0.96	24.365	P
8	21NMEX	ED04AH.LAG-TRES	05MAY92	19.14	0.06	319.000	P
9	21NMEX	M001AIWMSALTLKE	09JUN92	3.53	0.13	27.154	P
10	21NMEX	HA01AJ.CHICOSAL	26AUG92	7.40	0.64	11.562	N &/OR P

CARLSON TROPHIC STATE INDICES COMPUTED BY SAS
TSI <42 OLIGOTROPHIC, 42-47 MESOTROPHIC, >47 EUTROPHIC

OBS		STATION	DATE	CARLCHL	TSICHL	CARLSDD	TSISDD	CARLTP	TSITP
1	21NMEX	LE01AA.LAGATUNA	920331	25.0470	OLIGOTRO	60.0000	EUTRO	80.593	EUTRO
2	21NMEX	ED01AB.WLMSSINK	920401	32.4332	OLIGOTRO	54.1491	EUTRO	79.073	EUTRO
3	21NMEX	LE03AC.LANSALLK	920414	41.9761	OLIGOTRO	77.3733	EUTRO	89.855	EUTRO
4	21NMEX	LE04AD.MIDDLELK	920414	.	--	77.3733	EUTRO	71.967	EUTRO
5	21NMEX	ED01AE.LAGUNUNO	920504	.	--	77.3733	EUTRO	83.813	EUTRO
6	21NMEX	ED02AF.LAG-WALD	920504	28.7344	OLIGOTRO	77.3733	EUTRO	102.136	EUTRO
7	21NMEX	ED03AG.LGQUATRO	920505	55.7913	EUTRO	60.0000	EUTRO	103.228	EUTRO
8	21NMEX	ED04AH.LAG-TRES	920505	45.6853	MESOTRO	83.2242	EUTRO	63.220	EUTRO
9	21NMEX	M001AIWMSALTLKE	920609	32.2697	OLIGOTRO	66.2162	EUTRO	74.377	EUTRO
10	21NMEX	HA01AJ.CHICOSAL	920826	85.9582	EUTRO	93.2263	EUTRO	97.378	EUTRO

Fig. 36 Playa biota x 100 vs major ions.
Numbers of invertebrates relative to concentrations of selected major ions.



+ = number of invertebrates per square meter x 100 taken at Williams Sink, February 26, 1992.

Fig. 37 Stiff diagrams: Nash Draw playas meq/liter

Chemical Constituents in Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl
Walden	3/ 5/1692	240.88	18.96	55.36	0.00	0.00	12.08	0.31	321.59
Laguna Uno	3/ 5/1692	486.67	15.97	55.36	0.00	0.00	59.34	0.31	588.81
Laguna Tres	4/ 5/1692	583.30	2.35	56.76	0.00	0.00	58.09	0.45	583.59
Lag. Quatro	4/ 5/1692	716.04	2.35	56.76	0.00	0.00	63.50	0.37	837.84

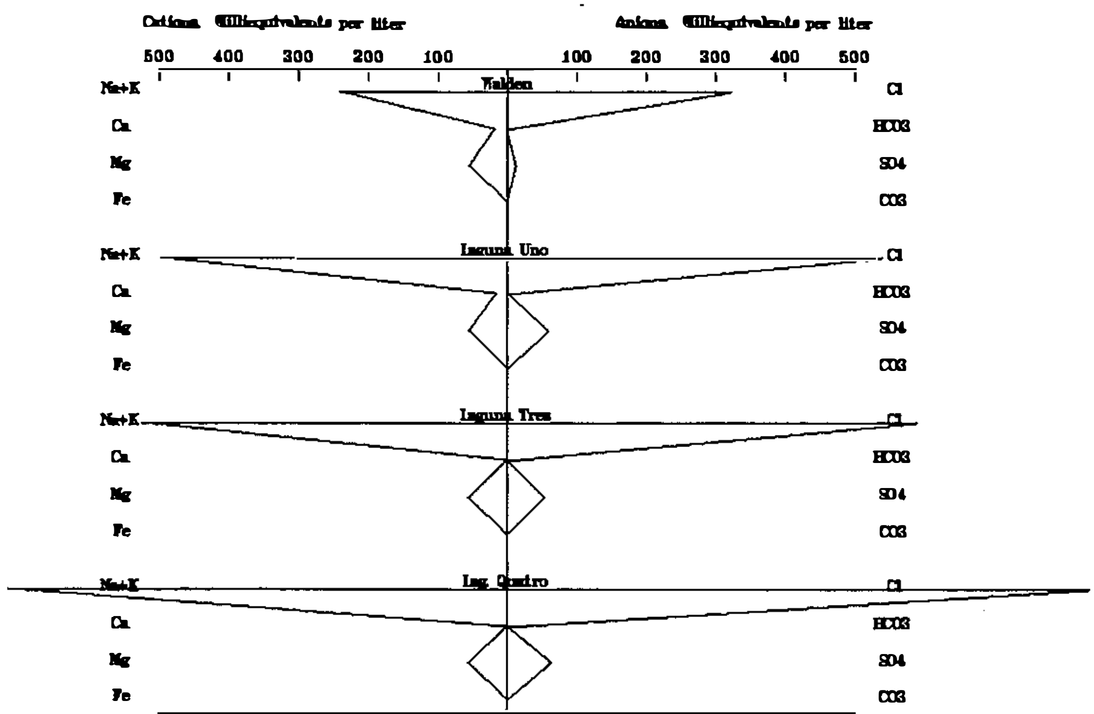


Fig. 38 Stiff diagrams: Nash Draw playas % meq/liter

Chemical Constituents in % Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl	SAR	ESP	RSC
Walden	3/ 5/1692	76.42	6.02	17.56	0.00	0.00	3.62	0.09	96.29	37.58	35.14	-74.01
Laguna Uno	3/ 5/1692	87.42	2.82	9.76	0.00	0.00	9.91	0.06	90.03	70.58	50.70	-71.02
Laguna Tres	4/ 5/1692	89.85	0.40	9.75	0.00	0.00	8.26	0.07	91.67	80.74	54.09	-58.65
Lag. Quatro	4/ 5/1692	82.38	0.30	7.32	0.00	0.00	7.04	0.04	82.82	120.43	63.82	-58.73

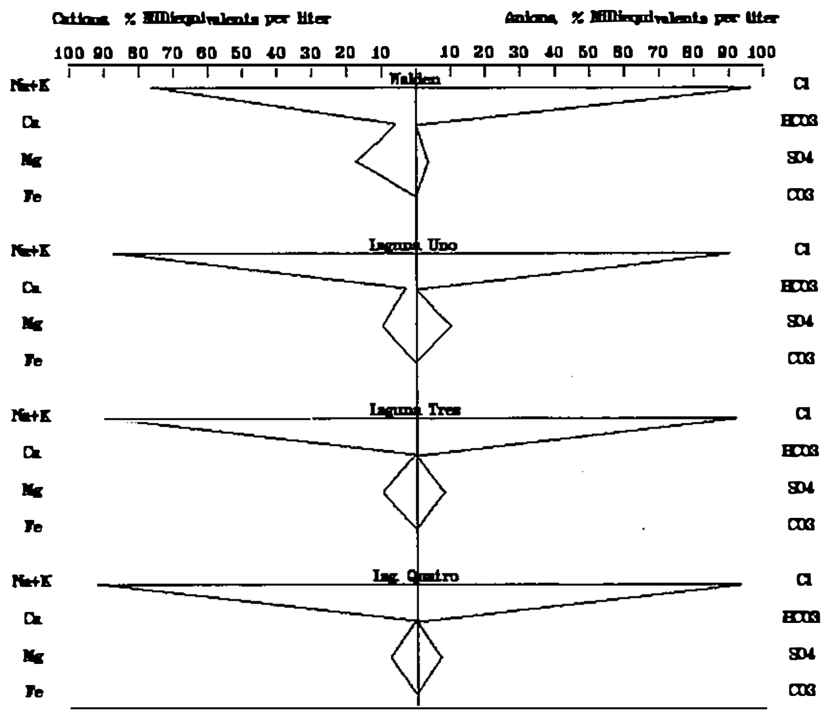
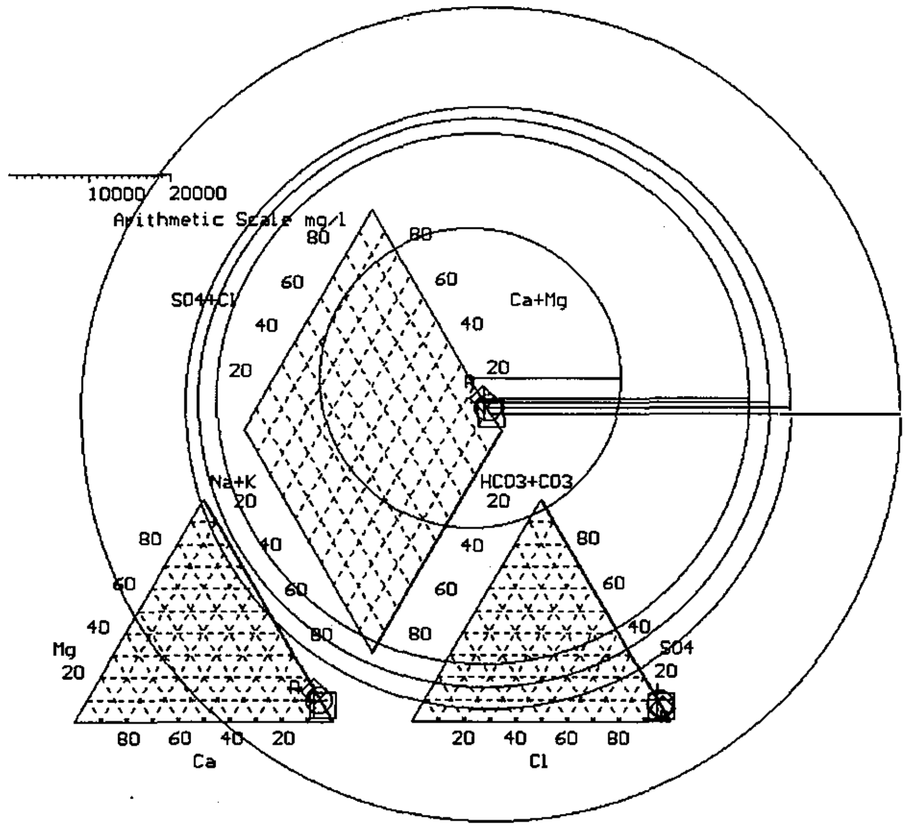


Fig. 39 Trilinear diagram: Nash Draw playas. mg/l x 0.1



Diamond=«» Square=■ Circle=°

Walden 05/04/1992-R Laguna Uno 05/04/1992-+ Laguna Tres 05/05/1992-° Lag. Quatro 05/05/1992-■
Cutoff basin 05/05/1992-«»

Table 43. Phytoplankton collected from Nash Draw playas, Eddy County, New Mexico, April 4-5, 1992.

Lake	Station	Date	Taxon	Count (%)
Laguna Walden	ED02AF.LAG-WALD	92/05/04	_Fragilaria_	395 (56.2)
			Synedra	169 (24.0)
			Achnanthes	29 (4.1)
			Cymbella	57 (8.1)
			Nitzschia	29 (4.1)
			Dunaliella	18 (2.5)
			Crucigenia	3 (0.4)
			Gleocystis	3 (0.4)
		Total		703
		Taxa Richness		8
		Shannon - Wiener Diversity		1.84
		Evenness		0.61
Laguna Uno	ED01AE.LAGUNUNO	92/05/04	none found	0 (100)
Laguna Tres	ED04AH.LAG-TRES	92/05/05	none found	0 (100)
Laguna Quatro	ED03AG.LGQUATRO	92/05/05	_Dunaliella_	1848 (100)
		Total		1848
		Taxa Richness		1
		Shannon - Wiener Diversity		0.00
		Evenness		0.00

Table 44.

QUALITATIVE DIATOM ANALYSIS OF LAGUNA TRES, MAIN BODY: N.M. 1992
Multiple substrate periphyton scrapes:

	NAME	# CELLS
1.	Achnanthes deflexa Reim. sp. nov.	9
2.	Amphora coffeiformis (Ag.) Kutz. var. coffeiformis	1
3.	Denticula sp.	2
	Total =	12

SHANNON-WIENER INDEX OF DIVERSITY

Total number of fields viewed for formal count = 100+
Total species per formal count = 3
Total species identified = 3

H = 1.04
Hmax = 1.58
Equitability = 0.66

Note:

Over 100 fields were scanned to derive the 12 diatom frustules listed above. Compare these analysis with Laguna Tres "cut-off" and notice the increased taxa richness as well as numbers of individuals. Diversity calculations are questionable in this sample due to the scaricity of diatoms.

Table 44, cont.

QUALITATIVE DIATOM ANALYSIS OF LAGUNA TRES CUTOFF, N.M.: 1992
Multiple substrate periphyton scrapes derrived from two slides.

	NAME	# CELLS
1.	*Denticula elegans* Kutz. var. *elegans*	1
2.	*Hantzschia amphioxys* (Ehr.) Grun.	29
3.	*Navicula mutica* var. *cohnii* (Hilse) Grun.	7
4.	*Pinnularia borealis* Ehr. var. *borealis*	3
5.	*Surirella* sp.	1
	Total =	41

SHANNON-WIENER INDEX OF DIVERSITY

Total number of fields viewed for formal count = 110
Total species per formal count = 5
Total species identified = 5

H = 1.33
Hmax = 2.32
Equitability = 0.57

Note: The Laguna Tres "cutoff" is so named because it is separated from the main body of Laguna Tres, and is suspected of being fed by springs as well as surface runoff.

Table 45. 1992 PLAYA SURVEY MACROINVERTEBRATE ABUNDANCES

Williams Sink 920401 (ref.)		**Laguna Gatuna** 920331
26° station		East Shore
Artemia salina	275	0
Hydropyrus sp., near *cinearea*	50	0
Dasyhelea sp.	21	0
Stratiomys sp.	1	0
240° station		West shore
Artemia salina	69	4
Hydropyrus sp., near *cinearea*	268	11
Dasyhelea sp.	11	0

Middle Lake 920414 (ref.)		**Lane Salt Lake** 920414
N side of island		inlet channel
Artemia salina	3890	0
Hydropyrus sp., near *cinearea*	1	541
Culicidae, prob. *Aedes* sp.	5	0
Stratiomys sp.	1	0
Muscidae	0	6
S. shore		½ mi. N. of S. end
Artemia salina	3507	0
Hydropyrus sp., near *cinearea*	15	0

"Laguna Walden" 920504 (ref.)		**Laguna Uno** 920504
S. end		W. end
Artemia salina	2201	0
Hydropyrus sp., near *cinearea*	3436	0
Nemotelus sp.	1	0

Laguna Tres 920505
near Murchison Nash #3
none found

Laguna Quatro 920505
W. end
none found

Table 46a. Results of adult *Artemia salina* 48 hr acute toxicity tests (100% test and control water).

Test Site	% Survival	Control site	% Survival
Laguna Gatuna	0[‡]	Williams Sink	97.8
Lane Salt Lake	0[‡]	Middle Lake	100.0
Burro Pipeline effl.	0[‡]	Middle Lake	100.0
Laguna Uno	0	Laguna Walden	96.0
Laguna Tres	0[‡]	Laguna Walden	96.0
Laguna Quatro	0	Laguna Walden	96.0

‡ 100% mortality/immobility after 24 hrs.

Table 46b. Results of larval *Hydropyrus sp.* 48 hr acute toxicity tests (100% test and control sediment).

Test Site	% Survival	Control Site	% Survival
Laguna Gatuna	56[1]	Williams Sink	80
Lane Salt Lake[2]	No sediment toxicity tests were conducted		
Laguna Uno	36[1]	Laguna Walden	96
Laguna Tres	58[1]	Laguna Walden	96
Laguna Quatro	12[1]	Laguna Walden	96

1 Survival = individual larvae that were not dead or immobile.

2 Too few *Hydropyrus* larvae were collected from Middle Lake for comparative toxicity testing.

Table 46c. Migratory bird species of Laguna Uno, Eddy County, New Mexico, May 4, 1992.

Species	Number	Activity
Blue-winged/cinnamon teal	2	Loafing
Swallow species	1	Fly over
Duck species	1	Fly over
Peregrine falcon	1	Chasing duck
Total	5	

Table 46d. Migratory bird species of Laguna Walden, Eddy County, New Mexico, May 4, 1992.

Species	Number	Activity
Black-necked stilt	14	Feeding/nesting
Wilson's phalarope	9	Feeding
Greater yellowlegs	1	Feeding
Killdeer	5	Vocalizing
Snowy egret	11	Fly over/nesting?
Total	40	

Table 46e. Migratory bird species of Laguna Tres, Eddy County, New Mexico, May 5, 1992.

Species	Number	Activity
Wilson's phalarope	10	Feeding/Loafing*
Snowy plover	10	Feeding*
Yellowlegs	2	Feeding*
Snowy plover	1	Along shore
Total	23	

Important note: There were no birds observed on Laguna Quatro during the survey.

* Birds encountered in a cut-off portion of Laguna Tres

CONCLUSIONS AND RECOMMENDATIONS ON HYPERSALINE PLAYA LAKES

New Mexico's closed basin lakes are subject to a variety of anthropogenic stresses ranging from riparian damage by grazing animals to contamination by industrial by-products. The naturally saline basins of Eddy and Lea counties form a special subset of the State's ephemeral lakes, not only because they have been subjected to the most extreme human impacts encountered during this survey, but also because of the unique position they occupy in the Southern High Plains ecosystem. The stark, other-worldly appearance of these lakes has led to a fundamental misunderstanding of the biological function and importance of these systems.

Under pre-industrial conditions the saline lakes of Eddy and Lea Counties were almost certainly dry most of the year. Runoff, carrying dissolved materials from the surrounding soils, would periodically accumulate sufficiently to produce pools of standing water, most of which would subsequently evaporate, leaving the dissolved solids fraction as a thin crust of salts. Continuous salt build up in normally functioning playa basins is limited by two primary hydrologic influences. Some lakes appear to be internally draining and salt is flushed out as water infiltrates through the basin floor. Other lakes have an impervious layer of clay covering the floor of their basins, preventing outflow of salt under normal water level conditions. During periods of high runoff, however, the salt is diluted and the water level may be raised above the elevation of the clay pan, whereupon salt is flushed into the ground-water table or washed from the basin by overland flow. Additionally, large quantities of salt may be removed by wind action as the crystalline structure of the salt layer degrades during the weathering process. This continuing cycle of accumulation and dispersion is thought to maintain a long term average dissolved solids concentration in water collecting in the basins within tolerances conducive to the robust productivity seen in Laguna Walden, Williams Sink and Middle Lake. The protein resources of the system then are available for the support of large populations of resident and migratory waterfowl, as well as other vertebrate life.

At Lane Salt Lake, Laguna Gatuna and in the Nash Draw the cyclic functioning of the saline lake systems has been interrupted. The continuous inputs of concentrated industrial brines have rendered the lakes virtually perennial and raised the average water level to a point at or above extreme natural flood conditions for much of the year.

The brine discharges enter the systems in an already concentrated condition and are further subject to a greater or lesser degree of evaporative concentration, depending on the season. The net effect of this dynamic is to produce a waterbody that is attractive to migratory waterfowl, but that is devoid of primary, and therefore secondary production, denying the birds of a much needed food source. Furthermore, under certain conditions, dissolved solids levels reach such high concentrations that waterfowl become encrusted with salt and, unable to feed, drink or leave, die. These lakes thus become an "attractive nuisance", luring migratory waterfowl to their death.

Playa lakes are Waters of the U.S. (40 CFR 122.2) and Waters of the State (Water Quality Standards for Interstate and Intrastate Streams 3-100 ss NMWQCC 1991). As such it is appropriate for the State to ascertain uses and to develop standards for the support and protection of those uses if the protection provided under the general standards and livestock and wildlife watering standards is not adequate.

As discussed above, playa lakes are highly dynamic, ephemeral systems supporting an indigenous biota specifically adapted to flourish under highly variable conditions. Saline and hypersaline playas are the extreme examples of this variability. In light of the above considerations the following numeric and narrative standards are proposed:

L. Wildlife Habitat: Numeric or narrative standards listed below shall not be exceeded.

1. Numeric Standards

Total mercury	0.012 ug/l
Total selenium	2.0 ug/l
Total chlorine residual	13.0 ug/l
Ammonia (un-ionized) NH_3 as N	0.19 mg/l

2. Narrative Standard

In addition to the numeric standards set out in L.1, the wildlife habitat narrative standard shall be the concentration of a substance which, if not exceeded, protects wildlife populations inhabiting aquatic environments or using aquatic organisms for food from adverse effects in the surface waters of the State. Numeric standards under this narrative provision shall be calculated as given in "Appendix D to Part 132--Great Lakes Water Quality Initiative Methodology for the Development of Wildlife Criteria and Values." *In* Wildlife Criteria Portions of the Proposed Water Quality Guidance for the Great Lakes System, July 1993. EPA-822-R-93-006, or latest edition thereof, which is incorporated herein by reference.

WATER QUALITY SURVEY OF WAGON MOUND SALT LAKE IN MORA COUNTY, NEW MEXICO JUNE 9, 1992

Introduction

During 1992 the Surveillance and Standards Section conducted a water quality assessment of Wagon Mound Salt Lake in Mora County, New Mexico (Fig. 40). The field team visited the playa lake on June 9, 1992.

Wagon Mound Salt Lake is located in northeastern New Mexico approximately 1.5 miles north of Wagon Mound, New Mexico, via the northbound frontage road (old highway 85), and then west for 1/2 mile to the lake. The lake is deeded property of the New Mexico Department of Game and Fish. Many years ago, the Department stocked Wagon Mound Salt Lake with rainbow trout. Because of the lack of overall fishing use, in part due to the water chemistry characteristics, the NMDG&F decided to discontinue fish stocking, and concentrate their efforts on providing a water fowl refuge and management area.

The lake is approximately 97 hectares (240 acres) at maximum pool with a corresponding elevation of 1875 meters (6,150 ft) above mean sea level. Maximum depth of the lake when at this elevation is about 4.3 meters (14 ft) deep, though a more normal depth is about 2 meters (6.5 ft) with a surface area of 61 hectares (150 acres). Water is supplied by both surface runoff from the watershed and from the five springs located on the western side of the lake. Between natural watershed runoff and the natural spring input, Wagon Mound lake may be classified as a perennial playa lake.

This basin is located in the semi-arid Western Tablelands ecoregion where mean annual precipitation is about 45 cm/yr (17.6 in/yr), with an annual deficit of about 38 cm/yr (14.9 in/yr) (Gabin and Lesperance 1977). These data were collected at Wagon Mound and represent a 32-year period of record.

Soils associated with Wagon Mound Salt Lake are of the Argiustolls-Rock outcrop complex, Vermejo silty clay loam and Vermejo-Karde association. The Argiustolls-Rock outcrop is located on the edges of basalt-capped mesas or canyon walls, and are usually steep, well drained soils produced by basalt weathering. There is little hazard of wind erosion, though potential for water erosion is very high. Vermejo silty clay loam is a moderately well drained soil usually associated with valley floors and dry lake beds. Runoff from this soil is rapid, and both water and wind erosion potential is high. The Vermejo-Karde association is typically found in the bottom of intermittent lakes and potholes. It is a moderately well drained soil exhibiting rapid runoff, and high water and wind erosion potential (Soil Conservation Service 1985).

Though cattle grazing by permit is no longer allowed by the New Mexico Department of Game and Fish, the long history of cattle use in the area appears to have had limited impact within the immediate vicinity of the lake. A lush mix of grasses, forbs, brush and a few trees surrounds the lake.

Water Quality Standards

Water quality standards for Wagon Mound Salt Lake are set forth in section 1-

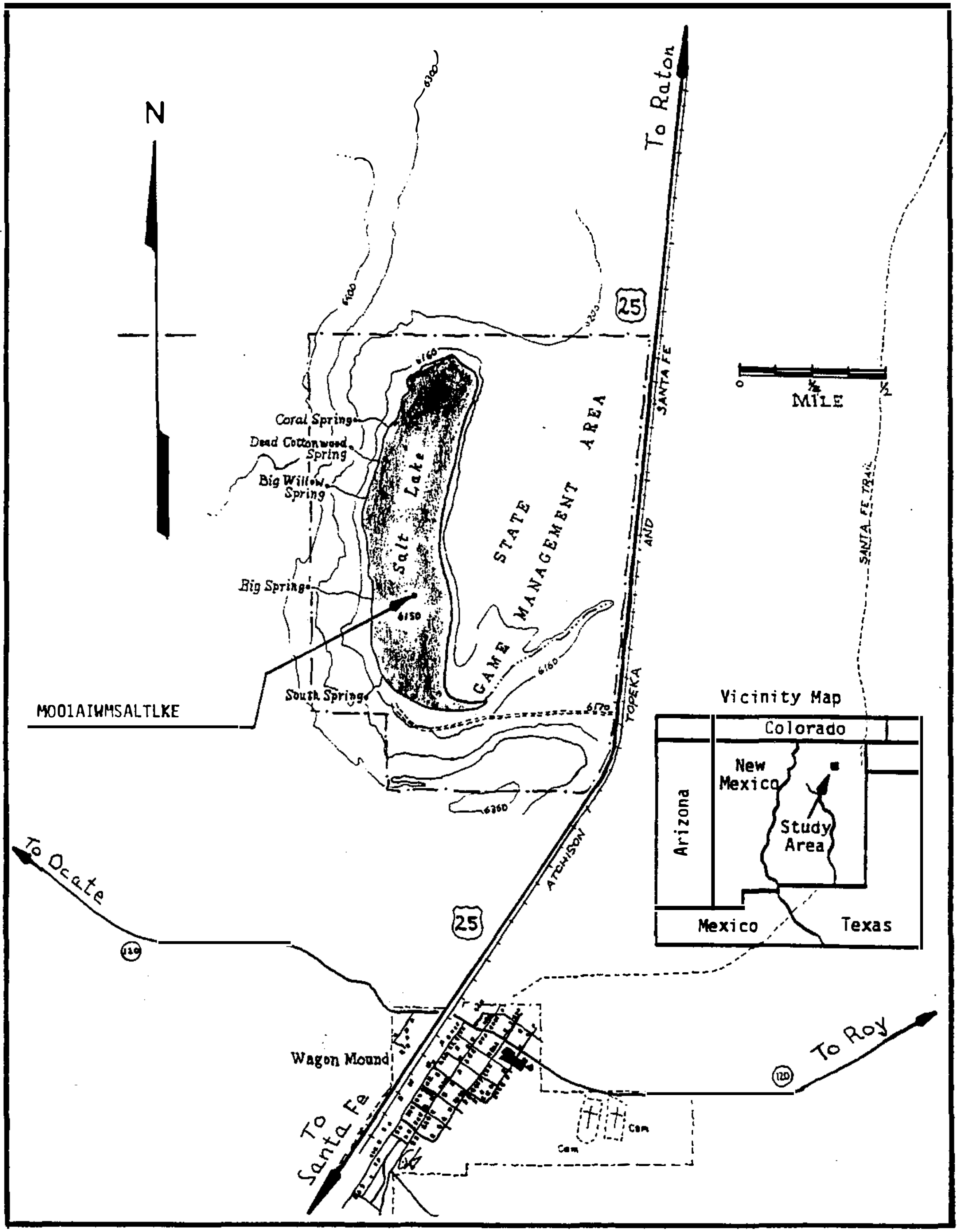


Fig. 40. Wagon Mound Salt Lake study site, 1992.

102 of the New Mexico water quality standards (NMWQCC 1991). Water quality standards specific to playa lakes have not been adopted. The principal objective of studying the diverse playa lakes of New Mexico is to develop numeric and narrative water quality standards that will support and protect the attainable uses of these waters of the State.

Methods

Water quality sampling methods were in accordance with the "New Mexico Clean Lakes Program: Lake Water Quality Assessment" work plan (NMED 1992) and the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 1992).

Water Quality Assessment

Water quality data for playa lake station MOO1AIWMSALTLKE are available on STORET and can be retrieved using the selector A=21NMEX and restrictor IS=923515. Parametric coverage, water quality and biological data are provided in tables 47 through 51.

Wagon Mound Salt Lake may be classified as eutrophic according to Carlson's (1977) indices for chlorophyll a, total phosphorus, Secchi disc depth, and Likens' (1975) phytoplankton community composition (Table 48). Total nitrogen to phosphorus ratios indicate that phosphorus is the limiting nutrient in Wagon Mound Salt Lake. Phytoplankton community composition consisted primarily of the blue-green algae Synechocystis and a small number of Anacystis, which totaled 1,566 cells/ml (Table 49). The Shannon-Wiener diversity indices indicate that phytoplankton diversity was poor during the sampling trip. Qualitative diatom analysis of multiple substrate periphyton scrapes resulted in 14 species per 205 cells. Shannon-Wiener diversity indices showed that diatom diversity was very good (Table 50).

Measurements for pH were 7.7 standard units in the main spring feeding the lake and 9.24 standard units at the mid-lake station. High nutrient concentrations and associated primary productivity are likely to be the major factors influencing pH in Wagon Mound Salt Lake. Early records from the 1950's, provided by the NMDG&F, show pH values to regularly be 9.5 standard units. This suggests that pH has remained fairly constant over the past 40 years.

Quantitative macroinvertebrate sampling was not performed though qualitative sampling was performed for both bottom sediment and littoral macroinvertebrates. Three species were identified from bottom sediments collected at the mid-lake station by an Ekman dredge. Littoral sweeps using a D-net yielded 14 different species representing various families of Diptera, Coleoptera, Hemiptera, Odonata and Cladocera (Table 51).

A large population of ducks and shorebirds were observed during the survey. American avocet, killdeer, eared grebes, Wilson's phalarope, cinnamon teal, ruddy ducks, solitary sandpipers, western grebes and mallards were present in large numbers. Also present were red winged blackbirds, yellow headed blackbirds, western meadow larks and swallows.

Wagon Mound Salt Lake had a total dissolved solids concentration of 9900 mg/l with sodium, sulfate and chloride making up the bulk of the solids (Figs. 41-43). Total and dissolved metals were within acceptable limits except for dissolved arsenic, which exceeded the standard for livestock and wildlife watering use. Results from analysis for radium 226 and 228 were well below levels of concern. Water quality data, biological integrity and the sizable waterfowl population strongly support the importance of Wagon Mound Salt Lake as wildlife habitat.

Table 47. Water quality data for Wagon Mound Salt Lake, 1992.

NOO1AIWMSALTLKE NOO1AIWMLAKE WAGONMOUNDLK
36 02 04.0 104 42 26.0 4
WAGON MOUND SALT LAKE-MIDDLE @ DEEPEST POINT
35033 NEW MEXICO MORA
SOUTHCENTRAL-LOWER MISS 101200
SOUTH CANADIAN RIV ABV TEX-OKLA ST LINE /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 11080003
0002 METERS DEPTH 1875 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00010 WATER TEMP CENT	00400 PH SU	00095 CNDUCTVY AT 25C MICROMHO	00300 DO MG/L	00480 SALINITY PPTH	00612 UN-IONZD NH3-N MG/L	82079 TURBIDTY LAB NTU	00608 NH3+NH4- N DISS MG/L	00053 SURFACE AREA ACRES	00612 UN-IONZD NH3-N MG/L
92/06/09	1120	WATER	0	18.0		14820J	7.1	7.2J				240	
92/06/09	1120	WATER	1	17.0		12180J	7.1	7.0J					
92/06/09	1120	WATER	2	16.5		11700J	7.5	7.0J	0.001J				
92/06/09	1120	VERT	2		9.24					12.8	.100		.001C
92/06/09	1120	VERT	QA REPLICATE								.150		

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00078 TRANSP SECCHI METERS	00079 COLOR FORL-ULE SCALE	00204 DEPTH-M 1% LIGHT REMAINS	00410 T ALK CACO3 MG/L	00440 HCO3 ION HCO3 MG/L	00530 RESIDUE TOT NFLT MG/L	70300 RESIDUE DISS-180 C MG/L	00600 TOTAL N N MG/L	00605 ORG N N MG/L	00680 TOT ORG CARBON MG/L
92/06/09	1120	VERT	2	.85	10	2.0	1460	1470	37	9900	3.53C	3.38C	200K
92/06/09	1120	VERT	QA REPLICATE				1450	1450	35	9735	3.73C	3.57C	200.0K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00610 NH3+NH4- N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00631 NO2&NO3 N-DISS MG/L	00640 T INORG. NITROGEN MG/L N	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P	00671 PHOS-DIS ORTHO MG/L P	00900 TOT HARD CACO3 MG/L	00915 CALCIUM CA,DISS MG/L
92/06/09	1120	VERT	2	.100K	3.48	.05	.05	.15C	.130	.020	.010K	1405	17.0
92/06/09	1120	VERT	QA REPLICATE	.110K	3.68	.05	.08	.16C	.070	.010	.010K	1399	18.0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00925 MGNSIUM MG,DISS MG/L	00930 SODIUM NA,DISS MG/L	00935 PTSSIUM K,DISS MG/L	00940 CHLORIDE TOTAL MG/L	00945 SULFATE SO4-TOT MG/L	32210 CHLRPHYL A UG/L	32211 CHLRPHYL A UG/L CORRECTD	32212 CHLRPHYL B UG/L	32214 CHLRPHYL C UG/L
92/06/09	1120	VERT	2	331.0	2552	36.0	1570	3650	1.38	1.19	.24	.46
92/06/09	1120	VERT	QA REPLICATE	329.0	2522	36.0	1610	3750				

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 47, cont.

MO01AIWMSALTLKE MO01AIWMLAKE WAGONMOUNDLK
36 02 04.0 104 42 26.0 4
WAGON MOUND SALT LAKE-MIDDLE @ DEEPEST POINT
35033 NEW MEXICO MORA
SOUTHCENTRAL-LOWER MISS 101200
SOUTH CANADIAN RIV ABV TEX-OKLA ST LINE /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920718 11080003
0002 METERS DEPTH 1875 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	32218 PHEOPHTN A UG/L	32221 % CHL A OF PHE A + CHL A
92/06/09	1120	VERT	2	.32	86

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	09501 RA-226 TOTAL PC/L	09502 RA-226 ERROR PC/L	11501 RA-228 TOTAL PC/L	11502 RA-228 ERROR PC/L	11503 RA-226 + RA-228 PC/L	11504 RA-226 + 228 ERR PC/L
92/06/09	1120	VERT	2	.20	.1	3.5	3.5	3.70	3.5
92/06/09	1120	VERT	QA REPLICATE	.12	.1	4.9	3.5	5.02	3.5

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01106 ALUMINUM AL,DISS UG/L	01000 ARSENIC AS,DISS UG/L	01010 BERYLIUM BE,DISS UG/L	01020 BORON B,DISS UG/L	01025 CADMIUM CD,DISS UG/L	82036 CALCIUM DISS CA UG/L	82037 MG DISS MG UG/L	01030 CHROMIUM CR,DISS UG/L	01035 COBALT CO,DISS UG/L	01040 COPPER CU,DISS UG/L
92/06/09	1120	VERT	2	100K	58	100K	800	1K	15000	400000	5	50K	100K
92/06/09	1120	VERT	QA REPLICATE	100K	53	100K	900	1K	15000	380000	5	50K	100K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01046 IRON FE,DISS UG/L	01049 LEAD PB,DISS UG/L	01056 MANGNESE MN,DISS UG/L	71890 MERCURY HG,DISS UG/L	01060 MOLY MO,DISS UG/L	01065 NICKEL NI,DISS UG/L	01145 SELENIUM SE,DISS UG/L	01140 SILICON SI,DISS UG/L	01075 SILVER AG,DISS UG/L	01080 STRONTUM SR,DISS UG/L
92/06/09	1120	VERT	2	100K	5K	50.0K	.5K	100K	100K	10	2500	100K	1000
92/06/09	1120	VERT	QA REPLICATE	100K	5K	50.0K	.5K	100K	100K	9	2400	100K	1000

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 47, cont.

MOO1AIWMSALTLKE MOO1AIWMLAKE WAGONMOUNDLK
36 02 04.0 104 42 26.0 4
WAGON MOUND SALT LAKE-MIDDLE @ DEEPEST POINT
35033 NEW MEXICO MORA
SOUTHCENTRAL-LOWER MISS 101200
SOUTH CANADIAN RIV ABV TEX-OKLA ST LINE /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 92071B 110B0003
0002 METERS DEPTH 1875 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01100 TIN SN,DISS UG/L	01085 VANADIUM V,DISS UG/L	01090 ZINC ZN,DISS UG/L	71900 MERCURY HG,TOTAL UG/L	01147 SELENIUM SE,TOT UG/L	01005 BARIUM BA,DISS UG/L
92/06/09	1120	VERT	2	100K	100K	100K	.5K	21	100K
92/06/09	1120	VERT	QA REPLICATE	100K	100K	100K	.5K	11	100K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01108 AL MUD DRY WGT MG/KG-AL	01008 BA MUD DRY WGT MG/KG-BA	01013 BERYLIUM SEDMG/KG DRY WGT	01023 B MUD DRY WGT MG/KG-B	01028 CD MUD DRY WGT MG/KG-CD	00917 CA MUD DRY WGT MG/KG-CA	01029 CHROMIUM SEDMG/KG DRY WGT	01038 CO MUD DRY WGT MG/KG-CO	01043 COPPER SEDMG/KG DRY WGT	01170 FE MUD DRY WGT MG/KG-FE
92/06/09	1120	WATER	2	612.00	7.40	.44K	1.75	0.31	3148.00	36.30	.22K	.44	525.00
92/06/09	1120	VERT	QA REPLICATE	840.00	9.2	.40K	2.50	0.33	3648.00	43.56	.25	.80	670.00

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00924 MG MUD DRY WGT MG/KG-MG	01053 MN MUD DRY WGT MG/KG-MN	01063 MO MUD DRY WGT MG/KG-MO	01068 NICKEL SEDMG/KG DRY WGT	01144 SI MUD DRY WGT MG/KG-SI	01078 SILVER SEDMG/KG DRY WGT	01083 SR MUD DRY WGT MG/KG-SR	01103 TIN MUD DRY WGT MG/KG-SN	01088 V MUD DRY WGT MG/KG-V
92/06/09	1120	WATER	0									
92/08/09	1120	WATER	1									
92/06/09	1120	WATER	2	1049.0	7.40	.44K	.44	20.60	.44K	33.70	.44K	1.75
92/08/09	1120	VERT	QA REPLICATE	1174.0	9.10	.40K	.80	22.60	.40K	35.60	.40K	2.10

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	01093 ZINC SEDMG/KG DRY WGT	71921 MERCURY SEDMG/KG DRY WGT	01148 SELENIUM SEDMG/KG DRY WGT	01103 ARSENIC SEDMG/KG DRY WGT	01052 LEAD SEDMG/KG DRY WGT
92/06/09	1120	WATER	0					
92/06/09	1120	WATER	1					
92/06/09	1120	WATER	2	1.30	1.1K	2.10	13.73	23.57
92/06/09	1120	VERT	QA REPLICATE	1.30	1.1K	1.76	11.87	26.12

REMARK CODES: C = calculated value, K = actual value is less than value shown, J = estimated value, * = WQ STANDARD VIOLATION

Table 48. Limiting nutrient and Carlson Trophic State indices computed by SAS.

LIMITING NUTRIENT FOR PLAYA LAKES, CALCULATED BY SAS
TN/TP > 17 INDICATES P-LIMITATION
TN/TP 10 - 17 INDICATES N AND/OR P LIMITATION
TN/TP < 10 INDICATES N-LIMITATION

OBS		STATION	DATE	TN	TP	RATIO	LIMITING
1	21NMEX	LE01AA.LAGATUNA	31MAR92	109.30	0.20	546.500	P
2	21NMEX	ED01AB.WLMSSINK	01APR92	4.33	0.18	24.056	P
3	21NMEX	LE03AC.LANSALLK	14APR92	17.85	0.38	46.974	P
4	21NMEX	LE04AD.MIDDLELK	14APR92	14.54	0.11	132.182	P
5	21NMEX	ED01AE.LAGUNUNO	04MAY92	40.65	0.25	162.600	P
6	21NMEX	ED02AF.LAG-WALD	04MAY92	1.67	0.89	1.876	N
7	21NMEX	ED03AG.LGQUATRO	05MAY92	23.39	0.96	24.365	P
8	21NMEX	ED04AH.LAG-TRES	05MAY92	19.14	0.06	319.000	P
9	21NMEX	MO01AIWMSALTLKE	09JUN92	3.53	0.13	27.154	P
10	21NMEX	HA01AJ.CHICOSAL	26AUG92	7.40	0.64	11.562	N &/OR P

CARLSON TROPHIC STATE INDICES COMPUTED BY SAS
TSI <42 OLIGOTROPHIC, 42-47 MESOTROPHIC, >47 EUTROPHIC

OBS		STATION	DATE	CARLCHL	TSICHL	CARLSDD	TSISDD	CARLTP	TSITP
1	21NMEX	LE01AA.LAGATUNA	920331	25.0470	OLIGOTRO	60.0000	EUTRO	80.593	EUTRO
2	21NMEX	ED01AB.WLMSSINK	920401	32.4332	OLIGOTRO	54.1491	EUTRO	79.073	EUTRO
3	21NMEX	LE03AC.LANSALLK	920414	41.9761	OLIGOTRO	77.3733	EUTRO	89.855	EUTRO
4	21NMEX	LE04AD.MIDDLELK	920414	.	--	77.3733	EUTRO	71.967	EUTRO
5	21NMEX	ED01AE.LAGUNUNO	920504	.	--	77.3733	EUTRO	83.813	EUTRO
6	21NMEX	ED02AF.LAG-WALD	920504	28.7344	OLIGOTRO	77.3733	EUTRO	102.136	EUTRO
7	21NMEX	ED03AG.LGQUATRO	920505	55.7913	EUTRO	60.0000	EUTRO	103.228	EUTRO
8	21NMEX	ED04AH.LAG-TRES	920505	45.6853	MESOTRO	83.2242	EUTRO	63.220	EUTRO
9	21NMEX	MO01AIWMSALTLKE	920609	32.2697	OLIGOTRO	66.2162	EUTRO	74.377	EUTRO
10	21NMEX	HA01AJ.CHICOSAL	920826	85.9582	EUTRO	93.2263	EUTRO	97.378	EUTRO

Fig. 41 Stiff diagrams: northeast lakes meq/l

		Chemical Constituents in Equivalents per Million							
Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl
Chicosa Lake	26/ 8/1992	92.88	14.62	85.80	0.00	0.00	116.59	2.96	76.17
Wagonmound	6/ 6/1992	111.93	0.85	27.23	0.00	0.00	75.99	24.09	44.29

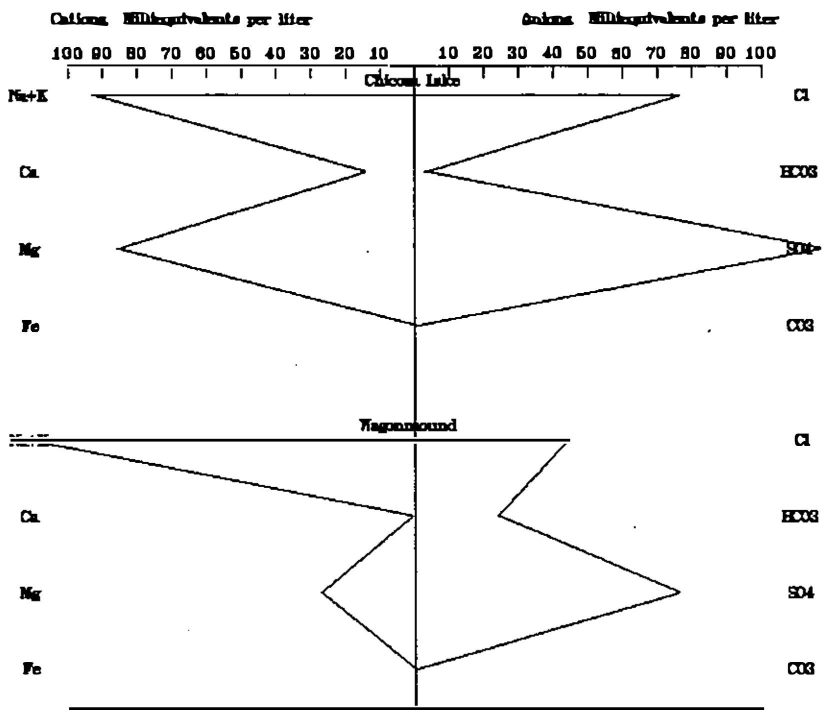


Fig. 42 Stiff diagrams: northeast lakes % meq/l

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl	SAR	ESP	RSC
	Chemical Constituents in % Equivalents per Million											
Chicosa Lake	26/ 8/1992	48.05	7.56	44.39	0.00	0.00	59.57	1.51	38.92	12.77	14.95	-97.47
Wagonmound	6/ 6/1992	79.95	0.61	19.45	0.00	0.00	52.64	16.69	30.68	29.[illegible]	29.80	-3.98

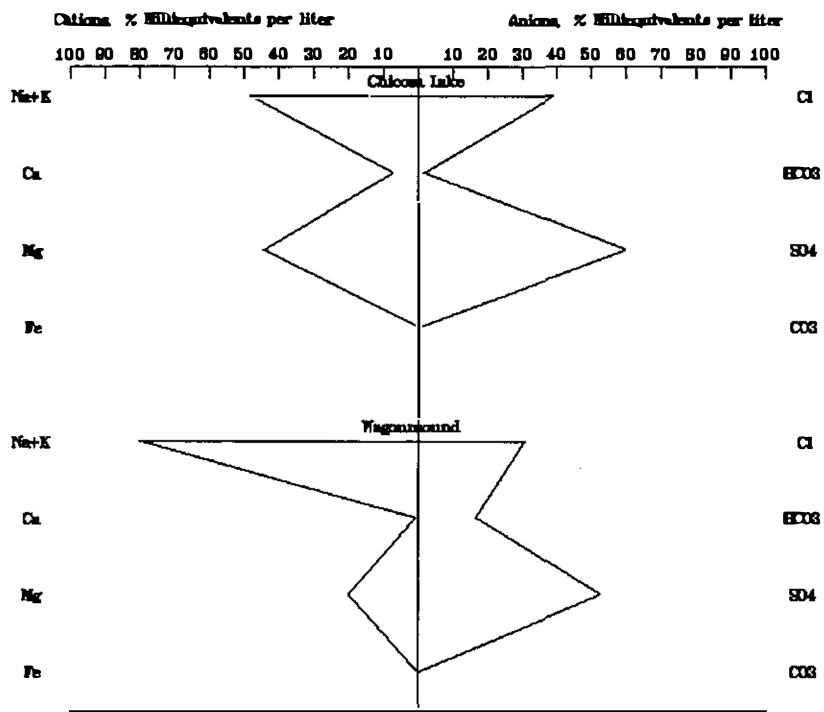


Fig. 43 Piper Trilinear diagram: northeast lakes mg/l

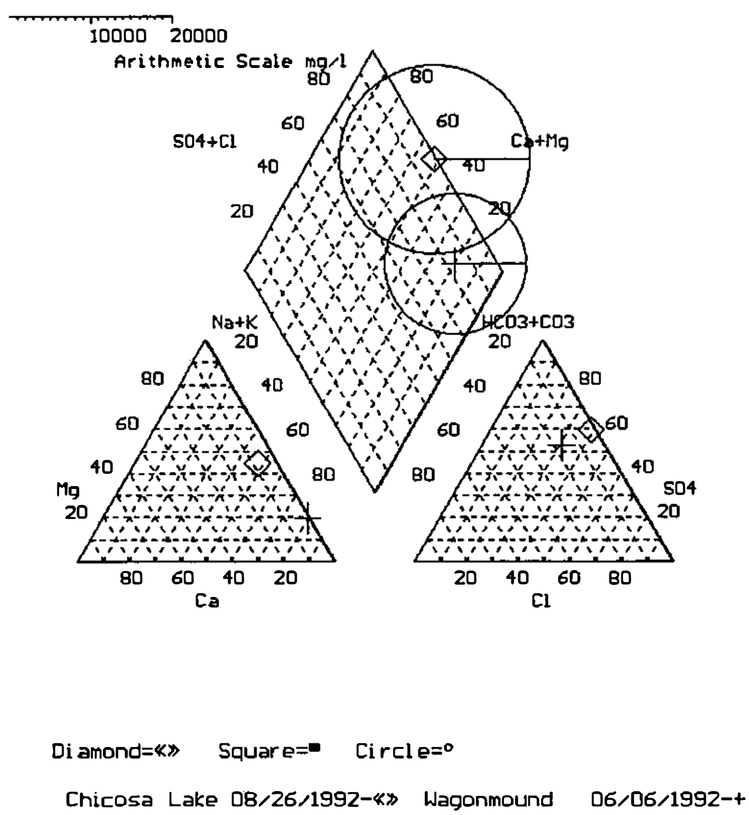


Table 49, Phytoplankton collected from Chicosa and Wagon Mound Salt Lakes, Harding and Mora Counties, June 9 and August 8, 1992.

Lake	Station	Date	Taxon	Count (%)
Wagon Mound S. Lk.	MO01AI.WMSALTLKE	92/06/09	*Anacystis*	6 (0.4)
			Synechocystis	1560 (99.6)
		Total		1566
		Taxa Richness		2
		Shannon - Wiener Diversity		0.04
		Evenness		0.04
Chicosa Lake	HA01AJ.CHICOSAL	92/08/26	*Anabaena*	16 (1.4)
			Centratractus	136 (11.5)
			Chlorobotrys	1026 (87.1)
		Total		1178
		Taxa Richness		3
		Shannon - Wiener Diversity		0.62
		Evenness		0.39

Table 50.

QUALITATIVE DIATOM ANALYSIS OF WAGON MOUND SALT LAKE, N.M.: 1992
Multiple substrate periphyton scrapes:

	NAME	# CELLS
1.	Amphora coffeiformis (Ag.) Kutz. var. coffeiformis	5
2.	Anomoeoneis costata (Kutz.) Hust. var. costata	9
3.	Cymbella lunata W. Sm. var. lunata	2
4.	Denticula rainierensis Sov. var. rainierensis	2
5.	Mastogloia elliptica var. danseii (Thwaites) Cl.	1
6.	Navicula cryptocephala Kutz. var. cryptocephala	15
7.	N. odiosa Wallace var. odiosa	43
8.	Navicula sp. #3	3
9.	Nitzschia hungarica Grun.	14
10.	N. palea (Kutz.) W. Sm.	22
11.	Pinnularia microstauron (Ehr.) Cl. var. microstauron	2
12.	Rhopalodia gibberula var. vanheurckii O. Mull.	28
13.	Surirella striatula Tarpin	2
14.	Synedra pulchella var. lacerata Hust.	57
		Total = 205

SHANNON-WIENER INDEX OF DIVERSITY

Total number of fields viewed for formal count = 71
Total species per formal count = 14
Total species identified = 14

H = 2.98
Hmax = 3.81
Equitability = 0.78

Table 51. Aquatic macroinvertebrate abundances for Wagon Mound Salt Lake and Chicosa Lake.

Wagon Mound Salt Lk. 920609

Qualitative, deep station, Eckman dredge, sediment grab

Cladocera	
poss. Sididae	rare
Chironomidae	
Chironomus sp.	abundant
Tanypodinae	present

Wagon Mound Salt Lk.
Qualitative, littoral, "D" net

Cladocera poss. Sididae	common
Libellulidae	
poss. *Belonia sp.*	rare (decayed specimen)
Coenagrionidae	
Enellagma sp.	abundant
Corixidae	
Trichocorixa sp.	rare
Tenagobia sp.	rare
Corisella sp.	common
Notonectidae	
Buenoa sp.	present
Hydrophilidae	
Berosus sp.	present
Hydraenidae	
poss. *Ochtebius sp.*	rare
Stratiomyidae	
Stratiomys sp.	present
Dolichopodidae	rare
Chironomidae	
Tanypodinae	abundant
Orthocladiinae	abundant
Chironominae	abundant

Chicosa Lake 920826

Quantitative, benthic sweep, "D" net

Hydrophilidae	
Berosus sp.	1
Corixidae	
Corisella sp.	1

Note also presence of cast ephydrid (Diptera) puparia and very numerous Gastropod tests in sample.

WATER QUALITY SURVEY OF CHICOSA LAKE IN HARDING COUNTY, NEW MEXICO, AUGUST 26, 1992

Introduction

In 1992 the Surveillance and Standards Section conducted a water quality survey of Chicosa Lake in Harding County, New Mexico (Fig. 44). The field team completed its sampling run on August 26, 1992. Chicosa Lake was selected for study as an example of the playas of the Southwestern Tablelands ecoregion.

Chicosa Lake is a small, shallow basin probably formed by aeolian erosion and the dissolution of some fraction of the soil in the basin by infiltrating water. Chicosa Lake is at an altitude of 1,777 m (5,830 ft) above mean sea level. The basin has a maximum wetted surface area of about 40 ac. When surveyed, the wetted area was less then 10 ac. Mean annual precipitation measured at Roy, 7 mi south of Chicosa Lake, is 39.6 cm (15.6 in) and the mean annual water deficit is 65.8 cm (25.0 in) (Gabin and Lesperance 1975).

Chicosa Lake is the smaller of two subbasins lying within a depression of about 2,500 ac. The floor of the larger subbasin, Big Chicosa Lake, about 1 mi southwest of Chicosa Lake, is covered with grasses and seldom accumulates much water. Chicosa Lake has historically held water sufficient to have been used regularly for stock water by 19th century cattle drovers. There is some reason to believe that the larger basin is actually the basin used as a water stop and rendezvous by cattle drovers on the Goodnight-Loving Trail.

In April of 1969 Chicosa Lake was purchased by the New Mexico Park and Recreation Division. At this time a series of low, earthen berms diverted runoff from Leonard Draw in the northwest and also from the southeast side of the lake basin to maintain lake water levels. The berms have since washed out and Chicosa Lake has returned to an ephemeral condition. During periods of sufficient rainfall Chicosa Lake is stocked with catchable sized trout and maintained as a "put and take" fishery by the New Mexico Department of Game and Fish. At the time of sampling, Chicosa Lake had only been holding water for a few days after an extended dry period (Levi Garcia, Park Manager, pers. comm.). Though Chicosa Lake has had recurring blooms of filamentous algae in the past, none was observed during the survey.

Probably due to the short time the playa had contained water and the long antecedent dry period, Chicosa Lake supported only a simple invertebrate and algal community. We observed seven ducks (*Anas* spp.), several unidentified wading birds, an American avocet (*Recurvirostra americana*) and a large number of swallows (Hirundinidae) on or about the lake. A herd of 28 longhorn cattle, maintained and used by the State Park and Recreation Division for historical interpretation, was kept in the vicinity of the lake, but a fence prevents their access to the lake.

Soil in the immediate Chicosa basin is Church clay loam, which is a clayey, calcareous, aquic camberthid aridisol. Church soils are subject to moderate wind erosion. Vegetative cover, consisting of short and mid grasses, was dense to moderate away from the lake; with alkali muhly (*Muhlenbergia* sp) dominant nearer the lake. The influence of aeolian processes in the development of Chicosa Lake is evidenced by the presence of relatively high,

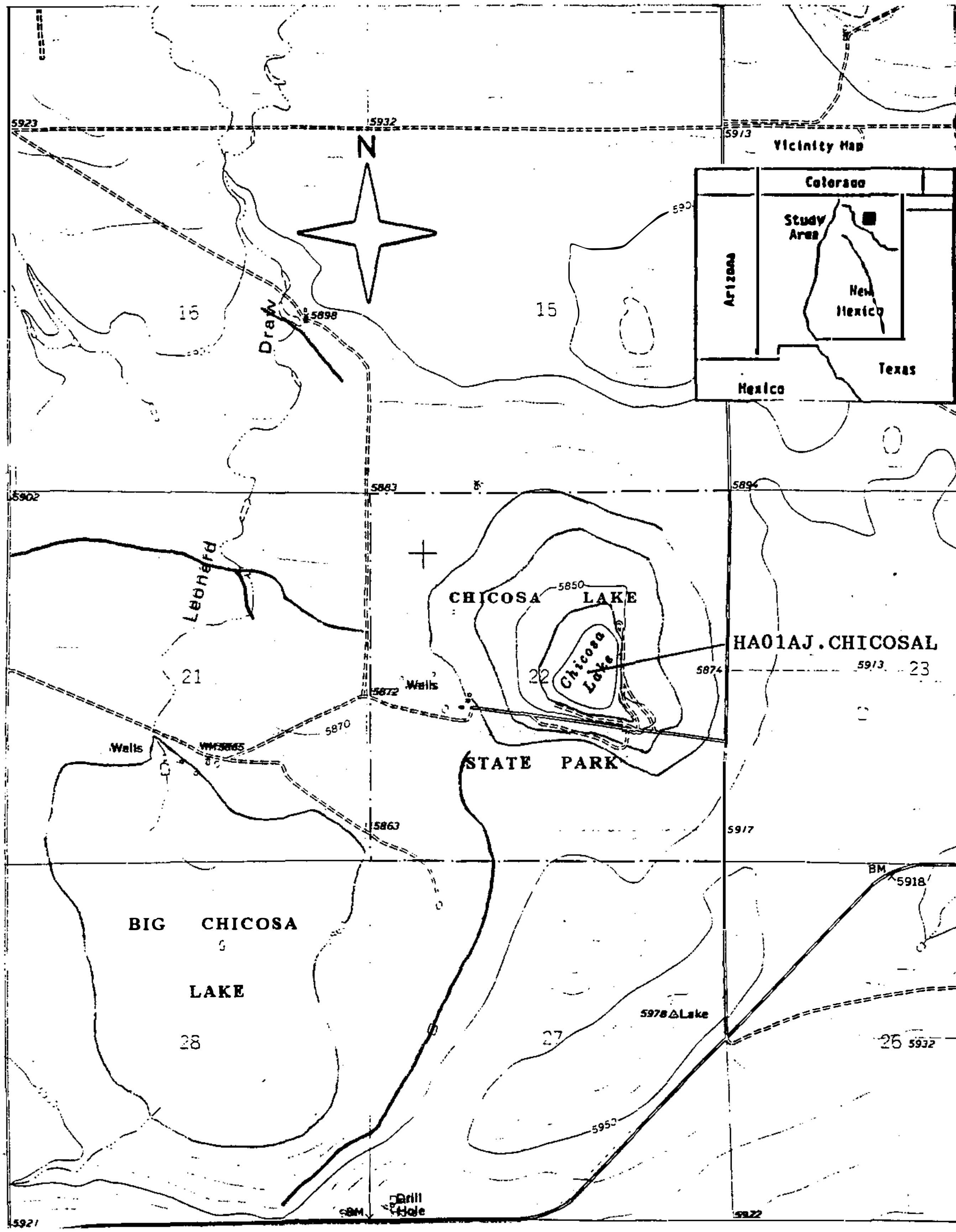


Fig. 44. Chicosa Lake study area, 1992.

wind laid deposits on the east side of the lake. These deposits have been cut into a series of steps by State Park personnel to facilitate access by the public. The presence of exposed 6-8 in roots on the vertical portions of these terraces attests to some degree of erosion since the excavation, however, vegetative cover appeared to be regenerating. The playa floor consisted of pale grey clay over a firmer layer of non-reduced clay and gravel. It is possible that the three to four inch thick layer of soft clay above the firmer, lower layer represents recent, erosional inputs to the lake basin, though this has not been verified.

Water Quality Standards

Water quality standards for Chicosa Lake are set forth in section 1-102 of the New Mexico water quality standards (NMWQCC 1991). Water quality standards specific to playa lakes have not been adopted. The principal objective of studying the diverse playa lakes of New Mexico is to develop numeric and narrative water quality standards that will support and protect the attainable uses of these waters of the State.

Methods

Water quality sampling methods were in accordance with the "New Mexico Clean Lakes Program: Lake Water Quality Assessment" work plan (NMED 1992) and the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 1992).

Water Quality Assessment

Water quality data for playa lake station HA01AJ.CHICOSAL is available on STORET and can be retrieved using the selector A=2INMEX and restrictor IS=923516. Parametric coverage, water quality and biological data are proved here in Tables 52 through 56.

The investigators computed Likens' (1975) phytoplankton community composition index and Carlson's (1977) chlorophyll a, total phosphorus and Secchi disk depth indices (Table 53). These trophic state indices were evaluated for their applicability in comparisons between the playa lakes under investigation. The investigators concluded that these indices have no applicability or usefulness in comparisons between playa lakes. Since these trophic state indices were developed using data from perennial temperate lakes, they were not expected to be useful in comparisons between ephemeral playa lakes.

Chicosa Lake is a sodium-magnesium - sulfate-chloride water (Figs. 45-47). Total dissolved solids at the time of sampling was 13.2 mg/l. Scans for organochlorine and pyrethroid pesticides detected nothing above practical quantitation limits (Table 52). Analysis for radium 226 and 228 found no levels of concern. Results of sediment and dissolved metals are pending as of preparation of this report. A pesticide scan run to determine the concentration of residuals from a 1987 range caterpillar (*Hemileuca oliviae*) control program yielded no results above detection limits. A discrepancy is noted in the results reported for total and dissolved nitrates. A value of 0.09 mg/l total nitrate (as N) is not consistent with a value of 0.24 mg/l dissolved nitrate (as N). This discrepancy could be due to sample contamination in the field or laboratory error. Other nutrient levels, e.g., total Kjeldahl nitrogen and total ammonia, were somewhat elevated, probably due to the presence of cattle in the immediate vicinity of the lake.

The high pH level (9.26 SU) in Chicosa Lake exceeds all fisheries standards, and are attributed to biological activity and the alkaline (pH 7.9 to 8.4 SU) nature of the soils in the lake basin. Un-ionized ammonia (0.3 mg/l), driven by high pH and temperature, exceeded all fisheries standards by an order of magnitude. Un-ionized ammonia at this level has been shown to be toxic to numerous test organisms, including rainbow trout. Were temperature in Chicosa Lake to be lowered to 15 degrees C and pH lowered to 8 SU, the un-ionized fraction of the total ammonia concentration would be reduced from 50.2% to 2.6%; bringing un-ionized ammonia levels well within standards. As this would involve acquisition of sufficient water rights to maintain a depth of at least four feet in the lake as well as shading the south and west shores, there is little likelyhood that the above scenario will ever be realized.

Phytoplankton density was 1,178 cells/ml with three taxa represented (Table 54). Shannon-Wiener diversity was low. Qualitative diatom analysis from multi-substrate periphyton scrapes yielded a total of six taxa for 16 individuals per 150 fields viewed (Table 55). Shannon-Wiener diversity was good. Note that the presence of refractory clays in the slide mount made identification and quantification of diatom frustules extremely difficult.

A benthic macroinvertebrate sweep yielded only two individuals of two taxa, although fragments of cast dipteran puparia (probably Ephydridae) and numerous gastropod tests were noted in the sample (Table 56). This situation, in the probable absence of toxic levels of contaminants, reflects the short period that the lake had contained water prior to sampling. Both insects taken in the water column were winged adults. The presence of cast puparia and numerous snail tests, as well as the presence of invertebrate eggs in the sediments suggests that the lake has supported a richer invertebrate community in the past and, given adequate water, would do so again in the future.

The reputation of Chicosa Lake as a reliable watering stop for cattle drives is not consistent with the current paucity of water in the basin. While the possibility exists that rainfall patterns have changed sufficiently to render Chicosa Lake dry most of the year, it is also possible that the opening of the ground cover associated with livestock grazing has allowed the erosional movement of enough material into the basin to raise the bed of the lake above the average ground-water level as has apparently happened in Big Chicosa Lake. If Chicosa Lake is filling with sediments, the implications for many of the State's playa lakes are considerable. The majority of New Mexico's playa lakes are located on grazed land, and if they are filling with erosional sediments they will eventually be unavailable to wildlife dependent on them for water, habitat and food.

Table 52. Water Quality Data for Chicosa Lake

HA01AJ.CHICOSAL HA01AJCHICOS CHICOSALAKE
36 02 13.0 104 09 31.0 4
LAKE CENTER- CHICOSA LK. ST. PARK
35021 NEW MEXICO HARDING
SOUTHCENTRAL-LOWER MISS. 101200
SOUTH CANADIAN RIV ABV TEX-OKLA ST LINE /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920905 110B0007
0001 METERS DEPTH 1779 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00010 WATER TEMP CENT	00400 PH SU	00095 CNDUCTVY AT 25C MICROMHO	00300 DO MG/L	82205 SPECIFIC GRAVITY GM/L	00480 SALINITY PPTH	00031 INCDT LT REMNING PERCENT	82079 TURBIDTY LAB NTU	00612 UN-IONZD NH3-N MG/L	00053 SURFACE AREA ACRES
92/08/26	1130	VERT	0.1	24.6	9.26	13709	10.1			100.0	256.0	.3	10

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00078 TRANSP SECCHI METERS	00079 COLOR FORL-ULE SCALE	00204 DEPTH-M 1% LIGHT REMAINS	00410 T ALK CACO3 MG/L	00440 HCO3 ION HCO3 MG/L	00530 RESIDUE TOT NFLT MG/L	70300 RESIDUE DISS-180 C MG/L	00600 TOTAL N N MG/L	00605 ORG N N MG/L	00608 NH3+NH4- N DISS MG/L
92/08/26	1130	VERT	0.1	.10	16	.1	148	180	227	13178	7.40C	6.800C	.480

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00610 NH3+NH4- N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00631 NO2&NO3 N-DISS MG/L	00640 T INORG. NITROGEN MG/L N	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P	00671 PHOS-DIS ORTHO MG/L P	00900 TOT HARD CACO3 MG/L	00915 CALCIUM CA,DISS MG/L
92/08/26	1130	VERT	0.1	.510	7.310	.09	.2	.60C	.640	.050	.010	5026	293.0

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	00925 MGNSIUM MG,DISS MG/L	00930 SODIUM NA,DISS MG/L	00935 PTSSIUM K,DISS MG/L	00940 CHLORIDE TOTAL MG/L	00945 SULFATE SO4-TOT MG/L	71870 BROMIDE BR MG/L	32210 CHLRPHYL A UG/L	32211 CHLRPHYL A UG/L CORRECTD	32212 CHLRPHYL B UG/L	32214 CHLRPHYL C UG/L
92/08/26	1130	VERT	0.1	1043.0	2080.00	94.00	2700	5600		288.60C	283.00C	44.20C	.00C

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	32218 PHEOPHTN A UG/L	32221 % CHL A OF PHE A + CHL A	09501 RA-226 TOTAL PC/L	09502 RA-226 ERROR PC/L	11501 RA-228 TOTAL PC/L	11502 RA-228 ERROR PC/L	11503 RA-226 + RA-228 PC/L	11504 RA-226 + 228 ERR PC/L
92/08/26	1130	VERT	0.1	8.54C	98C	1.3	.2C	3.0	6.0C	4.3C	6.0C

Remark codes: C= calculated value, J= estimated value, K= less than, L= greater than, U= undetected

Table 52, cont.

HA01AJ.CHICOSAL HA01AJCHICOS CHICOSALAKE
36 02 13.0 104 09 31.0 4
LAKE CENTER- CHICOSA LK. ST. PARK
35021 NEW MEXICO HARDING
SOUTHCENTRAL-LOWER MISS. 101200
SOUTH CANADIAN RIV ABV TEX-OKLA ST LINE /TYPA/AMBNT/LAKE/BIO/PLAYA
21NMEX 920905 110B0007
0001 METERS DEPTH 1779 METERS ELEVATION

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	39337 ALPHABHC TOTUG/L	39338 BETA BHC TOTUG/L	34259 DELTABHC TOTUG/L	39340 GAMMABHC LINDANE TOT.UG/L	39410 HEPTCHLR TOTUG/L	39330 ALDRIN TOT UG/L	39420 HPCHLREP TOTUG/L	39700 HCB TOT UG/L	39388 ENDOSULN WHL SMPL UG/L	39380 DIELDRIN TOTUG/L
92/08/26	1130	WATER		.050K	.050K	.050K	.050K	.050K	.050K	.050K	.080K	.050K	.100K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	39365 DDE WHL SMPL UG/L	39390 ENDRIN TOT UG/L	82624 ENDOSLFN BETA TOT REC UG/L	39360 DDD WHL SMPL UG/L	82623 ENDOSLFN -SO4 TOT REC UG/L	39370 DDT WHL SMPL UG/L	82622 ENDRIN ALDH TOT REC UG/L	39480 MTHXYCLR WHL SMPL UG/L	78008 ENDRIN KETONE UG/L	39348 A-CHLRDN WHL SMPL UG/L
92/08/26	1130	WATER		.100K	.100K	.1K	.100K	.1K	.100K	.1K	.500K	.10K	.500K

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (M)	39810 G-CHLRDN WHL SMPL UG/L	39400 TOXAPHEN TOTUG/L	39492 PCB-1232 TOTUG/L	39496 PCB-1242 TOTUG/L	39500 PCB-1248 TOTUG/L	39504 PCB-1254 TOTUG/L	39508 PCB-1260 TOTUG/L	39930 PYRTHRNS WHL SMPL TOTUG/L
92/08/26	1130	WATER		.50K	1.000K	.500K	.500K	.500K	1.000K	1.000K	0.5K

Table 53. Limiting nutrient and Carlson Trophic State indices computed by SAS.

LIMITING NUTRIENT FOR PLAYA LAKES, CALCULATED BY SAS
TN/TP > 17 INDICATES P-LIMITATION
TN/TP 10 - 17 INDICATES N AND/OR P LIMITATION
TN/TP < 10 INDICATES N-LIMITATION

OBS	STATION		DATE	TN	TP	RATIO	LIMITING
1	21NMEX	LE01AA.LAGATUNA	31MAR92	109.30	0.20	546.500	P
2	21NMEX	ED01AB.WLMSSINK	01APR92	4.33	0.18	24.056	P
3	21NMEX	LE03AC.LANSALLK	14APR92	17.85	0.38	46.974	P
4	21NMEX	LE04AD.MIDDLELK	14APR92	14.54	0.11	132.182	P
5	21NMEX	ED01AE.LAGUNUNO	04MAY92	40.65	0.25	162.600	P
6	21NMEX	ED02AF.LAG-WALD	04MAY92	1.67	0.89	1.876	N
7	21NMEX	ED03AG.LGQUATRO	05MAY92	23.39	0.96	24.365	P
8	21NMEX	ED04AH.LAG-TRES	05MAY92	19.14	0.06	319.000	P
9	21NMEX	MO01AIWMSALTLKE	09JUN92	3.53	0.13	27.154	P
10	21NMEX	HA01AJ.CHICOSAL	26AUG92	7.40	0.64	11.562	N &/OR P

CARLSON TROPHIC STATE INDICES COMPUTED BY SAS
TSI <42 OLIGOTROPHIC, 42-47 MESOTROPHIC, >47 EUTROPHIC

OBS	STATION		DATE	CARLCHL	TSICHL	CARLSDD	TSISDD	CARLTP	TSITP
1	21NMEX	LE01AA.LAGATUNA	920331	25.0470	OLIGOTRO	60.0000	EUTRD	80.593	EUTRO
2	21NMEX	ED01AB.WLMSSINK	920401	32.4332	OLIGOTRO	54.1491	EUTRO	79.073	EUTRO
3	21NMEX	LE03AC.LANSALLK	920414	41.9761	OLIGOTRO	77.3733	EUTRO	89.855	EUTRO
4	21NMEX	LE04AD.MIDDLELK	920414	.	--	77.3733	EUTRO	71.967	EUTRO
5	21NMEX	ED01AE.LAGUNUNO	920504	.	--	77.3733	EUTRO	83.813	EUTRO
6	21NMEX	ED02AF.LAG-WALD	920504	28.7344	OLIGOTRO	77.3733	EUTRO	102.136	EUTRO
7	21NMEX	ED03AG.LGQUATRO	920505	55.7913	EUTRO	60.0000	EUTRO	103.228	EUTRO
8	21NMEX	ED04AH.LAG-TRES	920505	45.6853	MESOTRO	83.2242	EUTRO	63.220	EUTRO
9	21NMEX	MO01AIWMSALTLKE	920609	32.2697	OLIGOTRO	66.2162	EUTRO	74.377	EUTRO
10	21NMEX	HA01AJ.CHICOSAL	920826	85.9582	EUTRO	93.2263	EUTRO	97.378	EUTRO

Fig. 45 Stiff diagrams: Chicosa/Wagon Mound meq/liter

Chemical Constituents in Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl
Chicosa Lake	26/ 8/1992	92.88	14.62	85.80	0.00	0.00	116.59	2.85	76.17
Wagonmound	6/ 6/1992	111.93	0.85	27.23	0.00	0.00	75.99	24.09	44.29

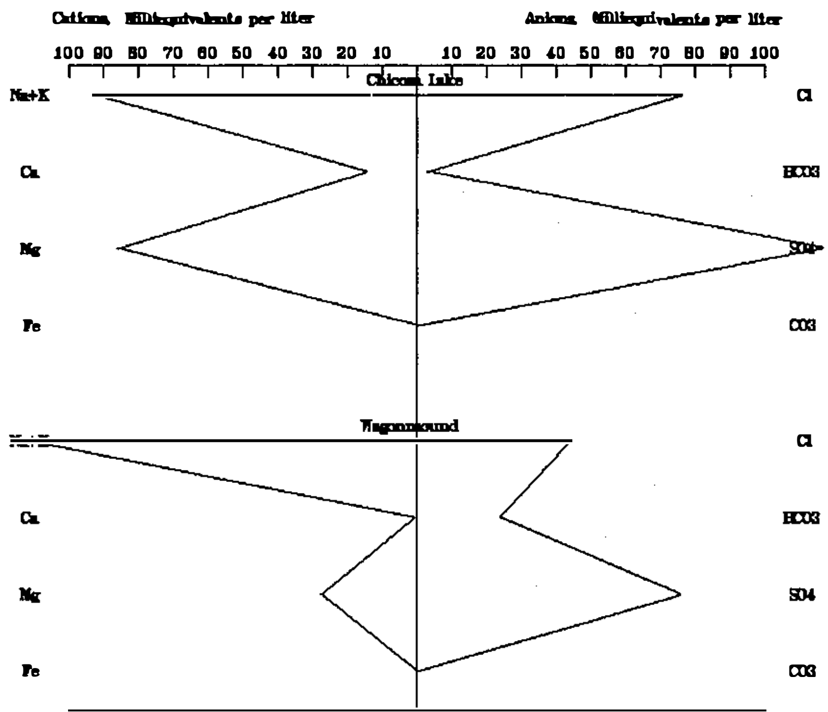


Fig. 46 Stiff diagrams: Chicosa/Wagon Mound % meq/liter

Chemical Constituents in % Equivalents per Million

Sample	Date	NaK	Ca	Mg	Fe	CO3	SO4	HCO3	Cl	SAR	ESP	RSC
Chicosa Lake	26/ 8/1992	48.05	7.56	41.39	0.00	0.00	59.57	1.51	38.92	12.77	14.95	-97.47
Wagonmound	6/ 6/1992	79.95	0.61	19.45	0.00	0.00	52.64	16.69	30.68	29.68	29.80	-3.98

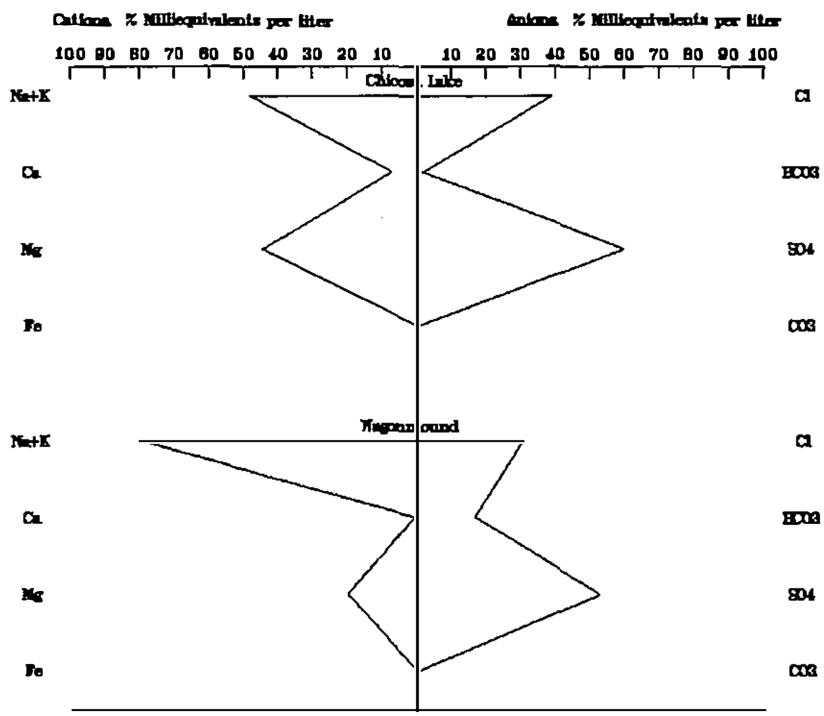
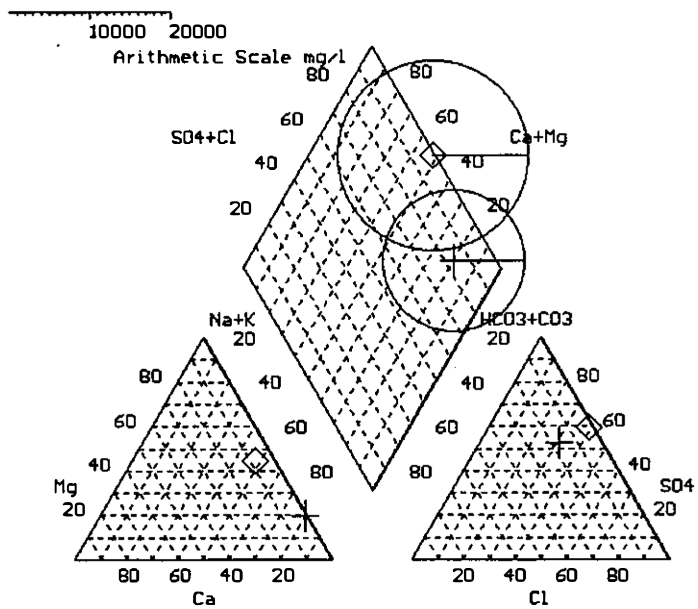


Fig. 47 Trilinear diagram: Chicosa/Wagon Mound Salt Lake



Diamond=«» Square=■ Circle=°

Chicosa Lake 08/26/1992-«» Wagonmound 06/06/1992-+

Table 54. Phytoplankton collected from Chicosa and Wagon Mound Salt Lakes, Harding and Mora Counties, June 9 and August 8, 1992.

Lake	Station	Date	Taxon	Count (%)
Wagon Mound S. Lk.	MO01AI.WMSALTLKE	92/06/09	Anacystis	6 (0.4)
			Synechocystis	1560 (99.6)
		Total		1566
		Taxa Richness		2
		Shannon - Wiener Diversity		0.04
		Evenness		0.04
Chicosa Lake	HA01AJ.CHICOSAL	92/08/26	Anabaena	16 (1.4)
			Centratractus	136 (11.5)
			Chlorobotrys	1026 (87.1)
		Total		1178
		Taxa Richness		3
		Shannon - Wiener Diversity		0.62
		Evenness		0.39

Table 55.

QUALITATIVE DIATOM ANALYSIS OF CHICOSA LAKE, N.M.: 1992
Sediment and periphyton mix:

	NAME	# CELLS
1.	Amphora coffeiformis (Ag.) Kutz. var. coffeiformis	8
2.	Cymbella sp. poss. affinis Kutz. var. affinis	1
3.	Naviculs mutica var. cohnii (Hilse) Grun.	2
4.	Navicula sp. #2	1
5.	Navicula sp. #3 prob. tripunctata var. schizonemoides (V.H.) Patr.	3
6.	Rhopalodia sp.	1
	Total =	16

SHANNON-WIENER INDEX OF DIVERSITY

Total number of fields viewed for formal count = >150
Total species per formal count = 6
Total species identified = 6

H = 2.08
Hmax = 2.59
Equitability = 0.80

Note: Sparcity of diatoms due to poor slide condition make the usefullness of these diversity calculations questionable.

Table 56. Aquatic macroinvertebrate abundances for Wagon Mound Salt Lake and Chicosa Lake.

Wagon Mound Salt Lk. 920609

qualitative, deep station, Eckman dredge, sediment grab

Cladocera	
poss. Sididae	rare
Chironomidae	
Chironomus sp.	abundant
Tanypodinae	present

Wagon Mound Salt Lk.
qualitative, littoral, "D" net

Cladocera poss. Sididae	common
Libellulidae	
poss. *Belonia sp.*	rare (decayed specimen)
Coenagrionidae	
Enellagma sp.	abundant
Corixidae	
Trichocorixa sp.	rare
Tenagobia sp.	rare
Corisella sp.	common
Notonectidae	
Buenoa sp.	present
Hydrophilidae	
Berosus sp.	present
Hydraenidae	
poss. *Ochtebius sp.*	rare
Stratiomyidae	
Stratiomys sp.	present
Dolichopodidae	rare
Chironomidae	
Tanypodinae	abundant
Orthocladiinae	abundant
Chironominae	abundant

Chicosa Lake 920826

quantitative, benthic sweep, "D" net

Hydrophilidae	
Berosus sp.	1
Corixidae	
Corisella sp.	1

Note also presence of cast ephydrid (Diptera) puparia and very numerous Gastropod tests in sample.

REFERENCES

American Public Health Association. Standard methods for the examination of water and wastewater, latest edition.

Bolen, E.G., Smith, L.M., Schramm, H.L. Jr. 1989. Playa Lakes: Prairie wetlands of the Southern High Plains. BioScience, Vol. 39 No. 9.

Carlson, R.E. 1977. A trophic index for lakes. Limnol. Oceanogr. 22: 361-369.

Cole, Gerald A. 1983. Textbook of Limnology. C.V. Mosby Company.

Dodd. J.J. 1987. Diatoms: Illustrated flora of Illinois. Robert H. Mohlenbrock [ed.]. Southern Illinois University Press.

Emerson, D., R. C. Russo, R. E. Lund, and R. V. Thurston. 1975. Aqueous ammonia equilibrium calculations: effect of pH and temperature. J. Fish. Res. Board Can. 32:2379-2383.

Gabin, V.L., and L.E. Lesperance. 1977. New Mexico climatological data: Precipitation, temperature, evaporation, and wind. Monthly and annual means 1850-1975. W.K. Summers and Associates.

Galat, D.L., Mark Coleman, Rob Robinson. 1988. Experimental effects of elevated salinity on three benthic invertebrates in pyramid Lake Nevada. Hydrobiologia. 158: 133-144.

Geohydrology Associates, Inc. 1986. Reassessment of Hydrologic Conditions, Laguna Tres Area, Eddy County, New Mexico. p 12.

Germaine, H. 1981. Flores des diatomes oeux douces aet Saumatres. Societe Nouvelle Des Editions Boubee.

Hem, John D. 1985. USGS, Water suppliment paper 2254 study and interpretation of the chemical characteristics of natural water.

Hustedt, F. 1956. Kieselalgen (diatomeen). Dosmos-Verlag Franckh.

ICF Technology Incorporated for BLM. 1988. International Minerals and Chemical Corporation preliminary assessment final report. Contract #AA-852-CT8-16.

Likens, G. 1975. Primary production of inland aquatic ecosystems. In Primary productivity of the biosphere. Leath, H., and R.H. Whittaker [eds.].

McClure, T.M. 1938. Twelfth and Thirteenth Biennial Reports of the State Engineer of New Mexico, Santa Fe.

Merriott, R.W. and K.W. Cummins. 1984. An introduction to the aquatic insects of North America 2nd ed. Kendall/Hunt, Dubuque.

New Mexico Bureau of Mines & Mineral Resources. 1977. Mineral and Water Resources of New Mexico. Bulletin 87, pp 306-309.

New Mexico Environment Department. 1992. Quality assurance project plan for water quality management programs.

New Mexico Water Quality Control Commission. 1991. Water quality standards for interstate and intrastate streams in New Mexico. WQCC 91-1.

Nicholson Jr, Alexander and Alfred Clebsch, Jr. 1961. Geology and Groundwater Conditions in Southern Lea County, New Mexico. New Mexico Institute of Mining & Technology, Socorro, New Mexico. pp 102-114.

Osterkamp, W.R. and W.W. Wood. 1987. Playa-lake basins on the Southern high plains of Texas and New Mexico: Part I. Hydrologic, geomorphic, and geologic evidence for their development. Geological Society of America Bulletin. v.99. p 215-223.

Osterkamp, W.R. and W.W. Wood. 1987. Playa-lake basins on the Southern High Plains of Texas and New Mexico: Part II. A hydrologic model and mass-balance arguments for their development. Geological Society of America Bulletin. v.99. p. 224-230.

Palmer, C.M. 1977. Algae and water pollution. EPA-600/9-77-036.

Patrick, R., and C.W. Reimer. 1966. The diatoms of the United States, Vols. I and II. Monographs of the Academy of Natural Sciences No. 13.

Pennak, R.W. 1989. Freshwater invertebrates of the United States, 3rd. ed. Wiley.

Prescott, G.W. 1962. Algae of the western Great Lakes area. Brown.

Prescott, G.W. 1970. How to know the freshwater algae. Brown.

Roy, R. 1992. Assessment of the impacts of produced water and potash mine discharges upon playa ecosystems, southeastern New Mexico (preliminary results) U.S.F. & W.S. unpublished.

Sandia National Laboratories. 1985. A Regional Water Balance for the Waste Isolation Pilot Plant (WIPP) Site and Surrounding Area. SAND84-2233.

Smith, G.M. 1950. Freshwater algae of the United States, 2nd ed. McGraw-Hill.

Sublette, J.E. and Mary S. Sublette. 1967. Limnology of playa lakes on the Llano Estacado, New Mexico and Texas. Southwestern Naturalist. 12(4).

United States Department of Agriculture, Soil Conservation Service. 1971. Soil survey of Eddy Area, New Mexico.

United States Department of Agriculture, Soil Conservation Service. 1973. Soil Survey of Harding County, New Mexico.

United States Department of Interior, Bureau of Land Management. 1975a. Executive summary and supplement to preliminary potash EAR, "Potash Leasing in Southeastern New Mexico.

United States Department of Interior, Bureau of Land Management. 1975b. Preliminary regional EAR potash leasing in southeastern New Mexico.

United States Department of Interior, Water & Power Resources Service. 1981. Ground Water Manual, Wiley Interscience.

United States Environmental Protection Agency. 1989. Ambient Water Quality Criteria for Ammonia (Saltwater). EPA440/5-88-004.

United States Environmental Protection Agency. 1984. Ambient Water Quality Criteria for Ammonia. EPA440/5-85-001.

United States Environmental Protection Agency. 1980. Plankton and periphyton analyses training manual. EPA-430/1-80-005.

United States Environmental Protection Agency. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. C.I. Weber [ed.]. EPA-670/4-73-001.

United States Environmental Protection Agency. Methods for chemical analysis of water and wastes. EPA-600/4-79-200 or latest edition.

Van der Werff, A. 1955. A new method of concentrating and cleaning diatoms and other organisms. Assoc. Theor. Appl. Lim. 12: 276-2771

Van der Werff, A., and H. Huls. 1957-1961, 1963. Diatomeenflora van Nederland. Stechert and Hafer.

40 CFR 436.140-436,142.