BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED BY THE
OIL CONSERVATION COMMISSION UPON ITS OWN
MOTION TO CONSIDER AN ORDER PROHIBITING THE
DISPOSAL OF OIL FIELD BRINES IN SURFACE
PITS IN LEA, CHAVES, ROOSEVELT, AND EDDY
COUNTIES, NEW MEXICO.

CASE No. 3551
Order No. R-3221

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on April 19, 1967, at Hobbs, New Mexico, before the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission."

NOW, on this 1st day of May, 1967, the Commission, a quorum being present, having considered the testimony presented and the exhibits received at said hearing, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That large amounts of water produced in conjunction with the production of oil or gas, or both, are being disposed of on the surface of the ground by means of unlined disposal pits located in Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico.

(3) That said produced water contains high concentrations of chlorides.

(4) That fresh water supplies as designated by the state engineer exist in substantially all areas where there is surface pit disposal and in substantially all the area encompassed by Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico.

(5) That the disposal of water produced in conjunction with the production of oil or gas, or both, on the surface of

the ground, or in any pit, pond, lake, depression, draw, streambed, or arroyo, or in any watercourse, constitutes a hazard to existing fresh water supplies, as designated by the state engineer, in the vicinity of such disposal.

(6) That in order to afford reasonable protection against contamination of fresh water supplies as designated by the state engineer, the disposal of water produced in conjunction with the production of oil or gas, or both, on the surface of the ground, or in any pit, pond, lake, depression, draw, streambed, or arroyo, or in any watercourse, or in any other place or in any manner which will constitute a hazard to any fresh water supplies existing in Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico, should be prohibited in said Counties.

(7) That the testimony indicates that the volume of water produced in conjunction with the production of oil or gas, or both, from the North Bagley-Upper Pennsylvanian, North Bagley-Middle Pennsylvanian, North Bagley-Lower Pennsylvanian, North Bagley-Wolfcamp, and Northeast Bagley-Wolfcamp Pools, Lea County, New Mexico, and being disposed of into unlined pits is so great as to constitute an imminent threat to fresh water supplies designated by the state engineer and the surface disposal of said water should, therefore, be prohibited after October 31, 1967, in the area encompassed by Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico.

(8) That large amounts of water are produced in conjunction with the production of oil from active waterflood projects and active water pressure maintenance projects.

(9) That one or more injection wells are present in each waterflood project.

(10) That in order to afford reasonable protection against contamination of fresh water supplies designated by the state engineer, the surface disposal of water produced in conjunction with the production of oil from active waterflood projects and active water pressure maintenance projects should be prohibited after December 31, 1967, in the area encompassed by Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico.

(11) That complete prohibition of surface disposal in Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico, of water produced in conjunction with the production of oil or gas, or both, should be accomplished by December 31, 1968, unless specifically exempted.

(12) That the surface disposal in pits of not more than one barrel per day for each developed 40-acre tract served by said pits, but limited to a maximum of 16 barrels per day, is so insignificant as to present little hazard to fresh water supplies and should be allowed in order to prevent waste caused by the premature abandonment of wells.

(13) That in order to prevent waste caused by the drowning out of oil or gas wells or burdensome delay or expenses, the District Supervisor of the appropriate District Office of the Commission should be empowered to authorize temporary disposal in surface pits for a period not to exceed 30 days for such contingencies as injection system failures and evaluation of wildcat wells.

IT IS THEREFORE ORDERED:

(1) That effective November 1, 1967, the disposal of water produced in conjunction with the production of oil or gas, or both, from the North Bagley-Upper Pennsylvanian, North Bagley-Middle Pennsylvanian, North Bagley-Lower Pennsylvanian, North Bagley-Wolfcamp, and Northeast Bagley-Wolfcamp Pools, Lea County, New Mexico, or within one mile thereof, on the surface of the ground, or in any pit, pond, lake, depression, draw, streambed, or arroyo, or in any watercourse, or in any other place or in any manner which will constitute a hazard to any fresh water supplies, is hereby prohibited in that area encompassed by Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico.

(2) That effective January 1, 1968, the disposal of water produced in conjunction with the production of oil from any waterflood project or water pressure maintenance project on the surface of the ground, or in any pit, pond, lake, depression, draw, streambed, or arroyo, or in any watercourse, or in any other place or in any manner which will constitute a hazard to any fresh water supplies is hereby prohibited in that area encompassed by Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico.

(3) That effective January 1, 1969, the disposal of water produced in conjunction with the production of oil or gas, or both, on the surface of the ground, or in any pit, pond, lake, depression, draw, streambed, or arroyo, or in any watercourse, or in any other place or in any manner which will constitute a hazard to any fresh water supplies and said disposal has not

previously been prohibited by Orders Nos. (1) or (2) above, or by Order No. R-1224-A, or by Order No. R-2526, or by Order No. R-2788, or by Order No. R-3164, is hereby prohibited in that area encompassed by Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico.

(4) That in those areas subject to the provisions of Orders Nos. (1) and (3) above, surface pits may be utilized for the disposal of a maximum of one barrel of produced water per day for each developed 40-acre tract served by said pits, provided however, that in no event shall said surface pit disposal exceed 16 barrels per day, and provided further, that this authorization shall not apply to those areas affected by Orders Nos. R-1224-A, R-2526, R-2788, or R-3164.

(5) That nothing contained in this order shall be construed as prohibiting the disposal of water produced in conjunction with the production of oil or gas, or both, in impervious lined pits presently in use, provided said pits were inspected and approved by a Commission representative prior to use, and for so long as said pits are properly maintained to ensure their continued imperviousness.

(6) That each unlined pit used for the disposal of water produced in conjunction with the production of oil or gas, or both, and not servicing a well exempt under the provisions of Order No. (4) above shall be filled, leveled, and compacted within six months after its use for the disposal of produced water is prohibited or by November 1, 1967, whichever date is later.

(7) That nothing contained in this order shall be construed as prohibiting the use and maintenance of mud pits or burn pits.

(8) That the District Supervisor of the approporate District Office of the Commission is hereby empowered to authorize temporary disposal in surface pits for a period not to exceed 30 days for such contingencies as injection system failures and evaluation of wildcat wells. Authority for said disposal shall only be granted on an individual case basis and only after the volume and quality of the water produced and the proximity of fresh water supplies have been taken into consideration.

(9) That the provisions of this order are in addition to the provisions of Order No. R-1224-A, Order No. R-2526, Order

No. R-2788, and Order No. R-3164 of the Commission and nothing herein contained shall be construed as abridging or altering in any manner the provisions of said orders.

(10) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

DAVID F. CARGO, Chairman

GUYTON B. HAYS, Member

A. L. PORTER, Jr., Member & Secretary

S E A L

esr/

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION UPON ITS OWN MOTION TO CONSIDER THE REVISION OF PARAGRAPH (1) OF ORDER NO. R-3221, TO PROVIDE THAT THE EFFECTIVE DATE FOR THE PROHIBITION OF SURFACE DISPOSAL OF PRODUCED WATER FROM THE NORTH BAGLEY-UPPER PENNSYLVANIAN, NORTH BAGLEY-MIDDLE PENNSYLVANIAN, NORTH BAGLEY-LOWER PENNSYLVANIAN, NORTH BAGLEY-WOLFCAMP, AND NORTHEAST BAGLEY-WOLFCAMP POOLS, LEA COUNTY, NEW MEXICO, OR WITHIN ONE MILE THEREOF, BE CHANGED FROM NOVEMBER 1, 1967, TO SOME EARLIER DATE.

CASE No. 3644
Order No. R-3221-A

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on August 30, 1967, at Santa Fe, New Mexico, before the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission."

NOW, on this 31st day of August, 1967, the Commission, a quorum being present, having considered the testimony presented and the exhibits received at said hearing, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That effective November 1, 1967, Order (1) of Order No. R-3221 forbids the disposal of water produced in conjunction with the production of oil or gas, or both, from the North Bagley-Upper Pennsylvanian, North Bagley-Middle Pennsylvanian, North Bagley-Lower Pennsylvanian, North Bagley-Wolfcamp, and Northeast Bagley-Wolfcamp Pools, Lea County, New Mexico, or within one mile thereof, on the surface of the ground, or in any pit, pond, lake, depression, draw, streambed, or arroyo, or in any watercourse, or in any other place or in any manner which will constitute a hazard to any fresh water supplies in that area encompassed by Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico.

(3) That upon considering the evidence presented in Case No. 3551 which resulted in the issuance of Order No. R-3221, the Commission found the production of salt water in the North Bagley Field to be so great as to constitute an imminent threat to the fresh water supplies designated by the state engineer and found that it would be necessary to prohibit surface disposal of said salt water no later than November 1, 1967, in order to afford reasonable protection against contamination of said fresh water supplies.

(4) That the evidence presented in Case No. 3644 establishes that the volume of salt water being produced in conjunction with the production of oil or gas, or both, in the North Bagley Field greatly exceeds the volume of produced salt water anticipated by the Commission when it issued Order No. R-3221.

(5) That the evidence presented in Case No. 3644 establishes that the excessive amounts of water being produced in conjunction with the production of oil or gas, or both, in the North Bagley Field constitute an even more immediate threat to the fresh water supplies than anticipated by the Commission at the time Order No. R-3221 was issued.

(6) That the testimony presented in Case No. 3644 indicates that all salt water disposal systems in the North Bagley Area heretofore authorized by the Commission can be in operation by approximately the middle of October, 1967.

(7) That the aforesaid salt water disposal systems will be capable of handling all salt water being produced in the North Bagley Field in mid-October.

(8) That the prohibition of water produced in conjunction with the production of oil or gas, or both, in the North Bagley Field, or within one mile thereof, on the surface of the ground, or in any pit, pond, lake, depression, draw, streambed, or arroyo, or in any watercourse, or in any other place or in any manner which will constitute a hazard to any fresh water supplies on or after November 1, 1967, in the area encompassed by Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico, will not afford reasonable protection against contamination of fresh water supplies designated by the state engineer.

(9) That in order to afford reasonable protection against contamination of fresh water supplies designated by the state engineer, Order (1) of Order No. R-3221 should be amended to

prohibit the surface disposal of water produced in conjunction with the production of oil or gas, or both, in the North Bagley Field, or within one mile thereof, on or after October 16, 1967.

IT IS THEREFORE ORDERED:

(1) That Order (1) of Order No. R-3221, dated May 1, 1967, is hereby amended to read in its entirety as follows:

"(1) That effective October 16, 1967, the disposal of water produced in conjunction with the production of oil or gas, or both, from the North Bagley-Upper Pennsylvanian, North Bagley-Middle Pennsylvanian, North Bagley-Lower Pennsylvanian, North Bagley-Wolfcamp, and Northeast Bagley-Wolfcamp Pools, Lea County, New Mexico, or within one mile thereof, on the surface of the ground, or in any pit, pond, lake, depression, draw, streambed, or arroyo, or in any watercourse, or in any other place or in any manner which will constitute a hazard to any fresh water supplies, is hereby prohibited in that area encompassed by Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico."

(2) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

DAVID F. CARGO, Chairman

GUYTON B. HAYS, Member

S E A L

A. L. PORTER, Jr., Member & Secretary

esr/

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION ON ITS OWN MOTION TO CONSIDER THE AMENDMENT OF ORDER No. R-3221, THE COMMISSION'S SALT WATER DISPOSAL ORDER, TO PERMIT THE EXEMPTION OF CERTAIN PRESENTLY EXISTING AND FUTURE POOLS IN EDDY AND LEA COUNTIES, NEW MEXICO, FROM CERTAIN REQUIREMENTS OF SAID ORDER.

CASE No. 3806
Order No. R-3221-B

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on July 17, 1968, at Santa Fe, New Mexico, before the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission."

NOW, on this 25th day of July, 1968, the Commission, a quorum being present, having considered the testimony presented and the exhibits received at said hearing, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That effective January 1, 1969, Order (3) of Commission Order No. R-3221, dated May 1, 1967, prohibits in that area encompassed by Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico, the disposal, subject to minor exceptions, of water produced in conjunction with the production of oil or gas, or both, on the surface of the ground, or in any pit, pond, lake, depression, draw, streambed, or arroyo, or in any watercourse, or in any other place or in any manner which will constitute a hazard to any fresh water supplies and said disposal has not previously been prohibited.

(3) That within the area described as:

EDDY AND LEA COUNTIES, NEW MEXICO

TOWNSHIP 19 SOUTH, RANGE 30 EAST, NMPM
Sections 8 through 36

TOWNSHIP 20 SOUTH, RANGE 30 EAST, NMPM
Sections 1 through 36

TOWNSHIP 20 SOUTH, RANGE 31 EAST, NMPM
Sections 1 through 36

TOWNSHIP 20 SOUTH, RANGE 32 EAST, NMPM
Sections 4 through 9; Sections 16 through 21; and Sections 28 through 33

TOWNSHIP 21 SOUTH, RANGE 29 EAST, NMPM
Sections 1 through 36

TOWNSHIP 21 SOUTH, RANGE 30 EAST, NMPM
Sections 1 through 36

TOWNSHIP 21 SOUTH, RANGE 31 EAST, NMPM
Sections 1 through 36

TOWNSHIP 22 SOUTH, RANGE 29 EAST, NMPM
Sections 1 through 36

TOWNSHIP 22 SOUTH, RANGE 30 EAST, NMPM
Sections 1 through 36

TOWNSHIP 23 SOUTH, RANGE 29 EAST, NMPM
Sections 1 through 3; Sections 10 through 15; Sections 22 through 27; and Sections 34 through 36

TOWNSHIP 23 SOUTH, RANGE 30 EAST, NMPM
Sections 1 through 19

exist a number of oil and gas pools which produce varying amounts of salt water.

(4) That the major portions of Clayton Basin and North Draw, broad depressions caused by the slumping of the surface due to the

removal of the underlying salt by solution, lie within the above-described area.

(5) That the general direction of movement of both ground water and surface water in the subject area is toward and into said basins, thence southwest in Nash Draw toward Malaga Bend.

(6) That a substantial amount of water is produced in conjunction with the production of oil or gas, or both, by the oil and gas wells located in the above-described area.

(7) That said produced water is presently being disposed of in surface pits located in the above-described area.

(8) That a number of large surface ponds, or lakes, containing extremely high concentrations of chlorides are located in the above-described area.

(9) That in relation to said surface lakes, said disposal pits are inconsiderable in volume of water received and seepage underground.

(10) That the aforesaid disposal pits and surface lakes are located within the same surface and subsurface drainage system, as described in Finding (5) above.

(11) That the purpose of Order No. R-3221, to afford reasonable protection against contamination of fresh water supplies by surface disposal of produced water, would not be advanced by the enforcement of said order as to the above-described area.

IT IS THEREFORE ORDERED:

(1) That all oil and gas wells, both existing and prospective, located in the following-described area are hereby excepted from the provision of Order (3) of Order No. R-3221, to authorize the operators of said wells to dispose of water produced in conjunction with the production of oil or gas, or both, from said wells in unlined surface pits located in said following-described area until further order of the Commission:

EDDY AND LEA COUNTIES, NEW MEXICO

TOWNSHIP 19 SOUTH, RANGE 30 EAST, NMPM
Sections 8 through 36

TOWNSHIP 20 SOUTH, RANGE 30 EAST, NMPM
Sections 1 through 36

TOWNSHIP 20 SOUTH, RANGE 31 EAST, NMPM
Sections 1 through 36

TOWNSHIP 20 SOUTH, RANGE 32 EAST, NMPM
Sections 4 through 9; Sections 16 through 21; and Sections 28 through 33

TOWNSHIP 21 SOUTH, RANGE 29 EAST, NMPM
Sections 1 through 36

TOWNSHIP 21 SOUTH, RANGE 30 EAST, NMPM
Sections 1 through 36

TOWNSHIP 21 SOUTH, RANGE 31 EAST, NMPM
Sections 1 through 36

TOWNSHIP 22 SOUTH, RANGE 29 EAST, NMPM
Sections 1 through 36

TOWNSHIP 22 SOUTH, RANGE 30 EAST, NMPM
Sections 1 through 36

TOWNSHIP 23 SOUTH, RANGE 29 EAST, NMPM
Sections 1 through 3; Sections 10 through 15; Sections 22 through 27; and Sections 34 through 36

TOWNSHIP 23 SOUTH, RANGE 30 EAST, NMPM
Sections 1 through 19

(2) That the Commission may by administrative order rescind such authority as to any or all such wells whenever it reasonably appears to the Commission that such rescission would serve to afford reasonable protection against contamination of fresh water supplies.

(3) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

DAVID F. CARGO, Chairman

GUYTON B. HAYS, Member

A. L. PORTER, Jr., Member & Secretary

SEAL

esr/

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION ON ITS OWN MOTION TO CONSIDER THE AMENDMENT OF ORDER No. R-3221, THE COMMISSION'S SALT WATER DISPOSAL ORDER, TO PERMIT THE EXEMPTION OF CERTAIN PRESENTLY EXISTING AND FUTURE POOLS IN EDDY AND LEA COUNTIES, NEW MEXICO, FROM CERTAIN REQUIREMENTS OF SAID ORDER.

CASE No. 3806
Order No. R-3221-B-1

NUNC PRO TUNC ORDER

BY THE COMMISSION:

It appearing to the Commission that due to clerical error, Order No. R-3221-B, dated July 25, 1968, does not correctly state the intended finding of the Commission in one particular,

IT IS THEREFORE ORDERED:

(1) That the phrase "North Draw" is hereby stricken from the first line of Finding (4) on Page 2 of Order No. R-3221-B, dated July 25, 1968, and the phrase "Nash Draw" is hereby substituted in lieu thereof.

(2) That this order shall be effective nunc pro tunc as of July 25, 1968.

DONE at Santa Fe, New Mexico, on this 13th day of August, 1968.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

DAVID F. CARGO, Chairman

GUYTON B. HAYS, Member

A. L. PORTER, Jr., Member & Secretary

S E A L

esr/

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION ON ITS OWN MOTION TO CONSIDER THE AMENDMENT OF ORDER NO. R-3221, THE COMMISSION'S SALT WATER DISPOSAL ORDER.

CASE No. 3807
Order No. R-3221-C

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on July 17, 1968, at Santa Fe, New Mexico, before the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission."

NOW, on this 10th day of September, 1968, the Commission, a quorum being present, having considered the testimony presented and the exhibits received at said hearing, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That effective upon various dates, Orders (1), (2), and (3) of Commission Order No. R-3221, dated May 1, 1967, prohibits, in that area encompassed by Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico, the disposal, subject to minor exceptions, of water produced in conjunction with the production of oil or gas, or both, on the surface of the ground, or in any pit, pond, lake, depression, draw, streambed, or arroyo, or in any watercourse, or in any other place or in any manner which will constitute a hazard to any fresh water supplies and said disposal has not previously been prohibited.

(3) That Order (4) of said Order No. R-3221 authorizes limited utilization of unlined surface pits in areas not affected by Orders Nos. R-1224-A, R-2526, R-2788, or R-3164.

(4) That Order (5) of said Order No. R-3221 authorizes utilization of certain impervious lined pits in use at the effective date of said order.

(5) That Order (8) of said Order No. R-3221 authorizes temporary disposal in surface pits during certain contingencies.

(6) That in order to provide more uniform provisions among the various salt water disposal orders of the Commission and to ease the administration of said orders, Order (4) of said Order No. R-3221 should be amended to also authorize, in those areas subject to Orders Nos. (1) and (3) of said Order No. R-3221, the utilization of unlined surface pits in those areas affected by Orders Nos. R-1224-A, R-2526, and R-3164 for the disposal of limited quantities of water.

(7) That the utilization of lined evaporation pits is feasible and in the interest of good conservation practices, provided they are properly designed, constructed, and maintained.

(8) That the utilization of properly designed, constructed, and maintained lined evaporation pits should be authorized in all areas subject to Order No. R-3221.

(9) That in order to prevent waste caused by burdensome delay or expenses upon operators of development wells, Order (8) of said Order No. R-3221 should be amended to also authorize temporary storage or disposal of water in surface pits during the evaluation of all newly completed wells.

IT IS THEREFORE ORDERED:

(1) That Order (4) of Order No. R-3221 is hereby amended to read in its entirety as follows:

"(4) That in those areas subject to the provisions of Orders Nos. (1) and (3) above, and in those areas affected by Orders Nos. R-1224-A, R-2526, and R-3164, surface pits may be utilized for the disposal of a maximum of one barrel of produced water per day for each developed 40-acre tract served by said pits, provided however, that in no event shall said surface pit disposal exceed 16 barrels per day, and provided further, that this authorization shall not apply to that area affected by Order No. R-2788."

(2) That Order (5) of Order No. R-3221 is hereby amended to read in its entirety as follows:

"(5) The use of lined evaporation pits in those areas affected by Orders Nos. (1), (2), and (3) above, and in those areas affected by Orders Nos. R-1224-A, R-2526, R-2788, and R-3164 is hereby prohibited except as follows:

"A. Continued disposal of water in impervious lined pits which were previously constructed pursuant to the provisions of Orders Nos. R-1224-A, R-2526, R-2788, and R-3164, and which were inspected and approved by a Commission representative prior to use, shall be permitted after October 10, 1968, only if the operator of any such lined pit shall have obtained a permit for such use from the appropriate district office of the Commission. The permit shall be applied for in accordance with the provisions of paragraph B-8 below and shall be valid only for so long as the pit is properly maintained to ensure its continued imperviousness.

"B. Under certain circumstances, the District Supervisor of the appropriate district office of the Commission may issue a permit authorizing the use of newly constructed lined pits for evaporation or storage of produced water.

To qualify for and to sustain a permit authorizing the operator to utilize newly constructed lined evaporation pits:

1. The lease or leases served by the installation should have a settled or decreasing rate of water production.

2. The installation must provide adequate storage capacity to safely contain all water produced, taking into account those months during which evaporation rates are normally at their minimum and must provide at least 600 square feet of evaporative surface for each barrel (42 U.S. Gallons) of produced water to be placed in said pit on a daily average basis throughout the year.

3. The installation must provide a header pit, or other appropriate scheme, lined with a suitable oil-resistant material to trap any oil carried with the water, constructed and operated in a

manner to prevent said oil from reaching the evaporation pit, and the surface of the evaporation pit must be maintained free of oil.

4. Evaporation and header pits must be constructed with underlying gravel-filled sumps and laterals, or other suitable devices, for the detection of leakage; the Commission shall be given an opportunity to inspect same prior to being lined with an impervious material, at least 30 mils in thickness, which is resistant to hydrocarbons, salts, and aqueous acids and alkalis. The material must also be fungus- and rot-resistant and must be sun-resistant, or provision made to protect it from the sun.

5. Each lined pit installation shall be identified by a sign, posted on or near said installation which shall show the name of the lease, name of the operator, the location by quarter-quarter section, township and range, and the permit number of the permit authorizing the installation. In addition, the installation must be adequately fenced, with the corners securely braced, and the fence maintained in good repair.

6. Whenever there is evidence that leakage is occurring, the pit or pits must be emptied and repaired to the satisfaction of the Commission before disposal therein may be resumed.

7. Any salt remaining in a lined pit must, upon termination of use of said pit for disposal purposes, be disposed of in a manner that will afford reasonable protection against contamination of fresh water supplies, and the pit shall be filled, leveled, and compacted as soon as practicable after termination of such use.

8. Application for a permit to utilize a lined evaporation pit shall be in triplicate on a form prescribed by the Commission (a copy of which is attached hereto and made a part hereof as Exhibit "A") and shall be filed with and

> approval obtained from the District Supervisor of the appropriate district office of the Commission prior to commencement of construction. Application forms and minimum specifications for the design and construction of lined evaporation pits are available at the district and Santa Fe offices of the Commission.

"C. The Commission may from time to time make such tests and require the furnishing of such evidence as it deems necessary to determine that any lined evaporation pit is maintained in satisfactory condition. The Commission may suspend or revoke by administrative order the permit authorizing a lined evaporation pit whenever it reasonably appears to the Commission that such suspension or revocation would serve to protect fresh water supplies from pollution."

(3) That Order (8) of Order No. R-3221 is hereby amended to read in its entirety as follows:

"(8) That the District Supervisor of the appropriate district office of the Commission is hereby empowered to authorize temporary storage or disposal in surface pits for a period not to exceed 30 days during such contingencies as injection system failures and evaluation of newly completed wells. Authority for said disposal shall only be granted on an individual case basis and only after the volume and quality of the water produced and the proximity of fresh water supplies have been taken into consideration. Any unlined pit used for temporary storage during an emergency must be emptied as soon as the emergency is ended."

(4) That Order (9) of Order No. R-3221 is hereby amended to read in its entirety as follows:

"(9) That subject to the provisions of Orders Nos. (4) and (5) above, the provisions of this order are in addition to the provisions of Orders Nos. R-1224-A, R-2526, R-2788, and R-3164 of the Commission and nothing herein contained shall be construed as abridging or altering in any manner the provisions of said orders."

(5) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

DAVID F. CARGO, Chairman

GUYTON B. HAYS, Member

A. L. PORTER, Jr., Member & Secretary

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APPLICATION FOR PERMIT PERMIT NO. ______

TO UTILIZE A LINED EVAPORATION PIT

New Mexico Oil Conservation Commission

Name of Operator ______

Address ______

Name of lease upon which evaporation pit will be located ______

Location of evaporation pit: Unit Letter ______ Section ______ Township ______ Range ______

Lease(s) which will be producing into pit ______

Pool(s) which will be producing into pit ______

Analysis of disposal water: Chlorides ______ ppm. Total dissolved solids ______ ppm.
(If more than one pool will be producing into pit, give water analysis for each pool.)

Quantity of water to be disposed of into this pit ______ barrels per day.

Water production from these same wells six months ago ______ bpd. Three months ago ______ bpd
(If more than one pool will be producing into pit, give water production data for each)

Method of hydrocarbon entrapment to be employed: Settling tank ______ Header pit ______

If settling tank is to be used, give size and number of barrels ______

If header pit is to be used, give dimensions and depth ______

Header pit lining material ______ Thickness ______

Dimensions of Evaporation Pit ("A" and "B" on diagram) ______

Number of square feet contained in above ______

Depth (Top of levee to floor of pit--"D" on diagram) ______

Material to be used as liner ______ Thickness ______

Does manufacturer recommend protection of material from direct sunlight? Yes ______ No ______

If yes, what means will be provided to so protect the material? ______

______

Is material resistant to hydrocarbons? Yes ______ No ______

Is material resistant to acids and alkalis? Yes ______ No ______

Is material resistant to salts? Yes ______ No ______

Is material resistant to fungus? Yes ______ No ______

Is material rot-resistant? Yes ______ No ______

Will joints in material be fabricated in the field? Yes ______ No ______

If yes, describe method to be used in joining material ______

______

Attach manufacturer's brochure describing the qualities of the lining material.

Describe the leakage detection system to be used ______

______

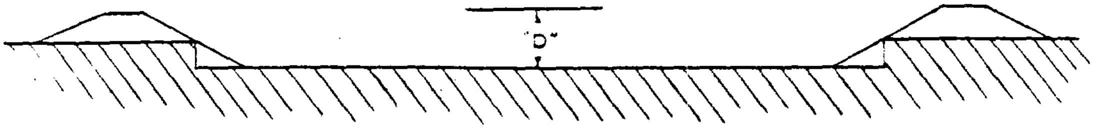
______

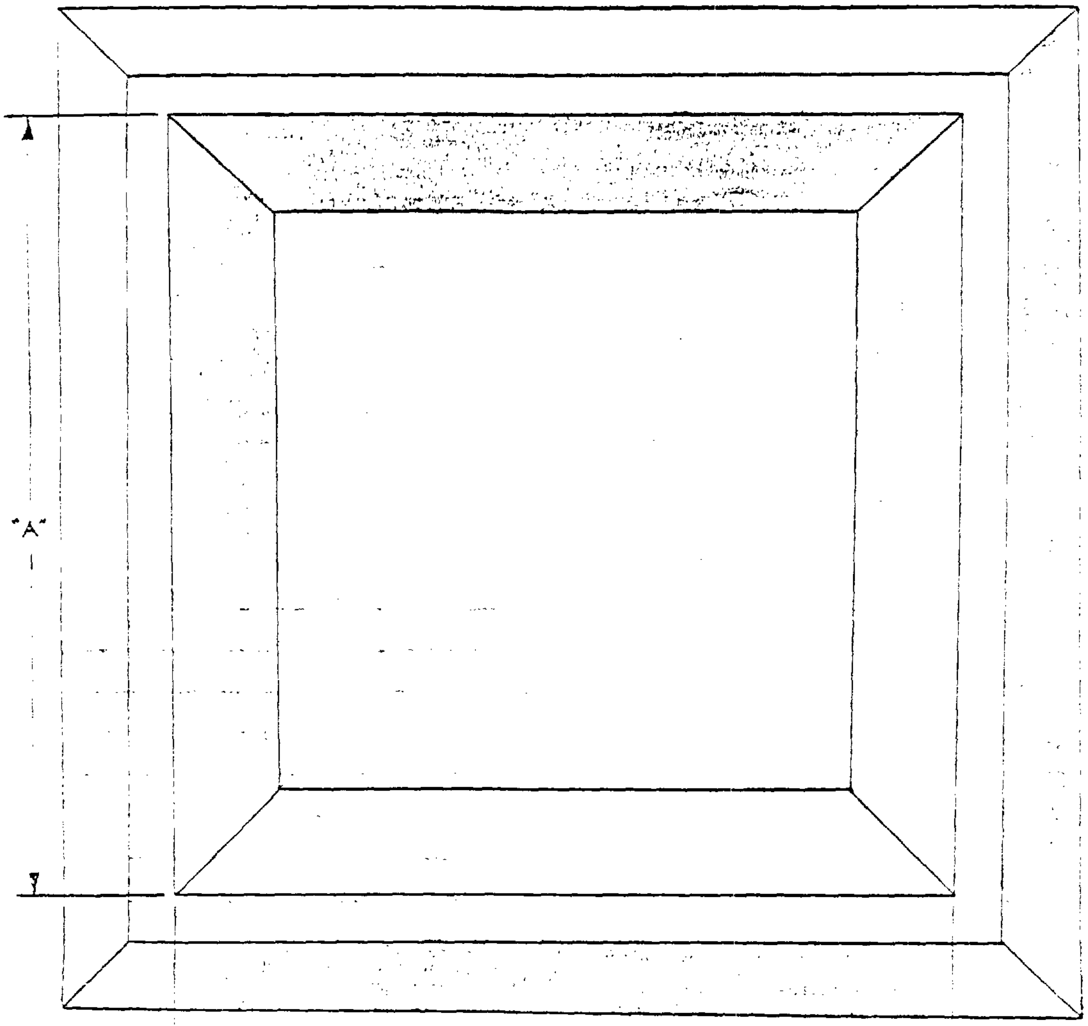
I hereby certify that the information contained herein is true and complete to the best of my knowledge and belief, and further, that the subject evaporation pit and appurtenances, when installed, will be kept in good repair, and that all due diligence will be exercised in keeping the surface of the water free of oil and other debris.

Name ______ Title ______ Date ______

Approved by ______ Title ______ Date ______

Exhibit "A" Order No. R-3221-C


"D"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Duke City — Sub. Opinion

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provides that issues tried by express or implicit consent of the parties shall be treated as if they had been raised by the pleadings, and a failure to move to so amend "does not affect the result of the trial of these issues." **See also Fidelity Nat. Bank v. Lobo Hijo Corp.**, 92 N.M. 737, 594 P.2d 1193 (Ct.App.1979).

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IT IS SO ORDERED.

s/MARY C. WALTERS, Justice

WE CONCUR:
s/WILLIAM RIORDAN, Justice
s/HARRY E. STOWERS, Jr., Justice

From The New Mexico Supreme Court

DUKE CITY LUMBER COMPANY,
Petitioner,

versus

NEW MEXICO ENVIRONMENTAL IMPROVEMENT BOARD and NEW MEXICO ENVIRONMENTAL IMPROVEMENT DIVISION,
Respondents.

No. 15078 (filed April 4, 1984)

ORIGINAL PROCEEDING ON CERTIORARI
Administrative Appeal

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ARRY P. AUSHERMAN
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SISK
lbuquerque, New Mexico
For Petitioner

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HERBERT M. SILVERBERG, Assistant Attorney General
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Santa Fe, New Mexico
For Division

OPINION

ILLIAM R. FEDERICI, Chief Justice.

The opinion of this Court eretofore filed on November 23, 1983 withdrawn and the following opinion is substituted therefor.

Duke City Lumber Company, petitioner, applied to the New Mexico Environmental Improvement Board (Board) for a one year variance from Air

Quality Control Regulation 402(A). The application was denied, and the denial was reviewed by the Court of Appeals. The court remanded "with instructions to the Board to conduct further proceedings to determine whether the wood smoke, in the volume being emitted from appellant's wigwam burner is **'injurious to health or safety.'" Duke City Lumber Co. v. New Mexico Environmental Improvement Board**, 95 N.M. 401, 407, 622 P.2d 709, 715 (Ct.App.1980), cert. denied, 95 N.M. 426, 622 P.2d 1046 (1981) (emphasis added).

The Board held a second hearing and again denied the application for a variance. Duke City Lumber Company again appealed. The Court of Appeals, affirming the Board's second denial of the variance, held that a condition injurious to health or safety does not mean actual harm, but "only a condition that **tends** to cause harm to health or safety."

The Court of Appeals also upheld, but questioned, the current New Mexico standard of judicial review which is limited to substantial evidence in the record. We granted certiorari.

The questions presented are:

I. Whether judicial review of an Environmental Improvement Board decision should be limited to the current standard of substantial evidence in the record, or whether this Court should now adopt a "whole record review" standard.

II. Whether the showing by the Environmental Improvement Division that wood smoke from Duke City Lumber's woodwaste burner **tends** to cause harm is sufficient to constitute "emission . . . as may with reasonable probability injure human health," as required by NMSA 1978, Section 74-2-2(B) (Repl.Pamp.1983).

III. Whether there was competent evidence to support a finding that wood smoke from Duke City's woodwaste burner is injurious to health or safety.

I. Substantial Evidence Rule.

The Air Quality Control Act (Act), NMSA 1978, Sections 74-2-1 through 74-2-17 (Repl.Pamp.1983), specifically provides for judicial review of the Act. Section 74-2-9 states: "Any person to whom the board denies a variance, after a hearing, may appeal to the court of appeals. All appeals shall be upon the record made at the hearing . . . ." The Court of Appeals may set aside the Board's denial of a variance if it is found to be arbitrary, capricious or an abuse of discretion, not supported by substantial evidence in the record, or otherwise not in accordance with law. **Id.**

The separation of powers doctrine directs administrative agencies to their duty of implementing legislation. The Legislature grants agencies the discretion of promulgating rules and regulations which have the force of law. The agencies must also determine whether there has been compliance with administrative decisions, and this is an adjudication. Therefore, agencies exercise in part functions of all three branches of government. This requires a carefully defined standard of review by the courts.

Some statutes, such as the New Mexico Administrative Procedures Act, provide for review of agency actions on the "entire record." NMSA 1978, Section 12-8-22(A). Other statutes, such as the New Mexico Air Quality Control Act before us, do not contain the words "entire record" or "as a whole." NMSA 1978, Section 74-2-9 (Repl.Pamp.1983). Certainly, in cases arising under statutes that expressly require whole record review of administrative decisions, the New Mexico Supreme Court has applied it. **Young v. Board of Pharmacy**, 81 N.M. 5, 462 P.2d 139 (1969). Also, in certain cases, even without express statutory provision for whole record review, we have engaged in a review of the record as a whole. **Ribera v. Employment Security Commission**, 92 N.M. 694, 696, 594 P.2d 742, 744 (1979) (deciding "based upon all of the evidence"); **Transcontinental Bus System v. State Corporation Commission**, 67 N.M. 56, 60, 352 P.2d 245, 247-248 (1959) (reviewing "the testimony of the witnesses, considered as a whole"); **Garrett Freight Lines v. State Corporation Commission**, 63 N.M. 48, 312 P.2d 1061 (1957) (considering testimony presented by both sides).

When the Legislature does not specify either standard the courts in New Mexico have followed the rule of substantial evidence in the record, requiring the reviewing court to determine whether the record contains substantial evidence to support the agency decision and to ignore evidence to the contrary. Substantial evidence is "such relevant evidence as a reasonable mind might accept as adequate to support a conclusion." **Rinker v. State Corporation Commission**, 84 N.M. 626, 627, 506 P.2d 783, 784 (1973).

The United States Supreme Court addressed whole record review as early as 1951. It held that courts are to review and consider not only evidence in support of one party's contention to determine whether there was substantial evidence to support the agency finding, but courts are to look also to evidence which is contrary to the finding. The reviewing court would then decide whether on balance, the agency's decision was supported by substantial evidence. **Universal Camera Corp. v. NLRB**, 340 U.S. 474 (1951). The federal courts require administrative findings of fact to be supplemented by substantial evidence, and also that those findings be reviewed on the whole record. **Committee for an Independent P-I v. Hearst Corp.**, 704 F.2d 467 (9th Cir.1983); **United States Soil Conditioning v. NLRB**, 606 F.2d 940 (10th Cir.1979).

The Court of Appeals was correct in applying to this case the more limited standard of review and ignoring all evidence unfavorable to the Board's decision. We have previously held that it is not proper for the Court of Appeals to change the standard of review, but their opinion properly addresses the shortcomings of this limited review and we agree with the Court of Appeals that it should be changed, insofar as administrative boards and agencies are concerned. **See Alexander v. Delgado**, 84 N.M. 717, 507 P.2d 778 (1973). New Mexico's present standard of review is not only outdated, but contrary to the rule followed by a majority of other jurisdictions and by the federal courts. Limited by our prior opinions the Court of Appeals concluded that because Section 74-2-9 provides for reversal of the Board's denial of variance if found not to be supported by substantial evidence in the record as opposed to substantial evidence in the record as a whole it was compelled to ignore strong evidence of medical effects of wood smoke and deficiencies in the air quality model which was before the Board. Not only does this interpretation shroud the judgment of the reviewing courts with imposed ignorance of enlightening evidence, but it also causes uneven treatment among those who seek review of the actions of various administrative boards and agencies.

We have continued to follow the rule that if there is substantial evidence in the record to support a finding, the reviewing court is bound thereby. Also, in deciding whether the finding has substantial support, the court must view evidence in the light most favorable to support the findings, and any evidence unfavorable to the finding will not be considered. **Trujillo v. Romero**, 82 N.M. 301, 481 P.2d 89 (1971); **Tapia v. Panhandle Steel Erectors Company**, 78 N.M. 86, 428 P.2d 625 (1967). This Court has said it will not weigh conflicting evidence or determine credibility of witnesses. **Lujan v. Pendaries Properties, Inc.**, 96 N.M. 771, 635 P.2d 580 (1981); **Worthey v. Sedillo Title Guaranty, Inc.**, 85 N.M. 339, 512 P.2d 667 (1973). We confirm this rule for the judicial review of orders and judgments of trial courts.

However, for administrative appeals we now expressly modify the substantial evidence rule as heretofore adopted by this Court and supplement it with the whole record standard for judicial review of findings of fact made by administrative agencies. A review of the whole record is clearly indicated in those cases where the administrative agency serves not only as the factfinder but also as the complainant and prosecutor. **See** 73A C.J.S., **Public Administrative Law and Procedure** Section 213 (1983).

The new standard which we have pronounced in this case has been previously considered and applied by this Court in **New Mexico Human Services Department v. Garcia**, 94 N.M. 175, 608 P.2d 151 (1980), where we stated:

> Whether the decision by HSD is

> supported by substantial evidence in the [record as a] whole, is one of the standards for judicial review of administrative decisions by HSD as required by Section 27-3-4(F), N.M.S.A. 1978. The language employed in the statute does not abrogate the substantial evidence rule as that rule has existed in New Mexico. The language does point to the fact that the substantial evidence rule must be applied to the **entire record** and that segments of the record may not be ignored in applying the rule. The statute does not mean that upon judicial review of the findings by HSD, the Court may reweigh the evidence and reassign the preponderance of evidence.
>
> In order to determine whether the decision by HSD is supported by substantial evidence in the record as a whole, we must view the evidence in the light most favorable to the decision by HSD. While this rule is applicable to decisions of administrative boards and tribunals as well as to decisions of courts, it does not permit accepting part of the evidence and totally disregarding other convincing evidence in the record considered as a whole. Because of the minor departure from the customary substantial evidence rule in reviewing administrative decisions where the record as a whole must be considered, the reviewing court may act on other convincing evidence in the record and may make its own findings based thereon.

Id. at 176-177, 608 P.2d at 152-153 (emphasis added).

II. Tends to Cause Harm.

This case was originally remanded by the Court of Appeals to the agency solely to determine whether the wood smoke Duke City emitted was "injurious to health or safety." **Duke City Lumber Co. v. New Mexico Environmental Improvement Board**, 95 N.M. 401, 407, 622 P.2d 709, 715 (Ct. App.1980), **cert. denied**, 95 N.M. 426, 622 P.2d 1046 (1981).

The Air Quality Control Act defines air pollution as, "the emission . . . into the outdoor atmosphere of one or more air contaminants in such quantities and duration as may with reasonable probability injure human health . . . . NMSA 1978, Section 74-2-2(B) (Repl.Pamp.1983).

The Board may grant a variance when compliance with air quality regulations will result in arbitrary and unreasonable taking of property or will impose an undue economic burden, and will not result in a condition injurious to health or safety. NMSA 1978, Section 74-2-8 (Repl.Pamp.1983). This definition does not permit the denial by the Board of a variance upon a mere showing that a condition "**tends** to cause harm." The Board has power under the New Mexico Air Quality Control Act to deny the variance when the air pollution that would result from granting a variance would with "**reasonable probability**" injure health. The Legislature has provided the standard of reasonable probability, and this Court must adhere to it. The Board and the Court of Appeals erred by expanding the statutory definition of air pollution from emissions from a "reasonable probability" of injuring health to a condition which "**tends** to cause harm." The result we have reached under this Point II would be the same whether we applied the old substantial evidence test or the new whole record review standard.

III. Sufficiency of the Evidence (Residuum Rule).

Administrative hearings in this case were conducted under relaxed rules of procedure to obtain information upon which to arrive at a definitive result. Town meeting-type hearings were held by the Board to solicit public participation regarding Duke City's request for a variance. Unsworn testimony of citizens and testimony of an Espanola physician was presented in support of the Board's decision that smoke from Duke City's mill would be injurious to health. Testimony by the physician was general rather than specific. He referred to and read from source material but he did not relate to or apply that material to the facts in this case. Lay witnesses and the doctor testified that smoke from the burner caused asthma attacks and irritation of eyes, nose and throat.

The New Mexico Administrative

Procedures Act provides that evidence may be relied upon "if it is of a type commonly relied upon by reasonably prudent men in the conduct of their affairs." NMSA 1978, Section 12-8-11(A). The standard for admissibility in an administrative hearing under this Act is therefore one of whether the evidence has any probative value. However, New Mexico courts require that an administrative action be supported by some evidence that would be admissible in a jury trial. This has been referred to as the legal residuum rule. **Young v. Board of Pharmacy**, 81 N.M. 5, 462 P.2d 139 (1969). New Mexico has continued to require a residuum of competent evidence to support the findings of an administrative agency where a substantial right is at stake. **Trujillo v. Employment Security Commission**, 94 N.M. 343, 610 P.2d 747 (1980).

Our decision in this case to review the whole record does not negate the residuum rule. The substantial evidence rule and the whole record standard which we now adopt reaffirm the rule that some competent evidence is required to support an action by an administrative agency which affects a substantial right.

In this opinion we have not addressed the question of whether the Duke City burner emissions exceeded the NAAQS. Neither have we made a determination as to whether violation of this standard alone, or in conjunction with medical evidence presented at trial, justifies denial of a variance. The agency decision on these questions should now be reviewed by the Court of Appeals, based upon the standard of review which we have pronounced in this opinion.

The Court of Appeals is reversed and the cause remanded to it for further proceedings consistent with this opinion.

IT IS SO ORDERED.

s/WILLIAM R. FEDERICI, Chief Justice

WE CONCUR:
s/WILLIAM RIORDAN, Justice
s/HARRY E. STOWERS, JR., Justice
s/MARY C. WALTERS, Justice

DAN SOSA, JR., Senior Justice, dissenting.

DISSENT

DAN SOSA, JR., Senior Justice.

After rehearing was granted and the new majority opinion filed, I still cannot agree with the majority for the reason that the new standard announced allows this Court to substitute its judgment for the lower court or administrative body with impunity. I agree that the Court of Appeals should review the matter. To that extent, I favor this opinion over the previous opinion which merely reversed.

s/DAN SOSA, JR., Senior Justice

The Supreme Court of New Mexico

MANZANO INDUSTRIES, INC.,
Plaintiff-Appellant,

versus

EDWARD MATHIS, et al.,
Defendants-Appellees.

No. 15103 (filed April 4, 1984)

APPEAL FROM THE DISTRICT COURT OF DONA ANA COUNTY
JAMES T. MARTIN, JR., District Judge

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[illegible]WELL
[illegible], New Mexico
for Appellant

KENNETH L. BEAL
SAGE, BEAL, BRIDGFORTH & BEAL
Las Cruces, New Mexico
for Appellees

TAYLOR

Transport of Organic Compounds Dissolved in Ground Water

by Joan M. Newsom

Abstract

Organic compounds, such as trichloroethylene (TCE) and chlorobenzene, that have been found in drinking water supplies are of public concern because they are possibly carcinogenic. These substances can now be routinely detected in trace amounts with gas chromatograph mass spectrometers. There are some polar organic compounds, which are not detectable individually by common methods and therefore little is known about them.

The transport of organic compounds is more difficult to predict than the flow of ground water because:

- Trace amounts of pollutants are difficult to measure
- Transport is complicated if the compound is partitioned into several phases
- The concentration of organics in ground water may vary due to aquifer heterogeneity and other hydrologic factors
- Reactions with other organic compounds and reactions with the aquifer material (such as adsorption) may affect the mobility of the organics
- Biodegradation may also affect net transport.

Adsorption is a factor in the attenuation of non-polar organics in aquifers with significant organic content (>0.1 percent organic carbon). The organic material adsorbs the non-polar organic chemicals. The mobility of a pollutant in such an aquifer depends on at least two parameters: the levels of dissolved organic matter and the content of organic carbon in the aquifer material. The partition coefficient of the chemical pollutant between the aquifer and water is commonly calculated as a function of the organic content of the aquifer and the partition coefficient between octanol and water.

Field and laboratory results reported in the literature indicate that the following organic compounds may be biodegradable under aerobic conditions: alkyl benzenes and chlorobenzenes. Under anaerobic conditions halogenated aliphatics, alkyl benzenes, several pesticides and phenolic compounds may be biodegradable. Halogenated aliphatics appear not to degrade under aerobic conditions and non-chlorinated aromatics and chlorobenzenes appear not to degrade under anaerobic conditions. Alkyl benzenes biodegrade more rapidly than their halogenated counterparts.

Introduction

Pollution of ground water by organic compounds is an important area of public concern, and hydrogeologists are increasingly required to evaluate hydrocarbon contamination in the subsurface. The methods of analysis have improved in recent years such that concentrations of less than one microgram per liter (μg/L) can be determined. The ability to measure more organic compounds, especially polar organics, will increase the number of different contaminants detectable in water.

Some of the organic compounds found in water are believed to be harmful in trace amounts. The health risks of the synthetic organics, however, are difficult to determine mainly because of the uncertainty in extrapolating the results of laboratory carcinogen tests on lab animals to humans. The health risks are not likely to become known very rapidly. References on health aspects of synthetic organics are found in Pearson (1982a, 1982b), and Merian and Zander (1982).

Man-made hydrocarbons are used in a wide range of industries and in household products. They are for the most part a product of technology used since the 1940s. Their solubility in non-polar substances and poor solubility in water account for their common and widespread use as degreasers. Trichloroethylene (TCE) is used, for example, to clean oil from industrial machines, to wash oils from airport runways, and to remove grease from clothes in dry cleaning.

Definitions

Hydrocarbon compounds, also called organic compounds, are composed of hydrogen and carbon. Aliphatic hydrocarbons are a group of hydrocarbons in which the carbon atoms are joined to form open chains. Aromatic hydrocarbons usually have structures that contain at least one benzene ring. Monocyclic aromatics, such as alkyl benzenes, have one ring. Polynuclear hydrocarbons possess more than one ring. This class of hydrocarbons can be divided into two groups. In the first, the rings are fused, which means at least two carbon atoms are shared between adjacent rings, e.g., naphthalene. In the second group, the aromatic rings are joined directly or through a chain of at least one carbon atom, e.g., biphenyl.

Many of the organic pollutants are halogenated;

that is, they contain halogen atoms in their molecular structure. Chlorine, bromine and fluorine are the most common halogens. Examples of halogenated aliphatics found in ground water include: trichloroethylene ($ClCH{:}CCl_2$, commonly abbreviated TCE), which contains two carbon atoms joined by a double bond; 1,1,1-trichloroethane (CH_3CCl_3), which contains two carbon atoms joined by a single bond; and tetrachloroethylene ($Cl_2C{:}CCl_2$, commonly abbreviated PCE), which contains two carbon atoms joined by a double bond. Trihalomethanes (THMs) are a subgroup of the halogenated aliphatics that contain three halogens in the methane (CH_4) molecular structure. Examples include chloroform or trichloromethane ($CHCl_3$), bromoform or tribromomethane ($CHBr_3$), and dibromochloromethane ($CHBr_2Cl$). Halogenated aromatics found in ground water include: chlorobenezene (ClC_6H_5), dichlorobenezene ($Cl_2C_6H_4$, abbreviated in this paper, DCB), and trichlorobenzene ($Cl_3C_6H_3$, abbreviated in this paper, TCB).

Hydrocarbon compounds can also be generally divided into polar and non-polar groups. Polar molecules are electrically neutral molecules with concentrations of negative charge in one part of the molecule and of positive charge in another, producing an electric dipole.

Occurrence of Organic Pollutants in Ground Water

The extent of ground water pollution by organic compounds is difficult to estimate both for a given aquifer and in general. Specific studies are difficult to compare because of variations in analytical sensitivity and differences among the compounds studied. Even for a given aquifer, the extent of ground water pollution by organic compounds can only be estimated because such a small fraction of the ground water is usually sampled.

There are many sources of organic pollution. Contaminants may reach the aquifer by way of precipitation, by seepage of pesticides and herbicides from the surface, from pollutants in sanitary landfills, waste storage ponds, polluted streams and lakes, and from accidentally or deliberately spilled material. Organic pollution is found both in industrial areas and in rural areas.

Man-made compounds pose a ground water pollution problem in industrialized countries. One or two percent of ground water supplies in the United States are polluted based on estimates of point sources, but only a fraction of these are contaminated primarily by organic pollutants (Pye and Patrick 1983). The compounds that occur most frequently in ground water in the United States are the trihalomethanes (THMs), which are the halogenated organics produced by chlorination of water containing humic materials (Bouwer et al. 1981). The problem of THMs, such as chloroform, has received considerable attention beginning in 1974 and the maximum contaminant level allowed by the EPA is 100 $\mu g/L$ total THMs (Cotruvo 1981).

The extent of ground water pollution by organics in the Netherlands was measured by sampling all 232 ground water pumping stations in the Netherlands between 1976 and 1978. The samples from 54 of the 232 locations, 25 percent of the locations, contained concentrations >0.1 $\mu g/L$ of chlorinated hydrocarbons with 1 or 2 carbons (e.g., TCE) (Zoeteman et al. 1981). The Netherlands is at the end of the Rhine River and receives pollutants from countries upstream. The compounds detected most frequently at concentrations greater than 0.01 $\mu g/L$ in Dutch ground water include: TCE (67 percent), chloroform (60 percent), tetrachloromethane (43 percent), PER (19 percent), and 1,1,1-trichloroethane (17 percent). These compounds are on the Environmental Protection Agency list of priority pollutants. The concentrations at higher levels ($>10 \mu g/L$) could always be associated with a specific source, i.e., local waste dumping. Concentrations at low levels (0.01 to 0.1 $\mu g/L$) may be due to volatile organics in rain water. Levels of substances such as chloroform and TCE are less than 1 $\mu g/L$ in rain water in the Netherlands.

Measurements of Organic Pollutants

Accurate measurements of the concentrations of organic pollutants in ground water are essential for understanding the behavior of the pollutants in aquifers. The problems of sampling an aquifer are especially severe for volatile organics, which are easily lost to the atmosphere (e.g., Pankow et al. 1984). Problems can arise from the type of well construction and the type of casing used. A study of the leaching of trace organics (0.5 ppb naphthalene and 0.5 ppb p-dichlorobenzene) into water from five common plastics used in well casing showed the following results: Teflon® (no leaching detected), nonglued PVC (0 to 0.1 ppb), Polyethylene (0.1 ppb), Polypropylene (0.5 ppb), glued PVC (0.5 ppb), and Tygon (1.0 ppb) (Curran and Tomson 1983).

Analytical results may be suspect because of the difficulty of analyzing water for trace concentrations of organics. In a comparison of analyses among certified private, state and university labs, large variations were reported even for relatively simple measurements of total dissolved solids (Keith et al. 1983). The following procedures were used to control the analytical precision and accuracy during an extensive investigation of a PCB spill site (Roberts, Cherry and Schwartz 1982). The concentrations of PCBs were determined by several analytical techniques. A standard with PCB concentrations similar to the samples being analyzed was run approximately every ten samples. Blanks were run during a switch from analysis of high PCB concentrations to low concentrations to ensure that the residual response of the system had returned to background levels.

The occurrence of some polar organic compounds in ground water has been much less studied than that of non-polar organic compounds. Very little is known about their health risk or their occurrence because they cannot be easily isolated and measured. The group parameter TOX (total organic halogen) provides a measure of the total amount of halogen in organic compounds and is determined by concentrating the organics by adsorption, and measuring halogen concentrations by titration, specific ion electrodes, or microcoulometer. TOX analyses are both relatively simple and quick compared to gas chromatography. The more polar, non-volatile and high molecular weight halogenated hydrocarbons presently can be detected by TOX and not by GC/MS (Jeckel and Roberts 1980). Field studies have shown that the TOX concentration is several times larger than the sum of halogenated organic compounds by gas chromatographic determination (Roberts, Schreiner and Hopkins 1982).

port increases

Advection and Dispersion

The mechanisms of advection and dispersion have an important control on the transport of organic pollutants. Total solute flow in porous media is composed of the portion that travels with the average ground water flow (advection) and the portion that deviates from the average ground water flow (dispersion). Dispersion causes a dilution of the solute concentration and a spreading of the contaminated area. Seen as a plot of concentration vs. the time to reach an observation point, dispersion causes the S-shaped breakthrough curve to broaden. The characteristic length of the porous medium, which is known as the dispersivity length, when multiplied with the ground water velocity, has been shown in the lab to yield the dispersion coefficient. This coefficient is used to determine the flux due to dispersive effects (Anderson 1979).

There are two types of dispersion: dispersion that occurs at the pore scale (microdispersion) and dispersion that occurs at the field scale due to aquifer heterogeneity (macrodispersion). Microdispersion is usually of not much significance for transport in relatively fast-flowing ground water. On the other hand, microdispersion and molecular diffusion are important in underground waste isolation site studies. Macrodispersion is significant due to the heterogeneity of the aquifer (e.g., Sudicky et al. 1983).

Lab dispersivity measurements do not agree with dispersivity measurements determined by field tracer tests because of scale factors. Lab measurements of dispersivity values for calculating microdispersion consist of determining breakthrough times at the outlet of cylindrical columns packed with porous media and then using the solute transport equation to determine dispersivity values. The field measurements of longitudinal dispersivity (in the direction of flow), which are on the order of 10 to 100m, are at least three orders of magnitude larger than lab measurements, 10^{-4} to 10^{-2}m (Anderson 1979). Field tracer tests show that longitudinal dispersivity is not constant for a given aquifer, but increases as the distance between the injection and observation well is increased. At some point, dispersivity stops increasing. This increase in dispersivity with increased travel distance or travel time of the solute is referred to as the scale effect in the literature (e.g., Molz 1983; Sudicky et al. 1983).

The cause of the variable dispersivity is the heterogenity of the aquifer, leading to anisotropic distributions of horizontal hydraulic conductivity. Field data indicate that most compounds prefer to travel through more permeable pathways, such as through gravel lenses. The variation in concentration due to heterogeneity of the aquifer causes the distribution of the compound in a horizontal sense to sometimes deviate from the theoretical plume shape derived for homogeneous aquifer characteristics (e.g., Sudicky et al. 1983).

The problem of aquifer heterogeneity is as important on a vertical scale as on a horizontal scale. Field data have shown that when chemicals enter the aquifers do not mix to the full vertical extent of the ground water and are influenced by aquifer heterogeneities and density effects (Sudicky et al. 1983; Rea and Upchurch 1980; Schwartz et al. 1982). Even though some of the data in these studies are for ions and not organic compounds, one would expect the principles to apply.

Organic pollutants dissolved in water infiltrated from the Glatt River into the upper approximately 9m of a 20m thick Quaternary glaciofluvial valley fill aquifer composed of sand and gravel (Schwarzenbach et al. 1983). The contaminated water was detected several kilometers from the Glatt River in the upper half of the aquifer, while water in the lower half originated from less polluted sources. Monitoring of a PER-spill in glacial deposits in Michigan showed that the PER (density = 1.62 g/cm^3 at 20 C), which was well below saturation, migrated downward as it traveled away from the source (Minsley 1983).

Adsorption

Most aquifers have less than 0.1 percent organic content. Quantitative relationships have not been well established between sorption and the controlling factors, although the specific surface area and the nature of the mineral surface influence the degree of sorption. Some adsorption of non-polar organic compounds was experimentally observed in columns containing materials that contain no organic carbon, such as clean sand, limestone and montmorillonite clay (Schwarzenbach and Westall 1981a). Sand and gravel aquifers are likely to contain insignificant amounts of organic matter, although this parameter is usually not measured. The aquifer near the Glatt River in Switzerland, for example, contains less than 0.1 percent organic content (Schwarzenbach et al. 1983). The retention of hexachlorobenzene, for example, was small between the aquifer next to the Glatt River and observation wells, which are up to 120m away from the river, despite the fact that hexachlorobenzene has a high log Kow of 6.06, and therefore, would be expected to be strongly retained in an aquifer with significant carbon content. The mobility of hexachlorobenzene indicates the low sorption capacity of sandy gravel aquifers with insignificant organic content (Schwarzenbach et al. 1983).

Aquifers comprised of deposits where former living matter is likely to have accumulated, such as from peat deposits, slow-moving streams, lakes or bogs, tend to have significant organic content. Studies have shown that at least 0.1 percent carbon content in the aquifer (0.001 g of organic carbon per gram sorbent) is needed for carbon adsorption to be significant (e.g., Schwarzenbach and Westall 1981a). Instead of solubility, the octanol:water partition coefficient (Kow) is often used as a measure of the partitioning of pollutants between water and organic phases. The Kow is the ratio of the concentration of a compound in octanol, a readily available alcohol that is relatively non-polar, to that in water. An inverse correlation between log Kow values (ranging between 1 and 6) and log solubility values, ranging between -3 to 5 in mg/L, has been found for non-polar organic compounds (Mackay 1980; Zoeteman et al. 1981). Kow values are also used to predict the partitioning behavior of compounds into soil that contains organic matter, as well as into the fat bodies of fish and other biota. Measured values of Kow can be found in: Chiou, Porter and Schmedding (1983); Banerjee, Yalkowsky and Valvani (1980); Kenaga and Goring (1980); and Hutzinger (1982); and estimated Kow values are found in Hansch and Leo (1979); and Leo, Hansch and Elkins (1971). In addition, chemical properties of organic compounds can be found in Verscheuren (1983), Hutzinger (1982, 1980), Weast and Astle (1982).

An example from California illustrates how the order of breakthrough of several organic compounds correlated with solubility and Kow such that the compounds that appear first have the highest solubility and lowest Kow. The order of appearance at an observation well 11m downstream from the injection well from first to last to appear was: chloride, chloroform, bromoform and dibromochloroform, 1,1,1-trichloroethane and chlorobenzene (Roberts, Schreiner and Hopkins 1982).

In another example from western Canada, TCB concentrations increased relative to that of PCB with depth as shown by the increase in the 1,2,4-TCB/PCB ratio from 0.02 in the surface fill to 0.19 in the underlying Regina clay (Roberts, Cherry and Schwartz 1982). The log Kow of 1,2,4-TCB is 4.05 (Leo, Hansch and Elkins 1971) while that of 2,4,5,2',4',5'-PCB is 6.72 (Schwarzenbach and Westall 1981a). The increased mobility of TCB is reflected by the lower Kow. Other indications of greater mobility are higher solubility, lower molecular weight and fewer chlorine atoms in the molecular structure in TCB compared with PCB.

Useful relationships have been found between the adsorption behavior of a pollutant and its Kow value and the organic content of an aquifer. Preliminary work indicates that the partitioning behavior of a pollutant and its residence time can be calculated for aquifers containing sufficient organic material. Karickhoff et al. (1979) demonstrated that the degree to which a compound is adsorbed in a soil, as measured by the partition coefficient (Kp), depends on the Kow and the "fraction organic content" (foc) of the soil by the relation:

$$\mathrm{Kp} = 0.63\ \mathrm{foc}\ (\mathrm{Kow}) \tag{1}$$

The equation was developed by examining the adsorption of 10 organic pollutants, whose log Kow ranged from 2 to 6, in river and pond sediments whose foc ranged from 0.1 to 3.3 percent. This equation applies when the pollutant concentration is less than half of the solubility limit in water. Based on surface and aquifer sediments, whose foc is greater than 0.001, Schwarzenbach and Westall (1981a) derived a similar equation:

$$\mathrm{Kp} = 3.2\ \mathrm{foc}\ (\mathrm{Kow}^{0.72}) \tag{2}$$

This equation is also valid only for low concentrations of the pollutant. Means et al. (1980) derived a similar equation for PAHs. Figure 1 illustrates the relationship described by Equation 2 for four chlorinated benzenes with different Kow coefficients. The equations establish the similar dependence of the parameters foc and Kow on the partition coefficient between soil containing organic matter and water. These equations apply only for non-polar substances in material with greater than 0.1 percent carbon. Kow provides a better estimate of sediment-water partitioning than does solubility, which gives at best an order of magnitude estimate of the partitioning behavior of a chemical in the organic fraction of the sediment medium (Karickhoff et al. 1979).

Schwarzenbach and Westall (1981a) found that more than 85 percent of the adsorption of the pollutants took place on particles of size less than 0.125mm (fine sand) and Karickhoff et al. (1979) observed that most of the adsorption took place on the particle fraction smaller than 0.05mm (silt or clay). More organic compounds were sorbed on the finer particle size fraction of sediments than on the coarse fraction principally because of the higher organic content as well as the larger surface area. Differences in sorption between silt and clay fractions depend on differences in foc rather than in sediment size (Karickhoff et al. 1979). Organic compounds also partition onto dissolved organic matter, such as fulvic and humic acids, such as in organic-rich water in landfill leachates (Cherry et al. 1984).

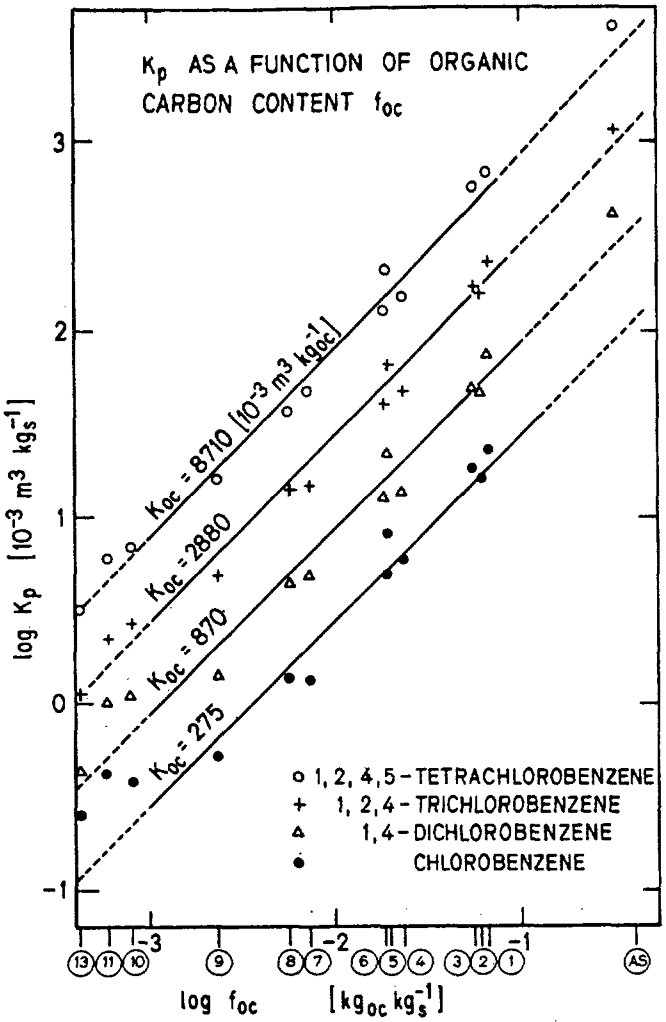

Figure 1. The sorbent to water partition coefficient (Kp) as a function of organic carbon fraction (foc) for four chlorobenzenes (Schwarzenbach and Westall 1981b). Koc is the partition coefficient based on organic content and Koc = Kp/foc. The circled symbols indicate the sorbents on which the data were obtained: AS, activated sludge; 1, 4, sea sediments (coastal zone); 2, detritus; 3, 5, lake sediments; 6, 8, river sediments; 7, 9, 10, 11, 13, aquifer material.

A pollutant that is adsorbed travels slower than the water containing the pollutant. The travel time of the solute divided by the travel time of the fluid is known as the retardation factor or the relative residence time (tr), which based on Equation 1 is:

$$\mathrm{tr} = 1 + 0.63\ \mathrm{foc}\ (\mathrm{Kow})\ \rho/\epsilon$$

where

ρ = average bulk density (g/cm^3)
ϵ = soil void fraction (unitless)
(Roberts, Reinhard and Valocchi 1982)

A comparison among tr values, which are dimensionless, calculated from the equation and those derived from the field show that tr values diverge for increasing values of Kow. The tr values are 5 (field) and 6 (equation) for chloroform; 36 (field) and 41 (equation) for chlorobenzene; and greater than 200 (field) and 140 (equation) for 1,4-DCB (McCarty et al. 1981). Kow values for these three compounds are 93, 692, and 2,400 respectively and the calculations are based on an average bulk density of 2 g/cm^3, $\epsilon = 0.22$, and foc = 1 percent carbon (McCarty et al. 1981). Schwarzenbach et al. (1983) derived a similar equation but did not make a comparison with field results.

The common method of modeling the effects of sorption on solute transport is to assume that the solute and sorbent react in instant equilibrium, i.e., no kinetic effects, that the ratio of the sorbed solute to the solute dissolved in water is constant, i.e., linear isotherm, and that adsorption and desorption is a reversible process. The above equations are based on these assumptions.

Formulas for the calculation of limiting kinetic effects, non-linear isotherms and unequal sorption/desorption behavior are given in Miller and Weber (1984). Kinetic effects are important when the ground water velocity is too fast to allow equilibrium and the above equations are no longer valid. The ground water flow rate (approximately 0.014 cm/s) close to the Glatt River during storm water events was probably fast enough for kinetics to affect the transport of pollutants in the aquifer. Kinetic effects are also important when contaminants are newly introduced to a ground water system and when spike or plug contamination sources are appropriate. Under these conditions less material is sorbed onto the aquifer media and the material that is not sorbed travels farther. Kinetic effects were observed in column experiments when water containing chlorinated benzenes flowed through a column at a rate of 0.01 cm/s (Schwarzenbach and Westall 1981a, 1981b), which is well within the range of typical ground water velocities. The breakthrough times were faster than the breakthrough times of the same column experiment conducted at a velocity of less than 0.001 cm/s. The results of the column experiment at the slower rate (0.001 cm/s) matched those of an 18-hour long equilibrium batch experiment indicating that sorption equilibrium occurred at the slower rate.

Although numerous studies have shown that trace levels of dissolved organic compounds follow linear isotherms, one exception are trace levels of PCBs (Cherry et al. 1984). Non-linear isotherms are most likely to occur when the concentration of the dissolved solute nears the solubility limit. For example, at low concentrations (well below the solubility limit) pesticides showed linear isotherms, but at high concentrations several organic pesticides have very non-linear isotherms (Cherry et al. 1984).

An important source of data on adsorption is the treatment of waste water by artificial recharge of an aquifer. The advantage of studies on waste water recharge is that the rate and length of time that a contaminant was injected or allowed to infiltrate into the aquifer is known, in contrast to most pollution studies.

In one study, approximately 92 percent of the organics were removed from the waste water (Tomson et al. 1979). The highest initial concentration was only 4.05 μg/L and the range in final concentrations was between 0.1 to 1 μg/L. Most removal rates for the 11 classes of compounds studied were between 90 to 100 percent, which included chloroaromatics and alkoxyaromatics, alkyl benzenes, naphthalenes, alcohols, ketones, indoles and indenes. Those groups whose removal rate was below 90 percent include the alkylphenols (85 percent), alkanes (71 percent), and chloroalkanes (70 percent) and phthalates (2 percent). The phthalates was the only group not to exhibit a dramatic decrease in concentration, and it was concluded the observed decline of only 2 percent was in error. A study of dune infiltration in northern Holland actually showed a dramatic increase in phthalate concentration (Piet et al. 1981). Perhaps PVC tubing contamination influenced the phthalate concentrations in both cases.

Adsorption and volatilization were thought to be the significant transport mechanisms for the pollutants studied by Tomson et al. (1981). Biodegradation had a minimal impact for two reasons: (1) The injected fluid was effluent from an activated sludge plant and compounds that easily biodegrade would not have been present. (2) Biodegradation does not occur for low pollutant concentrations. Tomson found that in the lab sewage bacteria reduced 2,3-dimethylnaphthalene from 1.3 mg/L to 40 μg/L in one day and that there was no further degradation for several days.

Under equilibrium conditions the net ratio of the rates of adsorption and desorption do not change and the reaction is said to be reversible. Sorption was reversible in several column studies (Schwarzenbach and Westall 1981a; Karickhoff et al. 1979). The reversibility of the reactions indicated that the initial removal of the compounds from solution was due to sorption and not to other factors such as biodegradation, which would cause the amount removed to be greater than the amount desorbed. A study by Horzempa and Di Toro (1983), however, showed that sorption of PCBs is not readily reversible under field conditions. The amount of sorption correlated with sediment surface area and organic content. The sorption effects were not felt to be attributable to biodegradation because PCBs are not readily biodegraded.

The restoration of aquifers depends upon the ability to remove contaminants adsorbed onto the subsurface material. One method is to flush the aquifer via injection and extraction wells. If the ground water velocity is too fast for equilibrium to be established, the concentration of the pollutant in ground water will decrease below the equilibrium concentration. Once the flushing stops, equilibrium conditions may become established and the concentration of dissolved pollutants may increase as desorption takes place. In such a case, the concentration of the pollutant at the extraction well decreases as the aquifer is flushed and then increases when the flushing is stopped. In addition to desorption during flushing as an important mechanism, the concentrations may also be affected by biodegradation rates of adsorbed, in-phase and dissolved pollutants.

Polar organics appear to be more mobile than non-polar organics, as shown by a study in an aquifer with significant amounts of organic carbon because they are poorly retained in the organic material in the soil (Roberts, Schreiner and Hopkins 1982). Piet et al. (1981) also found that the polar compounds were not as well adsorbed as non-polar compounds in soil column experiments using 50cm-long columns of soil composed of peat and sand layers. Those non-polar chlorine organics that were retained include: nitrobenzene, nitrotoluene and chloronitrobenzene. Similarly, studies with granulated activated carbon (GAC) exhibit less adsorption of the polar organics than the non-polar organics.

Biodegradation

Biodegradation is the breakdown of chemical compounds by microorganisms and is controlled by such environmental parameters as temperature, pH, dissolved oxygen, Eh, salinity, nutrients, competing organisms, toxicity to organisms, and the concentrations of the organisms and compounds. Lab studies have shown that under steady-state conditions a pollutant must be present in concentrations of milligrams per liter to be broken down directly by microorganisms (McCarty et al. 1981). In a similar study it was found that the pollutant concentration must be at least 100 μg/L to sustain a microbe population (Wilson and McNabb 1983). If the pollutant concentrations are not sufficiently high to sustain the microorganisms biodegradation will not occur (Kobayashi and Rittman 1982). Sewage bacteria reduced 2,3-dimethylnaphthalene from 1.3 mg/L to 40 μg/L and no further reduction was observed for several days (Tomson et al. 1981). A lower limit for biodegradation of 10 μg/L has also been found by Wilson and McNabb (1983). Trace levels of a compound can sometimes be broken down as a secondary result of the breakdown of another compound, which is present at much higher concentrations (Rittmann et al. 1980; McCarty et al. 1979).

Biodegradation depends on essential metabolic requirements, such as oxygenated water for aerobic processes. Metabolism can deplete the oxygen or other metabolic requirements in ground water at pollutant concentrations greater than 1,000 to 10,000 μg/L (Wilson and McNabb 1983). Thus, pollutants at high concentrations may be only partially degraded when oxygen is depleted.

Results of lab and field biodegradation studies under aerobic and anaerobic conditions for different classes of organic pollutants are presented below. Most of the priority pollutants have been shown to be biodegradable under laboratory conditions (Kobayashi and Rittman 1982). This does not, however, mean that these pollutants are necessarily biodegradable under field conditions. Aerobic conditions generally occur in the unsaturated zone and may be found below the water table at shallow depths as well as at great depths (Winograd and Robertson 1982).

Halogenated Aliphatics. Field and lab results show that several halogenated aliphatics may biodegrade slowly under anaerobic conditions, but not under aerobic conditions. CH_2Cl_2 does, however, degrade under aerobic conditions (R. Schwarzenbach, personal communication 1983). Halogenated aliphatics at low concentrations in treated waste water decreased in concentration when injected into a coastal aquifer in California (Roberts, Schreiner and Hopkins 1982). THMs degraded 10 times faster than the other halogenated aliphatics although the rate of anaerobic degradation was slow for both. The THMs concentration declined from 100μg/L to less than 0.1 μg/L at a rate of 0.03 per day. The decline was attributed to anaerobic biodegradation and not adsorption because the sorption capacity of the aquifer was saturated before the injection experiment began. Batch culture tests in the lab supported the field results that THMs degrade at low concentrations under anaerobic conditions (Bouwer et al. 1981). Similarly the THM bromodichloromethane degraded slowly under anaerobic conditions of a shallow fluvial aquifer in Oklahoma (Wilson and Enfield 1983). Halogenated aliphatics that have been reported to biodegrade under anaerobic lab conditions include: TCE, trichlorethane, methyl chloride, chloroethane, dichlorobromoethane, vinylidiene chloride, PER, methylene chloride and the THMs chloroform, dibromochloromethane, bromodichloromethane (Kobayashi and Rittman 1982).

No degradation was observed in studies of several compounds under anaerobic conditions, but the rate of degradation may have been too slow to be detected during the period of investigation. Bouwer et al. (1981) observed THMs but not TCE or PER to biodegrade in batch culture tests in the lab under anaerobic conditions. Wilson et al. (1983) did not observe degradation below the water table for several aliphatics: 1,2-dichloroethane, 1,1,2-trichlorethane, TCE or PER, but the period of study may not have been long enough to observe slow rates of degradation. Slow rates of degradation, therefore, cannot be ruled out. Similarly, Schwarzenbach et al. (1983) observed that TCE, PER, 1,1,1-trichloroethane, and hexachlorethane were persistent in the aquifer up to several kilometers away from the river, but the wide error bars on their figures may not rule out slow rates of degradation.

The decomposition of halogenated aliphatics under aerobic lab or field conditions has not been observed. No significant degradation of halogenated aliphatics (THMs, TCE, PER) was found under aerobic lab conditions (Bouwer et al. 1981; Bouwer and McCarty 1984). The persistance of chloroform, under aerobic conditions was reported in a study of ground water recharge, a study of chloroform passage through GAC columns, a study of bank filtration in Germany and a study of waste water percolation in soil columns (Bouwer et al. 1981). Wilson et al. (1983) in a field study in Oklahoma did not observe degradation of several halogenated aliphatics, 1,2-dichloroethane, 1,1,2-trichloroethane, TCE, or PER, above the water table.

Alkyl benzenes. Alkyl benzenes are known to degrade under aerobic conditions and may degrade under anaerobic conditions. Field observations show that toluene degraded rapidly in a shallow aquifer composed of flood-plain sediments in Oklahoma both above and below the water table (Wilson and Enfield 1979; Wilson et al. 1983). Schwarzenbach et al. (1983) observed a sharp decrease in non-halogenated compounds transported from the Glatt River to any of the ground water observation wells, the closest being 2.5m from the river. The alkyl benzenes included: toluene, 1,3-dimethyl benzene, and other 2 and 3 carbon benzene isomers. Aerobic respiration and nitrification occurred predominantly in the first few meters of infiltration, thus supporting the theory that the decrease in concentration was caused by biological processes under aerobic conditions. The biological processes that removed the organic compounds were efficient, considering the short residence time between the river and the closest well and the small retardation factors of the compounds. The decline was observed at different temperature throughout the year, including 5°C in winter. Alkyl benzenes degrade quicker than halogenated aromatics under aerobic conditions, probably because of the breaking of the halogen bond for halogenated aromatics is relatively slow.

Naphthalene and methyl-naphthalene also decreased in concentration but the decrease in naphthalene, however, may be due to adsorption based on the results of Ehrlich et al. (1982). Ehrlich et al. (1982) observed that naphthalene did not biodegrade under anaerobic conditions, but was slightly sorbed. Bouwer and McCarty (1984) observed that several non-chlorinated aromatics are removed under aerobic but not anaerobic conditions.

Chlorobenzenes. Chlorobenzenes have been observed to degrade under aerobic but not anaerobic conditions (e.g., Bouwer and McCarty 1984). The chlorobenzenes, 1,4-DCB, 1,2,4-TCB and 1,2,3-TCB decomposed under aerobic conditions in the aquifer near the Glatt River, and are suggested to have degraded to chlorinated phenols and catechols (Schwarzenbach and Westall 1981b). The rate of decrease was slower than for the alkyl aromatics, perhaps because the breaking of the halogen bond slows the process (Schwarzenbach et al. 1983). Halogenated aromatics do not degrade under anaerobic conditions. The concentrations of 1,4-DCB did not decrease in July and August of 1979, 1980 and 1981 between the river and 5m from the river, as it did the rest of the year because conditions were anaerobic during these summer months and the compounds did not decompose. During the rest of the year the conditions were aerobic and the chlorobenzenes decomposed. Chlorobenzenes in another Swiss study persisted for at least seven years under anaerobic conditions (Giger and Schaffner 1981). Chlorobenzenes (1,4-DCB, 1,2,4-TCB and 1,2,3-TCB) decomposed above, but not below the water table in a shallow fluvial aquifer in Oklahoma (Wilson et al. 1983). The failure of chlorobenzene to decompose in autoclaved (i.e., sterilized) lab samples established microorganisms as the likely agent of destruction.

Pesticides. Lab studies on sewer sludge indicated that pesticides such as lindane degraded more quickly under active anaerobic lab conditions than under corresponding aerobic conditions, probably due to bacteria (Hill and McCarty 1967). DDT, for example, converted rapidly to DDD under anaerobic conditions, but persisted as DDT under aerobic conditions of several mg/L of dissolved oxygen. Similarly, more than 20 species of bacteria were found to reductively dechlorinate DDT under anaerobic conditions, whereas aerobic conditions apparently did not promote dechlorination (Kobayashi and Rittman 1982). Other pesticides that were dehalogenated under anaerobic conditions in lab culture tests include: toxaphane by bacteria, lindane by soil bacteria and parathion by bacteria (Kobayashi and Rittman 1982). These lab results indicate that pesticides are easier to break down under anaerobic than under aerobic conditions. The breakdown process is relatively easy once the halogen bond is broken.

Phenolic compounds have been shown to biodegrade under anaerobic conditions in an aquifer composed of glacial drift material in Minnesota (Ehrlich et al. 1982). Methane and CO_2 were formed by the anaerobic bacteria breaking down the phenolic compounds. Lab studies supported the field results, and also indicated that principally biodegradation and not sorption account for the decline in concentration (Ehrlich et al. 1982). Glass column experiments showed that chlorophenols can biodegrade under aerobic conditions (Zullei 1981).

Biodegradation is an appealing cleanup method because expensive cleanup methods could be avoided and the pollutant is destroyed rather than transferred to another part of the environment, such as to the atmosphere via air stripping. In some cases, however, the degradation products could be as toxic or worse than the original compound. Management of some of the parameters that affect biodegradation, such as nitrate supply, may allow biodegradation to occur in situ in the vadose zone or aquifer. Limitations include the difficulty of managing environmental parameters that promote biodegradation and the difficulty in maintaining biodegradation as environmental conditions change.

Geological Considerations

The detailed structure and mineralogic composition of aquifers is critical to the transport of pollutants. One example is a PCB spill in a glacial till area in western Canada (Schwartz et al. 1982; Roberts, Cherry and Schwartz 1982). Between 6,800 and 21,000 liters of transformer oil containing PCBs and chlorobenzenes were spilled at a transformer plant. The PCBs traveled mainly in-phase because of the low solubility of PCBs (0.05 mg/L). The laboratory-determined conductivities of the till zone, between 10^{-5} and 10^{-9} cm/s, are too low to explain the observed vertical migration. Vertical movement is primarily through fractures in the clay, silt and till units, as indicated by the high PCB concentrations measured on fracture surfaces. Tritium was also found along fracture surfaces and used to calculate the rate of solute migration. This rate is a minimum because, unlike PCBs, some of the small tritium atoms diffuse into the sedimentary units. The geological units also have a low organic content; 0.2 to 0.9 percent carbon, minimizing the role of organic carbon in absorbing the PCBs.

Conclusions and Recommendations

Although progress is being made in understanding how organic compounds travel in the subsurface, large gaps and unknown important parameters exist. Several recommendations are given below on areas that need research.

- Some polar organic compounds are not commonly detectable by present methods. They appear to be persistent in ground water, able to travel significant distances and be resistant to degradation. Perhaps the increased ability to identify these polar organics will provide a better understanding of this type of contamination. Group parameter methods, such as TOX, may be attractive compliments to the commonly used GC/MS method because of the lower cost and because the measurements include classes of compounds, e.g., polar halogenated organics in the case of TOX, which are not readily identifiable individually.
- In cases where the aquifer might contain sufficient carbon for adsorption to be significant, the empirical relationships that have been developed may be useful for determining the partitioning behavior of organic pollutants. Further study of the effect of grain size, organic content, solute concentrations, dissolved organic matter and other controls on adsorption will help clarify how solutes are transported.
- Some elements, such as N, S, or P-compounds, when injected into pollution plumes may promote microbial degradation. The field conditions under which biodegradation of different compounds is promoted is not well understood. The phase in which the pollutant biodegrades might also be considered, i.e., dissolved in water, in-phase, or adsorbed onto the

matrix.

- More work is needed to determine how flushing of an aquifer via injection and extraction wells affects those pollutants sorbed onto aquifer or soil material. Travel of solutes in-phase during flushing, such as droplets within the water, may be an important mechanism.

Ground water flow models in porous media are useful for understanding a flow regime and for planning the placement of wells. Solute transport models assume constant dispersivity values and the solute is assumed to be dissolved, which in some cases may not be reasonable assumptions. Resolution problems with numerical models may occur in some cases, such as for modeling trace concentrations of a solute, high concentration gradients, or radial flow from a pulse on a rectangular grid. The mechanisms of adsorption and biodegradation are not well enough understood to model satisfactorily. The effects of such mechanisms will probably be lumped together in models because their effects will be difficult to separate in practice.

Although the technology may exist to clean up polluted ground water and pollution sites, the costs are often high. A water policy is needed to encourage prevention and set priorities for what should be cleaned up. The cost of cleanup can be several orders of magnitude larger than that of preventive measures. Monitoring of areas containing organic compounds has begun only recently, and as monitoring continues the understanding of solute transport will improve.

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Biographical Sketch

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Behavior of Organic Compounds during Infiltration of River Water to Groundwater. Field Studies

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■ The behavior of organic micropollutants during infiltration of river water to groundwater has been studied at two field sites in Switzerland. In agreement with predictions from model calculations, persistent organic chemicals exhibiting octanol/water partition coefficients smaller than about 5000 moved rapidly with the infiltrating river water to the groundwater. The biological processes responsible for the "elimination" of various micropollutants (e.g., alkylated and chlorinated benzenes) occurred predominantly within the first few meters of infiltration. Alkylated benzenes were "eliminated" at faster rates than 1,4-dichlorobenzene. Anaerobic conditions in the aquifer near the river hindered the biological transformation of 1,4-dichlorobenzene. Among the compounds that were found to be persistent under any conditions were chloroform, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene. With respect to such chemicals, bank filtration is ineffective as a first step in the treatment of river water for water supplies.

Since in many European countries a significant fraction of the groundwater is recharged through infiltration of river water (*1, 2*), the impact of river pollution on groundwater quality is of major concern. In addition, many waterworks use natural or artificial bank filtration as a first step in the treatment of river water for water supplies (*3, 4*). Therefore, the behavior of organic pollutants during infiltration is of great interest.

The transport and fate of organic pollutants in a river water–groundwater infiltration system is determined by several interacting processes, including advection, dispersion, (ad)sorption/desorption, hydrolysis, redox reactions, and biological transformations. In laboratory experiments, individual processes may be studied under controlled conditions (*5, 6*), and mathematical models may be developed to predict the effect of a particular process on the transport and fate of a compound in the environment (*7, 8*). However, comprehensive field investigations are needed to evaluate the applicability of laboratory studies and model calculations to natural systems.

To date, most of the field studies on natural river water–groundwater infiltration systems have been conducted with respect to the use of bank filtrate for public water supplies (e.g., ref 3). These studies have usually been confined to monitoring selected water constituents in the river and in groundwater wells near the region of infiltration. The temporal and spatial variations in concentration of organic compounds along the infiltration path have not been thoroughly investigated. Consequently, the results of such investigations provide only very limited insights into the behavior of individual compounds during infiltration.

In this paper, we report the results of two field studies aimed at investigating the transport and fate of organic micropollutants, including chlorinated hydrocarbons, alkylated benzenes, and chlorinated phenols during natural infiltration of river water to groundwater. In the near fields of two rivers, a network of observation wells was installed that allowed the contaminants in the infiltrating water to be traced from the river to the groundwater. The results of this 2-year field study contribute significantly to the limited field data on the behavior of trace organics in the groundwater environment (*9–11*).

Theoretical Section

Prediction of Retardation Factors for Hydrophobic Organic Compounds in the Ground. A rough estimate of the retention behavior of a given hydrophobic organic compound during infiltration may be obtained by treating transport through the river bed and in the aquifer in a first approximation as a one-dimensional process with constant flow in a homogeneous porous medium. Assuming that only the fine fraction of the aquifer material is relevant for sorption (*5, 12*) and assuming a linear sorption isotherm, an average retardation factor (R_f^z = ratio of the residence time τ_z of the solute to the residence time τ_w of the water) can then be calculated for compound z for a given segment of the aquifer (e.g., ref 8):

$$R_f^z = \tau_z/\tau_w = 1 + fK_p^z\rho(1-\epsilon)/\epsilon \qquad (1)$$

where f = fraction of the aquifer material responsible for sorption (e.g., grain size range $\phi < 125$ μm; assumption: homogeneous distribution), K_p^z = equilibrium partition coefficient of the compound z between water and the fine fraction of the aquifer material at a given location in the ground (cm³/g), ρ = density of the aquifer material (g/cm³), and ϵ = total porosity. As we have shown in a previous study (*5*), for the compounds reported here, the equilibrium partition coefficient, K_p^z, may be estimated from the organic carbon content of the fine fraction of the aquifer material, f_{oc}, and from the octanol/water partition coefficient of the compound, K_{ow}^z:

$$K_p^z = 3.2f_{oc}(K_{ow}^z)^{0.72} \qquad (2)$$

Similar relationships have been found for other types of compounds and natural sorbents (*12, 13*). Note that eq 2 is valid only for sorbents exhibiting organic carbon contents of greater than about 0.1% ($f_{oc} > 0.001$). For organic-poor sorbents, interactions of the chemical with the inorganic matrix of the sorbent may become important (*5*). Combining eq 1 and 2 yields

$$R_f^z = 1 + 3.2ff_{oc}(K_{ow}^z)^{0.72}\rho(1-\epsilon)/\epsilon \qquad (3)$$

Retardation factors calculated from eq 3 are valid only at sorption equilibria. At high groundwater-flow velocities, e.g., such as those encountered in the near field of a river during stormwater events (0.5 m/h; see ref 14), due to slow sorption kinetics, the compounds may be transported even faster than would be assumed from equilibrium considerations (*5, 15*). However, relationships such as eq 3 are very valuable for predicting the magnitude of the velocity at which a specific hydrophobic organic compound is transported in a given aquifer.

Experimental Section

Description of the Field Sites. The main field site of this investigation (field site I) is located in the lower

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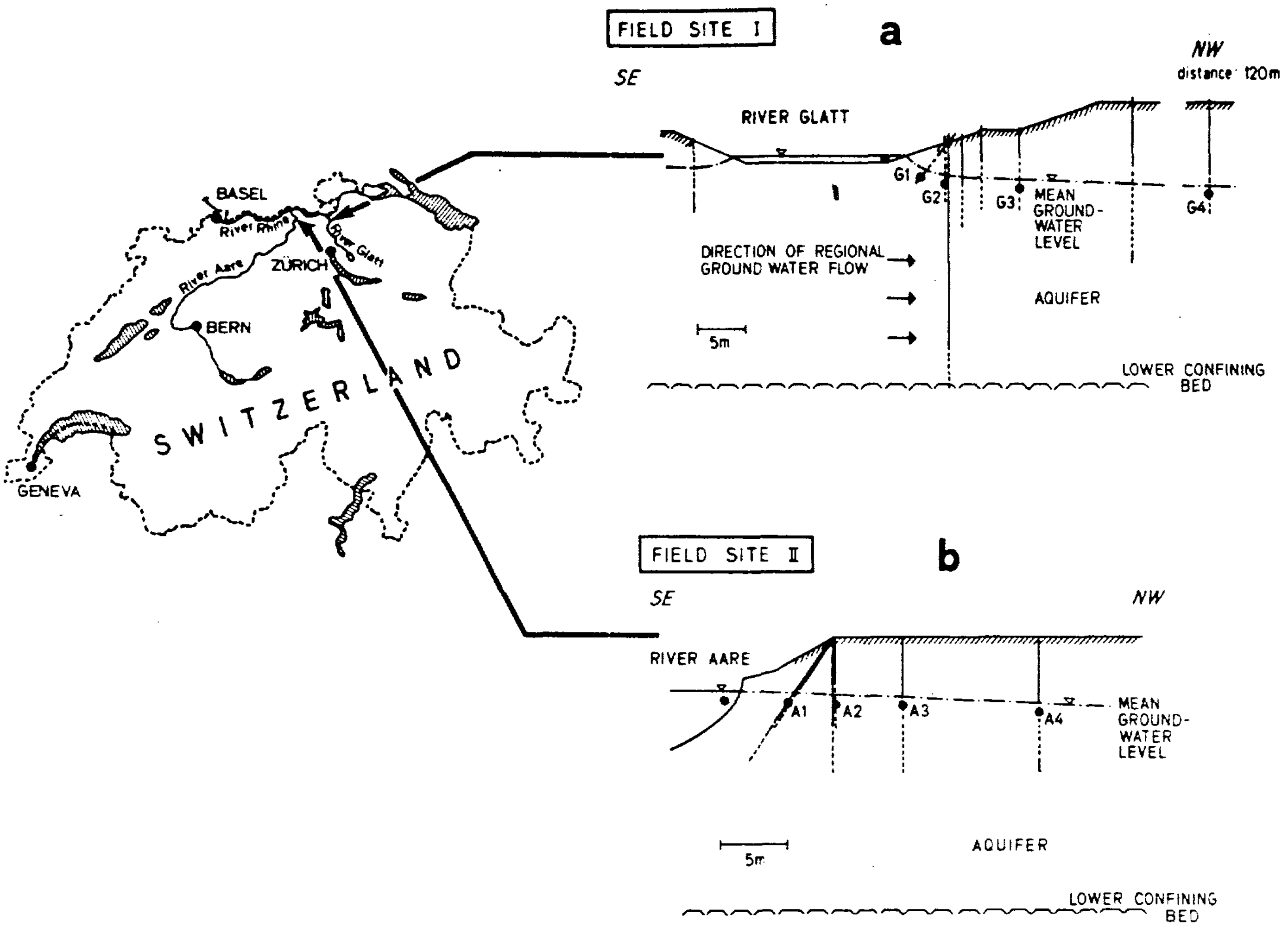

Figure 1. Locations and layouts of the two field study sites: (a) lower Glatt Valley, Switzerland (field site I); (b) lower Aare Valley, Switzerland (field site II); (● = sampling locations).

Glatt Valley, Switzerland (see Figure 1). In this region, the River Glatt infiltrates over a distance of about 5 km into a quaternary fluvioglacial valley fill aquifer composed of layers of gravel and sand containing very little organic carbon (<0.1%). The River Glatt is a small, rather heavily polluted perialpine river which has been studied extensively (*16, 17*). The average discharge of the river is approximately 8 m^3/s, of which 15–20% is effluent from a number of mechanical–biological sewage treatment plants. These treatment plants are the major source for organic micropollutants in the river. At the study site, permanent infiltration of the River Glatt through a saturated zone can be assumed.

Figure 1a gives a cross-sectional view of the study site on the right bank of the River Glatt. The groundwater flows beneath the river at an angle between 60 and 90° to the flow of the river. The results presented in this paper have been obtained primarily from measurements in wells G1–G4 (see Figure 1a). These wells gave access to freshly infiltrated water that stratified in the top layers of the aquifer. Some data from observation well G15, which is screened throughout the saturated thickness of the aquifer, will also be discussed. G15 is located in the center of the valley about 60 m downstream from G4. A detailed description of this field site is presented elsewhere (*18*).

To check the general validity of conclusions drawn from results obtained from the main field site, a second study was conducted on a different type of river system: River Aare in the lower Aare Valley (field site II; see Figure 1b). River Aare is a moderately polluted alpine river with an average flow of 550 m^3/s in the study area. The aquifer into which the river loses water is of the same geological formation as the one in the lower Glatt Valley (*19*). At the study site, the River Aare infiltrates through a saturated zone. Figure 1b shows the network of observation wells that were installed on the left bank of the river. At this location the regional groundwater flows beneath the River Aare at an angle of between 45 and 90° to the flow direction of the river.

Groundwater Observation Wells. All wells were lined with hard PVC tubes. In laboratory experiments, the PVC material was found neither to contaminate the samples nor to (ad)sorb the organic water constituents of interest. For technical details, see Hoehn et al. (*18*).

Sample Collection and Analytical Program. Between May 1979 and Apr 1980 (field site I) and between Nov 1980 and Oct 1981 (field site II), a program was conducted to determine temporal and spatial variations in the water composition of the rivers and of the groundwater in the observation wells shown in Figure 1. Samples were collected at approximately monthly intervals. In addition to the trace organic compounds, a variety of other chemical parameters were determined, mainly to characterize the river water and the groundwater, as well as to study the biogeochemical processes occurring during infiltration. Results of these measurements are discussed elsewhere (*20*).

The groundwater was sampled by using a small underwater plunger pump as described by Käss (*21*). The small discharge rate of this pump, typically between 0.5 and 1 L/min, allowed sampling of the groundwater without causing a measurable drawdown of the groundwater level. For sampling the upper layer of the groundwater, the pump was usually placed 0.5 m below the groundwater

Table I. Ranges of Retardation Factors (Lower Limit–Upper Limit) Calculated for Some Hydrophobic Organic Compounds Detected in the River Glatt

compound	octanol/water partition coeff (log K_{ow})	calcd retardation factors $(R_f)^{a,b}$: river sediment[c] (~0.1 m)	aquifer close to river bed[d] (<5 m)	aquifer far from river bed[e] (>5 m)
chloroform	1.97[f]	2.7-8	1.2-4	1-1.2
1,1,1-trichloroethane	2.17[g]	3.4-11	1.2-6	1-1.2
trichloroethylene	2.29[f]	4-13	1.3-7	1-1.3
toluene	2.69[f]	7-23	1.6-12	1-1.6
tetrachloroethylene	2.88[h]	9-31	1.8-16	1-1.8
1,3-dimethylbenzene	3.15[f]	13-48	2.2-24	1-2.2
naphthalene	3.30[i]	16-62	2.5-31	1-2.5
1,4-dichlorobenzene	3.38[f]	18-70	2.7-35	1-2.7
α-hexachlorocyclohexane	3.72[k]	32-123	4-62	1-4
hexachlorobenzene	6.06[f]	1500-6000	150-3000	~10-150

[a] Equation 3; $\rho = 2.5$ g cm^{-3}, $\epsilon = 0.2$. [b] Ranges in values for f and f_{oc} are based on experimental data (see ref 5 and 18). [c] $f_{oc} = 0.01$-0.02, $f = 0.2$-0.4. [d] $f_{oc} = 0.001$-0.01, $f = 0.2$-0.4. [e] $f_{oc} < 0.001$, $f < 0.2$. [f] Reference 39. [g] Reference 40. [h] Reference 41. [i] Reference 26. [k] Reference 42.

table. The water was pumped through stainless steel tubing (5 mm i.d.) into 1-L glass bottles. The bottles were filled completely and closed without headspace. The samples were stored at 4 °C within 6 h of collection and analyzed within 48 h.

Analytical Methods. Volatile organic compounds were concentrated from the water samples by the closed-loop gaseous stripping/adsorption/elution procedure developed by Grob (*22, 23*). The water samples (typically 1 L) were stripped for 90 min at 30 °C, and the organic compounds were trapped by adsorption on a filter of 1.5 mg of activated charcoal. The filter was then extracted with 20 µL of carbon disulfide (CS_2) and the extract analyzed by high-resolution glass capillary gas chromatography and, when necessary, by gas chromatography/mass spectrometry. The gas chromatographic equipment and parameters used have been described elsewhere (*24*).

Purgeable organochlorine compounds (POCl) were determined by the method described by Zürcher (*25*). The compounds were purged with oxygen from 1-L water samples for 30 min at 60 °C. The purged compounds were continuously combusted at 950 °C, and the resultant chloride was trapped and quantified by ion chromatography.

Pentachlorophenol was determined by a method based on the procedure described by Renberg and Lindström (*26*). The lipophilic phenols were extracted by percolating 0.5 L of the acidified water sample (pH 2) through a SepPak C_{18} cartridge (Waters Inc., Milford, MA). The adsorbed phenols were eluted with 1.5 mL of acetone and acetylated by adding 50 µL of acetic anhydride. The excess anhydride was then destroyed by adding 3 mL of 0.1 M aqueous K_2CO_3, and the acetylated phenols were extracted with 2 mL of pentane. The pentane extract was analyzed by glass capillary gas chromatography using electron capture detection. 2,4,6-Tribromophenol was used as internal standard.

α- and γ-hexachlorocyclohexane and hexachlorobenzene were determined by the method of Müller (*27*). For all three compounds, the detection limit of the method used was 0.02 ng/L.

Dissolved Organic Carbon (DOC). Fractionation of the DOC was carried out with the method described by Schneider et al. (*28*). The DOC is operationally separated into three fractions: a "hydrophilic" fraction, an "acidic" fraction, and a "hydrophobic" fraction (see Figure 2). The fractionation is based on the retention of the organic constituents on a column (50 mm × 4 mm) packed with octadecylsilica (LiChrosorb RP 18) and connected to an on-line DOC detector (*29*). The "hydrophilic" fraction 1 is not retained on the column at pH 2 (peak 1 in Figure 2). The "acidic" fraction 2 is retained at pH 2 but is eluted from the column at pH 8 (peak 2 in Figure 2). This fraction includes all fulvic acid type materials (*28*). The "lipophilic" fraction cannot be eluted from the column with water at any pH. Its concentration is calculated by subtracting fraction 1 and 2 from the total DOC, which is determined by passing the adsorption column (see peak T in Figure 2).

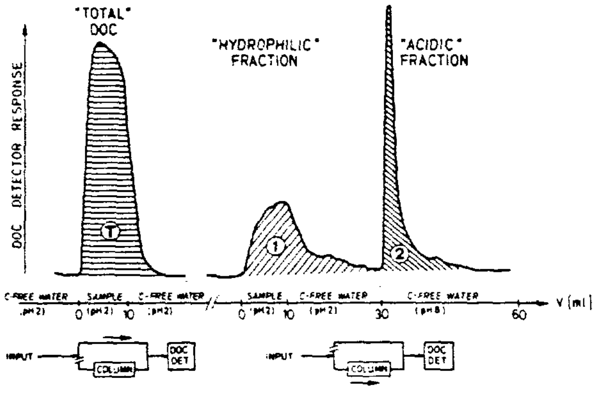

Figure 2. DOC fractionation by the method of Schneider et al. (*28*).

Results and Discussion

Field Site I. The names and octanol/water partition coefficients of some of the hydrophobic organic compounds found in the River Glatt are given in Table I. A more comprehensive inventory of the trace organics detected in this river has been published previously (*17*). The concentrations of individual compounds were usually between 0.01 and 2 µg/L.

Figure 3 depicts the temperature values, the concentrations of two representative volatile organic compounds, and the concentrations of oxygen, ammonium, and dissolved organic carbon determined over the course of 1 year in the River Glatt and in the wells G2 and G3, located 5 and 14 m, respectively, from the river. The average concentrations of some water constituents in the River Glatt and in wells G1–G4 are presented in Table II and Figure 4.

On the basis of the results of tracer experiments (*18*) and from the temperature data presented in Figure 3a, it can be assumed that the residence time of the water between the river and the two wells G2 and G3 was usually in the order of hours to a few days (well G2) and days to a few weeks (well G3). Figure 3b shows that for tetrachloroethylene, large fluctuations in concentration were observed

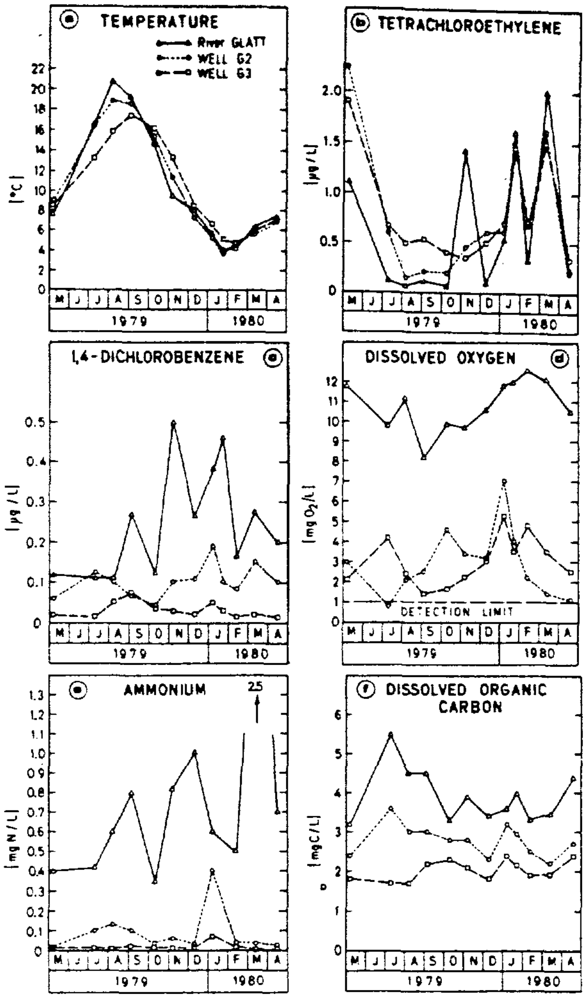

Figure 3. Field site I: monthly determined values for temperature, *tetrachloroethylene, 1,4-dichlorobenzene, dissolved oxygen* (detection limit = 1 mg of O_2/L), ammonium, and DOC, in the River Glatt and in observation wells G2 and G3.

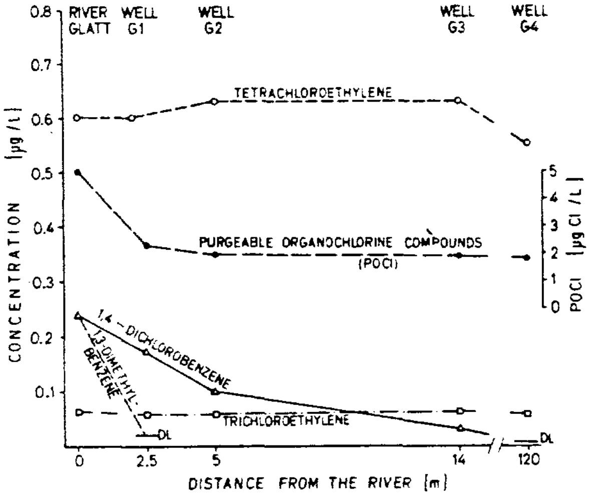

Figure 4. Field site I: average concentrations of selected organic micropollutants in the River Glatt and in the upper layers of the groundwater at various distances from the river (DL = detection limit).

in the River Glatt and in both observation wells, indicating a rapid response in the groundwater to concentration changes in the river. From the very similar average concentrations found for this compound in the river and in the groundwater in the top layers of the aquifer at different distances to the river (see Figure 4), one can conclude that tetrachloroethylene was not significantly affected by any elimination processes. The effect of the sorptive and dispersive processes, i.e., the attenuation of concentration

Table II. Yearly Average Concentrations and Standard Deviations of DOC, POCl, and Four Individual Organic Micropollutants in the River and in the Upper Layers of the Groundwater at Different Distances from the River

sampling location[a]	dist from river, m	DOC, mg/L	POCl,[b] µg of Cl/L	tetrachloroethylene,[c] µg/L	1,4-dichlorobenzene,[d] µg/L	1,3-dimethylbenzene,[e] µg/L	pentachlorophenol,[f] µg/L
field site I							
River Glatt	0	3.9 ± 0.7 {16}[g]	5.0 ± 4.2 {7}	0.60 ± 0.70 {16}	0.23 ± 0.13 {16}	0.23 ± 0.25 {16}	0.08 ± 0.005 {4}
well G1	2.5	3.0 ± 0.7 {9}	2.3 ± 1.8 {7}	0.60 ± 0.59 {9}	0.17 ± 0.07 {9}	<0.02 {9}	0.08 ± 0.02 {4}
well G2	5	2.8 ± 0.6 {16}	2.0 ± 1.0 {7}	0.63 ± 0.57 {16}	0.10 ± 0.04 {16}	<0.02 {16}	0.05 ± 0.04 {4}
well G3	14	2.1 ± 0.4 {16}	1.9 ± 0.9 {7}	0.63 ± 0.47 {16}	0.03 ± 0.02 {16}	<0.02 {16}	<0.02 {4}
well G4	120	1.5 ± 0.4 {9}	1.8 ± 0.9 {7}	0.55 ± 0.14 {9}	<0.005 {9}	<0.02 {9}	<0.02 {4}
field site II							
River Aare	0	2.3 ± 0.5 {12}	1.6 ± 0.9 {7}	0.24 ± 0.12 {12}	0.035 ± 0.015 {12}	0.05 ± 0.03 {12}	nd
well A1	4	1.0 ± 0.4 {12}	0.9 ± 0.6 {7}	0.25 ± 0.09 {12}	<0.01 {12}	<0.02 {12}	nd
well A2	7.5	0.8 ± 0.4 {12}	0.8 ± 0.5 {7}	0.24 ± 0.10 {12}	<0.005 {12}	<0.02 {12}	nd
well A3	13	0.7 ± 0.4 {12}	0.7 ± 0.3 {7}	0.20 ± 0.08 {12}	<0.005 {12}	<0.02 {12}	nd
well A4	23	0.7 ± 0.3 {12}	0.7 ± 0.3 {7}	0.20 ± 0.07 {12}	<0.005 {12}	<0.02 {12}	nd

[a] See Figure 1. [b] Purgeable organochlorine compounds (group parameter), detection limit 0.1 µg of Cl/L. [c] Detection limit 0.01 µg/L. [d] Detection limit 0.005 µg/L. [e] Detection limit 0.02 µg/L. [f] Detection limit 0.02 µg/L; nd = not determined. [g] The number of measurements is given in brackets.

fluctuations (see, e.g., ref 8), are reflected in the decreasing standard deviations observed with increasing flow distance (see Table II). Very similar results were found for chloroform, trichloroethylene (see Figure 4), and 1,1,1-trichloroethane.

The strong response in the groundwater to concentration changes in tetrachloroethylene in the River Glatt (Figure 3b) suggets that during infiltration this compound was not strongly retained in the ground. This finding is in agreement with the rather small average retardation factor predicted for tetrachloroethylene from eq 3 for this field site (see Table I and footnotes in Table I). It should be noted that for the aquifer in the near field of the River Glatt (<5 m; see Table I), the average retardation factors for the various compounds must be assumed to be closer to the indicated lower limits, since a sharp drop in the organic carbon content of the aquifer material occurs within a few meters distance from the river (*18*). Thus, at this field site, rapid transport in the ground can be expected for persistent organic compounds exhibiting octanol/water partition coefficients of smaller than about 5000 (see Table I). Unfortunately, because of the short residence time of the water between the river and the observation wells G2 and G3, no quantitative information on the actual retardation of the various compounds can be obtained from our data, since samples were taken only at monthly intervals.

Among the volatile organic compounds that were always present in the River Glatt but were almost never detected in any of the groundwater observation wells, were the aromatic hydrocarbons including toluene, various C_2- and C_3-benzene isomers (e.g., 1,3-dimethylbenzene; see Table II and Figure 4), and naphthalene. Since under the conditions typical for the groundwater environment these aromatic hydrocarbons, as well as all other volatile organic compounds listed in Table I (e.g., 1,4-dichlorobenzene), do not undergo chemical reactions at significant rates, and since these compounds are also only weakly sorbed, any observed "elimination" during infiltration must be attributed to biological transformation and/or mineralization. Parts d–f of Figure 3 indicate that the major biologically mediated processes, i.e., aerobic respiration and nitrification, occurred predominantly within the first few meters of infiltration. Therefore, it could be expected that the biological "elimination" of xenobiotic compounds would also take place primarily in the near field of the river.

Although the volatile aromatic hydrocarbons are biodegradable under simulated groundwater conditions (*30*), it is interesting to note that they were always eliminated between the river and well G1. Thus, considering the short residence time of the water between the river and this well and the small retardation factors of the compounds, the biological processes responsible for their removal were quite efficient, even at temperatures as low as 5 °C.

The observed significant decrease in concentration of 1,4-dichlorobenzene with increasing distance to the river (see Figures 3b and 4, Table II) indicates that this compound was also affected by biological processes. However, compared with the aromatic hydrocarbons, 1,4-dichlorobenzene was "eliminated" at a much slower rate, such that it was still detected in well G3. In addition, in July and Aug 1979 (Figure 3c) and during several short-term investigations in July and Aug 1980 and 1981 (*31*), no decrease in the concentration of 1,4-dichlorobenzene was found between the River Glatt and well G2. These findings suggest that, considering the steep concentration gradients usually detected between the river and G2, 1,4-dichlorobenzene was not significantly eliminated during parts of the summer. Since denitrification and manganese reduction were also observed during this time of the year (*20*, *31*), the persistence of 1,4-dichlorobenzene may be explained by the anoxic conditions that prevailed in parts of the aquifer near the river. This hypothesis is corroborated by other field observations (*32*) and by the results of laboratory experiments that suggest that halogenated benzenes are not biotransformed under anaerobic conditions (*33*). Whether, under aerobic conditions, 1,4-dichlorobenzene is completely mineralized or only transformed to products not detected by the analytical techniques used (e.g., to dichlorophenol and dichlorocatechol; see ref 34) is presently under investigation.

The results of the measurements of the group parameter "purgeable organochlorine compounds" (POCl; Table II, and Figure 4), which includes substances such as tetrachloroethylene and 1,4-dichlorobenzene, showed the same picture as the results of the single-component measurements: (i) the major "elimination" of volatile organochlorine compounds occurred predominantly within the first few meters of infiltration; (ii) for compounds not affected by any transformation processes, similar average concentrations were found throughout the upper layers of the aquifer.

From the few data obtained for pentachlorophenol (Table II), no final conclusions can be drawn as to whether or not this compound was "eliminated" during infiltration. At a pH of between 7.4 and 8, pentachlorophenol is present predominantly as phenolate anion ($pK_a = 4.75$). Thus, retardation factors of smaller than 50 in the near field of the river and smaller than 10 in the actual aquifer would be expected for this compound (*35*). The fact that the concentration of pentachlorophenol in well G3 was always below the detection limit could be an indication that this compound underwent some chemical and/or biological transformation reactions.

To date, only two sets of measurements have been conducted for α- and γ-hexachlorocyclohexane and for the highly lipophilic compound hexachlorobenzene. Although detected at very low concentrations, these compounds were found in the River Glatt and in all of the observation wells. The concentrations determined for α- and γ-hexachlorocyclohexane were 4 ng/L in the river, about 2 ng/L in the near field of the river (G2, G3), and less than 1 ng/L in G4. For hexachlorobenzene, very similar concentrations (between 0.1 and 0.2 ng/L) were found in the River Glatt and in all observation wells including G4. These findings demonstrate that, especially in aquifers composed of materials of low organic carbon content, even highly lipophilic compounds may be transported over long distances.

Field Site II. Compared to the River Glatt, the River Aare is a large river exhibiting much smaller short-term fluctuations in water composition (*31*). Also, in contrast to the field site in the lower Glatt Valley, the residence time of the water in the ground between the river and the observation wells (see Figure 1b) is generally much longer (in the order of weeks). This is evident from the temperature data shown in Figure 5a. Figure 5a also shows that very similar residence times can be assumed between the river and the two wells A1 and A3. Since a detailed investigation of the flow directions and velocities of the groundwater in the near field of the River Aare has not been conducted, it is not possible to give exact values for linear flow distances of the infiltrating water between the river and the wells. However, the results of the year-round study at this field site (see Figure 5 and Table II) can be qualitatively compared to those obtained in the lower Glatt Valley.

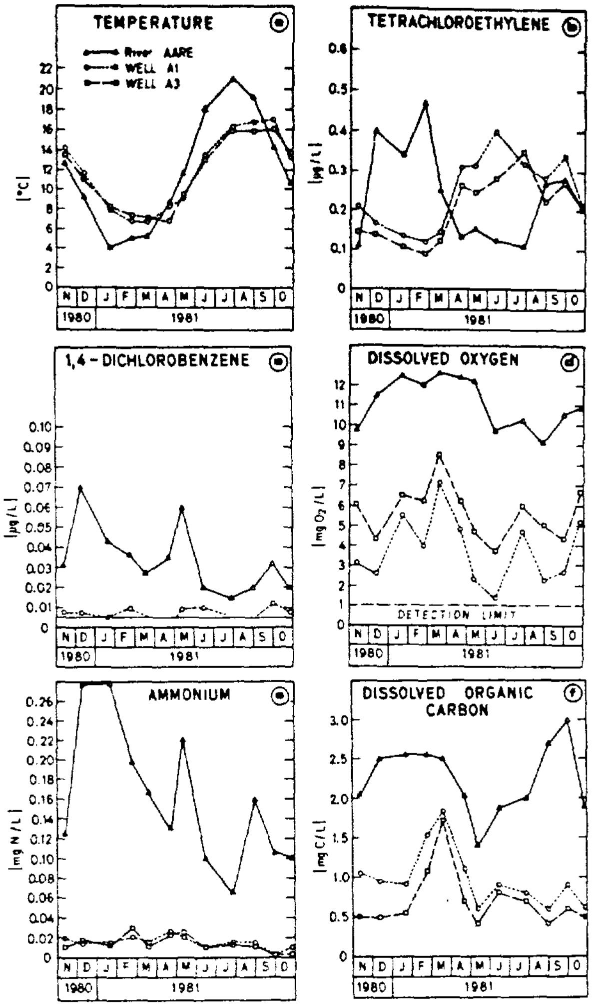

Figure 5. Field site II: monthly determined values for temperature, tetrachloroethylene, 1,4-dichlorobenzene, dissolved oxygen (detection limit = 1 mg of O_2/L), ammonium, and DOC, in the River Aare and in observation wells A1 and A3.

Table III. Average Concentrations of Total DOC and of the Three DOC Fractions Determined by the Method of Schneider et al. (*28*)

		dissolved organic carbon,^{b} mg of C/L			
sampling location^a	dist from river, m	total	fraction 1^c	fraction 2^d	fraction 3^e
River Glatt	0	4.0	1.5	1.0	1.5
well G1	2.5	2.7	1.0	0.9	0.8
well G2	5	2.6	1.0	0.9	0.7
well G3	14	2.0	0.8	0.8	0.4
well G4	120	1.5	0.9	0.5	0.1

^{a} See Figure 1. ^{b} Average values from four measurements conducted between Sept 1979 and Dec 1979. ^{c} Hydrophilic at pH 2. ^{d} "Acidic" fraction: hydrophobic at pH 2, hydrophilic at pH 8. ^{e} Hydrophobic at pH 2 and pH 8.

The data presented in Figure 5d–e show that the biologically mediated processes respiration and nitrification always occurred between the river and the wells A1 and A3. Reducing conditions were never observed in the groundwater at this field site. With respect to the organic micropollutants, all compounds exhibited behaviors similar to those observed at the Glatt site; that is, no elimination of tri- and tetrachloroethylene during infiltration, and degradation and/or transformation of the alkylbenzenes and 1,4-dichlorobenzene (see Figure 5b,c; Table II). It should be noted that the slightly lower average concentrations of tetrachloroethylene in A3 and A4 (see Table II) may be attributed to dilution of the infiltrated water with less polluted groundwater from other sources.

From the data shown in Figure 5b, it is possible to determine an average retardation factor for tetrachloroethylene. Figure 5b shows that significantly higher concentrations of this compound were observed in the river between Dec 1980 and Mar 1981. The response in the groundwater (i.e., in wells A1 and A3) to the high concentrations in the river was observed about 4 months later (τ_{tetra}). Thus, when an average residence time (τ_w) of the water between the River Aare and A1 and A3 of approximately 3 weeks to 1 month is assumed (see Figure 5a), an average retardation factor ($\tau_{\text{tetra}}/\tau_w$) of about 5 is obtained. This value is rather low when compared to the retardation factors determined by Roberts et al. (*11*) for compounds of similar lipophilicity in an aquifer in the Palo Alto Baylands (e.g., $R_f = 33$ for chlorobenzene). The result is, however, not surprising considering the much lower organic carbon content of the aquifer materials at this field site as compared to the Palo Alto site, and it is consistent with predictions from model calculations for the very similar type of aquifer at the study site in the Glatt Valley (see Table I).

Behavior of Dissolved Organic Carbon (DOC) during Infiltration. Although this study focused on the behavior of individual organic micropollutants, a few remarks may be made on compositional changes in the bulk DOC during infiltration. Table III contains the average values for DOC and the three DOC fractions determined in the River Glatt and in wells G1–G4. During the first few meters of infiltration, the concentrations of the hydrophilic (fraction 1) and the hydrophobic fraction (fraction 3) of the DOC were significantly reduced. These reductions may be primarly attributed to microbial mineralization (*20*). The "acidic" fraction 2, which includes all fulvic acid type materials (*28*), was not significantly affected by these processes. With increasing distance from the river (G1 → G4), the decrease in concentration of the "acidic" fraction might have been caused by the formation of insoluble complexes with metal ions (e.g., Ca^{2+}) and/or by adsorption onto clay minerals (*36–38*). Between G1 and G4, no significant changes in concentrations were observed in the hydrophilic fraction, whereas the lipophilic fraction was, to a great extent, removed and/or transformed into compounds appearing in one of the other fractions. It is not possible to identify the processes responsible for the removal of the lipophilic fraction of DOC from the available data.

Long-Range Effects of River Water Infiltration. Figure 6 shows the vertical concentration profiles of oxygen, DOC, and two persistent volatile organic compounds determined in well G15, which provides a representative picture of the water composition at various depths in the aquifer in the lower Glatt Valley (*20*). From the data in Figure 6 and from the results of the measurements of other parameters (*20*), it can be assumed that the upper half of the aquifer contained water that had predominantly been infiltrated from the River Glatt, whereas the water in the bottom half of the aquifer originated mostly from less polluted sources.

It is interesting to note that throughout the upper half of the aquifer, the concentrations of tri- and tetrachloroethylene were very similar to the average concentrations detected in the River Glatt (see Figure 4). Thus, when considering that the deeper layers of the upper half of the aquifer contained water that had been infiltrated from the river at distances of up to several kilometers from this well

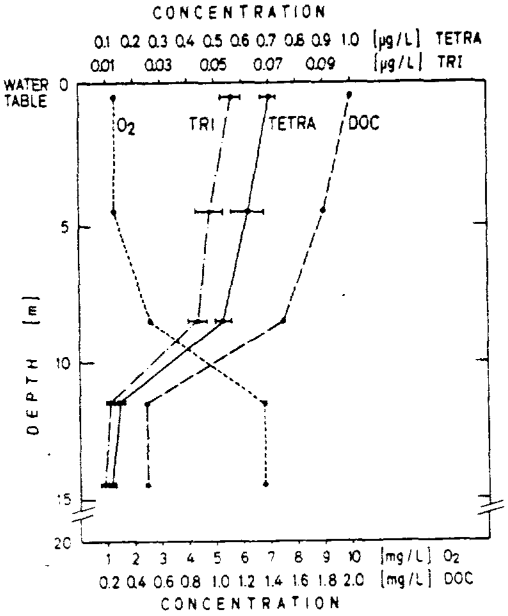

Figure 6. Field site I: vertical concentration profiles of selected parameters in well G15: (---) = dissolved oxygen (O_2); (– – –) dissolved organic carbon (DOC); (– · –) trichloroethylene (tri); (—) tetrachloroethylene (tetra).

(*18*), these findings again clearly demonstrate the great mobility of such persistent compounds in these types of aquifers and hence their potential to contaminate large groundwater areas.

Summary and Conclusions

The transport and fate of organic pollutants, including various volatile organic compounds, during infiltration of river water to groundwater has been studied in year-round investigations at two different field sites in Switzerland. The most important results and conclusions of this field investigation follow.

(1) As predicted by model calculations, volatile organic compounds move rapidly with infiltrating water from rivers to groundwaters. If a river is permanently charged with such chemicals, large groundwater areas may be contaminated, unless the compounds are eliminated during infiltration by biological processes.

(2) Among the volatile organic compounds for which no evidence of biological transformation under any conditions was found were chloroform, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene. With respect to such persistent chemicals, bank filtration is ineffective as a first step in the treatment of river water for water supplies.

(3) The compounds for which biotransformation was observed (e.g., all alkylated C_1–C_4-benzenes, naphthalene, the methylnaphthalenes, and 1,4-dichlorobenzene) were "eliminated" during infiltration to concentrations below their detection limits. Alkylated benzenes were always "eliminated" within the first few meters of infiltration, even at temperatures below 5 °C. The biotransformation of 1,4-dichlorobenzene occurred at a slower rate.

(4) There is strong evidence that certain organic micropollutants (e.g., 1,4-dichlorobenzene) were only biotransformed under aerobic conditions. The elimination of such compounds may therefore be hindered if anaerobic conditions prevail in the aquifer in the near field of a river.

(5) The retention of even highly lipophilic compounds such as hexachlorobenzene is rather small in aquifers composed of materials of low organic carbon content (i.e., $f_{oc} < 0.001$).

The results of this study show that long-term field measurements are useful (i) to gain relevant insights into the behavior of organic micropollutants in a natural river water–groundwater infiltration system and (ii) to check the general validity of conclusions drawn from laboratory investigations.

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Registry No. 1,4-Dichlorobenzene, 106-46-7; toluene, 108-88-3; 1,3-dimethylbenzene, 108-38-3; naphthalene, 91-20-3; hexachlorobenzene, 118-74-1; chloroform, 67-66-3; 1,1,1-trichloroethane, 71-55-6; trichloroethylene, 79-01-6; tetrachloroethylene, 127-18-4.

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OH Radical Rate Constants and Photolysis Rates of α-Dicarbonyls

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■ Photolysis rates of glyoxal, methylglyoxal, and biacetyl and OH radical reaction rate constants for glyoxal and methylglyoxal have been determined at 298 ± 2 K in an environmental chamber, by using the photolysis of CH_3ONO–air mixtures to generate OH radicals. The OH radical rate constants obtained were $(1.15 \pm 0.04) \times 10^{-11}$ and $(1.73 \pm 0.13) \times 10^{-11}$ cm^3 $molecule^{-1}$ s^{-1} for glyoxal and methylglyoxal, respectively. The photolysis rates of glyoxal, methylglyoxal, and biacetyl increased throughout this series, and average quantum yields for the wavelength region ≥290 nm of 0.029 ± 0.018, 0.107 ± 0.030, and 0.158 ± 0.024 were derived for glyoxal, methylglyoxal, and biacetyl, respectively. In addition, upper limits to the rate constants for the reaction of O_3 with glyoxal and methylglyoxal of $<3 \times 10^{-21}$ and $<6 \times 10^{-21}$ cm^3 $molecule^{-1}$ s^{-1}, respectively, were obtained at 298 ± 2 K. These data will serve as needed input to chemical kinetic computer modeling studies of the aromatic hydrocarbons.

Introduction

The α-dicarbonyls glyoxal, methylglyoxal, and biacetyl are important ring-cleavage products in the NO_x–air photooxidations of the aromatic hydrocarbons (*1–6*), and the photolysis of methylglyoxal to radical species is postulated to lead to the observed photochemical reactivity of toluene and the higher aromatics (*4, 6*). In addition, methylglyoxal is postulated to be an intermediate product in the NO_x–air photooxidation of the naturally emitted hydrocarbon isoprene (*7, 8*). Under atmospheric conditions, these α-dicarbonyls, besides photolyzing, may also react with OH radicals or with O_3. On the basis of the data for methylglyoxal (*9, 10*), their reactions with O_3 are expected to be negligible, as is the reaction of OH radicals with biacetyl (*2*). However, both glyoxal and methylglyoxal are expected to react rapidly with OH radicals with rate constants of $\sim(1–2) \times 10^{-11}$ cm^3 $molecule^{-1}$ s^{-1} at 298 K (*4*), although the only OH radical rate constant available for glyoxal or methylglyoxal is a recent value of $(7.1 \pm 1.6) \times 10^{-12}$ cm^3 $molecule^{-1}$ s^{-1} at 297 K for methylglyoxal (*11*). In addition, the rates and products of the photolysis of these α-dicarbonyls under atmospheric conditions are not well-known (*4, 6, 12*), and hence there is clearly a need to investigate the atmospheric loss processes of these α-dicarbonyls in more detail.

In this work, rate constants for the reactions of OH radicals with glyoxal have been determined at 298 ± 2 K, relative to the rate constant for the reaction of OH radicals with cyclohexane, and the photolysis rates of glyoxal, methylglyoxal, and biacetyl have been determined in 1 atm of air in an environmental chamber. In addition, upper limits to the rate constants for the reaction of O_3 with glyoxal and methylglyoxal have been determined at 298 ± 2 K.

Experimental Section

Photolysis and OH Radical Reactions. The technique for the determination of relative OH radical rate constants and of photolysis rates was essentially identical with those described previously (*13, 14*). Hydroxyl radicals were generated by the photolysis of methyl nitrite in air at ≳290 nm, at part-per-million concentrations:

$$CH_3ONO + h\nu \rightarrow CH_3O + NO$$

$$CH_3O + O_2 \rightarrow HCHO + HO_2$$

$$HO_2 + NO \rightarrow OH + NO_2$$

In order to minimize the formation of O_3 during these irradiations, NO was included in the reaction mixtures. In the presence of an α-dicarbonyl and a reference organic (cyclohexane), the OH radicals can, besides reacting with CH_3ONO, NO, NO_2, and the organic reaction products, react with these organics:

$$OH + \text{dicarbonyls} \rightarrow \text{products} \quad (1)$$

$$OH + \text{cyclohexane} \rightarrow \text{products} \quad (2)$$

Additionally, the α-dicarbonyls also photolyze:

$$\text{dicarbonyl} + h\nu \rightarrow \text{products} \quad (3)$$

Under the experimental conditions employed, reactions of the dicarbonyls and cyclohexane with $O(^3P)$ atoms and O_3 were negligible, and since dilution due to sampling was also negligible (<0.2%), then

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Amoco
McCoy Gas Com D

Operator Monthly Report
Not available:
1985 Feb & March

STATE OF NEW MEXICO

OPERATOR'S MONTHLY REPORT

JANUARY , 1985

FORM C-115 EDP

PERATOR: AMOCO PRODUCTION COMPANY P O BOX 591 TULSA, OK, 74102 BUS. ASSOC. 461488 00 PAGE 1

AMOCO ID	POOL NAME AND LEASE NAME STATE LAND LEASE OR FEDERAL LEASE NO. WELL NO.-UNIT LETTER-SEC.-TWP.-RNG. (NEW MEXICO DATA ENTRY CODES)	W S	INJECTION		TOTAL LIQUIDS PRODUCED			GAS PRODUCED MCF	DAYS PROD	DISPOSITION OF GAS				DISPOSITION OF OIL					
			VOLUME	PRES	OIL ALLOW	OIL BBLS.	WATER BBLS.			SOLD	TSP	OTHER	CD	BEG INV	TO TRANS.	TSP	OTHER	CD	END INV
	*** GAS SECTION ***																		
	BASIN-DAKOTA-GAS																		
29055201	MCCOY GAS COM /D/																		
93925701	001 H 28 30N 12W (018270 00000 71599 38455 00 DK 3)	F				39	5	4617	31										
84236501	E001 E 28 30N 12W (018270 00000 71599 38455 00 DK 3)	F				9		4284	31										
	LEASE TOTAL					48	5	8901		8818	EPG	83	U	502		PER			550
29057801	MCDANIEL GAS COM /B/																		
93669501	001 H 26 29N 10W (018270 00000 71599 38460 00 DK 3)	F				12	15	3673	31										
97597001	E001 F 26 29N 10W (018270 00000 71599 38460 00 DK 3)	F					44	1899	29										
	LEASE TOTAL					12	59	5572		5263	EPG	67 242	U V	394		PER	32	E2	374
15272701	MCGRADY GAS COM /C/																		
84227201	001 F 14 27N 12W (018270 00000 71599 67365 00 DK 3)	F				28	40	5358	31										
	LEASE TOTAL					28	40	5358		5320	EPG	37 1	U V	92		PER			120
29055301	MCGRADY, H B, /A/ NM- 35634																		
93453201	001 L 14 27N 12W (018270 00000 71599 38470 00 DK 3)	F				5	2	1031	31										
93453301	002 E 23 27N 12W (018270 00000 71599 38470 00 DK 3)	F				7	3	1822	31										

1J2827N10W	GAS	2503	3290	1922	2425	2754	3169	2372	2540	2269	2334	2281	2903	30988	1522155
	OIL	25	18	51	32	35	67	20	32	35	40	48	53	456	27764
	WAT				1	1		1	1	1	1	1	1	8	
2E2827N10W	GAS	2563	3040	2122	2164	2248	1858	1268	889	2057	2110	3062	3873	27254	1376353
	OIL	41	27	28	38	27	20			15	20	28	40	284	24998
	WAT				1	1	1	1	1	1	1	1	1	9	
C A MCADAMS C															
1P 527N10W	GAS	5719	178	711	7753	6953	4921	749	8558	4856	3427	3774	92	47691	1656015
	OIL	92			37	129	79	17	81	50	51	46		582	28371
	WAT						10	1	2	2	2	2		19	
E 1B 527N10W	GAS	1347	2012	993	7957	19322	8199	1027	13891	10717	4674	3916	663	74718	410695
	OIL	3	40	20	62	133	120	7	96	106	59	43		689	3420
	WAT						2	4	4	4	2	2		18	
2K 527N10W	GAS	5189	1753	7457	7865	2597	801	5457	4286	3660	6372	5057	3366	53860	1932443
	OIL	53		27	67	48	2	41	3	35	38	20	48	382	15492
	WAT							10	1	4	4	2	4	25	
E 2F 527N10W	GAS	6587	1037	5780	6509	5852	728	6661	9225	6876	6894	5892	5049	67090	254985
	OIL	100	14	30	75	139	2	66	146	84	96	68	81	901	3646
	WAT							8	6	4	5	3	3	29	
C A MCADAMS D															
1K2027N10W	GAS	3436	2900	2839	2222	1550	17	17	17	579	1103	1682	5456	21818	1039862
	OIL	25	25	16	13	7							83	169	14016
	WAT				1	1		1	1	1	1	1	1	8	
E 1C2027N10W	GAS	333	2750	2261	2916	2161	90			193	4311	1218	3009	19242	19242
	OIL	103	58	66	50	41					88		97	503	503
	WAT				1	1	1	1	1	1	1	1	1	9	
2G2027N10W	GAS	1219	2661	1402	311	503	357	328	344		20	20	248	7413	903864
	OIL		17	21	8									46	21762
	WAT				1	1	1	1	1	1	1	1	1	9	
E 2J2027N10W	GAS		19714	7471	1330	2308	15598	1130	1042					48593	48593
	OIL	100	206	114	13	25	184	20	15					677	677
	WAT				1	1	1	1	1	1	1		1	8	
MCCARTY GAS COM B															
101629N11W	GAS	43	1361	2772	3131	7039	4867	8056	6265	5909	2976	2067	2	44488	2529185
	OIL	13			97	70	40	99	159	38	40	26		582	32468
	WAT	2	1	6	1		1			1	1		2	15	
E 1G1629N11W	GAS	407	290	535	441	11719	2174	7591	10419	6290	855	2760	4025	47506	399525
	OIL	8			5	50	168	39	174	77		35	1	557	5238
	WAT	18	16	5	4	6			8	8	39		2	106	
MCCOY GAS COM D															
1H2830N12W	GAS	2094	597	235	184	5309	7026	4280	4242	3941	5462	4169	5005	42544	1628366
	OIL	9	6		5	62	59	34	11	49	25	30	26	316	12947
	WAT	15	2	4	10	10	5	6	5	5	10	6	5	83	
E 1E2830N12W	GAS	7444	51	5353	34	14191	9978	7130	8177	6345	4407	4309	5485	72904	110533
	OIL	141	13	4		99	65	47	52	26			5	452	730
	WAT	20	10	15		50	10	10	10	10	6	6	6	153	
MCDANIEL GAS COM B															
1H2629N10W	GAS	4461	3696	3696	3263	2832	3823	2453	2596	2765	2935	2174	2398	37092	2066188
	OIL	3			157	2	11				20	5	10	208	14444
	WAT	8	10	15	20	15	3		6	4	6	12	5	104	
E 1F2629N10W	GAS	1868	2559	2032	1535	1832	3064	1607	1817	1736	2057	2226	2478	24811	132519
	OIL	20	22	13	29	12	25	5			8	19	18	171	660
	WAT	7	6	5	7	15	5	2	8	8	4	10	6	83	
MCGRADY GAS COM C															
1F1427N12W	GAS	4710	4569	3507	6204	5327	3535	3744	1508	4217	3938	4971	6185	52415	237318
	OIL	13	17	13	22	23	29	23	33	9	8	18	12	220	992
	WAT	12	12	11	20	10	15	15	17	10	15	15		152	
H B MCGRADY A															
1L1427N12W	GAS	3814	1444	1600	1552	1582	1370	1503	901	1148	1182	971	1288	18355	1441637
	OIL	8	10	22	3	15	7	5	1	14		2	23	110	9778
	WAT	2	2	3	2	4	3	2		3		3		24	
2E2327N12W	GAS	3056	1320	1440	1327	1297	1644	1609	1145	1389	1562	1412	2006	19207	698739
	OIL	17	11	9	11	15	12	7	5	23		21	17	148	5874
	WAT	3	3	3	3	3	3	3	2	3		3	3	32	
H B MCGRADY B															
1P2427N12W	GAS	6766	4990	5835	5057	5229	5333	5528	5086	5922	5708	5587	5390	66431	2176042
	OIL	50	33	50	45	40	31	29	33	40	23	43	33	450	16844
	WAT	4	3	3	4	2	2	4	4	4		2		32	
MORRIS GAS COM B															
101027N10W	GAS	4771	7122	3893	4360	1480	65	581	65	557	229	8727	5521	37371	1989297
	OIL	87	68	21	81	7						176	143	583	46065
	WAT	1	1	1	1	1	1	1	1	1	1	1	1	12	
E 1M1027N10W	GAS	10747	14697	10723	5044	950		1983		2863	322	13511	12350	73190	291570
	OIL	174	173	185	185	9		14	5	45	100	279	202	1371	6987
	WAT	1	1	1	1	1	1	1	1	1	1	1	1	12	

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SOUTHERN UNION EXPLORATION COMPANY					******************	******************	******************	******************	******************						
JICARILLA K															
13E1125N 5W	GAS	1292	1034	1211	1519	894	967	22			63	1937	1655	10594	315238
14D1125N 5W	GAS	658	604	466	469	392	413	382	317	287	308	520	521	5337	205954
16D1225N 5W	GAS	545	325	182	215	95	209	282	145		82	6	5	2091	91271
18M 225N 5W	GAS	800	816	592	723	337	534	781	317	458	830	908	661	7757	215229
COMPANY TOTAL	GAS	3295	2779	2451	2926	1718	2123	1467	779	745	1283	3371	2842	25779	827692
SOUTHLAND ROYALTY COMPANY					******************	******************	******************	******************	******************						
CAIN															
E 1101528N10W	GAS	3665	3427	3014	3267	2138	2877	2559	268	2772	4006	3620	3243	34856	198688
	WAT							1		1	1	1	1	5	
23A1628N10W	GAS	3345	3209	2917	3031	2162	3331	1652	3295	2658	2798	2899	2587	33884	104295
	WAT	7	7	8	6	6	7	2	4	4	4	4	4	63	
24H1528N10W	GAS	6374	6253	4136	2868	4295				743	9492	4636	4565	43362	70643
	WAT									1	4	4	4	13	
CAIN COM															
E 1201628N10W	GAS	3402	2820	2253	2803	1568	2306	2237	163	2073	3997	3281	2773	29676	142750
	WAT	4	4	4	4	3	3	2		1	2	2	2	31	
COZZENS C															
E 1E2029N11W	GAS	3894	4178	2972	3198	2777	2783	3035	3227	2822	2637	2978	3303	37804	130409
	WAT	25	23	25	24	25	25	2	2	2	2	2	2	159	
HANKS															
24B 527N 9W	GAS	1257	1011	844	852	853	856	68			637	1132	1138	8648	69124
	WAT	3	3	3	3	3	3				2	5	5	30	
25B 627N 9W	GAS	531	1130	1057	1335	773	894	880	1211	917	1160	1076	912	11876	33288
	WAT	51	55	59	57	45	57	17	17	11	16	17	17	419	
MANGUM															
E 4D2829N11W	GAS	LAST PROD. DATE 11/83												S	39796
E 5A2929N11W	GAS	2824	3400	2592	2152	2286	2226	3234	3100	2781	2036	3955	2717	33303	112112
	WAT	28	26	28	21	28	27	3	3	3	3	3	3	176	
MCCLANAHAN															
21B1328N10W	GAS	2557	2400	2166	2319	2377	2617	2287	2674	2475	2292	2059	2227	28450	95892
	WAT	30	28	30	22	28	29	1	1	1	1	1	1	173	
22G1428N10W	GAS	7445	5566	5041	4747	4144	872						9885	37700	65831
	WAT												9	9	
REID															
E 2I1928N 9W	GAS	2813	2923	1647	1944	2185	2216	2055	2051	1761	2441	2539	2161	26736	118184
	WAT	23	22	23	17	22	22	7	4	3	4	4	4	155	
26N 728N 9W	GAS	7721	6702	5502	5204	3607	481				7871	5715	4462	47265	72162
	WAT										1	1	1	3	
COMPANY TOTAL	GAS	45828	43019	34141	33720	29165	21459	18007	15989	19002	39367	33890	39973	373560	1253174
	WAT	171	168	180	154	160	173	35	31	27	40	44	53	1236	
TENNECO OIL COMPANY					******************	******************	******************	******************	******************						
BUNCE COM															
1C1929N10W	GAS	2741	1552	606	9	2809	277	1956	885	2376	1691	1846	1593	18341	97965
	OIL														53
COLE A															
E 1I3528N10W	GAS	1402	1997	1917	1540	624	1132	1985	1726	1521	1313	1751	614	17522	93101
EATON A															
E 1B2529N11W	GAS	2166	1974	2382	2003	2101	1795	1068	1133	445	1824	1485	614	18990	147758
EATON COM B															
1P2529N11W	GAS	1985	1969	1866	1789	1583	1713	1783	1486		1578	1729	1913	19394	54670
FLORANCE															
E124M2729N 9W	GAS		2701	2900	2267	2268	1030	2611	2370	2408	2779	2227	2667	26228	68589
HELEN JACKSON															
E 1G3429N 9W	GAS	1201	1993		3010	1881		2790	2557	4491	2699	2494	1075	24191	81044
E 2B3329N 9W	GAS		4724	6292	1612	1613	4859	6022	2924	2757	4003	2677	5207	42690	121652
JICARILLA A															
E 1F1826N 5W	GAS	131	107	62	84	203	98		25	39	285	174	173	1381	3691
9D2026N 5W	GAS	615	892	226	661		969	571	330	176	415	38	115	5008	18260
	OIL				5									5	5
JICARILLA B															
E 2J1626N 5W	GAS	35	81	803	2572	1784	827			1467	2085	2311	1802	13767	44584
E 7C1626N 5W	GAS	427	1503	289	515	1698	1583	1100	1122	1151	1263	46	548	11245	22477
OMLER A															
E 1F2628N10W	GAS	3638	1495		1841	1152	1551	5099	3961	3183	3167	2996	2758	30841	175612
E 2D3528N10W	GAS	3008	2095	1960	1589	1013	843	2132	1813	1834	1666	2162	2307	22422	109238
E 3D2628N10W	GAS	1407	1147	1267	1473	1217	1028	962	1008	854	774	644	1409	13190	78495
E 4D2528N10W	GAS	3308	1742		1921	1763	1561	4066	2725	2528	2255	1798	2371	26038	126758
E 5E2528N10W	GAS	2786	1899	96	1023	1560	773	3364	2108	1753	1896	1804	2361	21423	102217
E 6D3628N10W	GAS	7200	3519	4408	3280	905	582	9127	3775	2399	4439	3396	3846	46876	190224
E 7J3628N10W	GAS	1322	1370	1262	1509	1421	1288	1226	1247	1197	1288	1252	1283	15665	89727

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WELL S T R		JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC 1984	PROD MP	ACCUM
11L2628N10W	GAS	1432	1669	824	1435	1605	962	1793	1485	978	927	814	786	14710	35708
12B3628N1 W	GAS	1930	1132	1575	1773	1659	1231	1333	1254	957	888	865	847	15394	35986

CONTINUED OTERO CHACRA (GAS)

WELL S T R		JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	1984 PROD	MP
TURNER HUGHES															
18A1127N 9W	GAS	1325	1021	1139	1044	1087	1012	951	944	992	928	1036	1010	12489	2
19B 327N 9W	GAS	588	619	645	629	547	512	496	506	487	585	506	517	6637	1
VAUGHN															
4J2926N 6W	GAS	502	430	497	395	387	411	399	409	469	467	473	787	5626	7
9M2626N 6W	GAS	1061	914	971	952	952	894	925	906	875	884	846	859	11039	3
10I2826N 6W	GAS	1287	1232	1297	1315	1268	1208	1261	1282	1172	1251	1435	1895	15903	7
11E2826N 6W	GAS	652	527	639	606	772	738	781	760	720	768	744	893	8600	2
16L2826N 6W	GAS	1059	974	1054	1022	987	983	999	992	871	970	1055	1372	12338	
17K2926N 6W	GAS	PLUGGING APPROVED 1984													
18D2926N 6W	GAS	527	531	649	628	544	644	453	664	518	542	547	590	6837	
19G2726N 6W	GAS	753	710	805	798	794	765	727	767	704	862	768	739	9192	
20M2726N 6W	GAS	924	391	1007	994	995	973	993	963	960	951	883	1315	11349	
21O2626N 6W	GAS	963	878	966	1141	853	840	872	860	795	818	897	861	10744	
22G2926N 6W	GAS	265	328	354	334	320	319	330	322	285	326	319	324	3826	
23F2726N 6W	GAS	659	592	999	841	864	817	1057	911	862	951	856	839	10248	
24O2726N 6W	GAS	750	772	866	860	850	816	844	856	796	914	860	863	10047	
25A2826N 6W	GAS	1330	769	887	761	943	870	899	870	799	920	888	942	10878	
26E2626N 6W	GAS	730	809	797	829	876	839	866	865	825	818	850	744	9848	
COMPANY TOTAL	OIL														
	GAS	116542	115989	123088	124145	127697	124362	145433	140946	124583	131831	123825	131859	1530300	57
	WAT	22	16	6	3	8	5	63	51	64				238	
ENERGY RESERVES GROUP INC					**********	**********	**********	**********	**********	**********					
JICARILLA 35															
3B 224N 5W	GAS	501	416	426	432	423	415	742	589	518	484	543	460	5949	
4M3525N 5W	GAS	1059	1005	1104	1026	1014	1087	1191	1153	1005	995	1040	1095	12774	
5J3625N 5W	GAS	564	458	491	491	493	539	465	576	436	390	455	511	5869	
6A 124N 5W	GAS	586	518	415	723	730	626	650	700	659	684	665	547	7503	
COMPANY TOTAL	GAS	2710	2397	2436	2672	2660	2667	3048	3018	2618	2553	2703	2613	32095	
W. M. GALLAWAY					**********	**********	**********	**********	**********	**********					
DELO															
10I2629N11W	GAS	3072	1814	3200	3548	2959	3479	2988	3106	2600				26766	
GETTY OIL COMPANY					**********	**********	**********	**********	**********	**********					
BUNCE A															
1A1929N10W	GAS	865	1255	1274	1343	702	694	768	851	773	808	883	898	11114	
JOHN CHARLES															
E 7D1327N 9W	GAS	2415	2153	2776	1690	1121	1171	2683	2288	1912	2103	2246	2350	24908	
8B1327N 9W	GAS	2837	2064	243	1379	3042	1383	4763	3421	2902	2990	1765	3481	30270	
MAE GALE A															
1E2429N11W	GAS	310	2910	4054	2747	1995		2572	3601	2938	3157	2775	2640	29699	
GARRETT A															
1G1229N11W	GAS	521	490	531	543	570	470	409	484	389	485	483	479	5854	
GARRETT B															
1J1229N11W	GAS	2560	2191	581	220	1684	911	1888	2002	1573	1879	1678	1641	18808	
GARRETT D															
1F1329N11W	GAS	1757	2365	1418	259	1517	1032	1887	1958	1957	1304	1433	1358	18245	
HANLEY A															
1F1829N10W	GAS	1829	1140	1258	640	2454	1807	1785	1688	1459	1621	1174	1099	17954	
HANLEY B															
1N1829N10W	GAS	1149	1079	1227	1116	1140	1092	1068	1055	968	957	850	872	12573	
EM HARTMAN															
1I1329N11W	GAS	95	2265	1925	2310	1413	896	3734	2412	2079	2437	2261	2243	24070	
B M HOUCK															
1B1329N11W	GAS	2592	1895	208	906	3094	1952	2063	1930	1771	1794	2084	1885	22174	
JICARILLA C															
9K2825N 5W	GAS	259	204	493	315	287	266	233	228	222	226	241	204	3178	
10M2225N 5W	GAS	521	387	268	312	352	371	349	368	348	333	302	292	4203	
11L2725N 5W	GAS	340	302	294	313	332	332	335	339	291	174	342	293	3687	
12C3325N 5W	GAS	117	110	116	123	128	165		136	145	132	136	139	1447	
13B3325N 5W	GAS	41	282	241	233	212	202	135	205	211	221	225	251	2459	
14A2725N 5W	GAS	1026	679	626	586	466	479	616	442	466	342	623	1045	7396	
15G3425N 5W	GAS	703	506	635	617	634	609	644	611	591	623	588	613	7434	
16D3425N 5W	GAS	314	345	328	594	465	683	1447	1676	1018	878	1094	1253	10095	
17D2825N 5W	GAS	336	238	523	375	371	362	387	336	259	318	289	285	4129	
18H2825N 5W	GAS	948	819	477	799	874	487	895	748	710	656	677	826	8916	
19I2725N 5W	GAS	853	794	809	782	795	745	730	832	718	748	669	781	9256	
24F2725N 5W	GAS	1202	967	1039	972	996	968	990	1012	892	844	900	859	11641	
29I2125N 5W	GAS	1699	1353	1916	2714	1441	3254	3134	1926	2178	2042	3200	2120	26977	
32J2825N 5W	GAS	863	307	436	1889	502	269	1822	3027	2775	3017	1013	382	16302	
33L2125N 5W	GAS	414		597	1361	1299	1373	906	1260	1439	825	829	742	11045	
MARSHALL A															
7B1427N 9W	GAS	174	4593	4914	3534	1916	1345	4723	3932	3472	3429	3205	3168	38405	
MEXICO FEDERAL N															

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CONTINUED BLANCO MESAVERDE (PRORATED GAS)

WELL S T R		JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	1984 PROD	ACCUM
Y 2G1332N10W	GAS	3063	2659	2919	2290	2543	2522	3179	55	140	4369	3472	3469	30680	553522
	OIL	5	3	5	2	7		2				3	2	29	311
	WAT	2	3	4	4	4	4	2		1	3	3	3	33	
VASALY FEDERAL 1F3132N11W	GAS	PLUGGING APPROVED 1978													2645548
	OIL														8229
A 1M3132N11W	GAS	5497	4237	3323	2132	4029	1757	5094	4029	7003	5620	5435	3874	53030	525383
	OIL								5	6	3	2	1	17	1175
	WAT							4	3	4	4	4	4	23	
Y 1C3132N11W	GAS	6374	5305	4180	2914	4377	2162	5557	4224	7626	6711	6802	4414	60646	1208239
	OIL	24	15	7		8		10	10	29	29	17	8	157	3511
	WAT	4	4	4	4	4	2	4	3	4	4	4	4	45	
WALLER 1M1132N11W	GAS	4472	1711	9154	3751			2434	8997	7326	10757	9117	10090	67809	2706720
	OIL	3	13	24	2			7	27	14	27	19	26	162	3297
	WAT		2	10	8			1	3	2	4	4	4	38	
A 1P1132N11W	GAS	3812	500	5449	3060			870	7200	6068	9716	7535	8243	52453	370524
	OIL			12	5				12	3	14		2	48	394
	WAT	50	10	48	36			3	16	14	20	21	22	240	
SADIE WEST 1L2131N12W	GAS		958	3075	1453	503		2513	32			3078	2222	13834	1173098
	OIL														153
	WAT												1	1	
A 1C2131N12W	GAS		1914	5468	2766	2278		4858	41			5034	6604	28963	393834
	OIL		18	22	17	3		16				33	47	156	1705
	WAT			7	7	4		1				1	1	21	
WILMER CANYON 1M2432N 8W	GAS	445	1054	1168	1018	1015	151	144			784	1359	1245	8383	238736
	WAT	7									2	4	4	17	
2C2532N 8W	GAS	1400	2856	3212	2592	2005	927				5454	5059	4102	27607	181100
	WAT	4	12	13	13	10	5				5	5	5	72	
ZACHRY COM 1H 230N12W	GAS	3060	2713	2851	2482	1616		1042	2277				49	16090	602154
	OIL	20	10	6	4				1					41	1253
	WAT	2	2	2	2	2			2					12	
A 1C 230N12W	GAS	7034	6125	6703	7117	3378		2792	3474				998	37621	407261
	OIL	24	20	17	18	3		8	2					92	1248
	WAT	7	7	7	7	5		2	5					40	
COMPANY TOTAL	OIL	5088	4986	3858	3264	3065	2742	3473	3022	4343	4205	4650	6289	48985	1062315
	GAS	1138953	1088240	995088	805825	792161	754821	937253	772478	1012060	1117663	1218147	1510352	12143041	355853481
	WAT	1565	1844	2099	1839	1740	1569	1347	1007	1133	1632	2126	2720	20621	
THE SUPERIOR OIL COMPANY						********	********	********	********	********					
BUNNY ET AL 1P1027N 9W	GAS	4240	4304	4605	3993	3920	3747	2924	3563	3763	3967	4191	5135	48352	1723095
	OIL	11	34	23	26	21	13	21	17	23	23	27	44	283	8952
MARSHALL 4A1527N 9W	GAS	731	529	567	561	478	465	394	403	473	430	609	877	6517	528974
	OIL	4	1	7	3	1	2			1	1	5	2	27	3283
	WAT	6	6	6	6		6	6	6	6	6	6	6	66	
NAVAJO 1G2527N 9W	GAS	780	704	727	574	806	689	587	789	567	861	742	798	8624	769719
	OIL	17	21	13	19	16	20	11	12	14	18	12	48	221	12369
	WAT	8		8	7	8	8	8	8	8	8	8	8	87	
COMPANY TOTAL	OIL	32	56	43	48	38	35	32	29	38	42	44	94	531	24604
	GAS	5751	5537	5899	5128	5204	4901	3905	4755	4803	5258	5542	6810	63493	3021788
	WAT	14	6	14	13	8	14	14	14	14	14	14	14	153	
SUPRON ENERGY CORP						********	********	********	********	********					
HUNSAKER 2B2631N 9W	GAS	PLUGGING APPROVED 1980													9059750
	OIL														86225
TENNECO OIL COMPANY						********	********	********	********	********					
FLORANCE 47G 530N 9W	GAS	PLUGGING APPROVED 1965													1318744
	OIL														4132
MESA VERDE BAY UNIT 1G3630N 3W	GAS	PLUGGING APPROVED 1963													689061
	OIL														19
COMPANY TOTAL	OIL														4151
	GAS														2007805
TENNECO OIL COMPANY						********	********	********	********	********					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

ARCHULETA															
1N1930N 8W	GAS	3476	3011	890	3682	215	3409	2008	4274	4551	4134	1736	5241	36627	2863708
	OIL												11	11	8852
A 1F1930N 8W	GAS		11370	8402	7880	2628	6590	3561		3895	9782	5547	8956	68611	1065267
	OIL		35	54	16	37	13	9			31	9	10	214	2166
BASSETT B															
1E3330N10W	GAS		2269	5471	789	3267	6401	1850			7495	8223	7124	42889	214117
	OIL		2	25	8	14	36				47	68	30	230	1107
M 1L3330N10W	GAS		14923	15468	3207	7413	11081				13674	20254	13691	99711	158281
	OIL				6	30	40				45	74	32	227	438
BLANCO COM 1															
1G 230N11W	GAS	2179	2377	2490	2170	2559	2002	1960	1893	1865	2102	1278	2805	25680	974304
	OIL			25	1	2								28	1248
A 1P 230N11W	GAS							20429	29395	16054	17644	8435	13900	105857	105857
	OIL								130	60	85	69	56	400	400
BLANCO COM 2															
1K 230N11W	GAS	2608	2454	2157	2358	1929	1432	2847	2552	2509	2121	2171	2044	27182	1054407
BUNCE COM															
1C1929N10W	GAS	31	TSTM	TSTM										31S	2066
	OIL														333
COLDIRON COM A															
M 1F 230N11W	GAS		5860	20552	6898			1653	4544			6266	18590	64363	93138
	OIL			14	13							13	47	87	153
DAWSON A															
1N 427N 8W	GAS	2052	1927	2050	1774	1897	2778	1133			540	1116	3352	18619	535322
	OIL	11	36	16	35	16	60	5			9	12	16	216	5476
M 1D 427N 8W	GAS	5563	5559	6143	4332	4518	2338			32	837	1647	8327	39296	251190
	OIL	30	45	21	17	9	30			17	4	25	56	254	3210
DAWSON FEDERAL															
1D2627N 8W	GAS	1766	1800	2092	1560	1454	977	1517	920	139	1827	1863	1739	17654	855233
	OIL			9				13		2	3	8	7	42	4702
M 1N2627N 8W	GAS	7982	1675	14568	12692		5576	14080	9110	6958	14024	9844	9916	106425	391211
	OIL	44	16	42	35		39	60	39	40	59	49	32	455	2368
EATON A															
E 1B2529N11W	GAS	4396	4008	4835	4067	4266	3644	2167	2301	904	3703	3015	1246	38552	174717
	OIL	48		19	12	29	15	26	17		34	19	45	264	1432
EATON COM B															
1P2529N11W	GAS	221	218	207	198	176	190	198	165	1853	176	192	213	4007	42746
	OIL	31	20	17	37		15	35	16	19	30	30		250	1480
FLORANCE															
1H3529N 9W	GAS			3606	391							3	4352	8352	4515977
	OIL			10									5	15	12773
A 1P3529N 9W	GAS			2125	427							3	6097	8652	363335
	OIL														1187
2A2030N 9W	GAS	15189	3542	2102	1808		2720	870	6789	12556	5489	4126	11995	67186	6918659
	OIL	72	8					2	10	82	18	5	42	239	20697
A 2O2030N 9W	GAS	16116	2058	1915	2747	3303	363	11059	15003	26064	20964	14174	3682	117448	1284192
	OIL	81	4	8	6	12		42	51	49	43	33	17	346	2908
3M2230N 9W	GAS	21904	13511	14803	15444	8768	9933	25605	17618	22682	15603	18603	17862	202336	11758831
	OIL	6		8	5	7	5	10	8	8	10	16	11	94	15126
A 3O2230N 9W	GAS	PLUGGING APPROVED 1984													219522
B 3I2230N 9W	GAS	16072	953	21	39	2128	1074			5739	19974	30878	7167	84045	1141696
	OIL	44								10	30	35	4	123	1679
4L1030N 9W	GAS	10946	251	324	1038	2140	424	8669	1011	5904	2695	86	5994	39482	5720892
	OIL	17		3		8		39		6	7	3	17	100	9753
A 4C1030N 9W	GAS	20980	10360	12295	19066	13407	4924	15653	14940	19112	10300	167	20868	162072	1569259
	OIL	31	42	4	40	35	3	20	22	36	18		30	281	2872
5A2230N 9W	GAS	16880	1412	18	15	3900	2260	16265	2325	1419		6	7513	52013	10688279
	OIL	24						19					12	55	17940
A 5C2230N 9W	GAS	31775	29753	15607	10142	31783	11786	27584	28714	23823		167	31268	242402	3056233
	OIL					8	2	10	16	4			1	41	1195
6M2330N 9W	GAS	14249	779	50	170	3056	2153					6	8430	28893	8582767
	OIL														23127
A 6O2330N 9W	GAS	16286	15028	2831	10028	8613	3742					210	2098	58836	1135468
	OIL	8	7	3	5	7	1							31	1414
7B2330N 9W	GAS	5086	411	337	84	1088	796	3372	1266	2650	1556	1181	3301	21128	5071693
	OIL								2					2	15895
A 7F2330N 9W	GAS	4927	265	91	51	724	254	343		2281	994	2399	25672	38001	592407
	OIL	2								2				4	976
8N1430N 9W	GAS	29475	15415	8580	10129	14394	8188	32223	22349	30694	8009	10949	25162	215567	8571812
	OIL	12	1		9	13		8	13	28	1	4	10	99	15084
A 8I1430N 9W	GAS	16117	478	543	635	2349	524	6491	2500	4732	23693	17957	3748	79767	1183733
	OIL	30	5			9		10		15	71	15	7	162	3067
9M1330N 9W	GAS	7758	1130	14	26	1735	992	1387	3264	3544	2476	1102	6027	29455	6847900
	OIL	4	3											7	6217

MESAVERDE 1984

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                 OIL      12       7       3      15      28      19      20      44      26      17      42      19     252      1123
  DUDLEY CORNELL A
   1D 129N12W    GAS     305       8    3385    5852    7858    5448    4367    5466    3644    2422    6030    8911   53696   2792686
                 OIL               6      22      63      68      38      35      66      14              67      46     425     24959
E  1G 129N12W    GAS     386       8    3740    6110    9919    6835    5916    8925    6215    2755    6700    7792   65301    346982
                 OIL              28      58      74      86      61      68     103      46      35      95      24     678      3038
  DAWSON A
   1N 427N 8W    GAS    1357    1438    1659    1529    1510    1735    1346    1320    1433    1794    1523    1360   18004    494892
                 OIL       8      30      24      19       9      51      19      28      28      30      22       9     277      6664
M  1D 427N 8W    GAS    3976    3750    4379    3960    4152    4464    3460    2996    4541    4469    4268    3431   47846    266491
                 OIL      33      50      61      37      73      45      50      48     100       7      73      99     676      2885
  DAWSON FEDERAL
   1D2627N 8W    GAS    LAST PROD. DATE 10/79                                                                           D     89398
                 OIL                                                                                                          3176
M  1N2627N 8W    GAS    2064    2016    2069    1983    1797    1791    1968    1843    1828    1904    1802    1623   22688    101463
                 OIL      46      77      91     102      49      43      98      47      49      91      46      69     808      3065
  DAY
   1H 729N 8W    GAS     739     587     734    1461    1342    1067    1057    1215     964     972     768    1127   12033    506939
                 OIL                                                                                                           247
E  1P 729N 8W    GAS     940    2948    3385    3651    3652    2766    2736    3543    3163    3075    2340    3333   35532     44554
                 OIL       8      13      17       8       4       6      31      11       4      10              13     125       160
   2G 829N 8W    GAS    2235       4    1523    2308   15933   13177           10613   11448                     145   57386    594422
                 OIL                       5       5      24      16              15                                      65       517
E  2I 829N 8W    GAS               4    5914    7936   22013   11094           12412   11515                    1331   72219    453384
                 OIL                       6       7      22       8              13      15                              71       334
   3A1729N 8W    GAS   12264   11961    2429                                                   11582   16697   14552   69485    597694
                 OIL       8      20       3                                                              16      25      72       671
E  3I1729N 8W    GAS       7   21947      65                                                    6860   25177   20101   74157    359264
                 OIL              34                                                                      20      29      83       466
   4F 829N 8W    GAS    3629   15023   11204                            8893   14093    9908    8563   10143    7835   89291    481764
                 OIL      13      27      13               2              28      34       1               2       2     122       743
E  4N 829N 8W    GAS    7407    8407    5115            5993    3255    6846    7559    7638    7541    6087    4329   70177    219459
                 OIL      20       5       8               1      19      17      17      13       5       7      15     127       297
   5P1829N 8W    GAS    1320    2248    1521    1794    2594                                              26     111    9614    176703
                 OIL       2               2       3                                                                       7       204
E  5A1829N 8W    GAS    2512    3381    2269    3535    2056                                                    4825   18578     39148
                 OIL       7      10       2       3       1                                                       4      27        98
  DELHI TAYLOR
   5A1726N11W    GAS    2741    3422    3342    2565    2385    2413    2343    2416    2428    2412    2328    2234   31029   3180791
                 OIL      21      15      45      25      20      24       8              12      17      17     103     307     24150
   6K1726N11W    GAS    PLUGGING APPROVED  1982                                                                               4150621
                 OIL                                                                                                         29893
E  6C1726N11W    GAS    LAST PROD. DATE 12/82                                                                           S      3765
  DELHI TAYLOR D
   1M 326N11W    GAS    2862    2648    2530    3415    1887              62     341     840     925     987     959   17456   4280037
                 OIL                                                      20                                              20     41136
E  1D 326N11W    GAS    1934    2062    2530    2440    3422    2704    2125    2166    2760    2705    2663    2972   30483     72632
                 OIL      11      20      15      20      26      18              20      14      23      18      22     207       561
  DELHI TAYLOR E
   1G 426N11W    GAS    1116    1062    2109    1759    1506    1508    1773    1737    1579    1580    1748    1636   19113   3294114
                 OIL               3      10      15      12       8                                                      48     25861
E  1J 426N11W    GAS    3239     288     328     316     313     326     322     331     300     296     282     274    6615     25672
                 OIL       1                                                                                               1        31
  DROLET
   1I2826N11W    GAS     848     827     862    1058     865     819     750     590     861     915     652     999   10046    990948
                 OIL       1      11       1                                                       3       6      39      61     14748
  DRYDEN
   1M2628N 8W    GAS      86       7    3074    3258    1216             957    3277    2608    2617    1899     236   19235    628497
                 OIL               7      38      41      16               3      40      30      35      28             238     12499
E  1I2828N 8W    GAS     221       4    7232    7716    5153    3832    3311    2666    5005            5834           40974     65807
                 OIL      16             438     657     373      28      18      63     245             288            2126      4149
  EATON A
   1P2529N11W    GAS    1501    2252    1867    2336    2081    2130    2558    1698    2241    1732    1647    2091   24134   2859640
                 OIL      25      66      85      57      72      70      70      81      67      44      95      81     813     17868
E  1B2529N11W    GAS    2871    4082    3595    2980    2623    2068    4237    2465    2265    3116    3092    1946   35340    132030
                 OIL      46              19      13      15      15      30      20              34      20             212      1209
  FIELDS
   1M2932N11W    GAS    3645    2857    2862    2804    6537    1086    2997    6602    7025    7402    6866    5091   55774    394753
                 OIL      10               2       3                               2                                      17        80
E  1I2932N11W    GAS    8264    3742    3671    6010   11718    2346    4608    8887    7814    7596    6852    4597   76105    248770
                 OIL      10               2      13                                                                      25        65
   2B2932N11W    GAS    3557    4733    6692    2549    3663    2272    3087    4834    4343    4203    4776    3045   47754    356928
E  2E2932N11W    GAS    9394    9992    9315    5808    5611    2799    4385    7076    8464    8171    7911    8284   87210    307280
                 OIL                       4                                                                               4        49
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BASIN DAKOTA 1984

OPERATOR'S MONTHLY REPORT

COMPANY: TENNECO OIL COMPANY   ADDRESS: P.O. BOX 3249 ENGLEWOOD, COLORADO 80155   MONTH: JANUARY ,1985 PAGE 30 OF

POOL NAME / LEASE NAME / WELL NO.	U	SEC	TWP	RNG	STAT	WATER INJECTION VOLUME	WATER INJECTION PRESS.	OIL ALLOW. (BBL)	OIL PRODUCED (BBL)	WATER PRODUCED (BBL)	GAS PRODUCED (MCF)	DAYS PROD	GAS SOLD	GAS TRANSPORTER	GAS OTHER	CODE	OIL ON HAND BEG. OF MONTH	BARRELS TO TRANSPORTER	OIL TRANSPORTER	OIL OTHER	CODE	OIL ON HAND END OF MONTH
GAS WELLS																						
BASIN (DAKOTA) (DAKOTA) DALLET COMM. AGREE NO. 91-006631																						
1	I	23	26N	11W	F						1210	31										
LEASE TOTAL											1210		1132	EPG	28	U	151					151
BASIN (DAKOTA) (DAKOTA) DRYDEN																						
1	M	25	28N	8W	F			25	25		2275	28										
1E	I	28	28N	8W	F			463	463		9256	28										
LEASE TOTAL								488	488		11531		11459	EPG	72	U	181	451	PER			218
BASIN (DAKOTA) (DAKOTA) EATON A COMM. AGREE NO. 91-007454																						
1	P	25	29N	11W	F			89	89		1255	31										
1E	O	25	29N	11W	F			6	6		3412	31										
LEASE TOTAL								95	95		4665		4591	EPG	74	U	208	145	PLA			158

STATUS CODE	GAS CODE	OIL CODE
F.....FLOWING	X.....USED OFF LEASE	C.....CIRCULATING OIL
P.....PUMPING	D.....USED FOR DRILLING	L.....LOST
G.....GAS LIFT	G.....GAS LIFT	S.....SEDIMENTATION
S.....SHUT IN	L.....LOST (MCF EST)	E.....EXPLANATION ATTACH
T.....TEMP. ABANDONED	E.....EXPLANATION ATTACHED	
I.....INJECTION	R.....REPRESS-PRESS MAINT	
D.....DISCONTINUED	V.....VENTED	
	U.....USED ON LEASE	

NAME : URSULA SULZBACH

POSITION : DISTRICT ADMINISTRATOR

SIGNATURE :   DATE: 02/26/85

PHONE : (303) 740-2590

ILLEGIBLE

NEW MEXICO OIL CONSERVATION COMMISSION FORM C-115-EDP
OPERATOR'S MONTHLY REPORT

COMPANY: TENNECO OIL COMPANY ADDRESS: P.O. BOX 3249 ENGLEWOOD, COLORADO 80155 MONTH: JANUARY ,1985 PAGE 96 OF

POOL NAME LEASE NAME WELL NO.	U L	SEC	TWP	RNG	STAT	WATER INJECTION VOLUME	WATER INJECTION PRESS.	MONTHLY OIL ALLOW. (BBL)	ACTUAL OIL PRODUCD (BBL)	WATER PRODUCD (BBL)	GAS PRODUCD (MCF)	DAYS PROD	DISPOSITION OF GAS SOLD	TRANSPORTER	OTHER	CODE	OIL ON HAND BEG. OF MONTH	BARRELS TO TRANSPORTER	TRANSPORTER	OTHER	CODE	OIL ON HAND END OF MONTH
GAS WELLS																						
DAWSON FEDERAL																						
1M	N	26	27N	8W	F			22	22		9637	31										
LEASE TOTAL								39	39		11269		11195	EPG	74	U	249	78	CST			210
BLANCO (MESAVERDE) (MESAVERDE) EATON A COMM. AGREE NO. 91-007454																						
1E	B	25	29N	11W	F			6	6		1537	31										
LEASE TOTAL								6	6		1537		1485	EPG	52	U	71	37	PLA			40
BLANCO (MESAVERDE) (MESAVERDE) EATON COM B COMM. AGREE NO. 93-000153																						
1	P	25	29N	11W	P			30	30		191	31										
LEASE TOTAL								30	30		191		183	EPG	8	U	207					237
BLANCO (MESAVERDE) (MESAVERDE) FLORANCE 1,1A,23,23A																						
1	H	35	29N	9W	F			8	8		8271	31										
1A	P	35	29N	9W	F						4907	31										

STATUS CODE	GAS CODE	OIL CODE
F.....FLOWING	X.....USED OFF LEASE	C.....CIRCULATING OIL
P.....PUMPING	D.....USED FOR DRILLING	L.....LOST
G.....GAS LIFT	G.....GAS LIFT	S.....SEDIMENTATION
S.....SHUT IN	L.....LOST (MCF EST)	E.....EXPLANATION ATTACH
T.....TEMP ABANDONED	E.....EXPLANATION ATTACHED	
I.....INJECTION	R.....REPRESS-PRESS MAINT	
D.....DISCONTINUED	V.....VENTED	
	U.....USED ON LEAS	

NAME : URSULA SULZBACH
POSITION : DISTRICT ADMINISTRATOR
SIGNATURE:
DATE: 02/26/85
PHONE : (303) 740-2590

ILLEGIBLE

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                                   NEW MEXICO OIL CONSERVATION COMMISSION                        FORM C-115-EDP
                                        OPERATOR'S MONTHLY REPORT

COMPANY: [illegible] OIL COMPANY   ADDRESS:P.O. BOX 3249, ENGLEWOOD, COLORADO 80155      MONTH:JANUARY ,1985 PAGE  143 OF
----------------------------------------------------------------------------------------------------------------------------
P O O L   N A M E          WATER      -TOTAL LIQUIDS PRODUCED-       --DISPOSITION OF GAS- --------- DISPOSITION OF OIL ------
   LEASE NAME            INJECTION    ------------------------      ---------------------- -------------------------------
                    S --------------- MONTHLY ACTUAL                                       C OIL ON BARRELS             C OIL ON
                    T                  OIL      OIL     WATER     GAS                TRANS  O HAND     TO      TRANS    O HAND
WELL U              A                ALLOW.  PRODUCD PRODUCD  PRODUCD DAYS        PORT=    D BEG.OF TRANS-  PORT=    D END OF
 NO. L SEC TWP RNG  T  VOLUME  PRESS. (BBL)   (BBL)   (BBL)    (MCF)  PROD  SOLD  TER  OTHER E MONTH  PORTER  TER  OTHER E MONTH
----------------------------------------------------------------------------------------------------------------------------
GAS WELLS

OTERO (CHACRA) (CHACRA)
  BUNCE COM

  1  C  19 29N 10W  F                                          2363  31

  LEASE TOTAL                                                  2363       2323 EPG     40 U    9                            9
OTERO (CHACRA) (CHACRA)
  EATON A
  COMM. AGREE NO. 91-007+54

  1E B  25 29N 11W  F                                           757  31


    STATUS CODE                  GAS CODE                     OIL CODE
   F.....FLOWING          X.....USED OFF LEASE          C.....CIRCULATING OIL        NAME      :  URSULA SULZBACH
   P.....PUMPING          N.....USED FOR DRILLING       L.....LOST
   G.....GAS LIFT         G.....GAS LIFT                S.....SEDIMENTATION          POSITION :  DISTRICT ADMINISTRATOR
   S.....SHUT IN          L.....LOST (MCF EST)          E.....EXPLANATION ATTACH
   T.....TEMP ABANDONED   E.....EXPLANATION ATTACHED                                 SIGNATURE:                         DATE:02/26/85
   I.....INJECTION        R.....REPRESS-PRESS MAINT
   D.....DISCONTINUED     V.....VENTED                                               PHONE     :  (303) 740-2590
                          U.....USED ON LEASE
```

ILLEGIBLE

NEW MEXICO OIL CONSERVATION COMMISSION
OPERATOR'S MONTHLY REPORT

FORM C-115-EDP

MPANY: TENNECO OIL COMPANY ADDRESS: P.O. BOX 3249 ENGLEWOOD, COLORADO 80155 MONTH: FEBRUARY ,1985 PAGE 30 OF

OL NAME LEASE NAME LL U . I SEC TWP RNG	S T A T	WATER INJECTION VOLUME	WATER INJECTION PRESS.	TOTAL LIQUIDS PRODUCED MONTHLY ACTUAL OIL ALLOW. (BBL)	OIL PRODUCD (BBL)	WATER PRODUCD (BBL)	GAS PRODUCD (MCF)	DAYS PROD	DISPOSITION OF GAS SOLD	TRANS PORT-TER	OTHER	C O D E	DISPOSITION OF OIL OIL ON HAND BEG. OF MONTH	BARRELS TO TRANS-PORTER	TRANS PORT-TER	OTHER	C O D E	OIL ON HAND END OF MONTH
S WELLS																		
SIN (DAKOTA) (DAKOTA) RCLET OMM. AGREE NO. 91-006691																		
I 28 26N 11W	F						916	28										
EASE TOTAL							916		891	EPG	25	U	151					151
SIN (DAKOTA) (DAKOTA) RYDEN																		
M 28 28N 8W	F			39	39		3027	28										
E I 28 28N 8W	F			372	372		6516	28										
EASE TOTAL				411	411		9543		9471	EPG	72	U	218	229	PER			400
SIN (DAKOTA) (DAKOTA) ATON A OMM. AGREE NO. 91-007454																		
P 25 29N 11W	F			71	71		491	28										
E B 25 29N 11W	F			17	17		1444	28										
EASE TOTAL				88	88		1935		1868	EPG	67	U	158					246

STATUS CODE
F.....FLOWING
P.....PUMPING
G.....GAS LIFT
S.....SHUT IN
T.....TEMP ABANDONED
I.....INJECTION
D.....DISCONTINUED

GAS CODE
X.....USED OFF LEASE
D.....USED FOR DRILLING
G.....GAS LIFT
L.....LOST (MCF EST)
E.....EXPLANATION ATTACHED
R.....REPRESS-PRESS MAINT
V.....VENTED
U.....USED ON SF

OIL CODE
C.....CIRCULATING OIL
L.....LOST
S.....SEDIMENTATION
E.....EXPLANATION ATTACH

NAME : URSULA SULZBACH
POSITION : DISTRICT ADMINISTRATOR
SIGNATURE: DATE:03/22/85
PHONE : (303) 740-2590

ILLEGIBLE

NEW MEXICO OIL CONSERVATION COMMISSION
OPERATOR'S MONTHLY REPORT

FORM C-115-EDP

PANY: TENNECO OIL COMPANY ADDRESS:P.O. BOX 3249 ENGLEWOOD, COLORADO 80155 MONTH:FEBRUARY ,1985 PAGE 96 OF

OL NAME LEASE NAME	U L	SEC	TWP	RNG	STAT	WATER INJECTION VOLUME	WATER INJECTION PRESS.	MONTHLY ACTUAL OIL ALLOW. (BBL)	OIL PRODUCD (BBL)	WATER PRODUCD (BBL)	GAS PRODUCD (MCF)	DAYS PROD	DISPOSITION OF GAS SOLD	TRANSPORTER	OTHER	CODE	OIL ON HAND BEG.OF MONTH	BARRELS TO TRANSPORTER	TRANSPORTER	OTHER	CODE	OIL ON HAND END OF MONTH
WELLS																						
AWSON FEDERAL																						
1	N	26	27N	8W	F			50	50		8047	28										
ASE TOTAL								60	60		9716		9649	EPG	67	U	210					270
LCO (MESAVERDE) (MESAVERDE) ATON A OMM. AGREE NO. 91-007454																						
	B	25	29N	11W	F			16	16		1383	27										
ASE TOTAL								16	16		1383		1336	EPG	47	U	40					56
ICO (MESAVERDE) (MESAVERDE) ATON COM B OMM. AGREE NO. 93-000153																						
	P	25	29N	11W	P			27	27		160	28										
ASE TOTAL								27	27		160		153	EPG	7	U	237	199	CST			65
LCO (MESAVERDE) (MESAVERDE) ORANCE 1,1A,23,23A																						
	H	35	29N	9W	F			7	7		5058	28										
	P	35	29N	9W	F						4581	28										

STATUS CODE	GAS CODE	OIL CODE
F.....FLOWING	X.....USED OFF LEASE	C.....CIRCULATING OIL
P.....PUMPING	D.....USED FOR DRILLING	L.....LOST
G.....GAS LIFT	G.....GAS LIFT	S.....SEDIMENTATION
S.....SHUT IN	L.....LOST (MCF EST)	E.....EXPLANATION ATTACH
T.....TEMP ABANDONED	E.....EXPLANATION ATTACHED	
I.....INJECTION	R.....REPRESS-PRESS MAINT	
D.....DISCONTINUED	V.....VENTED	
	U.....USED ON LEASE	

NAME : URSULA SULZBACH
POSITION : DISTRICT ADMINISTRATOR
SIGNATURE: DATE:03/22/85
PHONE : (303) 740-2590

ILLEGIBLE

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                              NEW MEXICO OIL CONSERVATION COMMISSION                     FORM C-115-EDP
                                    OPERATOR'S MONTHLY REPORT

MPANY: TENNECO OIL COMPANY      ADDRESS:P.O. BOX 3249 ENGLEWOOD, COLORADO 80155      MONTH:FEBRUARY ,1985 PAGE  144 OF
J O L    N A M E            WATER      -TOTAL LIQUIDS PRODUCED-         --DISPOSITION OF GAS- --------- DISPOSITION OF OIL ------
  LEASE  NAME              INJECTION   ------------------------         ---------------------  -------------------------------
                    S  -------------- MONTHLY ACTUAL                                        C OIL ON BARRELS           C OIL ON
                    I                  OIL    OIL    WATER    GAS                TRANS      O HAND    TO     TRANS    O HAND
LL U                A                 ALLOW. PRODUCD PRODUCD  PRODUCD DAYS       PORT-      D BEG.OF TRANS-  PORT-    D END OF
U. L SEC TWP RNG    T  VOLUME  PRESS. (BBL)  (BBL)   (BBL)    (MCF)  PROD  SOLD  TER  OTHER E MONTH  PORTER  TER OTHER E MONTH
-----------------------------------------------------------------------------------------------------------------------------
S WELLS

BUNCE COM

LEASE TOTAL                            1      1              2121     2085 EPG       36 U     9                          10

RO (CHACRA) (CHACRA)
EATON A
OMM. AGREE NO. 91-007454

LE B  25 29N 11W  F                                          681 27

LEASE TOTAL                                                  681      658 EPG        23 U

PO (CHACRA) (CHACRA)
AION COM B
COMM. AGREE NO. 91-002464

  P  25 29N 11W  P                                           1437 28

EASE TOTAL                                                   1437     1374 EPG       63 U

RO (CHACRA) (CHACRA)
LORENCE 124 & 124-E

E M  27 29N  9W  F                                           2414 28

EASE TOTAL                                                   2414     2383 EPG       31 U




  STATUS CODE               GAS CODE                     OIL CODE
 F.....FLOWING           X.....USED OFF LEASE         C.....CIRCULATING OIL    NAME     :  URSULA SULZBACH
 P.....PUMPING           D.....USED FOR DRILLING      L.....LOST
 G.....GAS LIFT          G.....GAS LIFT               S.....SEDIMENTATION      POSITION :  DISTRICT ADMINISTRATOR
 S.....SHUT IN           L.....LOST (MCF EST)         E.....EXPLANATION ATTACH
 T.....TEMP ABANDONED    E.....EXPLANATION ATTACHED                            SIGNATURE:                      DATE:03/22/85
 I.....INJECTION         R.....REPRESS-PRESS MAINT
 D.....DISCONTINUED      V.....VENTED                                          PHONE    :  (303) 740-2590
                         U.....USED ON   SE
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ILLEGIBLE

IPANY: TENNECO OIL COMPANY ADDRESS:P.O. BOX 3249 ENGLEWOOD, COLORADO 80155 MONTH:MARCH ,1985 PAGE 30 OF

U L / LEASE NAME	SEC	TWP	RNG	STAT	WATER INJECTION VOLUME	WATER INJECTION PRESS.	OIL ALLOW. (BBL)	OIL PRODUCD (BBL)	WATER PRODUCD (BBL)	GAS PRODUCD (MCF)	DAYS PROD	GAS SOLD	GAS TRANSPORTER	GAS OTHER	CODE	OIL ON HAND BEG. OF MONTH	BARRELS TO TRANSPORTER	TRANSPORTER	OTHER	CODE	OIL ON HAND END OF MONTH
WELLS																					
IN (DAKOTA) (DAKOTA) RULET UMM. AGREE NO. 91-006691																					
I	28	26N	11W	F			3	3		1026	31										
EASE TOTAL							3	3		1026		998	EPG	28	U	151					154
IN (DAKOTA) (DAKOTA) RYDEN																					
M	28	28N	8W	F			36	36		2592	31										
E I	28	28N	8W	F			95	95		2559	7										
LASE TOTAL							131	131		5151		5102	EPG	49	U	400	226	PER			305
IN (DAKOTA) (DAKOTA) ATON A UMM. AGREE NO. 91-007454																					
P	25	29N	11W	F			39	39		1251	22										
E B	25	29N	11W	F			31	31		3360	26										
EASE TOTAL							70	70		4611		4553	EPG	58	U	246	122	GEC			194

STATUS CODE	GAS CODE	OIL CODE
F.....FLOWING	X.....USED OFF LEASE	C.....CIRCULATING OIL
P.....PUMPING	D.....USED FOR DRILLING	L.....LOST
G.....GAS LIFT	G.....GAS LIFT	S.....SEDIMENTATION
S.....SHUT IN	L.....LOST (MCF EST)	E.....EXPLANATION ATTACH
T.....TEMP ABANDONED	E.....EXPLANATION ATTACHED	
I.....INJECTION	R.....REPRESS-PRESS MAINT	
D.....DISCONTINUED	V.....VENTED	
	U.....USED ON LEASE	

NAME : URSULA SULZBACH

POSITION : DISTRICT ADMINISTRATOR

SIGNATURE: DATE:04/24/85

PHONE : (303) 740-2590

ILLEGIBLE

OPERATOR'S MONTHLY REPORT

MPANY: TENNECO OIL COMPANY   ADDRESS:P.O. BOX 3249 ENGLEWOOD, COLORADO 80155   MONTH:MARCH ,1985 PAGE 97 OF

OOL NAME LEASE NAME				WATER INJECTION		-TOTAL LIQUIDS PRODUCED-					--DISPOSITION OF GAS-				----- DISPOSITION OF OIL -----					
						MONTHLY ACTUAL														
LL IO.	U L	SEC TWP RNG	STAT	VOLUME	PRESS.	OIL ALLOW. (BBL)	OIL PRODUCD (BBL)	WATER PRODUCD (BBL)	GAS PRODUCD (MCF)	DAYS PROD	SOLD	TRANSPORTER	OTHER	CODE	OIL ON HAND BEG.OF MONTH	BARRELS TO TRANS-PORTER	TRANSPORTER	OTHER	CODE	OIL ON HAND END OF MONTH
S WELLS																				
ANCO (MESAVERDE) (MESAVERDE) DAWSON FEDERAL																				
1	D	26 27N 8W	F			1	1		1422	31										
1M	N	26 27N 8W	F			16	16		8977	31										
LEASE TOTAL						17	17		10399		10325	EPG	74	U	270	76	CST			211
ANCO (MESAVERDE) (MESAVERDE) EATON A COMM. AGREE NO. 91-007454																				
1E	B	25 29N 11W	F			31	31		1629	20										
LEASE TOTAL						31	31		1629		1577	EPG	52	U	56	34				53
ANCO (MESAVERDE) (MESAVERDE) ATON COM B COMM. AGREE NO. 93-000153																				
1	P	25 29N 11W	P			18	18		222	31										
LEASE TOTAL						18	18		222		214	EPG	8	U	65					83

STATUS CODE	GAS CODE	OIL CODE
F.....FLOWING	X.....USED OFF LEASE	C.....CIRCULATING OIL
P.....PUMPING	D.....USED FOR DRILLING	L.....LOST
G.....GAS LIFT	G.....GAS LIFT	S.....SEDIMENTATION
S.....SHUT IN	L.....LOST (MCF EST)	E.....EXPLANATION ATTACH
T.....TEMP ABANDONED	E.....EXPLANATION ATTACHED	
I.....INJECTION	R.....REPRESS-PRESS MAINT	
D.....DISCONTINUED	V.....VENTED	
	U.....USED ON LEASE	

NAME : URSULA SULZBACH

POSITION : DISTRICT ADMINISTRATOR

SIGNATURE: DATE:04/24/85

PHONE : (303) 740-2590

ILLEGIBLE

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PANY: TENNECO OIL COMPANY        ADDRESS:P.O. BOX 3249 ENGLEWOOD, COLORADO 80155           MONTH:MARCH    ,1985 PAGE  144 OF
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 U L   N A M E             WATER      =TOTAL LIQUIDS PRODUCED=                 **DISPOSITION OF GAS* ********** DISPOSITION OF OIL ******
 LEASE  NAME             INJECTION    ------------------------                 --------------------- ------------------------------------
                  S ==============  MONTHLY ACTUAL                                                    C OIL ON BARRELS                  C OIL ON
                  T                    OIL     OIL      WATER      GAS                  TRANS         O HAND      TO      TRANS         O HAND
L U               A                    ALLOW.  PRODUCD  PRODUCD  PRODUCD DAYS           PORT=         D BEG.OF  TRANS=   PORT=         D END OF
. L SEC TWP RNG   T  VOLUME    PRESS. (BBL)   (BBL)    (BBL)    (MCF)   PROD  SOLD     TER    OTHER  E MONTH   PORTER   TER   OTHER   E MONTH
=================================================================================================================================
 WELLS

RO (CHACRA) (CHACRA)
UNCE COM

 C  19 29N 10W  F                                               1698 31

EASE TOTAL                                                      1698       1658 EPG        40 U  10                              10

RO (CHACRA) (CHACRA)
ATON A
OMM. AGREE NO. 91-007454

E B  25 29N 11W  F                                               803 20


   STATUS CODE                   GAS CODE                      OIL CODE
   F.....FLOWING             X.....USED OFF LEASE          C.....CIRCULATING OIL        NAME     :  URSULA SULZBACH
   P.....PUMPING             D.....USED FOR DRILLING       L.....LOST
   G.....GAS LIFT            G.....GAS LIFT                S.....SEDIMENTATION          POSITION :  DISTRICT ADMINISTRATOR
   S.....SHUT IN             L.....LOST (MCF EST)          E.....EXPLANATION ATTACH
   T.....TEMP ABANDONED      E.....EXPLANATION ATTACHED                                 SIGNATURE:                           DATE:04/24/85
   I.....INJECTION           R.....REPRESS-PRESS MAINT
   D.....DISCONTINUED        V.....VENTED                                               PHONE    :  (303) 740-2590
                             U.....USED ON LEASE
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ILLEGIBLE

	OIL														5409
E 4H3432N12W	GAS	1000	2007	2116	2183	1842	1373	1430	1700	1337	1543	1296	1402	19229	91678
	OIL	1	4									7		12	243
NEWBERRY B															
1C3532N12W	GAS	460	3146	6271	6313	4121		2812	7426	4400	1619	4924	6089	47578	1965220
	OIL			7				8	38				7	60	785
E 1M3532N12W	GAS	890	11709	13893	10984	5215	2695	9427	7979	5385	2813	8853	11419	91262	268413
	OIL		103	92	70	39	57	40	73	32	27	109	60	702	1962
NEWBERRY COM															
1G 531N12W	GAS	832	1078	1267	1351	1607	1462	1562	1552	1416	1575	1333	1318	16353	424654
	OIL			2										2	1983
NUCKI															
1P 425N11W	GAS	6271	5650	6530	7269	4775	3121	6404	6090	5638	6110	5567	6665	70090	1615778
	OIL	43	32	55	55	31	27	48	55	42	30	37	43	498	10666
OMLER A															
1G2628N10W	GAS	4261	3961	3031	3249	1916	1900	2067	809	224	2101	3655	3304	30478	2075425
	OIL	48	52	49	37	14					24	43	27	294	25090
E 1F2628N10W	GAS	4696	3263	3652	3085	899	2501	1569	1540	1565	5416	4035	4174	36395	175779
	OIL	29	23	34			2				22	59	35	204	1397
2G3528N10W	GAS	5382	3735	3466	2191	2526	155			107	875	10533	6417	35387	2321633
	OIL	75	18		20	13		7				4	35	172	35540
E 2D3528N10W	GAS	7146	4052	3019	3830	1542	1395			934	2222	3102	6307	33549	139206
	OIL	39	52	14	30	6	5			4	20	19	37	226	1012
3M2628N10W	GAS	965	942	776	1243	314		1877	499	2339	1891	1789	1302	13937	2630531
	OIL														49785
E 3O2628N10W	GAS	5125	4448	2683	2320	2711	2913	966	1997	1997	4487	5396	4592	39635	210177
	OIL	58	52	12		27				5	48	131	20	353	2184
4M2528N10W	GAS	8363	5387	3188	6613	2563	2620	41	980	3276	11325	8157	8181	60694	3384234
	OIL	99	79	9	49	20					186	61	66	569	43215
E 4O2528N10W	GAS	6161	3772	1110	3262	1982	494	47	2	44	4628	6658	3541	31701	182206
	OIL	41	43	11	52	17					30	47	43	284	1867
5G2528N10W	GAS	1995	3032	2421	2154	1459	619	1145		534	3758	3046	2683	22846	2038268
	OIL	39	30	29	34	5					49	22	44	252	24939
E 5E2528N10W	GAS	5795	3961	4054	4039	2216	536	87	1610	1339	5738	7238	6176	42789	230369
	OIL	79	47	66	43	18			22	6	117	51	46	495	2649
6G3628N10W	GAS	10273	4407	2720	5623	1801	298	1759	141	170	7709	6368	3015	44284	3113376
	OIL	44	43	18	11	36		52			138	13	116	471	39831
E 6D3628N10W	GAS	5104	4044	2954	3477	1778	2581		1135	3386	3544	3200	2834	34037	138651
	OIL	38	36	38	18				16		32	59		237	1480
7K3628N10W	GAS	5807	5164	2502	1719	1171	415	500	465	1318	6211	4525	6235	36032	2177857
	OIL	121	72	56	17						2	76	39	383	29098
E 7J3628N10W	GAS	3835	3591	1750	3951	1026	831	656	1971	2219	3523	4313	4070	31736	141873
	OIL	18	11	19	25					20	8	12	24	137	1023
PAH															
1L 325N11W	GAS	6712	7893	7040	7308	5196	3418	8223	6236	5421	7244	6858	8953	80502	1835075
	OIL	32	61	59	50	15	20	68	24			20	56	405	16284
PATTERSON															
1I2030N 8W	GAS	1657	4050	3711	3112	2496	2329	1661	2395	1802	2160	2123	2119	29815	83219
PAYNE A															
1C1929N10W	GAS	4156	2909	3070	3341	3236	3155	2305				1033	4008	27213	1972141
	OIL	47	5	28	27	26	22	18				13		186	20562
E 1N1929N10W	GAS	204	122	206	121	431	261	109	193	486	162	267	267	2829	124728
	OIL	3		1		3		1						8	1229
PRICE															
1K1328N 8W	GAS	1568	911	1707	1592	1353	1533	1918	1469	1336	1434	1170	1549	17540	511895
	OIL			1		26	11	12	30	10	3	10	17	120	3904
2O1328N 8W	GAS	1102	2833	1939							515	1946	5571	13906	144794
	OIL	14	18	8							7	17	72	136	1819
E 2B1328N 8W	GAS	3738	5251	3244					2452	7498	1570	2055	8825	34633	49520
	OIL	65	92	57					26	137	8	80	151	616	938
3A1528N 8W	GAS	1919	3027	1664	463	1915		1260	1877	2032	667	1726	3080	19630	208628
	OIL	13	25	14	1	3			2	44		28	28	158	2049
E 3C1528N 8W	GAS	3416	26968	16280	8536	11321		13757	13045	9177	7372	9167	8802	127841	175274
	OIL		214	205	12	81		120	102	165	66	95	28	1088	1529
4A1428N 8W	GAS				880	9677				966	10293	12330	7031	41177	343096
	OIL				9	121				9	108	177	54	478	4386
E 4I1428N 8W	GAS				2442	11496			13	11436	9368	7873	5173	47801	78509
	OIL				85	171			10	34	103	89	28	520	1118
PRICE COM															
4A2428N 8W	GAS	1779	2261	2225	2361	1342			6		770	1159	5018	16921	126089
	OIL	3	17	22	41							15	84	182	1669
E 4F2428N 8W	GAS	3810	3622	3330	3147	2274			2222	4761	272	993	4334	28765	41926
	OIL	80	63	72	19	15			50	5		2	1	307	598
5P1128N 8W	GAS	3	4	4049	3354	13457			5982	8860			1634	37343	255864
	OIL	74			9	148			24	109				364	3167

BASIN DAKOTA 1984

CONTINUED BASIN DAKOTA (PRORATED GAS)

WELL S T R		JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	1984 PROD	ACCUM
E 1P2729N10W	GAS	4060	4395	5495	4357	5221	609	1966	6139	6494	4108	5424	3529	52397	215744
	OIL	29	25	22	35	44			26	38	12	38	27	296	1257
	WAT	1	2	2	3	8			2	3	2	2	4	29	
MARSROW GAS COM															
1F1529N12W	GAS	6820	5984	4483	4480	3087							109	24963	3239151
	OIL	45	5	3	27	3								83	18865
	WAT	18	16	15	8	7	3	1	3	1	2			74	
E 1L1529N12W	GAS	2487	2160	1517	1886	1169							45	9264	106361
	OIL	6	4	1	25	7					4			47	359
	WAT	18	15	18	20	21		9	2					103	
MARTIN GAS COM															
1A1527N10W	GAS	2488	2571	1408	5622	3153	1345	865	4533	4309	3439	4576	2914	37223	2670220
	OIL	42	31	2	85	65		40	28	119	20	85	65	582	41021
	WAT	1	1	1	1	1	1	1	1	1	1	1	1	12	
E 1J1527N10W	GAS	4217	7144	1464	8010	5579	1332	1586	10481	9103	5247	8879	4920	67962	317429
	OIL	125	82	63	105	100	10	20	122	140	88	192	61	1108	4671
	WAT	1	1	1	1	1	1	1	1	1	1	1	1	12	
MARTIN GAS COM B															
1G3128N10W	GAS	4056	4798	4657	5081	4664	4796	4378	3047	4654	4556	4731	4917	54335	3017793
	OIL	30	43	24	43	27	28	25	14	29	34	28	34	359	33369
	WAT							2	2	3	4	3	3	17	
E 1P3128N10W	GAS	7542	8022	7545	4951	8440	6408	6753	6261	6043	5964	5902	5819	79650	244684
	OIL	40	67	80	67	72	40	62	28	52	25	44	47	624	2642
	WAT							4	2	4	3	4	4	21	
MARTIN GAS COM C															
1K1127N10W	GAS	6978	3763	3274	3668	5812	4598	3665	3506	5286	3546	4034	4600	52730	1682279
	OIL	73	57	27	54	31	40	21	26	35	32	25	28	449	20454
	WAT	1	1	1	1	1	1	1	1	1	1	1	1	12	
E 1O1127N10W	GAS	5584	5363	4613	3515	3741	4178	4014	3822	3696	3714	2988	4865	50093	215226
	OIL	62	83	61	82	77	54	48	50	15	74	34	33	673	2935
	WAT	1	1	1	1	1	1	1	1	1	1	1	1	12	
MARTIN GAS COM E															
1L1527N10W	GAS	9488	8950	3951	3823	10347	954	672	5738	8460	12190	7246	7931	79750	2846062
	OIL	102	52	39	13	92	3		53	42	132	72	107	707	39084
	WAT	1	1	1	1	1	1	1	1	1	1	1	1	12	
E 1C1527N10W	GAS	4129	7129	1559	4778	3967	771	447	2324	8217	4665	5208	2155	45349	241279
	OIL	155	176	42	88	65	13	7		171	197	48	80	1042	4925
	WAT	1	1	1	1	1	1			1	1	1	1	10	
MARTIN GAS COM F															
1E1427N10W	GAS		132											1320	2701551
	OIL		97											97	56548
	WAT		2											2	
E 1N1427N10W	GAS	6451	8303	8158	7592	4120	7213	9855	7158	6831	219		882	66782	258766
	OIL	118	95	84	43	52	45	52	74	53	19			635	5163
	WAT	1	1	1	1	1	1	1	1	1	1	1	1	12	
R 1F1427N10W	GAS			1621	5411	3575	3772	6702	7813	4380	37		762	34073	34073
	OIL	16		259	225	30	67	117	115	51				880	880
	WAT			1	1	1	1		1	1	2	1	1	10	
MARTIN GAS COM G															
1B1427N10W	GAS	2923	4174	5865	852	6893	8473	6965	3130	36	36		284	39631	2045835
	OIL	39	15	85	22	44	73	59	33	5		1		376	23124
	WAT	1	1	1	1	1	1	1	1	1	1	1	2	13	
E 1J1427N10W	GAS	1149	6701	8610	1350	11151	13889	13405	6655				1325	64235	415721
	OIL	29	93	120	26	75	166	126	95		1			731	4525
	WAT	1	1	1	1	1	1	1	1	4	1	1	1	15	
MARTINEZ GAS COM F															
1L2429N10W	GAS	1890	3062	2189	3295	1918	2444	3312	3281	3399	3649	4208	4045	36692	2224411
	OIL		20	45	20	8	5	17	13	15	14	10	46	213	9835
	WAT	2	1		2	3	2	4	4	5	6	4	3	36	
E 1P2429N10W	GAS	5166	6231	4902	3711	3499	5019	2370	2974	4029	4285	5100	5538	52824	430020
	OIL	30	27	37	7	33		34		1			15	184	2854
	WAT	20	30	20	15	30	32	10	18	30	25	18	20	268	
MARTINEZ GAS COM G															
1A2429N10W	GAS	3491	2826	3371	2744	2951	3542	2419	3685	523	819	2359	5793	34523	2590492
	OIL	18	2	30	13	13	24	26	22	11	4	8	32	203	11237
	WAT		2	2	2	2							4	12	
E 1O2429N10W	GAS								36		36	13068	26504	39644	39644
	OIL						59	83	5		42	10	63	262	262
	WAT						100	20	9	1	1	2	1	134	
MASDEN GAS COM															
1A2829N11W	GAS	4556	8586	8104	7164	5213	216	1088	7121	7590	6403	5398	6412	67851	3080198
	OIL	10		2	3	2								17	29009
	WAT	8	38	3	2	8		4	2	3	3	7	1	79	
E 1O2829N11W	GAS	2445	2618	1919	5871	3843	74	437	5273	5980	3604	4475	4681	41220	183928
	OIL	9	37	5	94	20			54	57	35	44	21	376	1541
	WAT	6	5	4	3	5		4	3	8	10		8	56	
C A MCADAMS B															
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JICARILLA 132 W	[illegible]	[illegible]	[illegible]	[illegible]	13	14	13	27	16	14	41	23	21	242	14859

		JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	1984 PROD	ACCUM
11L2628N10W	GAS	1432	1669	824	1435	1605	962	1793	1485	978	927	814	786	14710	[illegible]
12B3628N10W	GAS	1930	1132	1525	1773	1659	1231	1333	1254	957	888	865	847	15394	[illegible]
14A2528N10W	GAS	2204	1361		1186	1283	821	1244	636	957	1020	866	784	12362	[illegible]
16L3628N10W	GAS			9090	5018	629	953	5026	3531	2653	2466	2125	2874	34365	[illegible]
17B2628N10W	GAS			11410	5790	654	686	5449	3470	2258	2009	2397	2650	36773	36773
PAYNE A															
E 1N1929N10W	GAS	1960	1388	1372	1189	1383	1191	1234	865	941	770	1101	980	14374	87448
ROMERO COM															
1P2526N 6W	GAS	2736	2274		6	2909	1718	2906	2456	1951	2143	1856	1850	22805	60353
SULLIVAN A															
E 1M2529N11W	GAS	818	575	586	565	469	499	551	279	178	126	294	345	5285	24047
SULLIVAN FRAME A															
E 1A3029N10W	GAS	3710	2492	3653	2812	2169	2538	2551	2257	2162	1826	2145	2487	30802	108578
SULLIVAN FRAME COM B															
1D3029N10W	GAS	2935	2516	748	3	1469	495	2663	2299	2261	2124	2129	2274	21916	76674
	OIL														61
BRUCE SULLIVAN COM B															
1C2529N11W	GAS	4803	3351	2	3	3784	2384	3276	3242	2995	3257	2885	3786	33768	173754
VALDEZ A															
E 1G2429N11W	GAS	3002	2149		9	2822	757	3161	2604	2218	1754	1696	1610	21782	93609
VALDEZ COM B															
1O2429N11W	GAS	5185	4014		8	3763	1603	2779	1830	14	7332	4711	3786	35025	182431
COMPANY TOTAL	OIL				5									5	119
	GAS	64087	55681	55546	48495	50193	37747	79828	57403	51102	62062	54714	57715	674573	2616170
TURNER PRODUCTION CO.					************	************	************	************	************						
TURNER 26															
1I2626N 7W	GAS						782		1				254	1037	2605
UNION TEXAS PETROLEUM CORPORATION					************	************	************	************	************						
ALBRIGHT															
J 2E2229N10W	GAS					367	4090	1462	853		2365	1647	1385	12169	99520
ANGEL PEAK															
22M 728N10W	GAS	2401	1527	2012	2017	1895	1756	1096			3315	2040	2744	20803	145172
ANGEL PEAK B															
E 25F2428N11W	GAS	402		321	205	6	432					404	100	1870	5520
30B1328N11W	GAS	1295	1150	1174	1271	1186	1195	838			1762	1249	1174	12294	74546
CONGRESS															
E 4E3529N11W	GAS	2089	1224	1248	106	1020	408	226	6	472	612	1522	751	9684	72041
E 5P3429N11W	GAS	1049	2377	1786		674					683	1477	1335	9381	66056
E 6O3529N11W	GAS	3511	3011	2757	3273	2557	563	2484	1887	1592	1986	1292	2150	27063	122501
E 7F3429N11W	GAS	3034	3917	3414	2719	2245	2000	3976	3140	2162	328	2	537	27474	99938
8A3529N11W	GAS	1891	1396	1589	1645	1548	1579	116	273	1527	264	1964	1487	15279	283999
9N2629N11W	GAS	1755	2045	1926	2086	1881	1934	1792	1909	1537	438	2359	1918	21580	110045
10N3529N11W	GAS	3431	2962	2604	2089	3162	3036	2243	2532	2371	1616	3016	1976	31038	170471
GARLAND															
3M2729N11W	GAS	2205	1298	832	1392	966	1390	98	824	1671	386	1942	1056	14060	96152
JICARILLA L															
E 6J3425N 5W	GAS	1371	389	114	183	49	13			10	134	200	65	2528	11430
7L3425N 5W	GAS	731	623	447	299	250	171	538	349	463	764	416	476	5527	21464
MCCLANAHAN A															
3M2328N10W	GAS	1828	1675	1589	1472	1124	2206	1856	1728	1578	1806	2267	1833	20962	138750
NEW MEXICO B COM															
E 1D1629N11W	GAS	2	5559		697	5093	3990	6435	5685	4352	3367	5263	5488	45931	96284
REID B															
E 1I3129N10W	GAS	3039	2831	2711	3612	2340	2352	1110	2638		2554	3582	3040	29809	157986
E 2E3129N10W	GAS		2587	1804	1732	1584	1524	1586	1545	1519	1386	1329	1206	17802	89099
3M3129N10W	GAS	2764	2744	2630	2596	2402	2693	1845		1079	4105	2779	2557	28194	166338
SUMMIT															
9A3429N11W	GAS	2105	1150	2794	1794	1267	1988	1537	691	1736	535	2201	2046	19844	137362
10G3329N11W	GAS	1333	1272	1440	1597	1135	1469	867	1141	549	1843	1243	1402	15291	42792
11K3429N11W	GAS	2809	1997	1634	2035	1433	1153	487	17	628	1745	2753	2502	19193	140443
WILSON															
2G3129N10W	GAS	4442	5525	4682	5362	3057		5036	4897	2792	6016	5225	5390	52424	322221
WITT															
E 1P3329N11W	GAS	2085	1187	1998	504	2823	2053	13		903	798	1393	1556	15313	71872
ZACHRY															
E 16P3329N10W	GAS	3765	4176	4875	4173	3014		3025	4540	5828	6376	6627	6035	52434	171596
E 17O3529N10W	GAS	1001	1302	951	807	916	1224	1084	1362	1178	698	1197	859	12579	70002
E 18O1128N10W	GAS	2260	2402	1510	1792	1025	1271	948	789	1151	1594	1611	2248	18601	167983
E 19O1228N10W	GAS	5394	3980	3490	3144	2951	3144	3271	2905	2696	2575	2667	2342	38559	175611
20N3529N10W	GAS	2442	1929	1974	2094	1771	1879	1987	1929	2120	2044	2329	2372	24870	182015
21K3529N10W	GAS	1600	1588	1475	1503	1346	1290	1159	1226	1506	1432	1443	1368	16936	130102
22B3329N10W	GAS	4073	3935	3478	4024	2737		4101	3506	976	4705	4116	3896	39547	200755
23M3429N10W	GAS	3215	2354	2516	2782	1901	2755	635		739	4477	2986	2378	26738	147254
24N1028N10W	GAS	2330	1653	2013	2184	1505	2302	550	680	2894	2337	2261	2158	22867	132125

		OIL	25	15			14	2		12	38	14	33	20	173	1569
	3G 430N 8W	GAS					123	1048	6141	2680	3309	2580	996	5894	22771	6043804
		OIL														117
A	3I 430N 8W	GAS	16889	7873	1293		1668		23979	18895	6679	22955	14822	17999	133052	1854910
		OIL	9	2			3		11	5	4	8	6	4	52	383
	4H 530N 8W	GAS	19625	11743	6568	2841	1692		23769	23130	21006	17624	15651	18816	162465	6835146
		OIL	9	8	4	2	2		18	12	11	8	4	4	82	5160
A	4P 530N 8W	GAS	8346	559	1013	704	601	140	5726	346	14051	348	2230	12675	46739	782354
		OIL	8				2			2	1				13	333
	5N 930N 8W	GAS		1380	1735	2730	2656	1197	4009		1794	3407	3682	7931	30521	5274367
		OIL					2								2	4818
A	5O 930N 8W	GAS			1542		9023	8747	24671	21310	16400	16989	23679	21903	144264	1849239
		OIL								1	2		5	3	11	299
LINDA NYE																
	1B2030N 8W	GAS	9102	8070	2653	2932	5631	2824	6768	4265	8294	5664	2539	9910	68652	3366873
		OIL	16	7	4	4	8	5	18	1	15	12	3	12	105	4871
A	1D2030N 8W	GAS	14936	5262	3272	5217	9202	5028	11563	8164	15853	7050	6259	11148	102954	1251139
		OIL	48	10	4		30	3	43	24	60	20	8	15	265	3637
PAYNE A																
E	1N1929N10W	GAS	1604	1135	1123	973	1131	975	1009	708	770	630	902	802	11762	56726
		OIL	4	8	3	1		4	1			1			22	1289
PRITCHARD																
	1M 130N 9W	GAS	6792	9225	6460	11859	2089						125	16760	53310	4100353
		OIL		12	10	12	3							12	49	474[illegible]
A	1F 130N 9W	GAS	9628	11306	1864	4128	2558		14245	331			125	1636	45821	1265882
		OIL	2												2	1225
	2H 130N 9W	GAS	142810	127375	106408	116428	110033	89464	42776		61119	129763	71642	121331	1119149	54080881
		OIL	262	277	257	276	136	88	30		65	272	155	234	2052	44206
A	2I 130N 9W	GAS		2969	93	1128	1167	353	11388	10568	10927	4208	4383	6863	54047	526531
		OIL		2					41	64	75	31	7	30	250	3871
	3H3129N 8W	GAS		6485	4889	3771	4658	5085	5625	3521	5070	3608	3415	4491	50618	3072266
		OIL		40	41		12	18	7		19	11	21		169	5976
A	3P3129N 8W	GAS	5878	5914	2872	736	4668	5686	2	8055	5294	2977	1274	3267	46623	490022
		OIL	117	30	2	1	8	22	3	62	9	24	7	11	296	2884
	4L3129N 8W	GAS	3031	2388	1687	1236	955	2070	2340	2257	2299	1703	1167	2090	23223	2809381
		OIL														125
A	4F3129N 8W	GAS	12568	15322	6241	2323	2274	11815	2308	TSTM	14989	5697	3699	7759	84995	620909
		OIL	9	45	22	3	34	50	1	3	41	15	3	5	231	1211
RIDDLE																
	1G2130N 9W	GAS	22025	1347	875	1406	4079	2558	10015	3848	12771	8020	4053	12977	83974	10829553
		OIL	86				3		24		29	18	6	31	197	21376
A	1E2130N 9W	GAS	8258	969	362	654	1552	163	4343	351	7437	1726	390	5199	31404	842079
		OIL	13	5	3				12	1	25				59	2738
	2N1730N 9W	GAS	21223	2288	1987	1211	6001	2712							35422S	7737039
		OIL	59	4			15								78	15144
A	2J1730N 9W	GAS	20210	1423	1556	1720	4773	331							30013S	1329244
		OIL	46	7	3	2	15								73	3208
RIDDLE A																
	1A 927N 9W	GAS	1047	927	1593	1628	303	910	735	899	708	1019	976	907	11652	632416
		OIL			20	18									38	2678
RIDDLE COM A																
M	1I 927N 9W	GAS	1960	3117	2217	2002	755	1536	508	1072	1254	1902	1447	1030	18800	26229
		OIL	45	15	29	22		25	21	18	18	19	13	12	237	438
ROMERO COM																
	1P2526N 6W	GAS	7157					4351	9874		5	2801		535	24723	97985
		OIL	296					719	370		176	31		41	1633	7213
STATE COM																
	1M3230N 9W	GAS	605	1145	2092	2144	1014						3	3803	10806	1888488
		OIL			5									6	11	2958
A	1E3230N 9W	GAS	10316	17048	15330	12665	6096						125	20600	82180	987894
		OIL														722
STATE COM A																
	2M1630N 9W	GAS	836	84	38	1247	4891	1972	1145	851	1059	228	3599	10795	26745	4733988
		OIL	35			2	1			4			15	47	104	12349
A	2C1630N 9W	GAS				307	1530	114					3	5569	7523	673494
		OIL														2139
STATE COM B																
	3A1630N 9W	GAS	6314	2803	794	1405	2412	1123		839	9989	2938	2316	3654	34587	4633181
		OIL			4	3					25	3		4	39	9337
A	3P1630N 9W	GAS	13015	809	534	1582	3480	212	4201	1169	[illegible]	22056	[illegible]	19085	91544	943016
		OIL	33		4		7		9		22	34	13	20	142	1831
STATE COM C																
M	1O3229N 9W	GAS	9138	10432	6927	7184	6286	3020	1782					355	45124	98633
		OIL	218	133	76	23	119	100							669	1168

Mesaverde 1984

BLANCO MESAVERDE (PRORATED GAS)

NEW MEXICO OIL CONSERVATION COMMISSION
OPERATOR'S MONTHLY REPORT

FORM C-115-EDP

COMPANY: [illegible] OIL COMPANY   ADDRESS: P.O. BOX 3249 ENGLEWOOD, COLORADO 80155   MONTH: JANUARY ,1985 PAGE 71 OF

POOL NAME / LEASE NAME / WELL NO.	U L	SEC	TWP	RNG	STAT	WATER INJECTION VOLUME	WATER INJECTION PRESS.	MONTHLY OIL ALLOW. (BBL)	ACTUAL OIL PRODUCD (BBL)	WATER PRODUCD (BBL)	GAS PRODUCD (MCF)	DAYS PROD	DISPOSITION OF GAS SOLD	TRANSPORTER	OTHER	CODE	OIL ON HAND BEG. OF MONTH	BARRELS TO TRANSPORTER	TRANSPORTER	OTHER	CODE	OIL ON HAND END OF MONTH
GAS WELLS																						
BASIN (DAKOTA) (DAKOTA) PAH COMM. AGREE NO. 96-004263																						
1	L	3	25N	11W	F			52	52		5531	31										
LEASE TOTAL								52	52		5531		5491	EPG	40	U	133					135
BASIN (DAKOTA) (DAKOTA) PATTERSON																						
1	I	20	30N	3W	F						1916	31										
LEASE TOTAL											1916		1876	EPG	40	U						
BASIN (DAKOTA) (DAKOTA) PAYNE A																						
1	C	19	29N	10W	F			27	27		3165	31										
1E	N	19	29N	10W	F						142	31										
LEASE TOTAL								27	27		3307		3227	EPG	80	U	230	160	CST			97
BASIN (DAKOTA) (DAKOTA) PRICE																						
1	K	13	28N	8W	F			13	13		1585	31										

STATUS CODE
F.....FLOWING
P.....PUMPING
G.....GAS LIFT
S.....SHUT IN
T.....TEMP ABANDONED
I.....INJECTION
D.....DISCONTINUED

GAS CODE
X.....USED OFF LEASE
D.....USED FOR DRILLING
G.....GAS LIFT
L.....LOST (MCF EST)
E.....EXPLANATION ATTACHED
R.....REPRESS-PRESS MAINT
V.....VENTED
U.....USED ON LEASE

OIL CODE
C.....CIRCULATING OIL
L.....LOST
S.....SEDIMENTATION
E.....EXPLANATION ATTACH

NAME : URSULA SULZBACH
POSITION : DISTRICT ADMINISTRATOR
SIGNATURE:
DATE: 02/26/85
PHONE : (303) 740-2590

ILLEGIBLE

OPERATOR'S MONTHLY REPORT

COMPANY: T[illegible] OIL COMPANY ADDRESS:P.O. BOX 3249, ENGLEWOOD, COLORADO 80155 MONTH:JANUARY ,1985 PAGE 115 OF

POOL NAME / LEASE NAME / WELL NO.	LOC	SEC	TWP	RNG	STAT	WATER INJECTION VOLUME	WATER INJECTION PRESS.	TOTAL LIQUIDS PRODUCED MONTHLY OIL ALLOW. (BBL)	ACTUAL OIL PRODUCED (BBL)	WATER PRODUCED (BBL)	GAS PRODUCED (MCF)	DAYS PROD	DISPOSITION OF GAS SOLD	TRANSPORTER	OTHER	CODE	DISPOSITION OF OIL OIL ON HAND BEG. OF MONTH	BARRELS TO TRANSPORTER	TRANSPORTER	OTHER	CODE	OIL ON HAND END OF MONTH
GAS WELLS																						
[illegible]																						
5	[illegible]	7	30N	8W	F			4	4		22667	28										
LEASE TOTAL								71	71		114644		109188	SUG	5456	U	418					489
BLANCO (MESAVERDE) (MESAVERDE)																						
HYE, LINDA COMM. AGREE NO. 91-001162																						
1	B	20	30N	8W	F			37	37		9138	31										
1A	[illegible]	20	30N	8W	F			81	81		13011	27										
LEASE TOTAL								118	113		22149		22085	SUG	64	U	276	258	PLA			136
BLANCO (MESAVERDE) (MESAVERDE)																						
PAYNE A																						
1E	N	19	29N	10W	F			2	2		722	31										
LEASE TOTAL								2	2		722		687	EPG	35	U	119					121
BLANCO (MESAVERDE) (MESAVERDE)																						
PRITCHARD 1,1-A,2,2-A																						
1	M	1	30N	9W	F			31	31		14606	29										

STATUS CODE
F.....FLOWING
P.....PUMPING
G.....GAS LIFT
S.....SHUT IN
T.....TEMP ABANDONED
I.....INJECTION
D.....DISCONTINUED

GAS CODE
X.....USED OFF LEASE
D.....USED FOR DRILLING
G.....GAS LIFT
L.....LOST (MCF EST)
E.....EXPLANATION ATTACHED
R.....REPRESS-PRESS MAINT
V.....VENTED
U.....USED ON LEAS

OIL CODE
C.....CIRCULATING OIL
L.....LOST
S.....SEDIMENTATION
E.....EXPLANATION ATTACH

NAME : URSULA SULZBACH
POSITION : DISTRICT ADMINISTRATOR
SIGNATURE: DATE:02/26/85
PHONE : (303) 740-2590

ILLEGIBLE

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                                         NEW MEXICO OIL CONSERVATION COMMISSION                               FORM C-115 EDP
                                              OPERATOR'S MONTHLY REPORT

COMPANY: TENNECO OIL COMPANY         ADDRESS:P.O. BOX 3249 ENGLEWOOD, COLORADO 80155          MONTH:JANUARY  ,1985 PAGE  145 OF
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POOL NAME               WATER      -TOTAL LIQUIDS PRODUCED-             --DISPOSITION OF GAS- ---------- DISPOSITION OF OIL ------
   LEASE NAME          INJECTION   ------------------------             --------------------- -----------------------------------
                   S  -------------- MONTHLY ACTUAL                                            C OIL ON BARRELS              C OIL ON
                   T                  OIL      OIL     WATER      GAS                 TRANS     O HAND     TO     TRANS      O HAND
WELL U             A                 ALLOW.  PRODUCD  PRODUCD   PRODUCD DAYS          PORT-     D BEG.OF TRANS-   PORT-      D END OF
 NO. L SEC TWP RNG T  VOLUME   PRESS. (BBL)   (BBL)    (BBL)     (MCF)  PROD   SOLD   TER  OTHER E MONTH  PORTER  TER  OTHER E MONTH
------------------------------------------------------------------------------------------------------------------------------
GAS WELLS

OTERO (CHACRA) (CHACRA)
  JACKSON 1,1A,&1E

  1E G  34 29N  9W  F                                        557 31

  LEASE TOTAL                                                557      523 EPG    34 U

OTERO (CHACRA) (CHACRA)
  JACKSON 2,2A,&2E

  2E B  33 29N  9W  F                                       2913 31

  LEASE TOTAL                                               2913     2876 EPG    37 U

OTERO (CHACRA) (CHACRA)
  PAYNE A

  1E N  19 29N 10W  F                                        883 31

  LEASE TOTAL                                                883      840 EPG    43 U

OTERO (CHACRA) (CHACRA)
  ROMERO COM

  1  P  25 26N  6W  F                                       1698 31



     STATUS CODE                 GAS CODE                    OIL CODE
   F.....FLOWING           X.....USED OFF LEASE         C.....CIRCULATING OIL      NAME     :  URSULA SULZBACH
   P.....PUMPING           D.....USED FOR DRILLING      L.....LOST
   G.....GAS LIFT          G.....GAS LIFT               S.....SEDIMENTATION        POSITION :  DISTRICT ADMINISTRATOR
   S.....SHUT IN           L.....LOST (MCF EST)         E.....EXPLANATION ATTACH
   T.....TEMP ABANDONED    E.....EXPLANATION ATTACHED                              SIGNATURE:                          DATE:02/26/85
   I.....INJECTION         R.....REPRESS-PRESS MAINT
   D.....DISCONTINUED      V.....VENTED                                            PHONE    :  (303) 740-2590
                           U.....USED ON LEASE
```

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NEW MEXICO OIL CONSERVATION COMMISSION
OPERATOR'S MONTHLY REPORT

FORM C-115-EDP

IPANY: TENNECO OIL COMPANY   ADDRESS:P.O. BOX 3249 ENGLEWOOD, COLORADO 80155   MONTH:FEBRUARY ,1985 PAGE 71 OF

OOL NAME / LEASE NAME / U L	SEC TWP RNG	S T A T	WATER INJECTION VOLUME	WATER INJECTION PRESS	MONTHLY ACTUAL OIL ALLOW. (BBL)	OIL PRODUCD (BBL)	WATER PRODUCD (BBL)	GAS PRODUCD (MCF)	DAYS PROD	DISPOSITION OF GAS SOLD	TRANS PORT- IER	OTHER	C O D E	OIL ON HAND BEG.OF MONTH	BARRELS TO TRANS- PORTER	TRANS PORT- IER	OTHER	C O D E	OIL ON HAND END OF MONTH
WELLS																			
IN (DAKOTA) (DAKOTA) 'AH OMM. AGREE NO. 96-004263																			
L	4 25N 11W	F			65	65		7324	28										
LASE TOTAL					65	65		7324		7288	EPG	36	U	185					250
IN (DAKOTA) (DAKOTA) ATTERSON																			
I	20 30N 8W	F						1585	28										
LASE TOTAL								1585		1549	EPG	36	U						
IN (DAKOTA) (DAKOTA) AYNE A																			
G	19 29N 10W	F			21	21		2510	28										
N	19 29N 10W	F			6	6		212	28										
LASE TOTAL					27	27		2722		2650	EPG	72	U	97					124
IN (DAKOTA) (DAKOTA) RICE																			
K	13 28N 8W	F			19	19		1295	28										

STATUS CODE	GAS CODE	OIL CODE
F.....FLOWING	X.....USED OFF LEASE	C.....CIRCULATING OIL
P.....PUMPING	D.....USED FOR DRILLING	L.....LOST
G.....GAS LIFT	G.....GAS LIFT	S.....SEDIMENTATION
S.....SHUT IN	L.....LOST (MCF EST)	E.....EXPLANATION ATTACH
T.....TEMP ABANDONED	E.....EXPLANATION ATTACHED	
I.....INJECTION	R.....REPRESS PRESS MAINT	
D.....DISCONTINUED	V.....VENTED	
	U.....USED ON SE	

NAME : URSULA SULZBACH
POSITION : DISTRICT ADMINISTRATOR
SIGNATURE:
DATE:03/22/85
PHONE : (303) 740-2590

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                           NEW MEXICO OIL CONSERVATION COMMISSION                               FORM C-115-EDP
                                 OPERATOR'S MONTHLY REPORT

PANY: TENNECO OIL COMPANY         ADDRESS:P.O. BOX 3249 ENGLEWOOD, COLORADO 80155         MONTH:FEBRUARY ,1985 PAGE  115 OF

G L    N A M E        WATER     -TOTAL LIQUIDS PRODUCED-            --DISPOSITION OF GAS- --------- DISPOSITION OF OIL ------
 LEASE  NAME        INJECTION
           S  -------------- MONTHLY ACTUAL                                          C OIL ON BARRELS                 C OIL ON
           T                    OIL     OIL    WATER     GAS                TRANS    O HAND      TO    TRANS          O HAND
L U        A                  ALLOW.  PRODUCD PRODUCD  PRODUCD DAYS         PORT-    D BEG.OF TRANS-  PORT-           D END OF
L SEC TWP RNG  T  VOLUME   PRESS. (BBL)   (BBL)   (BBL)    (MCF)  PROD  SOLD  TER    OTHER E MONTH  PORTER  TER   OTHER E MONTH

WELLS

ORE

A U   9 30N  8W   F                5       5               18026 18

LASE TOTAL                        29      29               86948        82464 SUG    4484 U  489                        518

NGO (MESAVERDE) (MESAVERDE)
YL,LINDA
MA. AGREE NO. 91-001162

 H  20 30N  8W   F               23      23                7884 28

A D  20 30N  8W   F               32      32               10925 28

EASE TOTAL                        55      55               18809        18747 SUG      62 U  136                        191

NGO (MESAVERDE) (MESAVERDE)
AYNE A

E N  19 29N 10W   F                9       9                 798 28

EASE TOTAL                         9       9                 798          767 EPG      31 U  121                        130

NGO (MESAVERDE) (MESAVERDE)
RITCHARD 1,1-A,2,2-A

 M   1 30N  9W   F               20      20               11065 24


   STATUS CODE                 GAS CODE                      OIL CODE
 F.....FLOWING           X.....USED OFF LEASE          C.....CIRCULATING OIL      NAME      :  URSULA SULZBACH
 P.....PUMPING           D.....USED FOR DRILLING       L.....LOST
 G.....GAS LIFT          G.....GAS LIFT                S.....SEDIMENTATION        POSITION :  DISTRICT ADMINISTRATOR
 S.....SHUT IN           L.....LOST (MCF EST)          E.....EXPLANATION ATTACH
 I.....TEMP ABANDONED    E.....EXPLANATION ATTACHED                               SIGNATURE:                     DATE:03/22/85
 I.....INJECTION         R.....REPRESS-PRESS MAINT
 D.....DISCONTINUED      V.....VENTED                                             PHONE     :  (303) 740-2590
                         U.....USED ON  ASE
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                                   NEW MEXICO OIL CONSERVATION COMMISSION                                FORM C-115-EDP
                                       OPERATOR'S MONTHLY REPORT

OMPANY: TENNECO OIL COMPANY          ADDRESS:P.O. BOX 3249 ENGLEWOOD, COLORADO 80155            MONTH:FEBRUARY ,1985 PAGE  145 OF
-----------------------------------------------------------------------------------------------------------------------------
 O O L    N A M E           WATER      -TOTAL LIQUIDS PRODUCED-                --DISPOSITION OF GAS- --------- DISPOSITION OF OIL ------
    LEASE  NAME           INJECTION    ------------------------                --------------------- ----------------------------------
                    S  -------------- MONTHLY ACTUAL                                               C OIL ON BARRELS                C OIL ON
                    I                  OIL      OIL     WATER     GAS                  TRANS       O HAND     TO      TRANS        O HAND
ELL U               A                 ALLOW.  PRODUCD PRODUCD   PRODUCD DAYS           PORT-       D BEG.OF TRANS-   PORT-         D END OF
N.  L SEC TWP RNG   T  VOLUME   PRESS (BBL)    (BBL)   (BBL)     (MCF)  PROD   SOLD    TER   OTHER E MONTH  PORTER   TER   OTHER E MONTH
-----------------------------------------------------------------------------------------------------------------------------
AS WELLS

TERO (CHACRA) (CHACRA)
 FLORENCE 126 (DAK,CHAC)

2A A 26 29N  9W  F                                                  7626 18

 LEASE TOTAL                                                        7626        7626 EPG

TERO (CHACRA) (CHACRA)
 JACKSON 1,1A,E1E

 1E G  34 29N  9W  F                                                1273 28

 LEASE TOTAL                                                        1273        1242 EPG      31 U

TERO (CHACRA) (CHACRA)
 JACKSON 2,2A,E2E

 2E B  33 29N  9W  F                                                 424 14

 LEASE TOTAL                                                         424         407 EPG      17 U

TERO (CHACRA) (CHACRA)
 PAYNE A

 1E N  19 29N 10W  F                                                 977 28



      STATUS CODE                 GAS CODE                      OIL CODE
   F.....FLOWING             X.....USED OFF LEASE          C.....CIRCULATING OIL       NAME      :  URSULA SULZBACH
   P.....PUMPING             D.....USED FOR DRILLING       L.....LOST
   G.....GAS LIFT            G.....GAS LIFT                S.....SEDIMENTATION         POSITION  :  DISTRICT ADMINISTRATOR
   S.....SHUT IN             L.....LOST (MCF EST)          E.....EXPLANATION ATTACH
   T.....TEMP ABANDONED      E.....EXPLANATION ATTACHED                                SIGNATURE:                         DATE:03/22/85
   I.....INJECTION           R.....REPRESS PRESS MAINT
   D.....DISCONTINUED        V.....VENTED                                              PHONE     :  (303) 740-2590
                             U.....USED ON LEASE
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                                                    OPERATOR'S MONTHLY REPORT
PANY: TENNECO OIL COMPANY          ADDRESS:P.O. BOX 3249 ENGLEWOOD, COLORADO 80155               MONTH:MARCH     ,1985 PAGE    72 OF
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 O L     N A M E              WATER        =TOTAL LIQUIDS PRODUCED=                    =*DISPOSITION OF GAS* ========= DISPOSITION OF OIL ======
 LEASE  NAME                INJECTION      ------------------------                    --------------------- ---------------------------------
                    S  ============== MONTHLY ACTUAL                                                  C OIL ON BARRELS                  C OIL ON
                    T                    OIL      OIL      WATER      GAS                  TRANS      O HAND      TO     TRANS          O HAND
 L U                A                  ALLOW.  PRODUCD  PRODUCD  PRODUCD DAYS               PORT-      D BEG.OF  TRANS-  PORT-          D END OF
). L SEC TWP RNG    T   VOLUME   PRESS. (BBL)   (BBL)    (BBL)    (MCF)  PROD   SOLD       TER   OTHER E MONTH   PORTER  TER   OTHER  E MONTH
===================================================================================================================================
 WELLS

ATTERSON

EASE TOTAL                                                   1916        1876 EPG       40 U

SIN (DAKOTA) (DAKOTA)
AYNE A

   C  19 29N 10W    F                  37       37            3197 31

E  N  19 29N 10W    F                   5        5             155 26

EASE TOTAL                             42       42            3352        3278 EPG       74 U  124                             166

IN (DAKOTA) (DAKOTA)
RICE

   K  13 28N  8W    F                   6        6            1286 31

   O  13 28N  8W    F                  37       37            2429 31

E  B  13 28N  8W    F                  64       64            3888 31

   A  15 28N  8W    F                  28       28            2001 22

E  C  15 28N  8W    F                  63       63            6403 21

   A  14 28N  8W    F                  25       25            6579 23

E  I  14 28N  8W    F                  45       45            3974 21



   STATUS CODE                   GAS CODE                     OIL CODE
 F.....FLOWING            X.....USED OFF LEASE        C.....CIRCULATING OIL       NAME      :  URSULA SOLZBACH
 P.....PUMPING            D.....USED FOR DRILLING     L.....LOST
 G.....GAS LIFT           G.....GAS LIFT              S.....SEDIMENTATION         POSITION :  DISTRICT ADMINISTRATOR
 S.....SHUT IN            L.....LOST (MCF EST)        E.....EXPLANATION ATTACH
 T.....TEMP ABANDONED     E.....EXPLANATION ATTACHED                              SIGNATURE:                       DATE:04/24/85
 I.....INJECTION          R.....REPRESS-PRESS MAINT
 D.....DISCONTINUED       V.....VENTED                                            PHONE    :  (303) 740-2590
                          U.....USED ON LEASE
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OPERATOR'S MONTHLY REPORT

PANY: TENNECO OIL COMPANY ADDRESS:P.O. BOX 3249 ENGLEWOOD, COLORADO 80155 MONTH:MARCH ,1985 PAGE 116 OF

O U L N A M E LEASE NAME						WATER INJECTION		TOTAL LIQUIDS PRODUCED					DISPOSITION OF GAS				DISPOSITION OF OIL					
L .	U L	SEC	TWP	RNG	STAT	VOLUME	PRESS.	MONTHLY OIL ALLOW. (BBL)	ACTUAL OIL PRODUCD (BBL)	WATER PRODUCD (BBL)	GAS PRODUCD (MCF)	DAYS PROD	SOLD	TRANS PORT-TER	OTHER	CODE	OIL ON HAND BEG.OF MONTH	BARRELS TO TRANS-PORTER	TRANS PORT-TER	OTHER	CODE	OIL ON HAND END OF MONTH
WELLS																						
OURE																						
	G	4	30N	8W	F						103	4										
A	I	4	30N	8W	F						350	1										
	H	5	30N	8W	F						981	1										
A	P	5	30N	8W	F						152	4										
	N	9	30N	8W	F						257	4										
A	O	9	30N	8W	F						469	1										
EASE TOTAL											3506		3436	SUG	70	U	518					518
NCO (MESAVERDE) (MESAVERDE) YE,LINDA OMM. AGREE NO. 91-001162																						
	B	20	30N	8W	F						429	5										
A	O	20	30N	8W	F						104	5										
EASE TOTAL											533		521	SUG	12	U	191					191
ANCO (MESAVERDE) (MESAVERDE) PAYNE A																						
E	N	19	29N	10W	F			5	5		759	25										

STATUS CODE
F.....FLOWING
P.....PUMPING
G.....GAS LIFT
S.....SHUT IN
T.....TEMP ABANDONED
I.....INJECTION
D.....DISCONTINUED

GAS CODE
X.....USED OFF LEASE
D.....USED FOR DRILLING
G.....GAS LIFT
L.....LOST (MCF EST)
E.....EXPLANATION ATTACHED
R.....REPRESS-PRESS MAINT
V.....VENTED
U.....USED ON LEASE

OIL CODE
C.....CIRCULATING OIL
L.....LOST
S.....SEDIMENTATION
E.....EXPLANATION ATTACH

NAME : URSULA SULZBACH
POSITION : DISTRICT ADMINISTRATOR
SIGNATURE: DATE:04/24/85
PHONE : (303) 740-2590

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                                                             OPERATOR'S MONTHLY REPORT

MPANY: TENNECO OIL COMPANY               ADDRESS:P.O. BOX 3247 ENGLEWOOD, COLORADO 80155                         MONTH:MARCH      ,1985 PAGE  146 OF
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 O L   N A M E                WATER       =TOTAL LIQUIDS PRODUCED=                     ==DISPOSITION OF GAS= ========== DISPOSITION OF OIL ======
  LEASE  NAME               INJECTION     ------------------------                     --------------------- ------------------------------------
                     S  ============== MONTHLY ACTUAL                                                       C OIL ON BARRELS                 C OIL ON
                     T                    OIL       OIL      WATER       GAS                     TRANS      O HAND      TO      TRANS        O HAND
IL U                 A                    ALLOW.  PRODUCD  PRODUCD  PRODUCD DAYS          PORT-      D BEG.OF TRANS-  PORT-         D END OF
J. L SEC TWP RNG     T   VOLUME    PRESS. (BBL)    (BBL)    (BBL)    (MCF)  PROD   SOLD   TER    OTHER E MONTH  PORTER  TER   OTHER  E MONTH
=====================================================================================================================================================
 WELLS

ERO (CHACRA) (CHACRA)
JACKSON 1,1A,&1E

LE G  34 29N  9W  F                                                      1916 25

LEASE TOTAL                                                              1916       1888 EPG        28 U

ERO (CHACRA) (CHACRA)
JACKSON 2,2A,&2E

E B  33 29N  9W  F                                                       1927  8

LEASE TOTAL                                                              1927       1917 EPG        10 U

RO (CHACRA) (CHACRA)
AYNE A

E N  19 29N 10W  F                                                        927 25

LEASE TOTAL                                                               927        884 EPG        43 U

RO (CHACRA) (CHACRA)
OMERO COM

 P  25 26N  6W  F                                                        1657 31




     STATUS CODE                     GAS CODE                          OIL CODE
    F.....FLOWING                 X.....USED OFF LEASE              C.....CIRCULATING OIL          NAME      :  URSULA SULZBACH
    P.....PUMPING                 D.....USED FOR DRILLING           L.....LOST
    G.....GAS LIFT                G.....GAS LIFT                    S.....SEDIMENTATION            POSITION  :  DISTRICT ADMINISTRATOR
    S.....SHUT IN                 L.....LOST (MCF EST)              E.....EXPLANATION ATTACH
    T.....TEMP ABANDONED          E.....EXPLANATION ATTACHED                                       SIGNATURE:                           DATE:04/24/85
    I.....INJECTION               R.....REPRESS-PRESS MAINT
    D.....DISCONTINUED            V.....VENTED                                                     PHONE     :  (303) 740-2590
                                  U.....USED ON LEASE
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CHAPTER III FIELD OPERATIONS

RULE 3-100 POLLUTION ABATEMENT

RULE 3-101 PROHIBITION OF POLLUTION

(a) All operators, contractors, drillers, service companies, pipepulling and salvaging contractors, or other persons shall at all times conduct their operations and drill, equip, operate, produce, plug and abandon all wells drilled for oil or gas, service wells or exploratory wells (including seismic, core and stratigraphic holes) in a manner that will prevent pollution and the migration of oil, gas, salt water or other substance from one stratum into another, including any fresh water bearing formation. Pollution of surface or subsurface fresh water by deleterious substances used in connection with the exploration, drilling, producing, refining, transporting or processing of oil or gas is hereby prohibited.

(b) Sections 305, 306, 307 and 308 of Title 52, Oklahoma Statutes Annotated, governing the drilling, operation and plugging of oil and gas wells in workable coal beds are hereby adopted as rules of the Commission as fully as if set out verbatim herein.

RULE 3-102 ADMINISTRATION AND ENFORCEMENT OF RULES

The Manager of Pollution Abatement shall supervise and coordinate the administration and enforcement of these rules under the direction of the Director of Conservation and the Commission.

RULE 3-103 COOPERATION WITH OTHER AGENCIES

(a) These rules shall not be construed as modifying the rights, obligations or duties of any person under any law of this State, or under any order, rule or regulation of the Oklahoma Water Resources Board, State Department of Health, Oklahoma Wildlife Conservation Commission, State Board of Agriculture, Department of Pollution Control, or any other agency of this State with respect to the pollution of fresh water.

(b) Whenever a written complaint against any person is filed with the Commission, alleging pollution as prohibited by Rule 3-101, the Manager of Pollution Abatement shall immediately initiate such action as may be necessary or appropriate to abate the pollution.

RULE 3-104 PITS AND TANKS

(a) Pits and tanks for drilling mud or deleterious substances used in the drilling, completion and recompletion of wells shall be constructed and maintained so as to prevent pollution of surface and subsurface fresh water.

(b) Deleterious fluids other than fresh water drilling fluids that were used in drilling or workover operations, which are displaced or produced in well completion or stimulation procedures such as from

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fracturing, acidizing, swabbing, drill stem tests, and any other well stimulation process, shall be collected into a plastic lined pit of at least 30 mil, or metal tank and maintained separate from above-mentioned drilling fluids to allow for separate and legal disposal. (3-30-82)

RULE 3-105 SURFACE AND PRODUCTION CASING

(a) Owners, operators and drilling contractors shall comply with Rule 3-206, "Drilling and Casing Procedures" and Rule 3-301, "Approval of Enhanced Recovery Injection Wells or Disposal Wells". (3-16-81)

(b) In the event a rupture, break or opening occurs in the surface or production casing, the owner, operator or drilling contractor shall take immediate action to repair it, and shall report the occurence to the appropriate District Office or the Manager of Pollution Abatement.

RULE 3-106 FRACTURE AND ACIDIZING

In the completion of an oil, gas, injection, disposal or service well, where acidizing or fracture processes are used, no oil, gas or deleterious substances shall be permitted to pollute any surface and subsurface fresh water.

RULE 3-107 SWABBING AND BAILING

In swabbing, bailing or purging a well, all deleterious substances removed from the bore hole shall be placed in adequate pits or tanks, and no such substances shall be permitted to pollute any surface and subsurface fresh water.

RULE 3-108 PRODUCING OIL AND GAS WELLS

All wellhead connections, surface equipment and tank batteries shall be maintained at all times so as to prevent leakage of oil, gas, salt water or other deleterious substances.

RULE 3-109 OIL STORAGE

Oil storage tanks shall be constructed so as to prevent leakage; and dikes or walls, where necessary, shall be constructed so as to prevent oil or deleterious substances from polluting surface and sub-surface water.

RULE 3-110 USE OF EARTHEN PITS

RULE 3-110.1 USE OF ON-SITE EARTHEN PITS

(a) An earthen pit serving only the lease or unit on which it is located is defined as an on-site pit. An on-site earthen pit used for the handling, storage or disposal of any deleterious substance produced, obtained, or used in connection with the drilling or operation of wells, shall be constructed of, or sealed with, an impervious material, and shall be used and operated at all times so as to prevent any escape of any deleterious substance. (4-2-81)

(b) No on-site earthen pit shall be constructed, enlarged, reconstructed, or used until the District Office has issued a written permit for its use and assigned a permit number. The operator shall file Form 1014, in triplicate, with the appropriate District Office. When approved, one copy will be returned to the operator as a permit which shall bear the permit number assigned. The operator shall post a waterproof sign bearing the name of the operator and the permit number within twenty-five (25) feet of the pit. (4-2-81)

(c) Every on-site earthen pit not having a permit and permit number shall be emptied and leveled. (4-2-81)

(d) Paragraph (b) and (c) above, shall not apply to:

(1) An emergency pit constructed solely to prevent escape of substances. Provided, an emergency pit shall not be constructed in pervious soil unless lined, and shall never be used for the storage of any substance. (4-2-81)

(2) A circulating, frac or reserve mud pit used in drilling, deepening, testing, reworking or plugging a well while such operations are in progress. Each reserve pit shall be leveled within twelve (12) months after drilling operations cease. One six-month extension may be granted by the District Manager for reasonable cause. Each circulating pit shall be emptied and leveled within sixty (60) days after the drilling operations cease. Each fracture pit shall be emptied and leveled within sixty (60) days after completion of fracture operations. Provided, however, upon application, notice and hearing, and not less than ten (10) days notice by restricted mail to the occupying owner or tenant of the land upon which the pit is located, and for good cause shown, reasonable extensions of the times set out above may be granted. (4-2-81)

(3) A burn pit used solely to burn waste oil or other flammable material. Provided, a burn pit shall never be used for storage of any substance. (4-2-81)

(e) Notice of construction of an on-site emergency pit or burn pit shall be filed, in triplicate, with the appropriate District Office on Form 1014. The appropriate District Office shall be notified in writing of each use of an emergency pit. (4-2-81)

(f) No on-site earthen pit shall be constructed or maintained so as to receive outside runoff water and the fluid level of each earthen pit shall be maintained at all times at least eighteen (18) vertical inches below the lowest point of the embankment. (3-30-82)

(g) The appropriate District Office shall be notified in writing whenever an on-site earthen pit is abandoned. (4-2-81)

RULE 3-110.2 USE OF OFF-SITE EARTHEN PITS

(a) Any earthen pit not defined in Rule 3-110.1 is defined as an off-site earthen pit. An off-site earthen pit used for the handling, storage or disposal of any deleterious substance produced, obtained, or used in connection with the drilling or operation of wells, shall be constructed of, or sealed with, an impervious material, and shall be used and operated at all times so as to prevent any escape of any deleterious substance. (3-30-82)

(b) No off-site earthen pit shall be constructed, enlarged, reconstructed, or used until the District Office has issued a written permit for its use and assigned a permit number. The operator shall file Form 1014, in triplicate, with the appropriate District Office. When approved, one copy will be returned to the operator as a permit which shall bear the permit number assigned. The operator shall post a waterproof sign bearing the name of the operator and the permit number within twenty-five (25) feet of the pit. If Form 1014 is not approved by the appropriate District Office, or if a protest is received at the district level, the operator may file an application for hearing with the Commission, which shall be set for hearing. (4-2-81)

(c) Notice that an application has been filed with the Commission shall be published by the applicant in a newspaper of general circulation and published in the county in which the pit is located and not less than ten (10) days notice by restricted mail to the occupying owner or tenant of the land upon which the pit is located. The applicant shall file proof of publication prior to the hearing. (4-2-81)

(d) Every off-site earthen pit not having a permit and permit number shall be emptied and leveled. (4-2-81)

(e) Every off-site earthen pit shall be completely enclosed by a permanent woven wire fence of at least four (4) feet in height. (4-2-81)

(f) No off-site earthen pit shall be constructed or maintained so as to receive outside runoff water and the fluid level of each earthen pit shall be maintained at all times at least eighteen (18) vertical inches below the lowest point of the embankment. (3-30-82)

(g) The appropriate District Office shall be notified in writing whenever an off-site earthen pit is abandoned. (4-2-81)

(h) The provisions of Rule 3-110.2 shall not apply to an off-site reserve pit used for primary drilling operations. (4-2-81)

(i) Use of off-site earthen pits designed specifically for disposal of deleterious substances from more than one well site shall meet the additional following requirements: (3-30-82)

(1) No off-site earthen pit shall be constructed or maintained so as to receive outside runoff water and the fluid level in the off-site earthen pit shall be maintained at all times at least twenty-four (24) vertical inches below the lowest point of the embankment. (3-30-82)

(2) No off-site earthen pit shall be constructed in the 100 year flood plain of any drainage basin. (3-30-82)

(3) No off-site earthen pit shall contain fluids with a chloride content greater than 3500 MG/L. (3-30-82)

(4) No off-site earthen pit shall contain a soil seal less than 12 inches thick with the co-efficient of permeability no greater than 10^{-7} cm/sec. If a Bentonite seal is to be used, the Bentonite shall be mixed to form the previously mentioned permeability requirement into the soil to a uniform depth of at least 6 inches. (3-30-82)

(5) Two test borings shall be drilled to a minimum depth of 25' below the bottom of the earthen pit, and to be located outside of and near the low elevation side of the pit. The borings shall be submitted with the application to demonstrate the subsurface profile of the proposed pit. (3-30-82)

(6) Any earthen pit that contains deleterious substances shall be lined so as to prevent contamination of the fresh water. The type of liner proposed shall be approved by the Commission's District Manager and Manager of Pollution Abatement. (3-30-82)

(7) Written certification that the seal was provided and constructed in accordance with Commission-approved specifications shall be furnished by the supplier, project engineer, or independent soils laboratory. (3-30-82)

(8) All off-site earthen pits shall be filled and leveled within one (1) year after abandonment. (3-30-82)

(9) No abandoned mines or strip pits shall be used for disposal of oilfield waste unless the geology and hydrology demonstrate that such disposal will not contaminate the fresh water of the state. (3-30-82)

(10) No off-site earthen pit shall contain deleterious substances unless the geology and hydrology demonstrate that such disposal will not contaminate the fresh water of the state. (3-30-82)

RULE 3-110.3 AGRICULTURAL USE OF OIL FIELD WASTE PROHIBITED

Any spreading and/or soil farming of oil field drilling waste shall be prohibited.

RULE 3-111 REFINING AND PROCESSING OF OIL AND GAS

(a) All deleterious substances obtained or used in the processing and refining of oil and gas shall be disposed of in a manner that will prevent the pollution of fresh water.

(b) Chemicals, gasolines, oils and other deleterious substances shall be stored, where necessary, in tanks or containers of a material and of a construction and in a manner that will prevent the escaping, seepage, or draining of such liquids into any fresh water.

RULE 3-114 PROTECTION OF MUNICIPAL WATER SUPPLIES

The Commission, upon application of any municipality or other governmental subdivision, may enter an order establishing special field rules within a defined area to protect and preserve fresh water and fresh water supplies.

RULE 3-120 INSPECTION AND ENFORCEMENT

RULE 3-121 INFORMAL COMPLAINTS

If, upon information or inspection, it is found that an operator, processor, refiner, or transporter of oil or gas is violating any rule or order of the Commission or causing damage or pollution to any oil or gas formation, surface or underground fresh water, the Conservation Division shall cause an investigation to be made and shall file a written administrative complaint, in duplicate, on Form 1036, and one copy of Form 1036 shall be delivered or mailed to the operator. If, upon subsequent inspection it is determined that the operator has taken the corrective actions specified the complaint shall be dismissed; otherwise, formal application will be made to the Commission for an order shutting down the lease or well, and for any other appropriate remedy; pending the outcome of the final determination of the Commission on the formal application, any District Manager shall, after an on-site inspection, have the authority to shut down those operations where conditions appear obvious that surface or underground pollution is occurring. (4-2-81)

RULE 3-200 DRILLING AND DEVELOPMENT

RULE 3-201.1 OPERATORS AGREEMENT, FINANCIAL STATEMENT, ETC.

(a) Each person who drills or operates any well within the State of Oklahoma for the exploration, development or production of oil or gas, or as an injection or disposal well, shall furnish his agreement in writing to plug the well at the time and in the manner prescribed by the Rules and Regulations of the Commission and the laws of the State of Oklahoma. The agreement shall provide that if the Commission determines that he has neglected, failed or refused to plug any well in compliance with the Commission's Rules and Regulations, he will forfeit or pay to the State, through the

ILLEGIBLE

RAILROAD COMMISSION OF TEXAS
OIL AND GAS DIVISION

MACK WALLACE, Chairman
BUDDY TEMPLE, Commissioner
JAMES E. (JIM) NUGENT, Commissioner

J. H. MORROW, P.E.
Director
JERRY W. MULLICAN
Director of Underground
Injection Control

1124 S. IH 35 CAPITOL STATION – P. O. DRAWER 12967 AUSTIN, TEXAS 78711

NOTICE OF RULE ADOPTION

The following is a copy of amended Statewide Rule 8 relating to Water Protection (16 TAC §3.8) as amended by the Railroad Commission of Texas on March 5, 1984. These amendments will go into effect on May 1, 1984.

William H. Barnes
William H. Barnes
Legal Counsel
Underground Injection Control

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§ 3.8. Water Protection.

(a) Definitions. The following words and terms, when used in this section, shall have the following meanings, unless the context clearly indicates otherwise:

(1) Basic sediment pit -- Pit used in conjunction with a tank battery for storage of basic sediment removed from a production vessel or from the bottom of an oil storage tank. Basic sediment pits were formerly referred to as burn pits.

(2) Brine pit -- Pit used for storage of brine which is used to displace hydrocarbons from an underground hydrocarbon storage facility.

(3) Collecting pit -- Pit used for storage of saltwater prior to disposal at a tidal disposal facility, or pit used for storage of saltwater or other oil and gas wastes prior to disposal at a disposal well or fluid injection well. In some cases one pit is both a collecting pit and a skimming pit.

(4) Completion/workover pit -- Pit used for storage or disposal of spent completion fluids, workover fluids, and drilling fluid, silt, debris, water, brine, oil scum, paraffin, or other materials which have been cleaned out of the well bore of a well being completed or worked over.

(5) Drilling fluid disposal pit -- Pit, other than a reserve pit, used for disposal of spent drilling fluid.

(6) Drilling fluid storage pit -- Pit used for storage of drilling fluid which is not currently being used but which will be used in future drilling operations. Drilling fluid storage pits are often centrally located among several leases.

(7) Emergency saltwater storage pit -- Pit used for storage of produced saltwater for limited period of time. Use of the pit is necessitated by a temporary shutdown of a disposal well or fluid injection well and/or associated equipment, by temporary overflow of saltwater storage tanks on a producing lease, or by a producing well loading up with formation fluids such that the well may die. Emergency saltwater storage pits may sometimes be referred to as emergency pits or blowdown pits.

(8) Flare pit -- Pit which contains a flare and which is used for temporary storage of liquid hydrocarbons which are sent to the flare during equipment malfunction but which are not burned. A flare pit is used in conjunction with a gasoline plant, natural gas processing plant, pressure maintenance or repressurizing plant, tank battery, or a well.

(9) Fresh makeup water pit -- Pit used in conjunction with drilling rig for storage of water used to make up drilling fluid.

(10) Gas plant evaporation/retention pit -- Pit used for storage or disposal of cooling tower blowdown, water condensed from natural gas, and other wastewater generated at gasoline plants, natural gas processing plants, or pressure maintenance or repressurizing plants.

(11) Mud circulation pit -- Pit used in conjunction with drilling rig for storage of drilling fluid currently being used in drilling operations.

(12) Reserve pit -- Pit used in conjunction with drilling rig for collecting spent drilling fluids; cuttings, sands, and silts; and wash water used for cleaning drill pipe and other equipment at the well site. Reserve pits are sometimes referred to as slush pits or mud pits.

(13) Saltwater disposal pit -- Pit used for disposal of produced saltwater.

(14) Skimming pit -- Pit used for skimming oil off saltwater prior to disposal of saltwater at a tidal disposal facility, disposal well, or fluid injection well.

(15) Washout pit -- Pit located at truck yard, tank yard, or disposal facility for storage or disposal of oil and gas waste residue washed out of trucks, mobile tanks, or skid-mounted tanks.

(16) Water condensate pit -- Pit used in conjunction with a gas pipeline drip or gas compressor station for storage or disposal of fresh water condensed from natural gas.

(17) Generator -- Person who generates oil and gas wastes.

(18) Carrier -- Person who transports oil and gas wastes generated by a generator. A carrier of another person's oil and gas wastes may be a generator of his own oil and gas wastes.

(19) Receiver -- Person who stores, handles, treats, reclaims, or disposes of oil and gas wastes generated by a generator. A receiver of another person's oil and gas wastes may be a generator of his own oil and gas wastes.

(20) Director -- Director of the Oil and Gas Division or his staff delegate designated in writing by the Director of the Oil and Gas Division or the commission.

(21) Person -- Natural person, corporation, organization, government or governmental subdivision or agency, business trust, estate, trust, partnership, association, or any other legal entity.

(22) Affected person -- Person who, as a result of the activity sought to be permitted, has suffered or may suffer actual injury or economic damage other than as a member of the general public.

(23) To dewater -- To remove the free water.

(24) To dispose -- To engage in any act of disposal subject to regulation by the commission including, but not limited to, conducting, draining, discharging, emitting, throwing, releasing, depositing, burying, landfarming, or allowing to seep, or to cause or allow any such act of disposal.

(25) Landfarming -- A waste management practice in which oil and gas wastes are mixed with or applied to the land surface in such a manner that the waste will not migrate off the landfarmed area.

(26) Oil and gas wastes -- Materials to be disposed of or reclaimed which have been generated in connection with activities associated with the exploration, development, and production of oil or gas or geothermal resources, or activities associated with underground storage of hydrocarbons. The term oil and gas wastes includes, but is not limited to, saltwater, other mineralized water, sludge, spent drilling fluids, cuttings, waste oil, spent completion fluids, and other liquid, semi-liquid, or solid waste material.

(27) Oil field fluids -- Fluids to be used or reused in connection with activities associated with the exploration, development, and production of oil or gas or geothermal resources, or activities associated with underground storage of hydrocarbons. The term oil field fluids includes, but is not limited to, drilling fluids, completion fluids, surfactants, and chemicals used to detoxify oil and gas wastes.

(28) Pollution of surface or subsurface water -- The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any surface or subsurface water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

(29) Surface or subsurface water -- Groundwater, percolating or otherwise, suitable for domestic or livestock use, irrigation of crops, or industrial use, and lakes, bays, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Gulf of Mexico inside the territorial limits of the state, and all other bodies of surface water, natural or artificial, inland or coastal, fresh or salt, navigable or nonnavigable, and including the beds and banks of all watercourses and bodies of surface water, that are wholly or partially inside or bordering the state or inside the jurisdiction of the state.

(b) No pollution. No person conducting activities subject to regulation by the commission may cause or allow pollution of surface or subsurface water in the state.

(c) Exploratory wells. Any oil, gas, or geothermal resource well or well drilled for exploratory purposes shall be governed by the provisions of statewide or field rules which are applicable and pertain to the drilling, safety, casing, production, abandoning, and plugging of wells.

(d) Pollution control.

(1) Prohibited disposal methods. Except for those disposal methods authorized for certain wastes by paragraph (3) of this subsection or subsection (e) of this section, or disposal methods permitted pursuant to § 3.9 of this title (relating to Disposal Wells) or § 3.46 of this title (relating to Fluid Injection into Productive Reservoirs) (Rules 9 or 46), no person may dispose of any oil and gas wastes by any method without obtaining a permit to dispose of such wastes. The disposal methods prohibited by this paragraph include, but are not limited to, the unpermitted discharge of oil field brines, geothermal resource waters, other mineralized waters, or drilling fluids into any watercourse or drainageway, including any drainage ditch, dry creek, flowing creek, river, or any other body of surface water.

(2) Prohibited pits. No person may maintain or use any pit for storage of oil or oil products. Except as authorized by paragraph (4) of this subsection, no person may maintain or use any pit for storage of oil field fluids, or for storage or disposal of oil and gas wastes, without obtaining a

permit to maintain or use the pit. A person is not required to have a permit to use a pit if a receiver has such a permit, if the person complies with the terms of such permit while using the pit, and if the person has permission of the receiver to use the pit. The pits required by this paragraph to be permitted include, but are not limited to, the following types of pits: saltwater disposal pits; emergency saltwater storage pits; collecting pits; skimming pits; brine pits; drilling fluid storage pits (other than mud circulation pits); drilling fluid disposal pits (other than reserve pits or slush pits); washout pits; and gas plant evaporation/retention pits. If, after the effective date of this subsection, a person maintains or uses a pit for storage of oil field fluids, or for storage or disposal of oil and gas wastes, and the use or maintenance of the pit is neither authorized by paragraph (4) or (7)(C) of this subsection nor permitted, then the person maintaining or using the pit shall backfill and compact the pit in the time and manner required by the director. Prior to backfilling the pit, the person maintaining or using the pit shall, in a permitted manner or in a manner authorized by paragraph (3) of this subsection, dispose of all oil and gas wastes which are in the pit.

(3) Authorized disposal methods.

(A) Fresh water condensate. A person may, without a permit, dispose of fresh water which has been condensed from natural gas and collected at gas pipeline drips or gas compressor stations, provided the disposal is by a method other than disposal into surface water of the state.

(B) Inert wastes. A person may, without a permit, dispose of inert and essentially insoluble oil and gas wastes including, but not limited to, concrete, glass, wood, and wire, provided the disposal is by a method other than disposal into surface water of the state.

(C) Low chloride drilling fluid. A person may, without a permit, dispose of the following oil and gas wastes by landfarming, provided the wastes are disposed of on the same lease where they are generated, and provided the person has the written permission of the surface owner of the tract where landfarming will occur: water base drilling fluids with a chloride concentration of 3,000 milligrams per liter (mg/l) or less; drill cuttings, sands, and silts obtained while using water base drilling fluids with a chloride concentration of 3,000 milligrams per liter (mg/l) or less; and wash water used for cleaning drill pipe and other equipment at the well site.

(D) Other drilling fluid. A person may, without a permit, dispose of the following oil and gas wastes by burial, provided the wastes are disposed of at the same well site where they are generated: water base drilling fluids which had a chloride concentration in excess of 3,000 milligrams per liter (mg/l) but which have been dewatered; drill cuttings, sands, and silts obtained while using oil base drilling fluids or water base drilling fluids with a chloride concentration in excess of 3,000 milligrams per liter (mg/l); and those drilling fluids and wastes allowed to be landfarmed without a permit.

(E) Completion/workover pit wastes. A person may, without a permit, dispose of the following oil and gas wastes by burial in a completion/workover pit, provided the wastes have been dewatered, and provided the wastes are disposed of at the same well site where they are generated: spent completion fluids, workover fluids, and the materials cleaned out of the well bore of a well being completed or worked over.

(F) Effect on backfilling. A person's choice to dispose of a waste by methods authorized by this paragraph shall not extend the time allowed for backfilling any reserve pit, mud circulation pit, or completion/workover pit whose use or maintenance is authorized by paragraph (4) of this subsection.

(4) Authorized pits. A person may, without a permit, maintain or use reserve pits, mud circulation pits, completion/workover pits, basic sediment pits, flare pits, fresh makeup water pits, and water condensate pits on the following conditions:

(A) Reserve pits and mud circulation pits. A person shall not deposit or cause to be deposited into a reserve pit or mud circulation pit any oil field fluids or oil and gas wastes other than the following:

(i) drilling fluids, whether fresh water base, saltwater base, or oil base;

(ii) drill cuttings, sands, and silts separated from the circulating drilling fluids;

(iii) wash water used for cleaning drill pipe and other equipment at the well site;

(iv) drill stem test fluids; and

(v) blowout preventer test fluids.

(B) Completion/workover pits. A person shall not deposit or cause to be deposited into a completion/workover pit any oil field fluids or oil and gas wastes other than spent completion fluids, workover fluids, and the materials cleaned out of the well bore of a well being completed or worked over.

(C) Basic sediment pits. A person shall not deposit or cause to be deposited into a basic sediment pit any oil field fluids or oil and gas wastes other than basic sediment removed from a production vessel or from the bottom of an oil storage tank. Although a person may store basic sediment in a basic sediment pit, a person may not deposit oil or free saltwater in the pit. The total capacity of a basic sediment pit shall not exceed 50 barrels. The area covered by a basic sediment pit shall not exceed 250 square feet.

(D) Flare pits. A person shall not deposit or cause to be deposited into a flare pit any oil field fluids or oil and gas wastes other than the hydrocarbons designed to go to the flare during upset conditions at the well, tank battery, or gas plant where the pit is located. A person shall not store liquid hydrocarbons in a flare pit for more than 48 hours at a time.

(E) Fresh makeup water pits. A person shall not deposit or cause to be deposited into a fresh makeup water pit any oil field fluids or oil and gas wastes.

(F) Water condensate pits. A person shall not deposit or cause to be deposited into a water condensate pit any oil field fluids or oil and gas wastes other than fresh water condensed from natural gas and collected at gas pipeline drips or gas compressor stations.

(G) Backfill requirements.

(i) A person who maintains or uses a reserve pit, mud circulation pit, fresh makeup water pit, completion/workover pit, basic sediment pit, flare pit, or water condensate pit shall dewater, backfill, and compact the pit according to the following schedule:

(I) Reserve pits and mud circulation pits which contain fluids with a chloride concentration of 6,100 milligrams per liter (mg/l) or less and fresh makeup water pits shall be dewatered, backfilled, and compacted within one year of cessation of drilling operations.

(II) Reserve pits and mud circulation pits which contain fluids with a chloride concentration in excess of 6,100 milligrams per liter (mg/l) shall be dewatered within 30 days and backfilled and compacted within one year of cessation of drilling operations.

(III) All completion/workover pits used when completing a well shall be dewatered within 30 days and backfilled and compacted with 120 days of

well completion. All completion/workover pits used when working over a well shall be dewatered within 30 days and backfilled and compacted within 120 days of completion of workover operations.

(IV) Basic sediment pits, flare pits, and water condensate pits shall be dewatered, backfilled, and compacted within 120 days of final cessation of use of the pits.

(V) If a person constructs a sectioned reserve pit, each section of the pit shall be considered a separate pit for determining when a particular section should be dewatered.

(ii) A person who maintains or uses a reserve pit, mud circulation pit, fresh makeup water pit, or completion/workover pit shall remain responsible for dewatering, backfilling, and compacting the pit within the time prescribed by clause (i) of this subparagraph (G), even if the time allowed for backfilling the pit extends beyond the expiration date or transfer date of the lease covering the land where the pit is located.

(iii) The director may require that a person who uses or maintains a reserve pit, mud circulation pit, fresh makeup water pit, completion/workover pit, basic sediment pit, flare pit, or water condensate pit backfill the pit sooner than the time prescribed by clause (i) of this subparagraph (G) if the director determines that oil and gas wastes are likely to escape from the pit or that the pit is being used for improper disposal of oil and gas wastes.

(iv) Prior to backfilling any reserve pit, mud circulation pit, completion/workover pit, basic sediment pit, flare pit, or water condensate pit whose use or maintenance is authorized by this paragraph (4), the person maintaining or using the pit shall, in a permitted manner or in a manner

authorized by paragraph (3) of this subsection, dispose of all oil and gas wastes which are in the pit.

(5) Responsibility for disposal.

(A) Permit required. No generator or receiver may knowingly utilize the services of a carrier to transport oil and gas wastes if the carrier is required by this rule to have a permit to transport such wastes but does not have such a permit. No carrier may knowingly utilize the services of a second carrier to transport oil and gas wastes if the second carrier is required by this rule to have a permit to transport such wastes but does not have such a permit. No generator or carrier may knowingly utilize the services of a receiver to store, handle, treat, reclaim, or dispose of oil and gas wastes if the receiver is required by statute or commission rule to have a permit to store, handle, treat, reclaim, or dispose of such wastes but does not have such a permit. No receiver may knowingly utilize the services of a second receiver to store, handle, treat, reclaim, or dispose of oil and gas wastes if the second receiver is required by statute or commission rule to have a permit to store, handle, treat, reclaim, or dispose of such wastes but does not have such a permit. Any person who plans to utilize the services of a carrier or receiver is under a duty to determine that the carrier or receiver has all permits required by the Oil and Gas Division to transport, store, handle, treat, reclaim, or dispose of oil and gas wastes.

(B) Improper disposal prohibited. No generator, carrier, receiver, or any other person may improperly dispose of oil and gas wastes or cause or allow the improper disposal of oil and gas wastes. A generator causes or allows the improper disposal of oil and gas wastes if:

(i) the generator utilizes the services of a carrier or receiver who improperly disposes of the wastes, and

(ii) the generator knew or reasonably should have known that the carrier or receiver was likely to improperly dispose of the wastes and failed to take reasonable steps to prevent the improper disposal.

(6) Permits.

(A) Standards for permit issuance. A permit to maintain or use a pit for storage of oil field fluids or oil and gas wastes may only be issued if the commission determines that the maintenance or use of such pit will not result in the waste of oil, gas, or geothermal resources or the pollution of surface or subsurface waters. A permit to dispose of oil and gas wastes by any method, including disposal into a pit, may only be issued if the commission determines that the disposal will not result in the waste of oil, gas, or geothermal resources or the pollution of surface or subsurface water. A permit to maintain or use any unlined pit, other than an emergency saltwater storage pit, for storage or disposal of oil field brines, geothermal resource waters, or other mineralized waters may only be issued if the commission determines that the applicant has conclusively shown that use of the pit cannot cause pollution of surrounding productive agricultural land nor pollution of surface or subsurface water, either because there is no surface or subsurface water in the area of the pit, or because the surface or subsurface water in the area of the pit would be physically isolated by naturally occurring impervious barriers from any oil and gas wastes which might escape or migrate from the pit. Permits issued pursuant to this paragraph will contain conditions reasonably necessary to prevent the waste of oil, gas, or geothermal resources and the pollution of surface and subsurface waters. A permit to maintain or use a pit will state the conditions under which the pit may be operated, including the conditions under which the permittee shall be required to dewater, backfill, and compact the pit. Any permits issued pursuant to this paragraph may contain requirements

concerning the design and construction of pits and disposal facilities, including requirements relating to pit construction materials, dike design, liner material, liner thickness, procedures for installing liners, schedules for inspecting and/or replacing liners, overflow warning devices, leak detection devices, and fences. However, a permit to maintain or use any lined pit for storage or disposal of oil field brines, geothermal resource waters, or other mineralized waters will contain requirements relating to liner material, liner thickness, procedures for installing liners, and schedules for inspecting and/or replacing liners.

(B) Application. An application for a permit to maintain or use a pit or to dispose of oil and gas wastes shall be filed with the commission in Austin. The applicant shall mail or deliver a copy of the application to the appropriate district office on the same day the original application is mailed or delivered to the commission in Austin. A permit application shall be considered filed with the commission on the date it is received by the commission in Austin. When a commission-prescribed application form exists, an applicant shall make application on the prescribed form according to the instructions on such form. The director may require the applicant to provide the commission with engineering, geological, or other information which the director deems necessary to show that issuance of the permit will not result in the waste of oil, gas, or geothermal resources or the pollution of surface or subsurface water.

(C) Notice. The applicant shall give notice of the permit application to the surface owner of the tract upon which the pit will be located or upon which the disposal will take place. When the tract upon which the pit will be located or upon which the disposal will take place lies within the corporate limits of an incorporated city, town, or village, the applicant shall

also give notice to the city clerk or other appropriate official. Where disposal is to be by discharge into a watercourse other than the Gulf of Mexico or a bay, the applicant shall also give notice to the surface owner of each waterfront tract between the discharge point and 1/2 mile downstream of the discharge point except for those waterfront tracts within the corporate limits of an incorporated city, town, or village. When one or more waterfront tracts within 1/2 mile of the discharge point lie within the corporate limits of an incorporated city, town, or village, the applicant shall give notice to the city clerk or other appropriate official. Notice of the permit application shall consist of a copy of the application together with a statement that any protest to the application should be filed with the commission within 15 days of the date the application is filed with the commission. The applicant shall mail or deliver the required notice to the surface owners and the city clerk or other appropriate official on or before the date the application is mailed or delivered to the commission in Austin. If in connection with a particular application the director determines that another class of persons, such as offset operators, adjacent surface owners, or an appropriate river authority, should receive notice of the application, the director may require the applicant to mail or deliver notice to members of that class. If the director determines that, after diligent efforts, the applicant has been unable to ascertain the name and address of one or more persons required by this subparagraph (C) to be notified, then the director may authorize the applicant to notify such persons by publishing notice of the application. The director shall determine the form of the notice to be published. The notice shall be published once each week for two consecutive weeks by the applicant in a newspaper of general circulation in the county where the pit will be located or the disposal will take place. The applicant shall file proof of publication with the commission in Austin.

(D) *Protests and hearings*. *If a protest from an affected person is* made to the commission within 15 days of the date the application is filed, then a hearing shall be held on the application after the applicant requests a hearing. If the director has reason to believe that a person entitled to notice of an application has not received such notice within 15 days of the date an application is filed with the commission, then the director shall not take action on the application until reasonable efforts have been made to give such person notice of the application and an opportunity to file a protest to the application. If the director determines that a hearing is in the public interest, a hearing shall be held. A hearing on an application shall be held after the commission provides notice of hearing to all affected persons, or other persons or governmental entities, who express an interest in the application in writing. If no protest from an affected person is received by the commission, the director may administratively approve the application. If the director denies administrative approval, the applicant shall have a right to a hearing upon request. After hearing, the hearings examiner shall recommend a final action by the commission.

(E) Modification, suspension, and termination. A permit granted pursuant to this paragraph (6), or a renewal permit granted pursuant to paragraph (7) of this subsection, or a permit which has been issued by the commission prior to the effective date of this subsection but which does not expire pursuant to paragraph (7) of this subsection, may be modified, suspended, or terminated by the commission for good cause after notice and opportunity for hearing. A finding of any of the following facts shall constitute good cause:

(i) pollution of surface or subsurface water is occurring or is likely to occur as a result of the permitted operations;

(ii) waste of oil, gas, or geothermal resources is occurring or is likely to occur as a result of the permitted operations;

(iii) the permittee has violated the terms and conditions of the permit or commission rules;

(iv) the permittee misrepresented any material fact during the permit issuance process;

(v) the permittee failed to give the notice required by the commission during the permit issuance process;

(vi) a material change of conditions has occurred in the permitted operations, or the information provided in the application has changed materially.

(F) Emergency permits. If the director determines that expeditious issuance of the permit will prevent or is likely to prevent the waste of oil, gas, or geothermal resources or the pollution of surface or subsurface water, the director may issue an emergency permit. An application for an emergency permit to use or maintain a pit or to dispose of oil and gas wastes shall be filed with the commission in the appropriate district office. Notice of the application is not required. If warranted by the nature of the emergency, the director may issue an emergency permit based upon a verbal application, or the director may verbally authorize an activity before issuing a written permit authorizing that activity. An emergency permit is valid for up to 30 days, but may be modified, suspended, or terminated by the director at any time for good cause without notice and opportunity for hearing. Except when the provisions of this subparagraph (F) are to the contrary, the issuance, denial, modification, suspension, or termination of an emergency permit shall be governed by the provisions of subparagraphs (A) - (E) of this paragraph.

(G) Minor permits. If the director determines that an application is for a permit to store only a minor amount of oil field fluids or to store or dispose of only a minor amount of oil and gas waste, the director may issue a minor permit provided the permit does not authorize an activity which results in waste of oil, gas, or geothermal resources or pollution of surface or subsurface water. An application for a minor permit shall be filed with the commission in the appropriate district office. Notice of the application shall be given as required by the director. The director may determine that notice of the application is not required. A minor permit is valid for 30 days, but a minor permit which is issued without notice of the application may be modified, suspended, or terminated by the director at any time for good cause without notice and opportunity for hearing. Except when the provisions of this subparagraph (G) are to the contrary, the issuance, denial, modification, suspension, or termination of a minor permit shall be governed by the provisions of subparagraphs (A) - (E) of this paragraph.

(7) Existing permits and pits.

(A) Existing permits. Each permit to maintain or use a lined or unlined pit for storage or disposal of oil field brines, geothermal resource waters, or other mineralized waters, which has been issued by the commission prior to the effective date of this subsection (d), shall expire 180 days after the effective date of this subsection. Every other permit to store oil field fluids or oil and gas wastes or to dispose of oil and gas wastes, which permit has been issued by the commission prior to the effective date of this subsection (d), shall remain in effect until modified, suspended, or terminated by the commission pursuant to paragraph (6)(E) of this subsection. The permits which will expire pursuant to this paragraph (7) include, but are not limited to, permits for the following types of pits: saltwater disposal pits, emergency saltwater storage pits, skimming pits, and brine pits.

(B) Renewal permits. Any person holding a permit scheduled to expire pursuant to subparagraph (A) of this paragraph may apply to the commission for renewal of the permit. If a person makes timely and sufficient application for renewal of a permit, then, notwithstanding the provisions of subparagraph (A) of this paragraph, the permit shall not expire until final commission action renewing or denying renewal of the permit. An application for renewal of a permit shall be filed with the commission in Austin within 180 days of the effective date of this subsection. No notice of the application is required. The director may administratively approve an application for renewal of a permit. No hearing shall be held on an application for renewal of a permit unless the applicant requests a hearing or the director determines that a hearing is necessary. No renewal permit will be issued unless the standards for permit issuance stated in paragraph (6)(A) of this subsection have been met.

(C) Operating existing unpermitted pits. If, as of the effective date of this subsection, a person is maintaining or using a pit, which is required by this subsection to be permitted but which was not required to be permitted prior to the effective date of this subsection, then the person maintaining or using the pit may continue to maintain or use the pit for 180 days after the effective date of this subsection. If a person makes timely and sufficient application for a permit to maintain or use such an existing but unpermitted pit, then the person may continue to use the pit until final commission action denying the permit. An application for a permit shall be considered timely if it is filed with the commission within 180 days of the effective date of this subsection. The issuance or denial of the permit shall be governed by the provisions of paragraph (6) of this subsection. The unpermitted pits, whose use or maintenance is authorized by this subparagraph (C), include, but are not limited to, the following types of pits: drilling fluid storage pits, gas plant evaporation/retention pits, and washout pits.

(D) Backfilling existing pits. If, as of the effective date of this subsection, a person is maintaining or using a basic sediment pit which does not meet the 50 barrel size limitation of paragraph (4)(C) of this subsection, then that person shall dewater, backfill, and compact the pit or rebuild the pit to comply with the 50 barrel size limitation within 180 days of the effective date of this subsection. ' Any person who, as of the effective date of this subsection, is maintaining or using a lined or unlined pit for storage or disposal of oil field brines, geothermal resource waters, or other mineralized waters, which pit was permitted prior to the effective date of this subsection, shall dewater, backfill, and compact the pit within 270 days of the effective date of this subsection unless the person applies for a renewal permit pursuant to subparagraph (B) of this paragraph. If a person applies for a renewal of a permit to maintain or use a lined or unlined pit for storage or disposal of oil field brines, geothermal resource waters, or other mineralized waters, the director may extend the time for dewatering, backfilling, and compacting the pit to up to 90 days after final commission action denying renewal of the permit. If, as of the effective date of this subsection, a person is maintaining or using a pit, which is required by this subsection to be permitted but which was not required to be permitted prior to the effective date of this subsection, then the person maintaining or using the pit shall dewater, backfill, and compact the pit within 270 days of the effective date of this subsection unless the person applies for a permit to maintain or use the pit within the 180-day period allowed by subparagraph (C) of this paragraph. If a person applies for such a permit to maintain or use a previously unpermitted pit, the director may extend the time for dewatering, backfilling, and compacting the pit to up to 90 days after final commission action denying issuance of the permit. The director may require that pits required to be backfilled by this subparagraph be dewatered, backfilled, and compacted sooner than the time prescribed by this subparagraph if the director determines that oil and gas wastes are likely to escape from the pit or that the pit is being used for improper disposal of oil and gas wastes.

(e) Pollution prevention (reference Order Number 20-59,200, effective May 1, 1969).

(1)-(4) (No change.)

(f) Saltwater haulers.

(1)-(2) (No change.)

(g) Record keeping.

(1) Produced water. When produced water is hauled by truck from the lease where it is produced to an off-lease disposal facility, the person producing the water shall keep, for a period of two years from the date of water production, the following records:

(A) identity of the property from which the produced water is hauled;

(B) identity of the commission-approved disposal facility to which the produced water is delivered;

(C) name, address, and permit number (WHP No.) of saltwater hauler transporting the water from producing lease to disposal facility; and

(D) volume of produced water transported each day from producing lease to disposal facility by saltwater hauler.

(2) Retention of run tickets. A person may comply with the requirements of paragraph (1) of this subsection by retaining run tickets or

other billing information created by the saltwater hauler, provided the run tickets or other billing information contain all the information required by paragraph (1).

(3) Examination and reporting. The person keeping any records required by this subsection (g) shall make the records available for examination and copying by members and employees of the commission during reasonable working hours. Upon request of the commission, the person keeping the records shall file such records with the commission.

(h) Penalties. Violations of this section may subject a person to penalties and remedies specified in Title 3 of the Texas Natural Resources Code and any other statutes administered by the commission. The certificate of compliance for any oil, gas, or geothermal resource well may be revoked in the manner provided in § 3.68 of this title (relating to Pipeline Connection and Severance) (Rule 73) for violation of this section.

☐ New Application

☐ Application for Renewal

RAILROAD COMMISSION OF TEXAS

Oil and Gas Division

Application for Permit to Maintain and Use a Pit

Form H-11

May 1984

Comply with Instructions on Reverse Side

1. Operator's Name (As shown on Form P-5, Organization Report)	2. RRC Operator No.	3. RRC Dist. No.	4. County of pit site

Operator's Address (Street, City, State and Zip Code)

6. Name of Lease, Project or Facility of Pit Location | 7. RRC Oil Lease No. or 8. RRC Gas ID No.

9. Pit Location

- Section________ Block ________ Survey ______________________________ Abstract No. A-________
- Location is________ miles ________________ (direction) from ______________________________ (nearest town)

10. a. Is pit bottom below ground level?
☐ Yes ☐ No

b. Artificial liner?
☐ Yes ☐ No

c. If lined, equipped with a leak detection system?
☐ Yes ☐ No

11. Name and Address of Surface Owner

12. Are wastes or fluids from operations other than your own?
☐ Yes ☐ No

13. Type of pit (refer to item F of instructions)

a. Describe land use surrounding pit location:

b. Is land surrounding pit location productive agricultural land?
☐ Yes ☐ No

15. a. Briefly explain the need for this pit:

15. b. Type of waste or fluid:

15. c. Chloride concentration: ____________ mg/l

16. Pit is
☐ Proposed ☐ Existing
If existing, date constructed____________

17. Dikes

a. Height above ground level ________ feet Width at base ________ feet

b. Are dikes designed to keep wastes or fluids in the pit? ☐ Yes ☐ No

c. Are dikes designed to keep stormwater runoff out of the pit? ☐ Yes ☐ No

d. Source of Dike Material: ☐ Excavated from pit ☐ Adjacent borrow pit
☐ Off-site excavation (describe material):

18. Pit capacity (barrels)
____

19. Inside pit dimensions two feet below top of dike
Length ________ feet Width ________ feet
Depth:
from ground level to deepest point ________ feet

20. Wastes or fluids are transported to pit by (check all that apply):
☐ Contract Hauler ☐ Applicant's truck ☐ Pipe ☐ Other:______________________

21. a. Distance to nearest water well within one-mile of pit
________ feet

21. b. Depth of this water well
________ feet

22. Depth to shallowest fresh water ________ feet
Source of information:
☐ measured/observed ☐ well owner ☐ electric log ☐ TDWR

23. Have you included all attachments required by the Instructions on the reverse side of this form?

CERTIFICATE

I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I am authorized to make this report, that this report was prepared by me or under my supervision and direction, and that data and facts stated therein are true, correct, and complete, to the best of my knowledge.

____
Signature

____
Name of Person (type or print) Title

Telephone ________________ Date ____________
Area Code Number

• RRC DISTRICT USE ONLY •

Application Information Review

Date received ____________

Date inspected ____________

Inspector ____________

☐ Location ☐ Liner ☐ Agricultural Land ☐ Dimensions

☐ Grade Construction ☐ Type Pit ☐ Capacity ☐ Dikes ☐ Waste Transport

Comments:

• RRC AUSTIN USE ONLY •

Date received ____________ Pit code ______ Pit type ____________ Permit no. ____________ Permit date ____________

Instructions to Pit Application

Authority: Statewide Rule 8, Water Protection

A. File the application, including all attachments, with the Railroad Commission, Oil and Gas Division, P.O. Drawer 12967, Capitol Station, Austin, Texas 78711. On the same day file one copy of the application and its attachments with the appropriate District Office. This form is not required for a minor permit.

B. Notify the surface owner of the land where the pit will be located by mailing or delivering a copy of the application form, both front and back, but excluding the attachments. If the land where the pit is proposed is within corporate limits, also notify the city clerk or other appropriate city official. If application is for renewal of an existing permit, notice is not required.

C. Attach a plat showing the size of the lease or tract and the location of the pit within the lease or tract. Give approximate perpendicular distance to nearest intersecting lease/unit lines and section/survey lines. To avoid confusion, distinguish between the two sets of lines. Indicate scale on this plat.

D. Attach a county highway map (scale: 1″ = 4 miles) showing the location of the pit. County highway maps are available from the Texas Department of Highways and Public Transportation, P. O. Box 5051, Attn: Map Distribution File D-10, Austin, TX 78763.

E. If application is for renewal of a permit for an existing pit, attach a copy of your current authority to use the pit.

F. Identify the type of pit in item 13 using one of the following as defined in Statewide Rule 8(a): Emergency Saltwater Storage Pit, Collecting Pit, Gas Plant Evaporation/Retention Pit, Brine Pit (located at underground hydrocarbon storage facilities only), Saltwater Disposal Pit, Skimming Pit, Washout Pit, Drilling Fluid Disposal Pit, Drilling Fluid Storage Pit, or other (specify in item 13 and explain in item 15a).

G. Attach a drawing of two perpendicular, sectional views of the pit showing the pit bottom, sides, dikes and the natural grade. For an existing pit, dimensions below fluid level may be approximated. If the pit length and width are irregular, include a top view to show pit dimensions and dike widths. Indicate scale on all views.

H. **If pit is lined,** attach data on liner material, thickness, and installation procedures.

I. Attach an identification and description of the soil or subsoil that will make up the pit bottom and sides. The information shall describe the soil by typical name, appropriate proportion of grain sizes, texture, consistency, moisture condition, and other pertinent characteristics. (Example: clayey silt, slightly plastic, small percentage of fine sand, firm and dry in place.) Identify the source of soil information. Information on how to classify soils is available from the District Office or Austin Office upon request. If application is for renewal of a permit for an existing emergency saltwater storage pit or a lined pit with a leak detection system, this attachment is not required.

J. **If pit is equipped with a leak detection system,** attach engineering design drawing of the pit and leak detection system.

K. **If lined pit is not equipped with a leak detection system,** describe procedures for periodic maintenance and determining liner integrity, including any special monitoring.

L. **If pit is an emergency salt water storage pit,** attach justification for pit size based on water production, lease water storage capacity, and anticipated well or equipment shut-down time.

Note: The Director of the Oil and Gas Division may require the applicant to provide the Commission with any additional engineering, geological, or other information which the Director deems necessary to show that issuance of the permit will not result in the waste of oil, gas, or geothermal resources or the pollution of surface or subsurface water.

Protests and hearings.

An affected person may file a protest to the application and request a hearing. Any protest to the application should be filed with the Commission in Austin within fifteen days of the date the application is filed with the Commission. Any such protest shall be made in writing and shall include (1) the name, mailing address, and phone number of the person making the protest; and (2) a brief description of how the protestant would be adversely affected by the granting of the permit. If the Commission determines that a valid protest has been received, or that a hearing would be in the public interest, a hearing will be held after the issuance of proper and timely notice of the hearing by the Commission. If no protest is received within fifteen (15) days of receipt of the application in Austin, the application may be processed administratively.