1 SUB-2980 C 1

MEMORIA TECNICA

EXPLORACION DE AGUA SUBTERRANEA EN SALARES PUNTA NEGRA, IMILAC Y HAMBURGO

PROVINCIA Y COMUNA DE ANTOFAGASTA
REGION DE ANTOFAGASTA

DIRECCION GENERAL DE AGUAS
Centro de Información Recursos Hídricos
Área de Documentación

PREPARADA POR

MINERA UTAH DE CHILE INC.

PARA

Dirección General de Aguas

ABRIL, 1984

SUB-2980
c.1

DISEÑO RHEIN ART. 323.404

MINERA UTAH DE CHILE INC.

ESCALA 1:500.000

TERRENOS SOLICITADOS POR MINERA UTAH DE CHILE INC. DESTINADOS A EXPLORACION DE AGUAS SUBTERRANEAS UBICADOS EN LA PROVINCIA Y COMUNA DE ANTOFAGASTA II REGION

DIRECCION GENERAL DE AGUAS
Centro de Información Recursos Hídricos
Área de Documentación

SECCION 1.0 - INTRODUCCION

1.1. EL PROYECTO

Minera Utah de Chile Inc., y Getty Mining (Chile) Inc., subsidiarias de Utah international Inc., y de Getty Oil Co., respectivamente, han suscrito con el Estado de Chile un Contrato de Inversiones Extranjeras hasta por un total de US$ 1.500 millones (dólares de 1979). Utah y Getty desarrollan sus actividades en Chile bajo el esquema de "Joint Venture" del cual Utah es el operador. Las inversiones se efectúan con financiamiento hecho por partes iguales.

Las exploraciones iniciadas en 1979 permitieron descubrir un nuevo recurso cuprífero de importancia, "Escondida", ubicado a 180 Km. al Sur-Este de Antofagasta, a una altura de alrededor de 3200 metros, próximo al Salar de Hamburgo y a la Estación Adolfo Zaldivar del Ferrocarril de Antofagasta a Salta.

Dada la ubicación del yacimiento en una zona desértica, alejada de la costa, será indispensable para el eventual desarrollo de la misma y el beneficio de sus minerales, disponer de agua en cantidad y calidad aceptable en un radio razonable del centro de consumo, tanto para uso industrial como para agua potable del campamento, planta y oficinas.

No habiendo aguas corrientes disponibles en las cercanías, la ubicacioń del recurso se orientó hacia aguas subterraneas. Minera Utah de Chile Inc.,solicitó y obtuvo autorización para explorar por agua subterranea en el Salar de Punta Negra y cuenca anexa.

1.2. AUTORIZACION PARA EXPLORAR

La autorización se otorgó por Resolución DGA Nº 38 del 28 de Enero de 1982, por un total de 74 rectángulos de 5.000 Has. cada uno, posteriormente reducidos a 35 rectángulos por Resolución DGA Nº 47 del 14 de Febrero de 1983. Se adjunta copia de las Resoluciones y el plano de ubicación de la zona de exploración.

De acuerdo a lo establecido en punto 3º de la Resolución DGA Nº 38 de 1982, se entregó a la DGA un informe con el resultado de la exploración realizada en los seis primeros meses de la vigencia del permiso de exploración, adjunto a carta de fecha 14 de Julio de 1982, copia de la cual se incluye. Ese informe debe considerarse como preliminar pero como parte integrante del presente informe.

1.3. RESUMEN EXPLORACION

En la campaña de exploración preliminar, se perforó 35 pozos "S", cuya ubicación, profundidad y nivel freático se muestran en la Tabla 1.1. Ninguno de estos pozos fue bombeado.

Algunos de los pozos "S" fueron profundizados hasta la roca basal, pasando a construir pozos "ES". La ubicación, profundidad, nivel freático y características se muestran en la Tabla 1.2. Los pozos "ES" cuyo gasto fue medido por medio de "air lift" se indican en la Tabla 1.3.

Finalmente, se construyó 5 pozos de prueba de tiempo prolongado, los pozos "T", cuyas características se resumen en la Tabla 1.4.

1.4 GEOLOGIA e HIDROLOGIA

En la sección 2, se incluye el informe," Groundwater Exploration Report", que incluye antecedentes generales sobre clima e hidrología de la zona y en detalle la exploración, indicando las áreas consideradas de especial interés, los métodos empleados y estadísticas de la campaña. Las dos áreas principales de exploración, el Salar de Punta Negra que incluye el de Imilac y el Salar de Hamburgo, se analizan en detalle en los puntos 2.2 y 2.3 respectivamente. Para el Salar de Punta Negra, se incluye estudios sobre clima y fisiografía (2.2.1), Geología (2.2.2), secuencias sedimentarias y volcánicas (2.2.3), Geología estructural (2.2.4), aquíferos (2.2.5), movimiento del agua subterranea (2.2.6), calidad de agua (2.2.7) y almacenamiento (2.2.8).

Para el Salar de Hamburgo, se analiza clima y fisiografía (2.3.1), depósitos aluviales (2.3.2), roca basal (2.3.3), movimiento del agua subterranea (2.3.4) calidad del agua (2.3.5), almacenamiento (2.3.6) y potencial de desarrollo (2.3.7).

Se concluye con el programa de prueba de los pozos de producción y resultados en forma resumida en el punto 3.0.

1.5. LITOLOGIA

En la sección 3 se entregan los registros litológicos de los pozos productivos.

1.6 PRUEBAS DE BOMBEO

En la sección 4 se entregan informes completos de las pruebas de bombeo en los pozos T-1 a T-5 y las curvas de recuperación de los pozos en los que se bombeó con "air lift".

1.7 UTILIZACION DEL RECURSO

En la sección 5 se analiza la utilización de la recarga y del agua almacenada, junto con justificación de la zona de protección que se solicida.

1.8 PLANOS

En la sección 6 se incluye detalles de construcción de los pozos y los planos que no se han incorporado en el cuerpo del informe.

DPTO. DERECHOS DE AGUAS
-/glg.

Dpto. Legal D.G.A.

DIRECCION GENERAL DE AGUAS — INO. JEFE Derechos de Aguas

MINISTERIO DE HACIENDA
OFICINA DE PARTES

RECIBIDO

M.O.P.
DIRECCION GENERAL DE AGUAS
OFICINA DE PARTES
RESOLUCION TRAMITADA
Fecha - 4 FEB. 1982

CONTRALORIA GENERAL
TOMA DE RAZON

RECEPCION

DEPART. JURIDICO		
DEP. T. R. REGISTRO		
DEP. CONTABIL.		
SUB DEP. CENTRAL		
SUB DEP. CUENTAS		
SUB DEP. C. P. Y B. NAC		
DEPART. AUDITORIA		
DEPART. V. O. P., U. y T.		
SUB DEP. MUNICIP.		

REFRENDACION

REF. POR $ ....
IMPUTAC. ....
ANOT. POR $ ....
IMPUTAC. ....
....
DEDUC. DTO. ....

REF. : Otorga autorización de exploración de aguas subterráneas en Salar de Punta Negra y a su cuenca anexa a Minera UTAH de Chile Inc., Provincia de Antofagasta, II Región.

SANTIAGO, 28 ENE. 1982

Con esta fecha el Director Gral. de Aguas ha resuelto lo que sigue

VISTOS:

La solicitud de Minera UTAH de Chile Inc., el oficio ORD. N° 17 del 15 de Enero de 1982 del Departamento de Derechos de Aguas, y lo dispuesto en los Arts. 64; 268 y siguientes del Código de Aguas, aprobado por DFL. N° 162 de 1969 y en el Art. 12 Transitorio del Código de Aguas aprobado por DFL. N° 1122 de 1981, del Ministerio de Justicia, y lo establecido en el Art. 58 de este último texto legal,

RESUELVO:

D.G.A. N° 38

1°.- Otórgase autorización a Minera UTAH de Chile Inc., para que explore en bienes nacionales 74 rectángulos de 5.000 há. cada uno, ubicados en el lugar denominado Salar de Punta Negra y cuenca anexa, en la Provincia de Antofagasta, II Región, con el fin de alumbrar aguas subterráneas que serán destinadas al uso industrial, minero y potable del yacimiento de cobre La Escondida.

2°.- Los terrenos a explorar son abiertos y sin cultivos y están delimitados por las siguientes coordenadas.

//.

[redacted] -55/

2? ENE 1982

Sub-Jefe ...
Cumbre/ ...
Auditoria

TOMO RAZON

- 3 FEB. 1982

CONTRALOR GENERAL
SUBROGANTE

a) Límites de 70 rectángulos

Norte	: 24°05'	latitud Sur
Sur	: 24°55'	latitud Sur
Este	: 68°39'	longitud oeste
Oeste	: 69°00'	longitud oeste

b) Límites de 4 rectángulos

Norte	: 24°10'	latitud Sur
Sur	: 24°20'	latitud Sur
Este	: 69°00'	longitud oeste
Oeste	: 69°06'	longitud oeste.

3°.- El plazo de duración de estas autorizaciones de exploración será de seis meses contados desde la fecha de transcripción de esta Resolución a la interesada, pero en los rectángulos en que se inicien los trabajos dentro de dicho término la autorización será por un plazo total de dos años. La Dirección General de Aguas comprobará al termino de los seis meses antes señalados los rectángulos en que exista iniciación de trabajo.

4°.- Se entenderán iniciados los trabajos por el hecho que la beneficiaria inicie la perforación con el objeto de alumbrar agua subterránea con el equipamiento adecuado para tal efecto.

5°.- La concesionaria de este permiso de exploración deberá proporcionar a la Dirección General de Aguas los antecedentes técnicos que obtenga en el desarrollo de la exploración.

6°.- Comprobada la existencia de agua subterránea, la concesionaria del permiso tendrá derecho preferente para solicitar el respectivo derecho de aprovechamiento. Este derecho podrá ejercitarlo dentro del plazo de la autorización y hasta seis meses después. Expirado el plazo sin que se solicite el derecho, el terreno quedará libre para nuevas exploraciones.

7°.- Déjase constancia que Minera UTAH de Chile Inc., ha efectuado una consignación de $ 1.110.000.- para responder de los perjuicios que puedan causarse.

ANOTESE, TOMESE RAZON Y NOTIFIQUESE.

Lo que transcribo a Ud. para su conocimiento y fines pertinentes.

ENRIQUE GARCIA MERINO
DIRECTOR GENERAL DE AGUAS

Santiago, 14 de Julio de 1982
MU-266/82

Señores
Dirección General de Aguas
Departamento Derechos de Aguas
Ministerio de Obras Públicas
PRESENTE

Muy señores nuestros:

Por Resolución N°38 de esa Dirección de 28 de Enero de 1982, se otorgó a mi representada una autorización de Exploración de Aguas Subterráneas en el Salar de Punta Negra y en su cuenca anexa en la Provincia de Antofagasta, II Región.

El propósito de la autorización es alumbrar aguas que serán destinadas al uso industrial, minero y potable del yacimiento de cobre La Escondida.

Con la presente, adjuntamos a esa Dirección, el informe hidrológico de la zona del Salar de Punta Negra que hemos preparado y en el que se indican los antecedentes técnicos obtenidos en el desarrollo de la exploración.

Como ustedes podrán apreciar, hasta esta fecha se han iniciado trabajos en 35 de los 74 rectángulos comprendidos en la concesión. Lo anterior, sin perjuicio de los trabajos que se ejecuten en los restantes rectángulos de aquí hasta la expiración de los seis meses iniciales contados desde la fecha en que fue transcrita la Resolución N°38.

Queremos, además, expresar por la presente que estamos a su disposición para presentar o explicar mayores antecedentes a los técnicos de la Dirección General de Aguas sobre los trabajos que se han hecho hasta la fecha, como asimismo, para conversar con ustedes, si fuere necesario y fijar la fecha de viaje de un técnico de dicha Dirección a fin de que compruebe en el terreno los trabajos efectuados.

Saludamos a ustedes muy atentamente,

MINERA UTAH DE CHILE INC.

Paul Gordonneau G.
Gerente

cc. Sr. Layto Dalannais
Dir. General de Aguas

CLASIFICADOR 11 – CORREO 10 – SANTIAGO – TELEFONO 285548 – TLX. SGO 412
CASILLA 648 – ANTOFAGASTA – TELEFONO 225166

DEPTO. DE DERECHOS DE AGUAS
LGD/rary

M.O.P.
DIRECCION GENERAL DE AGUAS
OFICINA DE PARTES
RESOLUCION TRAMITADA
Fecha 24 FEB 1983

Ref.: Ordena la devolución de parte de la suma consignada por Minera UTAH Chile.INC., para explorar en Bienes Nacionales.

MINISTERIO DE HACIENDA
OFICINA DE PARTES

RECIBIDO

CONTRALORIA GENERAL
TOMA DE RAZON
15 FEB. 1983

RECEPCION

DEPART. JURIDICO		
DEPT. T. R. REGISTRO		
DEPART. CONTABIL.		
SUB. DEP. C. CENTRAL		
SUB. DEP. CUENTAS		
SUB. DEP. C. P. Y. BIENES NAC.		
DEPART. AUDITORIA		
DEPART. OP. U. Y T.		
SUB. DEP. MUNICIP.		1983

REFRENDACION

REF. POR $ ....
IMPUTAC. ....
ANOT. POR $ ....
IMPUTAC. ....
DEDUC. DTO. ....

[redacted]TE: V-2-55.

SANTIAGO, 14 FEB. 1983

Con esta fecha el Director Gral. de Aguas ha resuelto lo que sigue

VISTOS: La solicitud de Minera UTAH Chile INC., la Resolución D.G.A. Nº 38 de 1982; el Oficio ORD. Nº 32 del 26 de Enero de 1983 del Departamento de Derechos de Aguas; lo dispuesto en el Artículo 12º Transitorio del Código de Aguas aprobado por D.F.L. Nº 1.122 de 1981 y en Artículo 63 del Código aprobado por D.F.L. Nº162 de 1969, del Ministerio de Justicia, y

C O N S I D E R A N D O :

1.- Que por Resolución D.G.A. Nº 38 se otorgó autorización a Minera UTAH Chile INC. para explorar aguas subterráneas en 74 rectángulos de 5.000 Hás. cada uno, en la provincia de Antofagasta, II Región.

2.- Que en el punto 3 de la Resolución antes citada, quedó estipulado que la autorización sería por seis meses, pero en los rectángulos en que se iniciaren los trabajos de exploración, el permiso sería de un plazo total de 2 años.

3.- Que Minera UTAH Chile INC. ha efectuado una consignación por los 74 rectángulos ascendentes a la suma de $ 1.110.000 (un millón ciento diez mil pesos) para responder de los perjuicios que puedan causarse durante la exploración.

4.- Que la concesionaria ha iniciado trabajos sólo en 35 de los 74 rectángulos, y por lo tanto en 39 de ellos no se efectuaron exploraciones, razón por la cual no se produjo ningún tipo de perjuicios.

5.- Que la concesionaria ha solicitado la devolución de la suma en consignación correspondiente a los 39 rectángulos donde no se iniciaron trabajos de exploración, suma que asciende a $ 585.000 (quinientos ochenta y cinco mil pesos).

R E S U E L V O :

D.G.A. Nº 17 /

1.- Devuélvase a Minera UTAH Chile INC., la suma de $ 585.000 (quinientos ochenta y cinco mil pesos), correspondientes a lo consignado para explorar en los 39 rectángulos donde la concesionaria no realizó trabajos de exploración, en la provincia de Antofagasta, II Región.

1 5 FEB 1983

TOMO RAZON

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2.- Póngase la presente Resolución en conocimiento de la Sociedad interesada representada por don Paul Gondonneau; de la Dirección de Contabilidad y Finanzas; del Departamento de Derechos de Aguas, del Sub-Departamento de Presupuesto y Contabilidad de la Dirección General de Aguas y de la Oficina D.G.A. Regional Antofagasta.

ANOTESE, TOMESE RAZON Y COMUNIQUESE.

EUGENIO [illegible] [illegible]ARGA
DIRECTOR GENERAL DE AGUAS

Lo que transcribo a Ud. para su conocimiento y fines pertinentes.

R. DARIO VALENZUELA R.
Jefe [illegible]
y Secretaria General
Dirección General de Aguas

TABLA 1.1 UBICACION POZOS "S"

Pozo	Coordenadas Latitud	Coordenadas Longitud	Altura	Profundidad (m)	Nivel Estático (m.b.n.m)(1)	Cota Nivel Freático	Observaciones
SA- 5 (ES-11)	7.327.734	523.096	2.983,85	33	17.39	2966.48 (4.83)	
SA- 6	7.329.988	526.202	2.974,43	30	2.49	2971.94 (5.83)	
SA- 7	7.333.124	530.298	2.984,64	30	26.96	2957.68 (5.83)	
[redacted]	7.321.650	492.078	3.174,75	20.5	--	--	Seco
[redacted]	7.318.700	497.077	3.030,68	60	56.34	2974.34 (2.83)	
[redacted]	7.318.582	501.240	3.066,41	30	--	--	Seco
SB- 7	7.324.183	522.996	2.961,25	30	0.0	--	Artesiano
SB- 8 (ES-12)	7.323.959	525.684	2.981,95	299.31	--	--	Tapón de arcilla
[redacted]	7.314.345	494.804	2.999,53	16.6	11.43	2988.10 (2.83)	
[redacted] (ES-1)	7.316.625	496.298	3.016,11	152	28.89	2987.22 (2.83)	Corresponde ES-1
[redacted]	7.316.451	500.900	3.084,68	30	--	--	Seco
SC- 5	7.307.632	514.013	3.016,50	70	37.91	2978.59 (10.83)	
SC- 6	7.308.682	517.078	3.057,54	30	--	--	Seco
SC- 7	7.309.232	520.619	3.126,12	30	--	--	Seco
SC- 8	7.308.496	526.015	3.251,82	30	--	--	Seco
SD- 3 (ES-3)	7.299.061	514.514	3.018,17	228	39.47	2978.70 (10.83)	Corresponde ES-3
SD- 4 (ES-2)	7.305.352	517.732	3.067,09	242	86.43	2980.66 (2.83)	Corresponde Es-2
SD- 5	7.304.793	521.036	3.144,49	30	--	--	Seco
SD- 6	7.305.611	526.720	3.318,89	30	--	--	Seco
SE- 1	7.291.107	504.098	2.964,36	42	12.99	2951.37 (10.83)	
SE- 2	7.293.953	507.838	2.958,11	30	1.60	2956.51 (10.83)	
SE- 3 (ES-4)	7.293.635	511.959	2.983,47	226	14.75	2968.72 (10.83)	Corresponde ES-4

(1) m.b.p.m. = metros bajo punto medida

TABLA 1.1 UBICACION POZOS "S"

Pozo	Coordenadas Latitud	Coordenadas Longitud	Altura	Profundidad (m)	Nivel Estático (m.b.n.m)(1)	Cota Nivel Freático	Observaciones
SE- 4	7.296.465	517.319	3.099,72	30	--	--	Seco
SE- 5	7.293.136	521.532	3.259,49	30	--	--	Seco
SF- 2	7.281.085	508.374	2.958,95	30	6.68	2952.27 (10.83)	
SF- 3 (ES-5)	7.284.245	512.794	3.026,94	494	59.97	2966.97 (10.83)	Corresponde ES-5
SF- 4	7.285.545	515.519	3.103,04	30	--	--	Seco
SG- 1	7.269.502	503.134	2.965,03	30	11.92	2953.11 (10.83)	
SG- 2	7.275.073	507.501	2.956,05	30	4.20	2951.85 (10.83)	
SG- 3 (ES-9)	7.275.867	511.720	3.067,94	385.56	106.13	2961.81	
SG- 4	7.275.988	515.607	3.225,35	30	--	--	Seco
SH- 1	7.265.884	502.587	2.965,89	30	11.69	2954.20 (10.83)	
SH- 2	7.258.164	505.749	3.086,97	30	--	--	Seco
SI- 1	7.256.240	503.836	3.129,70	30	--	--	Seco
SI- 2	7.256.302	506.102	3.120,62	30	--	--	Seco

TABLA 1.2 UBICACION DE SONDAJES DE EXPLORACION "ES"

Pozo	Coordenadas Latitud	Coordenadas Longitud	Cota m.s.n.m.	Profundidad (m)	Nivel Estático (m.b.p.m.)(1)	Cota Nivel Freático		Observaciones
ES- 1	7.316.625	496.298	3.016,11	152	28.89	2987.22	(2.83)	
ES- 2	7.305.352	517.732	3.067,09	242	86.43	2980.66	(2.83)	
ES- 3	7.299.061	514.514	3.018,17	228	39.47	2978.70	(10.83)	
ES- 4	7.293.635	511.959	2.983,47	226	14.75	2968.72	(10.83)	
ES- 5	7.284.245	512.794	3.026,94	494	59.97	2966.97	(10.83)	
ES- 6	7.273.412	515.990	3.294,62	470,73	24.17?	--	(2.83)	Tapón de arcilla (inicialmen artesiano)
ES- 7	7.291.502	520.200	3.234,56	422,15	176.35	3058.21	(2.83)	
ES- 8	7.279.506	517.937	3.263,58	455,68	78.83?	--		Tapón de arcilla
ES- 9	7.275.867	511.720	3.067,94	385,56	106.13	2961.81		
ES-10	7.272.171	518.693	3.427,72	518,16	0.0	--		Artesiano
ES-11	7.327.734	523.096	2.983,85	361,19	17.39	2966.46		
ES-12	7.323.959	525.684	2.981,95	299,31	11.72	--	(4.83)	Tapón de arcilla
ES-13	7.335.967	529.620	3.003.87	288.04	43.21	2960.66	(5.83)	
ES-14	7.326.063	523.450	2.971,42	147.22	16.14	2955.28	(5.83)	
ES-15	---	---	---	29,87	--	--		
ES-15A	7.329.800	525.798	2.976.30	167.55	4.92	2971.38	(5.83)	
ES-16	7.333.499	528.632	2.987.11	268,22	16.33	2970.78	(5.83)	
ES-17	7.337.339	529.703	3.035,80	326,14	75,77	2960.03	(5.83)	
ES-18	7.341.602	527.146	2.973,12	374,90	30.07	2943.05	(5.83)	
ES-19	7.340.769	520.045	3.095,12	335,28	--	--		
ES-20	7.335.091	526.707	2.977,53	242,32	26.37	2951.16	(5.83)	
ES-21	7.334.149	531.365	2.994,61	118,87	--	--		
ES-21 A	7.334.154	531.365	2.995,20	323,09	19,57	2975.63	(5.83)	

(1) m.b.p.m. = metros bajo punto medida

TABLA 1.2 UBICACION DE SONDAJES DE EXPLORACION "ES"

Pozo	Coordenadas Latitud	Longitud	Cota m.s.n.m.	Profundidad (m)	Nivel Estático (m.b.p.m.)	Cota Nivel Freatico		Observaciones
ES-21 B	7.334.144	531.375	2.994,81	408,43	19.27	2975.54	(5.83)	
ES-22	7.325.316	529.969	3.076,78	365,76	96.34	2980.44	(5.83)	
ES-23	7.303.904	529.745	3.377,04	149,35	--	--		Aterrado
ES-24	7.291.486	524.470	3.332,35	259,08	0.00	--		Artesiano
ES-25	7.306.384	527.408	3.307,83	195,07	--	--		Aterrado
ES-26	7.297.163	526.587	3.332,76	487,68	11.54	3321.22	(10.83)	
ES-27	7.295.960	519.457	3.139,66	7,93	--	--		Aterrado
ES-28	7.284.682	513.006	3.033,02	121,92	--	--		Aterrado
ES-28 A	7.284.680	513.012	3.033,11	313,33	65.70	2967.41	(10.83)	
ES-29	7.286.975	513.724	3.044,91	313,33	--	--		Aterrado
ES-30	7.288.185	514.322	3.056,71	219,46	--	--		Aterrado
ES-31	7.288.276	511.501	2.991,90	280,42	28.70	2963.20	(10.83)	
ES-32	7.282.056	510.957	3.001,44	286,51	--	--		Aterrado
ES-33	7.279.527	511.101	3.026,79	243,84	--	--		Aterrado
ES-34	7.282.134	513.953	3.078,03	316,99	--	--		Aterrado
ES-35	7.277.322	509.317	2.993,30	262,13	--	--		Aterrado
ES-36	7.289.401	509.689	2.961,22	85,34	--	--		Seco
ES-37	7.926.465	517.319	3.099,72	286,51	--	--		Tapón de arcilla
ES-38	7.265.659	497.224	3.023,74	182,88	70.53	2953.21	(10.83)	
ES-39	7.268.192	494.251	3.063,13	152,40	?	--		
ES-40	7.263.088	500.565	2.993,71	219,46	39,36	2954.35	(10.83)	
ES-41	7.263.864	498.725	3.601,79	152.40	16.00?	--	(11.83)	Tapón de arcilla
ES-42	7.261.008	502.254	3.035,94	225,52	?	--	(11.83)	Tapón de arcilla

TABLA 1.2 UBICACION DE SONDAJES DE EXPLORACION "ES"

Pozo	Coordenadas		Cota	Profundidad	Nivel Estático	Cota Nivel		
	Latitud	Longitud	m.s.n.m.	(m)	(m.b.p.m.)	Freático		Observaciones
ES-43	7.260.703	500.318	3.042,31	231,65	86.02	2956.29	(10.83)	
ES-44	7.248.505	502.457	3.330,08	158,50	--	--	(11.83)	Seco
ES-45	7.258.061	500.136	3.103,71	243,84	142.54	2961.17	(10.83)	
ES-46	7.258.160	502.104	3.088,61	280.42	126.25	2962.36	(10.83)	
ES-47	7.258.212	503.359	3.077,03	158,50	--	--	(11.83)	Herramienta Atrapada
ES-48	7.258.164	505.749	3.086,97	292,61	--	--	(11.83)	Tapón de arcilla
ES-49	7.295.229	514.805	3.042,11	249,94	65.05	2977.06	(10.83)	
ES-50	7.307.636	514.000	3.017,13	164,59	39.30?	--	(11.83)	
ES-51	7.304.134	511.734	2.986,47	170,69	--	--		Aterrado
ES-52	7.310.862	519.726	3.090,78	152,40	--	--		Aterrado
ES-53	7.314.733	521.395	3.073,04	201,17	67.81	3005.23	(11.83)	
ES-54	7.301.921	510.205	2.984,27	54,86	7.12	2977.15	(10.83)	
ES-54 A	7.302.025	511.830	2.985,26	104,21	?	--		
ES-55	7.312.606	521.592	3.101,28	158,50	108.69	2992.59	(10.83)	
ES-56	7.293.806	514.235	3.041,07	146,30	67.80	2973.27	(10.83)	
ES-57	7.279.100	512.288	3.058,56	262,13	46.61	3011.95	(10.83)	
ES-58	7.268.334	504.879	2.996,35	164,59	54.00	2942.35	(10.83)	
ES-59	7.295.783	511.027	2.975,51	128,02	11.18	2964.33	(10.83)	
ES-60	7.295.228	514.842	3.040,47	140,21	65.38	2975.09	(10.83)	

TABLA 1.3 RESUMEN POZOS CON PRUEBA DE BOMBEO POR AIR-LIFT

Pozo Nº	Profundidad m	Profundidad ft	Distribucion Casing	Duracion Bombeo	Nivel Estático (m)	Q gpm	Q l/s	T°C	T gpd/ft	T m^3/hr/m	Conductividad µmho/cm	Obser
ES- 1	152	499	0 - 28 m 8" casing 28 - 61 m 8" screen 61 - 152 m 8" ranurado	12 hrs	28.89	47	30	16	2.700	14.0	8.000	
ES- 2	242	794	0 - 70 m 8" casing 70 - 78 m 8" ranurado 78 -242 m 6" ranurado	4 hrs	86.43	1	-	25	1.000	5.2	2.800	
ES- 3	228	748	0 - 59 m 8" casing 59 - 157 m 8" ranurado 157 - 203 m 8" screen 203 - 228 m 8" ranurado	12 hrs	39.47	194	12.2	22	3.600	18.7	950	
ES- 4	226	741	0 - 36 m 6" casing 36 - 226 m 6" ranurado	12 hrs	14.75	135	8.5	18.5	2.000	10.4	10.000	
ES- 5	494	1621	1 - 6 m 8" ranurado 6 - 120 m 8" screen	12 hrs 7 hrs	59.97	193 135	12.2 8.5	21 21	50.000 10.000	260.0 52.0	6.000 4.000	H&Montg J. Kief
ES- 7	422	1385	0 - 860' 6" casing 860 - 880' 8" casing 880 - 940' 8" screen 940 -1080' 8" casing 1080 -1160' 8" screen 1160 -1200' 8" casing	8 hrs	176.35	55	3.5	26.5	2.500	13.0	3.500	
ES- 9	386	1265	0 - 440' 8" casing 440 - 500' 8" screen 500 - 620' 8" casing 620 - 680' 8" screen 680 - 760' 8" casing 760 - 840' 8" screen 840 - 860' 8" casing	6.5 hrs	106.13	144	9.1	24.8	5.200	27.0	30.500	

TABLLA 1.3 RESUMEN POZOS CON PRUEBA DE BOMBEO POR AIR-LIFT

Pozo No	Profundidad m	Profundidad ft	Distribucion Casing		Duracion Bombeo	Nivel Estático (m)	Q gpm	Q l/s	T°C	T gpd/ft	T m^3/hr/m	Conductividad µmho/cm	Obser
ES-10	518	1700	0 - 220'	8" casing	7 hrs.	0.0	70	4.4	35	130	0.7	1.580	Fluyen 4 gp
			220 - 240'	8" scree									
			240 - 340'	8" casing									
			340 - 400'	8" screen									
			400 - 460'	8" casing									
			460 - 500'	8" screen									
			500 - 800'	8" casing									
			800 - 900'	8" screen									
			900 - 940'	8" blank									
			940 - 980'	8" screen									
			980 -1020'	8" blank									
			1020 -1060'	8" screen									
			1060 -1100'	8" blank									
			1100- 1140'	8" screen									
			1140 -1180'	8" blank									
			1180 -1200'	8" screen									
			1200 -1240'	8" blank									
			1240 -1300'	8" screen									
			1300 -1320'	8" blank									
			1320 -1340'	8" screen									
			1340 -1360'	8" blank									
			1360 -1380'	8" screen									
			1380 -1400'	8" blank									
			1400 -1440'	8" screen									
ES-11	361	1185	0 - 110'	8" blank	7 hrs	17.39	37	2.3	15			2.460	SA-5
			110 - 180'	8" slotted									
			180 - 275'	6" screen									
ES-13	288	945	0 - 640'	8" blank	8,5 hrs	43.21	234	14.8	19	1.200	6.2	25.000	
			640 - 880'	8" screen									
			880 - 900'	8" blank									
ES-14	147	483	0 - 80'	8" blank		16.14	80	5.0	13	1.260	6.6	9.000	
			90 - 350'	6" screen									

BLA[illegible] [illegible]UM[illegible] [illegible]ZOS [illegible] PR[illegible] D[illegible]MBE[illegible] R A[illegible]IFT

Pozo Nº	Profundidad m	Profundidad ft	Distribucion Casing		Duracion Bombeo	Nivel Estático (m)	Q gpm	Q l/s	T°C	T gpd/ft	T $m^3/hr/m$	Conductividad µmho/cm	Obser
ES-16	268	880	0 - 100'	8" blank	6.5 hrs	16.33	352	22.2	17	8.530	44.3	2.100	
			100 - 120'	8" screen									
			120 - 140'	8" blank									
			140 - 160'	8" screen									
			160 - 180'	8" blank									
			180 - 240'	8" screen									
			240 - 260'	8" blank									
			260 - 280'	8" screen									
			280 - 300'	8" blank									
			300 - 320'	8" screen									
			320 - 340'	8" blank									
			340 - 360'	8" screen									
			360 - 380'	8" blank									
			380 - 520'	8" screen									
			520 - 560'	8" blank									
			560 - 580'	8" screen									
			580 - 620'	8" blank									
			620 - 720'	8" screen									
			720 - 740'	8" blank									
ES-17	326	1070	0 - 460'	8" blank	7 hrs	75.77	136	8.6	19	900	4.5	9.500	
			460 - 840'	8" screen									
			840 - 860'	8" blank									
ES-19	335	1100	0 - 160'	8" blank	3.25 hrs	143(?)	41	2.6	17	220	1.1	3.558	
			160 - 180'	8" screen									
			180 - 200'	8" blank									
			200 - 220'	8" screen									
			220 - 240'	8" blank									
			240 - 260'	8" screen									
			260 - 280'	8" blank									
			280 - 300'	8" screen									
			300 - 320'	8" blank									
			320 - 360'	8" screen									
			360 - 580'	8" blank									
			580 - 600'	8" screen									
			600 - 620'	8" blank									
			620 - 640'	8" screen									
			640 - 680'	8" blank									
			680 - 740'	8" screen									
			740 - 760'	8" blank									

TABLA 1.3 RESUMEN POZOS CON PRUEBA DE BOMBEO POR AIR-LIFT

Pozo Nº	Profundidad m	Profundidad ft	Distribucion Casing	Duracion Bombeo	Nivel Estático (m)	Q gpm	Q l/s	T°C	T gpd/ft	T m^3/hr/m	Conductividad µmho/cm	Observ
ES-22	366	1200	0 - 200' 8" blank 200 - 280' 8" screen 280 - 300' 8" blank 300 - 340' 8" screen 340 - 360' 8" blank 360 - 400' 8" screen 400 - 440' 8" blank 440 - 500' 8" screen 500 - 520' 8" blank 520 - 540' 8" screen 540 - 560' 8" blank 560 - 600' 8" screen 600 - 620' 8" blank 620 - 640' 8" screen 640 - 660' 8" blank 660 - 680' 8" screen 680 - 700' 8" blank 700 - 740' 8" screen	5 hrs	96.34	352	22.2	17	1.000	5.2	4.200	
ES-24	259	850	0 - 380' 8" blank 380 - 520' 8" screen 520 - 540' 8" blank	8 hrs	0.0	10	0.6	2.5	7.6	--	1.600	Artesian
ES-28A	313	1028	0 - 300' 8" blank 300 - 585' 8" screen	8 hrs	65.70	401	25.3	23	25.143	130.7	10.000	
ES-38	183	600	0 - 240' 8" blank 240 - 380' 8" screen 380 - 400' 8" blank	7 hrs	70.53	90	5.7	17	14.000	72.8	21.000 a 85.000	
ES-40	219	720	0 - 160' 8" blank 160 - 560' 8" screen 560 - 580' 8" blank	8 hrs	39.36	510	32.2	21	11.400	59.3	50.000	
ES- 46	280	920	0 - 20' 10" blank 20 - 436.8' 8" blank 436.8- 721.5' 8" screen 721.5- 800' 8" blank	5 hrs	126.25	111	7.0	23	--	--	81.000	

TABLA 1.3 RESUMEN POZOS CON PRUEBA DE BOMBEO POR AIR-LIFT

Pozo Nº	Profundidad m	Profundidad ft	Distribucion Casing	Duracion Bombeo	Nivel Estático (m)	Q gpm	Q l/s	T°C	T gpd/ft	T m^3/hr/m	Conductividad µmho/cm	Observac
ES-50	165	640	0 -160' 8" blank 160 - 292' 8" screen 292 - 312' 8" balnk	8 hrs	39.30	301	19.0	15	30.634	159.5	1.600	
ES-54A	104	460	0 - 200' 6" blank 200 - 400' 6" screen	8 hrs	7.12	395	24.9	15.5	27.442	142.7	1.200 1.100	
ES-57	262	860	0 - 320' 8" blank 320 - 360' 8" screen 360 - 380' 8" blank 380 - 440' 8" screen 440 - 460' 8" blank 460 - 480' 8" screen 480 - 500' 8" blank 500 - 520' 8" screen 520 - 560' 8" blank	8 hrs	46.61	29	1.8	21.5	2.444	12.7	1.500	
ES-58	165	540	0 - 160' 8" blank 160 - 280' 8" screen 280 - 300' 8" blank	8 hrs	54..00	135	8.5	20.5	81.000	421.2	13.000	

TABLA 1.4 POZOS DE PRODUCCION

CARACTERISTICAS FISICAS

Pozo	Coordenadas, m			Profundidad		Nivel featico, m	
	Latitud	Longitud	Cota	m.	ft.	m.b.p.m.	Cota
T- 1	7284.703	513.023	3033,15	186,7	612	67.20	2965.95
T- 2	7307.628	514.024	3016,45	107.4	352	37,86	2978.59
T- 3	7302.036	511.847	2985,44	128.1	420	8.16	2977.28
T- 4	7295.288	514.785	3039,26	189.1	620	65.75	2973.51
T- 5	7258.135	502.077	3088,28	204.4	670	124.97	2963.31

CARACTERISTICAS HIDROLOGICAS

Pozo Nº	Gasto		Transmisividad		Coeficiente Almacenaje
	l/s	g.p.m.	m^3/hora/m	g.p.d./pie	
T- 1	36	570	104	20.000	0.13
T- 2	32	510	95.7	18.400	0.08
T- 3	32	510	117.5	22.600	4×10^{-4}
T- 4	30	475	114.9	22.100	0.20
T- 5	19	300	83.2	16.000	0.10

CALIDAD DE AGUA

Pozo Nº	Salinidad, mg/l	Conductividad, µmhos/cm	Relacion vertical/ Conductividad horizonal Kv/Kh
T- 1	6000	8200/8260	1/7
T- 2	700	953/1020	1/13
T- 3	1200	1790/1800	1/10
T- 4	1850	2350/1400	1/10
T- 5	7500	10540/11630	1/100

SECTION 2.0

GROUNDWATER EXPLORATION REPORT

DIRECCION GENERAL DE AGUAS
Centro de Información Recursos Hídricos
Área de Documentación

MINERA UTAH DE CHILE INC.
APRIL, 1984

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SUMMARY

An extensive program of groundwater exploration and testing was carried out over the period February, 1982 to February, 1984. This program was centered in the Punta Negra basin, a large topographically closed depression located about 25 Km (16 mi) east of the Escondida Project site.

Exploration phase activity accounted for the drilling of 53 boreholes totaling 13,474 m(44,196 ft) of these, 22 were developed as exploration air-lift pump test wells. Exploration phase activity was completed in August, 1983.

The program of exploration located a productive aquifer in alluvial sediments. This aquifer was tested with 5 production design wells during the period September, 1983 through February, 1984. This testing program accounted for a total of 1942 m (6,370 ft) of drilling in 12 boreholes.

A production scale testing program confirmed the existence of a productive aquifer which would economically meet project water requirements. These requirements are a minimum 30 year supply at an average rate of 404 l/s (6400 gpm) with a peaking demand of up to two years at 681 l/s (10,800 gpm).

Based upon hydrological information gained from exploration and testing programs, a conceptual well field will be designed. Wells would be constructed in essentially the same design as the test wells.

Approximatley 70% of project water will come from the depletion of stored water (water mining). Over a 30 year life, this will be a fraction of available stored water and will result in tolerable drawdowns in the production wells.

Water quality will be acceptable for industrial processes. The water will contain a concentration of total dissolved solids (TDS) of no greater than 6,000 mg/l (ppm). There will be no significant variation in water quality over a 30 year life at the required pumping rate.

1.0 REGIONAL WATER RESOURCES

The Escondida Project is located in the Atacama Dessert of northern Chile. This desert extends from the Pacific Ocean inland to the Andes Mountains along Chile's border with Argentina and Bolivia throughout the northern third of the country. The project is immediately west of two undrained topographic basins, Salar de Punta Negra and Salar de Imilac, in the east-central part of the Antofagasta Province. The project site is at an elevation of 3,000 meters (9,840 feet) and is not inhabited due to a lack of water. The Salar de Atacama, which is located to the northeast of the project, does have a sparse population due to small surface water inflows from the Andes.

1.1 Climate

The Atacama Desert is one of the most arid in the world. From the coast to elevations of 2,000 meters (6,560 feet), rainfall averages less than 1 millimeter per year with long periods of no rainfall being quite common. Generally, rainfall occurrence and magnitude is directly related to an area's location relative to the Andes. Most of the precipitation that does occur takes place during the summer months of December to March as a result of moisture-laden air masses passing over the Andes from the jungles of Argentina. While most of this moisture falls on the Andes, some reaches the area immediately to the west of the mountains. Precipitation in these high plains (elevation: 4,000 meters, 13,120 feet or more) can average as much as 500 millimeters (20 inches)per year.

The project site is situated some 40 kilometers (25 miles) to the west of the puna area and as a result receives very little of this rainfall. Precipitation data from the nearest meteorological station at Imilac suggests an expected annual average of only 5 millimeters (0.2 inches) per year. Stations located closer to the puna (e.g., the stations in Socaire and Toconao along the eastern edge of the Salar de Atacama) generally average ten times this amount.

Evaporation is high throughout this region, due to the lack of ground and cloud cover and amount of wind, and easily exceeds the available precipitation. The evaporation rate at Chuquicamata (3,100 meters, 10,168 feet elevation) is reported to be 1 cm/day (0.4 in). Temperatures variation can range up to 30°C (59°F) on a daily basis. Summertime maximums at the project site average about 40°C (104°F), while winter temperatures values are roughly 15°C (27°F) lower. Winds can be very strong during the winter months with gusts of 150 kilometers per hour (93 miles per hour) being not uncommon. Generally, winds are lightest in the morning and attain considerable force by afternoon throughout the year. Prevailing winds are from the west.

1.2 Hydrology

The general absence of precipitation in this region has a large impact on its hydrology. Surface waters are scarce with only three permanent river systems flowing within the desert: the Rio Loa, the Rio Grande, and the Rio Vilama. The Grande and Vilama disappear into the northern end of the Salar de Atacama after giving up most of their flow to irrigation in the San Pedro de Atacama area. The Rio Loa, which flows through Calama, actually reaches the Pacific but only after great reduction of its flow volume through various municipal and industrial diversions. The only untapped rivers are located in the more remote mountain areas. The two closest to the project, the Rio Quepiaco and Rio Zapaleri, are immediately northeast of the Salar de Atacama and empty into closed basins. All of these rivers are over 100 kilometers (62 miles) away from the project site (section 2.12).

Although groundwater is much more prevalent throughout this region, the quantities available varies considerably from place to place due to changes in local geology and distance from sources of recharge. Closed basins, such as Salar de Punta Negra, serve as the primary receptacles for groundwater storage through out this region. The amount of water in storage depends directly on the size of the basin and the relative coarseness of the sediments that fill it. Since groundwater recharge occurs primarily in the puna area, proximity to the puna and presence of geologic formation capable of carrying recharge waters down to the salars is of greatest importance. Groundwater exploration has yet to occur on a large scale.

2.0 GROUNDWATER EXPLORATION

2.1 Introduction

The Escondida project site is located in the Atacama desert, a region noted for scarce precipitation and limited surficial waters. Known water sources (section 1.0) in the region consist almost entirely of surficial flows eminating from the Andes mountains. As known sources of notable quantity are nearly fully utilized at the present time, the project was forced to turn to groundwater for its water resource.

There is very little utilization of groundwater in the region, and the body of existing knowledge regarding groundwater resources is contained in a study conducted under the auspicies of the U.N. in the 1970's [9]. For these reasons, the identification of a groundwater resource required an extensive exploration program. This program was centered on the Punta Negra basin to the east of Escondida and was carried out between Feb, 1982 and August, 1983.

2.1.1 Exploration program history

The need to conduct groundwater exploration was recognized immediately following discovery at Escondida. A preliminary field reconnaissance was carried out on May 25-31, 1981 by consultant John W. Harshbarger and a report issued June 18 [8]. The report concluded that the Salar de Punta Negra basin (Exhibit 2.1) provided the best potential for industrial scale groundwater development in the area and recommended that geological mapping, gravity geophysical surveying and exploration drilling of four wells be carried out in the Punta Negra basin. In addition, one hole was recommended for the Hamburgo basin for temporary water supply.

A gravity and magnetic survey was conducted in the Punta Negra basin during the period September 3-11, 1981 by Robert E. West, geophysicist for Mining Geophysical Surveys, Inc. of Tucson, Arizona. A report was issued December 9, 1981 [13 a]. The report concluded that a deep alluvial basin exists with bedrock depths of up to 1500 meters (5000 ft). The report also concluded that the bedrock surface was structurally controlled with the deepest portion occurring several kilometers to the east of the topographic low axis.

Preparations were completed for initial exploration drilling upon a Water Department resolution granting water exploration concessions on February 4, 1982. Drilling commenced on March 4, 1982 on exploration well ES-1, located in the Salar de Hamburgo. Subsequently, wells ES-2 through 5 were drilled at the four sites recommended by Mr. Harshbarger in the Punta Negra basin. Additionally, 30 boreholes of approximately 30 meters each were constructed to complete assesment requirements of the water exploration concessions. The "pilot" drilling program was completed May 13, 1982. A report was issued July 29, 1982 by Hargis and Montgomery, Inc. [7 a]. This report concluded that a very large water resource existed in the form of a groundwater reservoir stored within thick alluvial sediments and that sufficient permeability existed for economical exploitation. A program of additional exploration drilling and geological mapping was recommended.

Preliminary geological mapping of the Punta Negra basin was completed in July, 1983 by consultant Floreal García A. This mapping indicated that potentially permeable gravels existed in the northern part of the basin (Salar de Imilac) and it was decided to extend gravity survey work into this area. Three traverses of the basin were completed in the northern and two in the southern parts of the basin during the period October 8-21, 1982 by Robert E. West, geophysisist for Mining Geophysical Surveys. A report was issued on January 3, 1983 [13 b] which included a reinterpretation of the previous work in light of drilling results. The report concluded that the structural depression previously detected in the central Punta Negra basin extends through the Imilac Salar to the north where it is narrower and deeper.

Additional geological work was undertaken in August and September by consultant Lawrence H. Lattman. After examination of satellite imagery and stereographic air-photo coverage, field reconnaissance was completed during the period September 4-12, 1982. Nine exploration well locations were recommended [12]. These were located at fracture trace intersections in the east-central Punta Negra and Salar de Pajonales basins. As these sites were outside existing exploration concession areas, an additional concession was applied for. Exploration drilling operations commenced November 1, 1982. During the course of the drilling program, 6 "target areas" were defined and drilled within the basin (section 2.1.2). These were drilled as follows: "East Llullaillaco" area November 1, 1982-January 15, 1983 (ES-6 through 10); "Imilac" January 15-April 26, 1983 (ES-11 through 22); "Burried Ignimbrite" April 26, 1983-May 26, 1983 (ES-23 through 27); "ES-5 area" May-26-July 7,1983

(ES-28 through 37) "South Basin" area July 7-August 6, 1983 (ES-38 through 47); "ES-5" area August 6-15, 1983 (ES-48, 49); "Domeyko Sediments" August 15-29, 1983 (ES-50 through 53). In June, 1983 Dr. David Todd visited the area and issued a summary report in July [18 a]. This report recommended a testing program of several production design wells.

With the completion of hole 53 at the end of August, the exploration drilling phase was complete. From August 30 to November 1, drilling continued with the construction of production test wells (T-1 through T-5) as well as additional observation and aquifer definition wells (ES-54 through 60).

Production testing was carried out from October 8, 1983 through February 17, 1984 (section 3.1). This program was completed in conjunction with hydrological studies. (18 b, c, d, e, f).

2.1.2 Exploration target areas

Punta Negra basin

Within the Punta Negra basin, six target areas were explored by drilling. The "target" in each case was one or more geological conditions.

The "East Llullaillaco" area was targeted for a) coarsening of sediments upstream of the ES-2 through ES-5 wells, b) sediments made permeable by fracturing (the wells were placed on fracture trace intersections) and c) buried, fractured ignimbritic volcanic rocks expected to have a high permeability. This area was also expected to have a relatively high recharge. Drilling encountered a thin artesian aquifer with low transmissivity.

Drilling failed to encounter coarser sediments or sediments made permeable by fracturing. In fact, sediments encountered were very low permeability. An ignimbrite was drilled but was very thin.

The "Imilac" area was drilled to test coarse conglomerate deposits which outcrop in the area. Although relatively good permeability was encountered in some areas, the geological variability of the area made it impossible to define an area large enough for commercial scale development.

The "Buried Ignimbrite" target was drilled along the eastern margin of the basin looking for a thick, fractured ignimbrite (such formations have proven very productive in Chile). None of adequate thickness was found.

The "ES-5" area was drilled to more accurately define a section of moderate permeability sands discovered in well ES-5. This area proved to have a general N-S trend and to be large enough to be commercially developed. Transmissivities are moderate (180 to 250 m^2/day, 15,000 to 20,000 gpd/ft) and salinity ranges between 1700 and 6000 mg/l TDS.

The "South Basin" was drilled in search of alluvial sands which would have been deposited in an ancient river bed flowing from the south of the basin (Rio Frio). A broad area of relatively clean sands of moderate transmissivity was found. This area, however, was found to receive very little recharge. Because of this, water quality is highly dependant upon depth and proximity to the salar (section 2.2.7). The area appears to be commercially viable but suffers due to distance to the project site.

The "Domeyko Sediments" target was drilled to investigate the existance of a different character of alluvial sediment derived from the mountains bordering the basin to the west (all previous drilling had been targeted on sediments derived from the volcanic area to the east except the Imilac area conglomerates of unknown derivation). This target lay directly below salt formation and clay of the northern extension of the salar. The target was located and determined to be of moderately high transmissivity (230 to 280 m^2/day, 18,000-22,000 gpd/ft) and good water quality (700-1200 mg/l TDS). This area appears to have the best development potential owing to transmissivity, quality of water and proximity to the project site.

2.1.3 GROUNDWATER EXPLORATION CONCESSIONS

Groundwater exploration in Chile requires an exploration concessions. Over the life of the exploration program, 2 exploration concessions were held in the Punta Negra-Hamburgo areas.

A resolution was passed granting groundwater exploration concession to Minera Utah de Chile Inc. over a 370,000 hectares (1429 mi^2) area in February, 1982. This concession consisted of 74 rectangular areas of 5000 ha (19 mi^2) each. By Chilean law, the holder of a concession must demonstrate that exploration has begun within 6 months of the resolution. To fullfill this obligation, drilling was performed on 35 of the rectangles and a report was filed in June, 1982. This reduced the concession to an overall area of 175,000 ha (676 mi^2) (Resols DGA Nº 38, 1982 and Nº 47, 1983).

A second resolution was passed granting Minera Utah de Chile Inc. an exploration concession for an area of 190,000 ha (734 mi^2) in May, 1983. Because of changes in the law, it was not necessary to drill as extensively to hold this large area and a report was filed in October, 1983 retaining exploration rights, bringing the total area under concession to 365,000 ha (1409 mi^2) (Resol Nº 139, 1983).

Both concessions were valid for a period of two years from the date of resolution.

2.1.4 Groundwater exploration methods

Pre-drilling

Definition of drilling target was aided by geological mapping and geophysical prospecting techniques.

Geological mapping was carried out on bedrock exposures surrounding the Punta Negra Basin as well as sedimentary deposits exposed in the deep ravines on the east side of the salar and conglomerate outcrops in the Imilac area (section 2.2.3). This work was useful in estimating depth to bedrock and depositional environment of the targeted units.

Gravity geophysical surveys were employed in conjunction with geological mapping and early drilling results to approximate depth to bedrock. A total of 9 cross sectional traverses were completed with line separation of 5 to 20 Km (3-12 mi) with stations at ½ Km (1640 ft) spacings. A total of 355 Km (220 mi) of traverse was completed in this fashion [13]. In addition, magnetic and electromagnetic geophysical methods were tested for detection of saturated fracture zones acting as conductors. These methods did not prove usefull [5].

Drilling and logging

Because of the large area being investigated and the lack of knowledge of the stratigraphy within the basin, it was decided to emphasize geological interpretation in the drilling program. Thus a pattern arrangement of test wells was not employed in favor of a more interactive process of drilling, geological interpretation and well testing.

Drilling was carried out using a Gardner Denver 2000 rotary drill. In most cases, a 15 cm (6 inch) hole was started using DTH (down-the-hole) air hammer method. Upon reaching water level, in most cases the hole became unstable (caving) and a change was made to conventional mud-rotary techniques employing bentonite mud.

Drill cuttings were collected at 6 meter (20 ft) intervals and logged by a geologist. Cuttings were also subjected to sieve analysis in selected zones.

Upon completion of a hole, well logging was conducted. Well logs employed included 16 inch normal resistivity/spontaneous potential; neutron density/natural gamma; temperature and temperature differential; and caliper profiles.

The geologist in charge utilized these logs as well as the geological log of drill cuttings to decide if the hole should be pump tested. About 30% of the time, it was decided to test the well.

Test well construction was carried out by first reaming the pilot hole to 25 cm (9 7/8 inch) diameter. This was done using conventional mud-rotary techniques employing an organic based degradable drilling mud. Upon completion of reaming operations, 20 cm (8 inch) ID casing was lowered into the hole with desired sections screened for testing. Screens were wire wrap type with

1 mm (.040 inch) slot openings. With casing and screens in place the well was naturally developed (no gravel pack) by first chemically degrading the mud wall cake and then air jetting the screens.

Testing was completed by pumping the well using the air-lift method. Drill rods were lowered to the bottom of the well (without the bit). Air was supplied from an 1150 cfm/250 psi Ingrersoll Rand compressor (also used in drilling). Pumping was done for an 8 hour period during which flow was monitored using a 90° V-notch wier and specific conductivity was recorded. After pumping was stopped, recovery of the well was measured using an electrical sounder. Recovery was recorded for a minimum of 8 hours on a logarithmic (decreasing frequency) basis.

Post drilling

Water samples collected during testing were sent for chemical analysis of 22 cations and anions plus pH, TDS (total dissolved solids) and specific conductivity. After testing, water samples were collected from selected wells using a special sampling tool which can be opened at a selected depth. This sampling allowed a salinity profile to be determined.

Analysis of recovery measurement was done in the field and checked by company hydrologists in the United States. The analysis provided guideline values of transmissivity for the well.

Monitoring of water level inside the wells has been carried out on an occasional basis. This has been done using electrical sounders.

2.1.5 Program statistics

Well locations are shown in Exhibit 2.2 A summary of this drilling is as follows:

Exploration "ES" wells

Number of wells:	53 (ES-1 through 53)
Air lift tests :	22
Total drilling :	13,474 m (44,196 ft)
Total casing :	4,661 m (15,287 ft)

Concession assesment "S" wells

Number of wells:		30
Air lift tests	:	0
Total drilling	:	712 m (2,336 ft)
Total casing	:	0

Production test observation and definition "ES" wells

Number of wells:		7 (ES-54 through 60)
Air lift tests	:	4
Total drilling	:	1,122 m (3,680 ft)
Total casing	:	521 m (1,710 ft)

Production test "T" wells

Number of wells:		5
Cumulative days pumping	:	105
Total drilling	:	820 m (2,690 ft)
Total casing	:	806 m (2,643 ft)

2.2 Punta Negra Basin

The Salar de Punta Negra Basin was identified at an early stage as offering the best potential for groundwater development in conjunction with the Escondida Project. For this reason the majority of investigative work has gone into this area.

2.2.1 Climate and physiography

The Salar de Punta Negra Basin (Exhibit 2.1) lies to the east of Escondida at a minimum distance of approximately 20 kilometers (12 miles). The basin is a closed topographic depression with a north-northeast trending central axis approximately 150 kilometers (93 miles) long and with an average width of about 45 kilometers (28 miles). The western border of the basin is formed by the Cordillera de Domeyko which reaches a maximum elevation of approximately 4050 meters (13,300 ft) in the Sierra de Varas at the southern end of the basin. The eastern border is formed by a series of volcanoes and uplifted granitic rocks of the Cordillera de Los Andes, dominated by the peak of Volcán Llullaillaco, 6723 meters (22,057 ft).

The basin floor lies at an average elevation of about 3000 meters (9,800 ft) and includes two salars. The salars are flat dry lakebeds with surfaces of salt and clay. The Salar de Punta Negra

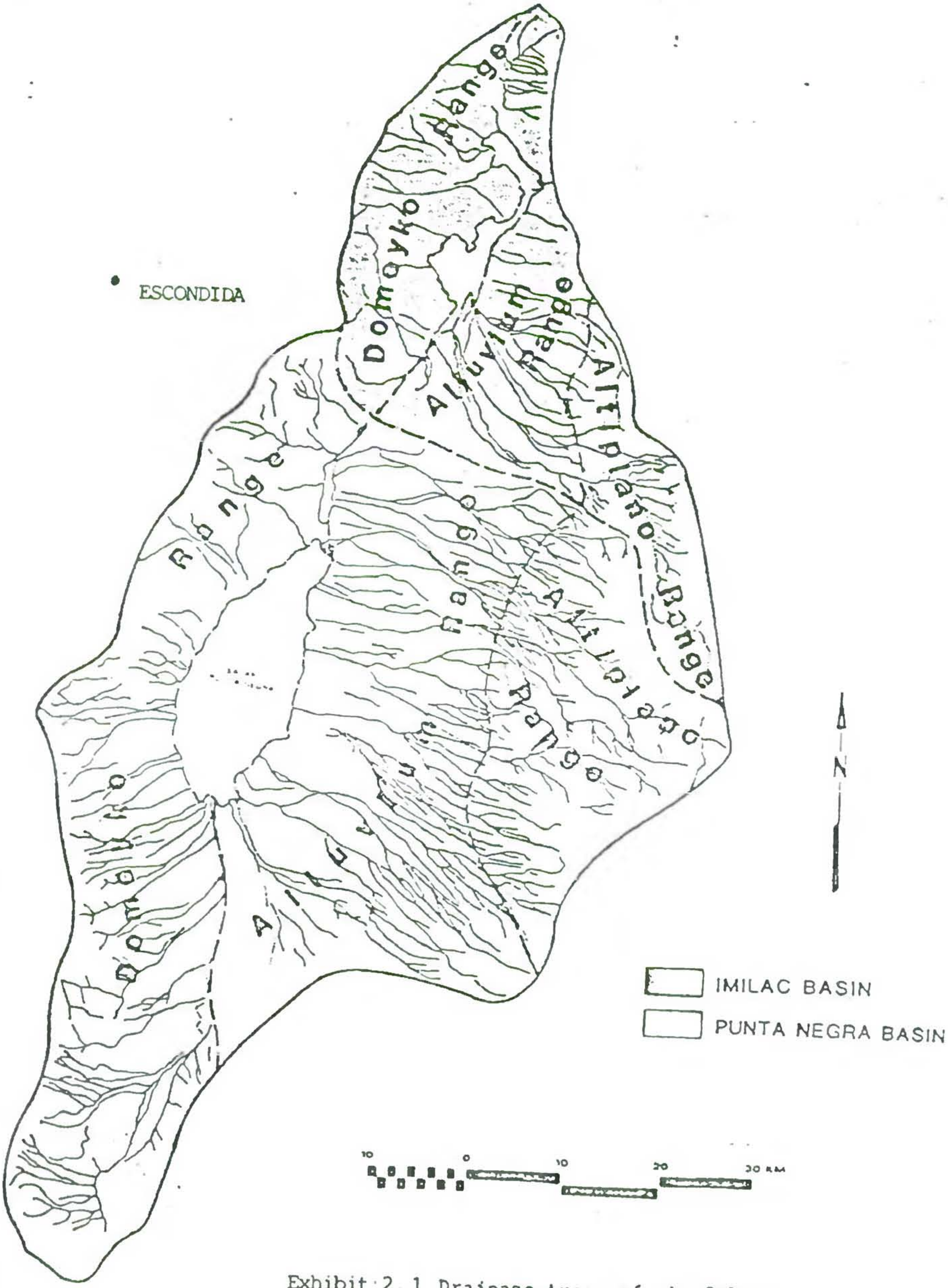

Exhibit 2.1 Drainage Areas of the Salares de Punta Negra and Imilac (after Krishnamurthi).

is the larger and has a surficial area of 256 Km^2 (100 mi^2) and is ringed by small salt marshes. The Salar de Imilac to the north covers 20 Km^2 (8 mi^2) [17]. Both salars have minimum elevations of about 2945 meters (9662 ft).

Access to the basin from the Hamburgo basin (Escondida area) is by way of a 3314 meter (10,873 ft) pass to the southeast and by the Imilac pass (3216 m, 10,551 ft) to the east. The Punta Negra basin adjoins the Atacama basin to the north by way of a 2996 meter (9829 ft) pass at Pan de Azucar which is the lowest point of the drainage divide.

The Punta Negra basin, as is typical of the desert region, is extremely arid with vegetation generally lacking and scarce precipitation. However, the mountainous area bordering the basin on the east does receive some precipitation which is estimated to average 400 mm (15.7 in) per year above 4000 meters (13,120 ft) elevation [5, 9,11]. Vegetation exists as small plants living in drainage channels above 3400 meters (11,150 ft) and grasses living in salt marshes bordering the salars.

Precipitation occurs as infrequent winter snowstorms at the high elevations and, to a greater extent as summer rain/snow showers. The later, known as "Bolivian Winter" are common occurrences above 4000 meters and infrequently extend to the lower slopes. Temperature ranges depend greatly on elevation. Maximum summertime temperatures at the salar elevations are near 40° C (104° F) while nighttime temperatures can reach freezing. Winter temperatures average 15° lower. Windy conditions are common in the winter months with afternoon west winds occurring daily and occasional strong winds up to 100 Km/hr (62 mph) occurring with winter storms.

2.2.2 Geological setting

The Salar de Punta Negra basin is a structural graben formed by extensional faulting between the Domeyko range on the west and the Andes on the east. The Domeyko range is of pre-Andean age consisting mainly of folded Jurassic and Cretaceous marine sediments, intrusive and volcanic rocks. The Andes consist principally of Jurassic to Quaternary volcanic rocks although older (pre-Cambrian?) bedrock is exposed along the western margin. The graben is filled up by Tertiary and Quaternary alluvial sediments consisting principally of playa deposits and fanglomerates. These sediments obsure most of the major structural features forming the basin. The geological map of the Punta Negra Basin is shown in Exhibit 2.3 and a generalized cross section A-A' in Exhibit 2.4.

2.2.3 Sedimentary and volcanic sequence

Sedimentary and volcanic rocks filling the Punta Negra basin are of principal interest as these act as conduits and reservoirs of groundwater. Bedrock areas act principally as barriers to groundwater flow and as source areas for basin filling sediments. In this respect, bedrock geology has not been investigated in detail. References treating bedrock geology include [2], [16].

Detailed work on the stratigraphic sequence for various parts of the basin have been carried out by Vila [19 a, b] and by Mongard [14]. This work has shown that lateral variation in all sedimentary and volcanic units is the rule. In this sense, broad correlation is lacking. Nonetheless, vertical spacial relationships between units have been defined for each area explored and relative temporal relationships established. A description of the major sedimentary units, from youngest to oldest, follows.

Evaporite deposits

Evaporite deposits are well developed on the Salar de Punta Negra and to a lesser extent on the Salar de Imilac surfaces. In the Salar de Punta Negra, three different sub units have been differentiated [19 b].

An assymetrically distributed outer rim sub unit exists with a variable width of 2-3 Km (1-2 mi) along the eastern border and 200-300 m (650-980 ft) along the western one. This outer rim corresponds to a very newly formed, hummocky, white, thin (.1-.3 m, .3-1 ft) salt crust developed over thick (3 m, 10 ft minimum) brown to dark red plastic clay layers. The surficial crust is developed by the precipitation of dissolved salts as groundwater reaches the surface by capillary movement and is evaporated. This crust is composed chiefly of gypsum and halite mixed with subordinate ulexite and some wind-borne clays. Toward the center of the salar, halite proportion increases.

Perennial, shallow streams flow from salt marsh springs at the border of the salar toward the central nucleous. Salinity in these streams increases toward the salar nucleous.

This outer rim is a relatively dynamic unit, with a slow but constant vertical (and lateral?) growth of the salt crust. Other salt deposits in Chile have been reported with growth rates of 5 mm (1/4 inch) per year. The width of this active rim appears to be directly related to the amount of evaporation, and therefore recharge occurring in the particular area. The fact that this rim is ten times as wide on the east as on the west indicates a similar proportion of recharge from east and west.

A central nucleous sub unit exists of crystalline halite. The unit is of unknown thickness. The surface elevation is about 1 meter (3.3 ft) above the surrounding rim, which at the border of the nucleous forms a shallow brine "moat". The central nucleous occurs only in the Salar de Punta Negra. It appears to be a "fossil" salt crust which is not actively growing but may in fact be dissolving.

The third sub unit is a "dry lake" extending from the northern part of the Punta Negra Salar for about 10 Km (6 mi) and also exists in the eastern Imilac Salar. The dry lake consists of dried muds and clays with abundant gypsum.

Recent alluvial deposits

Recent outwash deposits cover most of the basin between bedrock outcrops around the border and evaporite deposits at the basin center. These deposits consist of unconsolidated silts, sands and gravels deposited by occasional channel flow and flash-flood conditions. Due to the arid conditions there is no development of sorted sand deposits or soil.

Lacustrine deposits

Local lacustrine deposits are present near the southeast and northern margins of the basin. These deposits appear to be related to structural features along which they occur. The deposits are composed of arenaceous sediments, strongly compacted and cemented by a calcareous cement, with intercalated lenses and thin layers (9.2-0.5 m) of well crystallized yellow travertine (aragonite). The base of this unit corresponds to a polimictic sedimentary breccia (1-2 m thick), with angular fragments of rhyolite and reworked calcareous fragments, showing an incipient NNW-SSE imbrication. In the southeast area these lacustrine sediments overlie the Upper Tuff unit with an erosional unconformity, showing a N-S to N60°W strike with variable inclination (20-40°) N or E.

The presence of extremely well crystallized acicular aragonite crystal layers suggests a shallow litoral lacustrine environment, with intense geothermal springs water activity.

Andesitic-basaltic volcanic deposits

Recent (Plio-Pleistocene) volcanic deposits are present as effusions from the Tocomar volcano, to the south of the Llullaillaco volcano. These deposits consist primarily of aglomerates of andesitic composition.

Young basalt flows are present as effusions from the crater of the Llullaillaco volcano and as fissure flows in the Quebrada Gentilar to the north and Cerro Punta Negra to the east of the volcano. The later extends from 11 kilometers (7 mi) to the east of the Punta Negra Salar to the salar edge, lying directly upon alluvial sediments. This unit gives the salar its name, which means "black point". These rocks overly the Upper Tuff unit or directly upon older alluvium.

Upper Tuff

A volcanic unit crops out at the very upper part of the Barrancas Blancas cliff, where it forms a vertical, weather-resistant cornice approximately 50 m thick.

This unit extends to the north-northwest where it thins and eventually pinches out in the ravines east of the salar draining the Llullaillaco volcano.

In the Barrancas Blancas area this unit corresponds to a dark orange, very dense welded rhyolitic tuff (ignimbrite), with an approximately 10 m thick, black basal vitrophyric zone, probably representing a cooling unit. The contact between both sub-units appears relatively sharp.

The Upper Tuff unit was deposited in this area as a sub-aerial flow over a shallow lacustrine environment, which would explain the presence of such well defined basal cooling unit. The poorly welded Upper Tuff unit in the area west of volcán Lullaillaco represents a distal zone of the dense welded Upper Tuff.

In the southeast this unit shows a N-S to N-20° strike, dipping gently (5-10°) to the east. This inclination does not corresponds to the depositional one, and is probably the result of block tilting.

In the area west of volcan Llullaillaco it dips gently (5-10°) to the west.

Upper conglomerate

The best exposure of this unit crops out in the central course of the Quebrada Las Zorras, close to drillhole ES-24. In this area, the unit consists of weak to moderately consolidated, alternating dark brown-grayish lenticular, polimictic conglomerates and relatively more extensive and consolidated pale-brown tuffaceous, clay-silt rich sediment. Conglomerate lenses (0.5-3 m thick) show subangular to rounded clasts ranging in diameter from coarse sand to very coarse boulders in an arenaceous tuffaceous matrix (40% of the rock). Apparently there is an increase of the arenaceous matrix to the bottom of the unit. Imbrication of clasts, suggests a N20°-40°W flow direction.

The clay-silt rich consolidated sediments, (0.2-2 m thick) are more extensive and show thin laminations (1-5 mm), although some intercalated horizons of coarse rounded fragments may be present. A 0.3-0.5 m thick layer of very coarse boulders at the top of each clay-silt layer is a common feature. These same boulder layers sometimes appear restricted to shallow (1-2 m) paleochannels developed over the clay-silt layers. An examination of the sedimentary facies along the Quebrada Las Zorras, shows clearly the presence of a coarse grained, clast supported conglomerate of high energy facies in the central course of the ravine, extending approximately 1.000 m to the E and W of drillhole ES-24. To the east and west (?) the facies change progressively to low energy, muddy matrix supported gravel facies and finally to laminated silt-clay facies. Only silt-clay layers appear moderately fractured (vertical fractures) which are interpreted as dessication cracks.

This unit corresponds temporally with sediments hosting aquifers throughout the basin. In the area along the eastern slopes of the basin (ES-3 to ES-9) the unit is characterized by a thick sequence of poorly sorted sands and silts, underlain by a thick red clay unit which is tentatively correlated (temporally) with the lower tuff unit.

In the western part of the basin, this unit probably corresponds temporally with sandy sediments comprising the aquifers intersected between T-2 and San Carlos Well (in this area, a locally confining clay overlies the aquifer, probably corresponding to recent alluvial and evaporitic deposits).

In the Imilac area, correlation with this unit is more tenuous. However, a series of poorly sorted gravels with intercalated silt-clay units was drilled which overlies a well consolidated conglomerate, probably corresponding to the Lower Conglomerate.

Lower Tuff

This unit is a pink-orange colored, partial to dense welded tuff which is best exposed in Quebrada El Salado. In this area, at least four tuff layers can be distinguished, which from top to bottom are:

a) Poor to partial welded brown-grayish tuff, with increasing thickness from 20 to approximately 50 m in the middle course of the ravine.

b) Partial to dense welded light red tuff, of lenticular character. Its maximum thickness reaches 5 m, but in places tuff a overlies directly tuff c.

c) Dense welded dark red tuff. Variable thickness between 10-15 m.

d) Partial to dense welded pink tuff with variable thickness between 30-50 m. The contact between Tuff d and the Lower Conglomerate is characterized by a 2-5 cm thick dark red vithophyric horizon.

All those tuffs corresponds to subaerial deposited ash flows of rhyolitic to rhyodasitic composition with massive aspect, chaotic distribution of pumice and tuff fragments. Only the uppermost zone of the a layer shows inverse gradded bedding of subangular to tabular andesitic-rhyolitic fragments, whereas the lower layer shows disordered and incipiently imbricated clasts from the lower conglomerate unit. No crossbedding was seen in the tuff units.

Variation in thickness seems to be a result of the lenticular character of these tuffs, but in general there is an increase of thickness to the south and southeast. A N40°W oriented paleochannel developed over the Lower Conglomerates is responsible for the maximum thickness of the Lower Tuff unit in the Quebrada El Salado.

Lower Conglomerate

The best exposure of this unit crops out upstream of Quebradas Las Zorras, El Salado and El Salto. The Lower Conglomerate unit shows similar stratigraphic, sedimentary and compositional characteristics to the Upper Conglomerate except for a proportional increase in clay-silt stone layers and for an increase in compactation and cementation.

The Lower Conglomerate probably correlates temporarily with well consolidated conglomerates encountered in boreholes in the Imilac area. There the units are differentiated from younger Upper Conglomerate by relatively hard and slow drilling conditions. In the Imilac area, this well consolidated conglomerate may correlate with the Purilactis Formation [3] which crops out north of the Imilac area.

2.2.4 Structural geology

Basin structure is important to hydrogeology in that structural features control depth to bedrock and therefore the saturated thickness of water bearing sediments.

The regional structural style, as observed in the basin bordering mountains, is one of compresional tectonics (reverse and thrust faults, compressional folding). However, the basin itself appears to have resulted from extensional tectonics (normal and strike-slip faulting). Direct observation of these features is generally lacking throughout the basin due to recent sedimentary and volcanic cover.

Indirect evidence supporting extensional mechanisms includes gravity, drilling and surface morphological data.

Gravity geophysical surveys along with drilling data have been employed to define the gross features of bedrock morphology. These data indicate that a deep N-S trough exists in which have accumulated the lower density sediments [13 a,b].

Surface morphological features appear to correspond to some of the structural features indicated by gravity survey. Bedrock faulting appears to be indicated also by folding of overlying sedimentary and volcanic rocks. This is especially apparent on the east-central part of the basin where deep ravines have exposed folded conglomerates and volcanic tuffs corresponding to features interpreted as bedrock faults from the gravity work.

This evidence indicates that two main fault systems are present in the subsurface. A N-S system of normal faults of large displacement appears to be primarily responsible for basin development. A N50°W trending system is also present and appears to be primarily of right lateral strike slip displacement. The temporal relationship between the two systems is not completely understood but it appears that the two systems are either contemporaneous or the N-S system predates the N50°W system.

Since the gravity geophysical surveys were generally oriented E-W, the N-S system was much more clearly defined (although survey lines were 5-20 Km apart) than the N50°W system.

2.2.5 Aquifers

Three aquifers have been identified in the Punta Negra basin. These are, in order of importance, the Upper Conglomerate surrounding the Punta Negra Salar; the Upper Conglomerate surrounding the Imilac Salar and the Upper Conglomerate artesian zone to the east of the Punta Negra Salar at a distance of 7 to 15 Km.

The Upper Conglomerate surrounding the Imilac Salar is probably contemporaneous with the Upper Conglomerate surrounding the Punta Negra Salar (section 2.2.3). Drilling in the Imilac area identified a section of saturated, interbedded conglomerate and clay with low transmissivity. This area is characterized by rapid lateral facies variations and variable water quality. For this reason, and because the Imilac area receives a relatively small proportion of basin recharge, drilling was limited to 12 boreholes including 6 air lift tests (ES-11 through 22).

The Upper Conglomerate artesian aquifer is stratigraphically located at the base of the Upper Conglomerate unit, directly above the lower tuff. This aquifer has an identified aerial exent ranging from Quebrada de Las Zorras on the north to Cerro Punta Negra on the south. The western limit is defined by a topographic scarp corresponding to a monoclinal fold axis of the upper sedimentary and volcanic units and N-S normal faulting of the bedrock complex. The aquifer is thin, comprised of a zone of about 10 meters and is contained by very low permiability, clay rich conglomerates above and by the Lower Tuff below. This aquifer was drilled in 5 locations (ES-6, 7, 8, 10, 24) and air lift tested in 3.

Transmissivities are low in this aquifer owing to its limited thickness.

The Upper Conglomerate to the west of the topographic scarp, and surrounding the Punta Negra Salar on the north, east and south contains by far the greatest development potential. Although permeability and water quality are variable within this aquifer, lateral variations occur in a more predictable fashion than in the Imilac area. Transmissivities of test wells located in this aquifer are subtantially better than the other aquifers. For these reasons, only this aquifer has been seriously considered for development and subject to close hydrological examination.

The aquifer unit occurs within the upper 200 meters of sediments and is best identified by its lower boundary where a rather continuous thick clay unit begins. While the clay unit appears ubiquitous throughout the basin, the aquifer unit above is less predictable. The aquifer unit may consist of sands, sands and gravels, or tuffaceous sediments. The aquifer's lateral and vertical variability can be attributed to its origin as alluvial fan deposits which are related to the locations of past major drainage-ways.

The aquifer can be separated into two aerial zones of moderate transmissivity. These are the northern area extending from well T-2 at the north to well T-1 at the south and the southern area extending from ES-58 to T-5. These two zones are separated by a low transmissive zone around Cerro Punta Negra.

The saturated thickness of the aquifer is close to 112 meters at well T-1 decreasing to about 70 meters at T-2 in the northwest. At the southern end of the basin, the thickness is about 80 meters.

2.2.6 Groundwater movement

Groundwater level contours near Salar de Punta Negra are shown in Exhibit 2.5. It can be seen that all water converges toward the salar. No data are available on the western side of the salar, but it is reasonable to expect that groundwater inflow there is insignificant.

The average recharge rate of this area is about 510 l/s (8100 gpm) all of which appears to be released to the atmosphere by evaporation from the salar surface. With a salar area of about 240 Km^2, this amounts to an evaporation rate of 0.067 m/yr. This value is approximately 4 percent of the estimated water surface rate of 1.50 m/yr and is reasonable considering that most of the salar surface is covered by crystalline halite.

The movement of groundwater into the salar area is relatively slow. About 90 percent of recharge, some 460 l/s (7300 gpm) approaches the salar along a 32 Km (20 mi) eastern perimeter. With an estimated saturated thickness of 100 m (330 ft) and a porosity of 35 percent, the groundwater velocity equals 3.6 cm/day, or 13 m/yr.

This inflow means that the quantity of groundwater approaching the eastern side of the salar amounts to 1.5×10^{-2} l/s (0.23 gpm) per meter of salar perimeter. Thus, if pumping wells were spaced 500 m apart to intercept this flow, the recharge portion of yield would only be 115 gpm per well. It is apparent that groundwater development will require depletion of stored groundwater resource (water mining).

The water table is quite steep east of the topographic scarp and quite flat to the west. A steep water table normally implies a high resistance to flow and hence a formation with a low permeability, whereas a flat water table is the opposite. This appears to be the result of a lateral facies change from very poorly sorted (high clay content) to moderately sorted alluvial material.

The water table slope west of the topographic scarp approximates 0.006, while to the east the value is about 0.058 This suggests that the aquifer permeability west of the horst is roughly ten times greater than to the east.

2.2.7 Groundwater quality

Samples of groundwater have been obtained from test holes during pump testing and by selective sampling from various depths within the well. Results show that salinities, expressed as total dissolved solids, cover a wide range. Values reported in Salar de Punta Negra range from 450 mg/l to 114,600 mg/l.

The results of an extensive sampling and analysis demonstrates that the salinity of groundwater increases with distance from the salar, with depth and from north to south.

Water quality variations with depth and proximity to the salar result from density variations. Because saline water is denser than fresh water, salt water tends to underlie fresh water. Under static conditions a horizontal boundary, or interface, is formed with fresh water floating above salt water. For dynamic conditions where fresh water is flowing, the interface assumes a sloping position which is governed by the aquifer permeability, the density of salt water, and the rate of inflowing fresh water.

This condition is most apparent in the southern part of the basin (near well T-5). Here the small amount of recharge and the good permeability has resulted in a brine interface sloping gently away from the salar at an elevation of approximately 2950 meters to an elevation of 2875 meters at well T-5. Overlying this brine level is a wedge of relatively fresh water (approximately 6000 mg/l TDS) with a thickness of about 90 meters (290 ft) at well T-5 and apexing at the salar edge.

In the area between well T-2 and Abundancia well this effect is not observable in the wells. In the north at well T-2, excellent water quality (700 mg/l TDS) is present to the bottom of the aquifer. Since, in this area the bottom of the aquifer is defined by an impermeable clay layer, there does not exist a brine interface.

In the area to the east of the salar the brine interface appears to be very steep. This is due to the much larger recharge flux along this boundary than is found in the south.

Groundwater salinity of "fresh" water varies from a low in the north of 700 mg/l (T-2) to a high in the south of about 6000 mg/l (T-1 and T-5). This is believed to be due to variable salinity recharge. Because of the abundance of volcanic activity in the area, the dissolved solids in the "fresh" water are believed to derive from thermal spring activity rather than evaporation (water quality analysis, section 3 Table 3.1).

2.2.8 Groundwater storage

Estimates of the amount of groundwater in storage have ranged from 400×18^8 m^3 to 22×10^8 m^3, [18 a], [15], [7], depending upon whether only fresh water was considered. The minimum estimate represents a resource of 1150 l/s (18,200 gpm) over a 30 year life at an extraction rate of 50%, which is considered to be an attainable extraction. This amount alone is more than adaquate for project requirements. It is estimated that 70% of water requirements will be met by depletion of stored groundwater (water mining).

2.3 Hamburgo Basin

✓ LM 37

The Escondida project site is located in the Salar de Hamburgo basin. Because of its proximity to the project, the Hamburgo Basin was studied for its development potential [7 a, b, c].

The Salar de Hamburgo basin occupies a geologic structural depression which is partially filled by alluvial deposits. The basin comprises a hydrogeologic sink where surface water and groundwater flows from the surrounding mountains into the structural depression.

The principal geologic units in the Salar de Hamburgo basin, from youngest to oldest, are the alluvial deposits and the bedrock complex.

2.3.1 Climatic features

Average annual precipitation and evaporation at the valley floor for the Salar de Hamburgo basin is similar to precipitation and evaporation at the valley floor for the Salar de Punta Negra basin. The altitudes of the mountains surrounding the Salar de Hamburgo basin are lower than the altitudes of the mountain surrounding the Salar de Punta Negra basin. Average annual precipitation for the Hamburgo basin is approximately 1 to 2 millimeters, and average annual evaporation is about 1,500 millimeters [15].

Most of the precipitation which falls on the valley floors occurs as rain; however, snow may occur in the higher altitudes of the surrounding mountains. Much of the precipitation which falls in the basins is lost to evaporation. Most of the snow is lost via sublimation prior to melting and does not commonly sustain streamflow.

Small ephemeral streams occur on the slopes which surround the Salar de Hamburgo basin. These streams show internal drainage patterns and flow only after infrequent intense rainstorms. A small fraction of the precipitation provides ephemeral streamflow or lake storage. Excellent conditions for infiltration and percolation of surface water to the underlying aquifers exist in alluvial deposits in stream channels. Such infiltration constitutes a source of regional groundwater recharge.

2.3.2 Alluvial deposits

Alluvial deposits crop out chiefly in the basin floor of the Salar de Hamburgo basin. The formation comprises a heterogeneous, interbedded sequence, including: fluvial deposits consisting chiefly of gravel and sand; lake bed deposits consisting chiefly of silt and clay; mud-flow deposits consisting chiefly of boulders, gravel, sand, silt, and clay; and volcanic ash deposits. Evaporite deposits occur on the surface of the salar and may occur as interbeds in the alluvial deposits.

Alluvial deposits in the Salar de Hamburgo basin were penetrated by groundwater exploration well ES-1 to a depth of 142 meters (466 feet), and to shallow depths by boreholes SB-1, SB-2, SB-3, SC-1, and SC-3. Static water level at the ES-1 site was about 28 meters (92 ft) below land surface. At the ES-1 site, moderately permeable alluvial deposits occur from 28 to 55 meters (92-180 ft). Poorly permeable alluvial deposits occur from 55 to 142 meters (180-466). Poorly permeable, dense, older andesite bedrock occurs from 142 to 152 meters (466-499 ft).

2.3.3 Bedrock complex

In the Salar de Hamburgo basin, the bedrock complex consists chiefly of undifferentiated sedimentary rocks of Mesozoic age, older andesite lava-flow rocks, rhyolite of Mesozoic or Paleozoic age, and various plutonic igneous rock types.

Although the rocks classified with the bedrock complex are known from outcrops which occur on the margins of the salar, it is believed that these rocks also occur below the alluvial floor of the basin where they underlie younger deposits. The permeability and porosity of unfractured rock in the bedrock complex appear to be very low and, in most of the salar basin, these rocks are expected to act as a basal aquitard for the groundwater reservoir. The significant or main source of groundwater in the Salar de Hamburgo basin occurs almost entirely in the overlying alluvial deposits.

2.3.4 Groundwater movement

The principal aquifer in the Salar de Hamburgo basin is the alluvial deposits. Depth to static water level below land surface in the Salar de Hamburgo basin ranges from 10 meters (33 ft) at borehole SC-1 to more than 60 meters (66 ft) at borehole SB-2.

Groundwater flow is generally to the west in the Salar de Hamburgo basin. Groundwater discharge from the Salar de Hamburgo basin occurs by evaporation from the salar surface and by westward subsurface flow.

Groundwater recharge in the Salar de Hamburgo basin occurs principally via infiltration from infrequent ephemeral streamflow.

An air lift pumping test was completed on well ES-1. This well produced about 3 l/s (47 gpm). A calculation of transmissivity based upon recovery data gave a value of 33.6 m^2/day (2200 gpd/ft) which indicates a low transmissivity in this area.

2.3.5 Groundwater quality

Chemical analysis of water produced from ES-1 is presented in Table 3.1. This water contains about 4700 mg/l TDS and is a sodium-calcium-sulfate water type.

2.3.6 Groundwater storage

It has been estimated [7 b] that a total of 2.7 x 10^8 m^3 exists in storage in the basin. At 50% extraction, this represents a 30 year supply rate of 143 l/s (2260 gpm).

2.3.7 Development potential

Because of the low transmissivity encountered here, well production would be limited to about 6 to 10 l/s (100-160 gpm). For this fact, the development potential is limited to small production wells for temporary purposes such as drilling and construction activity.

3.0 RESOURCE DEVELOPMENT

3.1 Production Scale Testing

To obtain more definitive data on aquifer characteristics than is provided by short term air lift tests, a series of long term production scale tests were planned and executed. A total of five wells were constructed to specifications essentially identical to the design that will be used for production wells. These were pumped at rates of between 15.7 and 36.6 l/s (250-580 GPM) for periods ranging from 7 to 30 days. All of these tests successfully proved adequate aquifer characteristics and water quality for commercial scale development.

3.1.1 Well construction and development

All production tests wells were constructed in the same fashion to essentially the same design. The only important variation between the 5 wells was the location of well screen.

Well drilling was performed using a Gardner Denver 2000 rotary drill rig. Drilling was executed by first drilling a 7 7/8 inch diameter pilot hole to full depth. The pilot hole was drilled using conventional rotary techniques with a stabilizer used above the bit to produce a straight hole. Immediately after completion of the pilot hole, reaming operations began. For reaming, a 4-cone rotary hole opener of 41 cm (16 in) diameter was used behind the 7 7/8 inch bit. The hole openers were custom fabricated using salvaged oilfield bit parts to reduce costs.

To stablize the hole and control circulation an organic based drilling mud was used. To circulate this fluid a 6x10 inch Gardner Denver pump was used.

Upon completion of the reaming operation, casing was immediately placed in the hole. In all cases, one length of 8 inch casing with a closed bottom end preceeded 8 inch screen and then 10 inch casing. Casing and screen connections were welded and centralized in the hole with 3 weld on centralizers every 18 meters (60 ft). Screens are 6.7 m (22 ft) length and casing are random 6.1 m (20 ft) length, mild steel.

After placement of casing, the holes were packed with screened sand of between #4 and #10 mesh. The sand was placed with a tremie pipe and washed into place by circulating water in the hole.

Well development began by chemically breaking down the organic drilling fluid to the viscosity and weight of water and circulating the hole for about 6 hours. After this the well was air-lift pumped while the screens were jetted with air for approximately 12 hours until clean water was produced.

When testing was initiated the pump was lowered into the well (one pump and power unit were used for all 5 tests). The pump used is a 13 stage Reda pump with a 100 H.P. submergible electric motor. The power unit used was a Cummins 157 KW diesel generator set. Four inch "H" casing was used for column pipe. Water was discharged through an 8 inch diameter pipeline of from 300 to 600 meters (1000 to 2000 ft) away from the well head depending upon test conditions.

Production test well construction details for each well are illustrated in exhibits 3.1 through 3.5. The location of wells T-1 through T-5 are shown on Exhibit 2.2.

3.1.2 Testing Results

Production well test results are described in detail by Todd [18 d, e, f, g, h].

Testing procedures were essentially the same for all tests. Data was collected for drawdown, production rate and water quality by field crews stationed around the clock at the well site. The following procedures were followed.

Drawdown was determined by measuring water level depth below a standard measuring point near the top of the well casing. Measurement was made with electric sounders in the pumped well and at least one observation well. Data was collected on a logarithmic time frequency (decreasing frequency with total time) for both pumping and recovery phases of the test.

Production rate was read from a totalizing flow meter with the same frequency as was used for water level measurements.

Water quality samples were collected on a daily basis during pumping. Specific conductivity was determined in the field for each sample. Daily samples were sent to a local laboratory for determination of pH, specific conductivity and concentrations of total dissolved solids and chloride and sulfate anions. Additional samples were collected on a less frequent basis for analysis of a suite of 22 cations and anions plus TDS, pH, and specific conductivity. Additionally, water samples were collected before and after each test at various levels within the production and observation wells to detect vertical movement of waters of higher salinity. The salinity profile within the well was also observed by making fluid conductivity logs using a special logging tool lowered into the well. A summary of water quality analysis for wells T-1 through T-5 is presented in Table 3.1. Well ES-1 analysis is also presented as being representative of groundwater in the Salar de Hamburgo basin.

A summary of the production well testing is shown in Table 3.2.

TABLE 3.1 WATER QUALITY ANALYSIS SUMMARY

WELL	SALAR DE HAMBURGO ES-1	SALAR DE PUNTA NEGRA T-1	T-2	T-3	T-4	T-5
TDS (mg/l)	3640-4900	5480-5920	700-730	1240-1290	1700-1720	6640-8140
pH	7.0-7.7	7.7-7.8	7.3-7.8	7.5-7.8	7.2-7.6	7.2-7.4
Spec Cond (umhos/cm)	3650-5350	8200-8260	953-1020	1790-1800	2350-2400	10540-11630
Sulfate (mg/l SO_4)	2280-2360	880-910	120-125	150-160	420	130
Bicarbonate (mg/l HCO_3)	40-50	92-99	43-52	52-53	66-68	70-84
Carbonate (mg/l CO_3)	0	0	0	0	0	0
Nitrate (mg/l NO_3-N)	15-58	0.02-0.05	0.75-.86	1.61-1.69	0.75-0.92	4.38-4.88
Boron (mg/l B)	4.23-6.03	40-42	.98-1.02	1.79-1.83	3.2-3.4	2.1-2.3
Chloride (mg/l Cl)	130-470	2120-2180	190-200	420-430	470	3740-4460
Fluoride (mg/l F)	0.7-0.8	0.2	0.30-.45	0.7-0.8	0.4	0.4
Sodium (mg/l Na)	480-660	1020-1040	76-93	200-210	200	2050-2400
Magnesium (mg/l Mg)	79-140	120-140	4.1-4.2	18-21	55	22-34
Calcium (mg/l Ca)	490-530	470-480	91-95	120-130	180	330-470
Potassium (mg/l K)	18-19	170	8.5-9.6	18-21	33-35	20-28
Arsenic (ug/l As)	1	1-15	39-210	160-180	37-42	1-5
Copper (mg/l Cu)	0.012-.017	0.017-.018	.002-.009	.006-.008	0.008-.013	0.013-.036
Iron (mg/l Fe)	.01-.06	0.04	.01-.02	0.01-.02	0.08	0.05-0.09
Lead (mg/l Pb)	.01	.01-.01	0.01	.01	0.01	0.01
Manganese (mg/l Mn)	0.04-.08	0.01-.03	0.01-.09	0.01-.07	0.02-0.23	.01-0.29
Mercury (ug/l Hg tot)	.03-.34	.22-.71	0.05-.39	.04-.09	0.07-0.18	0.07-1.44
Molybdenum (mg/l Mo)	.01-.07	.01-.04	0.01	0.02-.03	0.02	0.02
Selenium (ug/l Se)	1	1	1	1	1	1
Silicon (mg/l Si)	17-24	.5	3.1-6.7	14-15	23-25	11-13
Silver (ug/l Ag)	2	1	2	1	1	1
Zinc (mg/l Zn)	0.02-.05	0.01-.03	0.01-.02	.03-.04	0.02-0.20	0.02-.09
Number of Analysis	3	3	3	3	3	9

All analysis performed by Utah International Inc. Minerals Laboratory.

TABLE 3.2 PRODUCTION TESTING SUMMARY

	T-1	T-2	T-3	T-4	T-5
Test Period					
Step Drawdown	10/8/83	---	12/1/83	12/13/83	1/16/84
Constant Discharge	10/11/83	11/5/83	12/2/83	12/14/83	1/17/84
Transmissivity					
(m^2/min)	0.174	0.160	0.194	0.192	0.139
(gpd/ft)	20,000	18,400	22,600	22,100	16,000
Specific Yield	0.13	0.08	---	0.02	0.10
Storage Coefficient	0.13	0.08	4×10^{-4}	0.02	0.10
Ratio Vert/Horiz Hydraulic Conductivity	1/7	1/13	1/10	1/10	1/100
Avg Discharge Rate					
(l/s)	35.2	15.5	24.9	24.0	16.0
(gpm)	558	246	394	380	250
Well Efficiency	75%	70%	30%	±70%	±70%
Static Water Level					
(m)	66.30	37.91	7.79	65.75	125.95
(ft)	217.52	124.38	25.56	215.72	413.22
Avg Water Quality					
TDS mg/l	6000	700	1200	1850	7500
pH	7.8	7.7	7.6	7.8	7.3

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LITHOLOGIC DESCRIPTION FOR DRILL CUTTINGS FROM EXPLORATION WELLS
(Washed samples)

described by D. Greene

HOLE NO: ES-1

INTERVAL *(meters)*	DESCRIPTION
0-2	White, brown, black; gravel 80%, sand 20%; welded ash 80%, evaporites 15%, andesite 5%.
2-4	Brown, white, black; gravel 80%, sand 20%; evaporites 70%, welded ash 25%, andesite 5%.
4-6	Brown, black, white; gravel 80%, sand 20%; evaporites 40%, welded ash 20%, andesite 40%.
6-8	Brown, black, white; gravel 10%, sand 10%, silt and clay 80%; andesite 15%, welded ash 5%.
8-12	Brown; silt and clay 100%.
12-14	Brown, black, white; gravel 5%, sand 10%, silt and clay 85%; andesite 10%, welded ash 5%.
14-18	Brown; silt and clay 100%.
18-20	Brown, white, black; gravel 5%, sand 10%, silt and clay 85%; andesite 10%, welded ash 5%.
20-24	Brown, black; gravel and sand 5%, silt and clay 95%; andesite 5%.
24-26	Brown, white, black; gravel 30%, silt and clay 70%; rhyolite 25%, andesite 5%.
26-28	Brown, white, black; gravel 50%, silt and clay 50%; rhyolite 45%, andesite 5%.
28-32	Light-brown, white, black; gravel 80%, sand 10%, silt and clay 10%; rhyolite 85%, andesite 5%.
32-34	Light-brown, white, black; gravel 80%, sand 20%; rhyolite 95%, andesite 5%.
34-42	Light-brown, white, black; gravel 90%, sand 10%; rhyolite 95%, andesite 5%.
42-48	Light-brown, white, black; gravel 100%.
48-50	Light-brown, white, red, black; gravel 45%, sand 45%, silt and clay 10%; rhyolite fragments 85%, andesite fragments 5%.
50-52	Light-brown, white, red, black; gravel 25%, sand 25%, silt and clay 5%, rhyolite fragments 45%, andesite fragments 5%.

FIGURE F-1a.

HOLE NO: ES-1

INTERVAL (meters)	DESCRIPTION
52-54	Light-brown, white, red, black; gravel 60%, sand 30%, silt and clay 10%; rhyolite fragments 85%, andesite fragments 5%.
54-56	Light-brown, white, black; gravel 20%, sand 20%, silt and clay 60%; rhyolite fragments 35%, andesite framents 5%.
56-64	Light-brown, white, grey, black; gravel 35%, sand 5%, silt and clay 60%; rhyolite fragments 35%, andesite fragments 5%.
64-66	Light-brown, white, grey, black; gravel 20%, sand 20%, silt and clay 60%; rhyolite fragments 35%, andesite fragments 5%.
66-78	Light-brown, white, grey, black; gravel 10%, sand 10%, silt and clay 80%; rhyolite fragments 19%, andesite fragments 1%.
78-82	Light-brown, white, grey, black; gravel 5%, sand 15%, silt and clay 80%; rhyolite fragments 19%, andesite fragments 1%.
82-142	Light-brown, white, grey, black; gravel 10%, sand 10%, silt and clay 80%; rhyolite fragments 19%, andesite fragments 1%.
142-144	Light-brown, white, grey, black; gravel 10%, sand 10%, silt and clay 80%; rhyolite fragments 15%, andesite fragments 5%. Much oxidation.
144-146	Light-brown, grey, red; gravel 10%, sand 10%, silt and clay 80%; rhyolite fragments 19%, andesite fragments 1%. Fragments more angular. Much oxidation.
146-148	Grey, light-brown, red; gravel 15%, sand 5%, silt and clay 80%. Fresh angular fragments of grey rock 15%, rhyolite fragments 5%. Some pyrite.

TOTAL DEPTH Driller: 148 meters
TOTAL DEPTH Logger: 152 meters

FIGURE F-1b.

LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM EXPLORATION WELLS

(Washed samples)

described by E. Peacock

HOLE NO: ES-3

INTERVAL *(meters)*	DESCRIPTION
0-2	Gravel 10%, fine sand 20%, brown silt and clay 65%, white evaporites 5%.
2-4	Gravel 80%, fine sand 10%, brown silt and clay 10%.
4-6	Gravel 5%, fine sand 10%, red silt and clay 85%.
6-8	Gravel 10%, fine sand 10%, brown silt and clay 80%.
8-10	Gravel 20%, fine sand 10%, brown silt and clay 70%.
10-12	Gravel 5%, fine sand 10%, brown silt and clay 85%.
12-14	Gravel 5%, fine sand 10%, brown silt and clay 85%.
14-16	Gravel (trace), fine sand 10%, brown silt and clay 90%.
16-18	Gravel (trace), fine sand 20%, red silt and clay 80%.
18-20	Gravel (trace), fine sand 20%, red silt and clay 80%.
20-22	Gravel (trace), red sand (trace), fine sand 20%, red silt and clay 80%, white evaporites (trace).
22-24	Gravel (trace), medium sand (trace), fine sand 20%, red silt and clay 80%.
24-26	Gravel (trace), fine sand 20%, tan silt and clay 80%.
26-28	Gravel (trace), fine sand 10%, tan silt and clay 90%.
28-30	Gravel (trace), medium sand (trace), fine sand 10%, tan silt and clay 90%.
30-32	Fine sand 10%, red silt and clay 90%.
32-34	Gravel (trace), fine sand 20%, red silt and clay 80%.
34-36	Medium sand (trace), fine sand 20%, red silt and clay 80%.
36-38	Medium sand (trace), fine sand 20%, red silt and clay 80%.
38-40	Medium sand (trace), fine sand 20%, red silt and clay 80%, white evaporites (trace).
40-42	Medium sand (trace), fine sand 20%, red silt and clay 80%.

FIGURE F-3a.

HOLE NO: ES-3

INTERVAL *(meters)*	DESCRIPTION
42-44	Medium sand (trace), fine sand 20%, red silt and clay 80%.
44-46	Medium sand (trace), fine sand 20%, medium silt and clay 80%.
46-48	Medium sand (trace), fine sand 10%, red silt and clay 90%, biotite (trace).
48-50	Gravel 20%, medium sand (trace), fine sand 10%, tan silt and clay 90%.
50-52	Gravel 10%, coarse sand 10%, fine sand 10%, red silt and clay 70%.
52-54	Gravel (trace), fine sand 10%, red silt and clay 90%.
54-56	Gravel (trace), fine sand 20%, red silt and clay 80%, white evaporites (trace).
56-58	Gravel (trace), volcanic ash (trace), fine sand 20%, tan silt and clay 80%.
58-60	Gravel (trace), volcanic ash (trace), fine sand 20%, tan silt and clay 80%.
60-62	Gravel 10%, fine sand 10%, tan silt and clay 80%.
62-64	Gravel 10%, volcanic ash (trace), fine sand 10%, tan silt and clay 80%.
64-66	Gravel 5%, volcanic ash (trace), fine sand 10%, tan silt and clay 85%.
66-68	Gravel (trace), fine sand 10%, tan silt and clay 90%.
68-70	Gravel (trace), fine sand 10%, tan silt and clay 90%, white evaporites (trace).
70-72	Gravel (trace), fine sand 10%, tan silt and clay 90%, white evaporites (trace).
72-74	Gravel (trace), fine sand 10%, red silt and clay 90%.
74-76	Gravel (trace), fine sand 20%, red silt and clay 80%.
76-78	Gravel (trace), fine sand 10%, tan silt and clay 90%.
78-80	Gravel (trace), fine sand 10%, tan silt and clay 90%, white evaporites (trace).
80-82	Gravel (trace), fine sand 10%, red silt and clay 90%, white evaporites (trace).
82-84	Gravel (trace), sand (trace), red silt and clay 100%.

FIGURE F-3b.

HOLE NO: ES-3

INTERVAL (meters)	DESCRIPTION
84-86	Gravel (trace), sand (trace), red silt and clay 100%.
86-88	Gravel 5%, fine sand 5%, red silt and clay 90%.
88-90	Gravel 5%, fine sand 5%, red silt and clay 90%.
90-92	Gravel (trace), fine sand 5%, red silt and clay 95%.
92-94	Gravel (trace), fine sand 5%, red silt and clay 95%.
94-96	Gravel 5%, fine sand 10%, red silt and clay 85%.
96-98	Gravel 5%, fine sand 10%, red silt and clay 85%.
98-100	Gravel 5%, fine sand 10%, red silt and clay 85%.
100-102	Gravel 5%, fine sand 10%, red silt and clay 85%.
102-104	Gravel (trace), fine sand 10%, red silt and clay 90%.
104-106	Gravel (trace), fine sand 10%, red silt and clay 90%.
106-108	Gravel (trace), fine sand 5%, red silt and clay 95%.
108-110	Gravel (trace), fine sand 5%, red silt and clay 95%.
110-112	Gravel (trace), fine sand 5%, red silt and clay 95%.
112-114	Gravel (trace), fine sand 5%, red silt and clay 95%.
114-116	Gravel (trace), fine sand 10%, red silt and clay 90%.
116-118	Gravel (trace), fine sand 10%, red silt and clay 90%, limonite (trace), biotite (trace).
118-120	Gravel (trace), fine sand 10%, red silt and clay 90%.
120-122	Gravel (trace), fine sand 10%, red silt and clay 90%.
122-124	Fine sand 5%, red silt and clay 95%.
124-126	Fine sand 5%, red silt and clay 95%.
126-128	Fine sand 5%, red silt and clay 95%.
128-130	Fine sand 5%, red silt and clay 95%.

FIGURE F-3c.

HOLE NO: ES-3

INTERVAL (meters)	DESCRIPTION
130-132	Gravel (trace), fine sand 5%, red silt and clay 95%.
132-134	Gravel (trace), fine sand 10%, red silt and clay 90%.
134-136	Gravel (trace), fine sand 10%, red silt and clay 90%.
136-138	Gravel 5%, fine sand 10%, red silt and clay 85%.
138-140	Gravel (trace), fine sand 10%, red silt and clay 90%.
140-142	Gravel 30%, fine sand 10%, red silt and clay 60%.
142-144	Gravel 40%, fine sand 10%, red silt and clay 50%.
144-146	Gravel 30%, fine sand 10%, red silt and clay 60%.
146-148	Gravel 40%, fine sand 10%, red silt and clay 50%.
148-150	Gravel 60%, fine sand 10%, red silt and clay 30%.
150-152	Gravel 70%, fine sand 5%, red silt and clay 25%. (Gravel consists of red to black, sub-angular to angular aphanitic andesite 90%, quartz and chert 10%).
152-154	Gravel 70%, fine sand 5%, red silt and clay 25%.
154-156	Gravel 70%, fine sand 5%, red silt and clay 25%.
156-158	Gravel 50%, fine sand 10%, red silt and clay 40%.
158-160	Gravel 50%, fine sand 10%, red silt and clay 40%.
160-162	Gravel 80%, fine sand (trace), red silt and clay 20%.
162-164	Medium to coarse sand 50%, red silt and clay 50%.
164-166	Medium to coarse sand 50%, red silt and clay 50%.
166-168	Medium to coarse sand 40%, red silt and clay 60%.
168-170	Medium to coarse sand 50%, red silt and clay 50%.
170-172	Medium to coarse sand 40%, red silt and clay 60%.
172-174	Medium to coarse sand 30%, red silt and clay 70%.
174-176	Medium to coarse sand 30%, red silt and clay 70%.

FIGURE F-3d.

HOLE NO: ES-3

INTERVAL *(meters)*	DESCRIPTION
176-178	Medium to coarse sand 40%, red silt and clay 60%.
178-180	Medium to coarse sand 30%, red silt and clay 70%.
180-182	Medium to coarse sand 60%, red silt and clay 40%.
182-184	Medium to coarse sand 50%, red silt and clay 50%.
184-186	Medium to coarse sand 50%, red silt and clay 50%. (Sand consists of red to black angular aphanitic andesite with traces of quartz, feldspar, and chert).
186-188	Medium to coarse sand 60%, red silt and clay 40%.
188-190	Medium to coarse sand 60%, red silt and clay 40%.
190-192	Medium to coarse sand 60%, red silt and clay 40%.
192-194	Angular andesite fragments 90%, red silt and clay 10%.
194-196	Angular andesite fragments 90%, red silt and clay 10%.
196-198	Angular andesite fragments 90%, red silt and clay 10%.
198-200	Angular andesite fragments 80%, red silt and clay 20%.
200-202	Angular andesite fragments 70%, red silt and clay 30%.
202-204	Angular andesite fragments 70%, red silt and clay 30%.
204-206	Angular andesite fragments 70%, red silt and clay 30%.
206-208	Angular andesite fragments 80%, red silt and clay 20%.
208-210	Angular andesite fragments 70%, red silt and clay 30%.
210-212	Angular andesite fragments 60%, red silt and clay 40%.
212-214	Sample missing.
214-216	Sample missing.
216-218	Angular andesite fragments 40%, red silt and clay 60%.
218-220	Angular andesite fragments 30%, red silt and clay 70%.

FIGURE F-3e.

HOLE NO: ES-3

INTERVAL *(meters)*	DESCRIPTION
220-222	Angular andesite fragments 30%, red silt and clay 70%.
222-224	Angular andesite fragments 40%, red silt and clay 60%.
224-226	Angular andesite fragments 30%, red sandy silt and clay 70%.
226-228	Angular andesite fragments 20%, red sandy silt and clay 80%.

TOTAL DEPTH Driller: 228 meters
TOTAL DEPTH Logger: 226 meters

FIGURE F-3f.

LITHOLOGIC DESCRIPTIONS FOR DRILL CUTTINGS FROM EXPLORATION WELLS

(Washed samples)

described by E. Peacock

HOLE NO: ES-5

INTERVAL *(meters)*	DESCRIPTION
0-2	Coarse to fine gravel 70%, medium to coarse sand 20%, fine sand 10%, evaporites (trace).
2-4	Medium to fine gravel 50%, medium to coarse sand 30%, fine sand 20%.
4-6	Coarse to fine gravel 80%, medium to coarse sand 15%, fine sand 5%.
6-8	Fine gravel 20%, medium to coarse sand 20%, fine sand 50%, clay 10%.
8-10	Fine gravel 30%, medium to coarse sand 25%, fine sand 35%, clay 10%.
10-12	Medium to fine gravel 30%, medium to coarse sand 25%, fine sand 35%, clay 10%.
12-14	Medium to fine gravel 30%, medium to coarse sand 35%, fine sand 25%, clay 10%.
14-16	Coarse to fine gravel 10%, medium to coarse sand 40%, fine sand 45%, clay 5%.
16-18	Coarse to fine gravel 20%, medium to coarse sand 40%, fine sand 35%, clay 5%.
18-20	Coarse to fine gravel 5%, medium to coarse sand 40%, fine sand 50%, clay 5%.
20-22	Coarse to fine gravel 70%, medium to coarse sand 10%, fine sand 15%, clay 5%.
22-24	Medium to fine gravel 50%, medium to coarse sand 30%, fine sand 15%, clay 5%.
24-26	Coarse to fine gravel 80%, medium to coarse sand 10%, fine sand 5%, clay 5%.
26-28	Medium to fine gravel 50%, medium to coarse sand 20%, fine sand 25%, clay 5%.
28-30	Coarse to fine gravel 20%, medium to coarse sand 30%, fine sand 45%, clay 5%.
30-32	Coarse to fine gravel 20%, medium to coarse sand 45%, fine sand 30%, clay 5%.

FIGURE F-5a.

HOLE NO: ES-5

INTERVAL *(meters)*	DESCRIPTION
32-34	Medium to fine gravel 20%, medium to coarse sand 45%, fine sand 30%, clay 5%.
34-36	Medium to fine gravel 10%, medium to coarse sand 55%, fine sand 30%, clay 5%.
36-38	Fine gravel (trace), medium to coarse sand 60%, fine sand 35%, clay 5%.
38-40	Fine gravel (trace), medium to coarse sand 60%, fine sand 35%, clay 5%.
40-42	Fine gravel (trace), medium to coarse sand 60%, fine sand 35%, clay 5%.
42-44	Fine gravel (trace), medium to coarse sand 60%, fine sand 35%, clay 5%.
44-46	Fine gravel (trace), medium to coarse sand 60%, fine sand 35%, clay 5%.
46-48	Fine gravel 5%, medium to coarse sand 55%, fine sand 30%, clay 10%.
48-50	Fine gravel (trace), medium to coarse sand 55%, fine sand 40%, clay 5%.
50-52	Fine gravel (trace), medium to coarse sand 55%, fine sand 40%, clay 5%.
52-54	Fine gravel (trace), medium to coarse sand 55%, fine sand 40%, clay 5%.
54-56	Fine gravel (trace), medium to coarse sand 50%, fine sand 45%, clay 5%.
56-58	Fine gravel (trace), medium to coarse sand 50%, fine sand 45%, clay 5%.
58-60	Fine gravel 5%, medium to coarse sand 40%, fine sand 45%, clay 10%.
60-62	Fine gravel 15%, medium to coarse sand 30%, fine sand 45%, clay 10%.
62-64	Fine gravel 15%, medium to coarse sand 30%, fine sand 45%, clay 10%.
64-66	Fine gravel 15%, medium to coarse sand 30%, fine sand 45%, clay 10%.
66-68	Medium to coarse gravel 15%, medium to coarse sand 30%, fine sand 45%, clay 10%.
68-70	Fine gravel 15%, medium to coarse sand 10%, fine sand 50%, clay 25%.
70-72	Fine gravel 15%, medium to coarse sand 10%, fine sand 50%, clay 25%.
72-74	Fine gravel 15%, medium to coarse sand 10%, fine sand 50%, clay 25%.
74-76	Coarse to fine gravel 30%, medium to coarse sand 15%, fine sand 45%, clay 10%.

FIGURE F-5b.

HOLE NO: ES-5

INTERVAL *(meters)*	DESCRIPTION
76-78	Coarse to fine gravel 50%, medium to coarse sand 20%, fine sand 25%, clay 5%.
78-80	Fine to coarse gravel 80%, medium to coarse sand 10%, fine sand 10%, clay (trace).
80-82	Fine to medium gravel 60%, medium to coarse sand 20%, fine sand 20%, clay (trace).
82-84	Fine to medium gravel 60%, medium to coarse sand 20%, fine sand 20%, clay (trace).
84-86	Fine to coarse gravel 80%, medium to coarse sand 10%, fine sand 10%, clay (trace).
86-88	Fine to coarse gravel 70%, medium to coarse sand 15%, fine sand 15%, clay (trace).
88-90	Fine to coarse gravel 60%, medium to coarse sand 15%, fine sand 15%, clay 10%.
90-92	Medium to coarse gravel 20%, medium to coarse sand 60%, fine sand 15%, clay 5%.
92-94	Medium to coarse gravel 20%, medium to coarse sand 60%, fine sand 15%, clay 5%.
94-96	Medium to coarse gravel 100%, sand (trace). (Gravel contains rhyolite, ash, quartzite, chert, and red sandstone).
96-98	Fine to coarse gravel 20%, medium to coarse sand 30%, fine sand 45%, clay 5%.
98-100	Fine to coarse gravel 30%, medium to coarse sand 35%, fine sand 30%, clay 5%.
100-102	Medium to coarse gravel 100%, sand (trace).
102-104	Fine to coarse gravel 30%, medium to coarse sand 20%, fine sand 45%, clay 5%.
104-106	Medium to coarse gravel 100%, sand (trace). (Gravel angular to sub-angular. Samples are more red below 106 meters. Have more clay).
106-108	Fine to coarse gravel 30%, medium to coarse sand 25%, fine sand 35%, clay 10%.

FIGURE F-5c.

HOLE NO: ES-5

INTERVAL (meters)	DESCRIPTION
108-110	Fine to coarse gravel 75%, medium to coarse sand 10%, fine sand 10%, clay 5%.
110-112	Fine to medium gravel 75%, medium to coarse sand 10%, fine sand 10%, clay 5%.
112-114	Fine to medium gravel 75%, medium to coarse sand 10%, fine sand 10%, clay 5%.
114-116	Fine to medium gravel 75%, medium to coarse sand 10%, fine sand 10%, clay 5%.
116-118	Fine to medium gravel 50%, medium to coarse sand 20%, fine sand 25%, clay 5%.
118-120	Fine to medium gravel 50%, medium to coarse sand 20%, fine sand 25%, clay 5%.
120-122	Fine to medium gravel 35%, medium to coarse sand 20%, fine sand 40%, clay 5%.
122-124	Fine to medium gravel 35%, medium to coarse sand 20%, fine sand 40%, clay 5%.
124-126	Fine to medium gravel 10%, medium to coarse sand 20%, fine sand 65%, clay 5%.
126-136	Samples missing.
136-138	Fine to medium gravel 100%, sand (trace).
138-140	Gravel (trace), medium to coarse sand 70%, fine sand 30%, clay (trace).
140-142	Sample missing.
142-144	Gravel (trace), medium to coarse sand 70%, fine sand 30%, clay (trace).
144-146	Gravel (trace), medium to coarse sand 70%, fine sand 30%, clay (trace).
146-148	Fine angular gravel chips 25%, medium to coarse sand 50%, fine sand 20%, sandy clay 5%.
148-150	Gravel (trace), medium to coarse sand 40%, fine sand 55%, sandy clay 5%.
150-152	Fine angular gravel chips 25%, medium to coarse sand 50%, fine sand 20%, sandy clay 5%.

FIGURE F-5d.

HOLE NO: ES-5

INTERVAL *(meters)*	DESCRIPTION
152-154	Fine angular gravel chips 25%, medium to coarse sand 50%, fine sand 20%, sandy clay 5%.
154-156	Fine angular gravel chips 15%, medium to coarse sand 40%, fine sand 40%, sandy clay 5%.
156-158	Fine angular gravel chips 15%, medium to coarse sand 40%, fine sand 40%, sandy clay 5%.
158-160	Fine angular gravel chips 15%, medium to coarse sand 35%, fine sand 35%, sandy clay 15%.
160-162	Fine angular gravel chips 15%, medium to coarse sand 35%, fine sand 35%, sandy clay 15%.
162-164	Fine angular gravel chips 15%, medium to coarse sand 25%, fine sand 35%, sandy clay 25%.
164-166	Fine angular gravel chips 15%, medium to coarse sand 25%, fine sand 35%, sandy clay 25%.
166-168	Fine angular gravel chips 15%, medium to coarse sand 15%, fine sand 20%, sandy clay 50%.
168-170	Fine angular gravel chips 10%, medium to coarse sand 50%, fine sand 25%, sandy clay 15%.
170-172	Fine angular gravel chips 15%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 65%.
172-174	Fine angular gravel chips 15%, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 45%.
174-176	Fine angular gravel chips 15%, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 45%.
176-178	Fine angular gravel chips 10%, medium to coarse sand 30%, fine sand 20%, sandy ashy clay 40%.
178-180	Fine angular gravel chips 10%, medium to coarse sand 15%, fine sand 15%, sandy ashy clay 60%.
180-182	Fine angular gravel chips 10%, medium to coarse sand 25%, fine sand 25%, sandy ashy clay 40%.
182-184	Fine angular gravel chips 10%, medium to coarse sand 15%, fine sand 15%, sandy ashy clay 60%.

FIGURE F-5e.

HOLE NO: ES-5

INTERVAL (meters)	DESCRIPTION
184-186	Fine angular gravel chips 10%, medium to coarse sand 15%, fine sand 15%, sandy ashy clay 60%.
186-188	Fine angular gravel chips 5%, medium to coarse sand 30%, fine sand 15%, sandy ashy clay 50%.
188-190	Fine angular gravel chips 5%, medium to coarse sand 15%, fine sand 20%, sandy ashy clay 60%.
190-192	Fine angular gravel chips 5%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 75%.
192-194	Fine angular gravel chips 5%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 75%.
194-196	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 10%, sandy ashy clay 65%
196-198	Fine angular gravel chips 5%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 75%.
198-200	Fine angular gravel chips 10%, medium to coarse sand 20%, fine sand 10%, sandy ashy clay 60%.
200-202	Fine angular gravel chips 10%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 70%.
202-204	Fine angular gravel chips 5%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 75%.
204-206	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 55%.
206-208	Fine angular gravel chips 5%, medium to coarse sand 15%, fine sand 10%, sandy ashy clay 70%.
208-210	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 10%, sandy ashy clay 65%.
210-212	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 55%.
212-214	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 55%.
214-216	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 20% sandy ashy clay 55%.

FIGURE F-5f.

HOLE NO: ES-5

INTERVAL *(meters)*	DESCRIPTION
216-218	Fine angular gravel chips, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 55%.
218-220	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 55%.
220-224	Fine angular gravel chips 5%, medium to coarse sand 30%, fine sand 20%, sandy ashy clay 45%.
224-226	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 55%.
226-228	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 55%.
228-230	Fine angular gravel chips 5%, medium to coarse sand 30%, fine sand 20%, sandy ashy clay 45%.
230-232	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 55%.
232-234	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 55%.
234-236	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 55%.
236-238	Fine angular gravel chips 5%, medium to coarse sand 30%, fine sand 20%, sandy ashy clay 45%.
238-240	Fine angular gravel chips 5%, medium to coarse sand 30%, fine sand 20%, sandy ashy clay 45%, volcanic ash (trace).
240-242	Fine angular gravel chips 5%, medium to coarse sand 20%, fine sand 20%, sandy ashy clay 55%, volcanic ash (trace).
242-244	Fine angular gravel chips 5%, medium to coarse sand 15%, fine sand 15%, sandy ashy clay 65%, volcanic ash (trace).
244-246	Fine angular gravel chips 5%, medium to coarse sand 10%, fine sand 20%, sandy ashy clay 65%.
246-248	Fine angular gravel chips 5%, medium to coarse sand 10%, fine sand 20%, sandy ashy clay 65%.
248-250	Fine angular gravel chips 50%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 30%.

FIGURE F-5g.

HOLE NO: ES-5

INTERVAL *(meters)*	DESCRIPTION
250-252	Fine angular gravel chips 50%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 30%.
252-254	Fine angular gravel chips 30%, medium to coarse sand 10%, fine sand 10%, sandy, ashy clay 50%.
254-256	Fine angular gravel chips 30%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 50%.
256-296	Fine angular gravel chips 20%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 60%.
296-332	Fine angular gravel chips 10%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 70%.
332-334	Fine angular gravel 60%, medium to coarse sand 10%, fine sand 5%, sandy ashy clay 25%.
334-336	Fine angular gravel 40%, medium to coarse sand 10%, fine sand 5%, sandy ashy clay 45%.
336-338	Fine angular gravel 40%, medium to coarse sand 10%, fine sand 5%, sandy ashy clay 45%.
338-342	Fine angular gravel 20%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 60%.
342-344	Fine angular gravel 20%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 60%, red sand (trace).
344-346	Fine angular gravel 20%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 60%.
346-348	Fine angular gravel 20%, medium to coarse sand 10%, fine sand 10%, red ashy clay 60%.
348-356	Fine angular gravel 10%, medium to coarse sand 10%, fine sand 10%, red ashy clay 70%.
356-378	Fine angular gravel 10%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 70%.
378-380	Fine angular gravel 10%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 70%.
380-382	Fine angular gravel 20%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 60%.

FIGURE F-5h.

HOLE NO: ES-5

INTERVAL (meters)	DESCRIPTION
382-384	Fine angular gravel 20%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 60%.
384-400	Fine angular gravel 10%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 70%.
400-402	Fine angular gravel 20%, medium to coarse sand 15%, fine sand 15%, sandy ashy clay 50%.
402-420	Fine angular gravel 5%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 75%.
420-422	Fine angular gravel 10%, angular medium to coarse sand 40%, fine sand 30%, sandy ashy clay 20%.
422-424	Fine angular gravel 5%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 75%.
424-426	Fine angular gravel 10%, angular medium to coarse sand 30%, fine sand 30%, sandy ashy clay 30%.
426-428	Fine angular gravel 10%, angular medium to coarse sand 30%, fine sand 30%, sandy ashy clay 30%.
428-436	Fine angular gravel 10%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 70%.
436-438	Fine angular gravel 5%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 75%.
438-440	Fine angular gravel 5%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 75%.
440-442	Fine angular gravel 40%, medium to coarse sand 20%, fine sand 10%, sandy ashy clay 30%.
442-444	Fine angular gravel 30%, medium to coarse sand 20%, fine sand 10%, sandy ashy clay 40%.
444-452	Fine angular gravel 10%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 70%.
452-454	Fine angular gravel 10%, medium to coarse sand 30%, fine sand 10%, sandy ashy clay 50%.
454-476	Fine angular gravel 5%, medium to coarse sand 5%, fine sand 5%, sandy ashy clay 85%.

FIGURE F-5i.

HOLE NO: ES-5

INTERVAL (meters)	DESCRIPTION
476-478	Fine angular gravel 10%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 70%.
478-484	Medium to coarse sand 5%, fine sand 5%, sandy ashy clay 90%.
484-486	Fine angular gravel 10%, medium to coarse sand 10%, fine sand 10%, sandy ashy clay 70%.
486-488	Medium to coarse sand 5%, fine sand 5%, sandy ashy clay 90%.
488-490	Fine angular gravel 5%, medium to coarse sand 5%, fine sand 5%, sandy ashy clay 85%.
490-492	Medium to coarse sand 5%, fine sand 5%, sandy ashy clay 90%.
492-494	Medium to coarse sand 5%, fine sand 5%, sandy ashy clay 90%.

TOTAL DEPTH Driller: 494 meters.
TOTAL DEPTH Logger: 326 meters (hole caving during logging).

FIGURE F-5j.

MINERA UTAH DE CHILE INC.
ESCONDIDA PROJECT

RDH ES - 10 SCALE
GEOLOGIST RJ DATE 12/12/82

PROJECT WATER PROGRAM

	Lithology	% Gravels	% Sands	COMPOSITION: Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz.	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
0														
15					20	60				20				sandstone weak tuffaceous w/calcareous matrix
30					20	60				20				"
45					20	70				10				" v weak reaction
60					15	80				5				"
66														no sample
80				10	10	70				10				as above
95				20		70				10				"
100				20		80								"
115				20		80								"
130				20		80								"
145				20		80								"
160				20		80								"
175				20		80								"
190				20		80								"
205				20		80								" less large grain frags
220				20		80								"
235				20		80								"
250				20		80								"
265				20		80								" increasing calcareous matrix ↓
280				20		80								"
295				20		80								"
310				20		80								"
325				20		80								"
340				20		80								"
355				20		80								"
370				20		80								"
385				20		80								"
400				20		80								"

Sheet ______

MINERA UTAH DE CHILE INC.
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PROJECT

	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz.	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
415				20		80								tuffaceous fragments in calcareous
430				20		80								matrix as above
445				20		80								" ↓
460				20		80								"
475				20		80								"
490				20		80								"
505				20		80								"
520				20		80								"
535				20		80								"
530				20		80								"
565				20		80								"
580				20		80								"
595				20		80								"
610				20		80								"
625				20		80								"
640				10		70		20						fining and increase in calcareous content ↓

Sheet

MINERA UTAH DE CHILE INC.
ESCONDIDA PROJECT

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PROJECT________________________

140	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz.	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
655				20		70				10				light brown, tuffaceous sandy
670				20		70				10				siltstone w/ calcareous matrix
685				20		70				10				
700				20		50				30				increase in rounded
715				20		50				30				quartz grains
730				20		50				30				
745				20		50				30				
760				20		50				30				
775				20		50				30				large biotite grains
790				30		30				40				decrease in fines, better
805				25		25				50				sorted, rounded grains
820				25		25				50				clean, v fine sand, light bro
835				25		25				50				
850				25		25				50				
865				25		25				50				·decreasing calcareous content +
880				25		25				50				·as above, abundant
895				25		25				50				feldspar and biotite,
910				40		10				50				·looks like a good target!
925				40		10				50				·increase in pink rhyolite
940				40		10				50				grains
955				40		10				50				
970				40		10				50				·decrease in sorting but
985				40		10				50				still relatively clean
1000				40		10				50				
1015				40		10				50				
1030				30		10		10		50				·increase grading and cal-
1045				30		10		10		50				careous content
1060				30		10		10		50				Sheet ________

MINERA UTAH DE CHILE INC.
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RDH
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PROJECT ______

	Lithology	% Gravels	% Sands	COMPOSITION: Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz.	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
1075				40	10					50				· better sorting, less
1090				40	10					50				fines
1105				40	10					50				
1120				40	10					50				
1135				40	10					50				
1150								100						· reddish brown clay, non calcareous
1165				10	10			80						interbedded reddish brown clays and
1180				15	15			70						silty sandstone. Angular to subrounded grains, mildly calcareous
1195				15	15			70						↓
1210				20	20			60						↑ increase in silty, clayey greyish -
1225				20	20			60						brown sandstone, decrease in red -
1240				20	20			60						brown clay
1255				20	20			60						↓
1270				80				20						· sudden increase in angular rhyolite -
1285				80				20						possibly thin flow w/interbedded sand ↑
1300				20				80						· interbedded reddish brown clays
1315														and grey-brown clayey sandstone
1330														mildly calcareous - similar to 1150-1195', relative amounts
1345														variable
1360														↓
1375														increase in grey-brown clay matrix material, less red clay, sand fraction
1390				80						20				COARSE sands, clasts x̄ 3MM MAINLY Rhyolitic, in a clay matrix
1405				70						30				FINE granded clayed gravels(?) brownish - red clay
1420				70	10					20				1D
1435				80						20				coarse clayed sands
1450				70	10					20				coarse clayed sands.
1465				70	10					20				coarse clayed sands to FINE [illegible] gravels
1480				70	10					20				1D · Sheet ______

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	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz.	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
				COMPOSITION										
1495				70	10					20				COARSE SANDS TO FINE GRAVELS IN A CLAY MATRIX
1510				70	10					20				ANGULAR CLASTS 1-2MM.
1525				80	10					10				red plastic clays, w/ angular fragments mainly of rhyolite
1540				80	10					10				coarse grained sand, w/ red-browyish clay matrix.
1555				80	10					10				clasts mainly rhyolite (could be a rhyolite other rock contamination)
1570				80	10					10				2% of calcareous fragments
1585				70	10					20				ANGULAR CLASTS $\bar{x}$ 1-2MM.
1600				70	10					20				COARSE SANDS TO FINE GRAINED GRAVELS. ANG. FRAGM. CLAY MATRIX.
1615				60	10	10				20				GRADUAL DECREASE IN THE CLAY CONTENT.
1630				60	10	10				20				COARSE SANDS TO FINE ~~grained~~ GRAVELS.
1645				10	10	10				20				ANGULAR FRAGMENTS
1660				90	10					10				1-3MM, IN A CLAYED
1675				80	10					10				MATRIX.
1690				70	10	10				10				
1700				70	10	10				10				

Sheet ______

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SCALE
DATE 4-5 MAR-83

PROJECT WATER PROGRAM

Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Volcan. Rocks	Qtz.	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
													SANDY CLAYS Brownish yellowish plastic clays (siliceous - volcanic clays)
			20% gyp 2-5% silt-clay										scarce sand + gyp. clasts. Brownish Redish
			30% gyp 2% silt-clay										PLASTIC CLAYS interbedded w/ gyp.
			10% gyp <1% clasts.										layers, + greenish grey silty clay
													redish-greenish clays, 80% light green clay, 80% ash w/ [illegible] biotite books, 10% clasts
			40	40	10				10				Redish brownish clays + gravels subangular to subrounded clasts.
			30	50	10				10				GRAVELS coarse grained gravels sub angular to sub rounded
			35	60	2				3				fragments
			40	40					20				Gravelly sands w/ clays subordinated. subrounded fragments.
			40	45	5				10				SANDY GRAVELS
			30	50	10				10				coarse grained, angular
			30	50	10				10				to subrounded fragments
			20	60	10				10				
			20	60	10				10				
			30	40	10				20				GRAVELLY SANDS
			30	50	10				10				SANDY GRAVEL, COARSE GR.
			30	50	10				10				GRAVELLY SANDS
			30	40	10				20				Subrounded to subangular clasts. clays subordinated
			30	40	10				20				
			20	70	10				10				
			30	40	20				10				
			30	40	20				10				SANDY GRAVELS
			35	35	10				20				GRAVELLY SANDS TO SANDY GRAVELS angular to sub ang. clasts Sands subrounded
			30	50	15				5				clays subordinated
			40	35	10				15				GRAVELLY SAND
			50	20	5				20				5% gyp. subrounded to subangular clasts
			50	30	10				5				gyp <1% TRACES OF CLAYS.
			30	40	10				15				5% gyp

Sheet 2

ESCONDIDA PROJECT

GEOLOGIST C. DOUGARD DATE 3-MARCH-8 SCALE

PROJECT WATER PROGRAM.

Depth	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Meteor. Rocks	Qtz.	% Silt	% Clay	% Traverline Limestone	OBSERVATIONS
4				30	40	10				15				Sandy Gravells — subangular to sub rounded clasts. 5% sulph. + gyp.
				20	60	10		gyp 1		9				GRAVELLY SANDS — coarse grained (40%) + fine
44				20	60	10				10				grained sands, sub ang. to subrounded clasts. granitic clast soft, stgly weathered (FAULT??)
3				20	70	5				5				SANDS — coarse grained sands
				20	55	5				15				in a silty-clay matrix subrounded clasts
84				25	50	5				20				SILTY SAND — silty fragments mainly silicious.
19				30	60	5				5				SANDY GRAVELS — subangular clasts
				20	70	5				5				coarse grained sandy matrix.
49				20	60	15				5				
				30	55	10				5				
79				30	50	5				15				
				30	50	10				10				GRAVELLY SANDS — subangular to sub rounded coarse grained clasts
09				30	40	10				20				
				30	40	10				20				SANDY GRAVEL
39				19	70	5		gyp 1		5				GRAVELLY SANDS
				20	60	15		gyp (-)		3				COARSE GRAINED SANDS, SUBROUNDED CLASTS x 2 mm.
69				35	50	10				15				
84				30	50	10				10				
				30	50	10				10				
14				30	40	15				15				
				25	50	10				15				
44				25	65	5		gyp 5						
				30	65	5								
74				20	70	5		gyp 5		1				SANDY GRAVELS
				20	70	10								GRAVELLY SANDS
04				30	50	10				10				coarse grained sands, ø 2 mm.
				30	20	10				10				subrounded fragments mainly granodioritic
20				30	50	5				15				

Sheet 2

MINERA UTAH DE CHILE INC.
ESCONDIDA PROJECT

RDH 16 SCALE
GEOLOGIST [illegible] DATE

PROJECT Water Program

	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz.	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
				30	50	5				15				
				20	60	5		GYP TR		15				
				15	60	5				20				

GRAVELLY SANDS.

COARSE GRAINED sands w/ subrounded to subangular clasts, $\phi \bar{x} \sim 2mm$. Mainly granodioritic.

EOH : 880 FT.

ENDED 6-MARCH-1983.

Sheet 3

ESCONDIDA PROJECT

SCALE

GEOLOGIST Dos Santos DATE 2 April 83

PROJECT Water Program Drilling

Qda de la Zorra.

	Lithology	% Gravels	% Sands	Composition: Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz	% Silt	% Clay	% [redacted]	OBSERVATIONS
				40	35	5		15		5				sandy Gravels - subrndd GRNS up to 1cm diam.
				35	35	5		20		5				sandy GRAVEL - similar to upper level
				40	30	5	5	15		5				MOST FRAGS. ARE SUBRNDD - possible rounding due to Drilling.
				40	35		5	15		5				white volc ash - frags NOTABLE ~3% of total volume, - some traces
				45	40	5		5		5				ASH FRAGS ARE very soft when wet. clean gravel layer. - little sand
90				[illegible]	40	10		5		5				sands appear in small amts. still good clean gravels.
				[illegible]	15	30		10		10				COARSE sands and GRAVELS with minor unconsolidated clays.
				15	[illegible]	[illegible]		[illegible]		5				finer sediments become more abundant but sandy gravels dominate
135				15	25	[illegible]		5		5				sandy gravel with minor clays.
150				20	45	[illegible]		[illegible]		5				clay traces in gravels and sands - subrndd frags.
				[illegible]	45	15		[illegible]		10				clayey GRAVEL - ANG. TO SUBANG. FRAGS. -rded gravels but frags may
				[illegible]	45	25				10				originally have been a good deal larger.
				[illegible]	[illegible]	[illegible]				[illegible]				GRAVELS CONTAIN ASH layer (white) same as @ 45-75' deep
				[illegible]	[illegible]	[illegible]				[illegible]				GRAVEL CONTAINS SOME UNCONSOLIDATED clays and sands. NO ASH VISIBLE
				25	45	15				15				clasts are ANG. TO SUB ANG. - shapes derived from drilling(?)
240				25	45	15				15				clayey Gravels same as previously described
				25	45	10	5			15				ABUNDANT SANDS with some clay and Gravels - med. GR. sand
				30	45	5	5			15				sands are mod. sorted. gravel may be med to coarse GR.
				25	45	10	5			15				clays are unconsolidated - matrix in gravels? sc ash-contam?
				25	45	10	5			15				clays are moderately abundant. sand & gravel still compose
				25	45	10	5			15				more than half the sample. clays probably abundant enough
				25	20	15	5			10				to plug any porosity in the gravels.
				25	50	15	5			10				gravels are med GR. - subang frags. med sands, unconsol. clays
360				25	50	15	5			10				
375				40	35	15	-	[illegible] 5		10				Increase in Rhyolitic tuffaceous rock
				75	10	10				5				Arenaceous tuff? Weak clays.
				85	5	5				5				Slight increase in Qz + Gr. Weak clays.
				75	5	5				10				Sheet _____

MINERA UTAH DE CHILE INC.
ESCONDIDA PROJECT

RDH 24 SCALE ___
GEOLOGIST C. Touard DATE 8-May-83

PROJECT WATER Program
Failing

	Lithology	% Gravels	% Sands	COMPOSITION Rhyolites	Granites	Andesite	Basalt	Sedimentary Rocks	Volcanic Rocks	Qtz	% Silt	% Clay	%	OBSERVATIONS
				10				TUFFS 70		20				SANDY TUFFS. w/30% of Rhyolitic gr fragm ab qtz fragm. of (.5 mm TUFFS)
				10				70		20				SANDY TUFFS 10% Lito fragm. 90% TUFFS fragm (+ qtz)
				15				70		15				SANDY TUFFS Pink TUFFS w/ q-eyes + biot ba
				15				70		15				SANDY TUFFS. 15% Rhy Clasts, the rest TUFFS
495				10				75		15				TUFFS
				15	2	3		60		20				CLAYED TUFFS Brown Clay
				5				75		20				CLAYED TUFFS.
540				5				70		25				CLAYED TUFFS.
				15	5	5		60		20				CLAYED SANDY TUFFS(?) TUFFS interbedded w/ Rhyolite(?)
				8		(?) 2		65		25				CLAYED TUFFS pink-brownish tuffs w/ q-eyes + biotite books, porous. Rhyolite cl. + abundant qtz xx.
				10		2		60		28				CLAYED TUFFS
600				10		5	5	60		20				CLAYED TUFFS.
				15		10	(?) 5	60		20		5%		CLAYED GRAVELLY TUFFS 25% Clasts x̄ 2-3mm.
				20		10		50		20		10		CLAYED SANDY TUFFS. (increase in the lithic clasts)
				30	5	10		40		15		10		FINE GRAINED GRAVELS, x̄ 3mm. Coarse gr. sands; brown clays TUFFS.
		10%		35	5	5		40		15		15%		
		5%		35	5	10		40		10		15%		40% Pink TUFFS. 40% very coarse grained sands, clasts mainly rhy. 5% fine gr gravels x̄ 3 mm
690				40	5	5		40		10		15%		TUFFS, coarse grained sands, clays.
				45	5	10		30		10		10%		coarse gr. sands, fine gr gravels. tuffs + clays.
				43	2	15		25		10		10%		ID.
				40	10	10		25		15		10%		GRAVELLY SANDS coarse gr. sands & fine gravels tuffaceous matrix.
				45	15	10		15		15		5%		SANDY GRAVELS. - Conglo subrounded fragm. x̄ 2-3mm. Tuff matrix
				45	10	15		15		15		5%		SANDY GRAVELS coarse gr. sands.
				40	15	15		15		15		5%		SANDY GRAVELS coarse gr. gravels x̄ 3-4mm. fine gr. sands.
				45	15	15		10		20		5%		SANDY GRAVELS.
				40	15	15		20		20		5%		GRAVELLY SANDS Subround fragm.
				40	10	15		25		20		5%		SANDY GRAVELS. Fine gr. gravels x̄ 2-3mm tuff around matrix.
				40	10	15		25		20		10%		Sandy Gravels. Tuffaceous

Sheet ___ ___

MINERA UTAH DE CHILE INC.
ESCONDIDA PROJECT

RDH 24 SCALE ______
GEOLOGIST C. ROMBARD DATE 14-MAY-83

PROJECT WATER PROGRAM – FAILING
QDA LA TORTA.

	Lithology	% Gravels	% Sands	COMPOSITION Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam Rocks	Qtz.	% Silt	% Clay	%	OBSERVATIONS
		—	—	40	15	10		TUFFS 20		15		H 10%		–
890		—	—	40	15	10		TUFFS 20		15		H 10%		SANDY GRAVELS sub rounded fragm
		H 10%	—	40	15	10		20		15		H 10%		GRAVELLY SANDS coarse + fine gd sands
		H ½	—	35	10	10		25		20		H 10%		GRAVELLY SANDS coarse gr + fine
		H 5%	—	40	10	10		20		20		H 8%		grained sands. clays subordinated
		H 2%	—	45	5	10		25		20		H 8%		tuffaceous matrix
		H 10%	—	45	5	5		20		25		H 10%		

EOH 945 FT.

Sheet ______

MINERA UTAH DE CHILE INC.
ESCONDIDA PROJECT

RDH ES-28 A
GEOLOGIST T. Vila SCALE
DATE 23 [illegible]

PROJECT WATER PROGRAM.

	Lithology	% Gravels	% Sands	COMPOSITION: Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks (Pumice and/or white rhyol)	Metam. Rocks	Otr.	% Silt	% Clay	tuffaceous matrix	OBSERVATIONS
		10%		80		10		5		5				Mod-well sorted, angular-sub rounded clasts medium-coarse sand Tuff+clay mx Pumice ?
		10%		80		10		5		5				Idem
			30	85		5		5		5				Idem
		30		80		5		5		10				Poorly sorted coarse sand. Angular (1-3 cm) fragments of rhyolites Tuff + clay mx ?
				75		5		10		10				Well sorted angular frag. coarse sand. Tuff + clay mx?
		10%		80		10		5		5		5%		Mod sorted angular frag coarse-fine sand Tuffaceous mx.
		5%		70		5		10		15		5%		Mod sorted coarse sand Pumice frag. Tuffaceous (& clay) mx
		5%		70		5		5		20				Mod-well sorted coarse sand Some 1-2 cm frag [illegible] in Gz
				75		5		10		10		5%		Mod sorted, angular frag. med-fine sand scarce Pumice, Tuffaceous mx.
		10%		60		5		30		5				Mod-well sorted [illegible] ang med sand Pumice fragm. Tuffaceous mx
				60		5		30		5				Mod sorted [illegible] round frag med sand Tuff + clay mx
		5%		70	5	5		15		[illegible]		5%		Sands, [illegible] fragments well-mod sorted Tuff mx, Scarce Gz ??? Pumice fragm
		10%		75		5		15		5		5%		Mod sorted angular-ang sands ang frag gravel Pumice [illegible] Gz
				70	5	5		10		10		5%		Gravelly sands frag. mod sorted [illegible] Tuff + clay [illegible] matrix 1-2 cm Pumice frag.
				75		10		10		5		5%		Well sorted ang frag. Sands No gravel Frag. along. Pumice frag
				70	5	10		5		10				Mod sort sub-ang frag Sands Less matrix. Gz grains mod.
				75	5	10		5		5				Mod sort. subang frag 2-3 cm ang fragm. gravels. No clay
		5%		75	5	10		5		10				Idem.
		10%		80		10				10				Mod sort ang frag Sands Angular frag. (2-4 cm) rhyol No clay Tuffaceous mx
		5%		80		10				10				Mod-well sort frag fine-med sand. 1-2 cm ang. frag rhyol Fine sand + tuff. mx
		5%		85		10				5				Well sort fine sand No clay. Tuffaceous mx.
				80		15				5				Very well sort. med. sand No clay, scarce tuff mx.
				80		15				5		5%		Idem. little more tuff + clay mx.
				85		10				5		10%		Idem.
		5%		85		5				10		5%		Idem. Angular frag. med sand.
		5%		80		10	5			5		5%		Idem. Sub-ang to well round frag. med-sand
				75		10	5			10				Idem Round. well sorted frag. Weak tuff + clay mx.
				75		15	5			5		5%		

Sheet 1

MINERA UTAH DE CHILE INC.
ESCONDIDA PROJECT

RDH Es-28 A
GEOLOGIST T. Vila
SCALE
DATE 29/05/85

PROJECT

Pumice (white tuff).

	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz	% Silt	% Clay	Tuffaceous matrix	OBSERVATIONS
				75		10	5	5		5		5%		Very well sort. fine-med sand. Tuffaceous - clay? mx
	Tuff			75		5		15		5		5%		well sorted fine sand Pumice-rhyol. rounded frag. Tuffaceous + clay? mx
				60		10		35		5				Idem Increase in pumice - white tuff?
								95		5				Only white-tuff pumice well round. frag. Tuffaceous mx.
								95		5				Idem.
	Tuff			40		5		50		5		5%		Med-fine well sort. sand. Tuffaceous mx (clay?)
				5				70		5		5%		Idem.
				40		5		50		5		10%		Idem Some ang frag of rhyol.
				55		5		35		5		10%		Well-mod sorted round.-sub ang frag. Increase in white pumiceous mat.
		15%		80		10	5			5		5%		Mod. sorted, subang. med sand frag. Tuff + clay mx
		15%		75		10	10			5		10%		Idem
		10%		70		15	5			10		10%		Idem. Some 1-2cm ang. rhy frag. Tuffaceous mx
		5%		80		10	5			5		5%		Idem.
				80		10		5		5				Idem. Slight increase in white tuff?
				70		10		10		10		5%		Well sorted fine-med sand subrounded frag. Tuffaceous mx.
				70		10		10		10		10%		Idem Increase in white tuff-pumice? Change in colour from dark brown to greenish brown
				80		5		10		5		5%		Mod-well sorted angular frag sands white rhyolite? ang. fragments
				80		5		10		5		5%		Idem. Increase in white rhyol frag %
				80		10		5		5		5%		Idem.
		5%		85		10				5		5%		Idem. Increase in white rhyol frag %.
				85		10				5		5%		Idem. Increase in white rhyol frag % and angularity. Rock???
				85		10				5		5%		Idem. Angular frag
				85		10				5		5%		Idem.

Sheet 2

MINERA UTAH DE CHILE INC.
ESCONDIDA PROJECT

RDH- 28 SCALE ______
GEOLOGIST C. HOLLAND DATE ______

PROJECT WATER Program

	Lithology	% Gravels	% Sands	COMPOSITION Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz.	% Silt	% Clay	% [illegible]	OBSERVATIONS
				10	20	10	10	TUFFS 45		5				CLAYED SANDY GRAVELS FINE GD SAND. SUBROUNDED CLASTS. TUFFS AS FRAGMENTS!
		5%		+ -	-	-				+			20% TUFF MATRIX	GRAVELLY SANDS Light greenish brown color. ∅ 0.5mm. TUFFACEOUS MATRIX.
		10%		PINK 80	5	5				10				GRAVELLY SANDS. FINE GD. SANDS 10% clasts, subrounded. TUFFACEOUS matrix w/ abund qtz & biotite books
		15%		65		5	15			15			TUFF	GRAVELLY SANDS. FINE GD SANDS and coarse gd (∅1-2mm). Subround to subang cl. ALSO CLASTS OF WELDED TUFFS.
				55		5	5	*(1) 20		15		5%		SANDY GRAVELS. Subrounded fragm the sands, most of the clasts qtz. TUFFACEOUS MATRIX
				40			5	PINK-YELL 30		25		5%		SANDY TUFFACEOUS GRAVELS TUFF MATRIX, CLASTS MAINLY VOLCANIC Light pink pumicitic TUFF, qtz, pink rhyol
		10%		30			10	40		20		5		GRAVELLY SANDS FINE GD. & coarse gd
		10%		50		5	5	20		20		5%		GRAVELLY SANDS COARSE GD SANDS, FINE GD SAND. TUFFACEOUS MATRIX. SUBROUNDED CL. ∅ 2-3mm
		5%		60		5		5		30				Sands, more than 50% rhyolite clasts subrounded to rounded clasts. No clay
		10%		60		5		5		30				Sands, some 10% gravels, mainly of rhyol comp. No clay, matrix of tuffaceous comp.
		5%		40	5	10	10	5	5	25		10%		Coarse sands, slight increase in clay cont. Gr & mod clasts angular - sub round
		15%		60		20	5	5		10		5%		Coarse sands, moderate - poorly sorted weak clay & tuff matrix. Sand
		5%		60		20	5			15				Sand, no clay subrounded. Larger clasts mainly rhyolitic, yellowish
				75		10				15				Moderate sorted gravelly sands. Angular to subrounded fragments. Tuff matrix
		15%		65		10	5			20				Mod-well sorted sands. Angular frags. No clay - Tuffaceous matrix
				70		10	5			15				Idem -
		5%		70		10				20		5%		Mod. sorted gravelly sands. Weak clay Tuffaceous matrix
		10%		75		5				20		5%		Sands well-mod sorted weak clay. Angular fragments Tuff. matrix
		5%		70		5	5			20		15%		Increase in clay content (nodules)
		5%		60		15	5			20		15%		Clay appears in nodules, similar to 300-35. No to scarce gravel Tuff. matrix.

Sheet ______

(1) TUFF - PUMICITIC YELLOWISH-PINKISH - POROUS TUFF SUB-ROUNDED

LECC..IDA PROJECT GEOLOGIST I.V.ia DATE 16-17/07/83

PROJECT WATER PROGRAM.

Depth / Unit	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	white tuffs + pumice	Qtz	% Silt	% Clay	tuffaceous matrix	OBSERVATIONS
0 silty sand!		5%		75	5	5			5	10				Areaceous clay. Scarce rounded frag. of fine gravel. Polimictic sediments.
10				70	10	5			5	10				Gravel. Big (5cm) ang. fragment. Matrix is mainly fine-med sand. (Coarse-med gravel)
20 sandy gravels				65	10	10				15				Fine sandy gravel. No to scarce sandy matrix. Ang-sub rounded fragm. Polimictic
30				75	5	10				10	5%			Idem. Slight increase in med-gravels frags.
40				70	10	5				15				Strong increase in very fine, Qz rich sand. Gravelly fine sand
50 sandy gravel				75	5	10				10				Sandy gravels. Decrease in Qz rich sand
60				75	5	5			5	10				Idem -
70		15%		75	5	10				10		5%		Increase in silty-clay matrix in the gravelly sand
80				75	5	10				15				Fine sandy gravel. Scarce sandy, Qz rich matrix
90				75	5	10				15				gravelly fine-med sand (Qz rich) frag. of med gravel.
100				60	5	10			5	20				Idem. Decrease in gravel
110 sands				70	5	5				20				Very well sorted, Qz rich fine grained sand. Scarce gravel fragments
120				70	5	5				20				Idem. -
130 fine Qz-rich				60	5	5				25				Idem. -
140				70	5	5				20				Idem. Slight increase in ang. gravel frag. % and size
150				70	5					25				Idem
160				70	5					25				Idem. Increase in gravel fragments.
170 sandy gravel				75	5					20				Sandy gravels. Angular fragments of med gravel
180				70	5					25				Idem. Increase in sandy, Qz rich matrix
190				70	5	5				25				Gravelly sands.
200 sands				80						20				Very well sorted fine sands + fine gravel fraction (change to med)
210		15%		70		5				25				Idem.
220				70		5				25				Idem.
230				70	5	5			-	20				Increase in ang. frag. of fine gravel.
240				70	5	5				20				Idem. -
250				70	5	5				20			10%	Idem. - Slight decrease in gravels.
260				70	5	5				20			10%	Idem.
270				70	5	5				20		5%		Idem. - Start of pinic clay

S.L. ← 130

Sheet 4

ESCONDIDA PROJECT

GEOLOGIST I. Vila DATE 16-13/07/83

PROJECT

	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
				70	5					25				Start clays. Clayed fine sand.
				80	5					15				Clayed fine sand
				85	5					10				clay + fine sand
				80	5					15				Slight increase in sand
		5%		80	5					15				Clayey sand. Scarce fine gravel frag
				85	5					10				Sandy clay
				80	5					15				clay
				80	5					15				Sandy clay
EOH														

Casing Program

0-160	8 blank casing 8"	
160-560	18 screen casing 8"	(21'9")
560-580	1 blank casing 8"	

Sheet 2

ESCONDIDA PROJECT

GEOLOGIST T. Vila SCALE DATE

PROJECT WATER PROGRAM.

	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
				75	5	5				15	~10%			Sandy fine grained gravel. Ang. frag.
				65	10	10				15	~10%			Idem. Increase in frag. size
				60	10	10				20				Fine grained gravel. Some big (5cm) ang. frag.
				65	10	5				20	~10%			Gravelly fine grained sand.
				75	5	5				15				Sandy fine-med. grained gravel.
														Brownish ignimbrite (welded tuff)
														Idem.-
				75	5	5				15				Sandy gravel. Ang. fragm. of tuff? contamination.
				70	10	5				15				Idem.-
				65	5	5	5			20				Idem.-
				70	5	10	5			10				Medium to coarse grained gravel
				75	5	10	5			5				Idem. Sandy matrix
				75	10	5	5			5				Idem. Slight increase in sandy matrix. Decrease in frag. size.
				70	5	10	5			10				Idem.-
				75	10	5	5			5				Clayed sandy gravel. Ang. fragm.
				65	10	10	10			5				Clayed gravel.
				70	5	10	5			10		~10%		Sandy (clay) gravel.
				70	5	10	5			10		~10%		Sandy clayed gravel.
				70	5	10	5			10				Sandy gravel. Med. grained ang. frag.
				75	5	10				10		~10%		Idem. Slight clay.
				60	5	5				30				Clayed fine grained, Qz rich sand
				60	5	5				30				Idem.-
				70	5	10	5			10				Clayed sandy gravel
				70	5	10	5			10				Idem
				70	5	10	5			10				Idem
				75	5	10	5			5				Clayed gravels
				75	5	10	5			5				Idem. Red plastic clays fragments
				80	5	10				5				Idem

Sheet 1

MINERA UTAH DE CHILE INC.
ESCONDIDA PROJECT

RDH FS-46
GEOLOGIST T. Vila
SCALE
DATE 30/7/83

PROJECT WATER PROGRAM -

	Lithology	% Gravels	% Sands	Rhyolites (Tuff)	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz.	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
				70	5	10	5			10				Clayed Sandy gravel
				75	5	5		10		5				gravel. Sandy matrix. Fragments of bright orange ignimbrite
GRAVAS				75	5	10		5		5				Medium-fined grained gravel, Sandy matrix. Ang. fragm.
				75	5	10				10				Idem.
				75	5	10				10				Idem
				75	5	10				10				Idem
				75	5	10				10				Idem
				75	5	10				10				Idem
gravelly clay				75	5	5				10				Red plastic gravelly clay.
				80	5	5				10				Idem
				80	5	5				10				Idem
				80	5	5				10				Idem -

Sheet 2

…NERA UTAH DE CHILE INC.
ESCONDIDA PROJECT

RDH ES-49
GEOLOGIST F. Garcia
SCALE
DATE 14-08-83

PROJECT WATER PROGRAM

Depth	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Tuff Dacite	Sedimentary Rocks	Metam Rocks	Qtz	% Silt	% Clay	%	OBSERVATIONS
20				40	10	20			10	20				Coarse sand - gravel scarse
40				30	10	20			10	30				Coarse sand - some gravel
60				30	10	20			10	30				coarse sand - fine gravel
80				30	10	20			10	30				coarse sand - fine gravel
100				30		20			10	40				Coarse sand - magnetite
120				30	10	10			10	40				coarse sand - magnetite
140				30	10	10			10	40				coarse sand - some magnetite
160				30	10	20			10	30				coarse sand - some magnetite
180				30	10	20			10	30				coarse sand - some magnetite
200				30	10	20			10	30				coarse sand
220				30	10	20			10	30				coarse sand
240				40	10	20			10	20				Coarse sand - some magnetite
260				40	10	20			10	20				Coarse sand - some magnetite
280				40	10	20			10	20			→	coarse sand - some magnetite 280 first water flow
300				40	10	20			10	20				carse sand - some magnetite water increase - 3400 μho
320				40	10	20			10	20				coarse to medium sand - magnetite some fine gravel
340				40	10	20			10	20				coarse to medium sand - magnetite some fine gravel
360				40	20	20			10	10				coarse sand to fine gravel fine magnetite
380				40	10	20			10	20				coarse to medium sand fine magnetite
400				40	10	20			10	20				coarse sand - some fine gravel fine magnetite - Water 3400 μho
420				40	10	20			10	20				coarse sand - some fine gravel fine magnetite - Change to med-pink [illegible]
440				30	10	20			20	20				Sandy red clay - impervious
460				30	10	20			20	30				sandy red clay - Impervious
480				30	10	20			20	20				sandy red clay - Impervious
500				10	10	10	50		10	10				clayish brown sand - coarse - Impervious abundant tuff grains
520				10	10	20	30		10	20				clayish brown coarse sand - Impervious abundant tuff grains
540				10	10	20	30		10	20				clayish brown coarse sand - Impervious abundant tuff grains
560				10	10	20	30		10	20				[illegible] coarse sand - Impervious [illegible] - tuff [illegible]

Sheet

MINERA UTAH DE CHILE INC.
ESCONDIDA PROJECT

RDH *ES-49* SCALE ____
GEOLOGIST *E. García* DATE *14-08-83* / *15-08-83*

PROJECT *WATER PROGRAM*

Depth	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Tuff Dacites	Sedimentary Rocks	Metam. Rocks	Qtz.	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
560–580			—	20	10	10	20		20	20		—		clayish brown coarse sand - Impervious Some tuff grains
580–600			—	20	20	20			20	20		—		Clayish brown coarse Sand - Impervious
600–620			—	20	20	20			20	20		—		clayish brown coarse sand - Impervious
620–640			—	20	20	20			20	20		—		clayish brown coarse sand - Impervious
640–660			—	20	20	20			20	20		—		clayish brown coarse sand - Impervious
660–680			—	20	20	20			20	20		—		clayish brown coarse sand - Impervious
680–700			—	20	30	30			10	10		—		clayish brown coarse sand - Impervious
700–720			—	20	30	30			10	10		—		clayish brown coarse sand - Impervious
720–740			—	20	30	30			10	10		—		clayis brown coarse sand -
740–760			—	20	30	30			10	10		—		clayis brown coarse sand -
760–780			—	20	30	30			10	10		—		clayish brown coarse sand - [illegible]
780–800			—	20	30	30			10	10		—		clayish brown coarse sand - Impervious
800–820			—	20	30	30			10	10		—		clayish brown coarse sand - Impervious 820 Total depth 5 5/8 Tricone

Sheet ____

~~ESCONDIDA PROJECT~~ (T-2)

GEOLOGIST L. Garcia SCALE DATE 15-08-83

16-08-83 08 hrs. reparaciones

PROJECT WATER PROGRAM

Depth	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalt	Sedimentary Rocks	Metam Rocks	Qtz.	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
0–20				40	10	20			10	20				clayish red sand - Impervious
40				[illegible]	10	20			10	20				sandy red clay - Impervious
60				[illegible]	20	30			10	10				sandy red clay - Impervious
80				30	20	30			10	10				Sandy red clay - Impervious
100				30	20	30			10	10				Sandy red clay - Impervious
120				30	20	30			10	10				Sandy red clay - Impervious
140				20	30	30			10	10				clayish red fine gravel - Impervious → 140 ft first water 4300 μmho
[illegible]				20	30	30			10	10				Sandy clean fine gravel - Pervious
[illegible]				30	30	30				10				sandy clean fine gravel - Pervious water 1706 μhs
[illegible]				30	30	30				10				Sandy clean medium sub rounded gravel - Pervious
[illegible]				30	30	30				[illegible]				Clean medium sub rounded gravel Water abundant - Pervious; Hrs 8:00 hrs 16-08-83 Reparaciones:
240				50	10	[illegible]				10				Idem-
260				60	10	20				10				Clayed gravel w/ abundant silty matrix
				60	10	20				10				Gravelly silt-clay. Avg. fragments
				60	10	[illegible]				10				Clayed gravel. Ang fragments fine grained
				60	10	[illegible]				10				Idem -
				65	10	20				5				Idem -
				65	10	20				5				Idem -
				70	5	20				5				Idem Very angular fragments
				70	5	20				5				Idem
				70	5	20				5				Gravel. Ang. fragments. Medium to fine grained
				70	5	20				5				Idem -
				65	5	20				10				Gravelly clay. Fine to medium grained fragments
				65	5	20				10				Idem
				65	5	20				10				Idem -
				70	5	20				5				Clayed gravel. Fine-medium grained Ang. fragments
				65	5	20				10				Light brown gravelly silt
				65	5	[illegible]				10				Idem-

Sheet 1

ESCONDIDA PROJECT

RDH [illegible]

GEOLOGIST J. V. [illegible]

SCALE

DATE 23/8/[illegible]

PROJECT ____________________

	Lithology	% Gravels	% Sands	COMPOSITION Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz.	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
	0.0			70	5	20				5				Clayed fine grained gravel Ang. fragments.
														Idem
E.O.H														
														Rosa 1 - 200 ft 9 7/8
														Sc[illegible] 100 - 280 [illegible] 6
														[illegible] 280 - 342'
														[illegible] 0 - 110'
														[illegible]
														0 - 170

Sheet 2

MINERA UTAH DE CHILE INC.
ESCONDIDA PROJECT

RDH ES-54-A
GEOLOGIST T. Vita
SCALE —
DATE 27/09/83

PROJECT WATER PROGRAM

Depth / Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
													Brown reddish plastic clay (+silt)
													Idem.-
CLAYEY GRAVEL													Med. grained, clayey gravel.
			50	10	20				30				Med-coarse grained gravel. Ang. fragments, probable boulders in clay-silt matrix
			60	10	30				10				Gravelly clay. Ang. fragments, scarce sand in matrix
			40	10	40				10				Clayey coarse grained gravel. Fresh ang. fragments
			40	10	40				10				Idem.-
			20	20	40				20				Coarse grained gravel. Angular fragments, scarce clay matrix
			30	20	30				20				Idem. Relatively clean sediments
			40	10	40				10				Med grained gravel. Decrease in fragment size, increase in clay matrix
			40	10	30				20				Idem.-
CLAYEY GRAVEL			50	10	30				10				Idem. Increase in clay.
			40	20	20				20				Coarse grained gravel fresh angular fragments. Decrease in clay
			30	10	40				20				Idem.-
													Red brownish plastic clay.
CLAY													Idem
													Idem.-
E.O.H.													

Sheet 1

ESCONDIDA PROJECT

RDH ES-4 SCALE

GEOLOGISTS: Maigard DATE 6/OCT/93

PROJECT --- Water Program.

Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Ign. Rocks	Qtz	% Silt	% Clay	Tuffaceous Matrix	OBSERVATIONS
	?		No sample										SANDY GRAVELS subangular to subrounded
			30		10			50	5			5%	fragments. ⌀ 0,2–0,5 cm ?. 5% tuffaceous matrix.
			30					55	10				iD
			25					60	10			Tuff. matrix	iD
			25					60	15				GRAVELLY SANDS, TUFFACEOUS matrix 10% clasts, ⌀ 0,3 cm.
			30					55	15				SANDY GRAVELS fine gd gravels subangular d. mainly 1 cm + [illegible]
			30			tr.		60	10				SANDY GRAVELS, tuffaceous matrix
		20%	29		1			60	10			25%	Sandy gravels iD. Slight increase in tuff. [illegible] clasts mainly of [illegible]
			25					60	15				TUFFACEOUS SANDY GRAVEL subangular clasts, in a tuffaceous matrix
			20					60	20				TUFFACEOUS SANDS, GRAVEL – subar-
	2%		25					60	15				TUFFACEOUS SANDS coarse gd sands in a tuffaceous matrix.
	10%		24		1			60	15				GRAVELLY, tuffaceous SANDS. subangular clasts.
	10%		18		2			60	20				iD.
	10%		20					55	25				tuffaceous sands Subangular clasts. Abundant Qtz fragm.
	10%		15					55	30				iD.
			10					60	30				TUFFACEOUS sand qz subord. abundant qtz ~1 cm [illegible]
	1?%		10		2			58	30				TUFFACEOUS SANDS subang. fragm
	5%		10					60	30				TUFFACEOUS SANDS
			10					70	20				GRAVELLY tuffaceous sands subang. clasts. Rhy w/ALT + min
			20					70	10				fine gd sands, fine gd subangular gr, iD tuff. matrix
			25					65	10				GRAVELLY tuff. sands.
			30					60	10				SANDY GRAVELS sub ang. clasts. volc.
		5%	25					70	5		5%		TUFFACEOUS gravels clays subord.
	5%	5%	25					70	5		25		tuffaceous clays. gravels + sands sub.
	15%	5%	25					70	5		15%		gravelly tuffaceous Sands, Clays subord.
	1?%	5%	15					80	5		15%		iD. TUFFS; gravels, clays + sands subord.
	15%	5%	25					70	5		10%		iD. slight increase in the gravel content.
	15	5	22		1	2		70	5		5%		iD.

Sheet ______

ESCONDIDA PROJECT

RDH ES-5+ SCALE

GEOLOGIST C. TOUGARD. DATE

PROJECT WATER Program.

Depth	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Ign + Tuffs	Qtz	% Silt	% Clay	Tuffaceous matrix	OBSERVATIONS
580		10%		20			5		70	5		10%		TUFFACEOUS clays gravels subordinated
600		5%												TUFFACEOUS CLAYS gravels (-)
620		5%	5%	25					70	5				TUFFACEOUS clays GR + sands (-)
640		3%	7%											TUFFACEOUS clays sands and gravels subordinated 70-80% tuffs 20% clays 20-10% SANDS + GR
660		5%	5%											
680		3%												
700		5%												
720		5%		CLASTS mainly of [illegible] and [illegible] subordinated rhyolites										TUFFACEOUS clays.
740		5%												ID
760		5%												ID
780		2%												ID
800		15%												ID
820		3%												TUFFACEOUS CLAYS.
840		2%												Brown plastic clays + Pinkish - brownish tuffs.
860														

EOH 860 FT.

Sheet

ESCONDIDA PROJECT

RDH ES-58 SCALE

GEOLOGIST I. Vila DATE 13/10/83

PROJECT WATER PROGRAM-

	Lithology	% Gravels	% Sands	Rhyolites	Granites	Andesite	Basalts	Sedimentary Rocks	Metam. Rocks	Qtz	% Silt	% Clay	% Travertine Limestone	OBSERVATIONS
				30	10	30				30				Fine grained, very well sorted sand, scarce fine gravel
				60	10	10				20				Med. grained sandy gravel sub-rounded fragments.
				70	5	10				15				Med. grained gravel.
				70	5	10				15				Med. grained gravel.
				70	5	10				15				Med. fine grained sandy gravel.
				70	5	5				20				Fine grained, Qz rich gravelly sand.
				70	10	10				10				Sandy silt.
				60	5	15				20				[illegible]
S.L.				70	·	10				20				Idem.
				70		5				25				Idem.
				70		5				25				Idem
				65		10				20				Idem
				70		5				20				Idem
				75		10				15				Silty (gravelly) sand.
				80		10				10				Idem slight increase in silt-clay
				80		10				10				Idem
				75	5	10				10				↓
				75	5	10				10				↓
				75	5	10				10				↓
				75	5	10				10				Dark brown to reddish brown clay, white calcareous-siliceous
														chert? fragments.
														Idem
														Idem
														Light reddish plastic clay. White calcareous nodules. Chert like angular fragments.
														↓
														↓

Sheet 1

POZO : UN Nº 31

UBIC. : AL NNE DEL SALAR
Coordenadas: 7286464N; 512001E

COTA TERRENO: 3003 s.n.m.

Profundidad

De	Hasta	Descripción Litológica
0.00	7.70	Grava mediana y gruesa arenosa-limosa subredondeados
7.70	22.00	Grava mediana y fina, limosa.
22.00	32.57	Grava arenosa-limosa. Clastos redondeados angulosos
32.57	37.40	Ceniza volcánica y lapilli, limosa.
37.40	43.50	Arena gravosa.
43.50	47.38	Grava mediana y gruesa, arenosa.
47.38	50.40	Grava mediana y fina, arenosa-limosa.
50.40	57.00	Arena gruesa, gravosa. Clastos angulosos redondeados.
57.00	82.00	Ceniza volcánica, en parte consolidada.
82.00	112.00	Ceniza volcánica, arcillosa-limosa.
112.00	122.00	Ceniza volcánica muy fina, limosa.
122.00	134.00	Grava y arena un poco arcillosa.
134.00	198.00	Estratos de arcilla y limo.
198.00	218.00	Grava arenosa.
218.00	262.00	Arcilla.

SECTION

MINERA UTAH DE CHILE, INC.
Antofagasta, Chile

WELL T-1 PUMP TESTS:

ANALYSIS OF RESULTS

November, 1983

DAVID KEITH TODD
Consulting Engineers, Inc.
Berkeley, California

CONTENTS

INTRODUCTION

This report describes tests conducted on well T-1 on October 8 and October 11-24, 1983. Step-drawdown and constant discharge tests were performed. Field measurements of levels, pumping rates, and water quality were made over time. The data were analyzed to evaluate well efficiency, transmissive and storage characteristics of the aquifer, and water quality. All basic data are tabulated in the appendix.

The purpose of this report is to provide information about hydrogeologic conditions around Salar de Punta Negra so that a preliminary design of a well field to supply water for Escondida mining operations can be prepared.

This is the first of five planned reports describing and analyzing pump tests around the salar.

Test Conditions

The relative locations of T-1, ES-28A, and ES-5 are shown on Figure 1. UN-31 is not shown on the figure, but it is located 2036 meters, N 25 degrees West of the pumping well, T-1.

The salient well construction features are shown on Figure 2. It is clear that the wells are screened across the same aquifer unit but have different percent penetrations. Well T-1 penetrates 60% of the aquifer while ES-28A and ES-5 penetrate 72% and 66% of the aquifer, respectively. The specific capacity of T-1 is reduced somewhat (perhaps by 30%) because of its partial penetration, but the drawdown obtained in ES-28A and ES-5 are, for practical purposes, unaffected.

Water level measurements were taken in ES-28A and ES-5 on a logarithmic frequency with electric sounders. Water level measurements were taken daily in UN-31 for background data. The apparent accuracy of the measurements based on the "noise" level of the ES-5 semi-log plot, is about 0.01 meter (0.4 inch). The data sheets from the test are shown in the appendix.

Flow measurements were taken every 1 or 2 hours using a totalizing flow meter and were recorded to the nearest one thousand gallons. The average flow rate was 558 gpm. (2.11 m^3 / min.) with the maximum being 650 gpm and the minimum being 433 gpm. The low flow rates occurred when the pump work was shut off for 10 to 15 minutes for maintenance.

The test was inadvertently terminated 18,242 minutes after pumping started due to a power failure. The power failure was recognized immediately and recovery measurements were taken in wells T-1 and ES-28A.

In summary, except for the power failure, there were few major problems with the test and adequate data were collected for a reliable determination of the transmissivity of the aquifer in the vicinity of T-1. Only a rough estimate could be made, however, of the specific yield because of the test's early termination.

Step-Drawdown Test on Well T-1

A step-drawdown test was conducted on October 8, 1983,for the purpose of estimating well T-1 efficiency.

The discharge rate was begun at 380 gpm for 123 minutes, stepped up to 480 gpm for 128 minutes, and finally set at 560 gpm for 124 minutes. The resulting drawdowns were plotted versus time on a semi-log graph as shown in Figure 3.

The incremental drawdowns were obtained at incremental times of 123 minutes. The ratios of incremental drawdown to incremental flow rate do not increase, however, as they should, even for very efficient wells. Either the well was very unstable during the test, becoming much more efficient, or there were significant errors in data measurements, particularly the flow rates. In either case, it is not possible to derive a well loss coefficient from the step-drawdown data.

It seems from the constant discharge test data on well T-1 that, indeed, well T-1 is very efficient. The calculated transmissivities from the T-1 data are nearly the same as the transmissivity values obtained from ES-28A data.

Assuming well T-1 to be 100% efficient, the theoretical drawdown just outside the gravel pack at t=30 minutes would be about 13 meters. Since the actual drawdown was 17.4 meters, the difference in drawdown is about 34%. When the drawdown due to partial penetration is taken into account and the seepage face is considered, the losses due to well construction and clogging are probably quite small.

Well ES-28A Analysis

Well ES-28A provides the best data with which to determine the aquifer properties because of its proximity to the pumping well, T-1, and its high ratio of aquifer penetration (about 70%).

A semi-log graph of the drawdown versus time in ES-28A is shown in Figure 4. The primary features of the graph include the typical early time curve, the straight line portion which runs for 4 to about 400 minutes, and a rapidly flattening trend followed by an upturn in the drawdown at about 7,000 minutes.

A straight-line was fitted to the early portion of the data to estimate the transmissivity. A value of 22,000 gpd/ft. was obtained as shown on the graph. By extrapolating the straight line to the zero-drawdown axis, a storage coefficient value of $7x10^{-4}$ was obtained. While a transmissivity of 22,000 gpd/ft. appears reasonable, the storage coefficient appears much too low, since available field observations indicate that the aquifer is unconfined.

The sharp flattening trend followed by the upturn in drawdown at t=7,000 minutes suggests that either a recharge boundary (very high transmissivity zone) was encountered very early or that a delayed yield condition exists, the latter often being typical of fine-grained, highly stratified unconfined aquifers. Since the flattening occurs at about the same time on the T-1 and ES-5 graphs as well, it is concluded that indeed a delayed yield condition exists. This explains the low storage coefficient obtained from the ES-28A semi-log graph, since aquifers with delayed yield effects behave as confined aquifers in the early portions of aquifer tests.

The drawdown versus time data were plotted on a log-log graph, shown in Figure 5, and analyzed according to the Neuman method. This method of analysis involves matching the early time data to a type "A" type curve and then matching the later time data, which includes the upturn in drawdown, to a type "B" type curve.

As expected, the early and late match points produce the same transmissivity: 19,500 gpd/ft. The early time match point gives an early storage coefficient of $9x10^{-4}$, consistent with the semi-log graph determination and the apparent confined aquifer response. The late time data, however, are limited so that the resulting match point is much less certain. Nevertheless, a specific yield of 0.13 was obtained, which is consistent with previous expectations for an unconfined aquifer.

An estimate of the vertical anisotropy was obtained by using the relation:

$$\frac{Kv}{Kh} = \beta \frac{m^2}{r2}$$

where Kv= vertical hydraulic conducting

Kh= horizontal hydraulic conducting

m= aquifer thickness

r= radial distance from observation well to pumped well

β= type curve parameter from curve matching = 0.007

the resulting $\frac{Kv}{Kh}$ ratio, using m= 113 meters, and r= 25.1 meters is 1:7.

The recovery semi-log graph shown in Figure 6 was used to verify previous calculations of transmissivity. The recovery data points do not form as smooth a curve as the drawdown data points, but the calculated transmissivity is essentially the same.

It is interesting to note that the calculated transmissivity from the recovery of an air-lift test on ES-28A, June 4, 1983, was 25,000 gpd/ft, which is very close to the results from the constant discharge test on T-1.

Well T-1 Analysis

The drawdown and recovery data from the pumping well T-1, were plotted on semi-log graphs and are shown on Figures 7 and 8.

The early straight-time portions of the curves give transmissivity values essentially the same as calculated from ES-28A data. The flat portions of the curves show the delayed yield effects as discussed earlier. It is likely that an increase in slope would have been seen in the recovery curve past t/t' = 3.6, corresponding to the increase in slope on the drawdown curve of t= 7,000 minutes. The increase in slope at the end of the test indicates that the delayed yield effect is weakening and the curve once again becomes coincident with the Theis type curve, as in the early portion of the test.

The similarity between the transmissivity values obtained from the T-1 data and the transmissivity values obtained from ES-28A data suggests a high efficiency for T-1.

Well ES-5 Analysis

The drawdown versus time data for ES-5 were plotted on a semi-log graph, as shown in Figure 9. Because of the large distance between ES-5 and T-1, the drawdowns are very small, reaching a maximum of about 0.2 meters. Therefore, the shape of the curve is very sensitive to measurement error. In addition, a straight-line portion does not form before the delayed yield effect takes over. Because of these uncertainties, a reliable calculation of transmissivity cannot be made. However, the average drawdowns observed at ES-5 are compatible with the calculated transmissivity.

Well UN-31 Analysis

Water level measurements were taken daily throughout the test in UN-31 to serve as background. The data are tabulated in the appendix. The range in water levels was 0.28 meters during the test. Such fluctuations would mask any drawdown data at ES-5 and would be quite apparent at ES-28A. However, such fluctuations were not evident on the ES-5 and ES-28A graphs.

Salinity Analysis

Water samples from the discharge of T-1 were taken daily and measured for specific conductance. The values are given in Table 1 and lie in the range of 8100 to 8500 μmhos/cm.

It is apparent that little change occurred during the course of the pump test.

Table 1. Conductivity of Water Samples from Well T-1

Date Sampled		Conductivity in Micromhos/cm at 25 degrees C.
October 11		8320
October 12		8200
October 13		8160
October 14		8210
October 15		8200
October 16		8260
October 17		8480
October 18		8410
October 19		8420
October 20		8452
October 21		8452
October 22		8316
October 23		8316
October 24		8160
	Mean	8311

Because there was little fluctuation in conductivity readings, this indicates that T-1 is not located in the immediate vicinity of a large salinity concentration gradient. Because all groundwater sampled originated within about 35 meters from the well, it is not possible to extrapolate these results in terms long-term water quality.

Conclusions

(1) The aquifer transmissivity within 500 meters of well T-1 is 20,000 gpd/ft.

(2) The long-term specific yield is estimated to be about 0.13; a longer pump test (30 days) would be needed to determine this value more accurately.

(3) The estimated ratio of vertical hydraulic conductivity to horizontal conductivity, Kv/Kh, is about 1/7.

(4) Well T-1 has a high efficiency; however, a well loss coefficient was not obtainable from the October 6 step-drawdown data.

(5) Water within about 35 meters of well T-1 appears to have a uniform quality with a specific conductance averaging 8311 μmhos/cm.

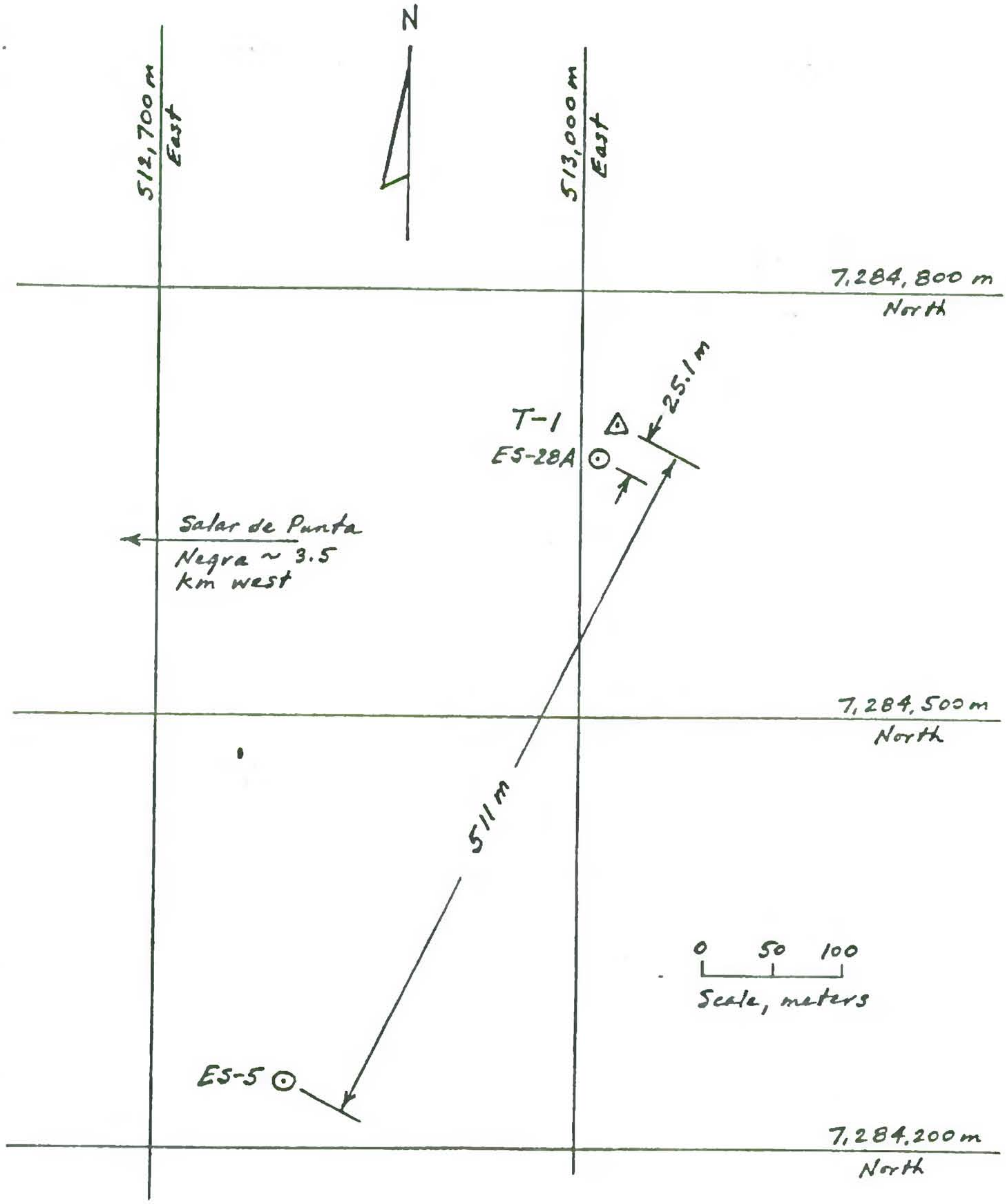

Figure 1. Location Map of
Pumped Well and Observation Wells

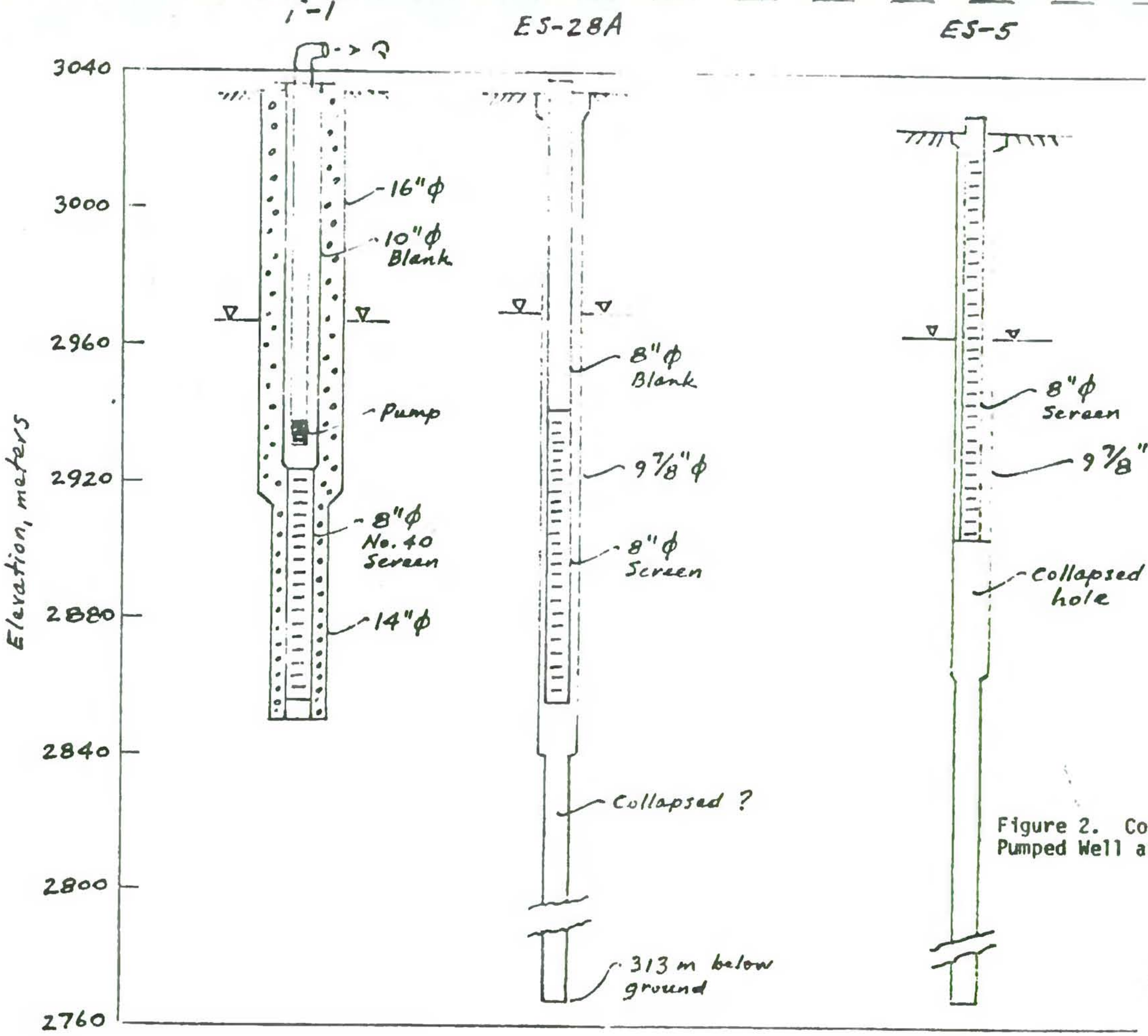

Figure 2. Construction of Pumped Well and Observation Wells

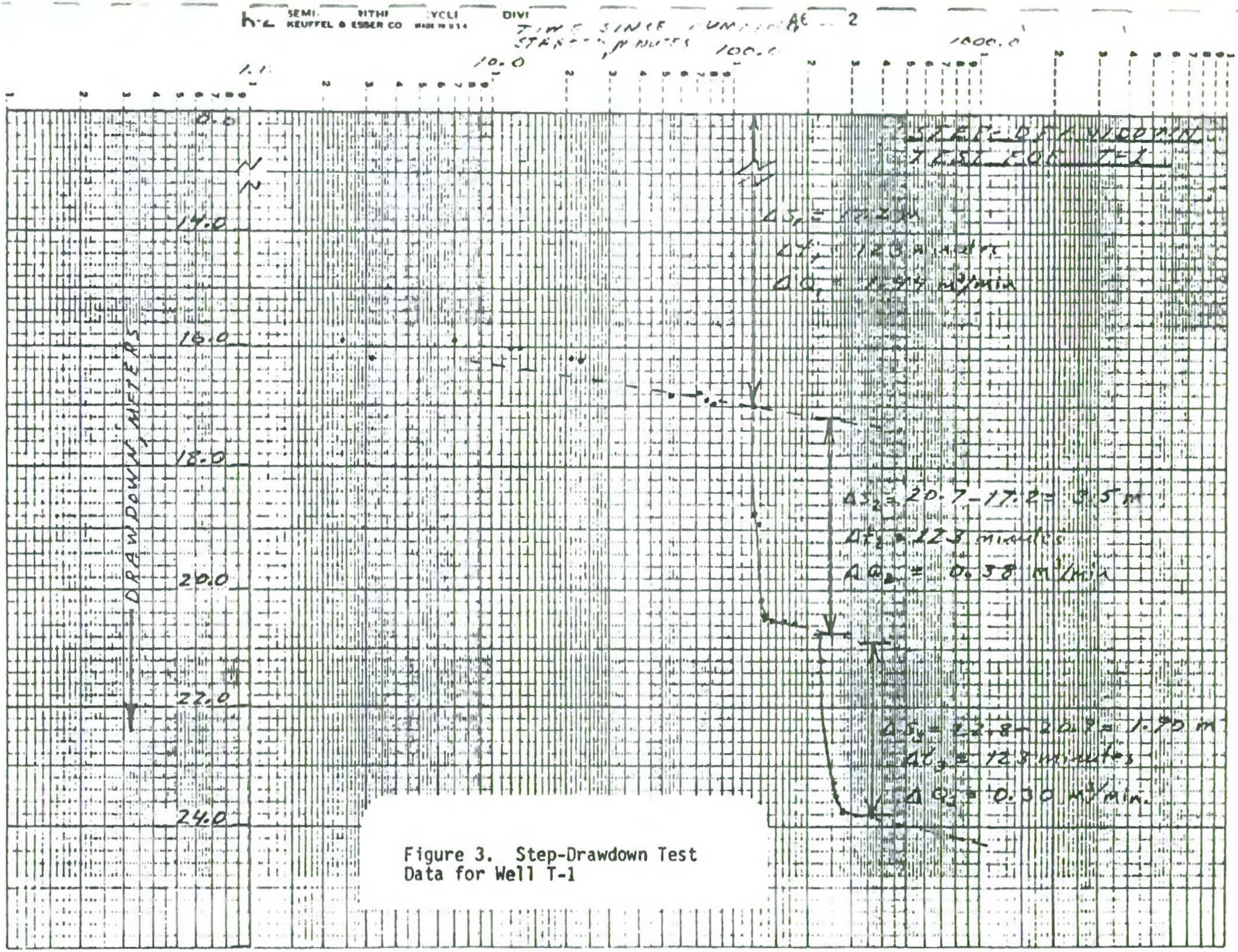

Figure 3. Step-Drawdown Test Data for Well T-1

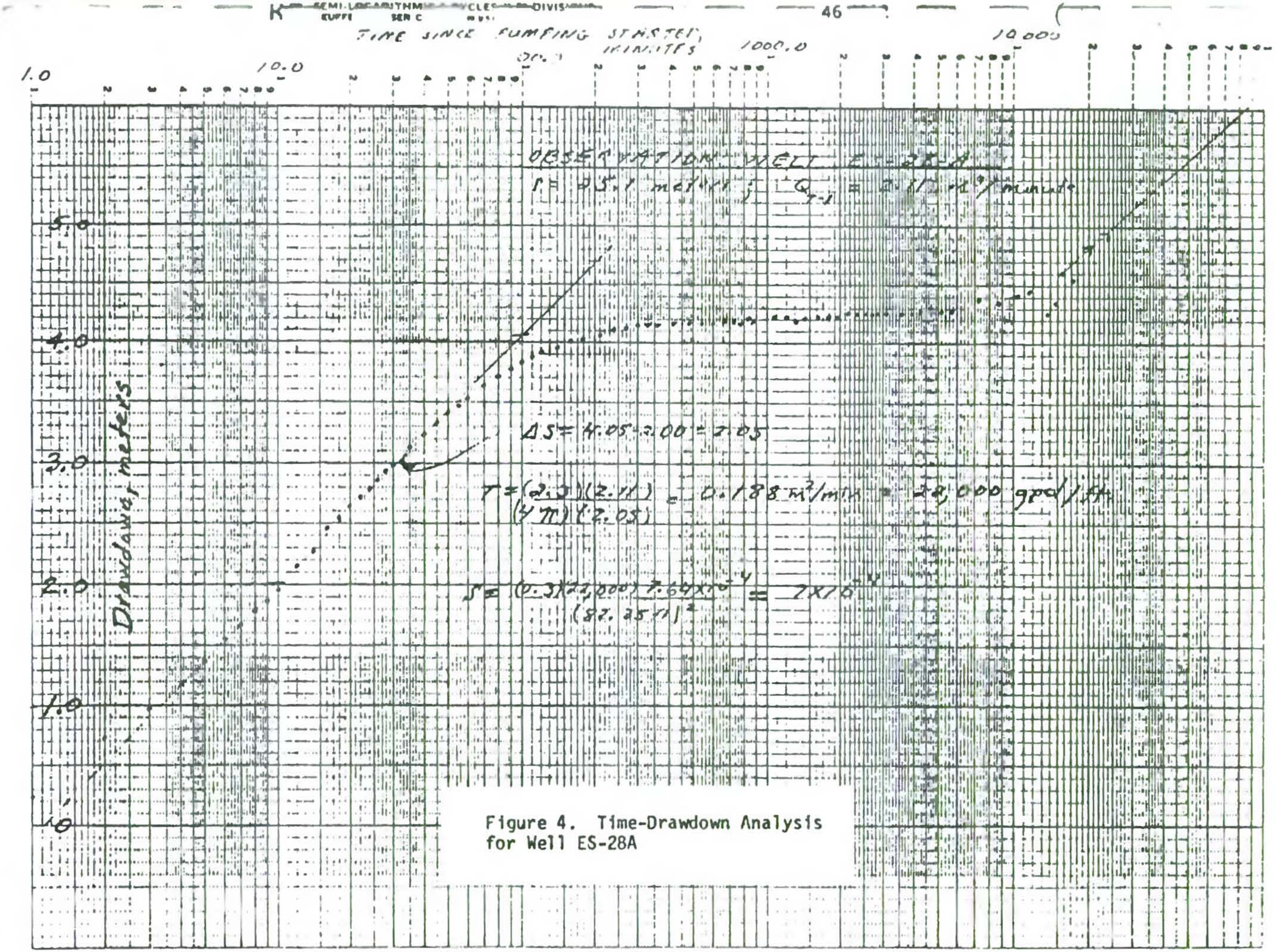

Figure 4. Time-Drawdown Analysis for Well ES-28A

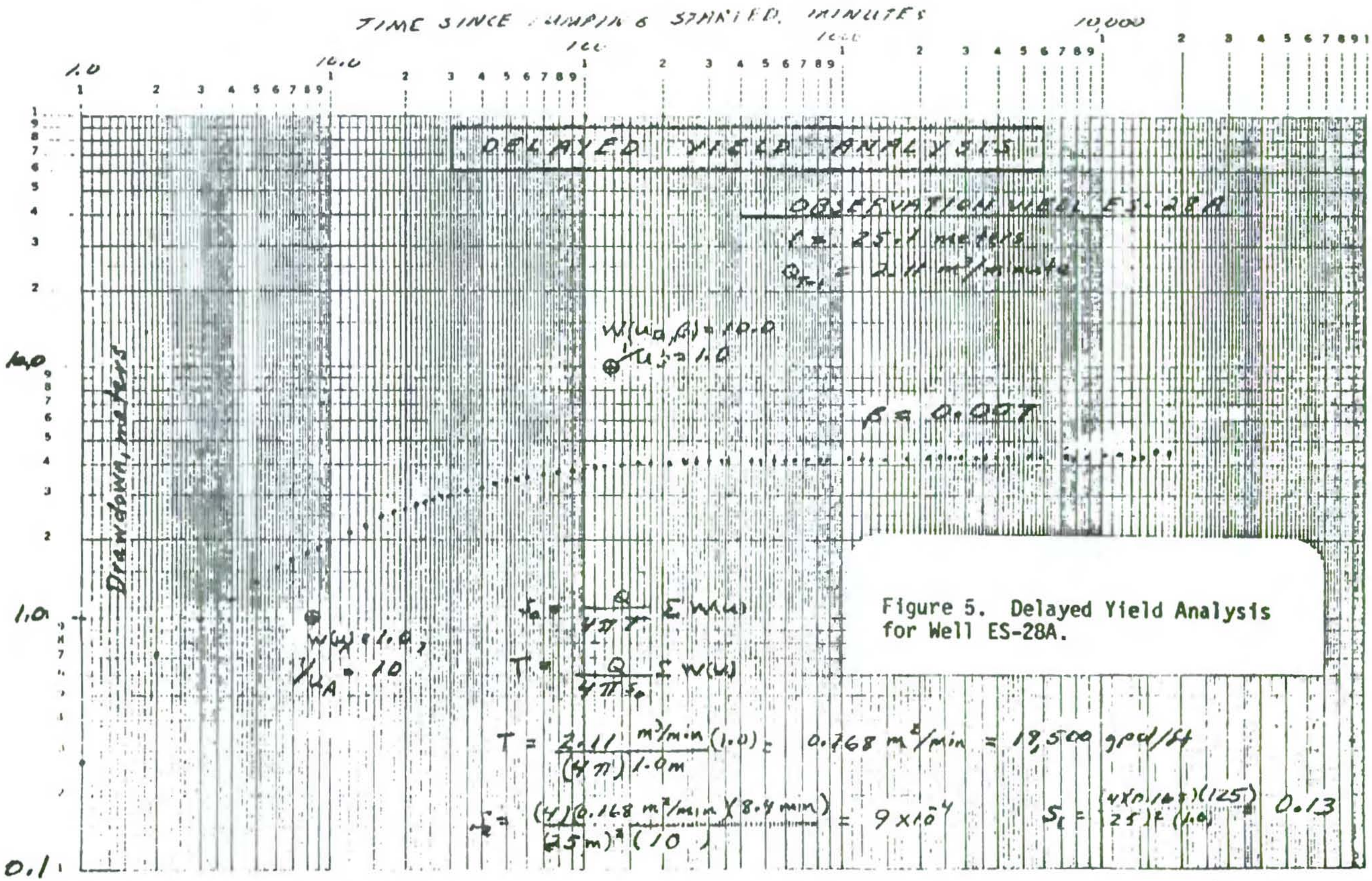

Figure 5. Delayed Yield Analysis for Well ES-28A.

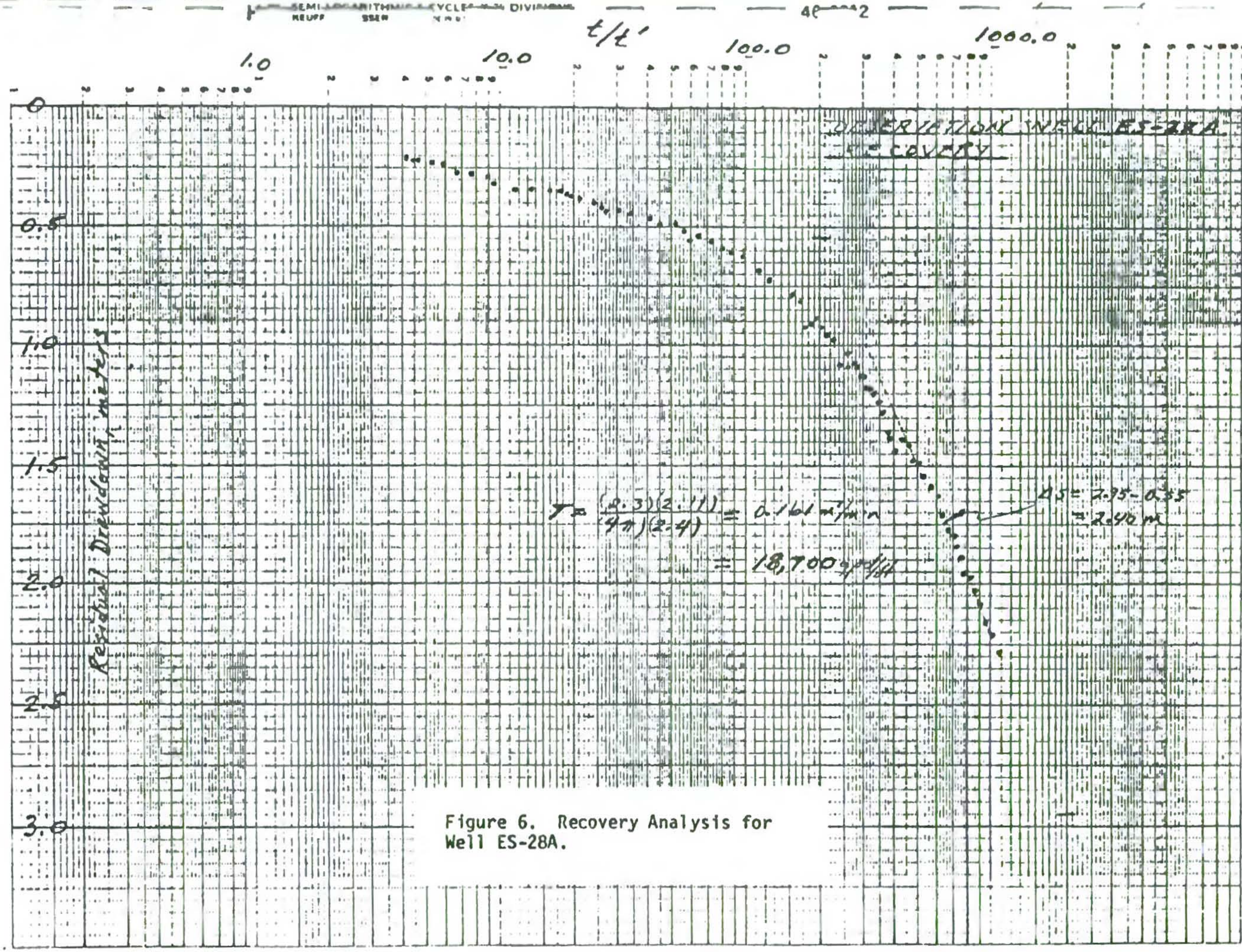

Figure 6. Recovery Analysis for Well ES-28A.

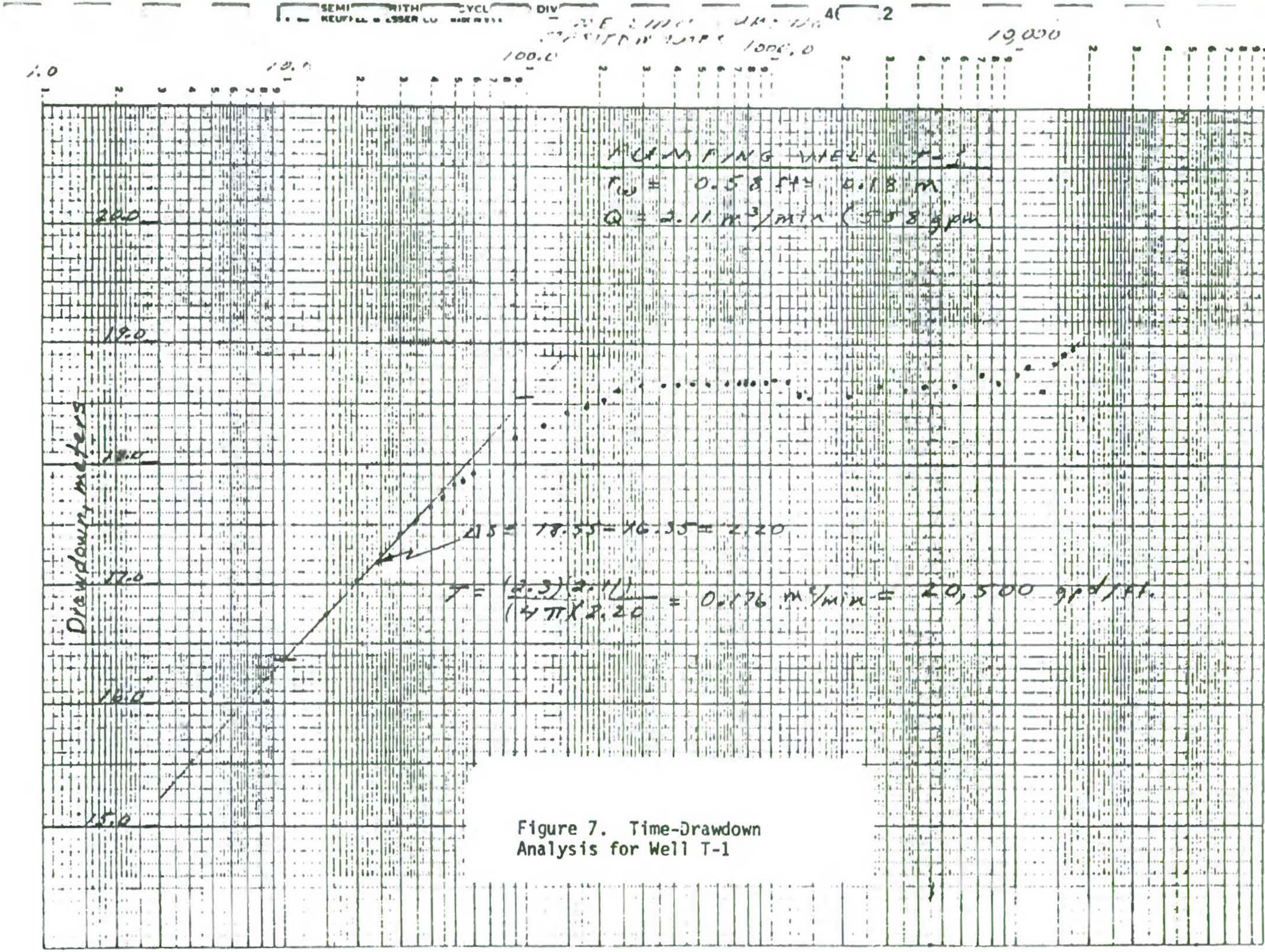

Figure 7. Time-Drawdown Analysis for Well T-1

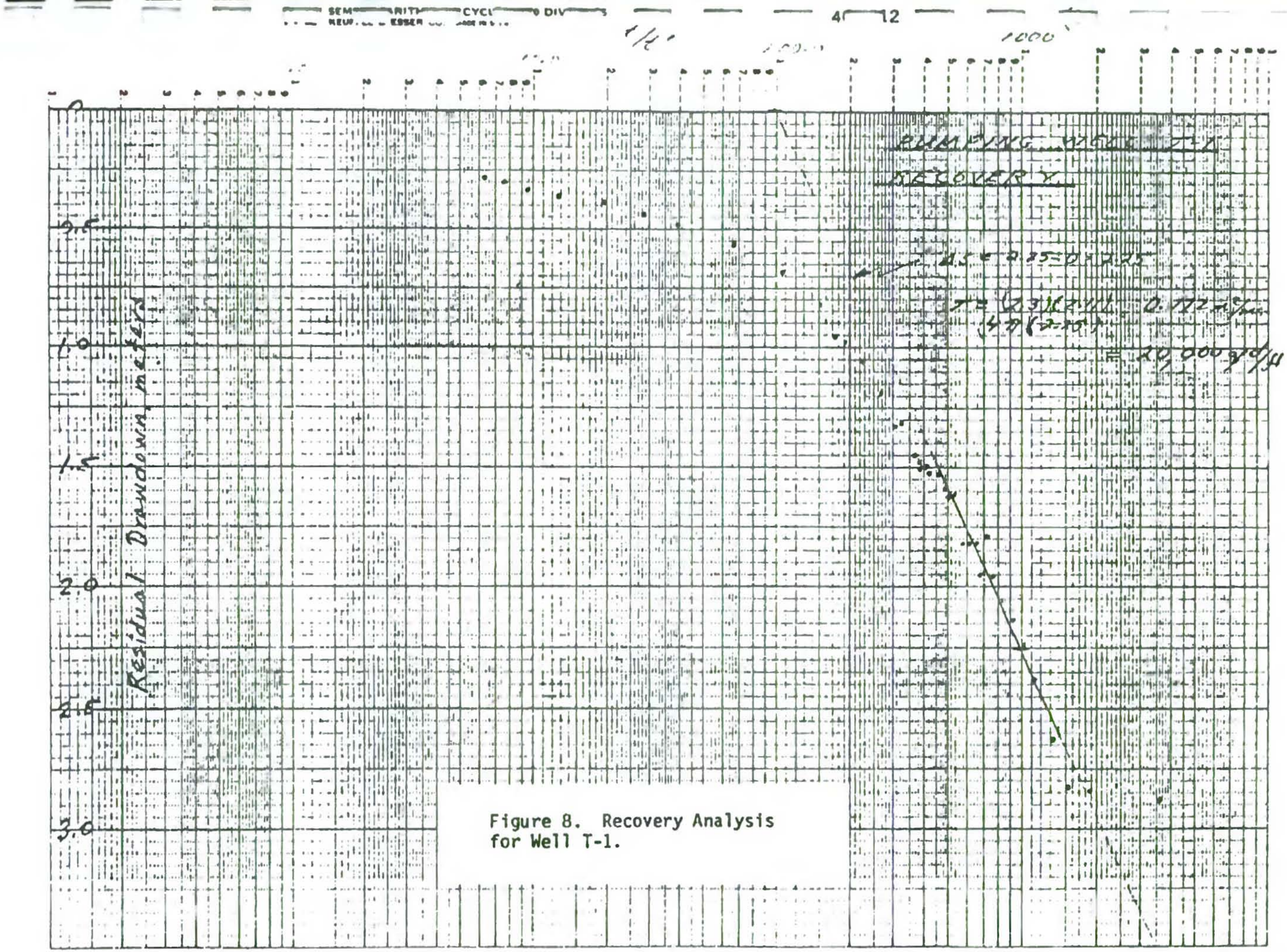

Figure 8. Recovery Analysis for Well T-1.

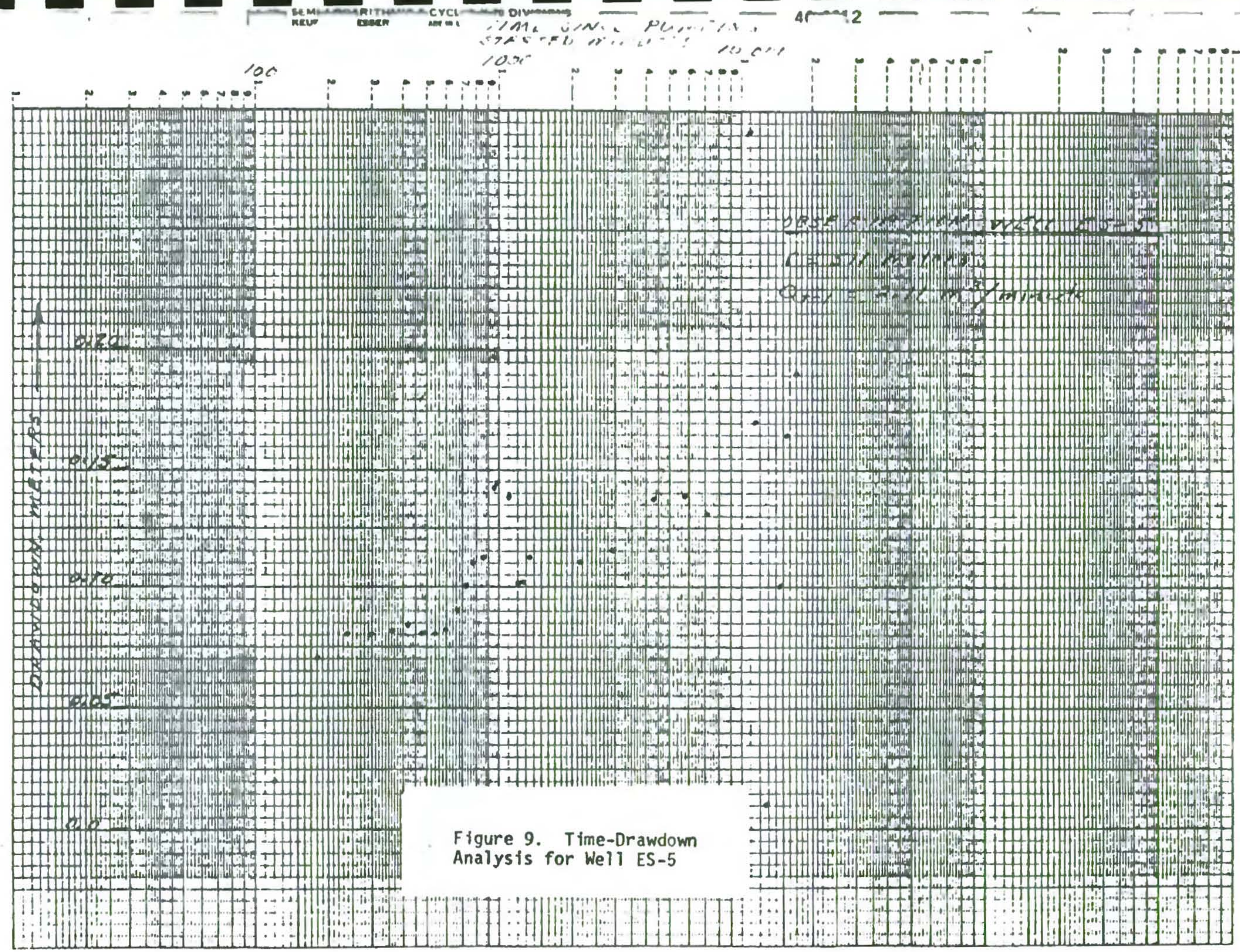

Figure 9. Time-Drawdown Analysis for Well ES-5

APPENDIX

The following pages contain tabulations of well discharge and water level measurements for the well T-1 pump tests.

MINERA UTAH DE CHILE INC.
FAX NUMBER 225930
ANTOFAGASTA - CHILE

RECEIVED
OCT 10 1983
ROGER E. NELSON

RAPIFAX MESSAGE Nº

Date: October 9, 1983

Page: 1 of 4

To : N. Krishnamurthi/D.K. Todd cc: R. Jones

From : C. Mongard

SUBJECT : STEP-DRAWDOWN TEST ON WELL T-1

A step drawdown test was conducted on T-1, the 8/Oct/83 for approx. 6 hours. Data is attached.

Well was pumped at a rate of 380 gpm for 123 min; 480 gpm for 128 min, and 560 gpm for 124 min.

Maximum flow with valve all open is 560 gpm, and minimum flow is 380 gpm.

Drawdown data was taken evey five, and then every 10 minutes on well ES 28-A (24.9 m from T-1). Data will follow.

Regards,

Christine

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet
[illegible]	00.00			67.207	static	
[illegible]	2.44			78.160		15.953
[illegible]	3.2[illegible]			78.420		16.213
[illegible]	4.07			[illegible]	?	
[illegible]	5.00			78.820		16.613
[illegible]	[illegible]			80. ?		
[illegible]	7.00			78..080	?	15.873
45.01	8.01			78.080		
46.00	[illegible]			78.080		
47.00	10.00			78.080		
[illegible]3.00	11.00			78.150		
[illegible]	12.00			78.230		16.023
[illegible]	13.00			78.220		16.013
[illegible]	14.00			[illegible]		
[illegible]	15.00			[illegible]		
[illegible]	16.00			[illegible]		
[illegible]	17.00			78.[illegible]		
[illegible]	18.00			[illegible]		
[illegible]	19.00			[illegible]		
[illegible]	20.00			[illegible]		
[illegible]	21.00			78.410		16.203
11:00.00	[illegible].00			78.440		16.233
[illegible]	25.00			78.[illegible]		
[illegible]	27.00			[illegible]		
[illegible]	29.00			[illegible]		
[illegible]	31.00			[illegible]		
[illegible]	33.00			[illegible]		
[illegible]	35.00			[illegible]		
[illegible]	37.00			[illegible]		
[illegible]	40.00			[illegible]		
20.00	43.00			[illegible]		
[illegible]	47.00			[illegible]		
28.00	51.00			[illegible]		
32.00	55.00			79.050		16.843
[illegible]	59.00			79.0[illegible]		
[illegible]	63.00			79.0[illegible]		

[illegible] DA WATER PROGRAM
TEST WELL DATA

WELL No. [illegible]
page [illegible] of [illegible] (3)

HOUR	t time since pumping began minutes	t' time since pumping stopped minutes	t/t' ratio	WATER LEVEL below top meters	WATER LEVEL below top feet	RESIDUAL DRAW DOWN feet
[illegible]	73.00			79.000		16.793
55.00	78.00			79.080		16.873
1.00.00	82.00			79.130 ?		16.923
[illegible]	[illegible]			[illegible]		
[illegible]	[illegible]			79.150		16.943
[illegible]	[illegible]			[illegible]		
[illegible]	103.00			[illegible]		
30.00	113.00			[illegible]		
[illegible]	123.00			79.250		17.043
[illegible]	0.00			81.000	stabilizing	18.793
52.00	1.00	125		81.060	flow	18.853
[illegible]	2.00	126		[illegible]		
[illegible]	3.00	127		[illegible]		
[illegible]	4.00	128		[illegible]		
46.00	5.00	129		[illegible]		
[illegible]	6.00	130		[illegible]		
[illegible]	8.00	131		82.450		20.243
[illegible]	10.00	? 132		82.640		20.433
54.00	[illegible]			[illegible]		
56.40	[illegible]			82.510		20.303
[illegible]	16.00	? 136		82.690	?	20.483
1.00.00	18.00	138		[illegible]		
[illegible]	21.00	141		82.[illegible]		
[illegible]	24.00	144		[illegible]		
[illegible]	27.00	147		82.655		20.448
10.00	30.00	150		[illegible]		
[illegible]	34.00	154		[illegible]		
[illegible]	38.00	158		[illegible]		
25.00	43.00	163		82.720	?	20.513
[illegible]	48.00	168		82.[illegible]		
[illegible]	53.00	173		[illegible]		
40.00	58.00	178		82.810		20.603
45.00	63.00	183		[illegible]		
[illegible]	68.00	188		[illegible]		
[illegible]	73.00	193		[illegible]		
[illegible]	78.00	198		[illegible]		
[illegible]	88.00	208		[illegible]		

[illegible]ANDA WATER PROGRAM — WELL Nº : [illegible] (4)

TEST WELL DATA — page [illegible] of [illegible]

HOUR	time since pumping began minutes	time since pumping stopped minutes	ratio	WATER LEVEL below mp meters	feet	RESIDUAL DRAW DOWN feet
[illegible]	108.00	228		[illegible]		
[illegible]:40	118.00	238	–	83.000		20.793
[illegible]	128.00	248		[illegible]		
[illegible]	[illegible]	249		83.410		21.203
[illegible]	1.0	250		[illegible]		
[illegible]	2.0	251		[illegible]		
[illegible]	3.0	252		85.500		23.293
[illegible].18	4.18			85.7[illegible]		
[illegible].11	5.11			85.480		
[illegible]	6.0	255		85.720		23.513
[illegible]	7.0			85.820		23.613
[illegible]	9.20			[illegible]		
	11.0			[illegible]		
[illegible]	[illegible]			85.620		23.413
[illegible]	15.0			86.000		23.793
[illegible]	17.0			[illegible]		
10	19.0	269		86.000		23.793
13	22.0			[illegible]		
16	25.0			[illegible]		
19	29.0			[illegible]		
22	31.0			[illegible]		
26	35.0			[illegible]		
30	39.0			[illegible]		
35	44.0			[illegible]		
40	49.0			[illegible]		
45	54.0			85.787		
50	59.0			85.756		23.549
55	64.0			85.740		
4:00	69.0			85.787		
05	74.0			85.760		
10	84.0			85.790		
20	94.0			[illegible]		
30	104.0			[illegible]		
40	114.0			[illegible]		
4:50	124.0	374		85.897		23.690

ESCONDIDA WATER PROGRAM — WELL Nº. ES: T-1

TEST WELL DATA — GAL x 1.000 — page 1 of ____

~~RECOVERY~~

11-10-83 — $\bar{Q}$ = 558

	HOUR	time since pumping began. minutes	Gal x 1000	Qgpm	WATER LEVEL below mp		RESIDUAL DRAW DOWN
					meters	feet	feet
10-83	09:50	-0-	67.208	-0-			
	10:20	30	67.226	600			
	10:50	60	67.242	533			
	11:20	90	67.258	533			
	11:50	120	67.276	600			
	12.20	150	67,293	567			
	12:50	180	67,309	533			
	13:50	240	67,345	600			
	14:50	300	67,375	500			
	15:50	360	67,410	583			
	16:50	420	67,444	567			
	17:50	480	67,477	550			
	18:50	540	67,513	600			
	19:50	600	67,544	517			
	20:50	660	67,579	583			
	21:50	720	67,612	550			
	22:50	780	67,646	567			
	23:50	840	67.682	600			
-83	01:50	960	67.746	533			
	03:50	1080	67.813	558			
	05:50	1200	67.879	550			
	07:50	1320	67.947	567			
	09:50	1440	68.014	558			
	12:32	1602	68.101	537			
	18:09	1939	68.290	561			
	21:50	2160	68,412	552			
10-83	01:55	2405	68.551	567			
	02:55	2465	68.585	567			
	03:55	2525	68.618	550			
	04:55	2585	68.649	517			
	05:55	2645	68.685	600			
	06:55	2705	68.713	467			
	07:55	2765	68.752	650			
	08:55	2825	68.783	517			
	09:55	2885	68.816	550			
	10:55	2945	68.852	600			
	11:55	3005	68 [illegible]	517			

ESCONDIDA WATER PROGRAM
TEST WELL DATA
~~RECOVERY~~

WELL Nº. ES: T-1
page 2 of ____

GAL x 1.000.

	HOUR	t time since pumping begon. minutes	Gal x 1000	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet
1-…-83	12:55	3065	68.916				
	13:55	3125	68.955	650			
	15:55	3245	69.017	517			
	17:55	3365	69.083	550			
	19:55	3485	69.148	542			
	21:55	3605	69.216	567			
	24:55	3785	69.315	550			
…0-8…	02:55		69.385				
	04:55		69.453				
	06:55		69 519				
	08:55		69 586		CHEQUEO		
	09 55	4320	69 619	550	HORA	GALONS.	
	10 55		69 654		10:52	550	
	11:55		69 684		10:57	560	
	12:55		69.717				
	15:25		69.801				
	15:50		99.815				
	16:32		69.838				
	17:50		69.882				
	18:33		69.906				
	19:22		69.934				
	20:00		69.954				
	20:57		69.987				
	22:00		70.022				
1-83	01:07		70.124				
	02:01		70.158				
	04:05		70.224				
	06:05		70.295				
	08:05		70.362				
	09:05	5710	70393	550			
	10:00		70.424				
	11:00		70.458				
	12:01		70.491				
	13:00		70.525				
	14:28		70.575				
	16:00		70.627				
	17:01		70 1'?				

ESCONDIDA WATER PROGRAM
TEST WELL DATA
~~RECOVERY~~

WELL Nº. ES: T-1

GAL X 1.000

	HOUR	t time since pumping began. minutes	Gal x 1000	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet
?-83	18:00		70.696				
	19:03		70.728				
	20:01		70.762				
	21:12		70.799				
	22:04		70.826				
	23:00		70.857				
	24:03		70.891				
1?-83	02:01		70.959				
	04:00		71.028				
	06:03		71.094				
	08:05		71.161				
	09:20		71.205				
	10:00		71.227				
	11:01		71.261				
	12:20		71.272				
	13:00		71.294				
	14:00		71.328	567			
	15:00		71 361				
	16:03		71.397				
	17:00		71 428				
	18:00		71.462				
	19:00		71 495				
	20:00		71.529	567			
	21:00		71.562.				
	22.00		71 596.				
	23 00		71 629.				
	24 00.		71.663.				
?-83	02 00		71.728.				
	04 14.		71 805.				
	06. 00		71.863.				
	08 00.		71 930.				
	09. 00	8590	71 963.	550			
	10.: 00		71.997.				
	11.: 00		72030				
	12: 00.		72063				
	13: 00		72096				
	14: 00		72130				

ESCONDIDA WATER PROGRAM
TEST WELL DATA
~~RECOVERY~~

WELL Nº. ES: T-1
page 4 of

GAL x 1.000

HOUR	t time since pumping began. minutes	Gal x 1000	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet
15:00		72.164				
16:00		72.197				
17:00		72.230				
18:00		72.264	567			
19:00		72.297				
20:00		72.331				
21:00		72.364				
22:00		72.398				
23:00		72.431				
24:00		72.464				
.83 02:00		72.531				
04:00		72.598				
06:00		72.665				
08:00		72.731				
09:00		72.765				
10 00		72.798				
11 00		72.831	550			
12 00		72.861				
13 00		72.891				
14 00		72.925				
15 00		72.958				
16 00		72.992				
17 00		73.026				
18 00		73.059				
19 00		73.093				
20 00		73.127	567			
21 00		73.160				
22 00		73.194				
23 00		73.228				
24 00		73.261				
02 00		73.328				
04 00		73.395				
06 00		73.462				
08 00		73.530	567			
09 00	11,470	73.563				
10 00		73.596				
11 00		73.630				

ESCONDIDA WATER PROGRAM
TEST WELL DATA
~~RECOVERY~~

WELL Nº. ES: T-1
page 5 of 5.

	HOUR	t time since pumping began. minutes	Gal x 1000	Qgpm	WATER LEVEL below mp		RESIDUAL DRAW DOWN feet
					meters	feet	
	12 00		73 656	433 PARA MOTOR	c/ACEITE		
	13. 00		73 689	550			
0.83	14 00		73 721.				
	15. 00		73 754				
	16. 00		73 788				
	17 00		73 822	567			
	18. 00		73 855				
	19. 00		73 888.				
	20 00		73 923.				
	21. 00		73 957				
	22. 00		73 990				
	23 00		74 024				
	24 00.		74 057.				
1.33.	02. 00		74 125				
	04. 00		74 191.				
	06 00		74 258.				
	08 00		74 325.				
	09. 00		74 358				
	10. 00		74 393				
	11 00	13030	74 426.	550 PARA MOTOR	REV. ACEITE		
	12 00		74 453.	450			
	13. 00		74 487.	567			
	14 00		74 520.				
	15. 00		74 554				
	16. 00		74 587.				
	17. 00		74 621.				
	18 00		74 654				
	19. 00		74 688				
	20 00		74 722.				
	21. 00		74 756.				
	22. 00		74 789.				
	23 00		74 823.				
	24 00		74 856.				
1.63.	02. 00		74 923.				
	04. 00		74 990.	558			
	06 00		75 057				
	08 00		75 124				

ESCONDIDA WATER PROGRAM
TEST WELL DATA
~~RECOVERY~~

WELL Nº. ES: T-1.
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HOUR	t time since pumping began minutes	Gal x 1000	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet
09. 00		75 158				
10. 00		75 191				
11 00		75 225	567			
12. 00		75 258				
13 00		75 291.				
14. 00		75 325				
15. 00		75 359				
16. 00		75 392.				
17. 00		75 425.				
18. 00		75.459				
19 00		75 492				
20 00		75 526.	567			
21. 00		75 560				
22.00		75 594				
23 00		75 627				
24.00		75 661				
-10-83 02.00		75 728				
04 00		75 794				
06. 00		75 860				
08. 00		75 927				
09. 00.		75 961.				
10 00		75 994				
11 00		76.024				
12. 00		76.058				
13 00		76 091				
14 00		76 126	583			
15 00		76 158.				
16. 00		76 191.				
17. 00		76.225				
18 00		76.258				
19. 00		76.292				
20 00		76.325				
21. 00		76:359				
22. 00		76.393	550			
23 00		76.426				
24.00		76.460				
[illegible]-83 02.00.		76.526				

ESCONDIDA WATER PROGRAM
TEST WELL DATA
[redacted]

WELL Nº. ES: T-1
page 7 of 9

HOUR	time since pumping began minutes	Gal x 1000	Qgpm	WATER LEVEL below mp meters	feet	RESIDUAL DRAW DOWN feet
04:00		76.593				
06:00		76.660				
08:00		76.727	558			
09:00	17,275	76.760				
10:00	17,335	76.793				
11:00	17,395	76.826	550			
12:00						

ESCONDIDA WATER PROGRAM
TEST WELL DATA

~~RECOVERY~~ 11-10-83

WELL Nº. ES: T-1

∴ ALT-CASING = 0.495

	HOUR	time since pumping begon. minutes	Gal x 1000	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN meters
[illegible]-83	09:50	-0-			static 67.172		-0-
5 min	:55	5			83.270		16.095
	10:00	10			83.550		16.378
	:05	15			83.930		16.758
	:10	20			84.200		17.028
	:15	25			84.445		17.273
	:20	30			84.590		17.418
	:25	35			84.695		17.523
	:30	40			84.790		17.618
	:35	45			84.880		17.708
	:40	50			84.998		17.826
	:45	55			85.051		17.879
	:50	60			85.105		17.9[illegible]
30 mins	11:20	90			85.380		18.[illegible]8
	:50	120			85.495		18.3[illegible]
	12:20	150			85.585		[illegible]8.41[illegible]
	12:50	180			85,645		18.47[illegible]
	13:20	210			85,701		18.5[illegible]
	13:50	240			85.782		[illegible]8.610
1 Hora	14:50	300			85,822		18.650
	15:50	360			85,820		18.648
	16:50	4[illegible]0			85,815		18.64[illegible]
	17:50	480			85 815		18.64[illegible]
	18:50	540			85, 817		18.645
	19:50	600			85 818		18.64[illegible]
	20:50	6[illegible]			85 820		18.648
	21:50	7[illegible]			85 840		18.668
	22:50	78[illegible]			85 842		18.670
	23:50	840			85.853		18.681
[illegible]-83	01:50	960			85.862		18.6[illegible]
2 Horas	03:50	1080			85.876		18.704
	05:50	1200			85.862		18.6[illegible]
	07:50	1320			85.742		18.570
	09:50	1440			85.744		18.572
2 Hors	21:50	2160			85.745		18.573
3-10-83	09:53	28[illegible]3			85.817		18.645
	21:50	360[illegible]			85.775		18.[illegible]

ESCONDIDA WATER PROGRAM
TEST WELL DATA

~~RECOVERY~~

WELL Nº. ES: T1
page 2 of

	HOUR	t time since pumping began. minutes	Gal x 1000	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet
0-83	09:50	4323			85 821		18.640
10-83	09:53	5766			85. 825		18.653
-10-83	09:55	7208			85.923		18.751
0-83	10^{05}	8658			85 865		18.693
-10-8	10:17	10110			85 920.		18.748
7-10-	08:41.	11454			85.980		18.805
			(13,030 min – [illegible])				
20-10-83	12.08	13101			85.795		18.623
					86,045.		18.873
21-10-83	11 00.	14,473					
22-10-83	10. 02.	15,855			86,085	J Rivera	18.9[illegible]3
2 -10-83	10:02	17.295			86,131	J. Rivera	18.959

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY

WELL Nº. ES: T-1
page 1 of ____
static level: 67.172 meter

HOUR	t time since pumping began. minutes	t' ~~Gal x 1000~~	t/t' Qgpm	WATER LEVEL below mp: meters	WATER LEVEL below mp: feet	RESIDUAL DRAW DOWN ~~feet~~ meter
4 Oct. 12:55	18230	5	3646	73.118	?	5.946
12:56	18231	6	3039	70.054		2.882
12:58	18233	8	2279	70.510	?	3.338
AM 1:00	18235	10	1824	70.011		2.839
02	18237	12	1520	70.000		2.828
04	18239	14	1303	69.800		2.628
06	18241	16	1140	69.560		2.388
08	18243	18	1014	69.420		2.248
10	18245	20	912	69.310		2.138
12	18247	22	829	69.240		2.068
14	18249	24	760	69.130		1.958
16	18251	26	702	68.966		1.794
18	18253	28	652	69.000		1.828
20	18255	30	609	69.000		1.828
22	18257	32	571	69.000		1.828
24	18259	34	537	68.780		1.608
26	18261	36	507	68.810		1.638
28	18263	38	481	68.750		1.578
1:30	18265	40	457	68.710		1.538
32	18267	42	435	68.670		1.498
34	18269	44	415	68.670		1.498
36	18271	46	397	68.690		1.518
38	18273	48	381	68.760		1.588
40	18275	50	366	68.630		1.458
42		52		68.620		
44	18279	54	339	68.480		1.308
46		56		68.490		
48	18283	58	315	68.520		1.348
50		60		68.620		
52		62		68.410		
54		64		68.340		
56	18291	66	277	68.370		1.198
58		68		68.400		
2:02		72		68.310		
05		75		68.410		
10	18305	80	229	68.240		1.068
15		85		68.200		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY

WELL Nº. ES: T-1
page 2 of ____

HOUR	t time since pumping began minutes	Gal x 1000	t/t' ~~Q gpm~~	WATER LEVEL below mp		RESIDUAL DRAW DOWN feet
				meters	feet	
2:20		90		68330		
25	18320	95	193	68. 160		0.988
30		100		68. 150		
35	18330	105	175	68. 140		0.968
40		110		68. 150		
45		115		68.000		
50	18345	120	153	68.000		0.828
55		125		68.000		
3:00		130		68.000		
3:10		140		68.000		
20	18375	150	123	67. 940		0.768
30		160		67. 880		
40	183[illegible]	170	108	67. 850		0.678
50		180		67. 850		
4:00		190		67. 820		
10		200		67. 820		
20		210		67. 800		
30		220		67. 760		
40		230		67. 770		
50		240		67. 750		
5:00		250		67. 760		
20	18495	270	68.5	67. 740		0.568
40		290		67. 760		
6:00		310		67. 720		
20		330		67. 700		
40		350		67. 710		
7:00		370		67.700		
20		390		67. 678		
40		410		67. 665		
8:00		430		67. 671		
20		450		67. 653		
40	18695	470	39.8	67. 660		0.488
9:00		490		67. 660		
9:30		520		67. 640		
10:00		550		67.660		
10:30		580		67.660		
11:00		610		67.660		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY

WELL Nº. ES: T-1
page 3 of

HOUR	t time since pumping began minutes	~~Gal x 1000~~	t/t' ~~Gpm~~	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet
11:30		640		67.619		
12:00	18895	670	28.2	67.612		0.440
12:30		700		67.614		
13:00		730		67.612		
14:00		790		67.559		
15:00		850		67.580		
16:00		910		67.576		
17:00	19195	970	19.8	67.560		0.388
18:00		1030		67.552		
19:00		1090		67.550		
21:00		1210		67.538		
23:00		1330		67.539		
25-OCT-83						
1:00		1450		67.535		
3:00	19795	1570	12.6	67.530		0.358
5:00		1690		67.533		
7:00		1810		67.510		
9:00		1930		67.523		
11:00		2050		67.517		
13:00	20,395	2170	9.40	67.510		0.338
15:00		2290		67.499		
17:00		2410		67.486		
19:00		2530		67.472		
21:00		2650		67.470		
23:00	20995	2770	7.56	67.475		0.303
26-OCT-83						
3:00		3010		67.486		
7:00		3250		67.477		
11:00	21715	3490	6.22	67.460		0.288

ESCONDIDA WATER PROGRAM
TEST WELL DATA

WELL Nº. ES: 28-0
page 1 of   r = 25.1 m

[redacted]

11-OCT-83

STATIC WATER LEVEL: 70.300 m (08:01)

HOUR	time since pumping began minutes	Gal x 1000	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN meters
9:50	0.00			70.300		-0-
9:51	1.0			70.537		.237
9:52	2.0			71.031		0.731
9:53	3.0			71.275		0.975
9:54	4.0			71.492		1.192
9:55	5.0			71.682		1.382
9:56	6.0			71.848		1.548
9:57	7.0			71.981		1.681
9:58	8.0			72.090		1.790
9:59	9.0			72.183		1.883
10:00	10.0			72.264		1.964
10:02	12.0			72.452		2.152
:04	14.0			72.579		2.279
:06	16.0			72.770		2.470
:08	18.0			72.830		2.530
:10	20.0			72.923		2.623
:12	22.0			73.011		2.711
:14	24.0			73.082		2.782
:16	26.0			73.170		2.870
:18	28.0			73.235		2.935
:20	30.0			73.278		2.970
10:25	35.0			73.425		3.125
:30	40.0			73.523		3.223
:35	45.0			73.622		3.322
:40	50.0			73.700		3.400
:45	55.0			73.766		3.466
:50	60.0			73.823		3.523
11:00	70.0			73.930		3.630
:10	80.0			74.000		3.700
:20	90.0			74.070		3.770
:30	100.0			74.135		3.835
:40	110.0			74.173		3.873
:50	120.0			74.210		3.910
12:10	140.0			74,266		3.966
:30	160.0			74,320		4.020
:50	180.0			74,345		4.045
13:20	210.0			74,383		4.083

ESCONDIDA WATER PROGRAM
TEST WELL DATA
~~RECOVERY~~

WELL Nº. ES· 28 A
page 2 of

	HOUR	time since pumping began minutes	Gal x 1000	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN ~~feet~~ meters
1/2 min	13:50	240			74,405		4.1~~85~~
	14:20	270			74,421		4.121
	14:50	300			74,440		4.140
	15:20	330			74,440		4.140
	15:50	360			74,440		4.140
1 Hora	16:50	420			74,465		4.165
	17:50	480			74,470		4.170
	18:50	540			74,482		4.182
	19:50	600			74,484		4.184
	20:50	660			74,490		4.190
	21:50	720			74,492		4.192
	22:50	780			74,474		4.174
	23:50	840			74,510		4.210
1 .83	01:50	860			74.494		4.194
2 Horas	03:50	1.080			74.523		4.223
	05:50	1.200			74.511		4.211
	07:50	1.320			74 492		4.192
	09:50	1.440			74 505		4.205
3 Horas	12:50	1620			74,510		4.210
	15:50	1800			74,521		4.221
	18:50	1980			74,510		4.210
	21:50	2160			69,570		4.270
	24:50	2340			69,560		4.260
3-10-83	03:50	2520			69.527		4.22[illegible]
	06:50	2700			69 536		4.236
	09:50	2880			69.551		4.25[illegible]
6 Horas	15:50	3240			69,565		[illegible]
	21:50	3600			69.545		4.245
4-10-83	03:50	3960			69.563		4.263
	09:50	4320			69.581		4.281
4-10-83	21:50	5040			69.589		4.289
5-10-83	09:50	5760			69.593		4.293
16-10	03:57	7207			69.683	NOTA: 11:15 a 12:16 cambio de aceite generador a los 1 30	4.383
17-10	08 07	8717			69,660		4.360
18-10	10:21	10171			69.710		4.410

ESCONDIDA WATER PROGRAM
TEST WELL DATA
~~RECOVERY~~

WELL Nº. ES: 28.A
page 3 of ___

	HOUR	time since pumping began minutes	Gal x 1000	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN ~~feet~~ meters
-10-82	08:52	11522			69.743		4.443
-10-83	12:03	13093			69.54[illegible]		4.245
-83	11:05	14473			69.642	J. [illegible]	4.340
-83	10.05	15853			69.911		4.611
-83	10:02	17293			69,830	J. [illegible]	4.530

ESCONDIDA WATER PROGRAM
TEST WELL DATA

RECOVERY

WELL Nº. ES: 28-A
page 1 of 4

static Level 65.300

HOUR	time since pumping ended minutes t_r	~~Gal x 1000~~	t/t' ~~Ggpm~~	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN ~~feet~~ meters
1:07 A.M.	17	18242	1073	67.595		2.295
1:08	18	18243	1014	67.510		2.210
09	19	18244	960	67.455		2.155
10	20	18245	912	67.387		2.087
11	21	18246	869	67.330		2.030
12	22	18247	829	67.275		1.975
13	23	18248	793	67.255		1.955
14	24	18249	760	67.188		1.888
15	25	18250	730	67.151		1.851
16	26	18251	702	67.114		1.814
17	27	18252	676	67.077		1.777
18	28	18253	652	—		—
19	29	18254	629	67.015		1.715
20	30	18255	609	66.935		1.635
1:22	32	18257	571	66.895		1.595
24	34	18259	537	66.845		1.545
26	36	18261	507	66.795		1.495
28	38	18263	481	66.790		1.490
30	40	18265	457	66.705		1.405
32	42	18267	435	66.695		1.395
34	44	18269	415	66.750		1.450
36	46	18271	397	66.695		1.395
38	48	18273	381	66.665		1.365
40	50	18275	366	66.570		1.270
42	52	18277	351	66.526		1.226
44	54	18279	339	66.504		1.204
46	56	18281	326	66.481		1.181
48	58	18283	315	66.471		1.171
50	60	18285	305	66.429		1.129
52	62	18287	295	66.423		1.123
54	64	18289	286	66.389		1.089
56	66	18291	277	66.375		1.075
58	68	18293	269	66.390	x	1.090
2:00	70	18295	261	66.331		1.031
05	75	18300	244	66.391		1.091
10	80	18305	229	66.282		0.982
15	85	18310	215	66.261		0.961

ESCONDIDA WATER PROGRAM
TEST WELL DATA

WELL Nº. ES: 28-A
page 2 of 4

RECOVERY

HOUR	time since pumping ended minutes t'	~~Gal x 1000~~	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN ~~feet~~ meters
2:20	90	18315	204	66.211		0.911
25	95	18320	193	66.197		0.897
30	100	18325	183	66.207		0.907
35	105	18330	175	66.241		0.941
40	110	18335	167	66.104		0.804
45	115	18340	159	66.117		0.817
50	120	18345	153	66.071		0.771
55	125	18350	147	66.103		0.803
3:00	130	18355	141	66.063		0.763
10	140	18365	131	66.020		0.720
20	150	18375	123	66.022		0.722
30	160	18385	115	65.980		0.680
40	170	18395	108	65.961		0.661
50	180	18405	102	65.946		0.646
4:00	190	18415	97	65.916		0.616
10	200	18425	92	65.922		0.622
20	210	18435	88	65.915		0.615
30	220	18445	84	65.902		0.602
40	230	18455	80	65.898		0.598
50	240	18465	77	65.861		0.561
5:00	250	18475	74	65.852		0.552
20	270	18495	69	65.848		0.548
40	290	18515	64	65.844		0.544
6:00	310	18535	60	65.857		0.557
20	330	18555	56	65.815		0.515
40	350	18575	53	65.793		0.493
7:00	370	18595	50	65.786		0.486
20	390	18615	48	65.783		0.483
40	410	18635	45	65.791		0.491
8:00	430	18655	43	65.763		0.463
20	450	18675	42	65.761		0.461
40	470	18695	40	65.780		0.480
9:00	490	18715	38	65.763		0.463
30	520	18745	36	65.752		0.452
10.00	550	18775	34	65.745		0.445
30	580	18805	32	65.742		0.442
1100	610	18835	31	65.738		0.438

ESCONDIDA WATER PROGRAM
TEST WELL DATA

WELL Nº. ES: 28-A.
page 3 of 4

RECOVERY

HOUR	time since pumping ~~began~~ minutes	~~Gal x 1000~~	t/t' ~~Q gpm~~	WATER LEVEL below mp meters	feet	RESIDUAL DRAW DOWN ~~feet~~ meters
M:30	640	18865	29	65.736		0.436
12:00	670	18895.	28	65.741		0.441
30	700	18925	27	65.745		0.445
13:00	730	18955	26	65.724		0.424
14.00	790	19015	24	65.700		0.400
15.00	850	19075	22	65.780		0.480
16.00	910	19135	21	65.680		0.380
17.00	970	19195	19.8	65.670		0.370
18.00	1030	19255	18.7	65.659		0.359
19.00.	1090	19315	17.7	65.650		0.350
x 20.00	1150	19375	16.8	—		–
21.00	1210	19435	16.1	65.650		0.350
x 22.00	1270	19495	15.4	—		–
23.00	1330	19555	14.7	65.660		.360
x 24.00	1390	19615	14.1	—		–
	25	-OCT	-83.			
1:00	1450	19675	13.6	65.646		0.346
3:00	1570	19795	12.6	65.635		0.335
5:00	1690	19915	14.8	65.648		0.348
7:00	1810	20035	11.1	65.613		0.313
9:00	1930	20155	10.4	65.613		0.313
11:00	2050	20275	9.9	65.611		0.311
13:00	2170.	20395	9.4	65.610		0.310
15.00	2290	20515	9.0	65.580		0.280
17.00	2410	20635	8.6	65.579		0.279
19:00	2530	20755	8.2	65.570		0.270
21:00	2650	20875	7.9	65.569		0.269
23:00	2770	20995	7.6	65.567		0.267
		26-OCT-83				
3:00.	3010	21235	7.1	63.570		0.270
7:00	3250	21475	6.6	65.569		0.269
11:00	3490	21715	6.2	65.565		0.265
15:00	3730	21955.	5.9	65.549		0.249
19:00	3970	22195	5.6	65.545		0.245
23:00	4210	22435	5.3	65.543		0.243

ESCONDIDA WATER PROGRAM
TEST WELL DATA

WELL Nº. ES: 28-A

HOUR	t' time since pumping stopped minutes	Time Since Pumping started t, min	t/t'	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet
	27 -	OCT -	83			
3:00	4450	22675.	5.1	65.552		0.252
7:00	4690	22915	4.9	65.560		0.260
11:00	4930	23155	4.7	65.532		0.232
15:00	5170	23395	4.5	65.530		0.230
19:00	5410	23635	4.4	65.529		0.229
23:00	5650	23875	4.2	65.530		0.230
	28-	OCT	83.			

ESCONDIDA WATER PROGRAM
TEST WELL DATA
~~RECOVERY~~

WELL Nº. ES: 5
page ____ of r= 511.2m

11-10-83   ALT-CASING = 0 500

	HOUR	time since pumping began. minutes	Gal x 1000	Qgpm	WATER LEVEL below mp: meters	WATER LEVEL below mp: feet	RESIDUAL DRAW DOWN meters
9-83	09:50	-0-			60,710		-o-
1 ora	10:50	60			60.710		·0
	11:50	120			60.730		0.020
	12:50	180			60,780		0.070
	13:50	240			60,790		0,080
	14:50	300			60,790		0.080
	15:50	360			60,791		0.081
	16:50	420			60,794		0.084
	17:50	480			60,790		0.080
	18:50	540			60,790		0.080
	19:50	600			60,792		0.082
	20:50	660			60,800		0,090
	21:50	720			60,810		0.100
	22:50	780			60,820		0.110
	23:50	840			60,822		0.112
1-83	01:50	960			60 853		0,143
2 Horas	02:01	971			60 855		0.145
	04:10	1100			60.848		0.138
	06:04	1214			60 811		0.101
	08:12	1342			60 814		0.104
	10:05	1455			60.823		0.113
/12 Horas	22:03	2173			60.820		0,110
0-83	10:10	2900			60.825		0.115
Hora	-						
0-83	10:03	4333			60 847		0.137
.0-83	10:01	5771			60.849		0.139
-10-83	10:10	7210			60.840		0.130
-10-83	10:21	8671			60.843		0.133
-10-83	10:06	10096			61.000		0.290
0-83	08:12	11482			60.880		0.170
-83	09.45.	12955			60.720.		0.01?
10-83	10:55	14465			60.810		0.10
-10-83	10:10	15860			60 875	J. RIVERA	0.165
-10-83	10:10	17300			60.900	"	0.190

ESCONDIDA WATER PROGRAM
TEST WELL DATA
~~RECOVERY~~

WELL Nº. ES: UN-31
page ____ of ____
r = 2036 m

12-10-83

HOUR	t time since pumping began minutes	Gal x 1000	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN ~~feet~~ meters
7-9-83				40.990		-0-
16:12	1812			40.878		-0-
18:05	3365			40.797		-0.081
10:10	4330			40 671		-0.207
10:07	5767			40.683		-0.195
10:10	7210			40.680		-0.198
10:15	8655			40.682		-0.196
10:00	10080			40.950		0.07
08:46	11446			40.801		-0.077
10 00.	12970			40 760		-0.118
11 45.	14515			40 770		-0.108

SECTION 4.2

MINERA UTAH DE CHILE, INC.

Antofagasta, Chile

WELL T-2 PUMP TESTS:

ANALYSIS OF RESULTS

January 1984

DAVID KEITH TODD

Consulting Engineers, Inc.

Berkeley, California

CONTENTS

LIST OF FIGURES

SUMMARY

Well T-2 was pumped at an average rate of 246 gpm for about 22 days to determine the aquifer characteristics in the northern portion of the preliminary well field line.

A finite element simulation model was used to analyze the drawdown data because the positioning of the various well screens precluded the use of standard analytical methods. Based on the numerical analysis, the transmissivity is 18,400 gpd/ft, the long term storage coefficient is 0.08, and the ratio of vertical to horizontal hydraulic conductivity is about 1/13.

Salinity of groundwater is estimated to be between 700 and 800 mg/l; therefore, this northern area near well T-2 indicates a favorable development potential.

INTRODUCTION

This report describes the aquifer test performed on well T-2 from November 5 to November 27, 1983. Field measurements of water levels, pumping discharge rates and water quality were made over time. The transmissivity and storage coefficient were determined by matching the observed water level data with computer simulations. All basic data are tabulated in the appendix.

The purpose of this report is to provide information about the hydrogeologic conditions north of Salar de Punta Negra to aid in the overall well field design for water supply of the Escondida mining operations.

This is the second of five planned reports describing and analyzing pump tests around the salar. Well T-2 is located at the northernmost extent of a preliminary well line described in a previous report.*

Test Conditions

Well T-2 was pumped at a relatively constant discharge rate while wells ES-50 and SC-5 were used as observation wells. The relative locations of T-2, ES-50 and SC-5 are shown on Figure 1.

The basic well construction features are shown on Figure 2. Wells T-2 and ES-50 penetrate about 60% of the aquifer, while SC-5 only penetrates the upper 47% of the aquifer. The partial penetrations effects on the drawdowns in the observation wells are substantial due to their proximity to the pumping well.

Water level measurements were taken on a logarithmic frequency in the

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*"Conceptual Well Field Design for Escondida Mine Water Supply", December 1983. David Keith Todd Consulting Engineers, Inc.

pumping and observation wells using electric sounders. Some trouble occurred with the sounding devices used on well T-2 causing several shifts in the water level measurements when the sounders were changed.

Flow measurements were taken every 3 to 5 minutes in the beginning of the test and then concurrently with the water level measurements. The average discharge rate for the first 140 minutes of the test was 269 gpm (1.018 M^3/min). Thereafter, until t = 3720 minutes, the discharge rate averaged 252 gpm (0.955 M^3/min).

A slow decrease in the discharge occurred from t = 3720 minutes until t = 17,040 minutes. During this period the discharge averaged 237 gpm (0.899 M^3/min). The overall average discharge rate from beginning to the end of the test was 246 gpm (0.951 M^3/min).

Recovery measurements were taken for a period of about 2½ days in all three wells. The residual drawdowns for pumping well T-2 were not calculated because the length of the sounder cord had changed as a result of being re-wired and the recovery measurements cannot be referenced back to the original static water level.

The water level measurements for the pumping and recovery portions of the test are tabulated in the appendix.

The test was terminated after 22 days instead of the intended length of 30 days due to a fuel supply problem in the generator.

Well ES-50 Analysis

The drawdown versus time data for ES-50 are shown on Figures 3 and 4. A delayed yield effect is apparent here even more than was observed in the T-1 aquifer test. An analysis using the curve-matching technique with delayed yield type curves would appear to be in order; however, because of the partial penetration of the pumping and observation well (<60%), this method is unreliable.

The analytical solution on which the curve-matching technique depends assumes at least one of the wells is fully penetrating or nearly so. Though the curves appear smooth they do not represent conditions that fall within the assumptions for the analytical equations. Therefore a more general solution, a finite element numerical model, was used to analyze the results.

The finite element model uses axisymmetric coordinates where the pumping well is at the center of a vertical cross-section that is rotated about the well. Well discharge is only allowed through nodes (grid intersections) representing the well screen. Likewise, an observation well screen is simulated by the appropriate nodes at its radial distance from the pumping well. Figure 5 shows the grid network representing the T-2 test conditions. The total drawdown in an observation well is obtained by averaging the drawdowns in the nodes representing the well screen.

Drawdowns computed by the finite element model were compared to the observed drawdowns. The values for transmissivity, storage coefficient, and vertical to horizontal permeability ratio that produced the best match with observations were taken as a reliable solution to the aquifer test. Since the storage coefficient increases with time during the aquifer test, only the early time and late time data were matched using the apparent confined storage coeffieient and specific yield, respectively.

The results of the analysis are shown on Figure 3. The transmissivity is 0.160 M^2/min (18,400 gpd/ft) and the long term specific yield is 0.08.

The ratio of vertical to horizontal permeability is estimated to be about 1/13.

The computed drawdown values are particularly sensitive to the position of the nodes chosen to represent the well screen, meaning that small uncertainties in the relative positions of the well screens cause moderate uncertainties in the aquifer parameters (transmissivity, etc.). Furthermore, the number of variables involved in the numerical simulation of the test make the results less certain than if an analytical solution could have been used. For these reasons the transmissivity, storage coefficient, and anisotropy ratio should be considered less reliable than the results obtained from the T-1 test.

The recovery data from well ES-50 are presented in the appendix but are not plotted on a graph because the standard analysis of these data would produce an erroneous value of transmissivity.

Well T-2 Analysis

The drawdown data for well T-2 are shown on Figure 6. Up until t = 140 minutes the data are reliable. Measurements after this time are affected by reduction in flow rate and the water level sounder problem mentioned earlier.

A straight line was fitted to the data up to t = 140 minutes and the early flow rate of 269 gpm was used to estimate the transmissivity. The resulting transmissivity of 18,000 gpd/ft was used as a preliminary estimate for the modelling of ES-50 data. The agreement with the final modelled transmissivity for ES-50 is quite good.

The recovery data for well T-2 are tabulated in the appendix, but as discussed earlier cannot be used to obtain residual drawdowns because water level sounding cord changed to unknown lengths during the test.

A step drawdown test was not performed on well T-2. Some idea of the well's efficiency can be obtained, however, by comparing the drawdowns calculated by the finite element model with the observed values. About 4 meters of drawdown appear to be a result of well losses, apart from the effects of partial penetration. Based on the ratio of the observed specific capacity to the theoretical specific capacity, the well is 70% efficient.

Negligible drawdowns were achieved in the model at 670 meters radially from the well. This indicates the approximate radius of investigation for the test.

Well SC-5 Analysis

The aquifer characteristics determined from matching ES-50 data were used to compute a theoretical response at SC-5. The results are shown in Figure 7. The discrepancy between the theoretical and the observed values can be explained by the position of the SC-5 well screen. The model assumes homogeneous aquifer conditions while in reality the upper portion of the aquifer appears much less permeable than the lower portion based on lithologic logs. SC-5 is mostly screened in lower permeable material. For this reason, the results obtained by matching model computations with ES-50 data are considered much more representative of the true aquifer characteristics than a match with SC-5 data. For this reason no further attempt was made to achieve a match with the SC-5 drawdowns. The recovery curves for SC-5 would likewise not represent the true aquifer characteristics. The basic recovery measurements are tabulated in the appendix.

Salinity Analysis

Conductivity measurements of the discharge from well T-2 were taken daily throughout the test. The results are presented in Table 1. Conductivity values essentially did not change during the course of the test and averaged 1016 micromhos/cm. The expected total dissolved solids content based on the conductivity measurements should lie between 700 and 800 mg/l. This water quality, along with the reasonable transmissive and storage properties of the aquifer make this portion of the well field highly desirable for development.

Conclusions

(1) The aquifer transmissivity in the vicinity of well T-2 is about 18,400 gpd/ft. (0.160 M^2/min).

(2) The long term storage coefficient is estimated to be 0.08.

(3) The ratio of vertical to horizontal hydraulic conductivity is estimated to be 1/13 indicating slightly more stratified conditions at T-2 than at T-1.

(4) Based on comparisons between theoretical drawdowns and observed drawdowns in well T-2 (excluding effects from partial penetration), the well efficiency is about 70%.

(5) The excellent water quality combined with the reasonable aquifer characteristics at T-2 indicate that this northern portion of the wellfield area has a very good development potential.

Table 1. Conductivity of Water

Samples from Well T-2

Date Sampled	Conductivity in Micromhos/cm at 25 degrees C.
November 5	961
November 6	987
November 7	1016
November 8	1044
November 9	1049
November 10	1015
November 11	1052
November 12	1041
November 13	949
November 14	1020
November 15	1023
November 16	1020
November 17	1026
November 18	1019
November 19	1023
November 20	1012
November 21	1020
November 22	1000
November 23	1020
November 24	1018
November 25	1016
November 26	1020
November 27	1018
Mean	1016

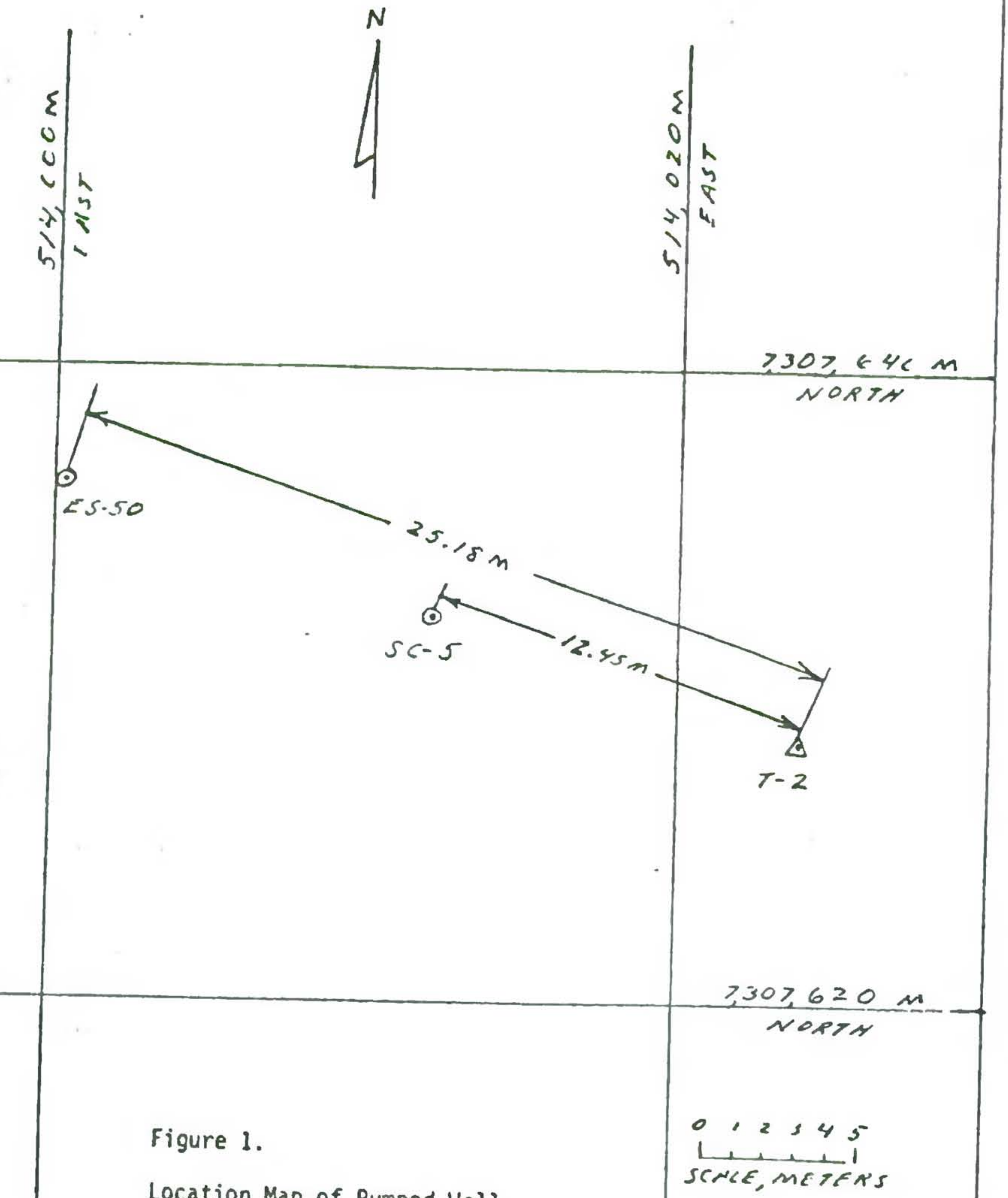

Figure 1.

Location Map of Pumped Well
and Observation Wells

David Keith Todd, Consulting Engineers, Inc

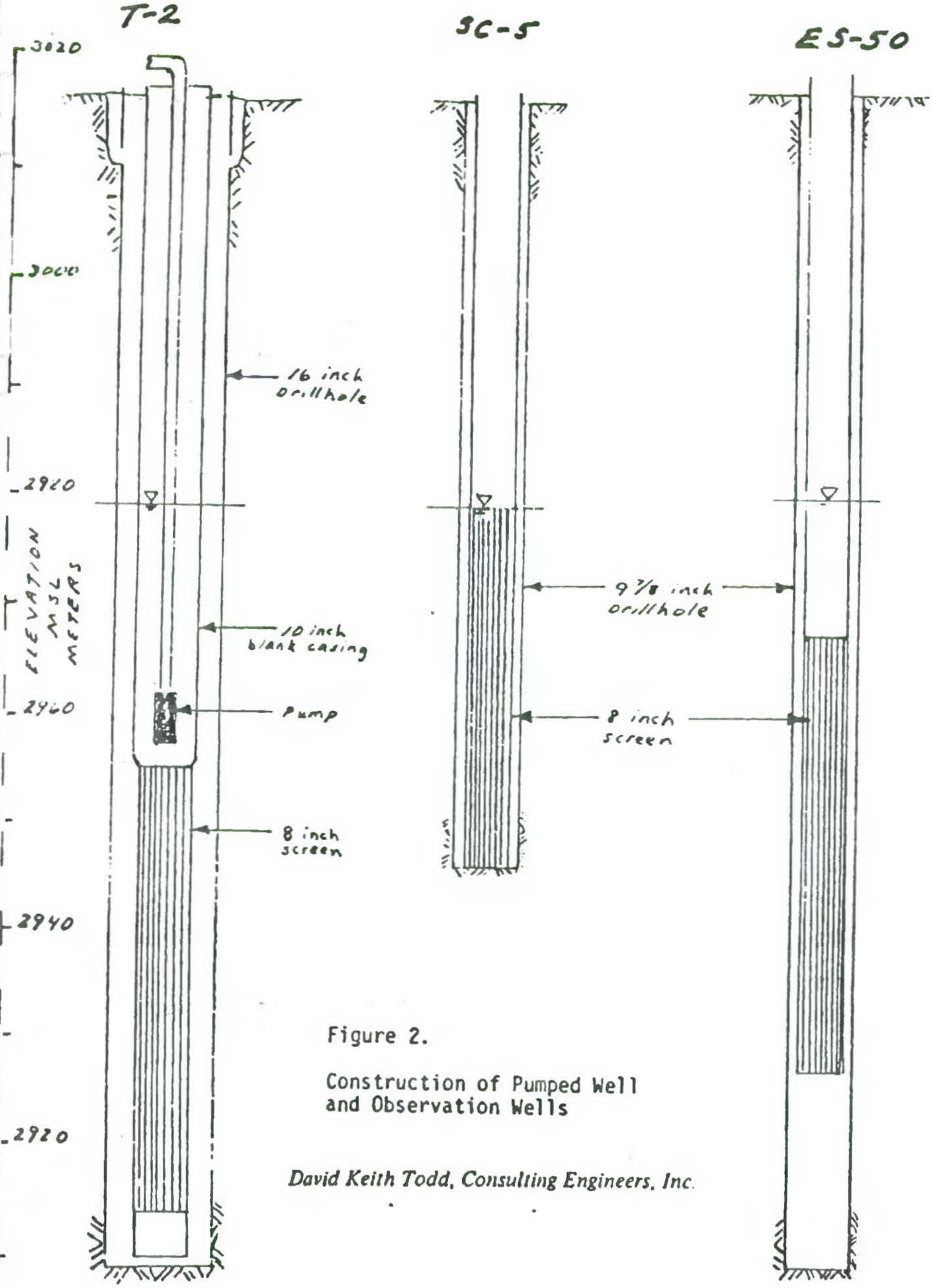

Figure 2.

Construction of Pumped Well and Observation Wells

David Keith Todd, Consulting Engineers, Inc.

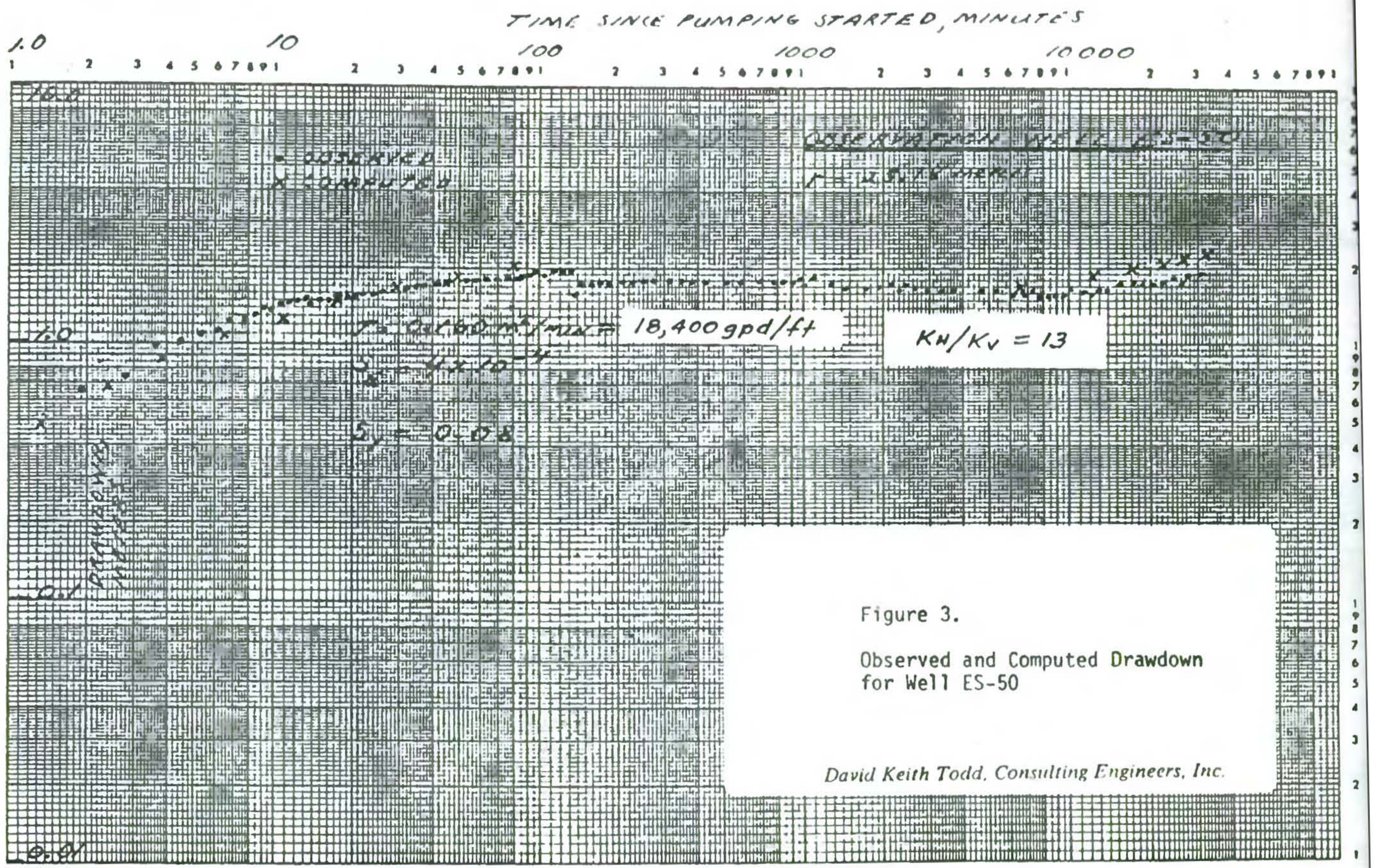

Figure 3.

Observed and Computed Drawdown for Well ES-50

David Keith Todd, Consulting Engineers, Inc.

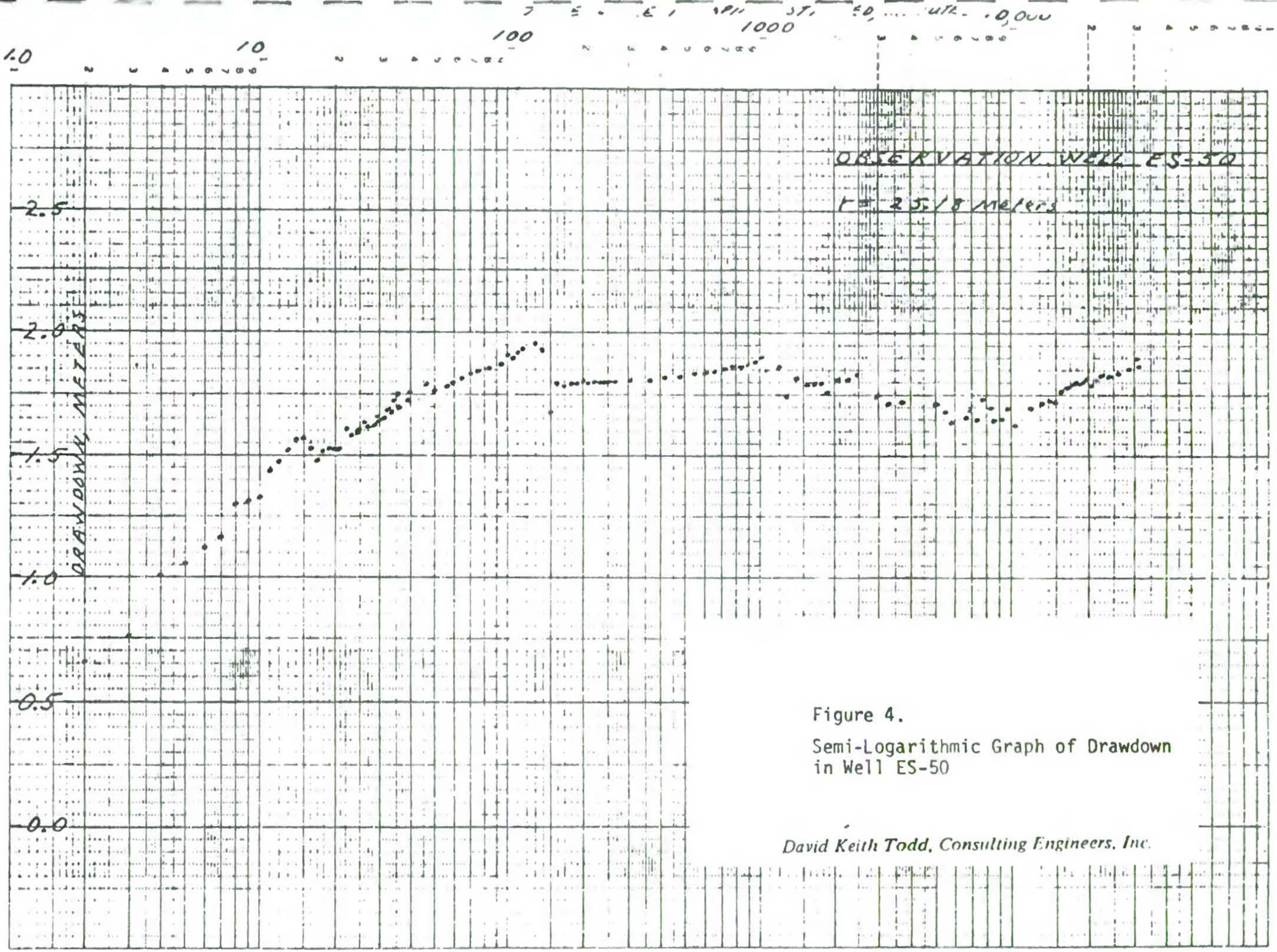

Figure 4.

Semi-Logarithmic Graph of Drawdown in Well ES-50

David Keith Todd, Consulting Engineers, Inc.

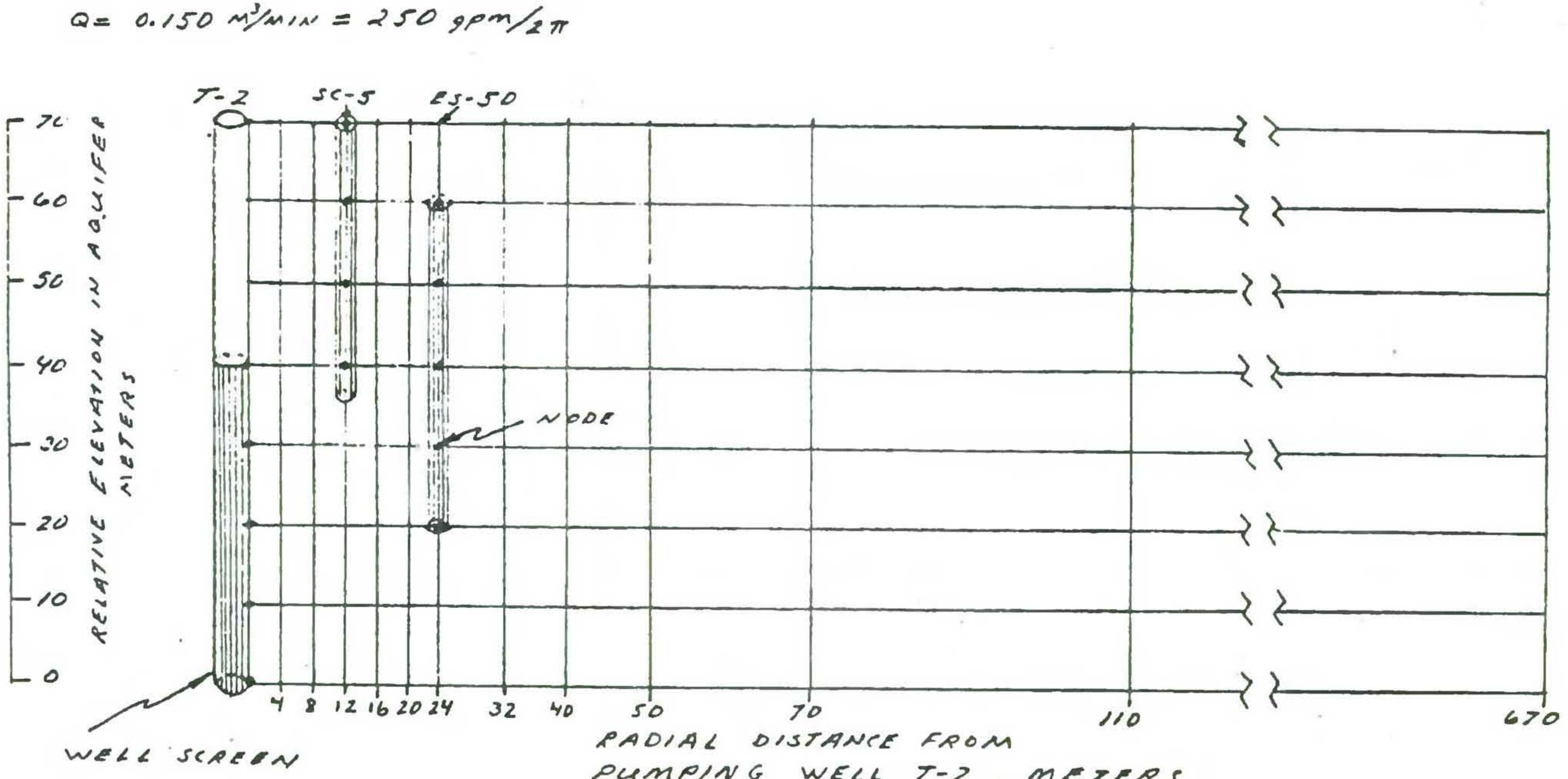

Figure 5.

Grid Network Representing Well T-2 Pump Test Conditions

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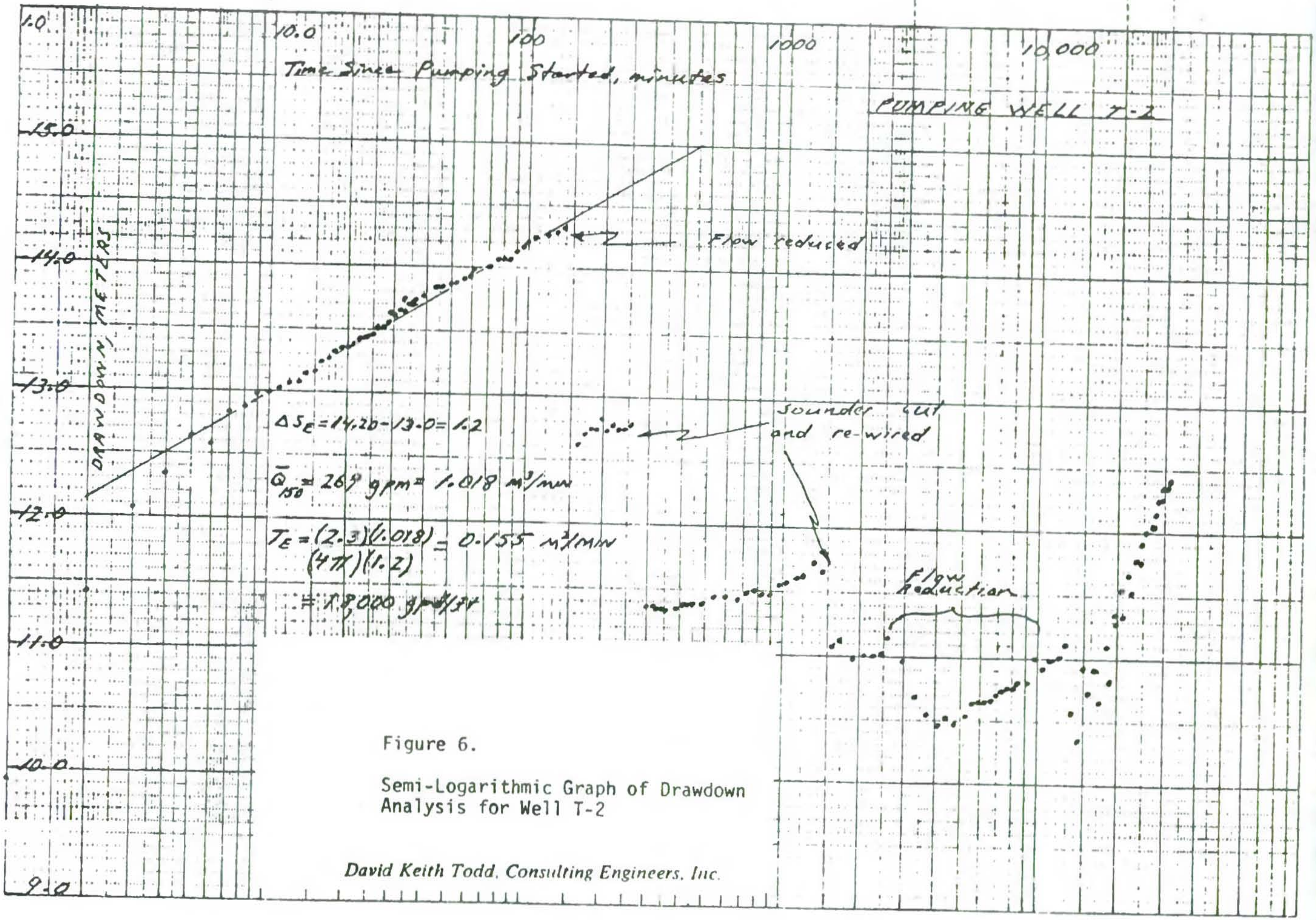

Figure 6.

Semi-Logarithmic Graph of Drawdown Analysis for Well T-2

David Keith Todd, Consulting Engineers, Inc.

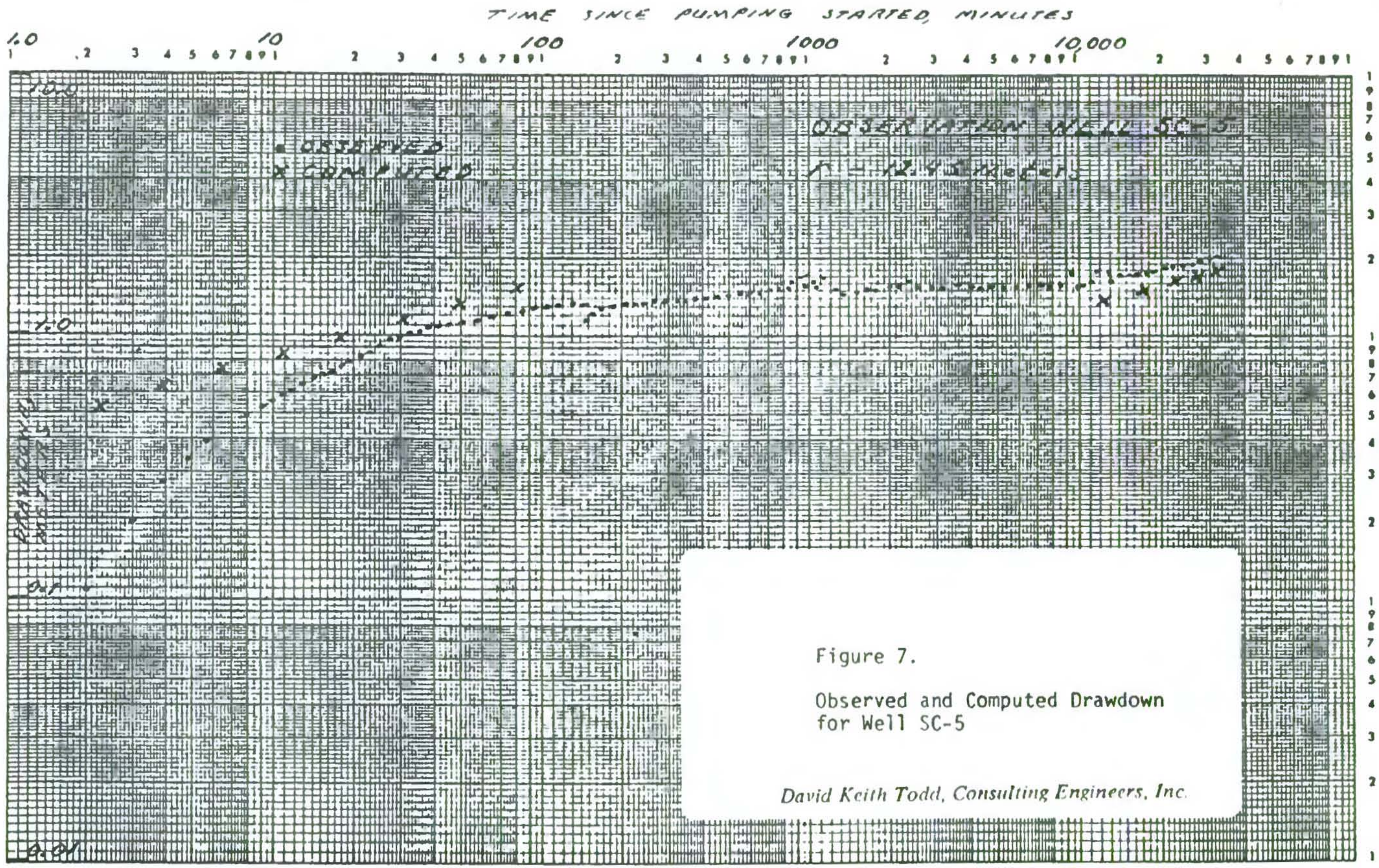

Figure 7.

Observed and Computed Drawdown for Well SC-5

David Keith Todd, Consulting Engineers, Inc.

APPENDIX

The following pages contain tabulations of well discharge and water level measurements for the well T-2 pump tests.

TEST WELL DATA

PUMP TEST

STATIC WATER LEVEL 37.858 m below mp

M.P. ABOVE GROUND LEVEL 0.780

DATE	HOUR	t time since pumping began, minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METER	CONDUCTIVITY µ mohs /cm.	TEMPERATURE °C.
5·11·83	14:00	0			37.858	124.204	0		
		1			37.652	123.5[illegible]	-0.206		
		2			38.515	126.3[illegible]	0.657		
		3			38.613	126.683	0.755		
		4			38.880	127.591	1.022		
		5			38.910	127.657	1.052		
		6			38.982	127.893	1.124		
		7			39.024	128.031	1.166		
		8			39.162	128.484	1.304		
		9			39.171	128.513	1.313		
		10			39.233	128.717	1.375		
		11			39.298	128.923	1.440		
		12			39.825	129.025	1.967		
		13			39.386	129.219	1.528		
		14			39.421	129.333	1.563		
		15			39.425	129.3[illegible]	1.567		
		16			39.386	129.219	1.528		
		19			39.345	129.08[illegible]	1.457		
		18			39.373	129.17[illegible]	1.515		
		14			39.391	129.235	1.533		
		20			39.381	129.202	1.523		
		21			39.383	129.20[illegible]	1.525		
		22			39.471	129.4[illegible]	1.613		
		23			39.439	129.393	1.581		
		24			39.450	129.429	1.592		
		25			39.464	129.475	1.606		
		26			39.495	129.576	1.637		
		27			39.470	129.494	1.612		
		28			39.478	129.520	1.630		
		29			39.519	129.655	1.661		
	14:30	30			39.505	129.609	1.647		
		31			39.512	129.632	1.654		
		32			39.536	129.711	1.678		
		33			39.503	129.734	1.685		
		34			39.594	129.901	1.736		
		35			39.612	129.960	1.754		
		36			39.554	129.770	1.696		

TEST WELL DATA

PUMP TEST

STATIC WATER LEVEL 37.858 m. below m.p.

M.P. ABOVE GROUND LEVEL 0.78?

DATE	HOUR	t time since pumping began. minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp: meters	WATER LEVEL below mp: feet	~~RECOVERY~~ DRAW DOWN ~~feet~~ METERS	CONDUCTIVITY μ mohs /cm.	T TEMPERATURE °C.
5-11-83	14:37	37			39.557	129.780	1.696		
		38			39.585	[illegible]	1.727		
		39			39.576	12?.842	1.718		
		40			39.615	12?.970	1.757		
		42			39.585	12?.872	1.727		
		[illegible]			39.590	129.8??	1.732		
		[illegible]			39.651	130.0??	1.793		
		48			39.606	[illegible]	1.748		
		50			39.620	[illegible]	1.762		
		52			39.629	130.016	1.771		
		54			39.630	130.019	1.772		
		56			39.638	130.0??	1.780		
		58			39.666	130.1??	1.808		
	15:00	[illegible]			39.653	130.0??	1.795		
		65			39.674	130.1??	1.816		
		70			39.6??	130.213	1.831		
		[illegible]			39.704	[illegible]	1.846		
		[illegible]			39.706	130.2??	1.848		
		[illegible]			39.719	130.311	1.861		
	15:30	[illegible]			39.730	130.3??	1.872		
		[illegible]			39.746	130.4??	1.888		
		100			39.767	130.4??	1.909		
		105			39.750	130.?12	1.892		
		110			39.773	[illegible]	1.915		
		115			39.792	130.??1	1.934		
	16:00	120			39.776	130.5??	1.918		
		[illegible]	SC RCADUCT ?USO ? ??? GAL.		39.814	130.6??	1.956		
		[illegible]			39.792	130.5??	1.934		
	16:30	[illegible]			39.543	129.??4	1.685		
		[illegible]			39.650	130.08?	1.792		
		[illegible]			39.645	130.068	1.787		
	17:00	[illegible]			39.651	130.085	1.793		
		[illegible]			39.657	130.108	1.799		
		[illegible]			39.658	130.111	1.800		
	17:30	[illegible]			39.656	[illegible]	1.798		
		[illegible]			39.656	130.104	1.798		
		[illegible]			39.657	130.108	1.799		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº ES-50
PAGE 3 OF ____
STATIC WATER LEVEL 37.858 m. below mp
M.P. ABOVE GROUND LEVEL 0.78[illegible]

DATE	HOUR	t time since pumping began. minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY µ mohs /cm.	T TEMPERATURE °C.
5-11-83	18:[illegible]	240			39.656	130.105	1.795		
	:15	255			39.658	130.111	1.800		
	:30	270			39.660	130.116	1.802		
	:45	285			–				
	19:00	300			39.661	130.121	1.803		
	:15	315			39.671	130.150	1.813		
	:30	330			39.666	130.137	1.808		
	:45	345			39.667	130.141	1.809		
	20:00	360			39.672	130.157	1.814		
	:30	390			39.677	130.173	1.819		
	21:00	420			39.696	1[illegible]203	1.838		
	:30	450			39.682	130.190	1.824		
	22:00	480			39.688	130.2[illegible]	1.830		
	23:00	540			39.701	130.252	1.843		
	24:00	600			39.699	130.246	1.841		
6-11-83	01:00	660			39.700	130.249	1.842		
	02:00	720			39.715	[illegible]	1.857		
	03:00	780			39.720	130.314	1.862		
	04:00	840			39.720	[illegible].314	1.862		
	05:00	900			39.725	[illegible]	1.867		
	06:00	960			39.740	130.38[illegible]	1.882		
	07:00	1.020			39.775	[illegible]	1.917		
	08:00	1.080			39.700	[illegible].249	1.842		
	09:00	1.140			39.705	[illegible]	1.847		
	10:00	1.200			39.715	130.256	1.857		
	12:00	1.320			39.605	[illegible]	1.747		
	14:00	1.440			39.675	130.161	1.817		
	16:00	1.560			39.636	130.039	1.778		
	18:00	1.680			39.623	129.9[illegible]	1.765		
	20:00	1.800			39.637	130.042	1.779		
	22:00	1.920			39.611	[illegible]	1.753		
7-11-83	01:00	2.100			39.675	130.003	1.817		
	04:00	2.280			39.685	130.200	1.827		
	07:00	2.460			39.700	130.24[illegible]	1.842		
	10:00	2.640			39.675	130.16[illegible]	1.817		
	16:00	3.000			39.601	[illegible]	1.743		
	22:00	3.360			39.584	[illegible]	1.726		

TEST WELL DATA
PUMP TEST

STATIC WATER LEVEL 37.858 m. below mp
M.P. ABOVE GROUND LEVEL 0.790

DATE	HOUR	t time since pumping began, minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY μ mohs /cm.	T TEMPERATURE °C.
8.11.83	04:00	3.720			39.580	129.855	1.722		
	10:00	4.080			39.550	129.671	1.692		
	16:00	4.440			39.645	129.953	1.787		
	22:00	4.800			39.647	129.990	1.789		
9.11.83	04.00	5.160			39.585	129.800	1.727		
	10:00	5.520			39.545	129.740	1.687		
	16:00	5.880			39.502	129.599	1.644		
	22:00	6.240			39.528	129.600	1.670		
10.11.83	04:00	6.600			39.510	129.625	1.652		
	10:00	6.960			39545	129.740	1.687		
	[illegible]	7.320			39.506	129.612	1.648		
	[illegible]	7.680			39.595	129.904	1.737		
11.11.83	04.00	8.040			39.550	129.757	1.692		
	[illegible]	8.400			39.502	129.599	1.644		
	22:00	9.120			39.509	129.619	1.650		
12.11.83	10:00	9.840			39.550	129.757	1.692		
	22:00	10.560			39.492	129.566	1.634		
13.11.83	10:00	11.280			39565	129.724	1.707		
	22:00	12.000			39.555	129.773	1.697		
14.11.83	10:00	12.720			39.601	129.839	1.743		
	22:00	13.440			39563	129.745	1.705		
15-11-83	10:00	14.160			39590	129.803	1.732		
	22:00	14.880			39.583	129.865	1.725		
16.11.83	10:00	15.600			39.619	129.95[illegible]	1.761		
	22:00	16.320			39.628	130.016	1.770		
17.11.83	10:00	17 040			39.655	130 101	1.797		
	22:00	17.760			39.660	130 118	1.802		
18-11.83	10:00	18 480			39.655	130.101	1.797		
	22:00	19.200			39 660	130.118	1.802		
19-11-83	10:00	19.920			39.675	130.167	1.817		
	22:00	20 640			39 646	130 072	1.788		
20-11-83	10:00	21.360			39 665	130.134	1.807		
	22:00	22.080			39 668	130 148	1.810		
21-11-83	10:00	22.800			39.690	130 216	1.832		
	22:00	23.520			39.689	130.242	1.831		
22-11-83	10.00	24 240			39 680	130 183	1.822		
	22:00	24 960			39 679	130 180	1.821		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº ES-20

STATIC WATER LEVEL 37.858 m. below mp.
M.P. ABOVE GROUND LEVEL 0.720

DATE	HOUR	t time since pumping began, minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY μ mhos /cm.	TEMPERATURE °C.
23-11-83	10:00	25.680			39.695	130.232	1.837		
	22:00	26,400			39.695		1.837		
24-11-83	10:00	27,120			39.680		1.822		
	[illegible]	27,840			39.775		1.917		
25-11-83	10:00	28,560			39.710		1.852		
	22:00	29,280			39.714		1.856		
26-11-83	10:00	30,000			39.717		1.859		
	22:00	30,720			39.760		1.902		
27-11-83	10:00	31,440			39.420		1.562		

TEST TERMINATED @ 20:30 11/27/[illegible]; t = 3[illegible] minutes.

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY

STC (1-30, [illegible]) 20:30

WELL Nº. ES: 50
page 1 of
27-11-88
[illegible]: 37.858 m

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	feet	RESIDUAL DRAW DOWN meters
20:33	32073	3	10691	39.410		1.552
:34	32074	4	8019	39.325		1.467
35	32075	5	6415	39.286		1.428
36	32076	6	5346	39.228		1.370
37	32077	7	4582	39.185		1.327
38	32078	8	4010	39.170		1.312
39	32079	9	3564	39.142		1.284
40	32080	10	3208	39.136		1.278
41	32081	11	2916	39.135		1.277
42	32082	12	2674	39.110		1.252
43	32083	13	2468	39.090		1.232
44	32084	14	2292	39.080		1.222
45	32085	15	2139	39.000		1.142
46	32086	16	2005	38.960		1.102
47	32087	17	1887	38.955		1.097
20:52	32092	22	1459	38.955		1.097
57	32097	27	1189	38.830		0.972
21:02	32102	32	1003	38.825		0.967
:07	32107	37	868	38.840		0.982
:12	32112	42	765	38.790		0.932
:17	32117	47	683	38.755		0.897
:22	32122	52	618	38.760		0.902
:27	32127	57	564	38.815		0.957
:32	32132	62	518	38.840		0.982
:37	32137	67	480	38.700		0.842
:42	32142	72	446	38.610		0.752
:47	32147	77	417	38.715		0.857
:52	32152	82	392	38.745		0.887
:57	32157	87	370	38.705		0.847
22:07	32167	97	332	38.735		0.877
:17	32177	107	301	38.635		0.777
:27	32187	117	275	38.645		0.787
:37	32197	127	254	38.520		0.662
:47	32207	137	235	38.540		0.682
:57	32217	147	219	38.555		0.697
[illegible]	32232	162	199	39.470		0.612

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY

WELL Nº. ES: 50
page 2 of ____

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	s' METERS	RESIDUAL DRAW DOWN
23:27	32247	177	182	38.465	0.607	
:42	32262	192	168	38.445	0.587	
:57	32277	207	156	38.550	0.692	
24:27	32307	237	136	38.475	0.617	
:57	32337	267	121	38.450	0.592	
01:00	32340	270	120	38.450	0.592	
02:00	32400	330	98.2	38.342	0.484	
03:00	32460	390	83.2	38.332	0.474	
04:00	32520	450	72.3	38.310	0.452	
05:00	32580	510	63.9	38.308	0.450	
06:00	32640	570	57.3	38.295	0.437	
07:00	32700	630	51.9	38.291	0.433	
08:00	32760	690	47.5	38.285	0.427	
09:00	32820	750	43.8	38.280	0.422	
10:00	32850	810	40.6	38.275	0.417	
11:00	32940	870	37.9	38.259	0.401	
12:00	33000	930	35.5	38.266	0.408	
13:00	33060	990	33.4	38.242	0.384	
14:00	33120	1050	31.5	38.226	0.368	
16:00	33240	1170	28.4	38.306	0.448	
18:00	33360	1290	25.9	38.255	0.39	
20:00	33480	1410	23.7	38.295	0.437	
22:00	33600	1530	22.0	38.305	0.447	
24:00	33720	1650	20.4	38.306	0.448	
02:00	33840	1770	19.1	38.265	0.407	
04:00	33960	1890	18.0	38.216	0.358	
06:00	34080	2010	17.0	38.214	0.356	
08:00	34200	2130	16.1	38.212	0.354	
10:00	34320	2250	15.3	38.240	0.3	
12:00	34440	2370	14.5	38.196	0.338	
16:00	34680	2610	13.3	38.236	0.378	
18:35	34835	2765	12.6	38.228	0.370	
24:00	35160	3090	11.4	38.198	0.340	
04:00	35400	3330	10.6	38.162	0.304	
08:00	35640	3570	10.0	38.280	0.422	
12:00	35880	3810	9.4	38.178	0.320	

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº T-2
PAGE 1 OF
STATIC WATER LEVEL 37.915 m. below mp.
M.P. ABOVE GROUND LEVEL 0.790

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY μ mohs /cm.	TEMPERATURE °C.
5-11-83	14:00	0			37.915	124.393	0		
		1			47.830	156.922	9.915		
		2			49.330	161.843	11.415		
		3		250	50.000	164.041	12.085		
		4			50.250	164.862	12.335		
		5			50.545	165.830	12.630		
		6		260	50.500	165.682	12.585		
		7			50.740	166.469	12.825		
		8			50.800	166.666	12.885		
		9		250	50.910	167.027	12.995		
		10			50.880	166.929	12.965		
		11			50.930	167.093	13.015		
		12		240	51.000	167.322	13.085		
		13			51.000	167.322	13.085		
		14			51.070	167.552	13.155		
	14:15	15		260	51.100	167.650	13.185		
		16			51.165	167.864	13.250		
		17			51.195	167.962	13.280		
		18		270	51.240	168.110	13.325		
		19			51.260	168.175	13.345		
		20			51.275	168.225	13.360		
		21		240	51.295	168.290	13.380		
		22			51.330	168.406	13.415		
		23			51.355	168.487	13.440		
		24		270	51.380	168.569	13.465		
		25			51.390	168.602	13.475		
		26			51.440	168.766	13.525		
		27		270	51.440	168.766	13.525		
		28			51.480	168.897	13.565		
		29			51.555	169.143	13.640		
	14:30	30		275	51.530	169.061	13.615		
		31			51.570	169.192	13.655		
		32			51.670	169.356	13.755		
		33		275	51.565	169.176	13.650		
		34			51.615	169.340	13.700		
		35			51.605	169.307	13.690		
		36		270	51.635	169.406	13.720		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº T-2
PAGE 2 OF ___
STATIC WATER LEVEL 37.915 m. below mp
M.P. ABOVE GROUND LEVEL 0.790

DATE	HOUR	t time since pumping began. minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN meters	CONDUCTIVITY μ mohs /cm.	TEMPERATURE °C.
5-11-83	14:37	37			51.695	169.603	13.780		
		38			51.665	169.504	13.750		
		39		275	51.685	169.570	13.770		
		40			51.690	169.586	13.775		
		42		270	51.760	169.816	13.845		
		44			51.765	169.832	13.850		
		46		270	51.765	169.832	13.850		
		48		280	51.770	150.843	13.855		
		50			51.800	169.947	13.885		
		52		270	51.805	169.963	13.890		
		54		270	51.825	170.029	13.910		
		56			51.845	170.095	13.930		
		58			51.840	170.078	13.925		
	15:00	60		280	51.885	170.226	13.970		
		65			51.925	170.357	14.010		
		70		275	51.915	170.324	14.000		
		75			52.000	170.603	14.085		
		80		270	52.000	170.603	14.085		
		85			52.000	170.603	14.085		
	15:30	90		280	52.050	170.767	14.135		
		95			52.100	170.931	14.185		
		100		280	52.120	170.997	14.205		
		105			52.140	171.062	14.225		
		110		280	52.140	171.062	14.225		
		115			52.140	171.062	14.225		
	16:00	120		280	52.190	171.161	14.255		
		130		270	52.200	171.259	14.285		
		140		280	52.240	171.391	14.325		
	16:30	150		200	48.625	159.530	10.710	WATER FLOW REDUCED TO [illegible] gpm DURING 2 min.	
		160		235	50.550	165.846	12.635		
		170		240	50.615	166.059	12.700		
	17:00	180		240	50.665	166.223	12.750		
		190		235	50.635	166.125	12.720		
		200		260	50.735	166.453	12.820		
	17:30	210		260	50.640	166.141	12.725		
		220		260	50.690	166.305	12.775		
		230		260	50.655	166.190	12.740		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº J-2
PAGE 3 OF
STATIC WATER LEVEL 37.915 m below mp
M.P. ABOVE GROUND LEVEL 0.990

DATE	HOUR	t time since pumping began, minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY μ mohs /cm.	T TEMPERATURE °C.
5.11.83	18:00	240		260	50.655	166.190	12.740		
	:15	255		260	50.685	166.289	12.770		
	:30	270		260	—	—	-	SE TRABA	POZOMETRO
	:45	285		—	—	—	-	REL. FLOW	
	19:00	300		260	49.275	161.663	11.360	CAMBIO POZOMETRO	
	:15	315		—	49.282	161.522	11.367		
	:30	330		250	49.243	161.558	11.328		
	:45	345		250	49.256	161.601	11.341		
	20:00	360		250	49.259	161.610	11.344		
	:30	390		260	49.271	161.650	11.356		
	21:00	420		255	49.288	161.706	11.373		
	:30	450		255	49.296	161.732	11.381		
	22:00	480		250	49.313	161.788	11.398		
	23:00	540		250	49.353	161.919	11.438		
	24:00	600		250	49.344	161.889	11.429		
6.11.83	01:00	660		240	49.322	161.817	11.407		
	02:00	720		250	49.385	162.024	11.470		
	03:00	780		250	49.415	162.122	11.500		
	04:00	840		255	49.380	162.007	11.465		
	05:00	900		250	49.384	162.020	11.469		
	06:00	960		250	49.460	162.270	11.545		
	07:00	1.020		255	49.495	162.385	11.580		
	08:00	1.080		255	49.495	162.385	11.580		
	09:00	1.140		255	49.520	162.467	11.605		
	10:00	1.200		255	49.535	162.516	11.620		
	12:00	1.320		255	49.650	162.893	11.735		
	14:00	1.440		260	49.575	162.647	11.660		
	16:00	1.560		255	48.985	160.711	11.070		
	18:00	1.680		260	49.030	160.859	11.115		
	20:00	1.800		255	48.899	160.429	10.984		
	22:00	1.920		250	48.809	160.134	10.894		
7.11.83	01:00	2.160		255	48.925	160.515	11.010		
	04:00	2.280		255	48.915	160.482	11.000		
	07:00	2.460		250	48.920	160.498	11.005		
	10:00	2.640		250	49.076	161.003	11.161		
	16:00	3.000		250	48.890	160.400	10.975	SE TRABA POZOMETRO (CAMBIO POZOMETRO)	
	22:00	3.360		245	48.588	159.409	10.673		

WELL Nº [illegible]

TEST WELL DATA

PUMP TEST

PAGE 4 OF ____

STATIC WATER LEVEL 37.915 m. below mp

M.P. ABOVE GROUND LEVEL 0.790

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY μ mohs /cm.	T TEMPERATURE °C.
8-11-83	04:00	3.720	078162	245	48.460	158.989	10.545		
	10:00	4.080	078246	245	48.395	158.776	10.480		
	13:00	4.260	078289	240	–	–			
	16:00	4.440	078332	240	48.431	158.894	10.516		
	19:00	4.620	078374	235	–	–			
	22:00	4.800	078416	230	48.406	158.812	10.491		
9-11-83	01:00	4.980	078459	230	-	-			
	04:00	5.160	078501	235	48.445	158.940	10.530		
	07:00	5.340	078543	230	–	–			
	10:00	5.520	078585	235	48.555	159.301	10.640		
	13:00	5.700	078628	245	–	–			
	16:00	5.880	078671	240	48.547	159.274	10.632		
	19:03	6.063	078714	240	–	–			
	22:00	6.240	078756	235	48.540	159.251	10.625		
10-11-83	01:00	6.420	078798	235	–	–			
	04:00	6.600	078841	240	48580	159383	10.665		
	07:00	6.780	078883	240	–	–			
	10:00	6.960	078925	240	48625	159.530	10.710		
	13:00	7.140	078.[illegible]	245	–	–			
	16:04	7.324	079.012	240	48.650	159.612	10.735		
	19:00	7.500	079.054	240	–	–			
	22:00	7.680	079.096	230	48.680	159.711	10.765		
11-11-83	01:00	7.860	079138	230	–	–			
	04:00	8.040	079.181	235	48.665	159.662	10.750		
	07:00	8.220	079 223	235	–	–			
	10:00	8.400	079.265	235	48.726	159.862	10.811		
	22:00	9.120	079.436	230	48.722	159.849	10.807		
12-11-83	10:00	9.840	079.605	235	48.920	160.498	11.005		
	22:00	10.560	079.776	237	48.829	160.200	10.914		
13 11 83	10:00	11 280	079945	237	48910	160.465	10.995		
	22:00	12.000	080116	235	48.956	160.616	11.041		
14.11 83	10:00	12.720	080.285	237	49.035	160875	11.121		
	22:00	13.440	080.456	237	48.484	159.068	10.569		
15-11-83	10:00	14.160	080.628	239	48 260	158.333	10.345		
	22:00	14.880	080 806	247	48.836	160.223	10.931		
16.11 83	10:00	15 600	080.982	244	48.650	159.612	10.735		
	22:00	16.320	081 158	244	48.834	160.216	10.919		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº J-2
PAGE 5 OF
STATIC WATER LEVEL 37.915 m. below mp
M.P. ABOVE GROUND LEVEL 0.790

DATE	HOUR	t time since pumping began. minutes	Gal. x 1000	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	~~RESIDUAL~~ DRAW DOWN ~~feet~~ METERS	CONDUCTIVITY µ mohs /cm.	T TEMPERATURE °C.
17-11-83	10:00	17.040	081 337	248	48 555	159 301	10.640		
	22:00	17 760	081.521	255	49 056	160.944	11.141		
18-11-83	10 00	18 480	081.700	248	48 750	159.940	10.835		
	22:00	19.200	081.882	253	49.294	161 725	11.379		
19-11-83	10.00	19.920	082.063	251	49 192	161.391	11.277		
	22.00	20 640	082 248	256	49 442	162 211	11.527		
20-11-83	10:00	21 360	082.431	254	49 242	161 555	11.327		
	22:00	22 080	082 616	257	49 598	162.723	11.683		
21-11-83	10.00	22 800	082.799	254	49.431	162.175	11.516		
	22:00	23.520	082.985	258	49.712	163 097	11.797		
22-11-83	10.00	24 240	083.167	253	49.690	162 270	11.775		
	22:00	24 960	083 353	258	49 844	163.530	11.929		
23-11-83	10 00	25.680	083 536	254	49 930	163 812	12.015		
	22 00	26,400	083.718	252	49.975		12.060		
24-11-83	10:00	27,120	083.904	254	49.950		12.036		
	22:00	27840	084089	254	50.060		12.145		
25-11-83	10:00	28,560	084272	254	50.180		12.265		
	22:00	29,280	084457	257	50.197		12.282		
26-11-83	10:00	30,000	084640	254	50.286		12.373		
	22:00	30720	084824	255	50.295		12.380		
27-11-83	10:00	31440	085008		50.320		12.405		

ESCONDIDA WATER PROGRAM — WELL Nº. ES: 1-2

TEST WELL DATA — page 1 of

RECOVERY 27-[illegible]-83 — static water level: 7.715 meters

STOP TEST PUMP 20:30 (t = 32,070 min)

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN METERS
21:00	32100	30	1070	38.415		
:05	32105	35	917	38.405		
:10	32110	40	803	38.360		
:15	32115	45	714	38.355		
:20	32120	50	642	38.340		
:25	32125	55	584	38.345		
:30	32130	60	536	38.350		
:35	32135	65	494	38.375		
:40	32140	70	459	38.295		
45	32145	75	429	38.210		
50	32150	80	402	38.087		
22:00	32160	90	357	38.045		
10	32170	100	322	38.026		
20	32180	110	293	38.001		
30	32190	120	268	38.000		
40	32200	130	248	37930		
50	32210	140	230	37.960		
23:00	32220	150	215	37.957		
15	32235	165	195	37.935		
30	32250	180	179	37.931		
45	32265	195	165	37.923		
24:00	32280	210	154	37.908		
30	32310	240	135	37.912		
01:00	32340	270	120	37.895		
02:00	32400	330	98	37.885		
03:00	32460	390	83	37.834		
04:00	32520	450	72	37.826		
05:00	32580	510	64	37.820		
06:00	32640	570	57	37.825		
07:00	32700	630	52	37.811		
08:00	32760	690	47	37.793		
09:00	32820	750	43.8	37.795		
10:00	32880	810	40.6	37.790		
11:00	32940	870	37.4	37.781		
12:00	33,000	930	35.5	37.774		
13:00	33060	990	33.4	37.760		
[illegible]	33130	1050	31.5	37.753		

ESCONDIDA WATER PROGRAM
TEST WELL DATA

WELL Nº. ES: T-[illegible]

page 2 of ____

RECOVERY

Static W.L.: 37.[illegible]75 meters

	HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	feet	RESIDUAL DRAW DOWN feet
[illegible]	16:00	33240	1170	28.4	37.795		
1-83	18:00	33360	1290	25.9	37 737		
	20:00	33480	1410	23.7	37 785		
	22:00	33600	1530	22.0	37 780		
	24:00	33720	1650	20.4	37 835		
[illegible]-11-83	02:00	33840	1770	19.1	37 770		
	04:00	33960	1890	18.0	37 725		
	06:00	34080	2010	17.0	37 736		
	08:00	34200	2130	16.1	37 731		
	10:00	34320	2250	15.3	37.726		
	12:00	34440	2370	14.5	37 621		
[illegible]	16:00	34680	2610	13.3	37.710		
	9 35	34895	2825	12.4	37 716		
	24:00	35160	3090	11.4	37 800		
[illegible] 11-83	04:00	35400	3330	10.6	37 710		
	08:00	35640	3570	10.0	37 696		
	11 30	35850	3780	9.5	37.730		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº SC-5
PAGE 1 OF ____
STATIC WATER LEVEL 37.160 m. below mp.
M.P. ABOVE GROUND LEVEL 0.045

DATE	HOUR	t time since pumping began, minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY μ mhos /cm.	T TEMPERATURE °C.
5-11-83	14:00	0							
		1			37.150	121.883	-0.010		
		2			37.255	122.227	0.095		
		3			37.335	122.490	0.175		
		4			37.410	122.736	0.250		
		5			37.468	122.926	0.308		
		6			37.530	123.129	0.370		
		7			37.578	123.287	0.418		
		8			37.617	123.415	0.457		
		9			37.653	123.533	0.493		
	14:10	10			37.685	123.638	0.525		
		11			37.717	123.743	0.557		
		12			37.743	123.828	0.583		
		13			37.770	123.917	0.610		
		14			37.790	123.982	0.630		
		15			37.804	124.028	0.644		
		16			37.830	124.114	0.670		
		17			37.845	124.163	0.685		
		18			37.867	124.235	0.707		
		19			37.900	124.343	0.740		
	14:20	20			37.918	124.402	0.758		
		21			37.940	124.475	0.780		
		22			37.957	124.530	0.797		
		23			37.970	124.573	0.810		
		24			38.000	124.671	0.840		
		25			38.004	124.685	0.844		
		26			38.030	124.770	0.870		
		27			38.071	124.904	0.911		
		28			38.064	124.881	0.904		
		29			38.060	124.868	0.900		
	14:30	30			38.088	124.960	0.928		
		31			38.100	125.000	0.940		
		32			38.100	125 000	0.940		
		33			38.114	125.045	0.954		
		34			38.145	125.147	0.985		
		35			38.140	125.131	0.980		
		36			38.147	125.154	0.987		

...GUNDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL № 5C-5
PAGE 2 OF ____
STATIC WATER LEVEL 37.160 m. below m.p.
M.P. ABOVE GROUND LEVEL 0.045

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY μ mohs /cm.	T TEMPERATURE °C.
5-11-83	14:37	37			38.150	125.164	0.990		
		38			38.153	125.173	0.992		
		39			38.156	125.183	0.996		
		40			38.168	125.223	1.008		
		42			38.176	125.249	1.016		
		44			38.188	125.288	1.028		
		46			38.194	125.308	1.034		
		48			38.202	125.334	1.042		
		50			38.211	125.364	1.051		
		52			38.221	125.396	1.061		
		54			38.230	125.426	1.070		
		56			38.243	125.469	1.083		
		58			38.244	125.472	1.084		
	15:00	60			38.248	125.485	1.088		
		65			38.273	125.567	1.113		
		70			38.290	125.623	1.130		
		75			38.299	125.652	1.139		
		80			38.310	125.688	1.150		
		85			38.325	125.738	1.165		
	15:30	90			38.336	125.774	1.176		
		95			38.350	125.820	1.190		
		100			38.355	125.836	1.195		
		105			38.361	125.856	1.201		
		110			38.372	125.892	1.212		
		115			38.379	125.915	1.219		
	16:00	120			38.393	125.961	1.233		
		130			38.418	126.043	1.258		
		140			38.424	126.062	1.264		
	16:30	150			38.259	125.521	1.099		
		160			38.342	125.793	1.182		
		170			38.356	125.839	1.196		
	17:00	180			38.373	125.895	1.213		
		190			38.380	125.918	1.220		
		200			38.382	125.925	1.222		
		210			38.385	125.935	1.225		
		220			38.397	125.974	1.237		
		230			38.396	125.971	1.236		

[illegible] WATER PROGRAM WELL Nº [illegible]

TEST WELL DATA

PUMP TEST

PAGE 2 OF ____

STATIC WATER LEVEL 37.160 m.below mp.

M.P. ABOVE GROUND LEVEL 0.045

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN ~~Feet~~ METERS	CONDUCTIVITY µ mohs /cm.	T TEMPERATURE °C.
5-11-83	18:00	240			38.400	125.984	1.240		
	:15	255			38.410	126.017	1.250		
	:30	270			38.415	126.033	1.255		
	:45	285			—	—			
	19:00	300			38.425	126.066	1.265		
	:15	315			38.438	126.108	1.278		
	:30	330			38.443	126.125	1.283		
	:45	345			38.444	126.128	1.284		
	20:00	360			38.454	126.161	1.294		
	:30	390			38.470	126.213	1.310		
	21:00	420			38.469	126.210	1.309		
	:30	450			38.502	126.318	1.342		
	22:00	480			38.500	126.312	1.340		
	23:00	540			38.519	126.374	1.359		
	24:00	600			38.523	126.387	1.363		
6-11-83	01:00	660			38.531	126.414	1.371		
	02:00	720			38.560	126.509	1.400		
	03:00	780			38.625	126.722	1.465		
	04:00	840			38.628	126.732	1.468		
	05:00	900			38.690	126.935	1.530		
	06:00	960			38.750	127.132	1.590		
	07:00	1.020			38.625	126.722	1.465		
	08:00	1.080			38.675	126.886	1.515		
	09:00	1.140			38.630	126.738	1.470		
	10:00	1.200			38.760	127.165	1.600		
	12:00	1.320			38.579	126.571	1.419		
	14:00	1.440			38.542	126.450	1.382		
	16:00	1.560			38.546	126.463	1.386		
	18:00	1.680			38.565	126.525	1.405		
	20:00	1.800			38.561	126.512	1.401		
	22:00	1.920			38.564	126.522	1.404		
7-11-83	01:00	2.100			38.610	126.673	1.450		
	04:00	2.280			38.620	126.706	1.460		
	07:00	2.460			38.690	126.935	1.530		
	10:00	2.640			38.635	126.755	1.475		
	16:00	3.000			38.587	126.597	1.427		
	22:00	3.360			38.601	126.643	1.441		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº SC-5
PAGE 4 OF ____
STATIC WATER LEVEL 37.160 m. below mp
M.P. ABOVE GROUND LEVEL 0.045

DATE	HOUR	t time since pumping began, minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY μ mohs /cm.	T TEMPERATURE °C.
8-11-83	04:00	3.720			38.660	126.837	1.500		
	10:00	4.080			38.645	126.788	1.485		
	16:00	4.440			38.567	126.532	1.407		
	22:00	4.800			38.597	126.630	1.437		
9-11-83	04:00	5.160			38.625	126.722	1.465		
	10:00	5.520			38.615	126.689	1.455		
	16:00	5.880			38.595	126.624	1.435		
	22:00	6.240			38.610	126.673	1.450		
10-11-83	04:00	6.600			38.590	126.607	1.430		
	10:00	6.960			38.740	127.099	1.580		
	16:00	7.320			38.610	126.673	1.450		
	22:00	7.680			38.640	126.771	1.480		
11-11-83	04:00	8.040			38.535	126.427	1.375		
	10:00	8.400			38.644	126.784	1.484		
	22:00	9.120			38.641	126.774	1.481		
12-11-83	10:00	9.840			38.810	127.329	1.650		
	22:00	10.560			38.653	126.814	1.493		
13-11-83	10:00	11.280			38.750	127.132	1.570		
	22:00	12.000			38.812	127.335	1.652		
14-11-83	10:00	12.720			38.790	127.263	1.630		
	22.00	13.440			38.735	127.0[illegible]	1.575		
15-11-83	10:00	14.160			38.760	1[illegible].165	1.600		
	22:00	14.880			38.760	127.165	1.600		
16-11-83	10:00	15.600			38.790	127.263	1.630		
	22:00	16.320			38.782	127.237	1.622		
17-11-83	10:00	17.040			38.815	127.345	1.655		
	22:00	17.760			38.845	127.444	1.685		
18-11-83	10:00	18.480			38.840	127.427	1.680		
	22:00	19.200			38.853	127.470	1.693		
19-11-83	10:00	19.920			38.870	127.526	1.710		
	22:00	20.640			38.866	127.513	1.706		
20-11-83	10:00	21.360			38.880	127.559	1.720		
	22:00	22.080			38.912	127.664	1.752		
21-11-83	10:00	22.800			38.940	127.755	1.780		
	22:00	23.520			38.910	127.657	1.750		
22-11-83	10:00	24.240			38.930	127.723	1.770		
	22:00	24.960			38.943	127.765	1.7[illegible]		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº SC-5
PAGE 5 OF
STATIC WATER LEVEL 37.160 m. below mp
M.P. ABOVE GROUND LEVEL 0.045

DATE	HOUR	t time since pumping began. minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY. μ mohs /cm.	T TEMPERATURE °C.
23-11-83	10:00	25,680			38.940	127.755	1.780		
	22:00	26,400			38.970		1.810		
24-11-83	10:00	27,120			38.935		1.775		
	22:00	27,840			39.000		1.840		
25-11-83	10:00	28,560			39.024		1.864		
	22:00	29,280			39.004		1.844		
26-11-83	10:00	30,000			39.030		1.870		
	22:00	30,720			39.035		1.875		
27-11-83	10:00	31,440			39.036		1.876		
	22:00	32,160							

TEST TERMINATED @ 20:30 11/27/83
t = 32,070 minutes

WELL Nº. ES: [illegible]

TEST WELL DATA

page 1 of

RECOVERY 27-11-83 STOP TEST PUMP 20 30

STATIC LEVEL: 37.160

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	feet	RESIDUAL DRAW DOWN ~~feet~~ METERS
21 45				38.057		0.900
50				38.040		0.880
55				38.021		0.860
22:00				38.010		0.850
15				37.973		0.810
30				37.952		0.790
45				37.940		0.780
11.00				37.912		0.750
30				37.893		0.730
24:00				37.870		0.710
30				37.861		0.700
01:00				37.835		0.680
02:00				37.800		0.640
03 00				37.790		0.630
04 00				37.778		0.620
05 00				37.761		0.600
06:00				37.766		0.606
07:00				37.753		0.593
08:00				37.735		0.575
09:00				37.722		0.562
10:00				37.711		0.551
11:00				37.706		0.546
12:00				37.752		0.592
13:00				37.688		0.523
14:00				37.676		0.516
16.00				37.712		0.552
18:00				37.698		0.538
20:00				37.705		0.590
22.00				37.665		0.505
24:00				37.666		0.506
02 00				37.652		0.492
24 00				37.638		0.478
06:00				37.643		0.483
08 00				37.640		0.480
10:00				37.630		0.470
12:00				37.621		0.461
16 00				37.620		0.460

WELL N°. CS: [illegible]

TEST WELL DATA

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RECOVERY

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp		RESIDUAL DRAW DOWN
				meters	feet	~~feet~~ METERS
19:35				37.624		0.464
24:00				37.600		0.440
04:00				37.587		0.427
08:00				37.720	?	0.560
11 30				37.573		0.413

SECCION 4.3

DISEÑO RHEIN ART. 323.404

MINERA UTAH DE CHILE, INC.

Antofagasta, Chile

WELL T-3 PUMP TESTS:

ANALYSIS OF RESULTS

February 1984

DAVID KEITH TODD

Consulting Engineers, Inc.

Berkeley, California

CONTENTS

LIST OF FIGURES

SUMMARY

Step-drawdown and constant discharge tests were conducted on well T-3, December 1 and December 2-10, 1983, respectively. The objectives of the tests were to determine well efficiency, groundwater quality, and the aquifer characteristics to aid in the design of the final well field.

Analysis of the data indicates the area around well T-3 has excellent development potential with a transmissivity of 22,600 gpd/ft and a salinity (T.D.S.) of 1260 mg/l. The aquifer within 1.5 kilometers west of well T-3 is confined and has a storage coefficient of 4×10^{-4}. However, the area west of T-3 should be avoided because of the proximity of the western aquifer boundary.

The estimated efficiency of well T-3 is 30% and the well loss coefficient is about 80 sec^2/ft^5 (8.4 $min^2/meter^5$). These values suggest severe clogging at the borehole face behind the gravel pack.

Introduction

This report describes a constant discharge aquifer test performed on well T-3 December 2-10, 1983 and a step-drawdown test performed on well T-3 on December 1, 1983. Field measurements of water levels, pumping rates and water quality were made over time. Well ES-54A was used as an observation well for water level measurements. The data from the tests were analyzed to evaluate well efficiency, transmissive and storage characteristics of the aquifer, and water quality. All basic data are tablulated in the appendix.

The purpose of this report is to provide hydrogeologic information necessary for design of a well field to supply water to the Escondida mining operations.

This is the third of five planned reports evaluating aquifer characteristics around Salar de Punta Negra. Well T-3 is located about 6 kilometers south southwest of well T-2 and is approximately 2 kilometers east of the aquifer's western boundary.

Test Conditions

The relative locations of pumping well T-3 and observation well ES-54A are shown in Figure 1. The well construction features are shown in Figure 2. It is important to note that both well screens fully penetrate the aquifer and that the aquifer is confined based on lithologic and geophysical logs. Therefore, head losses caused by partial penetration or a seepage surface do not occur here.

Water level measurements were taken on a logarithmic frequency in well T-3 and well ES-54A using electric sounders.

Flow measurements were made using a totalizing flow meter during both the step-drawdown and constant discharge tests. The flow rate during the step-drawdown test was increased from 300 gpm to 400 gpm and then finally to 425 gpm.

No aberrations in the flow rates were apparent during each step. The initial flow rate during the constant discharge test was 425 gpm but was cut back to 390 gpm after 1200 minutes to avoid breaking suction. This reduction, however, is less than 10% and does not adversely affect the analysis of the data. The average discharge over the length of the test was 394 gpm.

The conductivity of the discharge water from well T-3 was measured daily and the values are readily convertible to total dissolved solids concentrations.

The quality of data from this test is very good, enabling reliable evaluations of the aquifer and pumping well characteristics. The water level measurements, flow rates, and water conductivity values are tabulated in the appendix of this report.

Step-Drawdown Test on Well T-3

A step-drawdown test was conducted on well T-3 December 2, 1983, for the purpose of estimating the well's efficiency.

The time duration of each step was 120 minutes. The discharges for the three steps were 300 gpm, 400 gpm and 425 gpm. The resulting drawdowns were plotted versus time on a semi-logarithmic graph as shown in Figure 3.

The incremental drawdown, Δs, and incremental flow rate, ΔQ, for each step were used to evaluate the well loss coefficient, C, according to the following formula:

$$C = \frac{\Delta s_i/\Delta s_{i-1}/\Delta Q_{i-1}}{\Delta Q_i + \Delta Q_{i-1}}$$

The coefficient was calculated for steps 1 and 2, 2 and 3, and 1 and 3. The results were 114, 154 and 199 sec^2/ft^5, respectively. These values are extremely large indicating severe clogging of the well screen or gravel pack. The accuracy of these values is questionable, however, because the drawdown due to well loss calculated from these coefficients would be equal to the total observed drawdown during the test. This is a physical impossibility.

Another method was used to determine C which is more accurate, though more involved. For details on the method see Rorabaugh (1953) and Todd (1959)*. The results gave a C of 83 sec^2/ft^5. The well loss is calculated from the following equation:

$$Sw = C\ Q^n$$

where Sw = drawdown due to well loss

Q = discharge

n = coefficient which may vary between 1.0 and 3.5

The coefficient, n, was calculated to be 2.32 for the step-drawdown test conditions.

The amount of drawdown caused by the inefficiency of the well, based on the above parameters, is about 22 meters for a flow rate of 425 gpm. It is evident that, unlike wells T-1 and T-2, well T-3 is severely clogged; such well losses limit this well's usefulness for well field design.

<u>Well ES-54A Analysis</u>

The drawdown versus time data for well ES-54A are shown on Figures 4 and 5, and the recovery data are plotted on Figure 6. The nature of the curves suggest that the aquifer conditions fit the assumptions inherent in the standard Theis nonequilibrium equation: mainly, a confined, non-leaky aquifer and fully penetrating wells. The well construction diagram on Figure 2 indicates this also. There is a hint of leakage from the overlying clay at t = 5000 to t = 10,080 minutes, but this departure could also be due to a small variation

*Rorabaugh, M. I., 1953, "Graphical and Theoretical Analysis of Step Drawdown Test of Artesian Well", Proc. Amer. Soc. Civil Engrs., vol. 79, No. 362.
Todd, D. K., 1959, "Ground Water Hydrology", John Wiley, p.109.

in the flow rate or the effect of a zone encountering different aquifer characteristics.

The calculated transmissivities and storage coefficients are in good agreement. The average transmissivity is 22,600 gpd/ft. The log-log plot in Figure 5 is considered more reliable and therefore was weighted double against the semi-log and recovery plots in Figures 4 and 6. The average storage coefficient is 3.7×10^{-4}.

Based on these determined parameters, the radius of investigation or effect of pumping should have been between 2 and 3 kilometers. Geologic evidence indicates the presence of an impermeable boundary two kilometers to the west; however, there is no indication of this in the drawdown data. Other things being equal, the drawdown curve in Figure 4 should have steepened markedly after about 3000 minutes if a barrier exists two kilometers to the west of well T-3.

The possibility that the aquifer becomes unconfined between well T-3 and the barrier was examined using a numerical simulation model. It was discovered that a change from confined to unconfined aquifer conditions about 1.5 kilometers west of well T-3 not only masks the effect of a barrier but also actually causes the drawdown curve to flatten as observed in Figure 5 where t = 4400 minutes. This finding serves as a basis for estimating the extent of the confined aquifer zone.

Well T-3 Analysis

The drawdown data versus time for well T-3 are shown in Figure 7 and the recovery data are plotted in Figure 8. The transmissivity calculated from Figure 7 is less than half that determined from observation well ES-54A. This low transmissivity value is caused by the well's inefficiency as discussed earlier. The recovery graph on Figure 8 gives a transmissivity in excellent agreement with the transmissivity from Figures 4 through 6.

The efficiency of well T-3, defined as the ratio of the theoretical drawdown to the observed drawdown, X 100, is about 30%. This is in sharp contrast to the 70 to 75% efficiencies estimated for wells T-1 and T-2. Normally, well T-3 should have a higher efficiency than either well T-2 or well T-3 because well T-3 is not adversely affected by partial penetration or the development of a large seepage surface at the well. It can be concluded that there is significant clogging of the gravel pack, the wellbore face, or the well screen. Furthermore, the high well loss coefficient indicates that the well probably cannot be brought up to more than about 60% efficiency by additional development.

Salinity Analysis

The conductivity of the discharge water was measured daily in the field starting on December 3. Three water samples were sent for analysis of individual ionic parameters. The estimated total dissolved solids concentrations are given in Table 1. The asterisks mark those samples actually analyzed for TDS. The other salinity values are based on a ratio of TDS to specific conductance of 0.70 mg/l per micromho at 25°C.

Table 1. Salinity of Water Samples from Well T-3

Date Sampled	Salinity (T.D.S.), mg/l
December 3	1290*
December 4	1250
December 5	1250
December 6	1240*
December 7	1250
December 8	1270*

The change in salinity over the test period is insignificant, and the values indicate good water quality. The salinity at T-3 is quite consistent with the general trend of poorer water quality to the south and better water quality in the north in the Punta Negra basin.

This water quality, together with the good transmissivity, indicates this area is a prime area for development of a well field.

Conclusions

(1) The average transmissivity within about two kilometers of well T-3 is 22,600 gpd/ft.

(2) The storage coeffieient is about 4 X 10^{-4}.

(3) The aquifer in the vicinity of well T-3 is confined having about 47 meters of piezometric head above the top of the aquifer unit.

(4) Based on numerical simulations, the aquifer changes from confined to unconfined conditions about 1.5 kilometers to the west of well T-3; during the test this change masked the effect of the western aquifer boundary.

(5) Well T-3 has an efficiency of approximately 30% and the well loss coefficient is about 80 sec^2/ft^5 (8.4 $min^2/meter^5$)this indicates that severe clogging behind the well screen has occurred; however, this situation does not effect the calculations of transmissivity and storage coefficient derived from nearby observation well data.

(6) The average salinity throughout the constant discharge test was 1260 mg/l and no significant change in salinity was noted.

(7) This water quality coupled with the good aquifer characteristics makes the area of 2311 T-3 excellent for water development. However, the region to the west of well T-3 should be avoided because of the proximity of an impermeable aquifer boundary.

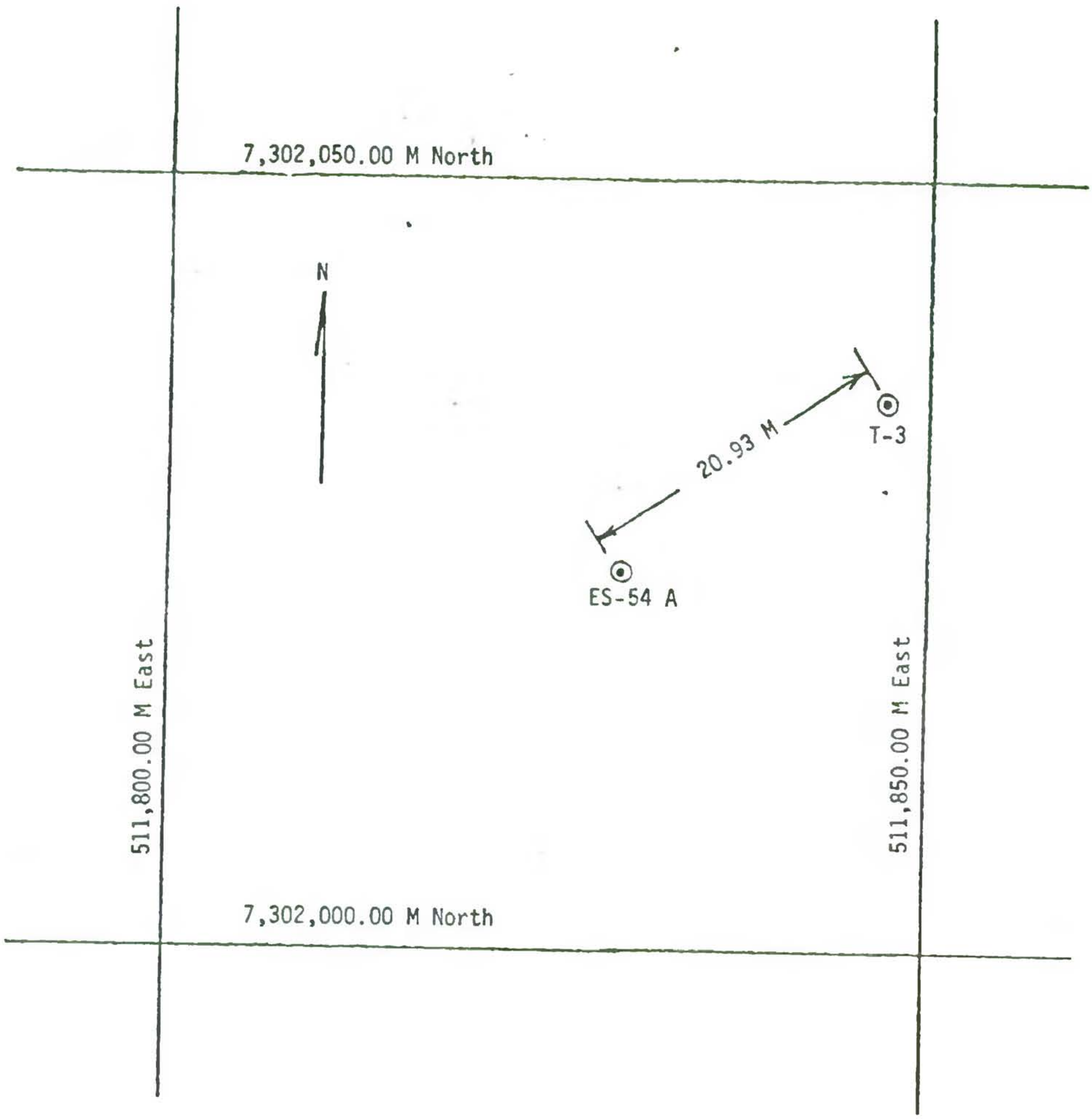

Figure 1.

Location Map of Pumped Well T-3
and Observation Well ES-54A

David Keith Todd, Consulting Engineers, Inc.

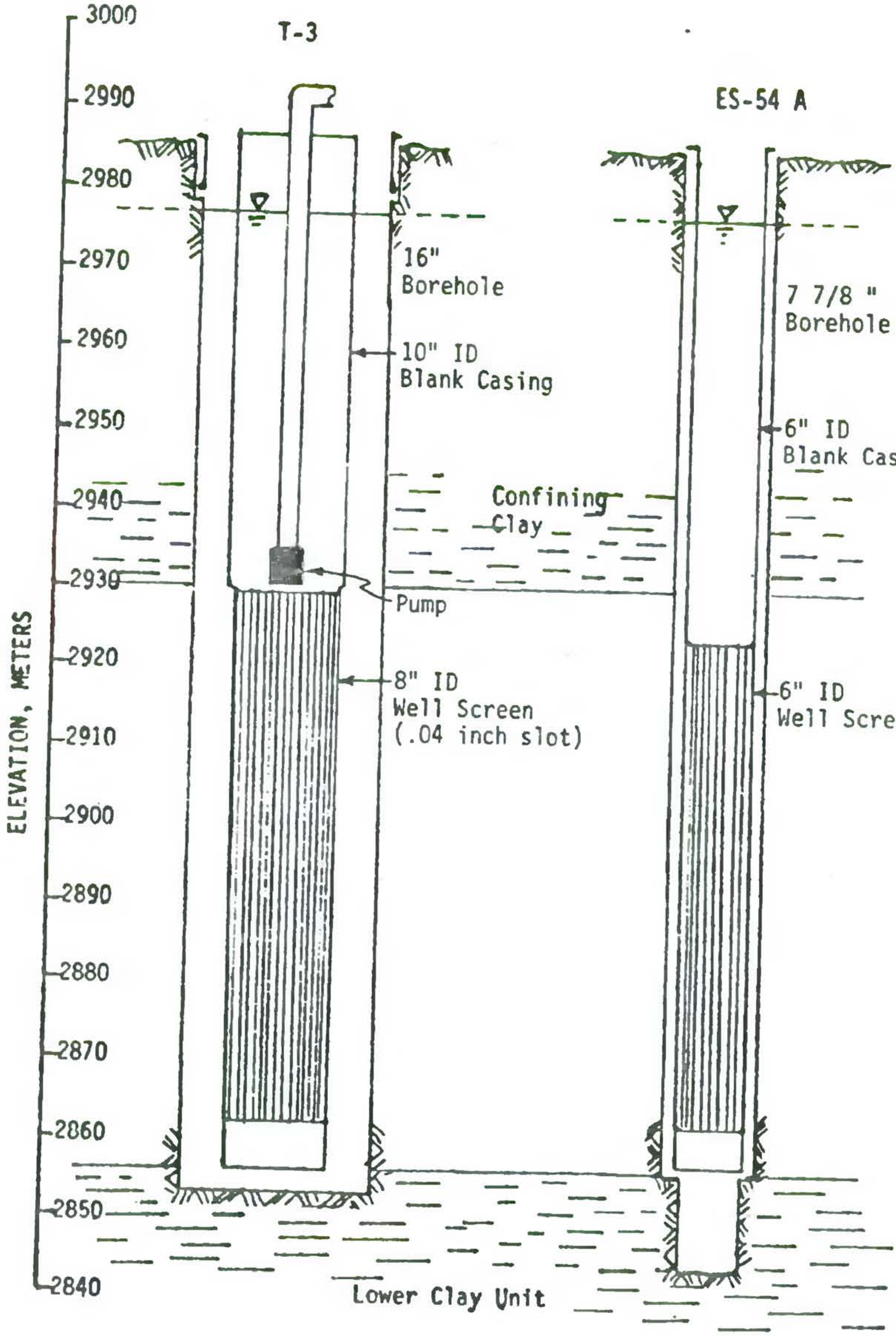

Figure 2.
Construction of Pumped Well and Observation Well

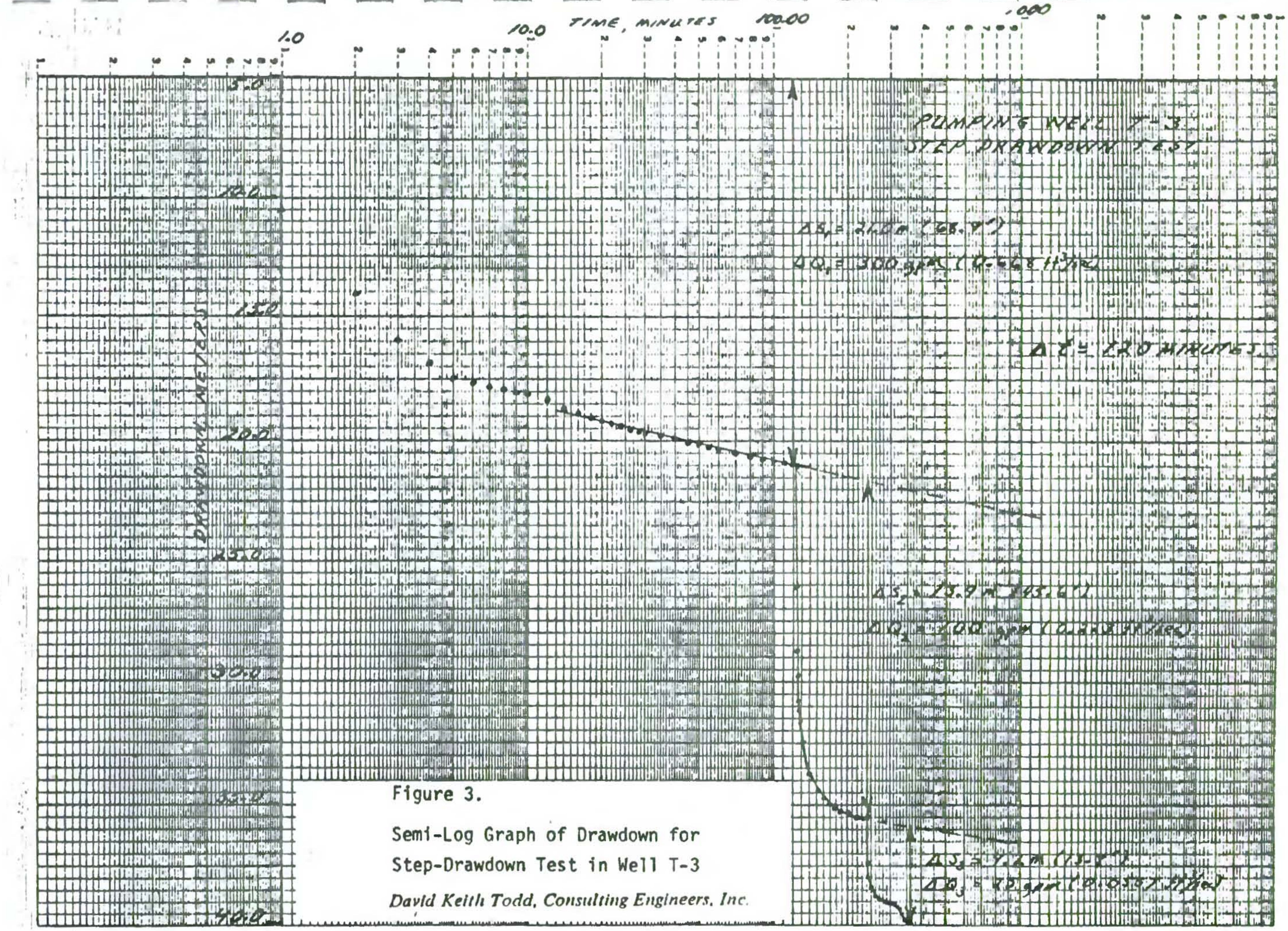

Figure 3.

Semi-Log Graph of Drawdown for Step-Drawdown Test in Well T-3

David Keith Todd, Consulting Engineers, Inc.

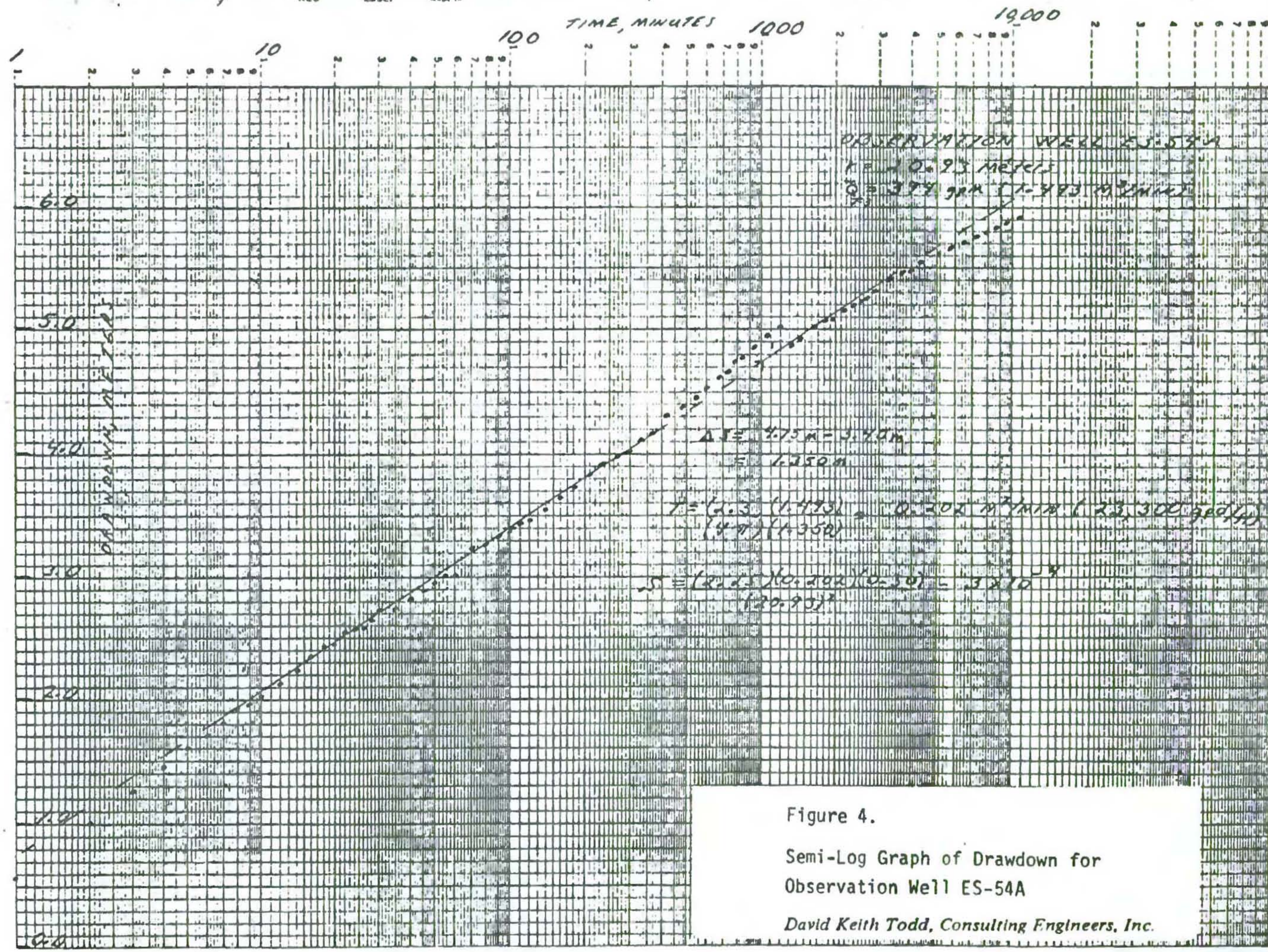

Figure 4.

Semi-Log Graph of Drawdown for Observation Well ES-54A

David Keith Todd, Consulting Engineers, Inc.

K•E LOGARITHMIC 3 x 5 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 7522

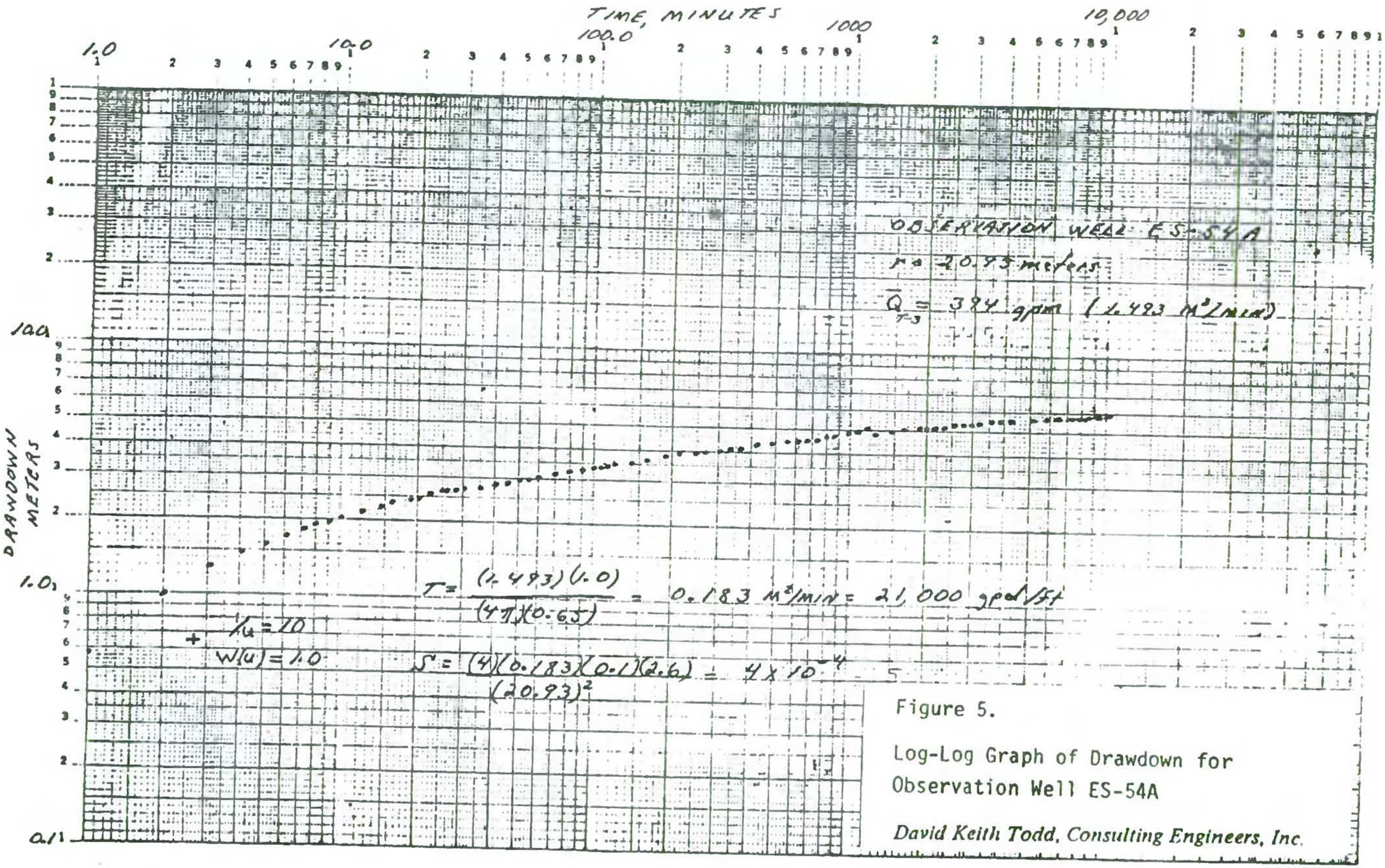

Figure 5.

Log-Log Graph of Drawdown for Observation Well ES-54A

David Keith Todd, Consulting Engineers, Inc.

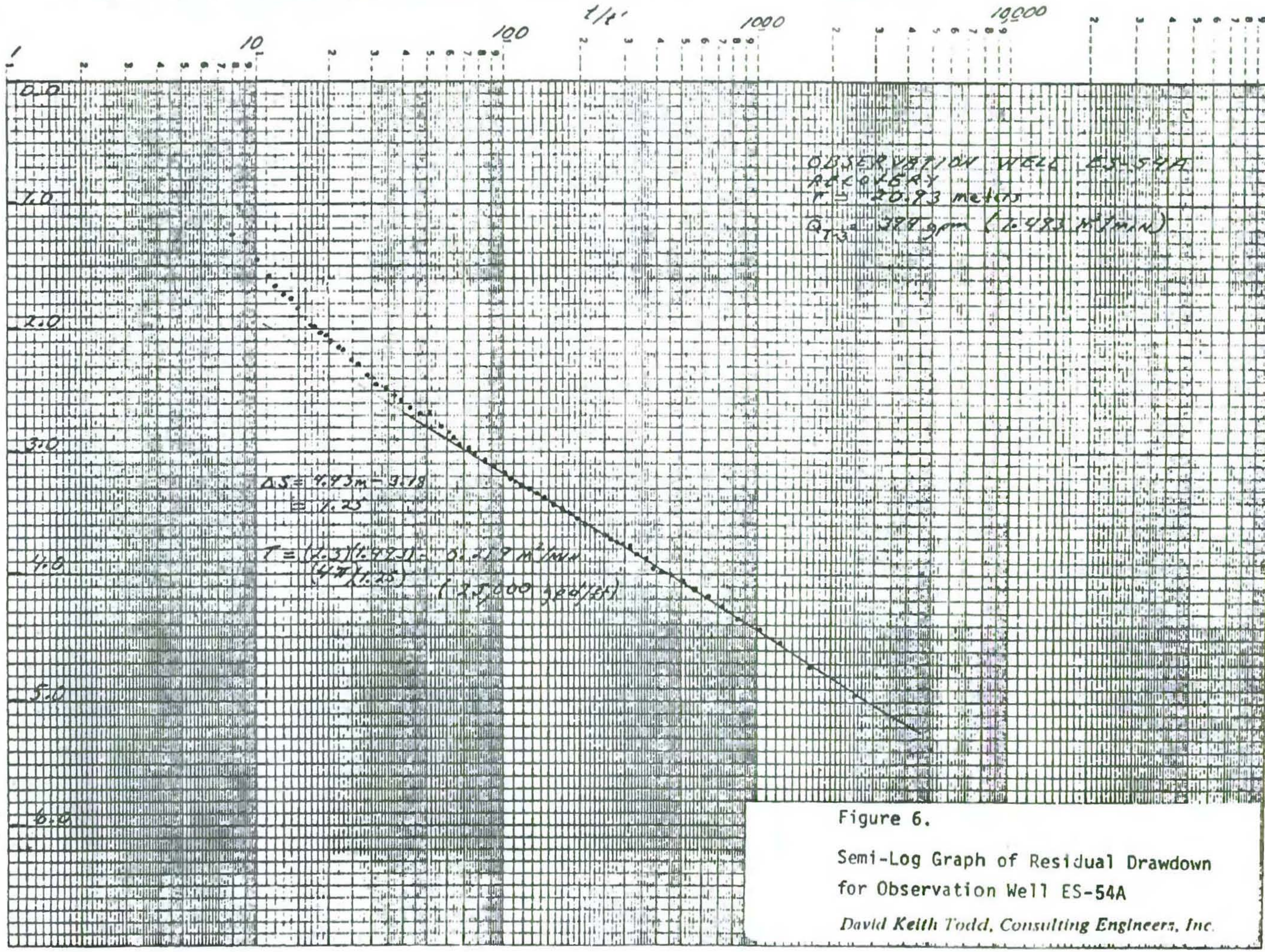

Figure 6.

Semi-Log Graph of Residual Drawdown for Observation Well ES-54A

David Keith Todd, Consulting Engineers, Inc.

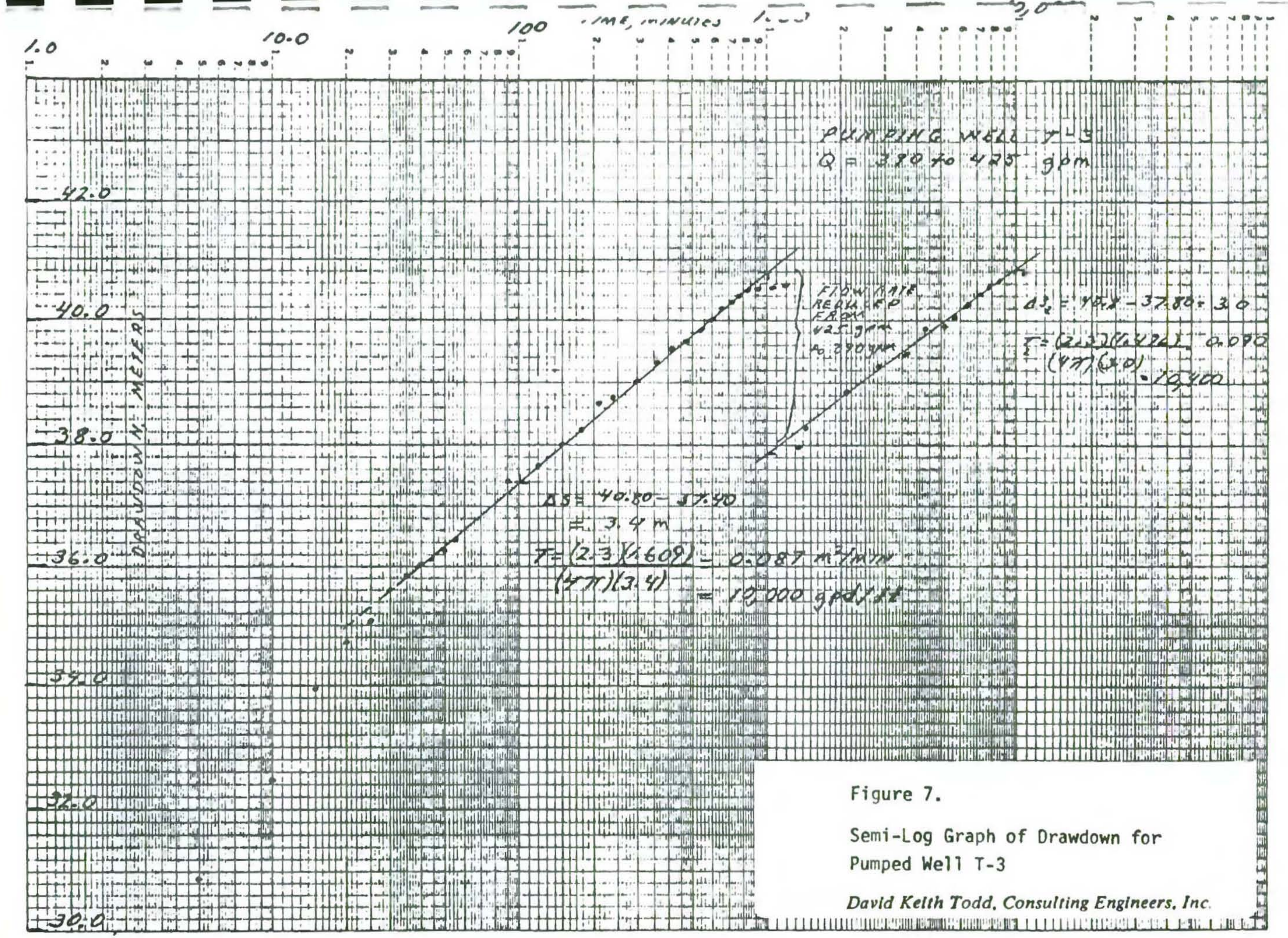

Figure 7.

Semi-Log Graph of Drawdown for Pumped Well T-3

David Keith Todd, Consulting Engineers, Inc.

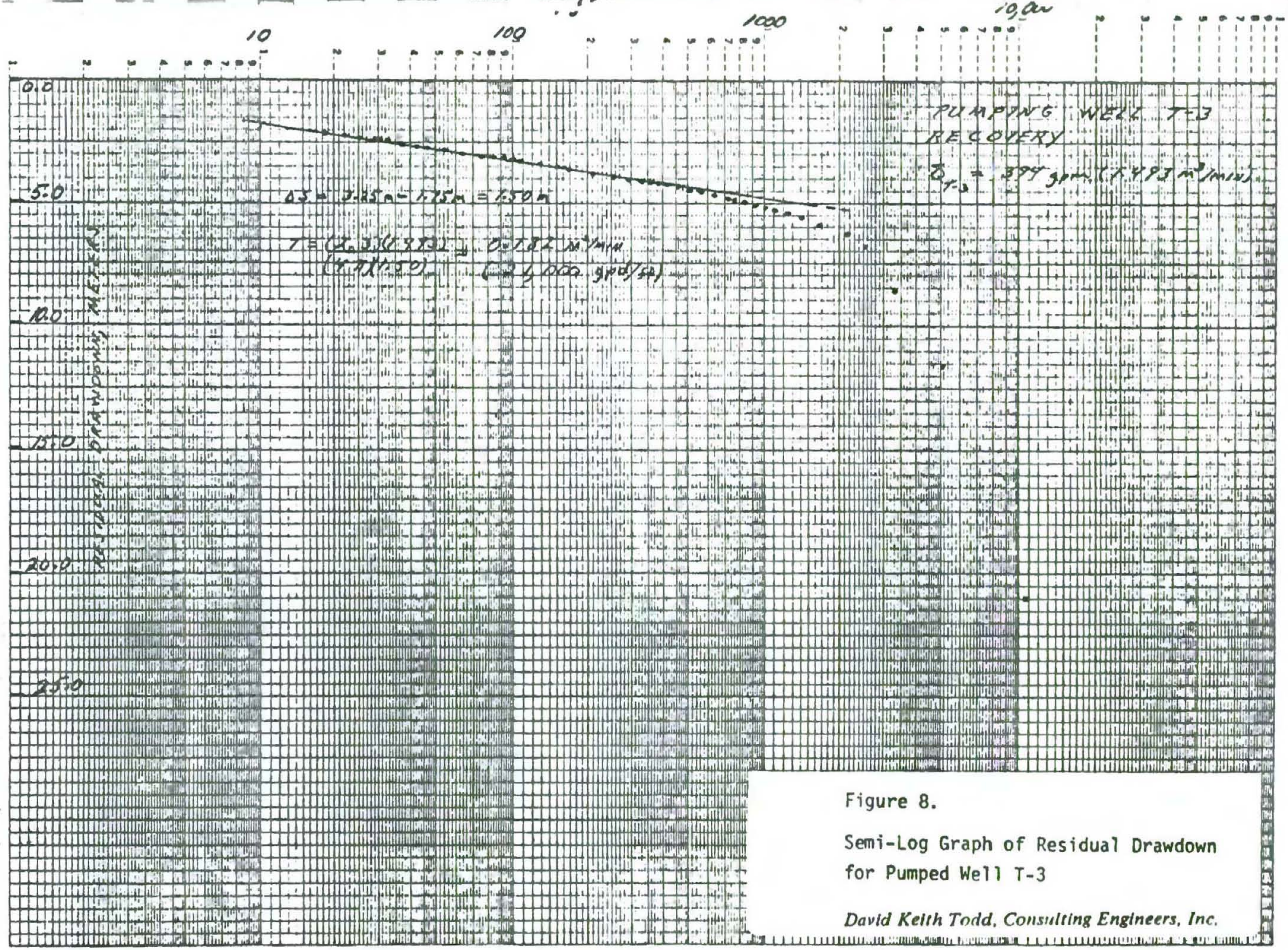

Figure 8.

Semi-Log Graph of Residual Drawdown for Pumped Well T-3

David Keith Todd, Consulting Engineers, Inc.

APPENDIX

The following pages contain tabulations of water level measurements, well discharge, and water conductivity measurements for the Well T-3 pump tests.

[illegible]CONDA WATER PROGRAM — WELL No. T-3
TEST WELL DATA — VALVULA = 1/4 VUELTA — PAGE 1 OF 3
PUMP TEST — STEP DRAW DOWN TEST. — STATIC WATER LEVEL 8.169 [illegible]
M.P. ABOVE GROUND LEVEL

DATE	HOUR	t time since pumping began, minutes	Gal. x 1000	Q gpm	WATER LEVEL below m.p. meters	WATER LEVEL below m.p. feet	DRAW DOWN METERS	CONDUCTIVITY μ mohs/cm.	TEMPERATURE °C.
1-12-83	2:30	0	85 194 ½		8.169		10.561		
	31	1			18 730		10.561		
	32	2			22 231		14.062		
	33	3			24 140		15.971		
	34	4			24 996		16.827		
	35	5		300	25.640		17.471		
	36	6			25 821		17.652		
	37	7			25 987		17.818		
	38	8			26 140		17.971		
	39	9			26 280		18.111		
	40	10			26 370		18.201		
	42	12			26 620		18.451		
	44	14			26 910		18.741		
	46	16			27 090		18.921		
	48	18			27.315		19.146		
	50	20			27.420		19.251		
	52	22			27.570		19.401		
	54	24		300	27.660		19.491		
	56	26			27 740		19.571		
	58	28			27 825		19.656		
	3:00	30			27 880		19.711		
	05	35			28 000		19.831		
	10	40			28 155		19.986		
	15	45			28 295		20.126		
	20	50			28 350		20.181		
	25	55			28 455		20.286		
	30	60		300	28 550		20.381		
	40	70			28.674		20.505		
	30	80			28 777		20.608		
	4:00	90		300	28 909		20.740		
	10	100			28 946		20.777		
	20	110			29 071		20.902		
	30	120		300	29.113		20.944		

ANACONDA WATER PROGRAM — WELL No. T-3
TEST WELL DATA — VALVULA = ½ VUELTA — PAGE 2 OF 3
PUMP TEST — STEP DRAW DOWN TEST — STATIC WATER LEVEL — M.P. ABOVE GROUND LEVEL

DATE	HOUR	t time since pumping began, minutes	Gal. x 1000	Gpm	WATER LEVEL below mp: meters	WATER LEVEL below mp: feet	DRAW DOWN METERS	CONDUCTIVITY µmhos/cm.	TEMPERATURE °C.
1-12-83	4:30	0		300					
	31	1			29 136		20.967		
	32	2			29 249		21.080		
	33	3			29.215		21.046		
	34	4			29 185		21.016		
	35	5			34.276		26.107		
	36	6			36 865		28.696		
	37	7			37.961		29.792		
	38	8			38 842		30.673		
	39	9			39 416		31.247		
	40	10			39 876		31.707		
	42	12			40 705		32.536		
	44	14			41 088		32.919		
	46	16			41 434		33.265		
	48	18			41.750		33.581		
	50	20			41 908		33.739		
	52	22			42 027		33.858		
	54	24			42 179		34.010		
	56	26			42 302		34.133		
	58	28			42 427		34.258		
	5 00	30		400	42.561		34.392		
	05	35			42 624		34.455		
	10	40			42 864		34.695		
	15	45			42 904		34.735		
	20	50			43.081		34.912		
	25	55			43.196		35.747		
	30	60		400	43.301		35.132		
	40	70			43.444		35.275		
	50	80			43 520		35.351		
	6:00	90		400	43.578		35.403		
	10	100			43.756		35.587		
	20	110			43.609		35.440		
	30	120		400	43.707		35.538		

[illegible] WATER PROGRAM — WELL No. T-3

TEST WELL DATA — VALVULA: 5/8 VUELTA — PAGE 3 OF 3

PUMP TEST: STEP DRAW DOWN TEST — STATIC WATER LEVEL ______ M.P. ABOVE GROUND LEVEL ______

DATE	HOUR	t time since pumping began, minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp: meters	WATER LEVEL below mp: feet	DRAW DOWN METERS	CONDUCTIVITY µ mhos /cm.	TEMPERATURE °C.
1-12-83	6:30	0							
	31	1 241			45 548		37.379		
	32	2			46 095		37.926		
	33	3			46 175		38.006		
	34	4			46 405		38.236		
	35	5			46.475		38.306		
	36	6			46 585		38.416		
	37	7			46.577		38.408		
	38	8			46 610		38.441		
	39	9			46 610		38.441		
	40	10 250			46.603		38.434		
	42	12			46.775		38.606		
	44	14			46 841		38.672		
	46	16			46.872		38.703		
	48	18			46.968		38.799		
	50	20 260			46.964		38.795		
	52	22			46.963		38.794		
	54	24			47.016		38.847		
	56	26			47.000		38.831		
	58	28			47.066		38.897		
	7:00	30 270		425	47.068		38.899		
	05	35			47 100		38.931		
	10	40 280			47 142		38.973		
	15	45			47 198		39.029		
	20	50 290			47 201		39.041		
	25	55			47 412		39.243		
	30	60 300		425	47 320		39.151		
	40	70 310			47.324		39.155		
	50	80 320			47.435		39.266		
	8:00	90 330		425	47.610		39.441		
	10	100 340			48.060		39.891		
	20	110 350			48.100		39.931		
	30	120 360		425	48 160		39.991		

[illegible] WATER PROGRAM

TEST WELL DATA

PUMP TEST STEP DRAW DOWN TEST

WELL No. ES-54

PAGE 1 OF 2

STATIC WATER LEVEL 8.075 m. below m.p.

M.P. ABOVE GROUND LEVEL

DATE	HOUR	t time since pumping began, minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY µ mohs /cm.	TEMPERATURE °C.
1-12-83	14:30	0			8.075		—		
	35	5		300	9.110		1.035		
	40	10			9.376		1.301		
	45	15			9.516		1.441		
	50	20			9.626		1.551		
	55	25			9.735		1.660		
	15:00	30			9.765		1.690		
	05	35			9.825		1.750		
	10	40			9.884		1.809		
	15	45			9.926		1.851		
	20	50			9.934		1.859		
	25	55			9.998		1.923		
	30	60			10.000		1.925		
	35	65			10.112		2.037		
	40	70			10.118		2.043		
	45	75			10.116		2.041		
	50	80			10.126		2.051		
	16:00	90			10.255		2.180		
	10	100			10.255		2.180		
	20	110			10.295		2.220		
	16:30	120			10.305		2.230		
—	—	—	—	—	—	—	—	—	—
		0							
	16:35	5		400	10.312		2.237		
	40	10 130			10.694		2.619		
	45	15 135			10.870		2.795		
	50	20 140			10.890		2.815		
	55	25 145			11.000		2.925		
	17:00	30 150			11.022		2.947		
	05	35 155			11.078		3.003		
	10	40 160			11.125		3.050		
	15	45 165			11.175		3.100		
	20	50 170			11.195		3.120		
	25	55 [illegible]			11.250		3.175		
	17:30	60 [illegible]			11.276		3.201		

[illegible] WATER PROGRAM — WELL No. ES-54

TEST WELL DATA — PAGE 2 OF 2

PUMP TEST *STEP DRAW DOWN TEST.—*

STATIC WATER LEVEL ______ m below mp ___

M.P. ABOVE GROUND LEVEL ______

DATE	HOUR	t time since pumping began minutes	Gal. x 1000	Gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY µ mhos /cm.	TEMPERATURE °C.
	35	65 185			11.400		3.325	(?.)	
	40	70 190			11.305		3.230		
	45	75 195			11.302		3.227		
	50	80 200			11.326		3.251		
	18:00	90 210			11.362		3.287		
	10	100 220			11.397		3.322		
	20	110 230			11.452		3.377		
	18:30	120 240			11.495		3.420		
		0							
	35	5 245		425	11.590		3.515		
	40	10 250			11.630		3.555		
	45	15 255			11.700		3.625		
	50	20 260			11.732		3.657		
	55	25 265			11.730		3.655		
	19:00	30 270			11.736		3.661		
	05	35 275			11.770		3.695		
	10	40 280			11.782		3.707		
	15	45 285			11.800		3.725		
	20	50 290			11.840		3.765		
	25	55 295			11.800		3.725		
	30	60 300			11.831		3.756		
	35	65			11.829		3.754		
	40	70 310			11.835		3.760		
	45	75			11.864		3.789		
	50	80 320			11.883		3.808		
	20:00	90 330			11.904		3.829		
	10	100 340			11.933		3.858		
	20	110 350			11.975		3.900		
	20:30	120 360			12.000		3.925		
				THE	END.—	STEP DRAW DOWN TEST.			

CORDOBA WATER PROGRAM

TEST WELL DATA

WELL No. ES-54

PAGE 1 OF 3

PUMP TEST 2-12-83

STATIC WATER LEVEL 8.150 m below mp

M.P. ABOVE GROUND LEVEL

DATE	HOUR	Time since pumping began, minutes		Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY µmhos/cm.	TEMPERATURE °C.
2-12-83	10:00	0	CADA 1 MINUTO			8.150		0		
	01	1				8.728		0.578		
	02	2				9.150		1.000		
	03	3				9.418		1.268		
	04	4				9.596		1.446		
	05	5				9.751		1.601		
	06	6				9.853		1.703		
	07	7				9.950		1.800		
	08	8				10.080		1.930		
	09	9				10.105		1.955		
	10:10	10				10.165		2.015		
	12	12	CADA 2 MINUTOS			10.280		2.130		
	14	14				10.375		2.225		
	16	16				10.501		2.351		
	18	18				10.574		2.424		
	20	20				10.582		2.432		
	22	22				10.694		2.544		
	24	24				10.730		2.580		
	26	26				10.735		2.585		
	28	28				10.790		2.640		
	10:30	30				10.870		2.720		
	35	35	CADA 5 MINUTOS			10.885		2.735		
	40	40				10.960		2.810		
	45	45				11.040		2.890		
	50	50				11.120		2.970		
	55	55				11.161		3.011		
	11:00	60				11.206		3.056		
	10	70	CADA 10 MIN			11.400		3.250		
	20	80				11.435		3.285		
	30	90				11.495		3.345		
	40	100				11.535		3.385		
	50	110				11.572		3.422		
	12:00	120				11.610		3.460		
	20	140	CADA 20 MIN			11.702		3.552		
	40	160				11.800		3.650		
	13:00	180				11.880		3.730		
	30	210				12.000		3.850		

[illegible] WATER PROGRAM
TEST WELL DATA
PUMP TEST

STATIC WATER LEVEL ______ m below mp
M.P. ABOVE GROUND LEVEL ______

DATE	HOUR	t time since pumping began, minutes		Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY µ mhos /cm.	T TEMPERATURE °C.
2-12-83	14:00	240	CADA 30 MIN			12 070		3.920		
	30	270				12.129		3.979		
	15:00	300				12.190		4.040		
	30	330				12 270		4.120		
	16:00	360				12.330		4.180		
	17:00	420	CADA 1 HORA			12 455		4.305		
	18.00	480				12 522		4.372		
	19:00	540				12.604		4.454		
	20:00	600				12 685		4.535		
	21:00	660				12 760		4.610		
	22:00	720				12.815		4.665		
	23:00	780				12.890		4.740		
	24:00	840				12.940		4.790		
3-12-83	02:00	960	CADA 2 HORAS			13.031		4.881		
	04:00	1 080				13.109		4.959		
	06:00	1 200				13.170		5.020		
	08:00	1 320				13.030		4.880	cut flow rate from 475 to 390	
	10:00	1440				13.076		4.926		
	13:00	1620	CADA 3 HORAS			13.165		5.015		
	16:00	1800				13.220		5.070		
	19:00	1 980				13.240		5.090		
	22:00	2 160				13.300		5.150		
4-12-83	01:00	2.340				13.347		5.197		
	04:00	2.520				13.371		5.221		
	07:00	2.700				13.406		5.256		
	10:00	2.880				13.462		5.312		
	16:00	3.240	CADA 6 HRS.			13.550		5.400		
	22:00	3.600				13.600		5.450		
5-12-83	04:00	3.960				13.625		5.475		
	10:00	4.320				13.688		5.538		
	22:00	5.040	CADA 12 HRS			13.755		5.605		
6-12-83	10:00	5.760				13 804		5.654		
	22:00	6 480				13.860		5.710		
7-12-83	10:00	7.200				13.903		5.753		
	22:00	7.920				13.940		5.790		
8-12-83	10:00	8.640				13.971		5.821		
	22:00	9.360				14.020		5.871		

[illegible] WATER PROGRAM

TEST WELL DATA

PUMP TEST

WELL № ES-54

PAGE 3 OF 3

STATIC WATER LEVEL ______ m. below mp

M.P. ABOVE GROUND LEVEL ______

DATE	HOUR	t time since pumping began, minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY µ mhos /cm.	T TEMPERATURE °C.
9-12-13	10.00	10.080			14.055		5.905		

"THE END PUMP TEST"

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY

WELL Nº ES: 54
page 1 of

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN METERS
10:00	10 080	0	–	14.055		5.905
	10 082	2	5041.0	13.540		5.390
	10 084	4	2521.0	13,090		4.940
	10 086	6	1681.0	12.865		4.715
	10 088	8	1261.0	12.680		4.530
	10 090	10	1009.0	12.575		4.425
	10 092	12	841.0	12.505		4.355
	10 094	14	721.0	12.385		4.235
	10 096	16	631.0	12.315		4.165
	10 098	18	561.0	12.270		4.120
	10 100	20	505.0	12.212		4.062
	10 102	22	459.2	12.155		4.005
	10 104	24	421.0	12.140		3.990
	10 106	26	388.7	12,090		3.940
	10 108	28	361.0	12.022		3.872
10:30	10 110	30	337.0	11.970		3.820
	10 112	32	316.0	11.925		3.775
	10 114	34	297.5	11.905		3.755
	10 116	36	281.0	11.870		3.720
	10 118	38	266.3	11.855		3.705
10:40	10 120	40	253.0	11.840		3.690
	10 124	44	230.1	11.810		3.660
	10 128	48	211.0	11.745		3.595
	10 132	52	194.9	11.690		3.540
	10 136	56	181.0	11.650		3.500
11:00	10 140	60	169.0	11.610		3.460
05	10 145	65	156.1	11.565		3.415
10	10 150	70	145.0	11.530		3.380
15	10 155	75	135.4	11.485		3.335
20	10 160	80	127.0	11.450		3.300
25	10 165	85	119.6	11.430		3.280
30	10 170	90	113.0	11.392		3.242
35	10 175	95	107.1	11.360		3.210
11:40	10 180	100	101.8	11.322		3.172
50	10 190	110	92.6	11.262		3.112
12:00	10 200	120	85.0	11.210		3.060
10	10 210	130	78.5	11.155		3.005

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY

WELL Nº. ES: 54.
page 2 of

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN METERS
20	10220	140	73.0	11.110		2.960
30	10230	150	68.2	11.075		2.925
40	10240	160	64.0	11.040		2.890
50	10250	170	60.3	10.980		2.830
13:00	10260	180	57.0	10.945		2.795
20	10280	200	51.4	10.823		2.673
40	10300	220.	46.8	10.840		2.690
14:00	10320	240	43.0	10.775		2.625
20	10340	260	39.8	10.730		2.580
40	10360	280	37.0	10.670		2.520
15:00	10380	300	34.6	10.630		2.480
20	10400	320	32.5	10.600		2.450
40	10420	340	30.7	10.545		2.375
16:00	10440	360	29.0	10.530		2.380
30	10470	390	26.9	10.435		2.285
17:00	10500	420	25.0	10.380		2.230
30	10530	450	23.4	10.330		2.180
18:00	10560	480	22.0	10.295		2.145
30	10590	510	20.8	10.252		2.102
19:00	10620	540	19.7	10.195		2.045
30	10650	570	18.7	10.180		2.030
20:00	10680	600	17.8	10.135		1.985
30	10710	630	17.0	10.105		1.955
21:00	10740	660	16.3	10.065		1.915
22:00	10800	720	15.0	9.960		1.810
23:00	10860	780	13.9	9.900		1.750
24:00	10920	840	13.0	9.860		1.710
01:00	10980	900	12.2	9.811		1.661
02:00	11040	960	11.5	9.729		1.579
03:00	11100	1020	10.9	9.870		1.720
04:00	11160	1080	10.3	9.571		1.421
05:00	11220	1140	9.8	9.536		1.386
06:00	11280	1200	9.40	9.483		1.333
07:00	11340	1260	9.00	9.461		1.311
08:00	11400	1320	8.64	9.437		1.287
09:00	11460	1380	8.30	9.397		1.247
10:00	11520	1440.	8.00	9.388		1.238

[illegible] WATER [illegible] WELL No. T-3

TEST WELL DATA VALVULA = 5/8 VUELTA SHEET 1 OF 2

PUMP TEST 2-12-83

STATIC WATER LEVEL 8.220

M.P. ABOVE GROUND LEVEL

DATE	HOUR	Elapsed time pumping began, minutes		Gal. x 1000	Q gpm	WATER LEVEL below m.p. meters	feet	DRAW DOWN METERS	CONDUCTIVITY µ mohs /cm.	TEMPERATURE °C.
2-12-83	10:00	0	CADA 5 MINUTOS	085.330	—	8 220		0		
	05	5		.332		39 107		30.887		
	10	10		.334		40 692		32.472		
	15	15		.336		42 172		33.952		
	20	20		.338		42 962		34.742		
	25	25		.340		43 336		35.116		
	30	30		.343	425	43 816		35.596		
	35	35		.345		44 051		35.831		
	40	40		.347		44 256		36.036		
	45	45		.349		44 380		36.160		
	50	50		.351		44 490		36.270		
	55	55		.353		44 697		36.477		
	11:00	60		.355	425	44 783		36.523		
	30	90	CADA 1/2 HR	.368		45 627		37.407		
	12:00	120		.381	425	45.880		37.660		
	30	150		.393		46 261		38.041		
	13:00	180		.406		46 480		38.260		
	30	210		.418		46 890		38.670		
	14:00	240		.431		47.000		38.780		
	15:00	300	CADA 1 HR	.456	425	47.330		39.110		
	16:00	360		.482	425	47 580		39.360		
	17:00	420		.507	425	47.745		39.525		16°C.
	18:00	480		.532	425	47.879		39.659		
	19:00	540		.557	425	48 075		39.855		
	20:00	600		.582	425	48 220		40.000		
	21:00	660		.608	425	48 410		40.190		
	22:00	720		.632	425	48.515		40.295		
	23:00	780		.659	425	48 616		40.396		
	24:00	840		.684	425	48.679		40.459		
3-12-83	02:00	960	CADA 2 HRS.	.734	425	48 697		40.477		
	04:00	1.080		.785	425	48 737		40.517		
	06:00	1.200		.836	425	48 810		40.590		
	08:00	1 320		.883	390	46.200		37.980		
	10:00	1 440		085.929	390	46.505		38.285		16°C
	22:00	2 160		086 207	390	47.070		38.850		
4-12-83	10:00	2 880		.483	390	47 467		39.247		16°C
	22:00	3.600		.761	390	47.665		39.445		

T-3

[illegible] WELL DATA

[illegible] TEST

STATIC [illegible] LEVEL

DATE	HOUR	t (time since pumping began), minutes	Gal x 1000	Q gpm	WATER LEVEL below mp: meters	WATER LEVEL below mp: feet	DRAW DOWN METERS	[illegible]CTIVITY µ[illegible] /cm.	[illegible] °C.
5-12-83	10:00	4 320	087.036	390	48.090		39.870		16°C
	22:00	5 040	.311	390	48.115		39.895		
6-12-83	10:00	5 760	.588	390	48.314		40.094		16°C
	22:00	6 480		390	48.470		40.250		
7-12-83	10:00	7 200		390	48.640		40.420		
	22:00	7 920		390	48.775		40.555		
8-12-83	10:00	8 640		390	48.835		40.615		
9-12-83	10:00	10 080		390	49.001		40.781		

(cada 12 hrs)

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY

WELL Nº. ES: T-3
page 1 of ___

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	feet	RESIDUAL DRAW DOWN METERS
10:00	10080	0	—			
	10081	1	10081	24 250		21.081
	10082	2	5041	20.705		12.536
	10083	3	3361	16 817		5.648
	10084	4	2521	15 151		6.992
	10085	5	2017	14.491		6.322
	10086	6	1681	14.142		5.973
	10087	7	1441	13 801		5.637
	10088	8	1261	13 627		5.[illegible]
	10089	9	1121	13 467		5.298
	[illegible]	10	1009	13 343		5.174
	10091	11	917.4	13.225		5.056
	10092	12	841.0	13.133		4.944
	10093	13	776.4	13.061		4.897
	10094	14	721.0	13.000		4.831
	10095	15	673.0	12 911		4.7[illegible]
	10096	16	631.0	12 837		4.668
	10097	17	593.9	12 783		4.614
	10098	18	561.0	12.736		4.567
	10099	19	531.5	12 678		4.503
10:20	10100	20	505.0	12.630		4.461
	10102	22	459.2	12.557		4.388
	10104	24	421.0	12.472		4.[illegible]
	10106	26	388.7	12 415		4.246
	10108	28	361.0	12.343		4.174
	10110	30	337.0	12.313		4.144
	10112	32	316.0	12 242		4.073
	10114	34	297.5	12 199		4.030
	10116	36	281.0	12.132		3.963
	10118	38	266.3	12.097		3.926
10:40	10120	40	253.0	12.084		3.915
	10124	44	230.1	12.009		3.84[illegible]
	10128	48	211.0	11 947		3.778
	10132	52	194.9	11.900		3.731
	10136	56	181.0	11.860		3.961
11:00	10140	60	169.0	11 801		3.632
04	10144	64	158.5	11.770		3.601

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY

WELL Nº. ES: T-3
page 2 of ____

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	feet	RESIDUAL DRAW DOWN METERS
11:08	10148	68	149.2	11.715		3.546
12	10152	72	141.0	11 685		3.516
16	10156	76	133.6	11.635		3.466
20	10160	80	127.0	11.603		3.434
11:25	10165	85	119.6	11.582		3.413
30	10170	90	113.0	11.532		3.363
35	10175	95	107.1	11.510		3.341
40	10180	100	101.8	11 461		3.292
45	10185	105	97.0	11 404		3.23[illegible]
50	10190	110	92.6	11.305		3.136
55	10195	115	88.7	11.363		3.194
12:00	10200	120	85.0	11.322		3.153
05	10205	125	81.6	—		—
10	10210	130	78.5	11.287		3.118
15	10215	135	75.7	11 250		3.081
20	10220	140	73.0	11.233		3.064
12:30	10230	150	68.2	11.164		2.995
40	10240	160	64.0	11.140		2.970
50	10250	170	60.3	11 091		2.922
13:00	10260	180	57.0	11.061		2.89[illegible]
10	10270	190	54.1	11 008		2.839
20	10280	200	51.4	10 990		2.821
40	10300	220	46.8	10.930		2.761
14:00	10320	240	43.0	10.865		2.696
20	10340	260	39.8	10,813		2.644
40	10360	280	37.0	10,780		2.611
15:00	10380	300	34.6	10,700		2.531
20	10400	320	32.5	10,635		2.466
40	10420	340	30.7	10,610		2.441
16:00	10440	360	29.0	10,560		2.391
30	10470	390	26.9	10,500		2.331
17:00	10500	420	25.0	10,450		2.281
30	10530	450	23.4	10,415		2.246
18:00	10560	480	22.0	10 350		2.181
30	10590	510	20.8	10 315		2.146
19:00	10620	540	19.7	10 275		2.106
30	10650	570	18.5	10,225		2.056

T-3

Date	Conductivity Micro mho cm-25°C	Resistivity ohm -cm - 25°C
3 Dec., 1983 •	1800	
4 "	1788	559
5 "	1783	561
6 " •	1783	561
7 "	1788	559
8 " •	1788	359

Samples taken during production pump test.

Water temperature = 16°C

•Samples send to USA

Average conductivity = 1788.3 $\pm$ 6 micro-mho-cm at 25°C.

SECTION 4.4

MINERA UTAH DE CHILE, INC.

Antofagasta, Chile

WELL T-4 PUMP TESTS:

ANALYSIS OF RESULTS

March 1984

DAVID KEITH TODD

Consulting Engineers, Inc.

Berkeley, California

CONTENTS

LIST OF FIGURES

Summary

Step-drawdown and constant discharge tests were conducted on well T-4 December 13, 1983 and December 14, 1983 through January 13, 1984, respectively. The objectives of the tests were to determine well efficiency, groundwater quality and the aquifer characteristics to aid in the design of the final well field.

Analysis of the data indicates the area around well T-4 has a transmissivity of 22,100 gpd/ft (0.192 m^2/min), a specific yield of 0.20 and a radial to vertical hydraulic conductivity ratio of 10/1. The salinity of the discharge water showed no significant increases during the test and was on the order of 1700 mg/l.

The efficiency of well T-4 is high, but considerable drawdowns occurred in the well due to the low percentage of the aquifer screened by well T-4.

The development potential of the area around well T-4 is only fair because of its proximity to highly saline water and its low saturated thickness.

Table 1. (Continued)

Date Sampled	Salinity (T.D.S.), mg/l
January 4, 1984	1850
5	1850 (1600)
6	1750
7	1800 (1540)
8	1850
9	1850 (1720)
10	1850
11	1850 (1700)
12	1850
13	2000 (1700)

* Static conditions

(1540) Values in parentheses analyzed in U.S.A. by Utah, Intl.

+ Values obtained by field specific conductance X 0.83

Introduction

This report describes the step-drawdown test and the constant discharge test performed on well T-4 December 13, 1983 and December 14, 1983 through January 13, 1984, respectively. The purpose of this report is to provide information about the hydrogeologic conditions in the vicinity of well T-4 to aid in the design of the well field for the water supply to the Escondida mining operations. This is the fourth in a series of five planned reports evaluating aquifer characteristics around Salar de Punta Negra.

Well T-4 is located about 5 kilometers east of the Salar and about 3 kilometers west of the aquifer's eastern boundary.

Test Conditions

The relative locations of pumping well T-4 and observation wells ES-49 and ES-60 are shown in Figure 1 and the well construction features are shown in Figure 2. The important aspect to note from Figure 2 is the low percentage of aquifer screened by well T-4 (about 21%). This causes more drawdown to occur than if the entire aquifer were screened. In addition, standard analytical methods to solve for the transmissivity and storage coefficient cannot be reliably used because they require that the pumping well be screened in nearly the entire aquifer thickness.

Water level measurements were taken in wells T-4, ES-49 and ES-60 on a logarithmic frequency using electric sounders. Flow measurements were taken from a totalizing meter on the pumping well's discharge line. Conductivity of the discharge water was measured and reported daily and selected water samples were sent to a laboratory for analysis of additional parameters.

The flow rates throughout the step-drawdown test remained within about ± 10% of the average flow rate during each step. The average flow rates for the steps were 195, 300, 389 and 464 gpm. The average flow rate during the constant discharge test was 386 gpm. Maintenance of the generator was required from t= 8835 to t= 8880 minutes during which time the pump was shut off; however, the effect on the water level measurements beyond this period was negligible.

Water level measurements taken in the observation wells were sufficiently accurate for purposes of analysis. Considerable problems were encountered in measuring the water levels in well T-4 because of obstructions from the pumping equipment in the casing. Therefore, these data are not reliable for analytical purposes.

In summary, the data are useful for analyzing the aquifer characteristics; however, due to problems with measuring the water level in the pumping well, an accurate evaluation of the pumping well efficiency cannot be made.

The basic flow rate, water level and conductivity data are tabulated in the appendix.

Step-Drawdown Test on Well T-4

A step-drawdown test was performed on well T-4 on December 13, 1983. The well was pumped at 195 and 300 gpm for 120 minutes each, at 389 gpm for about 180 minutes and finally at 464 gpm for 60 minutes. The resulting drawdowns are shown in Figure 3. As mentioned earlier, there was considerable difficulty in measuring the water level in well T-4 and it is clear the erratic nature of the drawdowns will not allow a reliable determination of the well-loss coefficient to be made. However, a qualitative assessment of well T-4 efficiency was obtained by comparing the specific capacities during the test with theoretical specific capacities using the transmissivity and storage coefficient evaluated later in this report. After the effects of partial penetration are taken out, it appears well T-4 has an efficiency on the order of 70 or 80 percent.

Simulation and Analysis of Results from Observation Wells

Drawdown data from observation wells ES-49 and ES-60 for the constant discharge test were plotted on a log-log graph as shown on Figure 4. The results were plotted versus t/r^2, where t is time in minutes and r is the radial distance to the pumping well from the observation well. This plot demonstrates the effects of delayed yield and partial penetration on the results. For a pumping well fully screened in a confined aquifer, the data points for both observation wells would fall on the same curve and could be analyzed using the standard curve-matching (analytical) technique. However, the disparity between the two curves shows that analytical methods would produce unreliable values of transmissivity and storage coefficient (or specific yield). Therefore, numerical computer simulation was used to evaluate the transmissivity and storage coefficient.

The simulation model uses axisymmetric coordinates where the pumping well is at the center of a vertical cross-section which is rotated about the well. The discharge is allowed only through certain nodes representing the well screen, thus taking into account partial penetration in the calculations. This method of evaluating the aquifer characteristics was also used for the T-2 aquifer test and the reader is referred to the Well T-2 Pump Test report for more details on the approach.

The best-match computed results are shown on Figure 4 for the early and late portions of the test. The horizontal portions of the drawdown curves indicate when the storage coefficient is in transition from the apparent "confined" storage coefficient to the true storage coefficient or specific yield. The horizontal portions of the curves are not simulated by the model.

It is clear from Figure 4 that well ES-49, the closest well to T-4, does not begin to show the effects of delayed gravity drainage until far into the test, while ES-60 shows the effects very early on and then begins to be free of gravity drainage effects at about 22,000 minutes into the test. Data points from the last 20,000 minutes of the drawdown curve for well ES-60 were used to estimate the true storage coefficient or specific yield.

The values for the aquifer characteristics determined from this simulation are as follows:

Transmissivity: 22,100 gpd/ft (0.192 m^2/min)

Early Storage Coefficient: 7×10^{-4}

Specific Yield: 0.20

Radial to Vertical Hydraulic Conductivity: 10/1

Salinity Analysis

Measurements of specific conductance were taken daily on the discharge water from well T-4. Most of the samples were sent to either CESMEC or Utah, Intl. personnel (or both) for analysis of additional chemical parameters. The salinity values are given in Table 1. There is a significant difference between the values reported by CESMEC and the Utah Intl. laboratory. For consistency, the ratio of conductivity to salinity (0.83) was taken from the CESMEC data to estimate the salinities for December 14 through 19.

There is no significant change in salinity values in the CESMEC data. However, the Utah Intl. laboratory data show an apparent abrupt rise from January 7 to January 9. The samples from December 21 through January 7 were received by Utah Intl.'s laboratory in one batch on January 19. The samples from January 9 through January 13 were received as another batch on February 24. Based on this information, it is concluded that the rise in salinity between January 7 and January 9 is an artifact of the laboratory procedures and does not represent a true rise in salinity at the well. The CESMEC salinity value for January 13 is probably an error, since the conductivity and other chemical parameters show no change from samples taken the previous days.

Whether the CESMEC values or the Utah Intl. laboratory values are correct, the salinity values are consistent with the overall salinity trend in the eastern Punta Negra basin: lower in the north and higher in the south.

Conclusions

(1) The aquifer transmissivity in the vicinity of well T-4 is 22,100 gpd/ft.

(2) The long term specific yield is estimated to be 0.20.

(3) The radial to vertical hydraulic conductivity ratio (K_r/K_z) is about $10/1$.

(4) The efficiency of well T-4 is high and most of the drawdown in T-4, apart from head losses in the aquifer, is due to the low percentage of the aquifer screened by well T-4.

(5) The salinity of the discharge water from T-4 is on the order of 1700 mg/l. No significant change was noted in the salinity during the test; however, the sampling radius from well T-4 was only on the order of 40 meters.

(6) Based on the excellent aquifer parameters and good water quality alone, this area would normally be considered good for water development. However, its proximity to very saline water only 3 kilometers to the west and its low saturated thickness make it only fair for development potential.

Table 1. Salinity of Water Samples from Well T-4

Date Sampled	Salinity (T.D.S.), mg/l
December 12, 1983*	1890+
14	1890+
15	1900+
16	1910+
17	1890+
18	1886+
19	1890+
20	NA
21	1900 (1540)
22	1900
23	1850
24	1900
25	1800 (1520)
26	1800
27	1800 (1530)
28	1750
29	1800
30	1700 (1540)
31	1850
January 1, 1984	1850 (1560)
2	1850
3	1850 (1600)

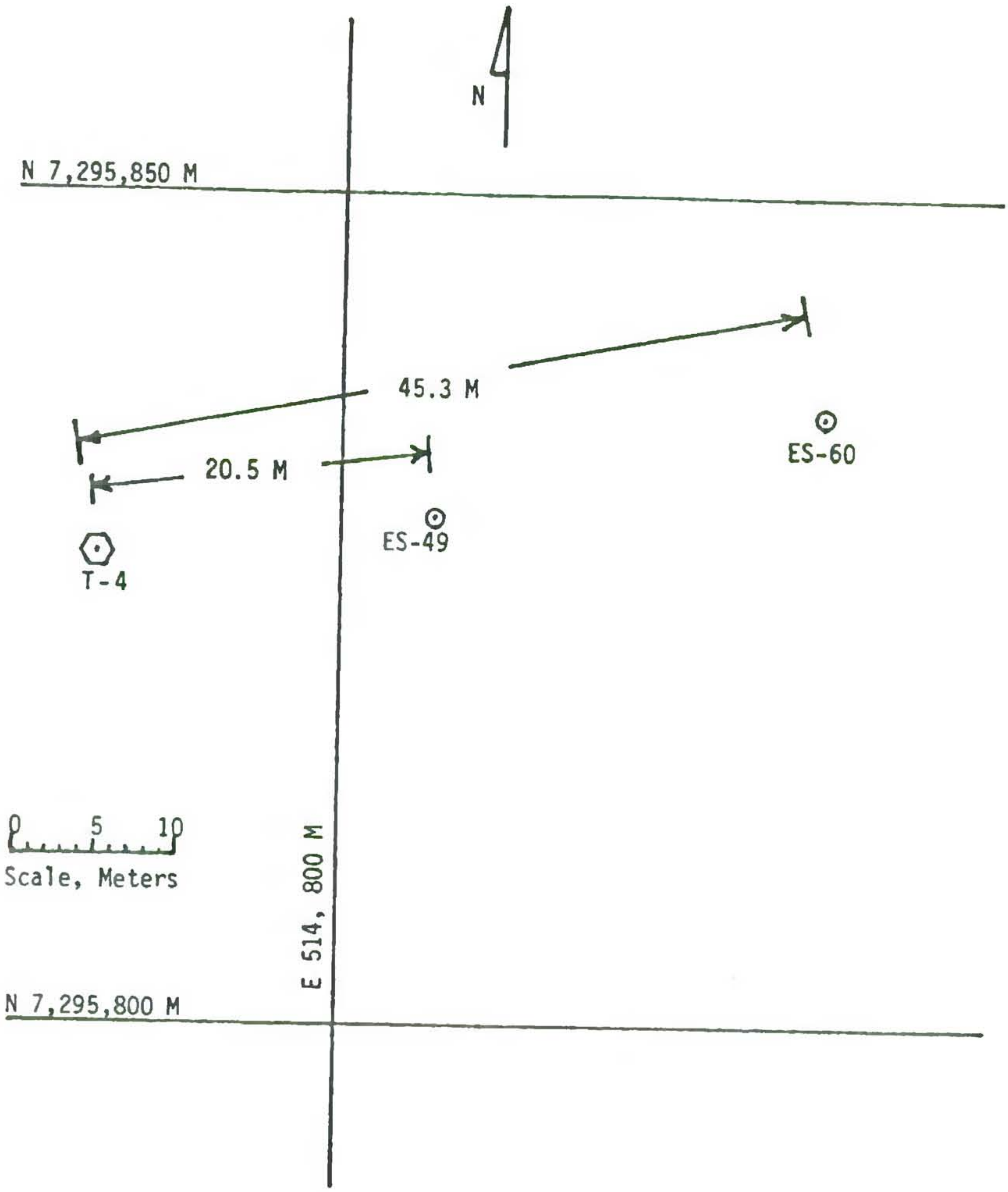

Figure 1.

Location Map of Pumped Well T-4 and Observation Wells ES-49 and ES-60

David Keith Todd, Consulting Engineers, Inc.

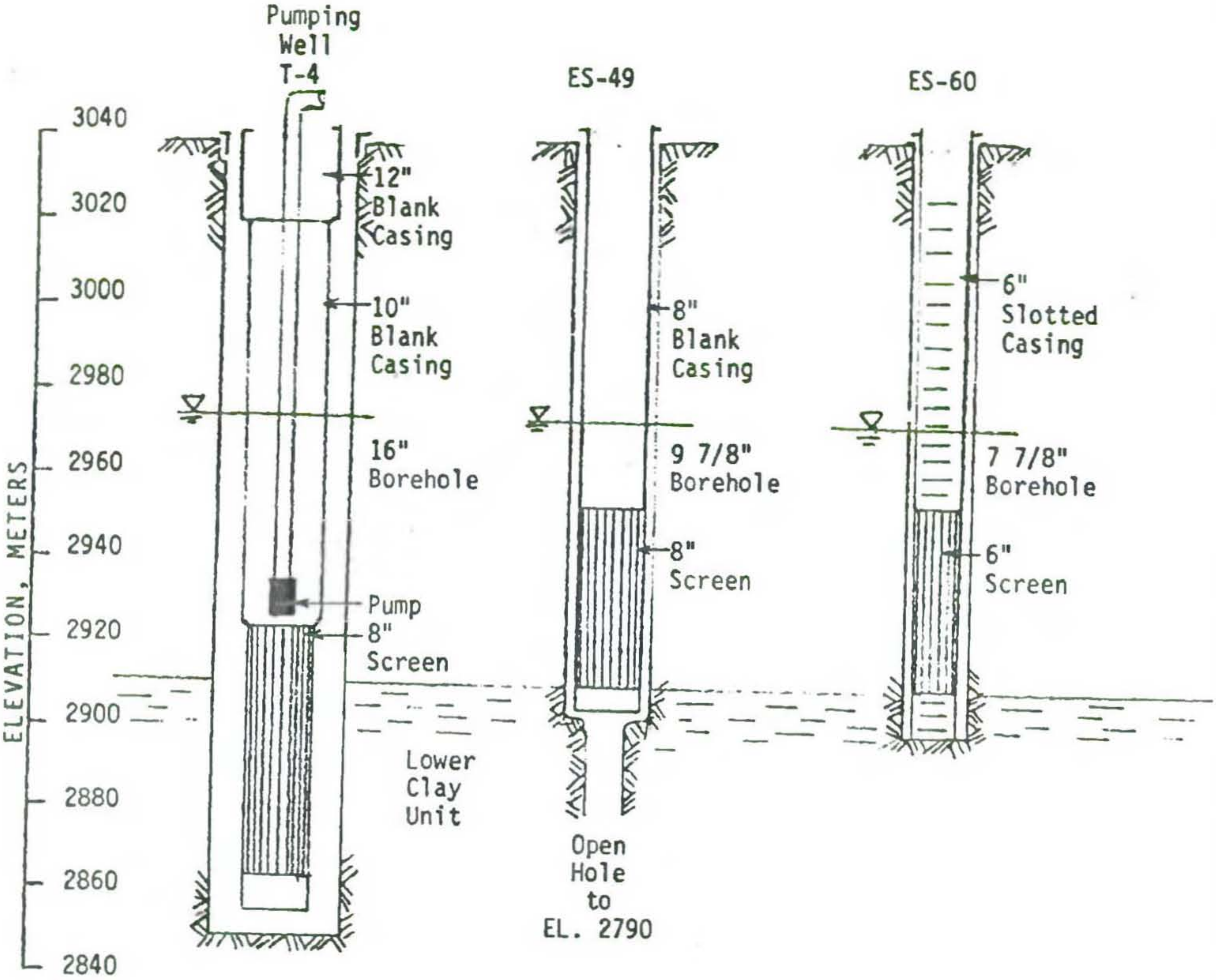

Figure 2.

Construction of Pumped Well and Observation Wells

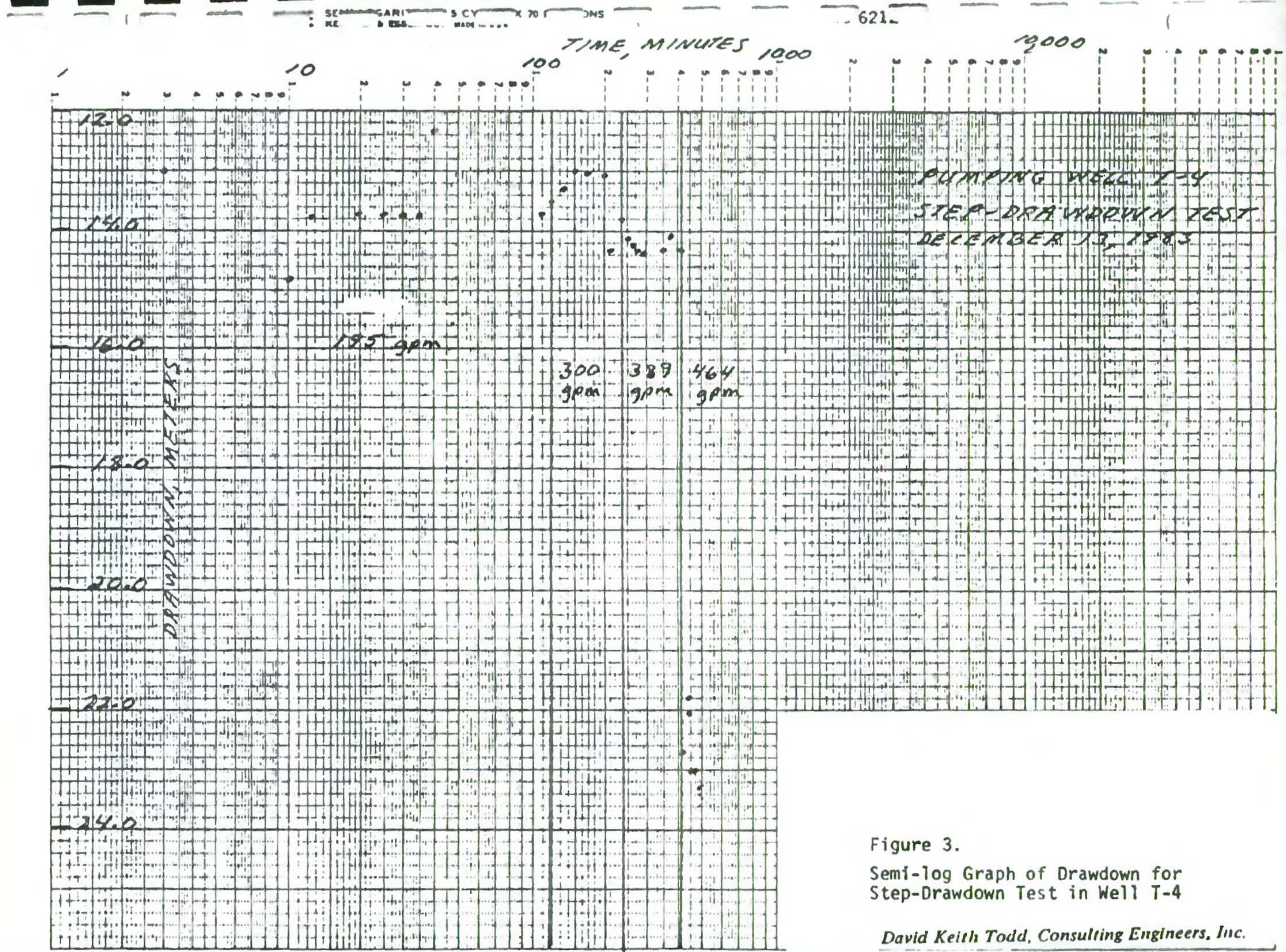

Figure 3.

Semi-log Graph of Drawdown for Step-Drawdown Test in Well T-4

David Keith Todd, Consulting Engineers, Inc.

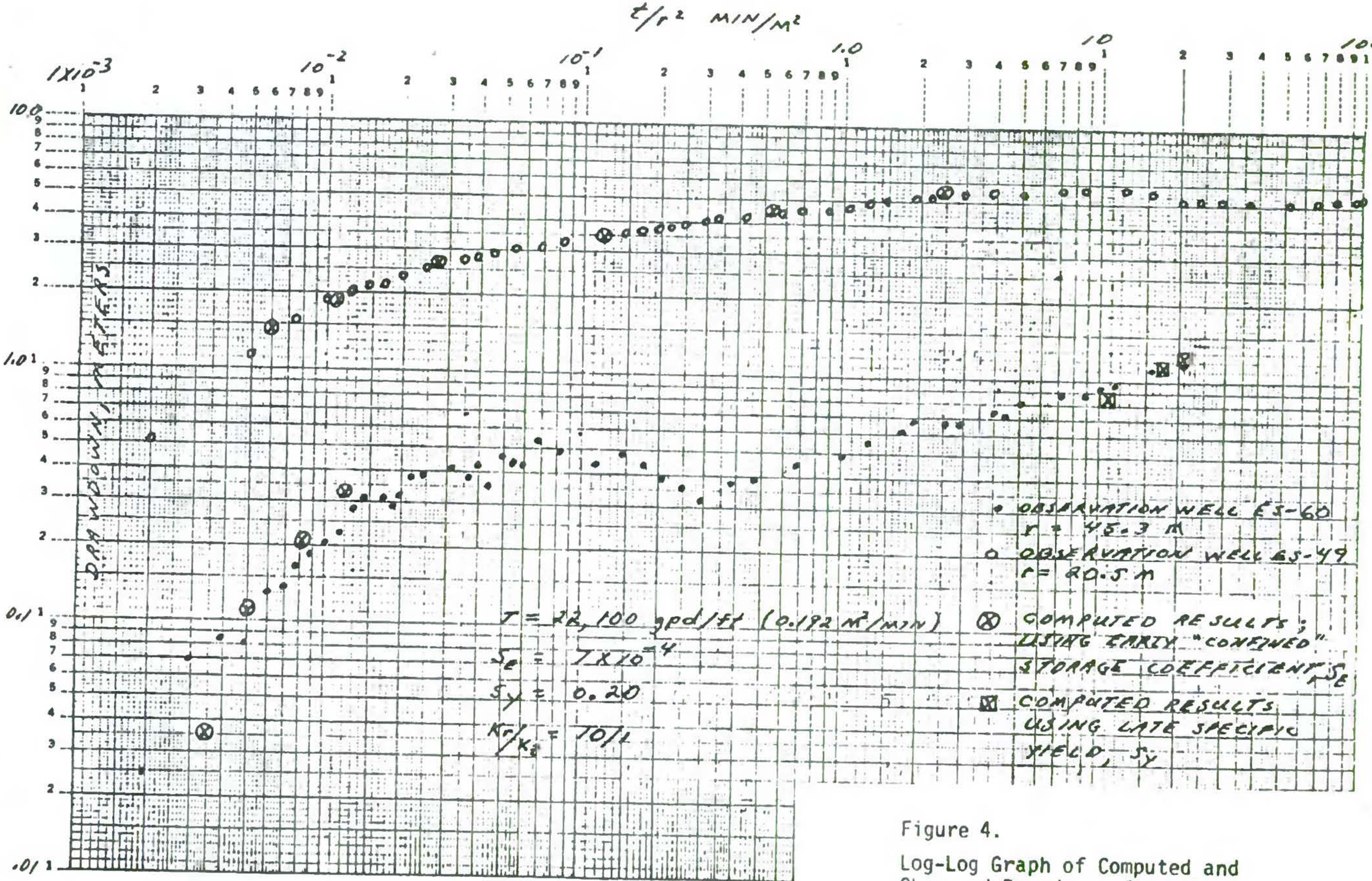

Figure 4.

Log-Log Graph of Computed and Observed Drawdowns for Wells ES-49 and ES-60

David Keith Todd, Consulting Engineers, Inc.

APPENDIX

The following pages contain tabulations of well discharge, water level measurements, and water conductivity measurements for the Well T-4 pump test.

TEST WELL DATA *STEP-DRAWDOWN*

PUMP TEST *Step drawdown TEST*

SHEET 1 OF [illegible]

STATIC WATER LEVEL [illegible]

M.P. ABOVE GROUND LEVEL [illegible]

DATE	HOUR	t time since pumping began minutes	Gal. x 1000	Q gpm	WATER LEVEL below m.p. meters	feet	RESIDUAL DRAW DOWN feet	CONDUCTIVITY μ mhos /cm.	TEMPERATURE °C.
13-12-83	09:15	0	289 041.200		65.76				STEP 1
→	:16	1:25	41.395	195	73.34	8.01			
	:17		.575	180				adjust flow	↑
→	:18	[illegible]:27	.770	195	78.35	13.02			
	:19		.970	200					
→	:20	[illegible]:03	42.165	195	76.23	10.9			
	:21		.360	195					
→	:22		.555	195	X				
	:23		.750	195					
	:24		.950	200					
→	25	[illegible]:04	43.145	195	80.15	14.82			
	:26		.345	200					
	:27		.540	195					
→	:28	[illegible]:03	.735	195	79.115	13.79			
	:29		.930	195					
	09:30		44.130	200					
→	:31	[illegible]:17	.325	195	79.06	13.73			
	:32		.520	195					
	:33		.710	180					
	:34	19	.910	200					
→	:35	20:04	45.100	190	78.99	13.66			
	:36	21	.295	195					
	:37	22	.495	200					
	:38	23	.690	195					
	:39	24	.890	200					
→	:40	25:14	46.090	200	79.03	13.70			
	:41	26	.285	195					
	:42	27	.480	195					
	:43	28	.680	200					
	:44	29	.880	200					
→	:45	30.05	47.075	195	79.022	13.678			
	:46	31	.275	200					
	:47	32	.470	195					
	:48	33	.670	200					
	:49	34	.870	200					
→	:50	35:11	48.070	200	79.00	13.67			
	:51	36	.270	200					
	:52	37	[illegible]	[illegible]					

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST 500

WELL Nº T-4

STATIC WATER LEVEL 65,33 m. below m.p.
M.P. ABOVE GROUND LEVEL [illegible]

DATE	HOUR	t time since pumping began. minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet	CONDUCTIVITY. µ mohs /cm.	T TEMPERATURE °C.
	09:53	38	48.660	200					STEP 1
	54	39	860	200					
→	:55	40:40	49.060	200	77.69		12.36		
	:56	[illegible]	255	195					
	:57	[illegible]	455	200					
	:58	[illegible]	665	200					
	:59	[illegible]	865	200					
→	10:00	[illegible]:04	50.065	200	77.28		11.95		
	:01	[illegible]	50.260	195					
	:02	[illegible]	.460	200					
	:03	[illegible]	650	190					
	:04	49	850	200					
→	:05	50:29	51.050	200	77.32		11.99		
	:06	[illegible]	245	195					
	:07	[illegible]	445	200					
	:08	[illegible]	645	200					
	:09	[illegible]	840	195					
→	:10	[illegible]	52.035	195	X				
	:11	[illegible]	230	195					
	:12		420	200					
	:13	[illegible]	620	190					
	:14	[illegible]	820	200					
→	10:15	[illegible]	53.010	190	X				
	:20	65	960	(195)					
→	:25	70	54.930	(195)	X				
	:30	75	55.890	(190)					
→	:35	80	56.845	(190)	X				
	:40	85	57.785	(190)					
→	:45	90	58.735	(195)	X				
	:50	95	59.665	(190)					
→	:55	100	60.595	(190)	X				
	11:00	105	61.520	(190)					
→	:05	110:13	62.445	(185)	78.990	13.66			
	.10	115	63.360	(185)					
→	:15	120:04	64.285	(185)	78.25	12.92		open valve	STEP 2
→	:16	121:09	555	270	78.79	13.46			
	:17	122	865	310				adjust ↓	

( ) QGPM TOMADO POR [illegible]

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST SDD

WELL Nº T-4
PAGE 3 OF 8
STATIC WATER LEVEL 65.[illegible] m. below m.p.
M.P. ABOVE GROUND LEVEL 0.42 m.

DATE	HOUR	t time since pumping began. minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet	CONDUCTIVITY. μ mohs /cm.	T TEMPERATURE °C.
13-17-73			.865						
→	11:18	123:10	65.165	300	78.30		12.97		step 2 out
	:19	124	.465	300					
→	:20	125:08	.770	305	78.31		12.98	adjust ↓	
	:21	126	66.075	305				adjust ↓	
→	:22	127:12	.375	300	78.29		12.96		
	:23	[illegible]	.675	300					
	:24	129	.980	305					
→	:25	130:08	67.235	255	78.30		12.97		
	:26	131	.590	355					
	:27	[illegible]	.895	305					
→	:28	133:45	68.190	295	78.62		13.29		
	:29	134	.490	300					
	:30	135	.790	300					
→	:31	136:26	69.090	300	78.27		12.94		
	:32	137	.390	300					
	:33	138	.700	310					
	:34	[illegible]	70,000	300					
→	:35	[illegible] 18	300	300	77.84		12.5		
	:36	[illegible]	595	295					
	:37	[illegible]	900	305					
	:38	[illegible]	71.200	300					
	:39	[illegible]	.500	300					
→	:40	[illegible]:22	.800	300	78.31		12.98		
	:41	146	72.105	305					
	:42	147	.400	295					
	:43	148	.705	305					
	:44	149	73.005	300					
→	:45	[illegible]:28	.300	295	78.36		13.03		
	:46	151	.605	305					
	:47	152	.910	305					
	:48	153	74.210	300					
	:49	154	.510	300					
→	:50	155:29	.815	305	78.24		12.91		
	:51	156	75.115	300					
	:52	157	.410	295					
	:53	[illegible]	.715	305					
	:54	[illegible]	76.020	305					

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST 500

WELL Nº 7-4
PAGE 4 OF 9
STATIC WATER LEVEL 65.33 m. below m.p.
M.P. ABOVE GROUND LEVEL 0.12 m.

DATE	HOUR	time since pumping began. minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet	CONDUCTIVITY. µ mohs /cm.	TEMPERATURE °C.
13-12-93			.020						
→	11:55	160 27	76.325	305	76.33		13.00		STEP 2
	:56	161	.630	305					CONT
	:57	162	.935	305					
	:58	163	77.235	300					
	:59	164	.535	300					
→	12:00	165:36	.835	300	78.16		12.83		
	:01	[illegible]	78.135	300					
	:02	167	.435	300					
	:03	168	.735	300					
	:04	169	79.035	300					
→	:05	170:22	.335	300	78.37		13.04		
	:06	171	.635	300					
	:07	172	.940	305					
	:08	173	80.240	300					
	:09	[illegible]	.540	300					
→	:10	175:47	.845	305	78.35		13.02		
	:11	[illegible]	81.145	300					
	:12	[illegible]	.445	300					
	:13	[illegible]	.745	300					
	:14	[illegible]	.050	305					
→	:15	180:	.350	300	78.030		12.70		
	:20	185	83.850	(300)					
→	:25	190:	85.350	(300)	78.510		13.18		
	:30	195	86.805	(300)					
→	:35	200:	88.320	(305)	78.440		13.11		
	:40	205	89.880	(300)					
→	:45	210:	91.385	(300)	—				
	:50	215	92.885	(300)					
→	:55	220:	94.390	(295)	79.630		14.30		
	13:00	225	95.880	(300)					
→	:05	230:	97.390	(300)	79.160		13.83		
	:10	[illegible]	98.890	600?					
→	:15	240:	100.390		79.151		13.82		STEP 3
→	:16	241:	100.710	380	79.040		13.71		
	:17	242	101.115	405					
→	:18	243:	. —		79.120		13.79		
	:19	244	.920						

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST SDD

WELL Nº T-4
PAGE 5 OF [illegible]
STATIC WATER LEVEL 65.33 m. below m.p.
M.P. ABOVE GROUND LEVEL 0.42 m

DATE	HOUR	t time since pumping began. minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet	CONDUCTIVITY. μ mohs /cm.	T TEMPERATURE °C.
13.12.93			Nº1 920						
→	13:20	245:04	102,320	400	75.163		9.83		STEP 3
	21	246	,—						CONT
→	22	247:07	103,110	395	79.504		14.17		
	23	248	,500	390					
	24	249	,900	400					
→	25	250:08	104,295	395	79.498		14.166		
	26	251	,685	390					
	27	252	105,080	395					
→	28	253:04	,470	390	79.603		14.27		
	29	[illegible]	,870	400					
	30	255	106,260	390					
→	31	256:18	,655	395	79.691		14.36		
	32	257	107,045	390					
	33	258	,435	390					
	34	259	,830	395					
→	35	260:21	108,220	390	79.573		14.24		
	36	261	,615	395					
	37	262	109,010	395					
	38	263	,395	385					
	39	264	,790	395					
→	40	265:09	110,185	395	79.585		14.26		
	41	266	,—						
	42	267	110,915	365					
	43	268	111,360	355					
	44	269	,750	390					
→	45	270:19	112,130	380	79.643		14.31		
	46	271	,525	395					
	47	272	,915	390					
	48	273	113,305	390					
	49	274	,700	395					
→	50	275:15	114,185	385	79.605		14.28		
	51	276	,480	395					
	52	277	,870	390					
	53	278	115,260	390					
	54	279	,650	390					
→	55	280:27	116,040	390	79.560		14.23		
	56	281	,440	400					

CONDIDA WATER PROGRAM

T WELL DATA

MP TEST SSD

WELL Nº 7-7

PAGE 6 OF 9

STATIC WATER LEVEL 65.33 m. below m.p.

M.P. ABOVE GROUND LEVEL 0.42 m

TE	HOUR	time since pumping began. minutes	Gal. x 1000	Qgpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet	CONDUCTIVITY. μ mohs /cm.	TEMPERATURE °C.
93			16,440						
	13:57	[illegible]	,830	390					STEP 3
	58	[illegible]	17,230	400					CONT
	59	[illegible]	,615	385					
→	14:00	[illegible]	18,000	385	79.740		14.40		
	01	[illegible]	,390	390					
	02	2[illegible]	19,785	385					
	03	[illegible]	,170	385					
	04	[illegible]	,565	395					
→	05	[illegible]	20,950	385	79.680		14.35		
	06	[illegible]	21,310	370					
	07	[illegible]92	,720	380					
	08	293	-	-					
	09	294	-	-					
→	10	[illegible]	22,910	390	79.657		14.33		
	11	[illegible]	23,295	395					
	12	[illegible]	,685	390					
	13	[illegible]	124,075	390					
	14	[illegible]	,475	400					
→	14:15	[illegible]	,850	375	79.555		14.23		
	20	[illegible]	125,810	392					
→	25	[illegible]	127,760	390	79.615		14.29		
	30	[illegible]	129,750	398					
→	35	[illegible]	131,690	385	79.620		14.29		
	40	325	133,600	386					
→	45	[illegible]	135,605	395	79.501		14.17		
	50	[illegible]	137,615	402					
→	55	[illegible]	139,470	390	79.480		14.15		
	15:00	[illegible]	141,300	384					
→	05	[illegible]	143,385	400	79.610		14.28		
	10	[illegible]	145,345	398					
→	15:15	[illegible]	147,195	400	79.471		14.14		STEP 4
→	16	[illegible]	,590	395	79.514		14.18		
	17	[illegible]	,990	400					
→	18	[illegible]	148,370	386	79.343		14.01		
	19	[illegible]	,760	370					
→	20	[illegible]	149,140	380	79.300		13.97		
	21	[illegible]	,540	400					

CONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST 500

WELL Nº T-4
PAGE 7 OF 8
STATIC WATER LEVEL 65.33 m. below m.p.
M.P. ABOVE GROUND LEVEL 0.42 m

DATE	HOUR	t time since pumping began. minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet	CONDUCTIVITY µ mohs /cm.	TEMPERATURE °C.
12-12-83	→ 15:22	[illegible]	[illegible], 930	390	79.260		13.93		STEP 4
	23	[illegible]	[illegible]	[illegible]					CONT
	24	[illegible]	[illegible]	[illegible]					
	→ 25	390:	[illegible]	390	79.400		14.07		
	26	[illegible]	[illegible]	380					
	27	[illegible]	[illegible]	390					
	→ 28	[illegible]	[illegible], 360	400	79.310		13.98		
	29	[illegible]	, 640	380					
	30	395	[illegible], 540	400					
	→ 31	[illegible]	, 420	[illegible]	—				
	32	[illegible]	, 810	390					
	33	[illegible]	[illegible]	400					
	34	[illegible]	[illegible]	[illegible]					
	→ 35	[illegible]	155, 990	410	79.411		14.08		
	36	[illegible]	, 360	370					
	37	[illegible]	, 750	390					
	38	[illegible]	[illegible]	380					
	39	[illegible]	[illegible]	390					
	→ 40	385:	, 910	390	79.329		14.00		
	41	[illegible]	157, 290	380					
	42	[illegible]	157, 7[illegible]	390					
	43	[illegible]	158, [illegible]	380					
	44	[illegible]	[illegible]	370					
	→ 45	[illegible]	, 830	380	79.613		14.28		
	46	[illegible]	[illegible], 220	390					
	47	392	, 640	420					
	48	393	160, 0[illegible]	380					
	49	[illegible]	[illegible]	390					
	→ 50	[illegible]	. 750	380	79.417		14.09		
	51	[illegible]	161, 120	340					
	52	[illegible]	. 510	380					
	53	[illegible]	, 910	370					
	54	[illegible]	162. [illegible]	420					
	→ 55	[illegible]	, 700	390	79.615		14.29		
	56	[illegible]	[illegible], 110	390					
	57	[illegible]	, 470	380					
	58	[illegible]	, 830	340					

[illegible] WATER PROGRAM

WELL Nº ______

TEST WELL DATA

PAGE 6 OF 8

PUMP TEST 30D

STATIC WATER LEVEL 65.33 m. below m.p.

M.P. ABOVE GROUND LEVEL 0.42 m

DATE	HOUR	t time since pumping began. minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN feet	CONDUCTIVITY. µ mohs /cm.	T TEMPERATURE °C.
13-12-83									
	15:59	[illegible]	164, [illegible]	400					STEP 4
→	16 00	[illegible]	, 6[illegible]0	390	79.493		14.16		CONT
	01	[illegible]	165, 010	400					
	02	[illegible]	, 430	390					
	03	[illegible]	, 020	390					
	04	[illegible]	166, 210	390					
→	05	[illegible]	, 610	400	79.600		14.27		
	06	[illegible]	, 960	350					
	07	412	167, 360	400					
	08	413	, 7[illegible]	400					
	09	414	168, 150	390					
→	10	415:	, [illegible]20	390	79.621		14.29		
	11	416	, [illegible]	[illegible]					
	12	417	[illegible]	[illegible]					
	13	418	, [illegible]	390					
	14	419	[illegible]	[illegible]					
→	16:15	[illegible]	[illegible]	[illegible]	79.659			ADJUST OPEN VALVE TOTAL	
	20	425	[illegible], 7[illegible]	452	79.990		14.66		
→	25	430:	[illegible]	[illegible]	88.000		22.[illegible]		
	30	435	[illegible]	452	87.100		21.7[illegible]		
→	35	440:	[illegible] 640	470	87.130		21.8		
	40	445	[illegible] 950	462	87.370		22.04		
→	45	450:	[illegible]	470	88.690		23.36		
	50	455	[illegible] 5[illegible]0	454	87.653		[illegible]		
→	55	460:	18[illegible] [illegible]00	470	88.315		23.0		
	17:00	465	191 [illegible]0	456	88.300		23.0		
→	05	470:	193. [illegible]	470	88.440		23.11		
	10	475	195, 710	460	88.231		22.9		
→	17:15	480:	198, 0.0	470	88.660		23.3		
		END OF	TEST						

CADA 1 HORA

... DATA

PAGE 1 OF T-4

CONTROL DE GALx1000 Y GPM

STATIC WATER LEVEL .

M.P. ABOVE GROUND LEVEL

T-4

DATE	HOUR	Time since pumping began, minutes	Gal. x 1000	Gpm	Water level below m.p. meters	Water level below m.p. feet	Residual draw down feet	Conductivity micromhos /cm.	Temperature °C.
15-12-83	20:00		90022,130	390					
-	21:00		90049 400	395					
	22:00		90.069 290	390					
	23:00		90.091,370	390					
	24 00		90.114.410	385					
16-12-83	01:00	2400	090137 420	390					
	02:		090160 690	390					
	03:		090,183 820	390					
	04		090,206 950	380					
	05:		090230 152	390					
	06:		090 252,140	380					
	07:		090 275 030	390					
	08:		090,297 860	380					
	09:		090320,720	390					
	10:		090 343 850	390					
	11:		090 367 740	390					
	12:		090,390 860	390					
	13:		090,414,990	390					
	14:		090.438.100	390					
	15		090 461 670	390					
	16:		090.496 320	400					
	17		090.509010	395					
	18:		090.51[illegible]	390					
	19		090.5[illegible].250	390					
	20:		090.5[illegible].730	395					
	21		090.5[illegible].580	395					
	22		090.611 250	395					
	23		090.6[illegible].090	395					
	24:		[illegible]	400					
17-12-83	01	3840.	090682.340	390					
	02:		090705420	395					
	03		090728500	390.					
	04:		090.751590	390					
	05	4080.	090774 650	390					
	06:		090797,770	390					
	07		090.824910	390					
	08:		090 847,290	390.					

[illegible] WATER [illegible] WELL No. T-[illegible]

TEST WELL DATA PAGE 2 OF

PUMP TEST

STATIC WATER LEVEL [illegible]

M.P. ABOVE GROUND LEVEL

DATE	HOUR	Time since pumping began, minutes	Gal. x 1000	Q gpm	WATER LEVEL below m.p. meters	WATER LEVEL below m.p. feet	RESIDUAL DRAW DOWN feet	CONDUCTIVITY µ mhos /cm.	TEMPERATURE °C.
17	09:		090 870 360	390					
-	11:		090 917 350	390					
	13:		090 963 975	390					
	15:		091 010 520	390					
	17:		091 057 090	385					
	19:		091 103 170	385					
	21		091 149 860	390					
	23		091 196280	385					
18 12 83	01:		091 242420	390					
	03:		091 288 590	390					
	05:		091334 700	385					
	07:		091 381 350	390					
	09:		091 427 560	390					
	11:00		091 473 860	385					
	13.00		091 520 230	390					
	15:00		091 566 610	380					
	17:00		091 613 080	375					
	19:00		091 659 590	385					
	21 00		091060070	390					
	23 00		091752 510	390					
[illegible]	01:00		091 798 970	390					
	03:00		091845 120	385					
	05:00		091 891 250	385					
	07:00		091938 650	385					
	09:00		091 985 350	390					
	11 00		092032 210	390					
	13:00		092 079.290	390					
	15:00		092.126.250	390					
	17:00		092.173.390	390					
	19:00		092.220.600	390					
	21:00		092 267.620	390					
	23:00		092.316 .620	390					
[illegible]	01:00		092 363 [illegible]	390					
	03.00		092 410 [illegible]	390					
	05 00		092 457 [illegible]	390					
	07.00		[illegible] 610	390					
	[illegible]		[illegible]	390					

[illegible] WATER [illegible]

TEST WELL DATA

PUMP TEST

WELL No. T-4

PAGE 3 OF

STATIC WATER LEVEL [illegible]

M.P. ABOVE GROUND LEVEL

DATE	HOUR	Time since pumping began, minutes	Gal. x 1000	Gpm	Water level below m.p. meters	Water level below m.p. feet	Residual draw down feet	Conductivity μmhos/cm	Temperature °C
20.12.83	11:00		092.605.150	390					
-	—							SE PARA	
	15:30		092.687.120	710				GENERA[illegible]	
	16:00		092.718.490	710				PARA MANTENCI[illegible]	
	16:30		092.739.860	710				(SE CAM[illegible]	[illegible]
	17:00		092.759.370	690				DE AG[illegible]	
	17:30		092.779.830	680				EL REGISTRO	
	18:00		092.800.290	680				EN TARJETA DE	
	19:00		092.841.130	680				CONTROL	SIGUE
	20:00		092.881.850	680				SIENDO	IRREGULAR
	22:00		092.962.610	670				"SE LA	AVISO"
	24:00		093.042.780	680					
21.12.83	02:00		093 087,0[illegible]	440			"NO	ES POS[illegible]	[illegible]
	04:00		[illegible]	410			REG[illegible]	[illegible]	[illegible]"
	06:00		[illegible]	400					
	08:00		[illegible]	370					
	10:00		[illegible]	380					
	12:00		093 [illegible]	560					
	14:00		093.417.720	570		SE REDUCE	FLUJO	A	410 ±
	16:00		093.461.520	360		SE AUMENTA	FLUJO		A 390 ±
	18:00		093.504.[illegible]	360		"	"		A 350 ±
	20:00		093.548.[illegible]	370		"			A 350 ±
	22:00		093.615.[illegible]	590		SE REDUCE	A	400	±
	24:00		093.660.750	360					
22.12.83	04:00		093.753.250	360					
	08:00		093.833.130	[illegible]					
	12:00		[illegible].952.630	530					
	16:00		094.040.[illegible]	[illegible]					
	20:00		[illegible].125.[illegible]	350					
	24:00		094 [illegible]	[illegible]					
23.12.83	04:00		[illegible]	[illegible]					
	[illegible]		094[illegible]	[illegible]			SE [illegible]	[illegible]	[illegible]
	11:02		094 [illegible]	410			DE 10	A 11:02	
	11:10		[illegible]	380					
	12:00		[illegible].110	370					
	16:00		094 560,350	540	—16:30—	SE	AJUSTA	FLUJO A 380	G.P.M.
	20:00		094 652,550	380					

[illegible] WATER [illegible]

TEST WELL DATA

PUMP TEST

WELL No. T-6

PAGE 4 OF

STATIC WATER LEVEL

M.P. ABOVE GROUND LEVEL

DATE	HOUR	Time since pumping began, minutes	Gal. x 1000	Q gpm	WATER LEVEL below m.p. meters	WATER LEVEL below m.p. feet	RESIDUAL DRAW DOWN feet	CONDUCTIVITY µ mhos /cm.	TEMPERATURE °C.
	24:00		094744,430	390					
24-12-83	04:00		094836320	390					
	08:00		094927920	390					
	12:00		095031,020	550.	12:10 = SE AJUSTA FLUJO A 380 GPM				
	16:00		095118,150	370					
	20:00		095204,450	360					
	24:00		095291,750	360					
25-12-83	06:00		095419,850	360					
	12:00		095548,830	360					
	18:00		095678,260	360					
	24:00		095810,050	365					
26-12-83	06:00		095942 7[illegible]	360.					
	12:00		096073,[illegible]30	360.					
	18:02		096[illegible],130	350.					
	24:00		096364800	360.					
27/12-83	06:00		096469,370	365					
	12:00		096600,640	365					
28-12-83	06:00		096996,520	365					
	12:00		097129,300	365					
	18:00		097.260.720	365					
	24:00		097392,210	365					
29-12-83	06:00		097,523,140	360					
	12:00		097,654,530	370					
	18:00		097.786.100	360					
	24:00		097.917.600	360					
30.12.83	06:00		098048,260	360					
	12:00		098179,500	365					
	18:00		098.311.[illegible]	360					
	24:00		098.442.[illegible]	365					
31.12.83	06:00		098.573.770	365					
	12:00		098.705.1[illegible]	365					
	18:00		098.836.[illegible]	365					
	24:00		098.968.130	365					
1.1.84	06:00		099.099.[illegible]	365					
	12:00		099.230.470	365					
	18:00		099.361.910	365					
	24:00		099.493.150	365					

[illegible] WATER [illegible]
TEST WELL DATA
PUMP TEST

FW10

WELL No. T-4
PAGE 5 OF
STATIC WATER LEVEL
M.P. ABOVE GROUND LEVEL

DATE	HOUR	Time since pumping began, minutes	Gal. x 1000	Gpm	WATER LEVEL below m.p meters	WATER LEVEL below m.p feet	RESIDUAL DRAW DOWN feet	CONDUCTIVITY μ mhos/cm	TEMPERATURE °C
2.1.84	06:00		99.623.0[illegible]	360					
-	12:00		99.753.120	365					
	18:00		99.884.1[illegible]	365					
	24:00		100015.050	365					
3.1.84	06:00		10014[illegible]	365					
	12:00		1002[illegible].990	365					
	18:00		100.407.650	360					
	24:00		100.538.470	365					
4.1.84	06:00		100.669.170	365					
	12:00		100.799.600	365			15:23		4.1.84
	15:23		100.873.730	365		SE	PARA	GENERADOR	PARA
	18:00		100.906.930	360		CAMBIO	DE	ACEITE	Y FILTRO
	24:00		101.037.530	365		HASTA	LAS	16:28	
5.1.84	06:00		101.165.[illegible]	365					
	12:00		101.300.[illegible]0	370					
	18:00		101.432.240	365					
	24:00		101 563.910	365					
6.1.84	06:00		101 694 930	365					
	12:00		101.826.640	365					
	18:00		101.958.500	370					
	24:00		102.089.560	365					
7.1.84	06:00		102.221.250	365					
	12:00		102.351.920	365					
	18:00		102.484.160	365					
	24:00		102.615.[illegible]	365					
8.1.84	06:00		102.[illegible]	365					
	12:00		102.[illegible]	365					
	18:00		103.0[illegible].350	365					
	24:00		103.[illegible]	365					
9.1.84	06:00		103.27[illegible].300	360					
	12:00		103,400,[illegible]	365					
	18:00		103 531,35[illegible]	365					
	24:00		103,662,[illegible]	365					
10-1-84	06:00		103792,540	365					
	12:00		103.924,030	365					
	18:00		[illegible]	365					
	24:00		104,158.[illegible]	365					

[illegible] WATER PROGRAM

TEST WELL DATA

PUMP TEST

WELL No. T-4

PAGE 6 OF

STATIC WATER LEVEL ___ ___

M.P. ABOVE GROUND LEVEL ___

DATE	HOUR	Time since pumping began, minutes	Gal. x 1000	Q gpm	WATER LEVEL below m.p. meters	WATER LEVEL below m.p. feet	RESIDUAL DRAWDOWN feet	CONDUCTIVITY µ mhos /cm.	TEMPERATURE °C.
11-1-84	06:00		104320,120	365					
-	12:00		104 451,380	365					
	18:00		104.583 620	365					
	24:00		104.713.320	365					
12-1-84	06:00		104.843.720	365					
	12:00		104.976,220	365					
	18:00		105.108.650	365					
	24:00		105.240.810	355					
13-1-84	06:00		105.371,660	365					
	09:00		105,436,850	365					
			STOP	TEST	PUMP.				

	Water level below mp: Meters	Water level below mp: Feet	Residual draw down: Meters
	10	214.599	.065
	00	214.5[illegible]	0.055
	[illegible]	214.5[illegible]0	0.050
	[illegible]1	214.5[illegible]	0.046
	[illegible]5	214.5[illegible]	0.043
	[illegible]	[illegible]	0.038
	[illegible]1	[illegible]4.504	0.036
	[illegible]	[illegible]	0.031
	[illegible]1	[illegible]	0.0[illegible]
	[illegible]	214.[illegible]	0.029
	1	[illegible]	0.016
	[illegible]	[illegible]	0.008
	0	[illegible]	0.005
	2	[illegible]	—
	0	[illegible]	—
	[illegible]	[illegible]	—
	[illegible]		
	1		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST [illegible]

WELL Nº T-4
PAGE 1 OF
STATIC WATER LEVEL 65.319 m. below m.p.
M.P. ABOVE GROUND LEVEL 0.62 m.

DATE	HOUR	t time since pumping began. minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY µ mohs /cm.	T TEMPERATURE °C.
14-12-83	09 00	0	89,204,090		65.319	214.301	-0-		
	:02	2			—	POZOM. TRABADO			
	:04	4	205,080	400	—	"			
	:06	6			—	"			
	:08	8			80.613	SE PONE UNO NUEVO	15.294		
	:10	10	208,060	400	80.975	265.666	15.656		
	:15	15	210,035	400	81.633	267.824	16.314		
	:20	20	212,010	395	82.495	270.636	17.171		
	:25	25	213,980	400	82.653	271.138	17.324		
	:30	30	215,965	395	82.673	271.253	17.359		
	:35	35	217,940	395	82.757	271.512	17.438		
	:40	40	219,935	400	82.600	271.128	17.321		
	:45	45	221,920	390	82.417	270.396	17.098		
	:50	50	223,910	405	82.628	271.089	17.309		
	:55	55	225,890	400	82.431	270.442	17.112		
	10:00	60	227,865	400	82.040	269.160	16.721		
	10	70	231,820	395	82.315	270.062	16.996		
	20	80	235,770	390	82.010	269.061	16.691		
	30	90	239,110	400	—	POZOM. TRABADO	–		
	40	100	243,685	390	—	"	–		
	50	110	247,610	400	—	SE PONE OTRO	–		
	11 00	120	251,600	395	80.700	264.763	15.381		
	20	140	259,450	390	—	POZOM TRABADO			
	40	160	269,330	395	79.849	261.971	14.53		
	12 00	180	279,285	405	79.497	260.816	14.178		
	20	200	282,—	390	79.310	260.203	13.991		
	40	220	290,—	395	78.830	258.628	13.511		
	13 00	240	298,—	395	78.982	259.127	13.663		
	20	260	306,710	390	78.970	259.087	13.651		
	1 00	280	89.315,—	395	78.400	257.217	13.081		
	14 00	300	89.322,—	390	78.397	257.208	13.078		
	30	330	89.333,—	400	78.715	258.251	13.396		
	15 00	360	89,345,200	395	78.472	257.454	13.153		
	30	390	",357,40	390	78.735	258.316	13.416		
	16 00	420	",368,830	390	78.365	257.103	13.046		
	30	450	".380,600	400	78.735	258.316	13.416		
	17 00	480	".392,370	395	[illegible]	258.251			

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST Dic 14, 1993

WELL Nº T-4
PAGE 2 OF ____
STATIC WATER LEVEL 65.319 m. below m.p.
M.P. ABOVE GROUND LEVEL 0.410

DATE	HOUR	time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	feet	DRAW DOWN METERS	CONDUCTIVITY. µ mohs /cm.	TEMPERATURE °C.
14-12-93	17:30	510	89.409,130	390	78.665	259.087	13.346		
	18:0	540	" ,415,920	390	78.745	258.349	13.426		
	[illegible]	570	" ,427,670	390	79.112	259.553	13.793		
	19:	600	" ,439,440	395	78.993	259.163	13.674		
	20:0	660	" ,462,920	395	79.110	[illegible]	13.791		
	21:0	720	" 486,[illegible]	390	79.102	259.520	13.783		
	22:	780	509,[illegible]	390	79.130	259.612	13.811		
	23:0	840	" 533,310	395	79.136	259.632	13.819		
	24:00	900	" 556,560	400	79.155	259.694	13.836		
15-12-93	01:	960	" 550,190	395	79.154	259.691	13.835		
	02:	1020	[illegible]	390	[illegible]	259.701	13.838		
	03:	1080	[illegible]	390	79.162	259.719	13.843		
	04:	1140	[illegible]	390	[illegible]	259.730	13.847		
	05:	1200	[illegible]	[illegible]	[illegible]	259.757	13.855		
	06:	1260	[illegible]	390	79.176	259.770	13.857		
	07:	1320	[illegible]	390	[illegible]				
	08	1380	[illegible]	390	—				
	09:	1440	" 766,500	385	—				
	10:	1500	" 789,560	390	—				
	11:00	1560	" 812,[illegible]	[illegible]	—				
	13:	1680	" 859,310	390	—				
	15:	1800	" 906,100	390	—				
	17:	1920	" 952,590	395	—				
	19:	2040	" 998,030	395	—				
	21:	2160	[illegible]	[illegible]					
	23:	2280	[illegible]	390					
16-12-93	01:00	2400	[illegible]	395					
	3:00	2520							
	5:00	2640							16-12-93
	7:00	2760	ojo	8hrs	79.056	[illegible]	13.736	[illegible]	
	9:00	2880		10:hrs	79.071 / 79.083		[illegible]	[illegible]	
	13:00	3120	gpm		79.190	[illegible]	13.871	[illegible]	
	17:00	3360	en		79.210	[illegible]	13.891	05 a 17.45	
	21:00	3600	hora		79.235	[illegible]	13.916		
17-12-93	1:00	3840	aparte		79.390	[illegible]	14.071		
	5:00	4080			79.310	[illegible]	13.991		
	9:00	4320			79.214	[illegible]	13.895		

NOTA: [illegible]

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº T-4
PAGE 3 OF ____
STATIC WATER LEVEL 65.319 m. below m.p.
M.P. ABOVE GROUND LEVEL 0.420

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY. µ mohs /cm.	T TEMPERATURE °C.
	15:00	~~5040~~ 4680			79.185	259.793			
	21:00	~~5760~~ 5040			79.375	260.42[illegible]			
18/12/83	3:00	~~6480~~ 5400			79.390	260.465			
	9:00	~~7200~~ [illegible]760			79.260	260.039			
	15:00	~~7920~~ 6120			Pozom[illegible] Tirrado				
	21:00	~~8640~~ 6480			—				
19/12	3:00	~~9360~~ 6840			—				
	9:00	~~10080~~ 7200			—				
	15:00	~~10800~~ 1560			79.287	260.456			
	21:00	~~11520~~ 79[illegible]0			79.401	260.501			
20/12	3:00	~~12240~~ 82[illegible]0			70.[illegible]	260.039			
	9:00	~~12960~~ 8640			Pozometro [illegible]				
	15:00	~~13680~~ 9[illegible]							
	21:00	~~14400~~ 93[illegible]0							
21/12	3:00	~~15120~~ 9[illegible]20							
	9:00	~~15840~~ 9[illegible]80							
	15:00	~~16560~~ 9[illegible]40							
	21:00	~~17280~~ [illegible]880							
22/12	9:00								
	21:00								
23/12	9:00								
	21.00								
24/12									
25/12									
26/12									
27/12									
28/12									
29/12									
		29/Dic/83	STOP	MEDIDAS POR PROBLEMA DE INSTRODUCIR POZÓMETRO					

FECHAS SIN MEDIDAS POR OBSTACULOS EN CASING. SE INTENTA, SIN RESULTADOS.

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY 65.319

WELL Nº. ES: T-4
page 1 of ____
T-4

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters		RESIDUAL DRAW DOWN METERS
13/1/84 15:00	43560	360	121	69.00	226.377	3.681
20	43580	380	115	68.820	225.787	3.501
40	43600	400	109	68.775	225.639	3.456
16:00	43620	420	104	68.720	225.459	3.401
20	43640	440	99	68.630	225.164	3.311
40	43660	460	95	68.587	225.022	3.268
17.00	43680	480	91	68.509	224.767	3.190
20	43700	500	87	68.465	224.622	3.146
40	43720	520	84	68.390	224.376	3.071
18.00	43740	540	81	68.351	224.248	3.032
30	43770	570	77	68.270	223.982	2.951
19.00	43800	600	73	68.202	223.759	2.883
30	43830	630	70	68.125	223.507	2.806
20.00	43860	660	66	68.060	223.293	2.741
21:00	43920	720	61	67.878	222.696	2.559
22:00	43980	780	56	67.830	222.539	2.511
23:00	44040	840	52	67.810	222.473	2.491
24:00	44100	900	49	67.792	222.414	2.473
14-1-84 01:00	44160	960	46	67.783	222.385	2.464
02:00	44220	1.020	43	67.681	222.050	2.362
03:00	44280	1.080	41	67.579	221.715	2.260
04:00	44340	1.140	39	67.491	221.427	2.172
05:00	44400	1.200	37	67.427	221.217	2.108
06:00	44460	1.260	35	67.383	221.072	2.064
07:00	44520	1.320	34	67.351	220.967	2.032
09:00	44580	1.380	32	67.[illegible]	220.866.	2.041
		~~1.440~~				
0900	44640	1.440	31	67.264	220.682	1.945
11:00	44760	1.560	29	67.164	220.354	1.845
13:00	44880	1.680	27	67.080	220.078	1.761
15:00	45000	1.800	25	67.020	219.881	1.701
17:00	45120	1.920	24	66.680	218.766	1.361
19:00	45240	2.040	22	66.670	218.733	1.351
21:00	45360	2.160	21	66.580	218.438	1.261
23:00	45480	2.280	20	66.552	218.346	1.233

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY

WELL Nº. ES: [illegible]
page 2 of ____

65.31[illegible]

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	 feet	RESIDUAL DRAW DOWN METERS
15/1/8[illegible] 01:00	45600	2.400	19	66.348	217.677	1.0[illegible]
03:00	45720	2.520	18	66.343	217.660	1.024
05:00	45840	2.640	17	66.361	217.719	1.042
07:00	45960	2.760	17	66.311	217.555	0.99[illegible]
09:00	46080	2.880	16	66.280	217.454	0.9[illegible]
1[illegible]:00	46320	3.120	15	66.222	217.263	0.[illegible]
1[illegible]:[illegible]	46560	3.360	14	[illegible].145	217.011	0.8[illegible]
21:00	46800	3.600	13	66.149	217.024	[illegible]
16-8[illegible] [illegible]	47040	3.840	12	66.103	216.873	0.784
[illegible]	47280	4.080	12	66.093	216.840	0.774
[illegible]	47520	4.320	11	66.021	216.604	0.702
[illegible]	47880	4.680	10	66.000	216.535	0.681
[illegible]	48240	5.040	9.6	65.998	216.528	0.6[illegible]
17/1 [illegible]:00	48480	5.400	9.0	65.951	216.374	[illegible]
[illegible]00	48840	5.760	8.5	65.843	216.020	0.52[illegible]
[illegible]	49200	6.120	8.0	65.719	215.623	0.4[illegible]
21:00	49560	6.480	7.6	65.710	215.583	0.39[illegible]
18/1 03:00	50040	6.840	7.3	65.708	215.577	0.38[illegible]
05:00	50400	7.200	7.0	65.700	215.551	0.381
[illegible]	50760	[illegible]	6.7	[illegible]	[illegible]	0.354
[illegible]	51120	[illegible]	6.5	[illegible]	[illegible]	0.350
[illegible]	51480	[illegible]	6.2	[illegible]	[illegible]	0.31[illegible]
[illegible]	51840	8.640	6.0	[illegible].657	[illegible]	0.36[illegible]
[illegible]	52200	[illegible]	5.8	[illegible].570	[illegible]	0.[illegible]
21:[illegible]	52560	[illegible]	5.6	[illegible]	[illegible]	
[illegible]	52920	[illegible]	5.4	[illegible]	[illegible]	
[illegible]	53640	10.[illegible]	5.1	65.512	[illegible]	0.1[illegible]
[illegible]	54360	11.[illegible]	4.9	[illegible]	[illegible]	
[illegible]:00	55080	11.[illegible]	4.6	[illegible]	[illegible].721	
[illegible] 03:00	55800	12.600	4.4	65.415	214.[illegible]	0.096
[illegible]	56520	[illegible]	4.2	[illegible]	214.[illegible]	0.0[illegible]
[illegible]	57240	14.[illegible]	4.1	[illegible]	214.[illegible]	0.016
[illegible]	57960	[illegible].760	3.9	[illegible]	214.[illegible]	0.0[illegible]
	[illegible]	[illegible]				

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST 14-12-83

WELL Nº 49
PAGE 1 OF ____
STATIC WATER LEVEL 65.00 m below mp
M.P. ABOVE GROUND LEVEL 0.520

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY. μ mohs /cm.	T TEMPERATURE °C.
14-12-83	08:00	0			66.000	216.535	-0-		
		1			66.520	218.241	.520		
		2			67.156	220.328	1.156		
		3			67.571	221.689	1.571		
		4			67.903	222.779	1.903		
		5			68.041	223.231	2.041		
		6			68.163	223.631	2.163		
		7			68.285	224.032	2.285		
		8			68.390	224.376	2.390		
		9			68.442	224.547	2.442		
	09:10	10			68.508	224.763	2.508		
		12			68.653	225.239	2.653		
		14			68.781	225.659	2.781		
		16			68.859	225.915	2.859		
		18			68.925	226.131	2.925		
		20			69.000	226.377	3.000		
		22			69.060	226.574	3.060		
		24			69.096	[illegible]	3.096		
		26			69.146	226.856	3.146		
		28			69.203	227.043	3.203		
	09:30	30			69.240	227.165	3.240		
		32			69.274	227.276	3.274		
		34			69.320	227.427	3.320		
		36			69.355	227.542	3.355		
		38			69.394	[illegible]	3.394		
	09:40	40			69.425	227.772	3.425		
		45			69.494	[illegible]	3.494		
	09:50	50			69.557	[illegible]	3.557		
		55			69.621	228.415	3.621		
	10:00	60			69.671	[illegible]	3.671		
	05	65			[illegible]	228.750	3.736		
	10	70			[illegible]	[illegible]	3.765		
	15	75			69.811	229.038	3.811		
	20	80			69.846	229.153	3.846		
	25	85			69.896	229.317	3.896		
	30	90			69.930	[illegible]	3.930		
	35	95			69.962	[illegible]	3.962		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº [illegible]- 49
PAGE 2 OF ____
STATIC WATER LEVEL [illegible] m. below m.p.
M.P. ABOVE GROUND LEVEL [illegible]

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY. μ mohs /cm.	T TEMPERATURE °C.
14-12-83	10:40	100			69.994	229.639	3.99[illegible]		
	45	105			70.021	229.729	4.021		
	50	110			70.055	229.839	4.055		
	55	115			70.081	229.924	4.081		
	11:00	120	c/10		70.102	229.993	4.102		
	10	130			70.155	230.167	4.155		
	20	140			70.197	230.305	4.197		
	30	150			70.241	230.449	4.241		
	40	160			70.282	230.583	4.282		
	50	170			70.326	230.728	4.326		
	12:00	180			70.354	230.820	4.354		
	20	200	c/20		70.431	231.072	4.431		
	40	220			70.480	231.233	4.480		
	13:00	240			70.522	231.371	4.522		
	20	260			70.576	231.548	4.576		
	40	280	✓		70.613	231.669	4.613		
	14:00	300	c/30		70.670	231.856	4.670		
	30	330			70.701	231.958	4.701		
	15:00	360			70.767	232.175	4.767		
	30	390			70.800	232.283	4.800		
	16:00	420			70.852	232.454	4.852		
	30	450			70.884	232.559	4.884		
	17:00	480			70.917	232.667	4.917		
	30	510			70.960	232.808	4.960		
	18:00	540			70.977	232.864	4.977		
	30	570			71.021	233.008	5.021		
	19:00	600	c/1 [illegible]		71.038	233.064	5.038		
	20:00	660			71.120	233.333	5.120		
	21:00	720			71.132	233.372	5.132		
	22:00	780			71.154	233.444	5.154		
	23:00	840			71.183	233.540	5.183		
	24:00	900			71.241	233.730	5.241		
15-12-83	01:00	960			71.250	233.759	5.250		
	02:00	1020			71.286	233.877	5.286		
	03:	1080			71.310	233.956	5.310		
	04	1140			71.342	234.061	5.342		
	05	1200			71.364	234.199	5.364		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº 49
PAGE 3 OF ____
STATIC WATER LEVEL 66.000 m below m.p.
M.P. ABOVE GROUND LEVEL 0.520

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY µ mohs /cm	TEMPERATURE °C.
5-12-83	06:	1260			71.416	234.304	5.416		
	07:	1320			71.435	234.363	5.435		
	08:	1380			71.450	234.416	5.450		
	09:	1440.			71.466	234.468	5.466		
	11:00 hrs	1560			71.540	234.711	5.540		
	13:	1680			71.533	234.688	5.533		
	15:	1800			71.551	234.747	5.551		
	17:	1920			71.567	234.799	5.567		
	19:	2040			71.583	234.852	5.583		
	21:	2160			71.620.	234.973	5.620		
	23:	2280			71.637	235.029	5.637		
16-12.	01:00	2400			71.630	[illegible]	5.630		
	03:00	2520			71.635	[illegible]	5.635		
	05 *	2640			71.629	[illegible]	5.629		
	07:	2760			[illegible]	[illegible]	5.690		
	09:	2880			[illegible]	[illegible]	5.765		
	13 hrs	3120	4ohw		71.769	235.452	5.769		
	17:00	3360			71.763	235.442	5.763		
	21:00	3600			71.723	235.311	5.723		
17-12-83	01:00	3840			71.810	235.597	5.810		
	05:00	4080			[illegible]	[illegible]	*5.800		
	09:00	4320			71.800	[illegible]	5.800		
			←		CADA 6	horas por	2 DIAS.		
					CADA 12	horas hasta	FINAL		
					DE LA	PRUEBA.			
					NOTA:	COMIENZA A	FALLAR		
17-12-83	15:00	~~5.040~~ 4560	dd		71.745	235.363	5.745 AMPERES DEL GENERADOR		
	21:00	~~5.760~~ 4840			71.740	235.367	5.740 MARCA TARJETA EN FORMA		
18/12/83	03:00	~~6.480~~ [illegible]			71.742	235.374	5.742 IRREGULAR.		
	09:00	~~6.840~~ 5760			71.700	235.236	5.700		
	15:00	~~7.200~~ 6120			71.574	234.822	5.574		
	21:00	~~7.560~~ 6480			71.523	234.655	5.523		
19/12/83	03:00	~~7.920~~ 6840			71.520	234.645	5.520		
	09:00	~~8.280~~ 7200			71.450	234.416	5.450		
	15:00	~~8.640~~ [illegible]	dd						
	21:00	~~9.000~~ 7920							
20/12/83	03:00	~~9.360~~ 8280			71.235	233.710	5.235		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº 60
PAGE 4 OF ____
STATIC WATER LEVEL 66.000 m. below mp
M.P. ABOVE GROUND LEVEL 0 520

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY µ mho /cm.	T TEMPERATURE °C.
20.12.83		A CONTAR DE ESTE DIA, LAS MEDIDAS SERIAN CADA 12 HRS							
		DETENIDO POR PROBLEMAS EN EL GENERADOR A LAS 11:00 AM							
		SE DECIDE TOMAR RECUPERACIÓN A LAS 12:50 P.M							
		SE SOLUCIONA PROBLEMA EN GENERADOR Y SE CONTINÚA							
		CON "PUMP TEST" A LAS 13:35.							
		HOJA DE RECUPERACION, APARTE.							
	13.00	~~9.960~~ 8882							
	13:35	~~9.995~~ 8915			69.730	228.772	.730		
	13:40	~~10.000~~ 8920	CADA 10 MTOS.		70.102	229.993	4.102		
	13:50	~~10.010~~ 8930			70.330	230.741	4.330		
	14:00	~~10.020~~ 8940			[illegible]	231.446			
	:10	~~10.030~~ 8950			70.651	231.794	4.651		
	:20	~~10.040~~ 8960			70.705	231.971	4.705		
	:30	~~10.050~~ 8970			70.790	232.250	4.790		
	15:30	~~10.110~~ 9030	CADA ½ HR		70.961	232.811	4.961		
	16:00	~~10.140~~ 9060			70.972	232.913	4.972		
	16:30	~~10.170~~ 9090			71.021	233.006	5.021		
	17:00	~~10.200~~ 9120			71.038	233.064	5.038		
	17:30	~~10.230~~ 9150			71.053	233.113	5.053		
	18:00	~~10.260~~ 9[illegible]			71.069	233.168	5.069		
	19:00	~~10.320~~ 9240	CADA 1 HR		71.086	233.221	5.086		
	20:00	~~10.380~~ 9300			71.105	233.284	5.105		
	22:00	~~10.500~~ [illegible]			71.130	233.366	5.130		
	24:00	~~10.620~~ 9540			71.136	233.392	5.136		
21.12.83	02:00	~~10.740~~ 9660			71.136	233.385	5.136		
	04:00	~~10.860~~ 9780			71.140	233.398	5.140		
	06.00	~~10.980~~ 9900	CADA 2 HRS.		71.142	233.405	5.142		
	08:00	~~11.100~~ 10020			71.135	233.382	5.135		
	10:00	~~11.220~~ 10140			71.110	233.300	5.110		
	12:00	~~11.340~~ 10260			71.115	233.316	5.115		
	14:00	~~11.460~~ 10380			71.077	233.192	5.077		
	16:00	~~11.580~~ 10500			71.056	233.123	5.056		
	18:00	~~11.700~~ 10620			71.045	233.087	5.045		
	20:00	11.820 10740			71.050	233.103	5.050		
	22:00	11.940 10860			71.036	233.057	5.036		
	24 00	~~12.060~~ 10980			71.035	233.054	5.035		
22.12.83	06:00	~~12.420~~ 11340			71.080	232.939	5.080		

SCONDIDA WATER PROGRAM
TEST WELL DATA
UMP TEST

WELL Nº ES-49
PAGE 5 OF ______
STATIC WATER LEVEL 66.000 m below m.p.
M.P. ABOVE GROUND LEVEL 0.320

ATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY. µ mohs /cm.	T TEMPERATURE °C.
[illegible]-12-83	12:00	~~12.480~~ 11700			71.005	232.956	5.005		
	18:00	~~13.140~~ 12060			71.000	232.939	5.000		
	24:00	13.500 12420			70.[illegible]	232.880	4.782		
[illegible]-12-83	[illegible]	~~13.860~~ 12780			71.00	232.939	5.[illegible] A las 10 hrs	[illegible]	
	12:00	~~14.220~~ 13140	CADA 6 HRS		70.735	235.351	4.735 [illegible]	[illegible] hasta las	
	18:00	~~14.580~~ 13500			70.972	232.847	4.772 11:[illegible]	[illegible]	
	24:00	~~14.940~~ 13860			71.006	232.959	5.006 [illegible]	activ[illegible] [illegible]	
[illegible]	[illegible]	~~15.300~~ 14220			71.005	232.556	5.005 [illegible]	[illegible]	
	[illegible]	~~15.660~~ 14580			71.005	232.956	5.005 de panel electric[illegible]		
	18:00	~~16.020~~ 14940			71.021	233.008	5.021		
	24:00	~~16.380~~ 15300			71.037	233.061	5.037		
[illegible]	12:00	~~17.100~~ 16020			71.065	233.153	5.065		
			CADA 12 HRS						
26-12-83	12:00	~~18.540~~ 17460			71.060	233.136	5.060		
	24:00	~~19.260~~ 18180			71.044	233.083	5.044		
27-12-83	12:00	~~19.980~~ 18900			71.043	233.080	5.043		
	24:00	~~20.700~~ 19620			71.040	233.070	5.040		
28-12-83	12:00	~~21.420~~ 20340			71.051	233.106	5.051		
	24:00	~~22.140~~ 21060			71.063	233.146	5.063		
29-12-83	12:00	~~22.860~~ 21780			71.076	233.186	5.07[illegible]		
	24:00	23.580 22500			71.083	233.211	5.083		
30-12-83	12:00	24.300 [illegible]			71.089	233.231	5.08[illegible]		
	24:00	~~25.020~~ 23940			71.120	233.333	5.170		
31-[illegible]	[illegible]	25.740 24660			71.129	233.362	5.129		
	24:00	26.460 25380			71.161	233.467	5.161		
1-[illegible]	12:00	~~27.180~~ [illegible]			71.179	233.576	5.179		
	24:00	~~27.900~~ 26820			71.187	233.553	5.187		
1-[illegible]	12:00	~~28.620~~ 27540			71.195	233.579	5.195		
	24:00	29.340 28260			71.20[illegible]	233.625	5.207	4.1.83	se [illegible]
3-1-84	12:00	~~30.060~~ 28980			71.230	233.654	5.230 ge[illegible]	[illegible]	2 : 1[illegible]
	24:00	~~30.780~~ 29700			71.237	233.717	5.237 15	: 23 a	16 : 28
4-1-84	[illegible]	~~31.500~~ 30420			71.251	233.763	5.251		
	[illegible]	~~32.220~~ 31140			71.242	233.723	5.242		
[illegible]-1-84	12:00	~~32.940~~ 31860			71.293	233.900	5.293		
	24:00	33.660 32580			71.310	233.956	5.310		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº ES-49
PAGE 6 OF ______
STATIC WATER LEVEL 66.000 m. below m.p.
M.P. ABOVE GROUND LEVEL 0.520

DATE	HOUR	time since pumping began. minutes	Gal. x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY. µ mohs /cm.	TEMPERATURE °C.
6-1-84	12:00	~~34,380~~ 33[illegible]			71,320	233,989	5.320		
	24:00	~~35,100~~ 34620			71,334	234,035	5.334		
7-1-84	12:00	~~35,820~~ 34[illegible]			71,340	234,055	5.340		
	24:00	~~36,540~~ 35[illegible]60			71,360	234,120	5.360		
8-1-84	12:00	~~37,260~~ 36180			71,341	234,058	5.341		
	24:00	~~37,980~~ 36[illegible]00			71,358	234,114	5.338		
9-1-84	12:00	~~38,700~~ 37620			71,339	234,051	5.339		
	24:00	~~39,420~~ 38340			71,367	234,143	5.367		
10-1-84	12:00	~~40,140~~ 37060			71,364	234,133	5.364		
	24.00	~~40,860~~ 39780			71,365	234,137	5.365		
11-1-84	12:00	~~41,580~~ 40500			71,366	234,140	5.366		
	24.00	~~42,300~~ 41220			71,380	234186	5.380		
12-1-84	12:00	~~43,020~~ 41940			71,385	234.202	5.385		
	24:00	~~43,740~~ 42660			71,395	234.235	5.395		
13-1-84	09:00	~~44,280~~ 43200			71.401	234.263	5.401	STOP TEST PUMP	

TEST WELL DATA t · 43200

RECOVERY FRIDAY – 13-1-84.–

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN METERS
13/1/84 09:00	43200	0	–			
01	43201	1	43201	71,145	233,415	5.145
02	43202	2	21601	70,733	232,032	4.733
03	43203	3	14401	70,359	230,836	4.359
04	43204	4	10801	70,141	230,121	4.141
05	43205	5	8641	69,950	229,494	3.950
06	43206	6	7201	69,818	229,061	3.815
07	43207	7	6172	69,705	228,690	3.705
08	43208	8	5401	69,621	228,415	3.621
09	43209	9	4801	69.561	228,218	3,561
09:10	43210	10	4321	69,464	227,900	3.464
12	43212	12	3601	69,369	227,588	3.369
14	43214	14	3087	69,271	227,267	3.271
16	43216	16	2701	69,184	226,981	3.184
18	43218	18	2401	69,112	226,745	3.112
20	43220	20	2161	69.058	226,568	3.056
22	43222	22	1965	69.000	226,377	3.000
24	43224	24	1801	68,948	226,207	2.948
26	43226	26	1663	68.910	226,082	2.910
28	43228	28	1544	68.869	225,948	2.869
30	43230	30	1441	68,832	225,826	2.832
32	43232	32	1351	68.790	225,688	2.790
34	43234	34	1272	68.765	225,606	2.765
36	43236	36	1201	68,723	225,469	2.723
38	43238	38	1138	68.702	225,400	2.702
09:40	43240	40	1081	68.669	225,291	2.667
44	43244	44	983	68,626	225,150	2.626
48	43248	48	901	68,571	224,970	2.571
52	43252	52	832	68,534	224,849	2.534
56	43256	56	772	68,489	224,701	2.487
10:00	43260	60	721	68,466	224,625	2.466
05	43265	65	657	68,412	224,448	2.412
10	43270	70	618	68,381	224,347	2.381
15	43275	75	577	68,350	224,245	2.350
20	43280	80	541	68.300	224,081	2.300
25	43285	85	509	68,261	223,953	2.261
30	43290	90	481	68.230	223,851	2.230

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY

WELL Nº. ES: 49
page 2 of

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp		RESIDUAL DRAW DOWN METERS
				meters	feet	
13/1/8[illegible] 10:35	43295	95	456	68,209	223,782	2.209
40	43300	100	433	68,178	223,681	2.178
45	43305	105	412	68,150	223,589	2.150
50	43310	110	394	68,122	223,497	2.122
55	43315	115	377	68,094	223,405	2.094
11:00	43320	120	361	68 069	223,323	2.069
10	43330	130	333	68,045	223,244	2.045
20	43340	140	310	67,989	223,061	1.989
30	43350	150	289	67,942	222,906	1.942
40	43360	160	271	67,929	222,864	1.929
50	43370	170	255	67,890	222,736	1.890
12:00	43380	180	241	67,856	222,624	1.856
20	43400	200	217	67.815	222,490	1.815
40	43420	220	197	67.782	222,381	1.782
13:00	43440	240	181	67.680	222,047	1.680
20	43460	260	167	67.628	221,876	1.628
40	43480	280	155	67.600	221,784	1.600
14:00	43500	300	145	67.580	221,719	1.580
20	43520	320	136	67,525	221,538	1.525
40	43540	340	125	67.495	221,440	1.495
15:00	43560	360	121	67.450	221,292	1.450
20	43580	380	115	67.420	221,194	1.420
40	43600	400	109	67.390	221,095	1.390
16:00	43620	420	104	67,374	221,043	1.374
20	43640	440	99	67.340	220,931	1.340
40	43660	460	95	67,325	220,882	1.325
17:00	43680	480	91	67, 290	220,967	1.290
20	43700	500	87	67, 270	220,702	1.270
40	43720	520	84	67, 251	220,639	1.251
18:00	43740	540	81	67, 248	220,629	1.248
30	43770	570	77	67, 191	220,442	1.191
19:00	43800	600	73	67,175	220,390	1.175
30	43830	630	70	67,162	220,347	1.162
20:00	43860	660	66	67,140	220,275	1.140
21:00	[illegible]	720	61	67.121	220,213	1.121
22:00	43980	780	56	67.100	220,144	1.100
23:00	44040	840	52	66.991	219,786	0.991

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY

WELL Nº. ES: 49
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HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	feet	RESIDUAL DRAW DOWN METERS
24:00	44100	900	49	66.977	219,740	0.977
14/1/84 01:00	44160	960	46	66.961	219,688	0.961
02:00	44220	1020	43	66.931	219,589	0.831
03.00	44280	1080	41	66.883	219,432	0.883
04:00	44340	1.140	39	66.845	219,307	0.845
05:00	44400	1 200	37	66.824	219,238	0.824
06:00	44460	1260	35	66.800	219,160	0.800
07:00	44520	1 320	34	66.792	219,133	0.792
08:00	44580	1380	32	66.780	219,094	0.780
09:00	1er DIA 44640	1 440	31	66 765	219045	0.765
11:00	44760	1.560	29	66.718	218,891	0.718
13.00	44880	1.680	[illegible]	66.681	218,769.	0.681
15:00	45000	1.800	25	66.650	218,667	0.650
17:00	45120	1.920	24	66.615	218,553	0.615
19:00	45240	2040	[illegible]	66.530	218,274	[illegible]
21:00	45360	2160	21	66 570	218405	0.570
23:00	45480	2 280	20	66.551	218,343	0.551
15/1/84 01:00	45600	2400	19	66 450	218,011	0.451
03:00	45720	2520	18	66.450	218,011	0.450
05:00	45840	2640	17	66.475	218,093	0.475
07:00	45960	2760	17	66.461	218,047	0.461
09:00	2do DIA 46080	2880	16	66 453	218,021	0.4526.5
13:00	46320	3120	15	66.432	217,952	0.432
17:00	46560	3 360	14	66,360	217,716	0.360
21:00	46800	3 600	13	66 351	217,687	0.351
16/1/84 01:00	47040	3.840	12	66,310	217.552	0.310
05:00	47280	4080	12	66,260	217,388	0.260
09:00	3er DIA 47520	4.320	11	66 241	217,326	0.241
15:00	47880	4680	10	66.199	217,188	0.199
21:00	48240	5.040	9.6	66.186	217.145	0.186
17/1/84 03:00	48480	5 400	9.0	66 177	217,116	0.177
09:00	4to DIA 48840	5.760	8.5	66 172	217,099	0.172
15:00	49200	6120	8.0	66.160	217,060	0.160
21:00	49560	6480	7.6	66.153	217.053	0.153

[illegible] ATER PROGRA[illegible] . WELL Nº. ES: [illegible]

TEST WELL DATA page [illegible] of

RECOVERY

	HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters		RESIDUAL DRAW DOWN METERS
					meters	feet	
8/1/84	07:00	50040	6840	7.3	66.153	217.037	0.153
	09:00	50400	7200	7.0	66.150	217.027	0.150
	15:00	50760	7560	[illegible]	66.147	[illegible].017	0.147
	21:00	51120	7920	6.5	66.133	216.[illegible]	0.133
10/1/84	03:00	51480	8280	6.2	66.130	216.961	0.130
	09:00	51840	8640	6.0	66.115	[illegible]	0.115
	15:00	52200	9000	5.8	66.111	216.[illegible]	0.111
	21:00	52560	9360	5.6	66.095	[illegible]	0.095
[illegible]	03:00	52920	9720	5.4	66.086	[illegible]	0.086
	15:00	53640	10440	5.1	[illegible]	[illegible]	0.077
[illegible]	03:00	54360	11160	4.9	66.054	[illegible]	0.054
	15:00	55080	11880	[illegible]	66.063	[illegible]	0.063
[illegible]	03:00	55800	12600	4.4	66.047	[illegible]	0.047
	15:00	56520	13320	4.2	66.033	[illegible]	[illegible]
[illegible]	03:00	57240	14040	4.1	[illegible].022	[illegible]	0.022
	15:00	[illegible]	14760	3.9	66.010	[illegible]	0.010

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº ES 60
PAGE 1 OF ____
STATIC WATER LEVEL [illegible] m below mp
M.P. ABOVE GROUND LEVEL [illegible]

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY. µ mohs /cm.	T TEMPERATURE °C.
6-12-83	09:00	0			65.3[illegible]5	214.386	-0-		
		2			65.365	214.452	0.020		
		4			65.370	214.4[illegible]	0.025		
		6			65.415	214.616	0.070		
		8			65430	214.665	0.085		
		10			65.425	214.648	0.080		
		12			65.475	214.812	0.130		
		14			65.480	214.829	0.135		
		16			65.510	214.927	0.165		
		18			65.530	214.993	0.185		
		20			65.540	215.026	0.195		
		22			65.550	215.059	0.205		
		24			65.570	215.124	0.225		
		26			65625.	215.305	0.2[illegible]		
		28			65650	215.387	0.305		
		30			65.670	215.452	0.325		
		32			65.605	215.239	0.260		
		34			65.610	215.255	[illegible]		
		36			65.650	215.387	0.305		
		38			65635	215.337	0.290		
		40			65.670	215.288	0.325		
		45			65.730	215.649	0.385		
		50			65.735	215.666	0.390		
		55			65685	215.501	0.340		
	10:00	60			65.720	215.616	0.375		
	[illegible]	65			65.755	215.731	0.4[illegible]		
	10	70.			65840	216.010	0.495		
	[illegible]	75			65.720	215.616	0.375		
	20	80			65765	215.764	0.420		
	25	85			65.740	215.682	0.395		
	30	90			65.705	215.567	0.360		
	35	95			65.765	215.764	0.420		
	[illegible]	100			65.805	215.895	0.460		
	[illegible]	105			65.740	215.682	0.395		
	[illegible]	110			65.785	215.830	0.440		
	[illegible]	115			65.740	215.682	0.395		
	11:00	120			65.780	215.813	0.435		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº ES 60
PAGE 2 OF ____
STATIC WATER LEVEL 65.345 m below m.p.
M.P. ABOVE GROUND LEVEL 0.775

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY. µ mhos /cm.	T TEMPERATURE °C.
14-12-83	10	130	410		65.850	216.141	0.535		
	20	140			65.870	216.108	0.525		
	[illegible]	150			65.800	215.879	0.455		
	[illegible]	160			65.800	215.979	[illegible]		
	[illegible]	170			65.825	215.961	0.480		
	12:00	180			65.780	215.813	0.435		
	[illegible]	200	420		65.752	215.721	0.407		
	[illegible]	220			65.757	215.738	0.412		
	13:00	240			65.773	215.790	0.428		
	20	260			65.875	216.125	0.53		
	40	280			65.813	215.921	0.468		
	14:00	300	+		65.820	215.944	0.475		
430	30	330	430		65.796	[illegible]	0.451		
	15:00	360			65.798	215.872	0.453		
	:30	390			65.815	215.926	0.470		
	16:00	420			65.729	215.646	0.384		
	:30	450			65.744	215.695	0.399		
	17:00	480			65.716	215.603	0.371		
	:30	510			65.712	215.590	0.367		
	18:00	540			65.714	215.597	0.369		
	:30	570			65.681	215.488	0.336		
	19:00	600	[illegible]		65.680	215.485	0.335		
	20:00	660			65.710	215.583	0.365		
	21:00	720			65.711	215.587	0.366		
	22:0	780			65.718	215.610	0.373		
	23:	840			65.731	215.652	0.386		
	24:	900			65.730	215.649	0.385		
15-12-83	01:00	960			65.733	215.662	[illegible]		
	02	1020			[illegible]	[illegible]	0.395		
	03:	1080			[illegible]	[illegible]	0.403		
	04:	1140			[illegible]	215.734	0.411		
	05:	1200			[illegible]	215.761	0.419		
	06:	1260			[illegible]	215.780	0.425		
	07:	1320			[illegible]	215.813	0.435		
	08:	1380			[illegible]	215.879	0.455		
	09:	1440			[illegible]	[illegible]	0.455		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº 65-60
PAGE 2 OF
STATIC WATER LEVEL 65.341 m below mp
M.P. ABOVE GROUND LEVEL 0.775

DATE	HOUR	time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY μ mohs /cm.	TEMPERATURE °C.
	11:00	1560	42U.		[illegible]	215.[illegible]	0.475		
	13:00	1680			65.[illegible]	215.902	0.462		
	15:00	1800			65.[illegible]	215.912	0.467		
	17:00	1920			65.811	215.915	0.466		
	19:	2040			65.[illegible]	215.[illegible]	[illegible].458		
	21:	2160			65.842	216.017	0.497		
	23:	2280			65.891	[illegible]	0.546		
16-12-83	01:00	2400			[illegible]	[illegible]	0.551		
	03:	2520			[illegible]	[illegible]	0.555		
	05:	2640			[illegible]	[illegible]	0.560		
	07:	2760			[illegible]	[illegible]	0.565		
	09:	2880			[illegible]	[illegible]	0.580		
	13:00	3120	[illegible]		[illegible]	[illegible]			
	17:00	3360			65.[illegible]	216.338	0.595		
	21:00	3600			65.950	216.394	[illegible].609		
17-12-83	01:00	3840			[illegible]	[illegible]			
	05:00	4080			[illegible]	[illegible]			
	09:00	4320			66.00	[illegible]	0.655		
			→		CADA	6 horas		por	2 dias
					CADA	12 horas		hrs [illegible]	el
					final	DE		LA	prueba
	15:00	~~5.040~~ 4680	c/6H		65.074	216.[illegible]	0.629	Nota:	
	21:00	~~5.760~~ 5040			[illegible]	[illegible]	EL	REGISTRO	EN
18-12-83	03:00	~~6.480~~ 5400			66.00	216.535	0.633 TAR	JETA DE	CONTROL
	09:00	~~6.840~~ 5760			66.[illegible]	216.[illegible]	ES	ARREGLAR.	
	15:00	~~7.200~~ 6120			[illegible]	216.591	0.672		
	21:00	~~7.560~~ 6480			[illegible]	216.627	0.681		
19-12-83	03:00	~~7.920~~ 6840			[illegible]	216.633	0.685		
	09:00	~~8.280~~ 7200			[illegible]	216.732			
	15:00	~~8.640~~ 7560							
	21:00	~~9.000~~ 7920							
20-12-83	03:00	~~9.360~~ 8280	[illegible]		[illegible]	216.830	0.745		
	15:00								

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº EJ-60
PAGE 4 OF ____
STATIC WATER LEVEL 65.345 m below m.p.
M.P. ABOVE GROUND LEVEL 0.775

DATE	HOUR	t time since pumping began, minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY µ mohs/cm.	T TEMPERATURE °C.
20-12-83	12:50	NOTA:	SE PARA TEST PUMP POR PROBLEMA DE GENERADOR:						
		DE 12:50 TO 13:35 SE HACE RECOVERY, ESTÁ EN HOJA APARTE.							
	13:35	NOTA:	SE REPARA GENERADOR SE HACE TEST PUMP						
c/1 minut	:36	~~9.996~~ 8880			65.791	215.849	0.446		
	:37	~~9.997~~			65.822	215.951	0.477		
	:38	9.998			65.826	215.964	0.481		
	:39	9.999			65.834	215.990	0.489		
	:40	10.000			65.843	216.020	0.498		
	:41	~~10.001~~			65.863	216.085	0.518		
	:42	10.002			65.870	216.108	0.525		
	:43	10.003			65.873	216.118	0.528		
	:44	10.004			65.881	216.145	0.536		
	:45	~~10.005~~			65.883	216.151	0.538		
c/5 mt	:50	10.010			65.891	216.177	0.536		
	:55	~~10.015~~			65.897	216.197	0.552		
	14:00	~~10.020~~ 8940			65.903	216.217	0.558		
c/10 minut	:10	~~10.030~~			65.912	216.246	0.567		
	:20	~~10.040~~			65.936	216.325	0.591		
	30	~~10.050~~			65.960	216.404	0.615		
c/15 minut	:45	10.065			65.974	216.450	0.627		
	15:00	~~10.080~~			65.998	216.528	0.653		
20-12-83	15:30	10.110			66.020	216.601	[illegible]		
	16:00	~~10.140~~ 9060			66.031	216.637	0.686		
	:30	~~10.170~~			66.044	216.679	0.699		
	17:00	~~10.200~~ 9120			66.035	216.650	0.690		
	:30	10.230			66.039	216.663	0.694		
c/1 Hora	18:00	10.260			66.042	216.673	[illegible]		
	19:00	~~10.320~~ 9240			66.051	216.702	0.706		
	20:00	10.380			66.069	216.761	0.715		
c/2 Hora	22:00	10.500			66.086	216.817	0.741		
	24:00	10.620 9540			66.096	216.850	0.751		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº ES-60
PAGE 5 OF
STATIC WATER LEVEL 65.345 m below m.p.
M.P. ABOVE GROUND LEVEL 0.775

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY. µ mohs /cm.	T TEMPERATURE °C.
21-12-83	02:00	10.740			66.095	216.857	0.750		
c/2 Hours	04:00	~~10.860~~ 9780			66.090	216.830	0.745		
	06:00	10.980			66.100	216.863	0.755		
	08:00	~~11.100~~ 10020			66.115	216.912	0.770		
	10:00	11.220			66.125	216.945	0.780		
	12:00	~~11.340~~ 10260			66.145	217.011	0.800		
	14:00	11.460			66.080	216.797	0.735		
	16:00	11.580			66.076	216.748			
	18:00	~~11.700~~ 10620			66.072	216.771			
	20:00	11.820			66.065	216.748			
	22:00	11.940			66.101	216.866			
	24:00	~~12.060~~ 10980			66.107	216.886	0.762	NOTA: A LAS 10 HRS.	
22-12-83	06:00	12.420			66.120	216.929		SE PARA GENERADOR	
	12:00	~~12.780~~ 11700			66.140	216.994		PARA REVISAR NIVELES	
	18:00	13.140			66.067	216.755		HASTA LAS 11 02 HRS	
	24:00	13.500			66.121	216.932	0.776		
23-12-83	06:00	~~13.860~~ 12780			66.160	217.060			
	12:00	14.220			66.072	216.771			
	18:00	14.580			66.124	216.942	0.779		
	24:00	~~14.940~~ 13820			66.163	217.070			
24-12-83	06:00	15.300			66.180	217.126			
	12:00	~~15.660~~ 14580			66.220	217.257	0.575		
	18:00	~~16.020~~ 14940			66.162	217.066			
	24:00	16.380			66.198	217.185			
25-12-83	12:00	17.100			66.240	217.322	0.895		
	24:00	17.820			66.198	217.185			
26-12-83	12:00	18.540			66.220	217.257	0.875		
	24:00	~~19.260~~ 18180			66.226	217.276			
27-12-83	12:00	19.980			66.227	217.280			
	24:00	20,700			66.250	217.355	0.905		
28-12-83	12:00	21.420			66.229	217.286			
	24:00	~~22.140~~ 21060			66.264	217.401	0.919		
29-12-83	12:00	22.860			66.280	217.454			
	24:00	23.580			66.282	217.460			
30-12-83	12:00	24.300			66.285	217.470	0.940		
	24:00	~~25.020~~ 23[illegible]			66.286	217.473			
31-12-83	12:00	25.740			66.291	217.[illegible]			

ESCONDIDA WATER PROGRAM
TEST WELL DATA
PUMP TEST

WELL Nº ES-CC
PAGE 6 OF ____
STATIC WATER LEVEL 65.345 m below mp
M.P. ABOVE GROUND LEVEL 0.775

DATE	HOUR	t time since pumping began. minutes	Gal x 1000	Q gpm	WATER LEVEL below mp meters	WATER LEVEL below mp feet	DRAW DOWN METERS	CONDUCTIVITY µ mohs /cm.	T TEMPERATURE °C.
31.12.83	24:00	26.460			66.326	217.604			
1.1.84	12:00	27.180			66.323	217.595			
	24:00	~~27.900~~ 26.82[illegible]			66.328	217.611			
2.1.84	12:00	28.620			66.318	217.578			
	24:00	29.340			66.320	217.583		4.1.87	
3.1.84	12:00	30.060			66.360	217.716	1.015 [illegible]	PARA GENERADOR	
	24:00	30.780 [illegible]			66.369	217.746		PARA MANTENCION [illegible]	
4.1.84	12:00	31.500			66.373	217.759	LAS	15:23 A 16:28	
	24:00	32.220			66.451	218.015	1.106		
5.1.84	12:00	~~32.940~~ 31.860			66.374	217.762			
	24:00	33.660			66.397	217.837			
6.1.84	12:00	34.380			66.395	217.831			
	24:00	35.100			66.400	217.847	1.055		
7.1.84	12:00	~~35.820~~ 347:0			66.407	217.870			
	24:00	36.540			66.450	218.011			
8.1.84	12:00	37.260			66.415	217.896			
	24:00	37.980			66.460	217.979	1.095		
9.1.84	12:00	~~38.700~~ 37620			66.410	217.880			
	24:00	39.420			66.450	218.011			
10.1.84	12:00	40.140			66.428	217.939			
	24:00	40.860			66.450	217.939	1.105		
11.1.84	12:00	~~41.580~~ 405[illegible]			66.444	217.992			
	24:00	42.300			66.470	218.077			
12.1.84	12:00	~~43.020~~ 41940			66.480	218.110			
	24:00	42.780			66.490	218.143			
13.1.84	09:00	44.280 43.7[illegible]			66.490	218.143	STOP	TEST.	
							1.145		

ESCONDIDA WATER PROGRAM
TEST WELL DATA
RECOVERY FRIDAY – 13-1-84.

WELL Nº. ES ES-60
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65.345

HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN METERS
13/1/84 09:00	43200	0	–	66 490		1.145
01	43201	1	43201	66 475		1.130
02	43202	2	21601	66 474		1.129
03	43203	3	14401	66 470		1.125
04	43204	4	10801	66 45[illegible]		1.114
05	43205	5	8641	66. 440		
06	43206	6	7201	66. 4[illegible]		
07	43207	7	6172	66, 420		1.075
08	43208	8	5401	[illegible] 41[illegible]		1.074
09	43209	9	4801	66 410		1.065
09:10	43210	10	4321	66, 400		1.055
12	43212	12	3601	66, 385		1.04
14	43214	14	3087	66. 370		1.025
16	43216	16	2701	66, 360		1.015
18	43218	18	2401	66. 345		1.000
20	43220	20	2161	66, 340		0.995
22	43222	22	1965	66, 335		0.990
24	43224	24	1801	66, 322		0.977
26	43226	26	1663	66. 310		0.965
28	43228	28	1544	66. 300		0.955
30	43230	30	1441	66 295		0.950
32	43232	32	1351	66. 287		0.942
34	43234	34	1272	66 280		0.935
36	43236	36	1201	66, 275		0.930
38	43238	38	1138	66. 2[illegible]		0.921
09:40	43240	40	1081	66. 2[illegible]		0.915
44	43244	44	983	66 255		0.910
48	43248	48	901	66. 249		0.904
52	43252	52	832	66, 240		0.895
56	43256	56	772	66 235		0.890
10:00	43260	60	721	66, 225		0.880
05	43265	65	657	66, 215		0.870
10	43270	70	618	66. 219		0.874
15	43275	75	577	66. 211		0.866
20	43280	80	541	66 [illegible]55		0.840
25	43285	85	509	66 1[illegible]		0.835
30	43290	90	481	66 175		0.830

ESCONDIDA WATER PROGRAM
TEST WELL DATA
.RECOVERY

WELL Nº. ES: ES-60
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HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters		RESIDUAL DRAW DOWN METERS
10:35	43295	95	456	66 177	0.832	
40	43300	100	433	66 164	0-821	
45	43305	105	412	66.160	0.815	
50	43310	110	394	66 157	0.812	
55	43315	115	377	66 150	0.805	
11:00	43320	120	361	66, 141	0.796	
10	43330	130	333	66, 138	0.793	
20	43340	140	310	66, 120	0.775	
30	43350	150	289	66, 115	0.770	
40	43360	160	271	66 100	0.755	
50	43370	170	255	66 095	0.750	
12:00	43380	180	241	66, 090	0.745	
20	43400	200	217	66, 085	0.740	
40	43420	220	197	66 080	0.735	
13:00	43440	240	181	66.060	0.715	
20	43460	260	167	66 040	0.695	
40	43480	280	155	66. 022	0.677	
14:00	43500	300	145	66, 030	0.685	
20	43520	320	136	66.009	0.664	
40	43540	340	128	66.000	0.655	
15:00	43560	360	121	65, 999	0.654	
20	43580	380	115	65, 980	0.635	
40	43600	400	109	65, 970	0.625	
16:00	43620	420	104	65, 962	0.616	
20	43640	440	99	65 950	0.605	
40	43660	460	95	65 949	0.604	
17:00	43680	480	91	65, 940	0.595	
20	43700	500	87	65, 928	0.583	
40	43720	520	84	65, 925	0.580	
18:00	43740	540	81	65, 910	0.565	
30	43770	570	77	65, 904	0.559	
19:00	43800	600	73	65. 895	0.550	
30	43830	630	70	65 892	0.547	
20:00	43860	660	66	65.880	0.535	
21:00	43920	720	61	65.883	0-538	
22:00	43980	780	56	65 871	0.526	
23:00	44040	840	52	65 862	0.517	

ESCONDIDA WATER PROGRAM

TEST WELL DATA

RECOVERY

WELL Nº. ES: 60

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	HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN METERS
	24:00	44100	900	49	65 852		0.507
1/84	01:00	44160	960	46	65 840		0.495
	02:00	44220	1020	43	65 818		0.473
	03:00	44280	1080	41	65.793		0.448
	04:00	44340	1140	39	65 781		0.436
	05:00	44400	1200	37	65.772		0.427
	06:00	44460	1260	35	65.760		0.415
	07:00	44520	1320	34	65 758		0.413
	08:00	44580	1380	32	65. 758		0.413
	09:00	1er DIA 44640	1440	31	65 755		0.410
	11:00	44760	1560	29	65.731		0.386
	13:00	44880	1680	27	65,714		0.369
	15:00	45000	1800	25	65,710		0.365
	17:00	45120	1920	24	65,670		0.325
	19:00	45240	2040	22	65,650		0.305
	21:00	45360	2160	21	65,650		0.305
	23:00	45480	2280	20	65 650		0.305
1/1/84	01:00	45600	2400	19	65,650		0.305
	03:00	45720	2520	18	65,620		0.275
	05:00	45840	2640	17	65,611		0.266
	07:00	45960	2760	17	65,580		0.235
	09:00	2do DIA 46080	2880	16	65,573		0.228
	13:00	46320	3120	15	65571		0.226
	17:00	46560	3360	14	65.570		0.225
	21:00	46800	3600	13	65.539		0.194
	01:00	47040	3840	12	65,528		0.183
	05:00	47280	4080	12	65 519		0.174
	09:00	3er DIA 47520	4320	11			
	15:00	47880	4680	10	65,508		0.163
	21:00	48240	5040	9.6	65,485		0.140
1/84	03:00	48480	5400	9.0	65,467		0.122
	09:00	4to DIA 48840	5760	8.5	65,441		0.096
	15:00	49200	6120	8.0	65,420		0.075
	21:00	49560	6480	7.6	65 419		0.074

TEST WELL DATA

WELL No. ES. [illegible]

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RECOVERY

Date	HOUR	t time since pumping began. minutes	t' time since pumping stopped. minutes	t/t' ratio	WATER LEVEL below mp meters	WATER LEVEL below mp feet	RESIDUAL DRAW DOWN METERS
8/1/84	03:00	~~6840~~ 50040	6840	7.3	65.410	214.599	.065
	09:00	~~7200~~ 50400	7200	7.0	65.400	214.5[illegible]	0.055
	15:00	~~[illegible]~~ 50,760	7560	6.7	65.395	214.550	0.050
	21:00	~~7[illegible]~~ 51120	7920	6.5	65.391	214.537	0.046
10/1/84	03:00	~~8[illegible]~~ 52480	8280	6.2	65.388	214.5[illegible]	0.043
	09:00	~~8[illegible]~~ 51840	8640	6.0	65.383	214.511	0.038
	15:00	~~8[illegible]~~ 52200	9000	5.8	65.381	214.504	0.036
	21:00	~~[illegible]~~ 52560	9360	5.6	[illegible]	[illegible].488	0.031
2[illegible]	[illegible]	~~[illegible]~~ 52920	9720	5.4	65.[illegible]81	[illegible].504	0.036
	15:00	~~10[illegible]~~ 53640	10440	5.1	65.376	214.[illegible]	0.029
[illegible]	[illegible]	~~11[illegible]~~ 54360	11160	4.9	65.361	[illegible].438	0.016
	[illegible]	~~11[illegible]~~ 55280	11880	4.6	65.352	[illegible]	0.008
[illegible]	[illegible]	~~12[illegible]~~ 56800	12600	4.4	[illegible] 350	214.[illegible]	0.005
	[illegible]	~~13[illegible]~~ 56520	13 320	4.2	[illegible]	214.[illegible]	—
23/1/84	[illegible]	~~[illegible]~~ 57240	14040	4.1	65.340	[illegible]	—
	[illegible]	~~[illegible]~~ 57960	14760	3.9	[illegible]33[illegible]	[illegible]	—

STOP RECOVERY

T-4

Date	Conductivity Micro mho cm-25°C	Resistivity ohm-cm 25°C
12 Dec. 1983	2277	439
14 "	2277	439
15 "	2288	437
16 "	2301	434
17 "	2281	438
18 "	2272	440
19 "	2277	439

Samples taken during production pump test.

Water temperature = 21°C

Conductividad eléctrica de muestras de agua en sondajes

Sondaje T-4

Fecha	Conductividad en micromho cm a 25°C	Resistividad en ohm cm a 25°C
Dic. 21, 1983•	2230	448,4
Dic. 22, 1983	2230	448,4
Dic. 23, 1983	2240	446,4
Dic. 24, 1983	2250	444,4
Dic. 25, 1983•	2280	438,6
Dic. 26, 1983	2270	440,5
Dic. 27, 1983•	2300	434,8
Dic. 28, 1983	2300	434,8
Dic. 29, 1983	2290	436,7
Dic. 30, 1983•	2300	434,8
Dic. 31, 1983	2290	436,7
Ene. 01, 1984•	2310	432,9
Ene. 02, 1984	2290	436,7
Ene. 03, 1984•	2300	434,8
Ene. 04, 1984	2300	434,8
Ene. 05, 1984•	2300	434,8
Ene. 06, 1984	2310	432,9
Ene. 07, 1984•	2310	432,9

Conductividad promedio en micromho cm a 25°C = 2.283.3 ± 27.4
2.283.3 ± 0,01%).

Resistividad promedio en ohm cm a 25°C = 438,0 ± 5,3
(438,0 ± 0,01%).

Temperatura del agua durante prueba de producción = 22°C

•Muestras a U.S.A.