Well #2 Chilson Southwest of Burdock

Q=extraction rate gpm (rate from historic records was higher than SEO allows without water rights permit so using default max from SEO)			25,920	gpd	3465.01152 ft^3/day	18 gpm
from 1930 to 2047 tx(days)=	43100	App B Part 1 p. 13 of pdf; Table 1:constructed 1930s;				
b screened interval	63	Notice of Well Construction				
Min porosity (n)=						
Max porosity (n) =	0.319					
hydraulic gradient (i)	0.00316	ft/ft	Tech Memo Fig 4			
min transmissivity T	150	ft^2/day	KP Chilson Burdock	p. 39 App J pdf		
max transmissivity T	190	ft^2/day	TVA Chilson Burdock	p. 21 App J pdf		
Z=Q/2πKbi			Z=	1164.037	T min (B9)	
KB=T Z=Q/2πTi			Z=	918.976	T max (B10)	

$$t_x = n/Ki\,[r_x - (Q/2\pi Kbi)\ln\{1 + (2\pi Kbi/Q)r_x\}] \quad (4\text{-}7)$$

where
t_x = travel time from point x to a pumping well
n = porosity
r_x = distance over which ground water travels in T_x, r_x is positive (+) if the point is upgradient, and negative (–) is downgradient

Q = discharge
K = hydraulic conductivity
b = aquifer thickness
I = hydraulic gradient

tx = n/Ki[rx-Z*LN{1 + rx/z}]
tx = (n/((T/b)*i))[rx-Z*LN{1 + rx/z}]

adjust the values in red so numbers in purple cells in column D match the number in cell shaded same color in column F	n/((T/b)*i)	n min, Tmin	39.342	tx/(n/((T/b)*i))	1095.528
	n/((T/b)*i)	n max,Tmin	42.399	tx/(n/((T/b)*i))	1016.540
	n/((T/b)*i)	n min,Tmax	31.059	tx/(n/((T/b)*i))	1387.668
	n/((T/b)*i)	n max, Tmax	33.473	tx/(n/((T/b)*i))	1287.617

[rx-Z*LN{1 + rx/z}]

rx=	2398		1096.096	T min (D11)	n min match F16
rx=	2279		1016.649	T min (D11)	n max match F17
rx=	2630	max	1388.321	T max (D12)	n min match F18
rx=	2494		1288.230	T max (D12)	n max match F19

well is 4,600 downgradient from B-WF2

using the distance from the AE boundary as rx, solved for tx

tx= n/Ki[rx-Z*LN{1 + rx/z}]
tx = (n/((T/b)i))*[rx-Z*LN{1 + rx/z}]

rx= 4600

for T min tx =	107711.4392	days	295.0998333 years
for T max tx =	91704.51346		251.2452424 years

Y max calculation

$Y_{max} = \pm Q/2bKi$

$Y_{max} = \pm Q/2Ti$

Y_{max}=	3655.075443	ft	T min
Y_{max}=	2885.585876	ft	T max

stagnation point (X_0)=	-Q/2πTi	-1164.036765	ft with Tmin (B9)
		-918.9763937	ft with Tmax (B10)

Well #7 Fall River South of Burdock

Q=extraction rate gpm — 6120 gpd — 818.1277 ft^3/day — 4.25 gpm

when well was new through 2047 tx (days) = 32873

b=aquifer thickness (Fall River) — 186 ft — from oil and gas test well API 4004705093

porosity (n)= 0.29

hydraulic gradient (i) 0.00308 ft/ft Tech Memo Fig 5

min Transmissivity T 54 ft^2/day TVA Fall River Burdock

max Transmissivity T 255 ft^2/day KP Fall River Dewey

Z=Q/2πKbi KB=T

Z=Q/2πTi

Z= 783.280 T min

Z= 165.871 T max

adjust the values in red so numbers in purple cells in column D match the number in cell shaded same color in column F

K=T/b

n/Ki	n/[(T/b)*i]	324.315	tx/{n/[(T/b)*i]}	101.361	T min
n/Ki	n/[(T/b)*i]	68.678	tx/{n/[(T/b)*i]}	478.651	T max

rx-Z*LN{1 + rx/z}

T min rx= 469 — 101.461 match F14 — T min

T max rx= 765 max — 478.887 match F15 — T max

Y max calculation — well is 4,750 ft crossgradient from B-WF2

$Y_{max} = \pm Q/2bKi$

$Y_{max} = \pm Q/2Ti$

Y_{max}= 2459.498918 ft T min — 0.465814189 miles

Y_{max}= 520.8350649 ft T max

using the distance from the AE boundary as rx, solved for tx

tx= n/Ki[rx-Z*LN{1 + rx/z}]

rx= N/A cross-gradient and width of capture zone will never increase greater than 2460'

stagnation point (X_0)= -Q/2πTi -783.27991 ft with Tmin (B8)

-165.87104 ft with Tmax (B9)

$$t_x = n/K_I\,[r_x - (Q/2\pi Kb_I)\ln\{1 + (2\pi Kb_I/Q)r_x\}] \quad (4\text{-}7)$$

where

t_x = travel time from point x to a pumping well

n = porosity

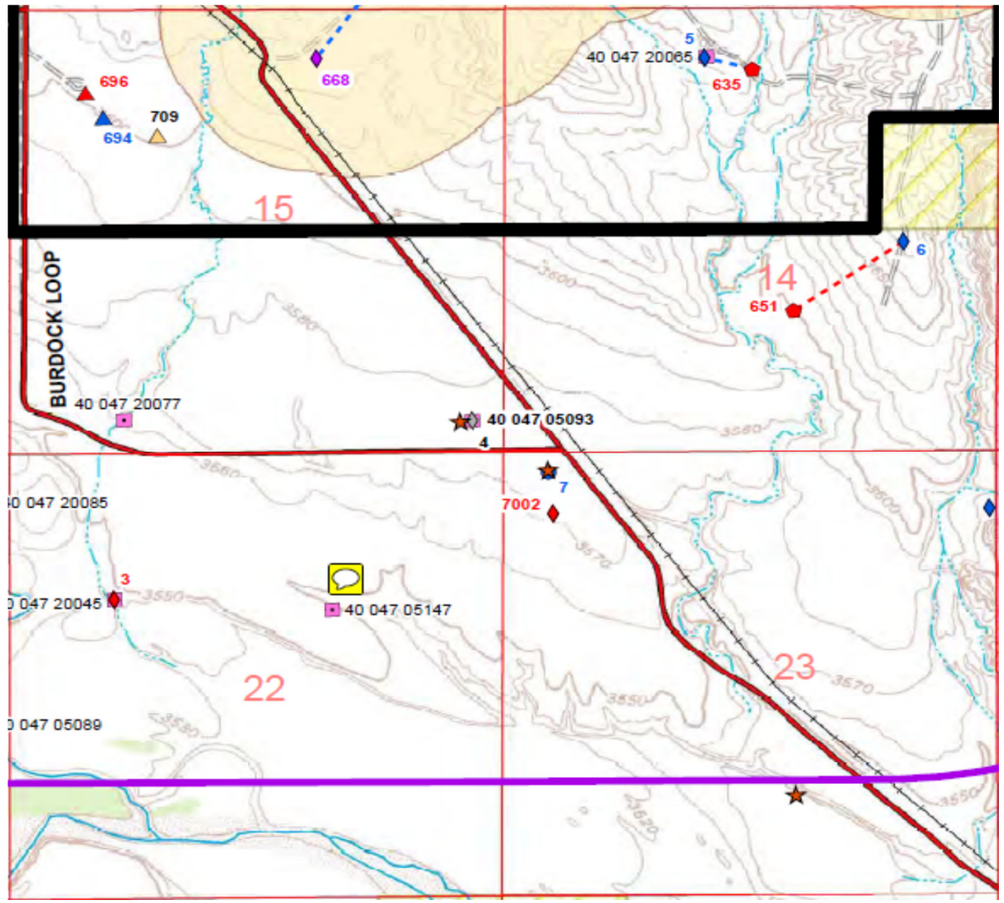
r_x = distance over which ground water travels in T_x, r_x is positive (+) if the point is upgradient, and negative (–) is downgradient

Q = discharge

K = hydraulic conductivity

b = aquifer thickness

I = hydraulic gradient



Well #8 Fall River South of Burdock

Q=extraction rate gpm			3600 gpd	481.2516 ft^3/day	2.5 gpm
through 2047 tx (days) =	43100				
b=aquifer thickness (Fall River)			20 ft	perforations from well repair form	
porosity (n)=	0.29				
hydraulic gradient (i)	0.00364	ft/ft	Tech Memo Fig 5		
min Transmissivity T	54	ft^2/day	TVA Fall River Burdock		
max Transmissivity T	255	ft^2/day	KP Fall River Dewey		
Z=Q/2πKbi					
Z=Q/2πTi			Z= 389.8678286	T min (B6)	
			Z= 82.560	T max (B7)	

adjust the values in red so numbers in purple cells in column D match the number in cell shaded same color in column F

tx = n/Ki[rx-Z*LN{1 + rx/z}]

tx =(n/((T/b)*i))*[rx-Z*LN{1 + rx/z}]

n/((T/b)*i)	29.508	tx/(n/((T/b)i))	1460.644	T min
n/((T/b)*i)	6.249	tx/(n/((T/b)i))	6897.486	T max

rx-Z*LN{1 + rx/z}

T min rx=	2199	1460.915	match F14
T max rx=	7269 max	6898.376	match F15

Y max calculation			well is 9,625 ft crossgradient from B-WF2		
Y_{max} =± Q/2bKi	Ymax=	1224.184982	ft T min	0.231853216	miles
Ymax =+ Q/2Ti	Ymax=	259.2391726	ft T max		

using the distance from the AE boundary as rx, solved for tx

tx= n/Ki[rx-Z*LN{1 + rx/z}]

rx= N/A cross-gradient and width of capture zone will never increase greater than 1224'

stagnation point (X_0)=	-Q/2πTi	-389.8678286	ft with Tmin (B6)
		-82.56024605	ft with Tmax (B7)

Well #13 Chilson Burdock

Q=extraction rate gpm when well was new through 2047 tx(days)=	35795		1440 gpd	192.50064 ft^3/day	1 gpm
b=Min aquifer thickness (Chilson)			45 ft	Notice of Well Construction	
b=Max aquifer thickness (Chilson)			145 ft	Plate 6.7 Chilson Isopach Map	
Min porosity (n)=	0.296				
Max porosity (n) =	0.319				
hydraulic gradient (i)	0.00215 ft/ft		Tech Memo Fig 6		
minimum Transmissivity (T)	150 ft^2/day		KP Chilson Burdock		
maximumTransmissivity (T)	190 ft^2/day		TVA Chilson Burdock		
Z=Q/2πKbi		Z=	95.048 T min (B8)		
Z=Q/2πTi		Z=	75.038 T max (B9))		

tx =(n/((T/b)*i))*[rx-Z*LN{1 + rx/z}]

	n/((T/b)i)	n min (B5), Tmin (B8), b min (D3)	41.302	tx/(n/((T/b)i))	866.658
	n/((T/b)i)	n min (B5), Tmin (B8), b max (D4)	133.085	tx/(n/((T/b)i))	268.963
adjust the values in red so numbers	n/((T/b)i)	n min (B5), Tmax (B9), b min (D3)	32.607	tx/(n/((T/b)i))	1097.767
in purple cells in column D match	n/((T/b)i)	n min (B5), Tmax (B8), b max (D4)	105.067	tx/(n/((T/b)i))	340.686
the number in cell shaded same	n/((T/b)i)	n max (B6),Tmin (B8), b min (D3)	44.512	tx/(n/((T/b)i))	804.172
color in column F	n/((T/b)i)	n max (B6),Tmin (B8), b max (D4)	143.426	tx/(n/((T/b)i))	249.571
	n/((T/b)i)	n max (B6), Tmax (B9), b min (D3)	35.141	tx/(n/((T/b)i))	1018.618
	n/((T/b)i)	n max (B6), Tmax (B9), b max (D4)	113.231	tx/(n/((T/b)i))	316.123

rx-Z*LN{1 + rx/z}

rx=	1108	866.746	n min, T min, b min	use D10 in equation; match number at F14
rx=	432	269.191	n min, T min, b max	use D10 in equation; match number at F15
rx=	1317 max value	1097.850	n min, T max, b min	use D10 in equation; match number at F16
rx=	493	341.109	n min, T max, b max	use D11 in equation; match number at F17
rx=	1040	804.276	n max, T min, b min	use D11 in equation; match number at F18
rx=	408	249.621	n max, T min, b max	use D11 in equation; match number at F19
rx=	1234	1019.463	n max, T max, b min	use D11 in equation; match number at F20
rx=	465	316.902	n max, T max, b max	use D11 in equation; match number at F21

well is 1,750 ft downgradient from B-WF10

Y max calculation

Y_{max} =± Q/2bKi	Ymax=	298.4506047	ft with Tmin (B8)	0.056524736	miles
Ymax =+ Q/2Ti	Ymax=	235.6188984	ft with Tmax (B9)	0.044624791	miles

stagnation point (X_0)=	-Q/2πTi	-95.04796326	ft with Tmin (B8)
		-75.03786574	ft with Tmax (B9)

Well #16 Chilson Burdock

Q=extraction rate gpm (rate from historic records was higher than SEO allows without water rights permit so using default max from SEO)			25,920 gpd	3465.01152 ft^3/day	18 gpm
tx(days)=	no well age was needed for the Ymax calculation	App B Part 1 p. 14 of pdf; Table 1:constructed mid 1970s			
Min porosity (n)=	0.296				
Max porosity (n) =	0.319				
hydraulic gradient (i)	0.00215 ft/ft		Tech Memo Fig 6		
minimum Transmissivity (T)	150 ft^2/day		KP Chilson Burdock		
maximumTransmissivity (T)	190 ft^2/day		TVA Chilson Burdock		

$Y_{max} = \pm Q/2bKi$

$Ymax = + Q/2Ti$

Ymax=	39.0204	ft with Tmin (B9); n min (B6)	0.007390227	miles
Ymax=	36.20701693	ft with Tmin (B9); n max (B7)	0.00685739	miles
Ymax=	30.80557895	ft with Tmax (B10); n min (B6)	0.00583439	miles
Ymax=	28.58448705	ft with Tmax (B10); n max (B7)	0.005413729	miles

Well #18 Fall River West of Burdock

Q=extraction rate gpm		11520 gpd	1540.005 ft^3/day	8	
through 2047 tx (days) =	43100				
b=aquifer thickness (Fall River)		128 ft	Plate 6.9 Fall River Isopach Map		
porosity (n)=	0.29				
hydraulic gradient (i)	0.00364 ft/ft	Tech Memo Fig 7			
min Transmissivity T	54 ft^2/day	TVA Fall River Burdock			
max Transmissivity T	255 ft^2/day	KP Fall River Dewey			
Z=Q/2πKbi					
Z=Q/2πTi		Z= 1247.577 T min			
		Z= 264.193 T max			
		tx = n/Ki[rx-Z*LN{1 + rx/z}]			
		tx = (n/((T/b)*i))*[rx-Z*LN{1 + rx/z}]			

adjust the values in red so numbers in purple cells in column D match the number in cell shaded same color in column F

		n/Ki=n/((T/b)i)	188.848	tx/(n/Ki)=tx/(n/((T/b)*i))	228.226 T min
		n/Ki=n/((T/b)i)	39.991	tx/(n/Ki)=tx/(n/((T/b)*i))	1077.732 T max
			rx-Z*LN{1 + rx/z}		
T min rx=	914		228.288 match F15		
T max rx=	1593		1077.786 match F16		

well is 7,880 downgradient from B-WF4

Y max calculation				
Ymax =± Q/2bKi				
Ymax =+ Q/2Ti	T min Ymax=	3917.391941 ft		0.741930292 miles
	T max Ymax=	829.5653523 ft		

using the distance from the AE boundary as rx, solved for tx

rx= 7880

tx= n/Ki[rx-Z*LN{1 + rx/z}]

tx = (n/((T/b)i))*[rx-(Z*LN{1 + (rx/z)})]

T min tx =	1019251.576 days	2792.47 years	
T min tx =	278909.7455 days	764.1363	

stagnation point (X_0)=	-Q/2πTi	-1247.577051	ft with Tmin (B6)
		-264.1927874	ft with Tmax (B7)

Wells #40 and #4002 Inyan Kara Dewey

these two wells are very close together, so they are being treated as 1 well pumping at 2,880 + 25,920 gpd

when well was new — 28800 gpd — 3850.013 ft^3/day

through 2047 tx (days) = 39,448.0 — used age of 4002 which is the older well constructed in 1940

b=aquifer thickness (Fall River) — 150 ft — Plate 6.9 Fall River isopach map

porosity (n)= 0.29

hydraulic gradient (i) — 0.00364 ft/ft — Tech Memo Fig 8

Transmissivity (T) — 255 ft^2/day — Using T from Fall River (KP Dewey) because historic records indicate the wells are 660 and 680 feet deep. Top of Chilson in that area is 734'

Z=Q/2πTi — Z= 660.482

T/b=K Z=Q/2πTi

$$t_x = n/Ki\ [r_x - (Q/2\pi Kbi)\ln\{1 + (2\pi Kbi/Q)r_x\}] \quad (4\text{-}7)$$

where
t_x = travel time from point x to a pumping well
n = porosity
r_x = distance over which ground water travels in T_x, r_x is positive (+) if the point is upgradient, and negative (–) is downgradient

Z=Q/2πKbi 1/Z=2πKbi/Q
T/b=K
Z=Q/2πTi 1/Z=2πTi/Q

adjust the values in red so numbers in purple cells in column D match the number in cell shaded same color in column F

n/Ki — n/((T/b)*i) — 46.865 — tx/(n/((T/b)*i)) — 841.739

rx= 1677 — 842.243

Y max calculation

$Y_{max} = \pm Q/2bKi$

Ymax = ±Q/2Ti — Ymax= 2073.913381 ft — 0.392786625 miles

The closest well 4002 is 2,125 feet away from D-WF2 cross-gradient

stagnation point (X_0)= -Q/2πTi -660.4819684

Well #41 Fall River Dewey

pumping rate from Source B = 12 gpm

when well was new			17,280 gpd	2310.01 ft^3/day	12
through 2047 tx (days) =	43,100		no info so use 1930		
b=aquifer thickness (Fall River)				from Fall River isopach map	
from Hydro ID 2 well completion form			165 ft	Plate 6.9	
porosity (n)=	0.29				
hydraulic gradient (i)	0.00421 ft/ft		Tech Memo Fig 9		
Transmissivity (T)	255 ft^2/day		KP Fall River Dewey		
Z=Q/2πTi		Z=	342.635		

T/b=K Z=Q/2πTi

adjust the values in red so numbers in purple cells in column D match the number in cell shaded same color in column F

n/Ki	n/((T/b)*i)	44.572	tx/(n/((T/b)	966.980
rx=	1554	967.693		

well is 2,750 downgradient from D-WF1

Y max calculation

$Y_{max} = \pm Q/2bKi$

Ymax =±Q/2Ti	Ymax=	1075.873355	ft	0.203764 miles

Well 41 is 3,300 feet away from D-WF1 cross-gradient

stagnation point (X_0)=	-Q/2πTi	-342.6348264

Well #41 Chilson Dewey

pumping rate from Source B = 12 gpm			12	gpm	
Q=extraction rate gpm					
when well was new			17,280	gpd	2310.008 ft^3/day
from 1930 to 2047		no information so use construction date of			
tx(days)=	43,100	oldest well in the area.			
b=Max aquifer thickness (Chilson)			140	Plate 6.7 Chilson isopach map (see Slide 20)	
Min porosity (n)=	0.296				
Max porosity (n) =	0.319				
hydraulic gradient (i)	0.00631	ft/ft		Tech Memo Fig 10	
Transmissivity (T)	590	ft^2/day	TVA Dewey Chilson		

Z=Q/2πKbi
Z=Q/2pTi Z= 98.804

n/Ki K=T/b	n/((T/b)*i)		tx = n/Ki[rx-Z*LN{1 + rx/z}]		
adjust the values in red	n/((T/b)*i)	n min (B6)	11.131	tx/(n/Ki)=t›	3872.032
so numbers in purple	n/((T/b)*i)	n max (B7)	11.996	tx/(n/Ki)=t›	3592.857
cells in column D					
match the number in		well is 3,000 ft downgradient from D-WFs 2&4			
rx=	4246	max	3872.167	n min	
rx=	3696		3593.548	n max	

Y max calculation			
Ymax =+ Q/2bKi			
Ymax =+ Q/2Ti	Ymax=	310.2430471	ft

stagnation point (X_0)=	-Q/2πTi	-98.80351818	ft

Wells #42 and #704 Chilson Dewey

these two wells are very close together, so they are being treated as 1 well pumping at 2 x 25,920 gpd

when well was new			51840	gpd	6930.02304 ft^3/day
		used age of well 42 which			
through 2047 tx(days)=	36,160	is the older well			
b=Max aquifer thickness (Chilson)			150	Plate 6.7 Chilson isopach map (see Slide 20)	
Min porosity (n)=	0.296				
Max porosity (n) =	0.319				
hydraulic gradient (i)	0.00646	ft/ft	Tech Memo Fig 11		
Transmissivity (T)	590	ft^2/day	TVA Chilson Dewey		

$$t_x = n/Ki\ [r_x - (Q/2\pi Kbi)\ln\{1 + (2\pi Kbi/Q)r_x\}] \quad (4\text{-}7)$$

where
t_x = travel time from point x to a pumping well
n = porosity
r_x = distance over which ground water travels in T_x, r_x is positive (+) if the point is upgradient, and negative (–) is downgradient

Q = discharge
K = hydraulic conductivity
b = aquifer thickness
I = hydraulic gradient

Z=Q/2πKbi
Z=Q/2pTi Z= 289.528

n/Ki K=T/b	n/((T/b)*i)		tx = n/Ki[rx-Z*LN{1 + rx/z}]		
adjust the values in red so	n/((T/b)*i)	n min (B6)	11.649	tx/(n/Ki)=tx/(n/((T/b)*i))	3104.059
numbers in purple cells in	n/((T/b)*i)	n max (B7)	12.554	tx/(n/Ki)=tx/(n/((T/b)*i)	2880.255
column D match the					
number in cell shaded					
rx=	3877	max	3104.949	n min	
rx=	3073		2781.020	n max	

wells are 4,800 downgradient from D-WF4

Y max calculation				
Ymax =+ Q/2bKi				
Ymax =+ Q/2Ti	Ymax=	909.1177835	ft	0.172181398 miles

stagnation point (X_0)=	-Q/2πTi	-289.5279565	ft

Well #43 Chilson Burdock

						s	
when well was new			25920	gpd	3465.01152	ft^3/day	18
through 2047 tx(days)=	43100						
b=aquifer thickness (Chilson)			145	ft	Plate 6.7 Chilson isopach		
Min porosity (n)=	0.296						
Max porosity (n) =	0.319						
hydraulic gradient (i)	0.00237	ft/ft	Tech Memo Fig 6				
minimum Transmissivity (T)	150	ft^2/day	KP Chilson Burdock				
maximum Transmissivity (T)	190	ft^2/day	TVA Chilson Burdock				
Z=Q/2πKbi		Z=	1552.049	T min (B7)			
Z=Q/2πTi		Z=	1225.302	T max (B8)			

tx = n/Ki[rx-Z*LN{1 + rx/z}]

adjust the values in red so	n/((T/b)i)	n min, Tmin	120.731	tx/(n/((T/b)i))	356.991
numbers in purple cells in column	n/((T/b)i)	n max, Tmin	130.113	tx/(n/((T/b)i))	331.252
D match the number in cell	n/((T/b)i)	n min, Tmax	95.314	tx/(n/((T/b)i))	452.188
shaded same color in column F	n/((T/b)i)	n max, Tmax	102.720	tx/(n/((T/b)i))	419.586

rx=	1303		357.006	n min, T min (D9)	match F14
rx=	1246		331.306	n max, T min (D9)	match F15
rx=	1374	max	452.505	n min, T max (D10)	match F16
rx=	1312		420.086	n max, T max (D10)	match F17

Y max calculation						
$Y_{max} = \pm$ Q/2bKi	Ymax=	4873.433924	ft with Tmin (B7)	0.922998849	miles	
Ymax =+ Q/2Ti	Ymax=	3847.447835	ft with Tmax (B8)	0.728683302	miles	
stagnation point (X_0)=	-Q/2πTi	-1552.04902	ft with Tmin (B7)			
		-1225.301858	ft with Tmax (B8)			