DOCKETED

Docket Number:	21-AFC-02
Project Title:	Gem Energy Storage Center
TN #:	242794
Document Title:	AttDA515-1_Groundwater Drawdown
Description:	N/A
Filer:	Elizabeth Diaz
Organization:	Golder Associates
Submitter Role:	Applicant Consultant
Submission Date:	4/25/2022 3:13:32 PM
Docketed Date:	4/25/2022

TECHNICAL MEMORANDUM

DATE April 22, 2022 **Reference No.** R1

TO Nyree Grimes
Hydrostor, Inc.

CC David Stein, Peter Masson

FROM George Wegmann, CHG; Michael Bombard, CHG **EMAIL george.wegmann@wsp.com**

GROUNDWATER DRAWDOWN ASSESSMENT GESC

Golder Associates USA Inc. (Golder) prepared this technical memorandum (memo) to address comments from the California Energy Commission (CEC) regarding the amount of potential drawdown from using onsite groundwater supply for the Gem Energy Storage Center (GESC). Information requested by CEC Staff is stated below:

> If the project will pump groundwater, an estimation of aquifer drawdown based on a computer modeling study shall be conducted by a professional geologist and include the estimated drawdown on neighboring wells within 0.5 mile of the proposed well(s), any effects on the migration of groundwater contaminants, and the likelihood of any changes in existing physical or chemical conditions of groundwater resources shall be provided.

A Golder California Certified Hydrogeologist modeled the effects of pumping groundwater on drawdown on neighboring wells and potential migration of groundwater contaminants. The estimates were based on established hydrogeological principles and the US Environmental Protection Agency (USEPA) document titled: *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems*, dated January 2008 (EPA, 2008).

1.0 BACKGROUND

GESC is in the Antelope Valley Groundwater Basin (AVGB) of the South Lahontan Hydrologic Region. The AVGB is designated Basin Number 6-44 and covers a surface area of approximately 1,580 square miles in Los Angeles, Kern, and San Bernardino counties (California Department of Water Resources 2004, 2016). The primary water-bearing materials are Pleistocene and Holocene age unconsolidated alluvial and lacustrine deposits that consist of compact gravels, sand, silt, and clay (California Department of Water Resources 2004, 2016). Coarse alluvial deposits form the two main aquifers of the basin: a lower aquifer and an upper aquifer. Clay deposits form a zone of low permeability between the permeable alluvium of the upper aquifer and that of the lower aquifer, although leakage between the two aquifers may occur (Planert and Williams 1995). Generally, the consolidated material (bedrock) has little permeability and is not a viable source for production wells.

1.1 Water Usage

During construction and the initial filling of the surface compensation reservoir, GESC will require approximately 1,115 acre-feet (AF) of water over 60 months. Water will be used for cavern development as well for filling the compensation reservoir. The water for cavern development will be used for shaft drilling and for operating construction equipment. Water demand for filling the compensation reservoir will be approximately a total of 860 AF. The reservoir fill will require approximately 24 months at a rate of 430 acre-feet per year (AFY). The required fill amount accounts for both precipitation and evaporation. The compensation reservoir will be equipped with a cover estimated to be 90 percent effective in reducing evaporation; however, the estimated fill amount conservatively assumes no benefit from the cover.

The average and peak monthly construction demand are calculated to be 19 AF/month and 41 AF/month, respectively. The site is in an adjudicated basin; therefore, water rights will be obtained and leased through the Antelope Valley (AV) Watermaster. A native safe yield of 82,300 AFY, with a total safe yield of 110,000 AFY, was established by the AV Watermaster under the authority of the Court for the Antelope Valley Area of Adjudication. GESC is in the process of obtaining an agreement with a private entity to lease their carryover water rights to produce onsite groundwater. The private entity has water rights exceeding the quantity needed during the construction phase.

There may be a small water demand as the facility is projected to produce water when in operation. The groundwater drawdown analysis completed and described herein is based on the worst case water consumption during construction. When the facility operates it will produce some water as a result of the air compression process. Depending on precipitation and facility utilization factor, the facility may either produce a small quantity of water or require a small quantity of water makeup. These amounts are significantly less than the peak flow evaluated for the construction period.

1.2 Offsite Wells

Groundwater in the AVGB is primarily used for public and domestic water supply and for irrigation purposes. Public-supply wells in Antelope Valley are completed to depths between 360 and 700 feet, consist of solid casing from the land surface to a depth of 180 to 350 feet.

Production and domestic wells within 0.5 miles of the proposed GESC well are shown in Figure 1. One well (Well 09N13W05_61531) is located within 0.5 miles based on a GAMA database review. Additional wells were identified based on USGS topographic maps and California's Statewide Groundwater Monitoring Program. The wells in black on Figure 1 are shallower, lower producing wells used for primarily domestic purposes. The well in blue (Well 09N13W05_61531) is a deeper production well used for irrigation purposes on the adjacent property to the north of the GESC site. It has not been confirmed if any of the wells on Figure 1 are still in use; however, well 09N13W05_61531 appears to be in use based on the adjoining property's recent agriculture use as evident from GoogleEarth™ images.

2.0 EVALUATION METHODS

2.1 Drawdown Evaluation

Golder evaluated the potential impact of the project on water levels within 0.5 miles from the proposed well. A review of publicly available documents was completed to obtain basin-specific groundwater parameter data to calculate aquifer drawdown using the Theis solution for evaluating drawdown in a confined aquifer (Freeze and Cherry, 1979). Table 1 below lists the parameters used in the calculation of drawdown associated with the proposed GESC Well.

Table 1: Parameters Used in Drawdown Calculations

AVGB Parameters		GESC Well Parameters		
K*	10 ft/dy	Q Construction	46 gpm	8,856 ft^3/dy
S*	2.03E-02	t (time)	36 months	
b*	484 ft	Q Initial Reservoir Fill	267 gpm	51,401 ft^3/dy
T	4,840 ft^2/dy	t (time)	24 months	

*Source: Simulation of Ground-Water Flow and Land Subsidence, Antelope Valley Ground-Water Basin, California (USGS, 2003).
K = hydraulic conductivity
S = Storativity
b = saturated thickness
T = Transmissivity (calculated using the equation T=K×b)
Q = flow rate

The calculation of the drawdown in terms of radius and time is performed by first calculating *u* (a dimensionless variable necessary to performing the analytical drawdown solution), using the following equation:

$$u = \frac{r^2 S}{4Tt}$$

where:
r = radius (ft), S = storativity (dimensionless), T = Transmissivity (ft^2/dy), and t = time (days)

The resultant value of *u* is used to derive the well function (*W(u)) term* using a table such as Table 1 below:

Table 2: Values of *W(u)* for Various Values of *u*

u	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
×1	0.219	0.049	0.013	0.0038	0.0011	0.00036	0.00012	0.000038	0.000012
$\times 10^{-1}$	1.82	1.22	0.91	0.70	0.56	0.45	0.37	0.31	0.26
$\times 10^{-2}$	4.04	3.35	2.96	2.68	2.47	2.30	2.15	2.03	1.92
$\times 10^{-3}$	6.33	5.64	5.23	4.95	4.73	4.54	4.39	4.26	4.14
$\times 10^{-4}$	8.63	7.94	7.53	7.25	7.02	6.84	6.69	6.55	6.44
$\times 10^{-5}$	10.94	10.24	9.84	9.55	9.33	9.14	8.99	8.86	8.74
$\times 10^{-6}$	13.24	12.55	12.14	11.85	11.63	11.45	11.29	11.16	11.04
$\times 10^{-7}$	15.54	14.85	14.44	14.15	13.93	13.75	13.60	13.46	13.34
$\times 10^{-8}$	17.84	17.15	16.74	16.46	16.23	16.05	15.90	15.76	15.65
$\times 10^{-9}$	20.15	19.45	19.05	18.76	18.54	18.35	18.20	18.07	17.95
$\times 10^{-10}$	22.45	21.76	21.35	21.06	20.84	20.66	20.50	20.37	20.25
$\times 10^{-11}$	24.75	24.06	23.65	23.36	23.14	22.96	22.81	22.67	22.55
$\times 10^{-12}$	27.05	26.36	25.96	25.67	25.44	25.26	25.11	24.97	24.86
$\times 10^{-13}$	29.36	28.66	28.26	27.97	27.75	27.56	27.41	27.28	27.16
$\times 10^{-14}$	31.66	30.97	30.56	30.27	30.05	29.87	29.71	29.58	29.46
$\times 10^{-15}$	33.96	33.27	32.86	32.58	32.35	32.17	32.02	31.88	31.76

Source: Wenzel (1942).

The W(u) term is inserted into the following equation:

$$h_o - h = \frac{Q}{4\pi T} W(u)$$

where:

h_o-h = initial head – pumping head or drawdown (ft) at specified radius or time, Q = pumping rate (ft^3/dy), T = Transmissivity (ft^2/dy) , W(u) = dimensionless parameter derived from Table 1

Note, any system of units can be use to calculate the drawdown as long as consistent units are are used between the terms. The analysis assumes the following simplifying assumptions for the aquifer:

1.) horizontal
2.) infinite in horizontal extent
3.) constant thickness
4.) homogeneous and isotropic with respect to its hydrogeological parameters

Additional simplifying assumptions for using the anaylical method are:

1.) there is only a single pumping well in the aquifer
2.) the pumping rate is constant over time
3.) the well diameter is infinitesimally small
4.) the well penetrates the entire aquifer
5.) the hydraulic head in the aquifer prior to pumping is uniform throughout the aquifer

The parameters in Table 2 were then inserted into an analytical model to determine different drawdown curves based on transmissivity, pumping duration and pumping demand. The curves show the modeled drawdown for the following scenarios:

- Construction phase with continuous pumping for a 36-month duration at 46 gpm
- Initial Reservoir Fill phase with continuous pumping for a 24-month duration at 267 gpm

The modeled drawdown curves for the above scenarios are included in Attachment A.

Table 3 below lists the published available well dataset, dataset well ID, coordinates source and distance from the proposed location of the GESC well within a 0.5-mile radius (Figure 1).

Table 3: Well Information and Location Data for Wells Located within 0.5-Mile Radius

Dataset Well ID	X	Y	Well Type	Distance (ft)
09N13W06_241836	6474265.874	2146853.857	Domestic Shallow	530
09N13W18_354080	6474550.580	2145759.421	Domestic Shallow	1,700
09N13W05_61531	6475702.996	2148918.498	Irrigation Deep	2,000
09N13W06_128113	6473611.682	2149797.573	Domestic Shallow	2,550

The proposed GESC well is assumed to have 484 feet of saturated thickness and will be in the confined portion of the aquifer, which is outside the zone of influence for the domestic supply wells screened in shallow, weathered bedrock at around 300 to 400 below grade. The only well that is screened at a similar depth and targeted water bearing zone is well 09N13W05_61531, which is located on the adjacent property approximately 2,000 feet to the northeast of the proposed GESC well location. Well 09N13W05_61531 is installed to a total depth of 705 feet and had a reported production rate of 1,500 gpm at the time of installation.

2.2 Capture Zone Evaluation

The capture zone evaluation is an analytical solution published by the United States Environmental Protection Agency (EPA) and used for demonstrating the effectiveness of capture to regulatory agencies such as the California Department of Toxic Substances Control. This method is directly applicable to answering the portion of the comment regarding the effect of the proposed well on the migration of contaminants as it is designed for use with extraction wells, (i.e., wells designed to capture contaminant plumes). As stated in the document on page 12, drawdown and capture are not the same. While drawdown from a well may be measured at a point far distant from the well, the drawdown's effect on the migration of a contaminant at that point will be negligible due to the natural gradient, subsurface conditions, or pumping influences from other closer wells.

Golder followed EPA's analytical capture zone evaluation (EPA 2008), which is based on the following simplifying assumptions:

- homogeneous, isotropic confined aquifer of infinite extent
- uniform aquifer thickness
- fully penetrating extraction well(s)
- uniform regional horizontal hydraulic gradient
- steady-state flow
- negligible vertical gradient
- no net recharge, or net recharge is accounted for in regional hydraulic gradient

- no other sources of water introduced to aquifer due to extraction (e.g., from rivers or leakage from above or below).

Note that EPA acknowledges in the document that one or more of these simplifying assumptions will not be met at most sites. EPA also states, "however these simple horizontal analyses can be performed in minutes and force the practitioner to perform a basic assessment of hydrogeologic data (e.g., hydraulic parameter values, variation of hydrogeologic parameters over space and/or time). For those reasons, EPA recommends that these simple horizontal analyses be performed, even though in most cases one or more of the assumptions will be violated and additional lines of evidence from more sophisticated capture zone evaluation techniques will likely be appropriate to more rigorously account for site-specific conditions." The calculation is based on the following equations:

Equation 1 $X_o = -Q/2\pi Ti$

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

Equation 3 $Y_{well} = \pm Q/4Ti$

Where:

X_o	=	distance from the well to the downgradient end (stagnation point) of the capture zone along the central line of the flow direction
Y_{max}	=	maximum capture zone width from the central line of the plume
Y_{well}	=	capture zone width at the location of well from the central line of the plume
Q	=	flow in ft^3/dy
T	=	transmissivity in ft^2/dy
I	=	horizontal hydraulic gradient (dimensionless)

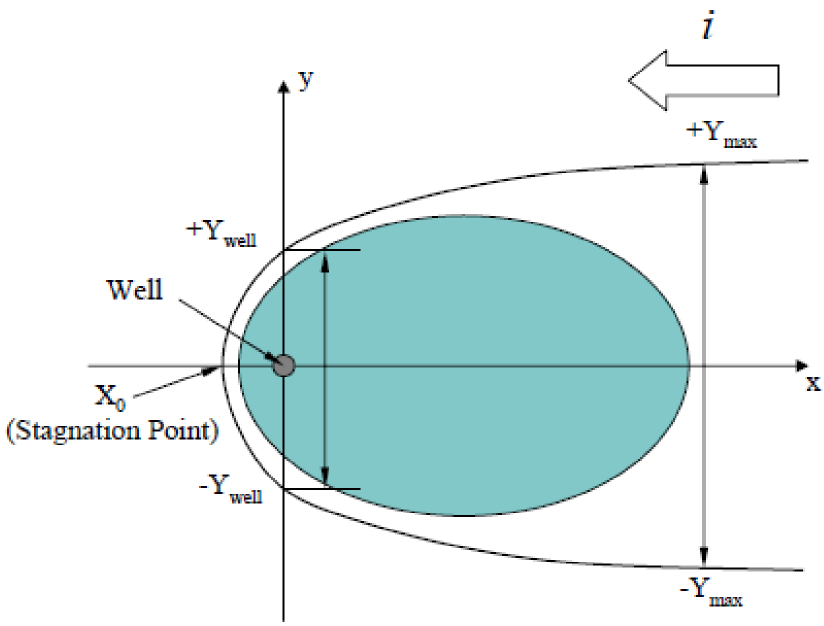
For any value between 0 and Y_{max}, the user calculates the corresponding x value using Equation 4 below, which allows the outline of the capture zone to be plotted.

Equation 4: $$x = y/\tan\{[\pm 1 - (\frac{2Ti}{Q})y]\pi\}$$

Golder used an iterative process for values of y to derive desired x values and allow preparation of the plume capture curves included in Attachment B. The curves were analyzed to the 0.5-mile radius used in the drawdown evaluation to evaluate the width of the capture zone at this point.

Figure 2 below shows the conceptual geometry of a plume capture zone based on Equations 1 through 3.

Figure 2: Plume Capture Zone Geometry



Source: EPA 2008

Capture zone calculations are provided in Attachment B and the results are discussed in Section 3.2. For the evaluation, Golder used the initial construction flow rate of 8,856 ft^3/dy and the monthly flow rate of 51,401 ft^3/dy.

Table 4: Parameters Used in Drawdown Calculations

AVGB Parameters		Well Parameters	
K (ft/dy)*	10	Q (Initial Construction, ft^3/dy)	8,856
I*	0.0036	Q (Reservoir Fill, ft^3/dy)	51,401
b (ft)*	484		
T (ft^2/dy)	4,840		

*Source: Simulation of Ground-Water Flow and Land Subsidence, Antelope Valley Ground-Water Basin, California (USGS, 2003)

3.0 RESULTS OF EVALUATIONS

3.1 Drawdown Evaluation Results

The results of the evaluation are presented in Table 5 below:

Table 5: Results of Drawdown Evaluation

Dataset Well ID	Distance (ft)	Initial Construction Drawdown at 36 Months construction period 46 gpm (feet)	Reservoir Fill Drawdown at 24 Months Fill period 276 gpm (feet)	Cumulative Drawdown at 60 Months (feet)
09N13W06_241836	530	1.1	6.2	7.3
09N13W18_354080	1,700	0.78	4.0	4.8
09N13W05_61531	2,000	0.73	3.9	4.6
09N13W06_128113	2,640	0.65	3.4	4.1

Table 5 shows the drawdown during the initial construction and reservoir fill phases. Continuous operation of the GESC well at the construction flow rate of 46 gpm for a period of 36 months results in minimal drawdown (e.g., 0.65 feet in the equivalent well located 2,000 feet from the proposed well). Operation of the GESC well at the reservoir fill rate of 267 gpm results in drawdowns ranging from 3.4 to 6.2 feet in offsite wells located within 0.5 miles from the Site. Wells 09N13W06_241836 and 09N13W18_354080 are shallow domestic wells screened in weathered bedrock, which is not anticipated to be in direct hydraulic communication with the proposed GESC well.

Recharge to the groundwater system from precipitation is not considered. Additionally, the drawdown values calculated are based on published values for the AVGB. The use of published values, rather than site-specific data, coupled with the simplifying assumptions for the method, suggest that the calculated values represent an idealized drawdown and are likely conservative, worst case estimates. Furthermore, the groundwater basin is adjudicated and therefore, prior to extracting groundwater, water rights will be procured by GESC and leased through the Antelope Valley (AV) Watermaster.

3.2 Capture Zone Evaluation Results

The capture zone evaluation results are included in Attachment B and summarized below.

Table 6: Results of Capture Zone Evaluation

	Initial Construction Q			**Reservoir Fill Q**		
T	X_o =	-	80 ft	X_o =	-	469 ft
	Y_{max}=	±	254 ft	Y_{max}=	±	1,475 ft
	Y_{well}=	±	127 ft	Y_{well}=	±	737 ft
	$Y_{0.5\text{-mile}}$	±	247 ft	$Y_{0.5\text{-mile}}$	±	1,235 ft

The capture zone extent downgradient of the of the proposed well ranges between 80 feet at the initial construction flow rate to 469 feet at reservoir fill flow rate. The width of the capture zone at 0.5 mile ranges between 494 feet at the initial construction flow rate to 2,470 feet at the reservoir fill flow rate. This indicates that the GESC proposed well would capture potential upgradient contaminant plumes migrating onto the site from the west-northwest during the reservoir fill period; however, the initial fill would not capture any potential upgradient plumes migrating onto most of the site. The model predicts steady-state conditions; therefore, the capture zone may not have reached its full width at the completion of construction or when the reservoir was filled. Similar to the drawdown evaluation, the model relies on published AVGB basin parameters and simplifying assumptions and demonstrates likely worst-case condition.

Golder reviewed the State Water Resources Control Board Geotracker database for known contaminants sites and observed that the nearest site (a closed leaking underground storage tank site) is almost 5 miles to the southeast (downgradient) No upgradient sites were identified on the Geotracker map at distances greater than 20 miles. Golder also reviewed the Geotracker GAMA database for concentration data for nearby wells. Well 09N13W05M001S was listed as being located about 2,000 feet from the property boundary on the adjacent property to the north (in the area of well 09N13W05_61531) had data for only one sample collected in 1965. This well mainly showed detections for naturally occurring metals and a low concentration of nitrate as N (below the maximum contaminant limit of 10 milligrams/liter (mg/L) at 1 mg/L). There were no wells within 2 miles of the site that had recent sampling data.

Given the lack of identified upgradient contaminated sites, the rural nature of the surrounding properties, low published concentrations of contaminants in nearby wells, and the distance to identified downgradient sites, it is Golder’s opinion that operation of the Site well will not result in capture or changes in chemistry of a contaminant plume.

4.0 SUMMARY

The calculated drawdown values indicate minimal excess drawdown risk to existing wells during operation of the proposed well. The capture zone evaluation, review of published contaminant sites and concentration data from the nearby well, indicate that no risk of plume capture or chemical changes to existing plumes. Further, the drawdown period is limited as the operation of the proposed GESC well would be for a limited timeframe during the construction and reservoir fill phases of the project. This projection is based on worst case water demand which will occur during the construction period.

The project must source water in compliance with adjudication requirements and groundwater use will need to be obtained through adjudicated water rights. Water rights will be procured by GESC and leased through the AV Watermaster. A native safe yield of 82,300 AFY, with a total safe yield of 110,000 AFY, was established for the AVGB. The project’s total water demand for the construction phase represents less than 0.3% of the annual total safe yield of the AVGB. It will be the responsibility of the water purveyor to ensure the quantity provided to the customer project site does not exceed safe Productions Right and the annual safe yield. Please refer to the following attachments included in the Groundwater Drawdown Assessment contained herein:

Attachment A: Drawdown Evaluation
Attachment B: Capture Zone Evaluation
Attachment C: Figure 1 Well Locations

$$u = \frac{r^2 S}{4Tt}$$

$$h_o - h = \frac{Q}{4\pi T} W(u)$$

AVGB Parameters

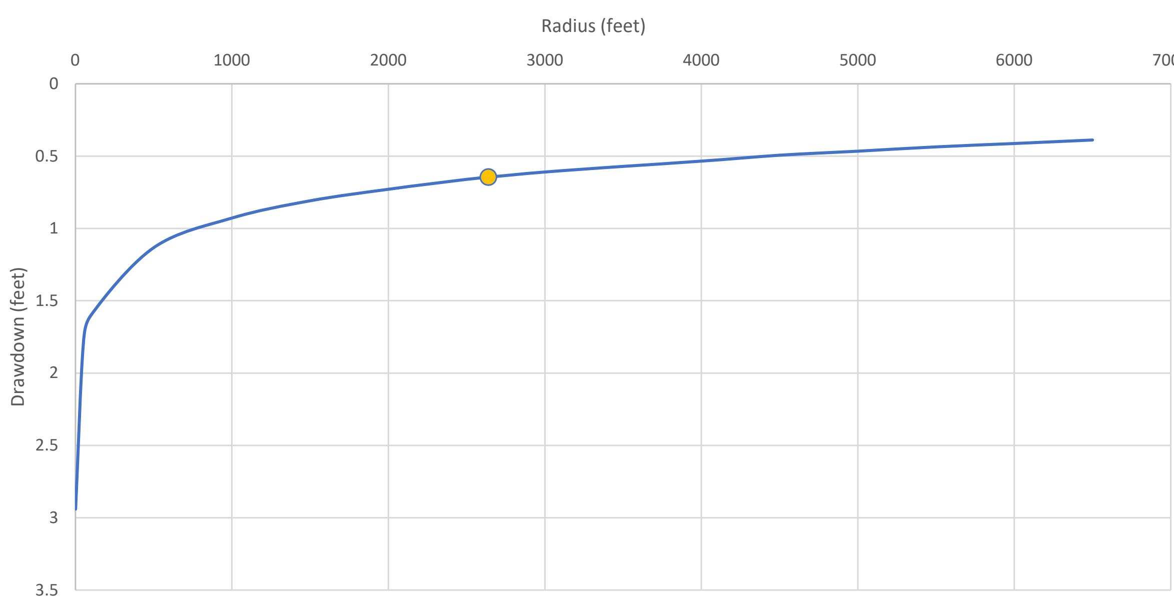
		low
K (ft/dy)		10
S	2.03E-02	
b (ft)	484	
T (ft^2/dy)		4840

Source: Simulation of Ground-Water Flow and Land Subsidence, Antelope Valley Ground-Water Basin, California (USGS, 2003)

Well Parameters

	gpm	f^3/d
Flow Rate	46	8856
Duration (months)	36	

radius (ft)	time (dy)	T -High (ft^2/dy)	u	W(u)	h_o-h (ft)	W(u) Upper	W(u) Lower	u remain-der	W(u) minus	W(u) final
1	1095	4840	9.578E-10	20.1922	2.939998707	20.25	20.15	0.578	0.0578	20.19
50	1095	4840	2.394E-06	12.38846	1.803768603	12.55	12.14	0.394	0.16154	12.39
100	1095	4840	9.578E-06	10.9822	1.599016145	11.04	10.94	0.578	0.0578	10.98
500	1095	4840	0.000239	7.77846	1.132549318	7.94	7.53	0.394	0.16154	7.78
1000	1095	4840	0.000958	6.37642	0.928411295	6.44	6.33	0.578	0.06358	6.38
1500	1095	4840	0.0022	5.558	0.80924876	5.64	5.23	0.2	0.082	5.56
2000	1095	4840	0.0038	5.006	0.728877167	5.23	4.95	0.8	0.224	5.01
2500	1095	4840	0.0060	4.54	0.661027235	4.54	4.39	0	0	4.54
2640	1095	4840	0.0067	4.435	0.64573916	4.54	4.39	0.7	0.105	4.44
3000	1095	4840	0.0086	4.188	0.609775784	4.26	4.14	0.6	0.072	4.19
3500	1095	4840	0.0117	3.9227	0.571147915	4.04	3.35	0.17	0.1173	3.92
4000	1095	4840	0.0153	3.6743	0.534980698	4.04	3.35	0.53	0.3657	3.67
4500	1095	4840	0.0194	3.3914	0.493790256	4.04	3.35	0.94	0.6486	3.39
5000	1095	4840	0.0239	3.1979	0.465616519	3.35	2.96	0.39	0.1521	3.20
5500	1095	4840	0.0290	2.999	0.436656537	3.35	2.96	0.9	0.351	3.00
6000	1095	4840	0.0345	2.834	0.412632419	2.96	2.68	0.45	0.126	2.83
6500	1095	4840	0.0405	2.6695	0.388681102	2.68	2.47	0.05	0.0105	2.67



Drawdown with Distance from GEM Site Well
After 36 Months of Operation - 46 gpm and 484' Saturated Thickness

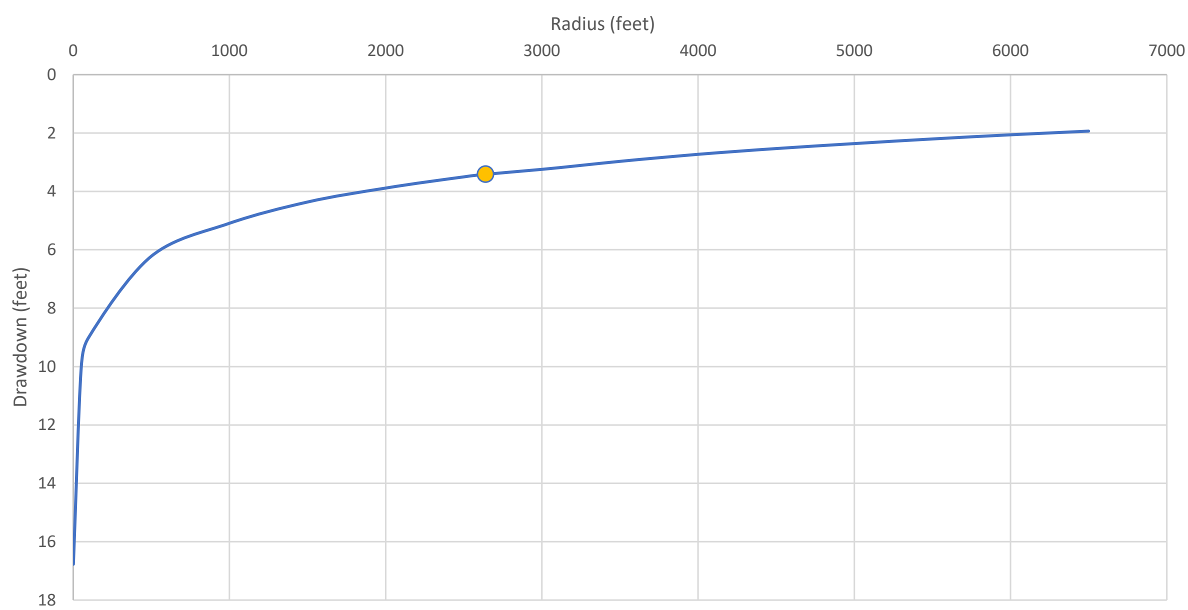
$$u = \frac{r^2 S}{4Tt}$$

$$h_o - h = \frac{Q}{4\pi T} W(u)$$

AVGB Parameters			**Well Parameters**		
				gpm	f^3/d
K (ft/dy)		10	Flow Rate	267	51401
S	2.03E-02		Duration (months)	24	
b (ft)	484				
T (ft^2/dy)		4840			

Source: Simulation of Ground-Water Flow and Land Subsidence, Antelope Valley Ground-Water Basin, California (USGS, 2003)

radius (ft)	time (dy)	T (ft^2/dy)	u	W(u)	h_o-h (ft)	W(u) Upper	W(u) Lower	u remain-der	W(u) minus	W(u) final
1	730	4840	1.437E-09	19.8441	16.77058981	20.15	19.45	0.437	0.3059	19.84
50	730	4840	3.592E-06	11.96832	10.11463284	12.14	11.85	0.592	0.17168	11.97
100	730	4840	1.437E-05	10.6341	8.987060595	10.94	10.24	0.437	0.3059	10.63
500	730	4840	0.000359	7.3648	6.224119001	7.53	7.25	0.59	0.1652	7.36
1000	730	4840	0.001437	6.02847	5.094763561	6.33	5.64	0.437	0.30153	6.03
1500	730	4840	0.003233	5.16476	4.364827402	5.23	4.95	0.233	0.06524	5.16
2000	730	4840	0.0057	4.597	3.885003673	4.73	4.54	0.7	0.133	4.60
2500	730	4840	0.00898	4.1424	3.500813403	4.26	4.14	0.98	0.1176	4.14
2640	730	4840	0.01001	4.03931	3.413690273	4.04	3.35	0.001	0.00069	4.04
3000	730	4840	0.0129	3.8399	3.245165456	4.04	3.35	0.29	0.2001	3.84
3500	730	4840	0.0176	3.5156	2.971093955	4.04	3.35	0.76	0.5244	3.52
4000	730	4840	0.0230	3.233	2.73226384	3.35	2.96	0.3	0.117	3.23
4500	730	4840	0.0291	2.9951	2.531210463	3.35	2.96	0.91	0.3549	3.00
5000	730	4840	0.0359	2.7948	2.361933492	2.96	2.68	0.59	0.1652	2.79
5500	730	4840	0.0435	2.6065	2.202797927	2.68	2.47	0.35	0.0735	2.61
6000	730	4840	0.0517	2.4411	2.063015546	2.47	2.3	0.17	0.0289	2.44
6500	730	4840	0.0607	2.2895	1.934895782	2.3	2.15	0.07	0.0105	2.29



Drawdown with Distance from Gem Site Well
After 24 Months of Operation - 267 gpm and 484' Saturated Thickness

Capture Zone Calculations Gem Facility, Kern County, California

Q	ft3 / acft	acft/mth*	ft3/mth	ft3 /dy	gpd	gpm
Initial Const.	43560	6	265668	8856	66240	46
Reservoir Fill		35	1542032	51401	384480	267

*Source: Application for Certification GEM Energy Storage Facility, Section 5.15 Water Resources, Golder Associates Inc.

Parameters*		
K : 10 ft/dy	i : 0.0036 ft/ft	b : 484 ft

Source: Simulation of Ground-Water Flow and Land Subsidence, Antelope Valley Ground-Water Basin, California (USGS, 2003)

		Q (ft^3/dy)	/	2π*	× K (ft/dy)	× b (ft)	× I (ft/ft)	=	X_o (ft)
Initial Const.	X_0 =	8856	/	6.28318531	10	484	0.0036	=	**80**
Reservoir Fill	X_0 =	51401			10	484	0.0036		**469**

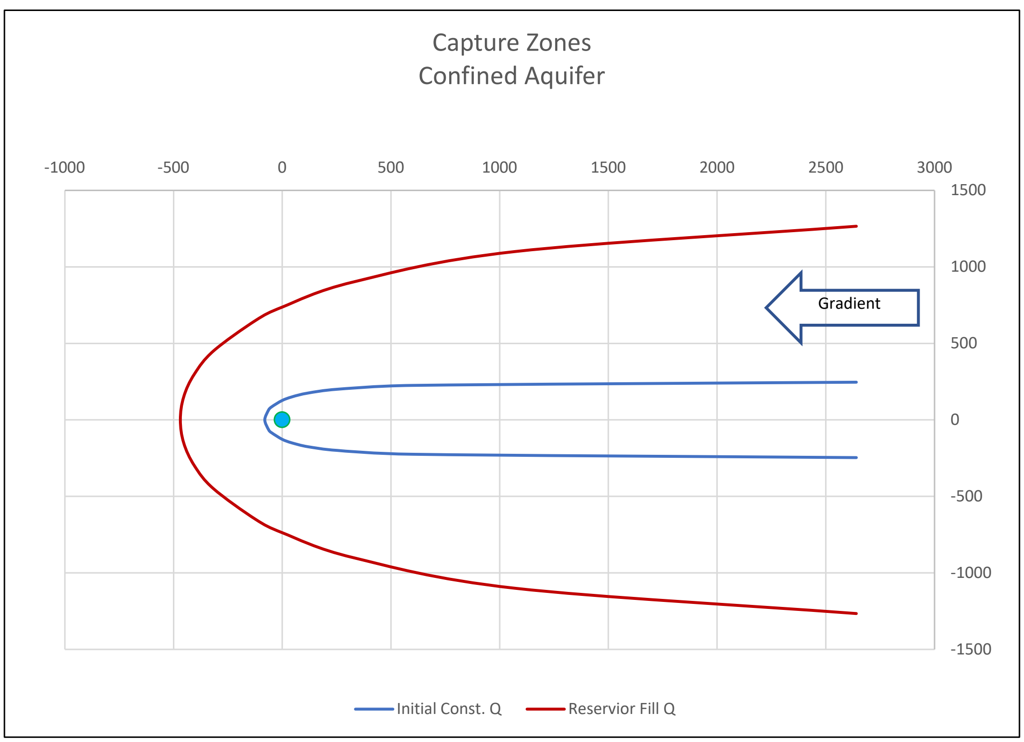
		±Q	/	2*K (ft/dy)	× b (ft)	× I (ft/ft)	=	Y_{max} (ft)
Initial Const.	Y_{max}=	8856	/	20	484	0.0036	=	**254**
Reservoir Fill	Y_{max}=	51401		20	484	0.0036		**1475**

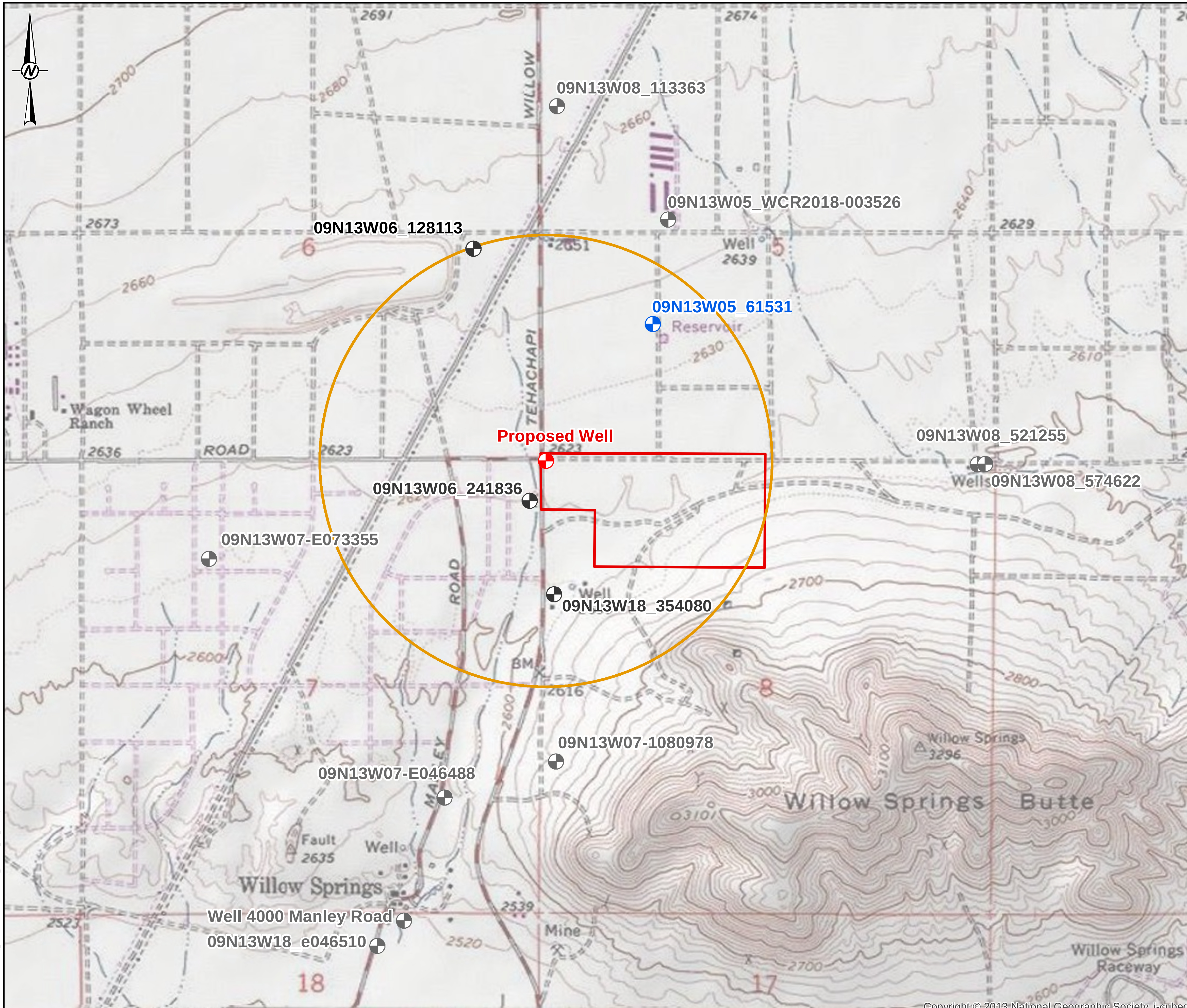
		±Q	/	4*K (ft/dy)	× b (ft)	× I (ft/ft)	=	Y_{well} (ft)
Initial Const.	Y_{well}=	8856	/	40	484	0.0036	=	**127**
Reservoir Fill	Y_{well}=	51401		40	484	0.0036		**737**

$$x = y/\tan\{[\pm 1 - (\frac{2Ti}{Q})y]\pi\}$$

Capture Zone width at 0.5 mile from well:

	X value (ft)	Y Value (ft)
Initial Const.	2640	247
Reservoir Fill	2640	1265





LEGEND

- PROPOSED WELL
- EQUIVALENT WELL
- SHALLOW WELL
- OUTSIDE RADIUS
- RADIUS - 0.5 MILE
- GEM SITE

NOTES

0 1,000 2,000 Feet

REFERENCE

COORDINATE SYSTEM: NAD 1983 STATEPLANE CALIFORNIA V FIPS 0405 FEET

CLIENT
HYDROSTOR, INC.

PROJECT
GEM ENERGY STORAGE CENTER

TITLE
WELL LOCATIONS

CONSULTANT
WSP GOLDER

YYYY-MM-DD	2022-04-21
PREPARED	MR
DESIGN	MR
REVIEW	GW
APPROVED	GW

PROJECT No.	CONTROL	Rev.	FIGURE
20449449	---	---	1