Analysis of Streamflow Depletion and Well Interference under Various Conditions

In the process of revising the County well ordinance (SCCC 7.70) and developing policies to minimize impact on streamflow and public trust values, County staff have analyzed the potential effects of individual wells under various conditions using several different analytical models. These models are used to provide a sensitivity analysis and evaluate the extent to which different factors may influence streamflow depletion in Santa Cruz County. However, it's important to note that analytical models rely on various assumptions, commonly including the presumption of steady-state conditions for the stream and aquifer. In reality, the degree of stream depletion is likely to fluctuate in response to changing climate conditions over time. Modeled estimates of depletion are likely somewhat inaccurate as the environment of the Santa Cruz Mountains is inconsistent with many of the underlying assumptions upon which the models are based.

The variability of Santa Cruz County's climate, geology, topography, ecological, and stream conditions makes challenging the establishing thresholds for each Tier, and allowed additional stream depletion for specific streams. The thresholds and limits are based on empirical data, current and expected water use conditions, model simulations, and expert judgment, and are subject to refinement as new data and models emerge. It's important to recognize that model-derived values are especially influenced by specific hydrogeologic conditions unique to our community. Therefore, while our approach provides a valuable framework for assessing local impacts, its application to other regions should consider local conditions, and professional discretion.

In addition, the amount of total depletion that is estimated to be presently occurring based on numeric groundwater models and flow measurements (Table 4) is considerably less than the amount that would be calculated by multiplying the number of current wells by the worst-case calculations of the direct effect of individual wells provided by the analytical models.

Estimates of streamflow depletion were calculated and analyzed using a combination of models including the USGS web based calculation, STRMDEPL08 (U.S. Geological Survey, 2013), the analytical depletion function (ADF) model developed by Li et al. (2022) and ADF model developed by Bakker (2013). Below is a summary of the key results, along with their policy implications, detailed observations, a more in-depth discussion of our sensitivity analysis and modeling tools, and appendices providing supporting documents of our analysis.

Summary and Policy Implications:

In our sensitivity analysis, we examined various aquifer conditions and potential well mitigation strategies to account for a wide range of effects. This included assessing both unconfined and confined aquifers, incorporating detailed regional data on the variability in aquifer properties and confining layers. Specifically, we analyzed the Santa Margarita Formation (Tsm) under unconfined conditions due to its wide range of aquifer properties (e.g., hydraulic conductivity values from 2 to 130 ft/day), aiming to establish upper and lower bounds for streamflow depletion estimates. Similarly, the Monterey Formation (Tm) was studied to understand streamflow impacts under confined conditions.

In general, stream depletion impacts are more significant in interconnected wells within aquifers of high hydraulic conductivity and low storage coefficients, and less pronounced in aquifers with low conductivity and high storage coefficients. Our analysis shows that in unconfined aquifers without well seals, stream depletion correlates closely with extraction rates over relatively short distances and time periods (about 700 days). For example, pumping from the Santa Margarita Formation in an unconfined state can deplete streams by up to 98% of the pumped volume.

For confined settings, over shorter time periods (approximately 2 years), wells extracting from a confined aquifer with median Tsm hydraulic conductivity values, and a confining layer consisting of median Tm hydraulic conductivity values, the estimated stream depletion is approximately 25% of the pumped volume. However, over 10 years under the same conditions, total stream depletion can rise to about 55% of the pumping volume, indicating delayed impacts, especially pronounced in confined settings. Therefore, Tier 3 permit applications must evaluate stream depletion impacts over a 10-year timeframe. For detailed hydraulic properties used and modeled results, refer to the plots in Appendix A.

We also analyzed potential well mitigation strategies, including the use of deeper well seals. Analytical models indicate that deeper well seals are effective in reducing stream depletion, especially over short distances and periods (~200 days) when wells are within 800 feet of streams (Appendix D). For example, in an unconfined aquifer with median Tsm properties, after pumping 200 days, a well with a 100-foot seal located 100 feet from the stream would result in 60% less depletion compared to a well without a seal. Extending the pumping time period to 10 years reduces the effects of diminished stream depletion, yet it still can be 20 to 70% more effective than wells without a seal (Appendix B). When evaluating the impacts of wells situated at farther distances, such as 1000 feet from the stream, the effectiveness of the deeper seal diminishes significantly (Appendix E).

Based on this analysis, we are requiring a minimum 100-foot well seal for Tier 1 applicants within 1000 feet of a stream, and a minimum 200-foot seal for Tier 2 and 3 wells within 2000 feet of a stream.

Other well mitigation strategies and their impact on stream depletion were also analyzed, including the effects of setbacks. Analytical models suggest that increasing the distance from the well to the stream can lead to minor to substantial reductions in stream depletion. For example, at 50 feet from the stream, depletion reductions range from 2 to 10%, and at 100 feet, reductions add some additional margin of protection at a range from 3 to 20%. A 1000-foot setback can reduce depletion by approximately 15 to 75%, and at 2000 feet, up to 95%. Actual impacts in Santa Cruz County can vary widely due to abrupt changes in topography, hydrogeology, faulting, folding, and fracturing.

Based on the modeled benefits of setbacks for wells near streams and considering existing provisions in the County Code, we are establishing specific setbacks for different tiers of applicants. Tier 1 wells must maintain a minimum 50-foot setback from the stream, and Tier 2 wells are required to maintain a 100-foot setback. Setbacks for Tier 3 wells will be determined based on the criteria necessary to meet stream depletion standards, potentially advancing to Tier 4 standards if compliance is not feasible. Given the modeled potentially significant adverse impacts of stream depletion within 1000 feet (Tier 1) and 2000 feet (Tiers 2 and 3), these wells must adhere to standards aimed at minimizing impacts on streamflow (see Resource Protection Policy), except in cases where a Health Officer designates a stream as exempt.

<u>Detailed Observations Relative to Direct Streamflow Depletion:</u>

1. The amount of depletion is moderately reduced by a greater setback from the creek in aquifers characterized by high transmissivity and low storativity. Increasing the setback from 50 ft to 1000 ft reduces the amount of depletion by 25-30% for formations with moderately favorable aquifer properties concerning stream depletion impacts. Conversely, in aquifers with low transmissivity and high storativity, increasing the setback from 50 feet to 1000 feet reduces depletion by approximately 55% for formations with highly favorable aquifer properties.

2. Wells pumping 10 af/y or less have very minimal impact on direct flow depletion: less than 0.01-0.02 cubic feet per second (cfs) at a setback of 50 ft from a creek. Incorporating a seal depth of 100 feet further diminishes depletion, with the depletion reduced by approximately 82% for aquifers characterized by low transmissivity and high storativity values, and depletion reduced by up to 31% for aquifers with high transmissivity and low storativity values. Previous analysis showed that total non-municipal pumping has reduced the 10^{th} percentile dry

season flow by 2-4% in the Santa Margarita Groundwater Basin (Groundwater Sustainability Plan, 2021). and 15-17% in the Mid-County Groundwater Basin Model(Montgomery & Associates, 2019). Cumulative impacts are not expected to increase in the future, given the low rate of new rural development and the active management of both basins to reduce the impacts of municipal pumping and raise groundwater levels.

3. Pumping from a deeper zone below an aquitard significantly reduces the impact of streamflow depletion, particularly over short time periods (Hunt, 2003). Over modeled 700-day periods, depletion when pumping from below an aquitard with a 50-foot separation is 95-97% less than the depletion at the same distance when pumping from an unconfined aquifer more hydraulically connected to the stream. Over longer periods, such as 10 years, the benefits can remain substantial. With median confining layer hydraulic conductivities, depletion when pumping from below an aquitard with a 100-foot separation is approximately 50% less than the extraction rate. However, under high hydraulic conductivities and low storativity values for both the confining unit and primary aquifer, depletion at a 100-foot separation can still be significant and amount to approximately 80% of the pumped volume. While not required, it is encouraged that new and replacement wells incorporate a deep seal below an aquitard, as this strategy is expected to be a highly effective for reducing streamflow depletion. These conditions are expected to occur within the Monterey Formation and certain parts of the Purisima Formation.

4. Some of the calculations were done assuming the annual volume of pumping all took place in 180 days during the dry season. However, if a 2-year drought was assumed, with the same rate of pumping assumed for the dry season for 700 days, the amount of depletion increased by 17% in the Purisima AA and 56% in the Santa Margarita. If the pumping was from below an aquitard, depletion increased by about 90% in both aquifers when compared with the 180-day scenario, although the amount of depletion was still only 1.6% of the pumping volume.

5. Incorporating a deep seal within 1000 feet of a stream is an effective method to mitigate streamflow depletions and reducing drawdown in the upper portion of the aquifer, where the stream is most likely closely interconnected to (Figure 1). This mitigation strategy is particularly impactful for streams connected through aquifers with low permeabilities. However, the degree of reduction in depletion is notably more pronounced when the well is closer to the stream, likely due to the attenuation of the cone of depression.

For wells with extraction rates of less than 100 acre-feet per year (AFY) located beyond 1000 feet from the stream, the impact of the well seal diminishes (Appendix E) as the curvature of the cone of depression flattens out at farther distances. At these longer distances, the overall drawdown resulting from the pumping volume of the aquifer becomes the primary factor contributing to streamflow depletion.

For instance, when assessing the effects of wells situated 50 feet from a stream, tapping into an aquifer with median values of transmissivity and storativity in the Santa Margarita Formation, a seal depth of 100 feet is projected to decrease stream depletion by approximately 54%, while a 200-foot seal depth could reduce it by around 72%.

For wells positioned 200 feet from the stream under similar geological conditions, a 100-foot seal depth is estimated to mitigate stream depletion by approximately 43%, and a 200-foot seal could reduce it by approximately 62%.

However, when evaluating the impacts of wells situated at farther distances, such as 1000 feet from the stream, the effectiveness of the seal diminishes significantly. In this scenario, with aquifers of similar properties as above, a 100-foot seal depth is anticipated to reduce stream depletion by only 3%, while a 200-foot seal might reduce it by just 5%.

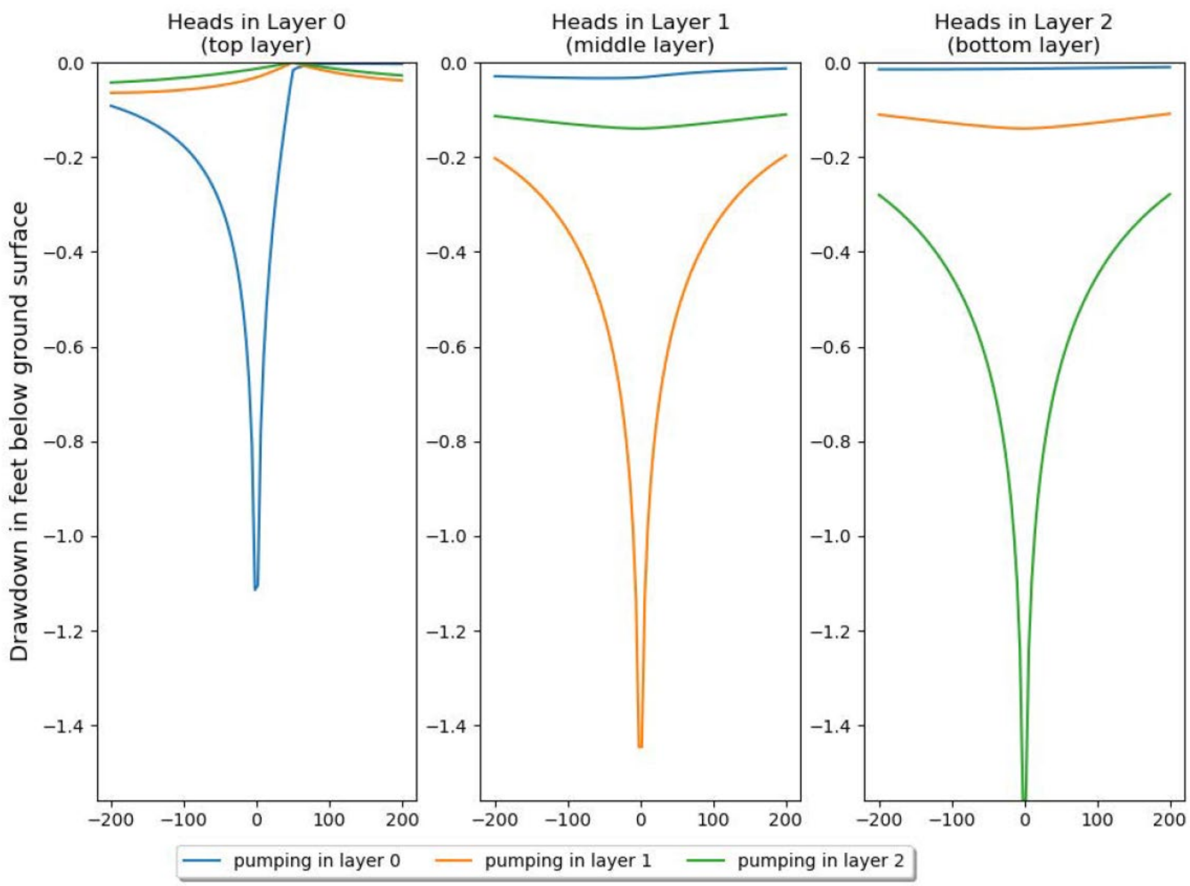


Figure 1- Drawdowns at Different Seal Depths (TTim, Bakker 2013)

6. Beyond 1000 feet, well seal depths are not expected to have a significant impact for wells using less than 100 AFY (see observation #7), and the primary driver to further reduce stream depletion depends on increasing the distance between the stream and the well. For example, considering depletion modeled for wells without seals located in aquifers with high transmissivity and low storativity values, where the zone of influence is expected to be most extensive, stream depletion impacts are reduced by approximately 50% when the well location is increased from 800 feet to 2000 feet (Figure 2). The reduction is projected to be even more significant with distance for aquifers with lower permeabilities.

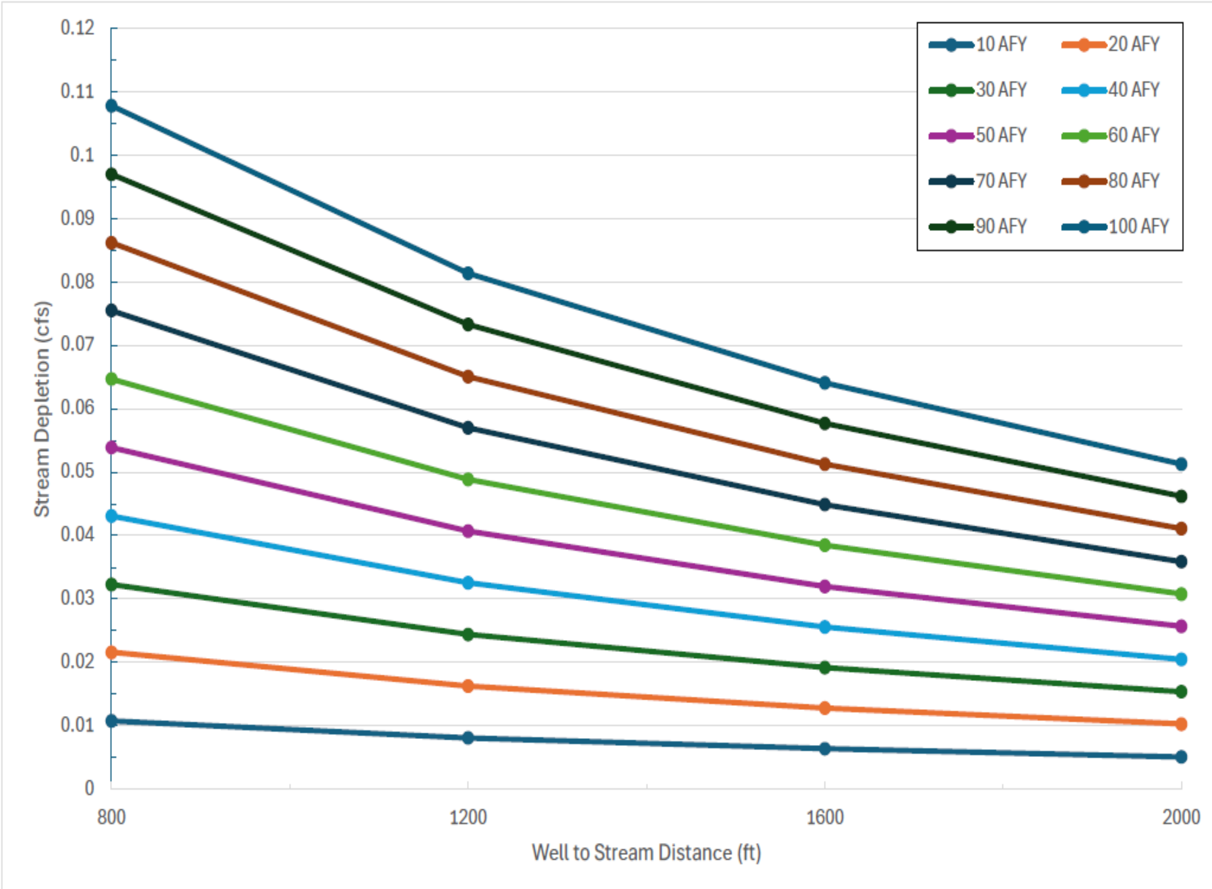


Figure 2- Stream Depletion Beyond 800 Feet without Seals (TTim, Bakker 2013)

<u>Streamflow Depletion in the Santa Margarita Formation for De minimis and Tier 1 Wells:</u>

Tier 1 wells are expected to have minimal impact on stream depletion due to their specific requirements which include a minimum 50-foot setback from the stream and a minimum 100-foot well seal depth when located near the stream. Rural households typically use up to 0.5 AFY of water, based on metered rural users. For this low usage level, with the minimum protective measures (50-foot setback from the stream and 100-foot well seal), a simulated scenario doubling the pumping rate from 0.5 AFY to 1 AFY to represent dry-season extraction shows that stream depletion within the Santa Margarita Formation can range from 0.0002 to 0.0009 cfs after 10 years (Figures 3-5). Specifically, for a 0.5 AFY well situated in the high-permeability portion of the Santa Margarita Formation, the model indicates a maximum depletion of 0.0009 cfs after 10 years.

Two AFY is the maximum pumping allowed for new wells to be able to qualify for the Tier 1 setbacks and seal depth, without needing to calculate the estimated stream depletion. If the pumping rate exceeds two AFY, the well would fall under Tier 3, requiring stream depletion calculations to ensure it does not exceed the allowable limits. For these wells, typically associated with shared wells serving up to four households, the maximum estimated depletion ranges from 0.0009 to 0.0036 cfs— the former corresponding to very low Tsm permeability conditions and the latter to very high Tsm permeability conditions. These depletion ranges are projected to be lower for streams with streambed resistance or where an aquitard exists between the stream and the well screen. Additionally, most domestic wells also use septic systems, which allows a significant portion of groundwater extraction to be recharged back into the aquifer that is hydraulically connected to the stream.

For wells pumping up to 2 AFY, the maximum expected depletion will generally remain below the “Allowed Depletion cfs” for all streams in the Critical Streams Table, except for E. Branch Soquel at the West Branch confluence, Valencia, and Browns Valley. These exceptions are due to the very low “additional depletion allowed” for these streams. However, given the geological conditions and existing development near these streams, the impact of new de minimis wells on these streams is expected to be minimal.

For E. Branch Soquel, most existing wells are near the confluence with the West Branch, in an area where development is already dense with few if any developable parcels remaining, meaning any new well permits are likely to be replacements. Upstream, the stream is primarily bordered by parkland, where no well development is expected. Additionally, farther upstream near Highland Way, the stream is hydraulically disconnected according to the Santa Cruz Mid-County Basin Model Integration and Calibration report (Montgomery & Associates, 2019).

Similarly, much of Valencia Creek is hydraulically disconnected from the groundwater, with most adjacent parcels already developed. This suggests few if any new well applications within 1,000 feet of the stream are possible. In the hydraulically connected upper reach adjacent to Valencia Creek Forest Company, any new well would be classified as non-de minimis as the property is not zoned for residential uses. Wells near Valencia Creek are expected to draw from the BC Unit, which has a hydraulic conductivity of less than 5 feet/day (Montgomery & Associates, 2019), which would favorably limit impacts on stream depletion.

For Browns Valley Creek, like Valencia, de minimis wells are expected to be drawing primarily from the BC Unit, which will limit impacts to stream depletion. Pajaro Valley Water Management Agency’s Groundwater Sustainability Update (Montgomery &

Associates, 2022) data also indicate that Browns Valley Creek is likely hydraulically disconnected from the groundwater. As with E. Branch Soquel and Valencia, the developed status of adjacent parcels makes additional well applications within 1,000 feet unlikely.

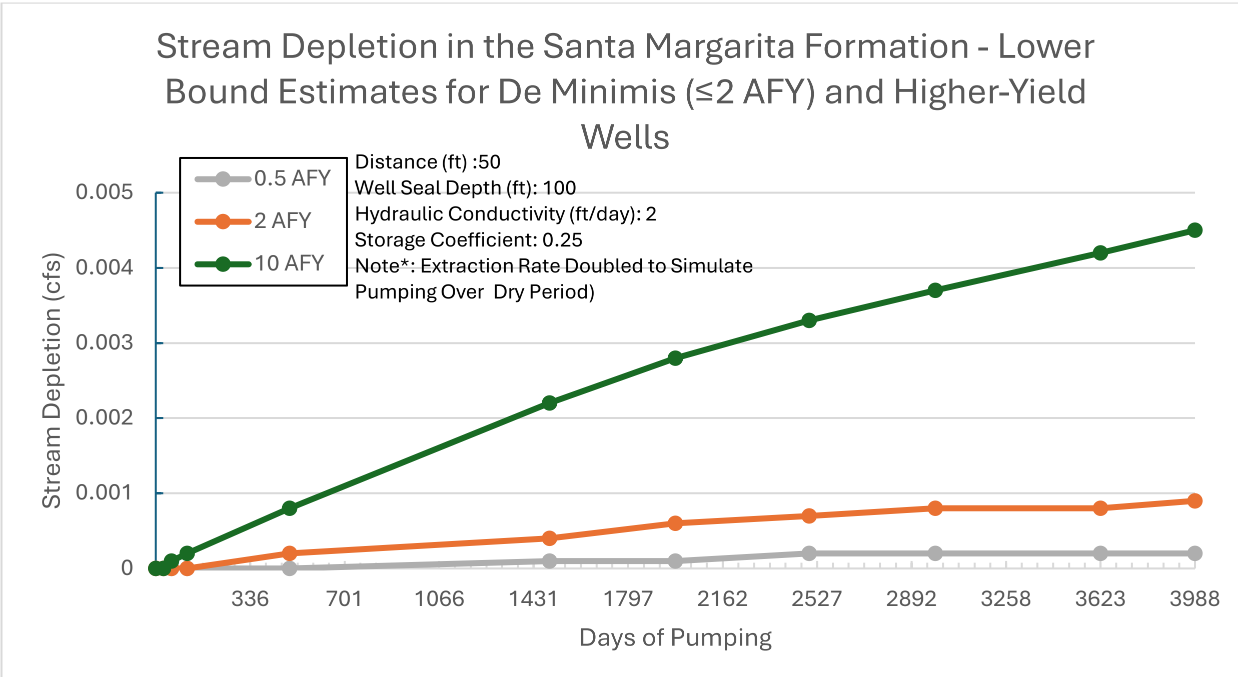


Figure 3- Lower Bound Stream Depletion Estimates in Tsm for De Minimis and Higher-Yield Wells (TTim, Bakker 2013)

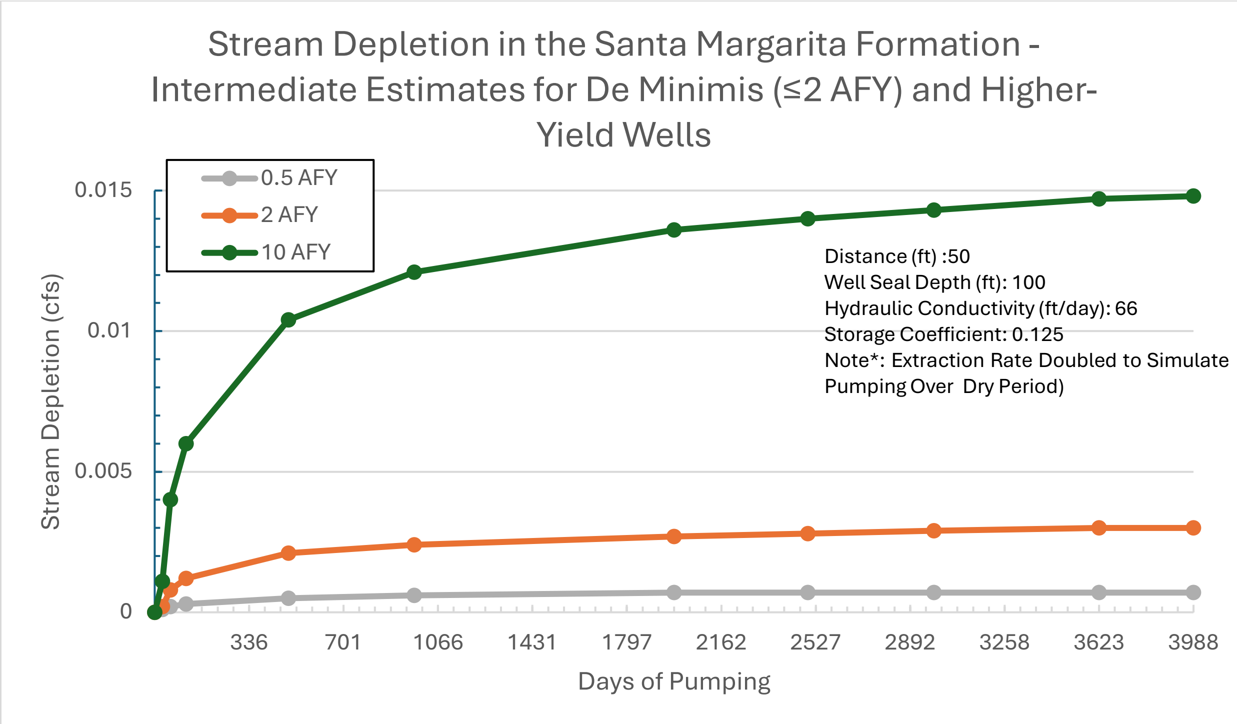


Figure 4- Intermediate Bound Stream Depletion Estimates in Tsm for De Minimis and Higher-Yield Wells (TTim, Bakker 2013)

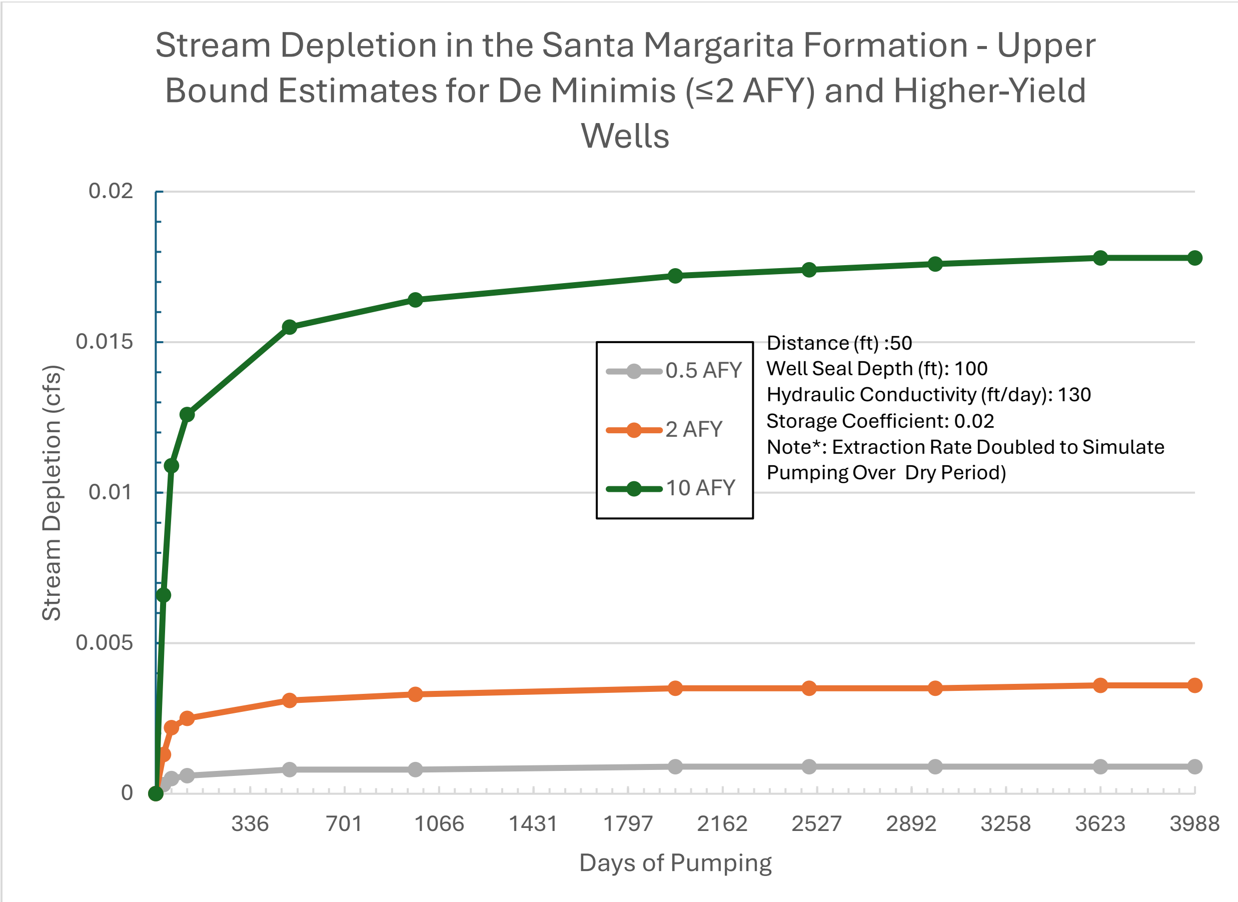
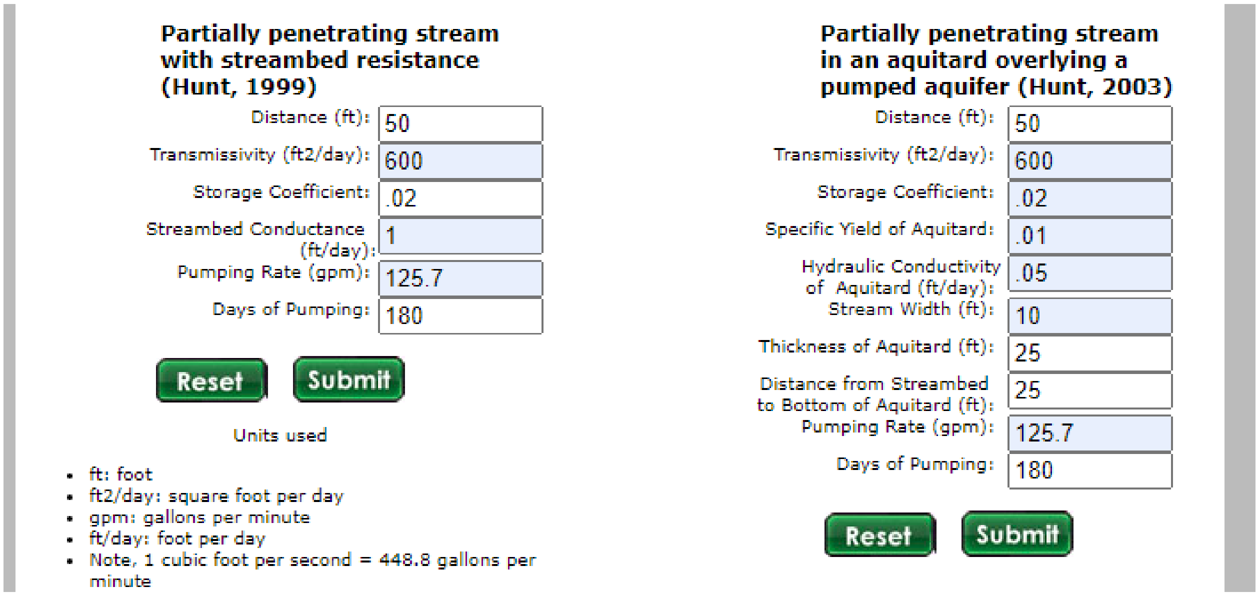


Figure 5- Upper Bound Stream Depletion Estimates in Tsm for De Minimis and Higher-Yield Wells (TTim, Bakker 2013)

Streamflow Depletion Analysis Using USGS Analytical Models:

For the USGS application, three models were primarily used: a partially penetrating stream with nearby pumping from an unconfined aquifer (Hunt, 1999) a partially penetrating stream in an aquitard overlying a pumped aquifer (Hunt, 2003), and a fully penetrating stream with no streambed resistance (Jenkins, 1968). Hunt, 2003 was used to evaluate the effects of requiring a deep seal to the first impermeable layer. Below is a figure showing the set-up for running STRMDEPL08 for pumping from an aquifer associated with the Purisima AA formation with a stream that partially penetrates the aquifer and has streambed resistance (left), and with a stream partially penetrating an impermeable layer with properties similar to the Monterey Formation overlying a pumped aquifer (right). Aquifer parameters are taken from the Groundwater Sustainability Plans, with generally the median figures used (as shown in Table 3, an example from the GSP of the Santa Margarita Groundwater Agency).



The USGS analytical models were run for two different aquifer types, the Purisima AA, which has the potential for low to moderate permeability, and the Santa Margarita formation, which has the potential for high permeability. The models were run for various pumping rates and stream setbacks (Table 1). The pumping rates were derived from the annual production (af/y), with a worst-case assumption that the total annual amount is drawn during the typical 6-month dry period (180 days) and maintained at a consistent average amount of continuous pumping to achieve that volume. The volume of pumping for 100 af/y at a 50 ft setback was also considered for situations where pumping occurred below an aquitard, over a 700 day period (2-year drought) and a 10-year period, to understand potential long term effects. However, very long-term effects would normally be mitigated by recharge during normal wet winters.

Purisima AA (T=600, S=.02)			Depletion (cfs) with indicated setback from creek (ft) 180 days of pumping, unless noted otherwise			
Af/y	summer gpm	pumping cfs	50 ft	100 ft	200 ft	1000 ft
0.5	0.6	0.0014	0.001*	0.001	0.0009	0.0007
2	2.5	0.0056	0.004*	0.004	0.0039	0.003
10	12.6	0.0280	0.0204*	0.0201		0.0149
100	125.7	0.2801	0.2035*			0.1486
100	125.7	0.2801	0.2383*	No aquitard, 700 days		
100	125.7	0.2801	0.2613*	No aquitard, 3650 days		
100	125.7	0.2801	0.0095**	Pumping from below aquitard		
100	125.7	0.2801	0.0181**	Below aquitard, 700 days		
100	125.7	0.2801	0.0388**	Below aquitard, 3650 days		
250	314.3	0.7002	0.5765*			0.4288
	1000	2.2282	1.619*		1.547	1.1845

Santa Margarita (T=3000, S=.1)			Depletion (cfs) with indicated setback from creek (ft), 180 days of pumping, unless noted otherwise			
Af/y	summer gpm	pumping cfs	50 ft	100 ft	200 ft	1000 ft
0.5	0.6	0.0014	0.0004*			
2	2.5	0.0056	0.0018*	0.0017		0.0012
10	12.6	0.0280	0.0089*			
20	25.1	0.0560	0.0177*			
50	62.9	0.1400	0.0443*			
100	125.7	0.2801	0.0885*	0.0869	0.0839	0.0616
100	125.7	0.2801	0.1383*	No aquitard, 700 days		
100	125.7	0.2801	0.1994*	No aquitard, 3650 days		
100	125.7	0.2801	0.0023**	Pumping from below aquitard		
100	125.7	0.2801	0.0044**	Below aquitard, 700 days		
100	125.7	0.2801	0.0100**	Below aquitard, 3650 days		
	1000	2.2282	1.1000*		1.0456	0.7798

*Uses Hunt, 1999 model with a streambed conductance of 1 (ft/day)

**Uses Hunt, 2003 model using aquitard properties similar to the Monterey Formation

Table 1- Key Results Using USGS Models (STRMDEPL08, Reeves 2008)

Analyzing Ranges of Streamflow Depletion and Seal Depth Impacts:

In our analysis of streamflow depletion, we focused on evaluating the upper and lower range of impacts by analyzing various models. Specifically, we examined models that assume a fully penetrating stream without streambed resistance, such as those by Glover, Jenkins, and Bakker (with streamed resistance as an optional parameter). These models predict more significant streamflow depletion compared to models that incorporate streambed resistance or consider partially penetrating streams, such as Hunt's models.

Our simulations utilized the aquifer properties of the Santa Margarita Formation under unconfined conditions. This formation was selected because it represents one of the primary water-bearing units in the county, which is also commonly interconnected with surface water. With its potential for high transmissivity/high hydraulic conductivity values and low specific yield values, streams and aquifers associated with the Santa Margarita Formation are particularly susceptible to significant stream depletion (refer to Table 2 for aquifer properties).

We conducted the models for various pumping rates and stream setbacks over a 700-day and 3,650 day periods (Appendix B), corresponding to a 2-year and 10-year drought cycle. During the 2-year timeframe, stream discharge reaches near-equilibrium with unconfined aquifers under steady-state conditions (see Figure 6). To simulate drought conditions and the worst-case effects of intermittent pumping (all water extraction occurring during dry period), we derived pumping rates from annual production, assuming that the total amount is drawn during the typical 6-month dry period and maintained over the drought period. This effectively doubles the amount of typical usage during normal years over the modelled period and serves as a very conservative approach (e.g., 2 AFY wells are modeled as 4 AFY wells).

To analyze the influence of seal depths on stream depletion, we employed the TTim model developed by Bakker i(2013), known for its effectiveness in simulating transient flow in multi-layer systems. The TTim model also served as our primary tool for assessing the worst-case and most extreme impacts on streamflow depletion.

Our simulation environment emulates a homogeneous aquifer divided into three layers with each layer 100 feet thick. Despite this division, all layers share identical aquifer properties, effectively representing one homogenous aquifer. The top layer is designated as phreatic to mimic unconfined conditions. The simulation includes a well screen positioned sequentially in each layer to assess the impacts of different seal depths for each respective layer. For example, during the third iteration, the well screen is placed in layer 2, effectively simulating sealing of layers 0 and 1. When the iteration has the well screen in Layer 0, the simulation effectively represents no seal for the well. Layer 0 represents the topmost layer (0 - 100 feet below ground surface), while Layer 2 represents the bottommost layer (200 - 300 feet below ground surface). The extraction of the well is averaged over the entire screen interval. An example of this simulation is provided in Figure 7, used to assess the worst-case impacts of a 50 AFY well located 200 feet away from the stream.

Table 2-14. Principal Hydrogeologic Units Hydraulic Properties

Principal Hydrogeologic Unit	Hydraulic Conductivity (feet/day)	Transmissivity (feet²/day)	Storativity[1]	Specific Yield[2]
Santa Margarita Aquifer Entire Basin	2 – 130	430-7,700	0.008 – 0.02	0.02 – 0.25
Santa Margarita Aquifer Quail Hollow/ Olympia	2 – 50	430 – 6,200	0.008 – 0.02	0.12 – 0.25
Santa Margarita Aquifer Central Portion of Basin	3 – 130	2,000 – 7,700	NA	0.02 – 0.13
Santa Margarita Aquifer Scotts Valley Area	12 – 35	1,000 – 1,700	NA	0.02 – 0.13
Monterey Aquifer [3]	0.05 – 6	170 – 1,000	0.00001 – 0.001	0.01 – 0.03
Lompico Aquifer	0.5 – 7	500 – 3,200	0.000001 – 0.001	0.02 – 0.07
Butano Aquifer	0.1 – 6	100 – 1,070	0.000001 – 0.0007	

Adapted from Kennedy/Jenks Consultants (2015); NA = non-applicable given unconfined conditions
[1] Storativity is the volume of water released from confined aquifer storage per unit decline in hydraulic head in the aquifer per unit area of the aquifer.
[2] Specific yield is the amount of water released from an unconfined aquifer if allowed to drain completely under force of gravity.
[3] The Monterey Formation is not a principal aquifer but is included here as there are aquifer test data available for it, and because its occurrence between 2 principal aquifers plays an important role in the hydrogeology of the Basin.

Table 2 “Principal Hydrogeologic Units Hydraulic Properties”, (Kennedy/Jenks Consultants, 2015)

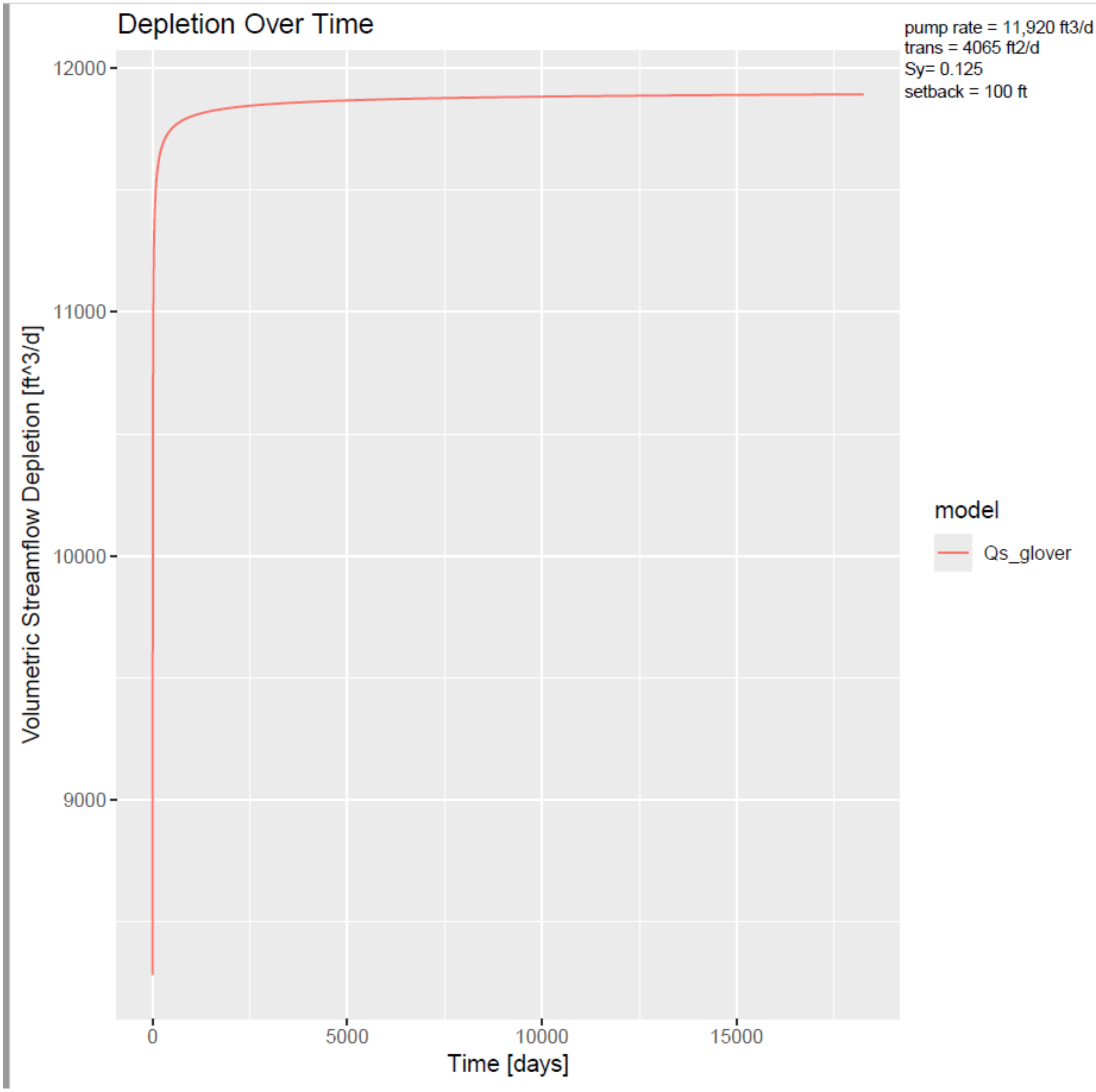


Figure 4- Stream Depletion Over 50 Years (streamDepletr, Li et. al)

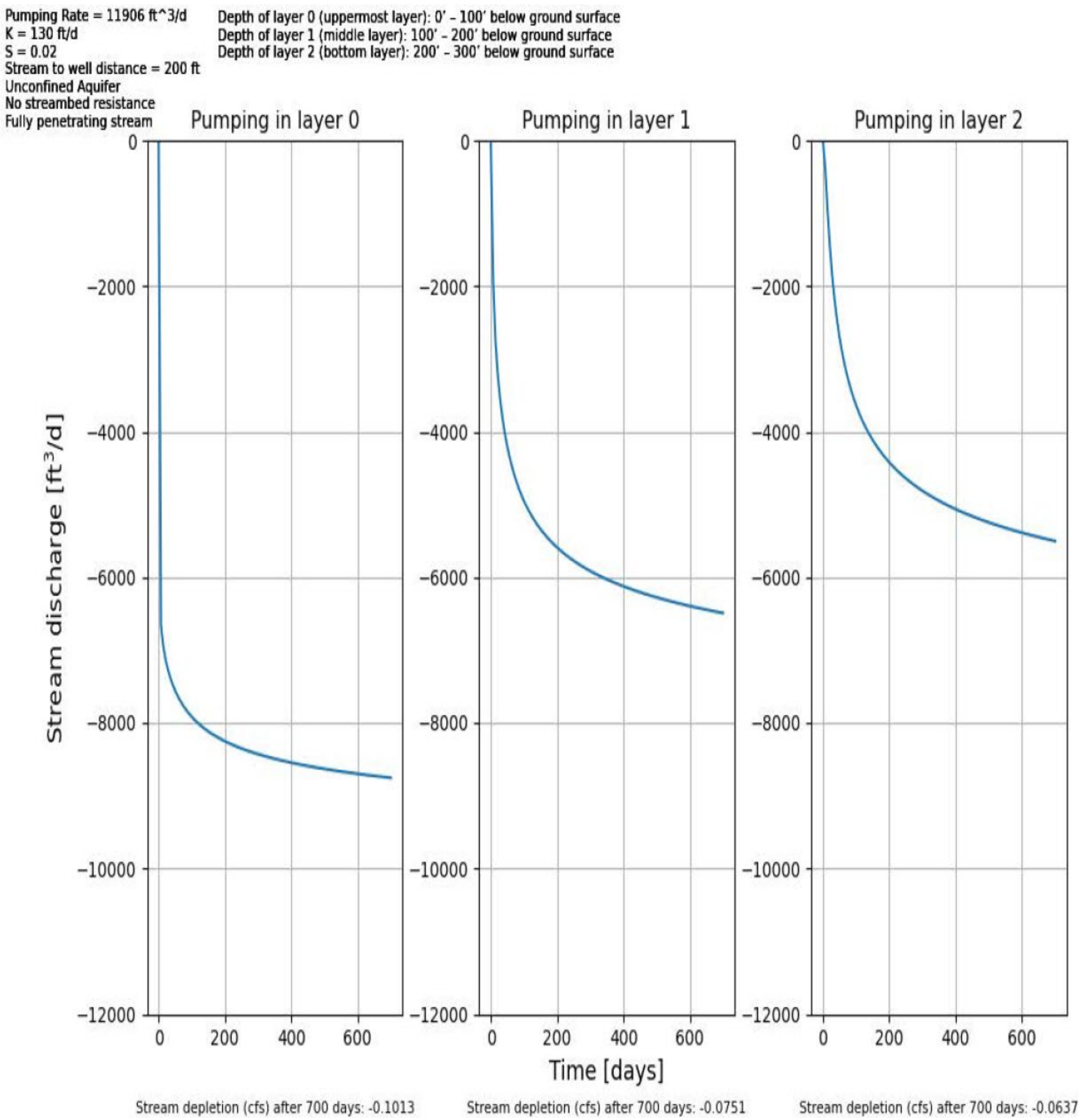


Figure 7-Simulation of Well Seal Depth Impacts on Groundwater Extraction at Different Depths (TTim, Bakker 2013)

Streamflow Depletion Assessments and Tool Selection :

In evaluating streamflow depletion due to groundwater pumping, County staff have used numeric groundwater models where they have been developed for the Mid County and Santa Margarita groundwater basins. Staff have also applied the analytical models developed by Hunt, Jenkins, Li, and Bakker. Staff have assessed more complex models cited by Li, et.al. and Bakker, recognizing their significance and usefulness in establishing thresholds for policy development and testing. These models are particularly valuable for evaluating impacts over extended timeframes, intermittent pumping, seal depths, setbacks, and areas requiring more thorough analysis.

While County staff found these programming models (Li. et al, Bakker) useful, they did not observe significant differences in the fundamental calculation for stream depletion (without incorporating well seals) when assuming fully penetrating streams with no streambed resistance compared to the simpler USGS web-based application, especially when analyzing single-point scenarios that focus on streams closest to the well. While the USGS web-based application may be suitable for Tier 3 applications, Tier 4 applicants must prepare a report by a qualified geoscience professional, such as a professional geologist, hydrogeologist, or engineering geologistto evaluate more detailed projected impacts, including the cumulative effects on streamflow in the overall basin. Because of this requirement, we encourage these consultants to consider using more advanced tools, particularly Li et al. for evaluating cumulative impacts on a network of streams and Bakker for evaluating the influence of deeper seals in minimizing stream depletion impacts.

When assessing whether Tier 3 applicants meet the minimum stream depletion standards, County staff will utilize ADFs and collect the necessary inputs, including pumping rates and stream setbacks (determined from well location), from the well application. Additionally, staff will use the proposed well location and depth to determine the corresponding aquifer and aquitard properties (if applicable), such as the permeability and storage coefficient, sourced from the Santa Margarita GSP (2021) and the Santa Cruz Mid-County Basin Model Integration and Calibration (2019) for wells located within these basins. For wells outside of these basin areas, representative hydraulic properties from Domenico and Schwartz (1990) will be used for specific geologic units not studied in the GSPs. Each evaluation will assume a 10-year pumping duration, which qualified geoscience professionals should also use when assessing stream depletion impacts for Tier 4 applicants.

Local Aquifer Properties: Range (typical value used)	**Transmissivity (ft^2/day) {gpd/ft}**	**Storage/ Storativity**	**Specific Yield**	**Hydraulic Conductivity**
TP-a - Purissima A	(2000) {15,000}	0.00055	0.02-0.07 (0.05)	5.2
TP-aa- Purissima AA	(600) {4500}	0.03100	(0.02)	1.7
TSM - Santa Margarita	430-7700 (3000) {22,500}	0.01	0.02-0.25 (0.2)	2-130
TLO - Lompico	500-3200 (2000) {15,000}	0.0000020	.02-.07 (.05)	0.5-7

Aromas/Purisima F	(4000) {30,000}	0.004		
Tm-Monterey	170-1000	0.00001-0.001	.01-.03	.05-.6

Table 3- Example aquifer parameters from Groundwater Sustainability Plans

Estimated Surface Water Depletion from Groundwater Pumping in Selected Santa Cruz County Streams

		Dry Season Flows, cfs (All Years)			
Creek		10th Percentile	Median	90th Percentile	Source
Bean Cr. @ Mt Hermon Rd (USGS)	Estimated Natural Flow*	0.509	1.08	1.89	FF model*
	Observed *	1.9	2.25	2.82	FF Database*
	Est.depletion by total gw pumping	0.5	0.5	0.5	GSP model
	% depletion**	21%	18%	15%	
	Est depletion by Non-Mun pumping	0.08	0.08	0.08	Apply Basin-wide proportion from GSP Model
	% Non-muni depletion	4%	3%	3%	
San Lorenzo River @ Big Trees (USGS)	Estimated Natural Flow*	15.2	20.2	23.7	FF model*
	Observed*	12	19	32	FF Database*
	Est.depletion by total gw pumping	1.5	1.5	1.5	GSP model
	% depletion**	10%	7%	4%	
	Est depletion by Non-Mun gw pumping	0.23	0.23	0.23	Apply Basin-wide proportion from GSP Model
	% Non-muni depletion	2%	1%	1%	
Moore Cr	Estimated Natural Flow*	0.0542	0.153	0.452	FF model*
	Observed	0.15	0.3	0.5	Estimated based on Occasional Measurements
	Est.depletion by Non-Mun gw pumping	0.03	0.03	0.03	Water Budget
	% depletion	17%	9%	6%	
Soquel Cr. @ Soquel (USGS) ***	Estimated Natural Flow*	2.44	3.05	5.28	FF model*
	Observed *	0.84	2.86	8.05	FF Database*
	Est.depletion by total gw pumping***	1.4	1.4	1.4	GSP model
	% depletion	57%	33%	15%	
	Est depletion by Non-Mun pumping	0.15	0.15	0.15	GSP Model
	% Non-muni depletion	15%	5%	2%	

Notes

* Estimated Natural Flow and Observed Flow is provided by the California Unimpaired Flow Database, v2.1.2 (Zimmerman, et.al., 2023)

** % depletion is the estimated depletion divided by the greater of the estimated natural flow, or the observed flow plus the estimated depletion

*** Soquel Creek experiences signficant riparian surface diversions, potentially 0.5-0.7 cfs (RCDSCC,2019).

The potential effect of surface diversions has not been factored into this table, other than where the estimated natural flow is used.

Table 4- Estimated Natural Flows and Depletion Based on Natural Flows Database, Streamflow Measurements, Local Groundwater Modelling, and Water Budgets

Well Interference

County staff have used the Modified Theis Non-Equilibrium Equation to estimate the amount of drawdown at various distances from a proposed pumping well in order to evaluate the potential for well interference and potential impacts on nearby wells. Values for local aquifer properties, pumping rates and potential setbacks were entered in the formula to produce an estimated drawdown. The following table shows the setbacks required for particular pumping rates in order to keep the drawdown less than 5 ft after 180 days of pumping.

Pumping Rate (GPM)	**2**	**8**	**20**	**50**	**100**
Aquifer					
TP-a/TLO	10	10	10	10	150
TP-aa	10	10	25	500	1400
TSM	10	10	10	10	25

Equation	**s=(264Q/T)*log(.3Tt/((r^2)S)**		**Input Values**	**Result**
Q	Discharge	gpm	50	
T	Transmissivity	gpd/ft;(7.48*ft^2/d)	4500	
S	Storage Coefficient	dimensionless	0.020	
t	Pumping time	days	180	
r	Distance	ft	100	
s=	drawdown-calculated	ft		**9.0**

County staff is proposing to use a standard of 50 ft separation for de minimis wells and replacement non-de minimis wells, although a greater setback could be required for new non-de minimis wells after applying the Modified Theis Non Equilibrium Equation to the specific well and aquifer properties.

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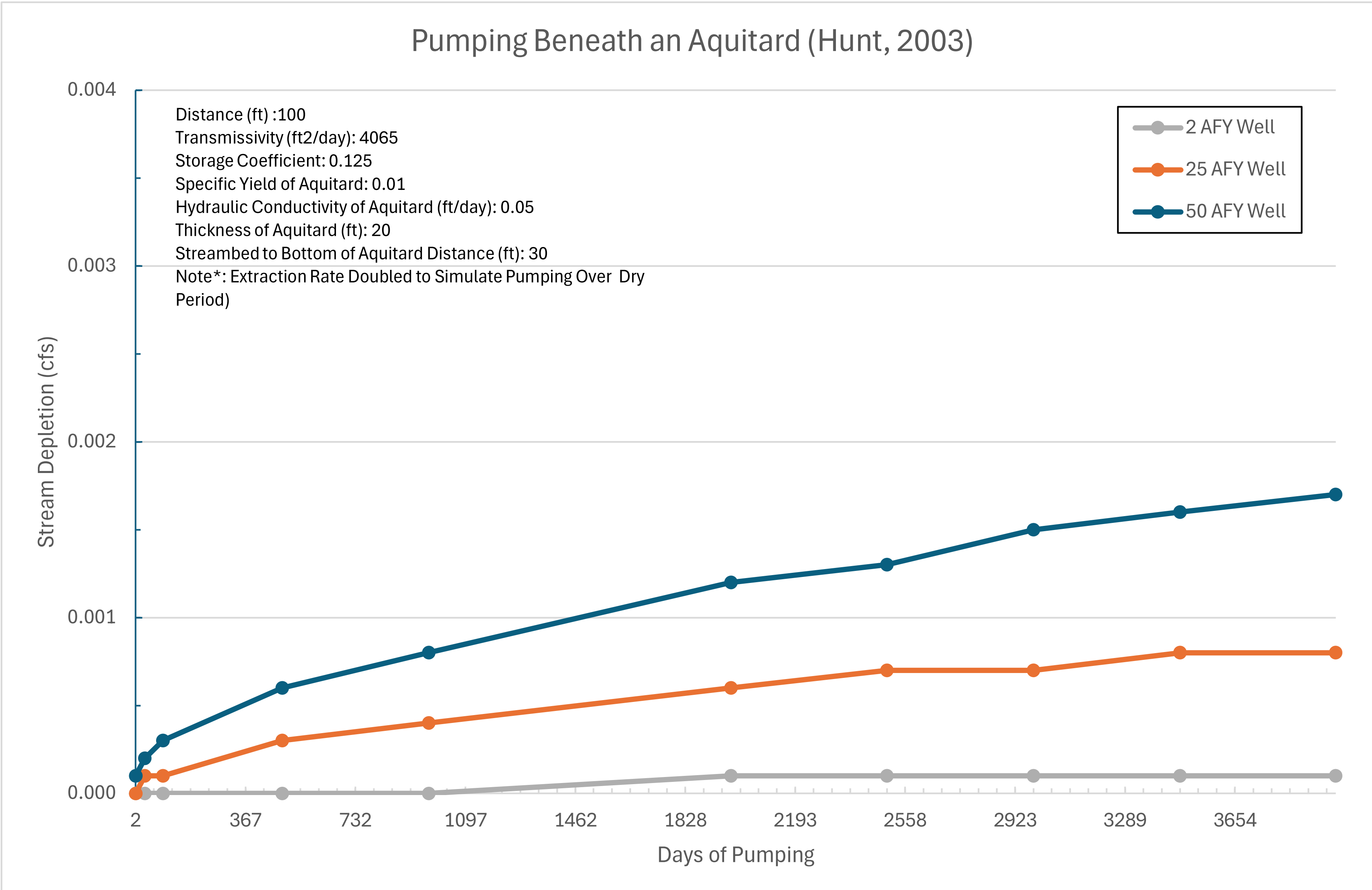
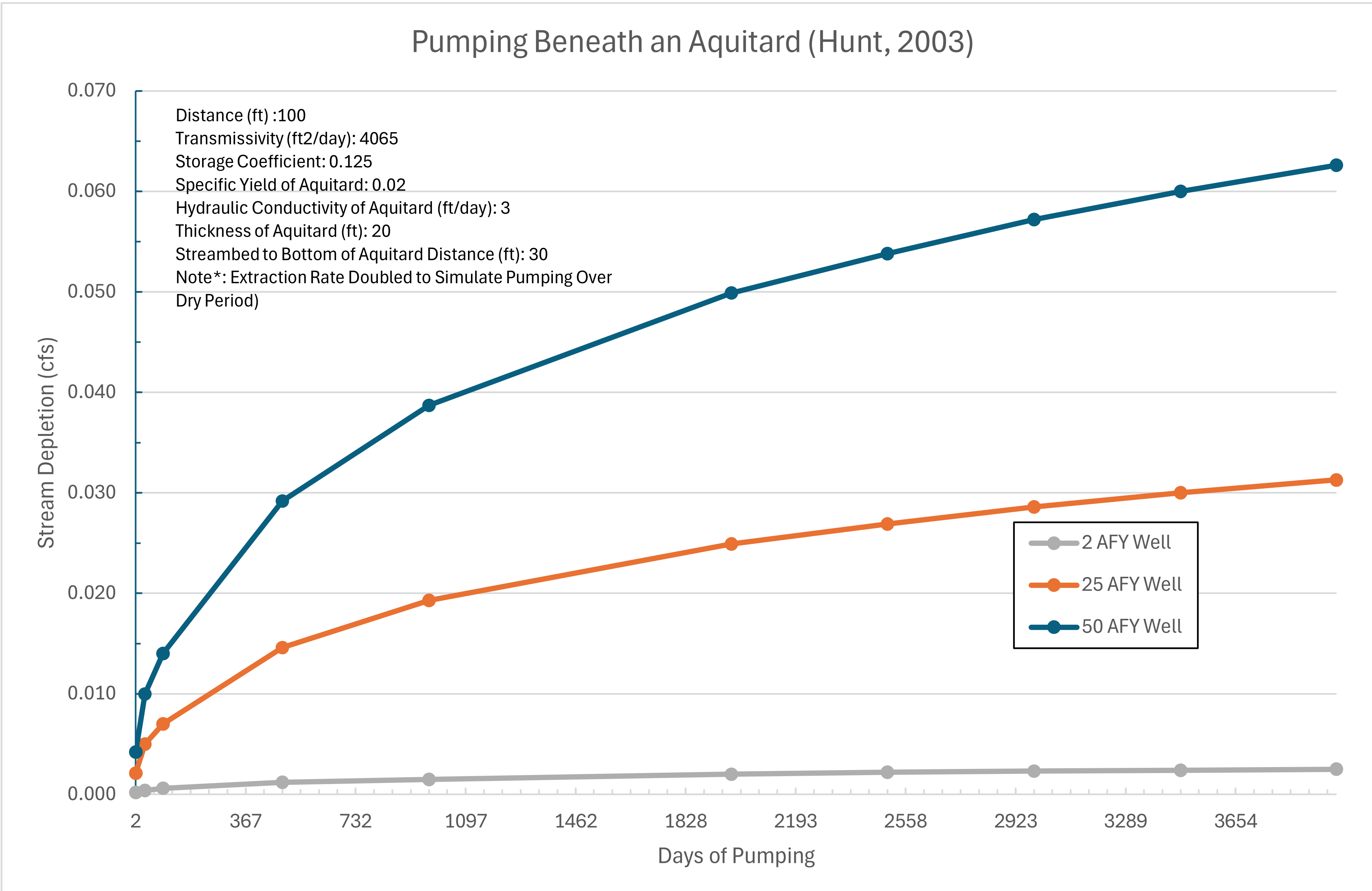
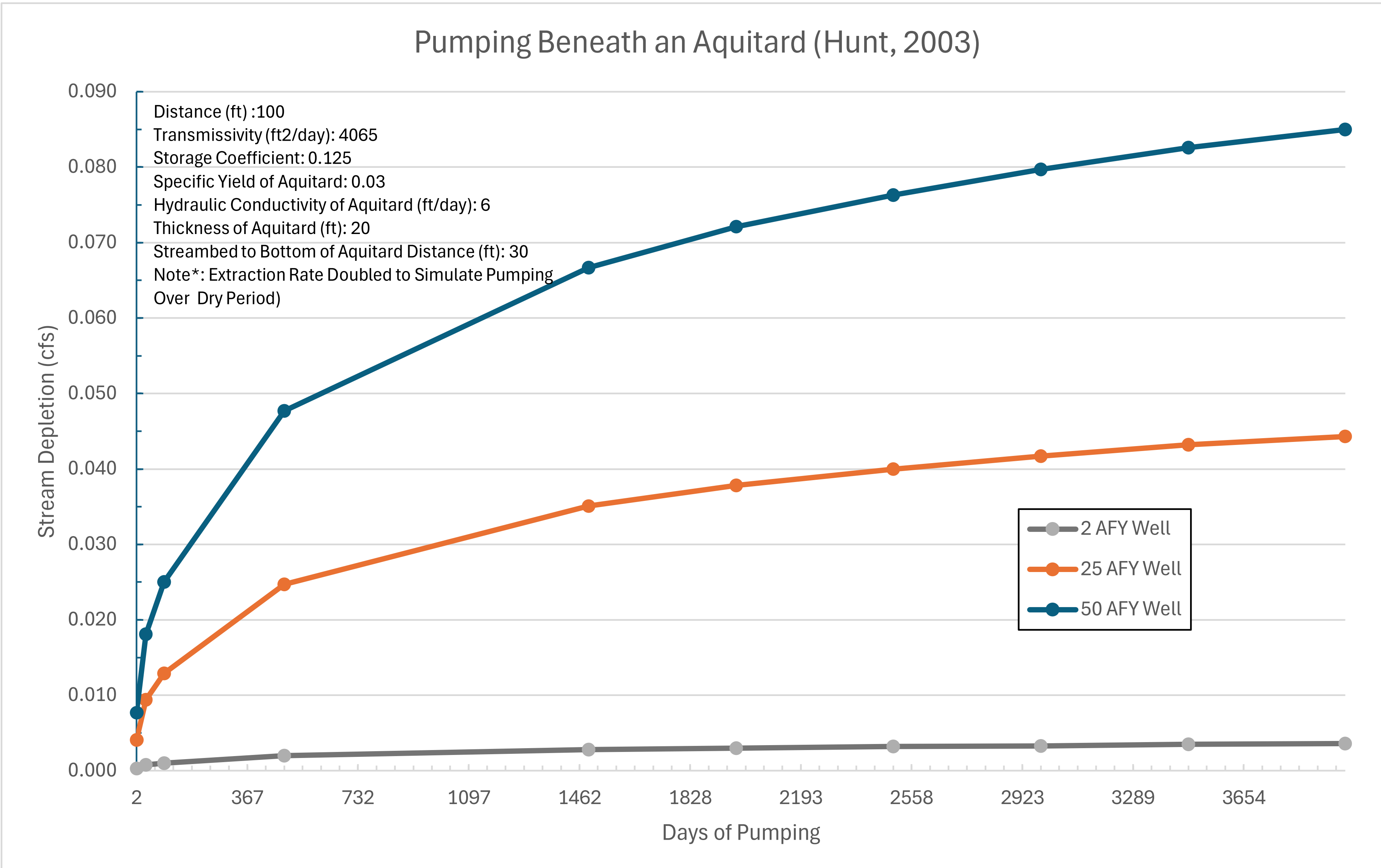


Pumping Beneath an Aquitard (Hunt, 2003)
Distance (ft) :100
Transmissivity (ft2/day): 4065
Storage Coefficient: 0.125
Specific Yield of Aquitard: 0.01
Hydraulic Conductivity of Aquitard (ft/day): 0.05
Thickness of Aquitard (ft): 20
Streambed to Bottom of Aquitard Distance (ft): 30
Note*: Extraction Rate Doubled to Simulate Pumping Over Dry Period)
2 AFY Well
25 AFY Well
50 AFY Well
Stream Depletion (cfs)
0.004
0.003
0.002
0.001
0.000
2
367
732
1097
1462
1828
2193
2558
2923
3289
3654
Days of Pumping



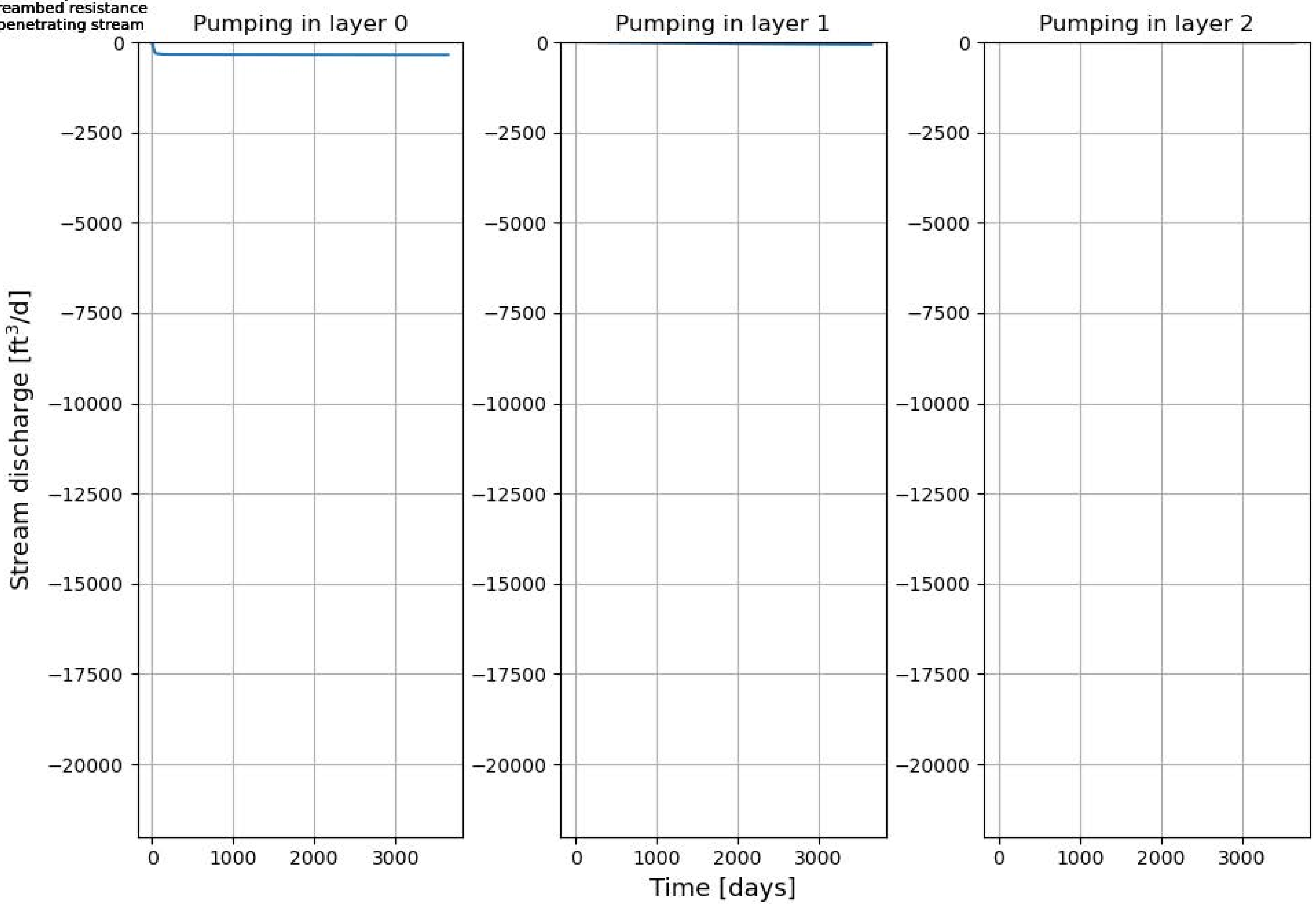
Pumping Beneath an Aquitard (Hunt, 2003)
Distance (ft) :100
Transmissivity (ft2/day): 4065
Storage Coefficient: 0.125
Specific Yield of Aquitard: 0.02
Hydraulic Conductivity of Aquitard (ft/day): 3
Thickness of Aquitard (ft): 20
Streambed to Bottom of Aquitard Distance (ft): 30
Note*: Extraction Rate Doubled to Simulate Pumping Over Dry Period)
Stream Depletion (cfs)
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
2
367
732
1097
1462
1828
2193
2558
2923
3289
3654
Days of Pumping
2 AFY Well
25 AFY Well
50 AFY Well



Pumping Beneath an Aquitard (Hunt, 2003)
Distance (ft) :100
Transmissivity (ft2/day): 4065
Storage Coefficient: 0.125
Specific Yield of Aquitard: 0.03
Hydraulic Conductivity of Aquitard (ft/day): 6
Thickness of Aquitard (ft): 20
Streambed to Bottom of Aquitard Distance (ft): 30
Note*: Extraction Rate Doubled to Simulate Pumping Over Dry Period)
Stream Depletion (cfs)
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
2
367
732
1097
1462
1828
2193
2558
2923
3289
3654
Days of Pumping
2 AFY Well
25 AFY Well
50 AFY Well

Pumping Rate = 480 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



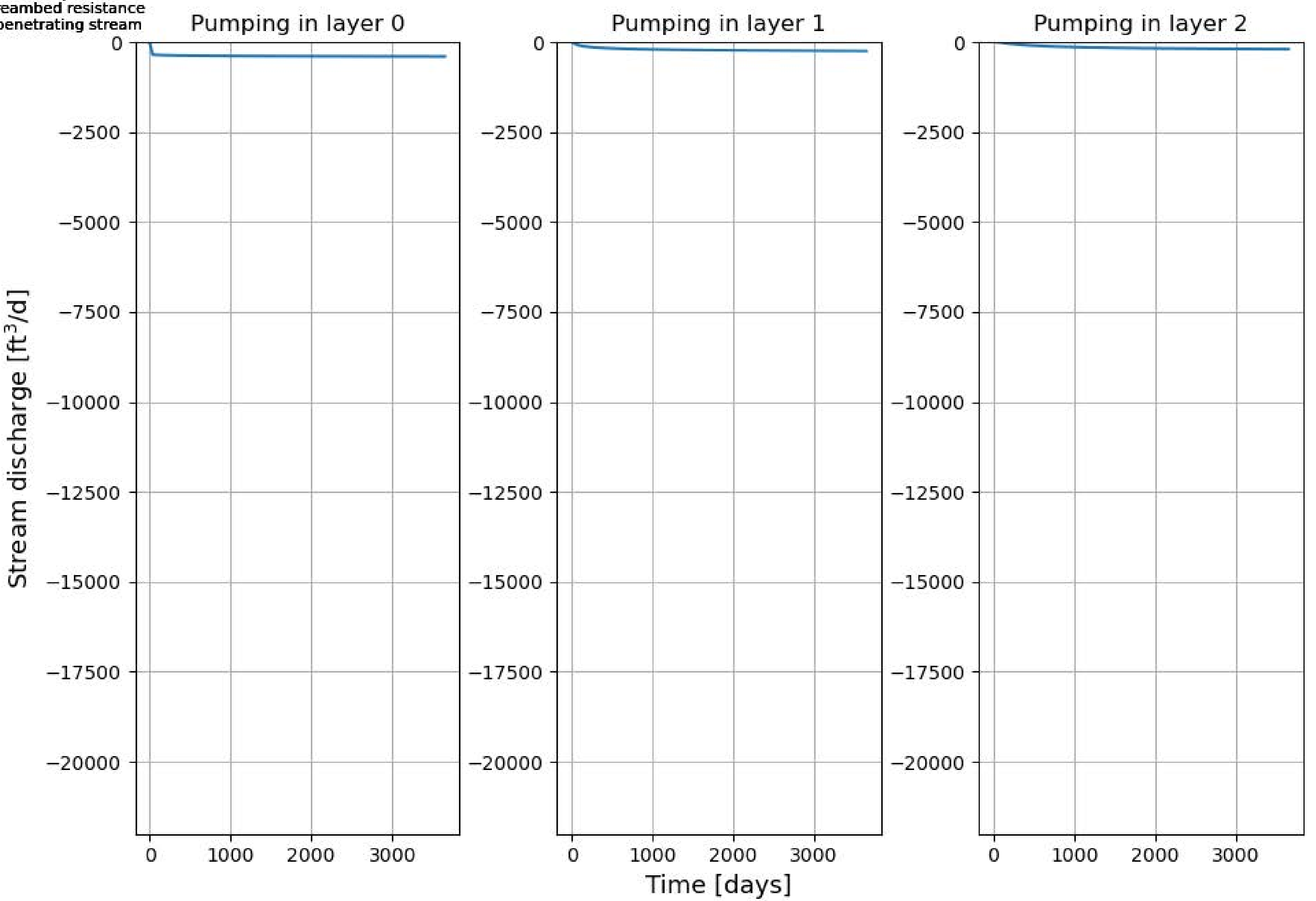
Stream depletion (cfs) after 10 years: -0.0041

Stream depletion (cfs) after 10 years: -0.0008

Stream depletion (cfs) after 10 years: -0.0001

Pumping Rate = 480 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

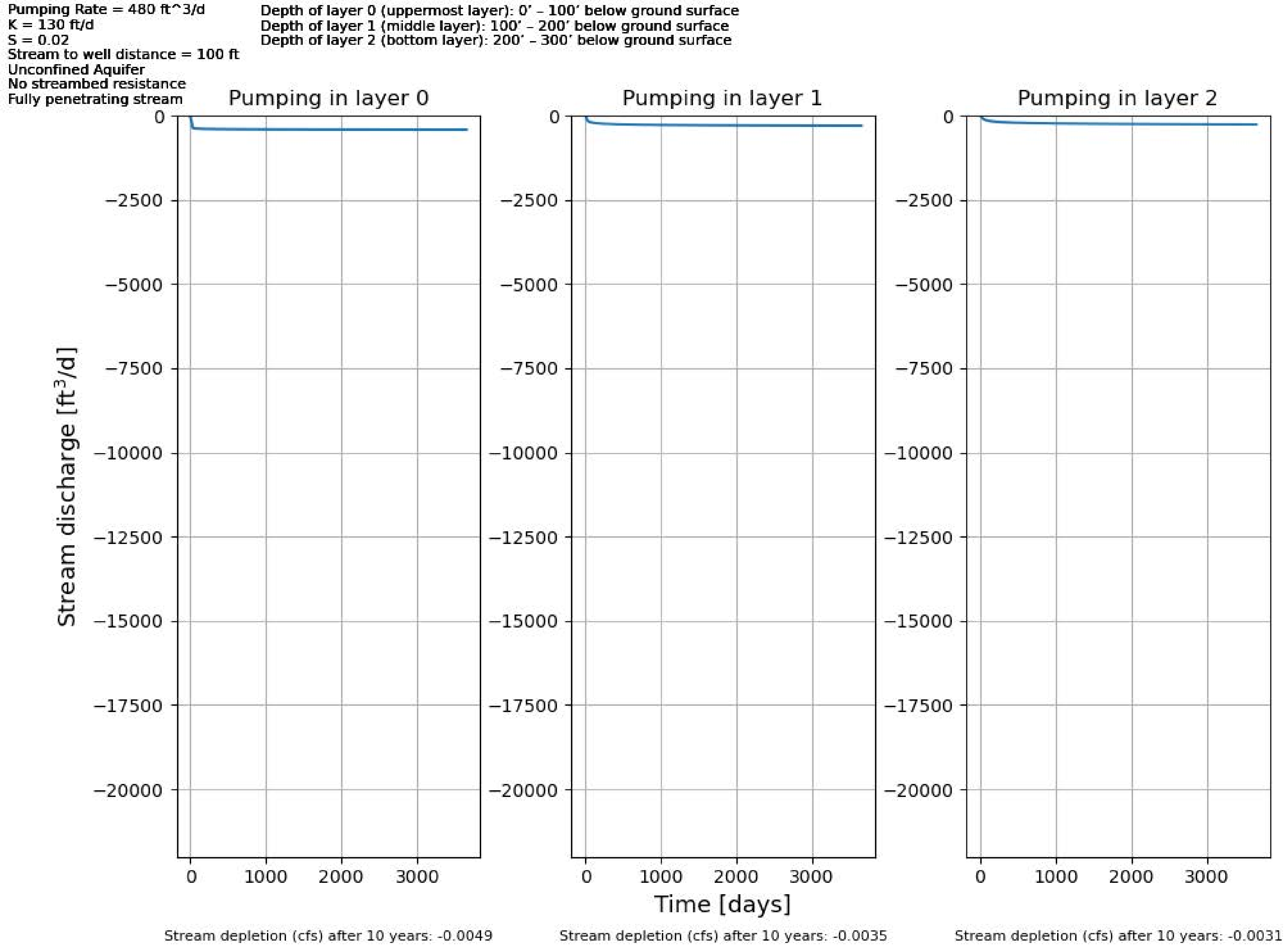
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface

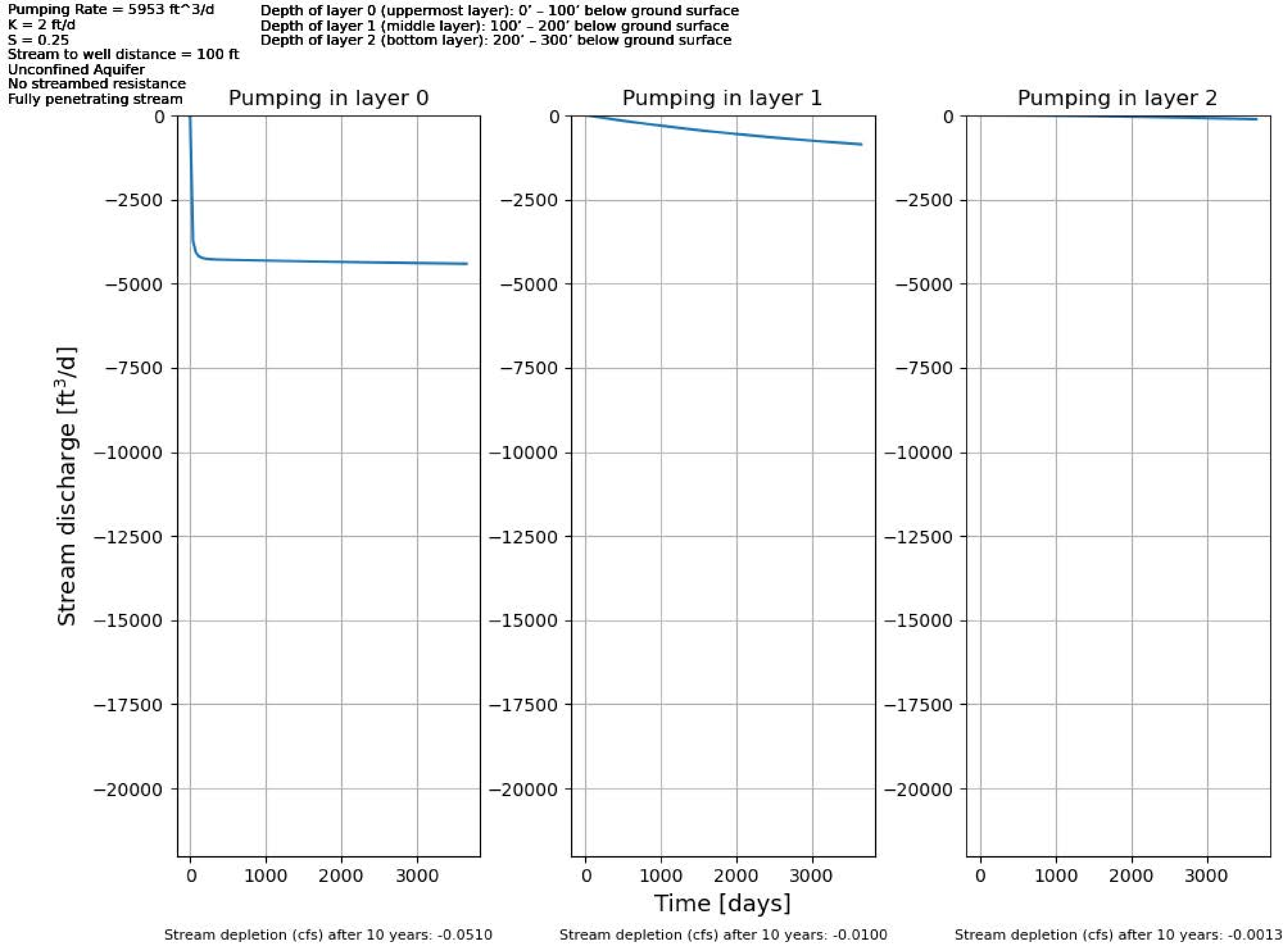


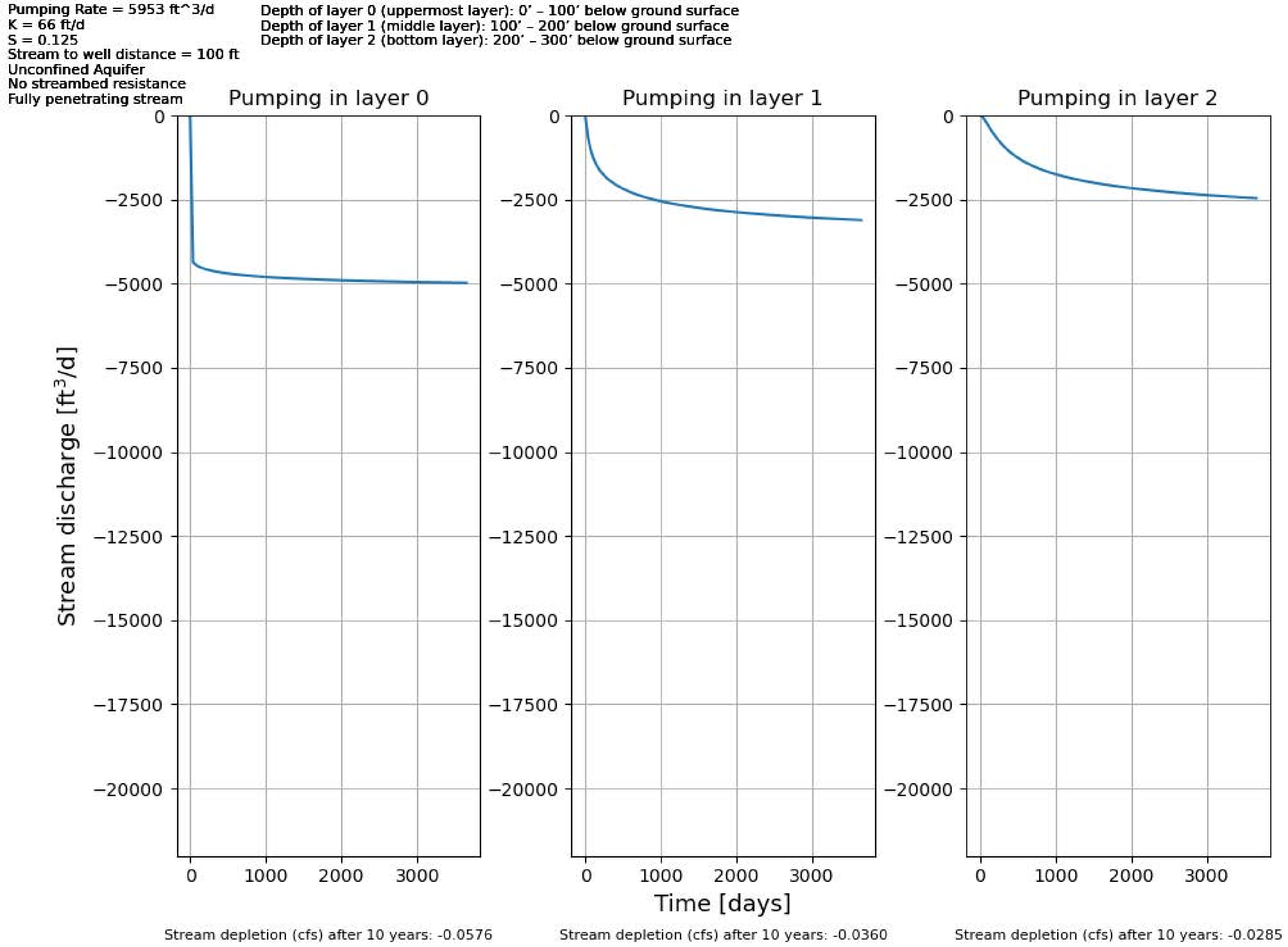
Stream depletion (cfs) after 10 years: -0.0046

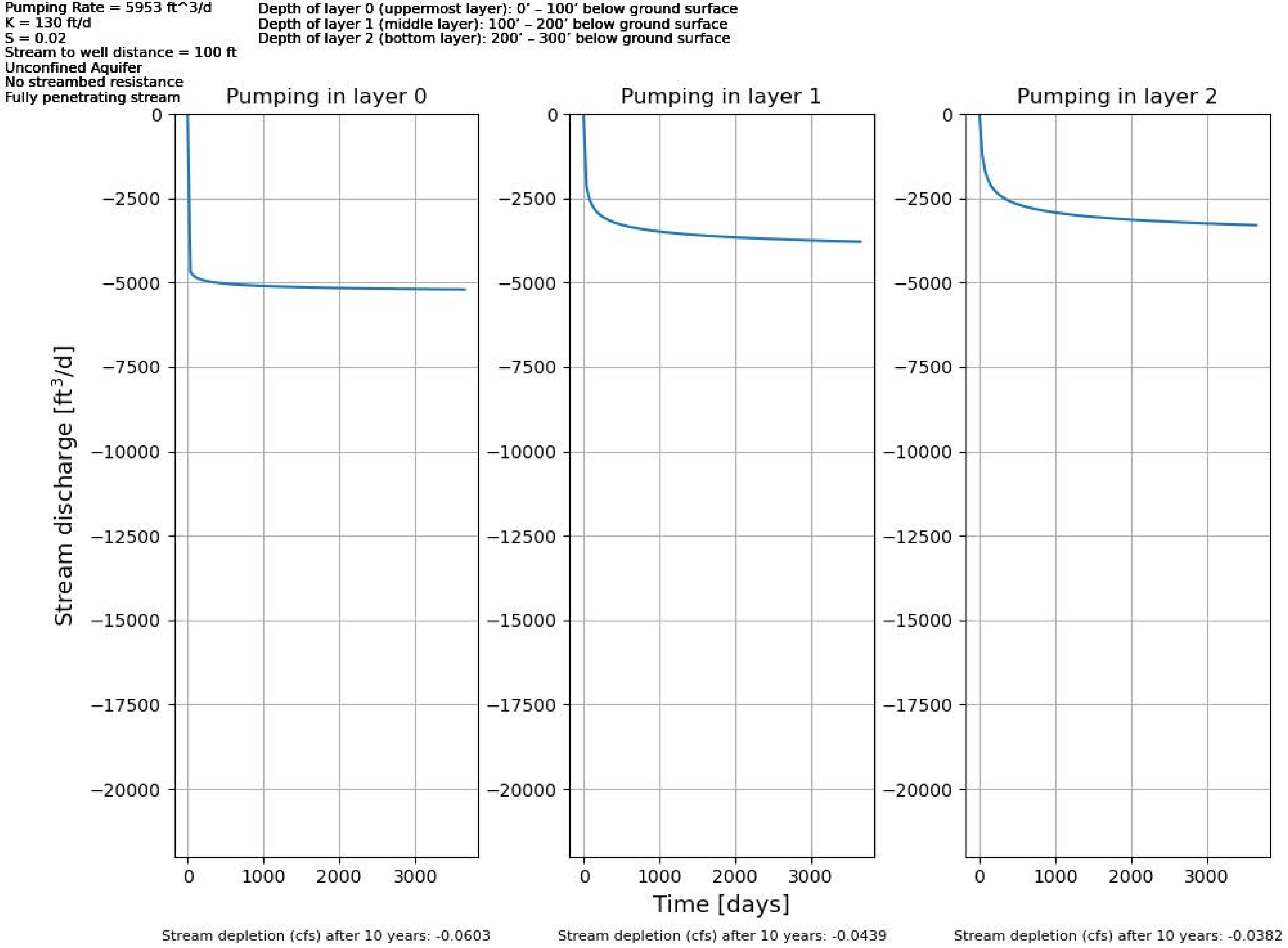
Stream depletion (cfs) after 10 years: -0.0029

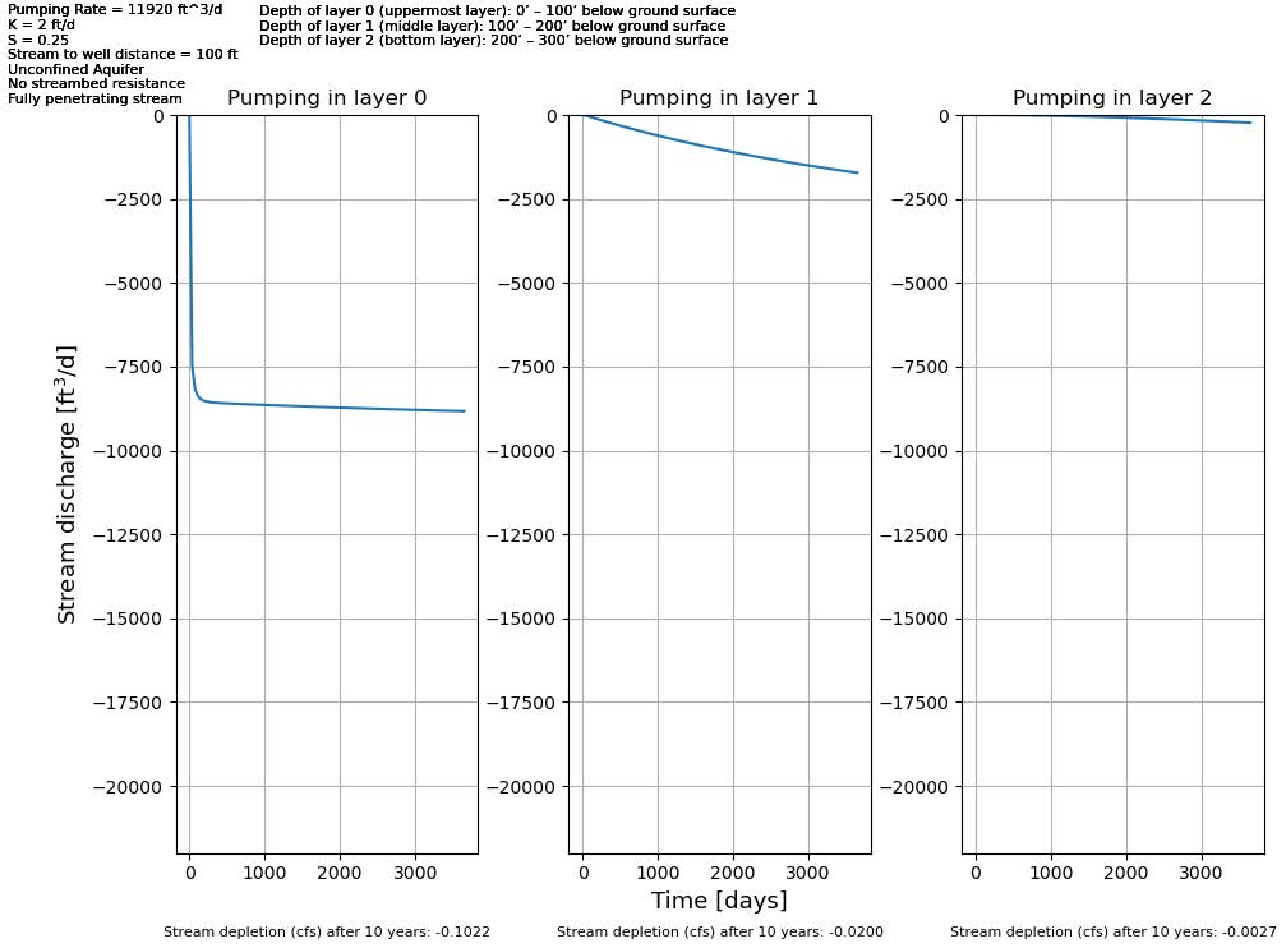
Stream depletion (cfs) after 10 years: -0.0023

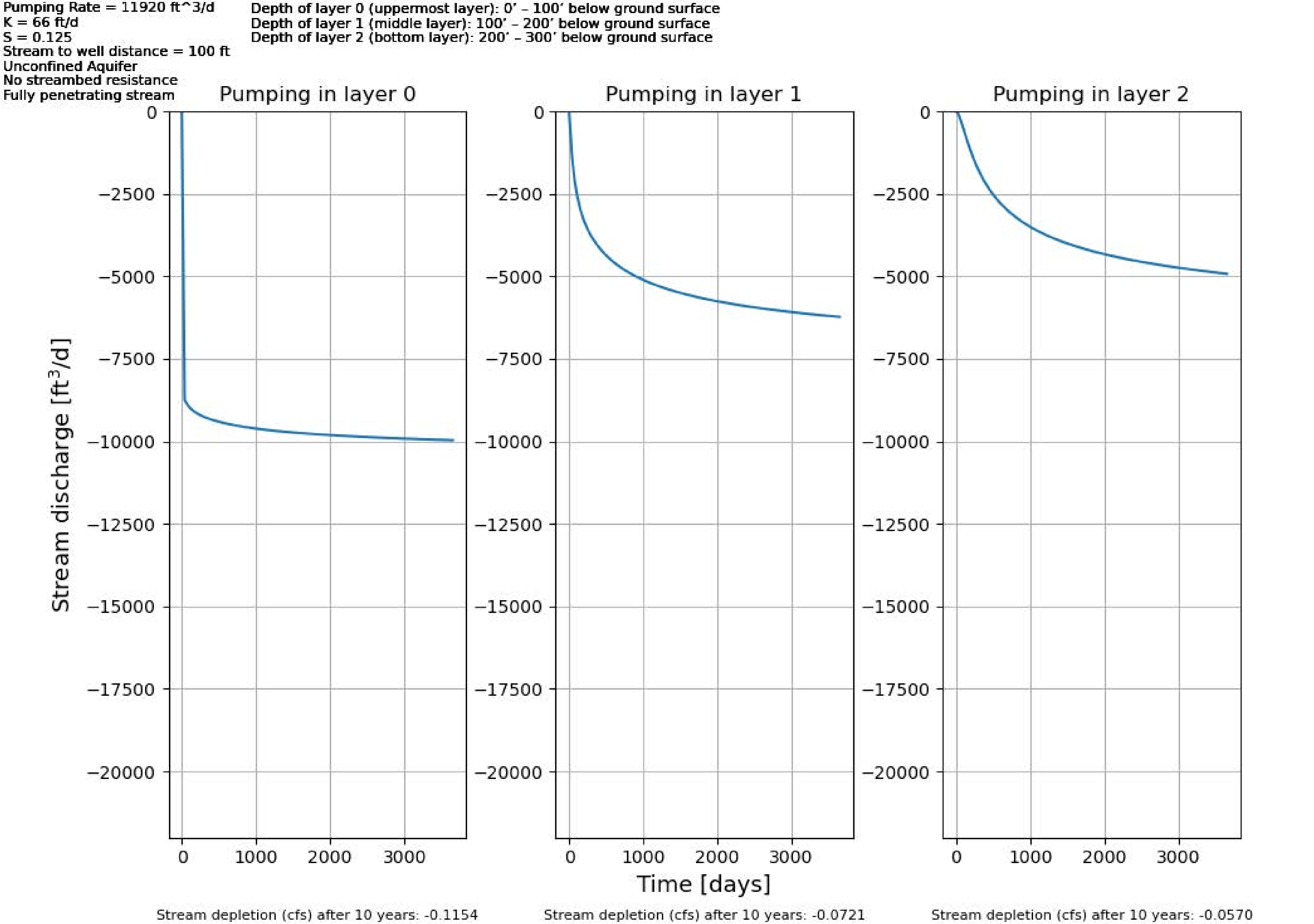

Pumping Rate = 480 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
1000
2000
3000
Time [days]
Stream depletion (cfs) after 10 years: -0.0049
Stream depletion (cfs) after 10 years: -0.0035
Stream depletion (cfs) after 10 years: -0.0031


Pumping Rate = 5953 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
1000
2000
3000
Time [days]
Stream depletion (cfs) after 10 years: -0.0510
Stream depletion (cfs) after 10 years: -0.0100
Stream depletion (cfs) after 10 years: -0.0013


Pumping Rate = 5953 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
Time [days]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
1000
2000
3000
Stream depletion (cfs) after 10 years: -0.0576
Stream depletion (cfs) after 10 years: -0.0360
Stream depletion (cfs) after 10 years: -0.0285

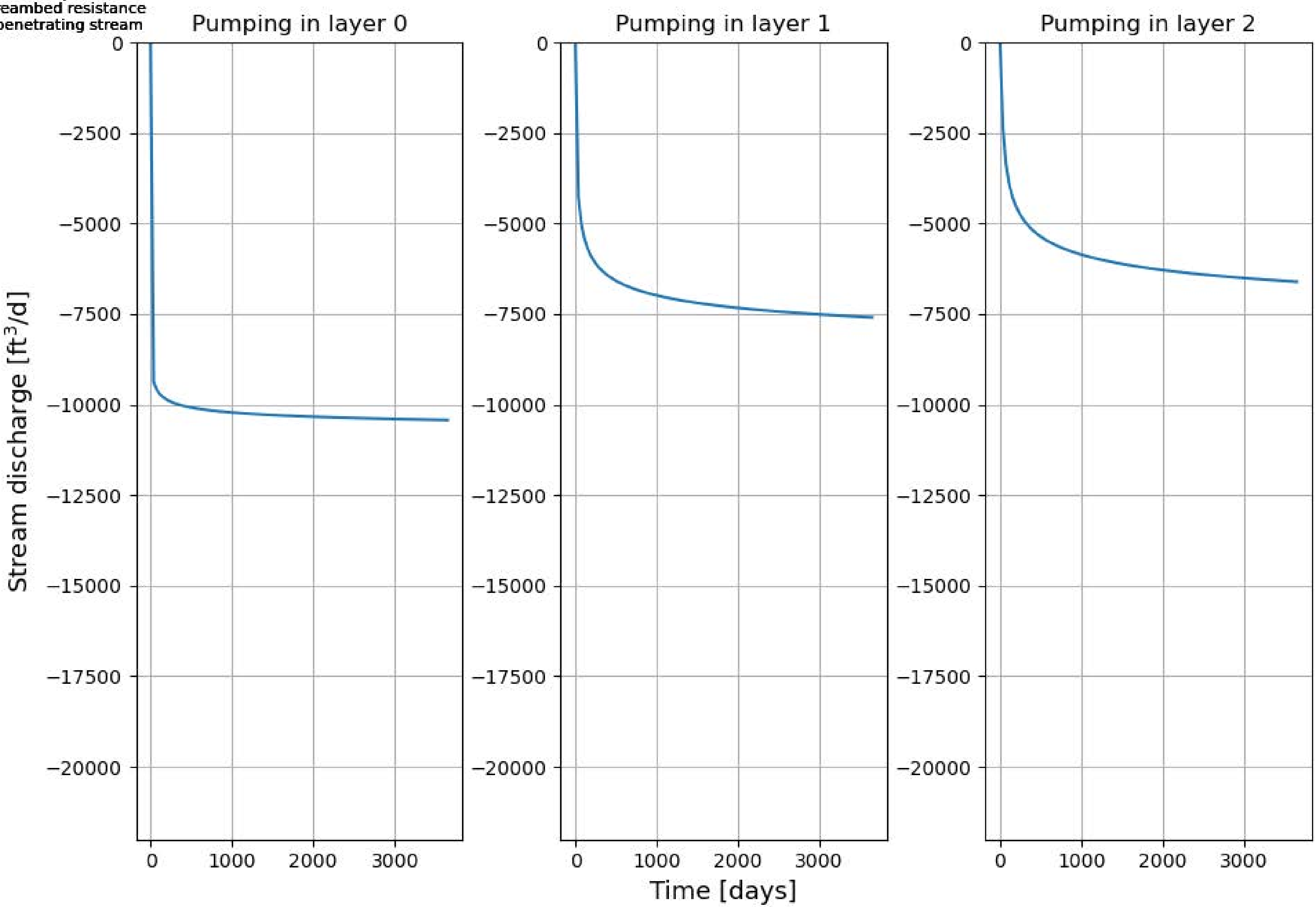

Pumping Rate = 5953 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
1000
2000
3000
Time [days]
Stream depletion (cfs) after 10 years: -0.0603
Stream depletion (cfs) after 10 years: -0.0439
Stream depletion (cfs) after 10 years: -0.0382


Pumping Rate = 11920 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
1000
2000
3000
Time [days]
Stream depletion (cfs) after 10 years: -0.1022
Stream depletion (cfs) after 10 years: -0.0200
Stream depletion (cfs) after 10 years: -0.0027


Pumping Rate = 11920 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
Time [days]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
1000
2000
3000
Stream depletion (cfs) after 10 years: -0.1154
Stream depletion (cfs) after 10 years: -0.0721
Stream depletion (cfs) after 10 years: -0.0570

Pumping Rate = 11920 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

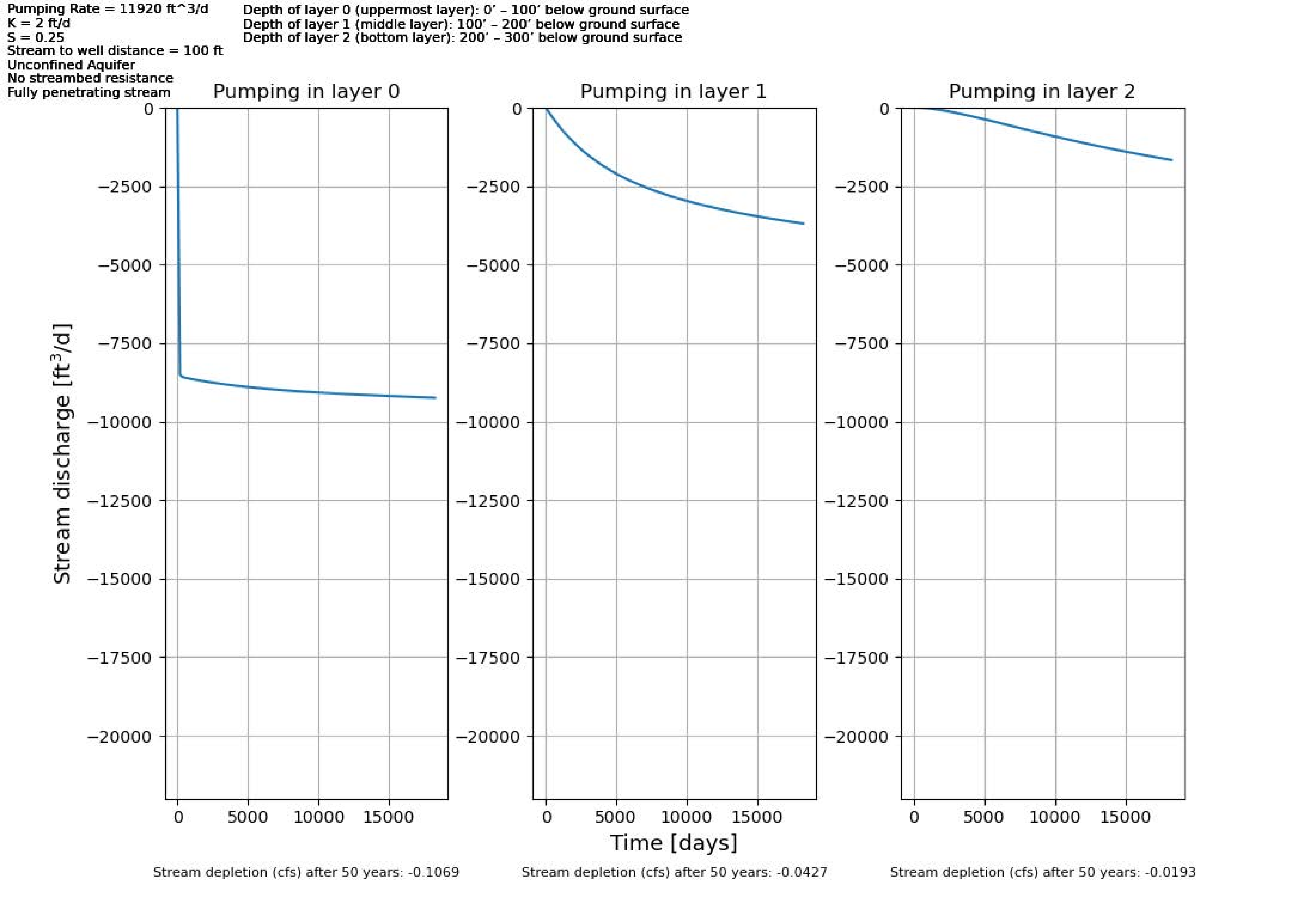
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface

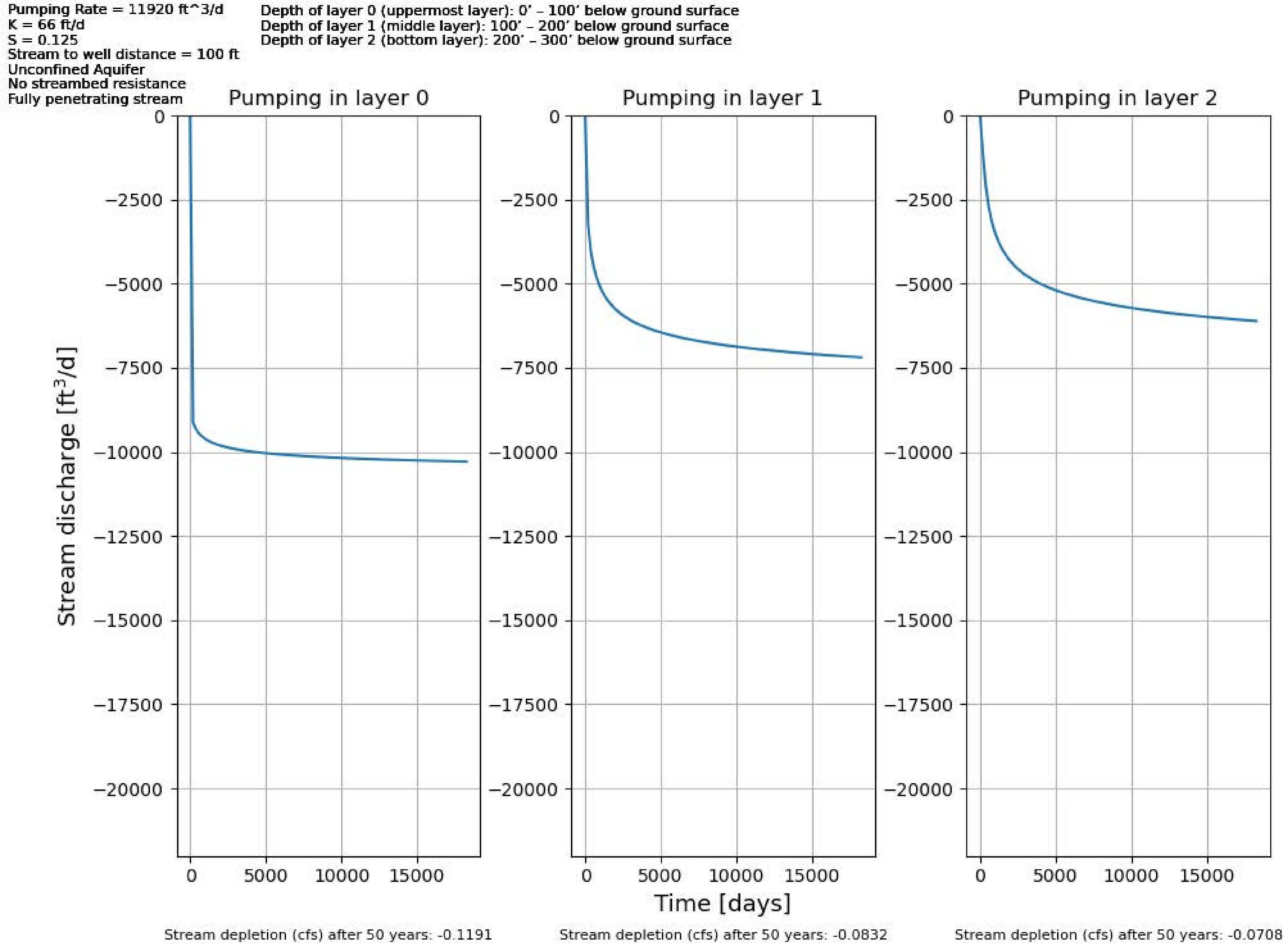


Stream depletion (cfs) after 10 years: -0.1207

Stream depletion (cfs) after 10 years: -0.0879

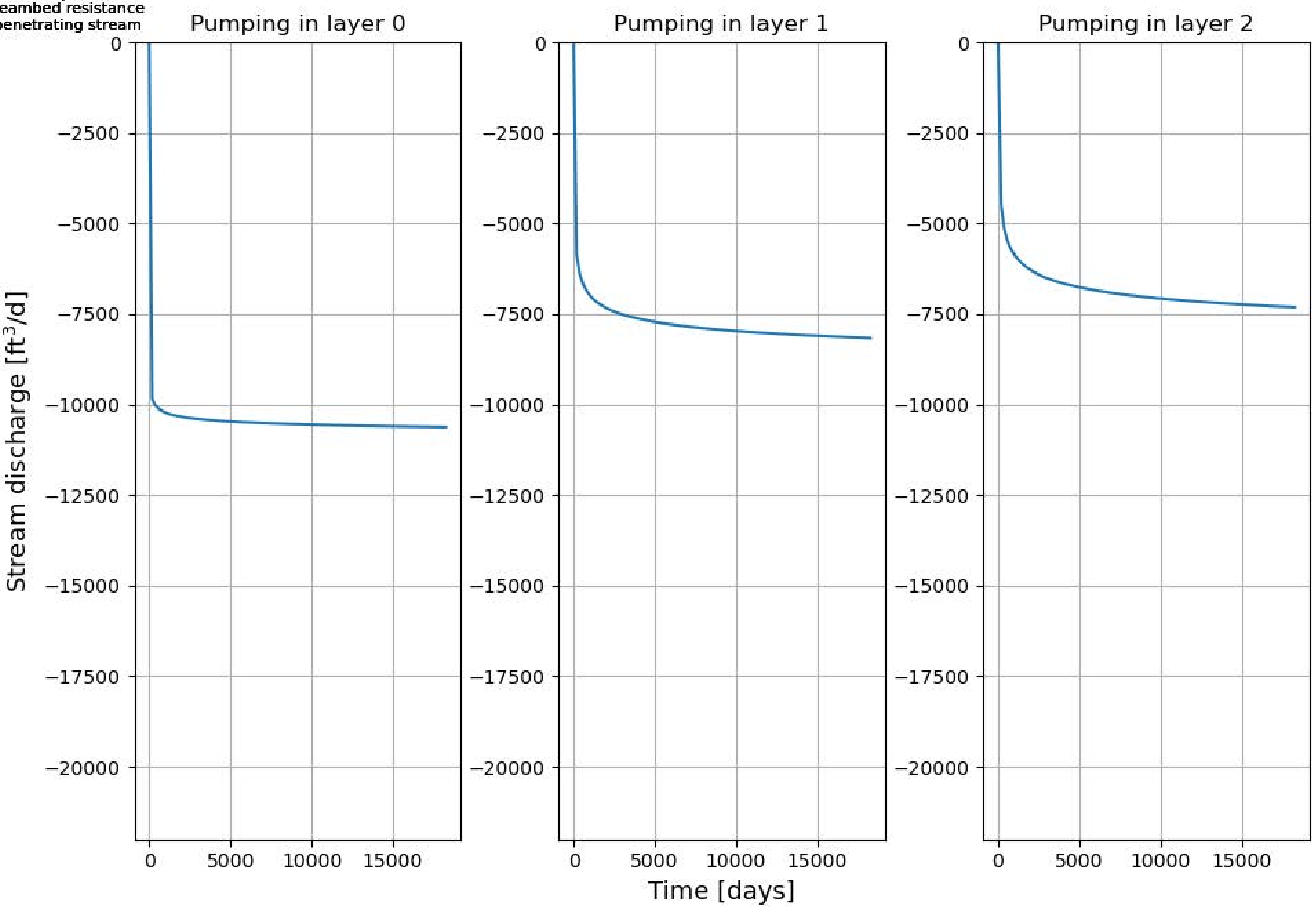
Stream depletion (cfs) after 10 years: -0.0765


Pumping Rate = 11920 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft3/d]
Time [days]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
5000
10000
15000
Stream depletion (cfs) after 50 years: -0.1069
Stream depletion (cfs) after 50 years: -0.0427
Stream depletion (cfs) after 50 years: -0.0193


Pumping Rate = 11920 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
5000
10000
15000
Time [days]
Stream depletion (cfs) after 50 years: -0.1191
Stream depletion (cfs) after 50 years: -0.0832
Stream depletion (cfs) after 50 years: -0.0708

Pumping Rate = 11920 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

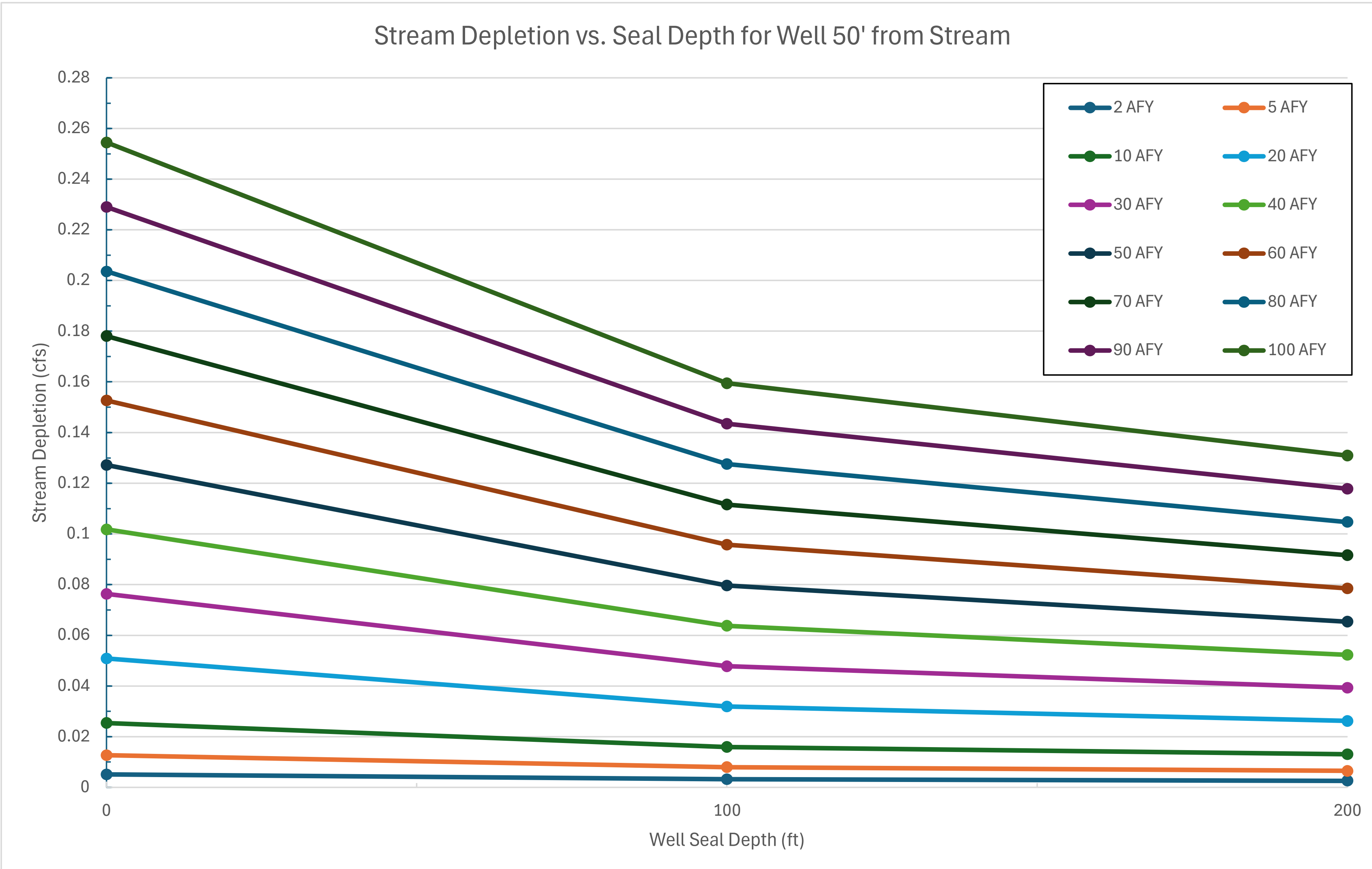
Depth of layer 0 (uppermost layer): 0’ – 100’ below ground surface
Depth of layer 1 (middle layer): 100’ – 200’ below ground surface
Depth of layer 2 (bottom layer): 200’ – 300’ below ground surface



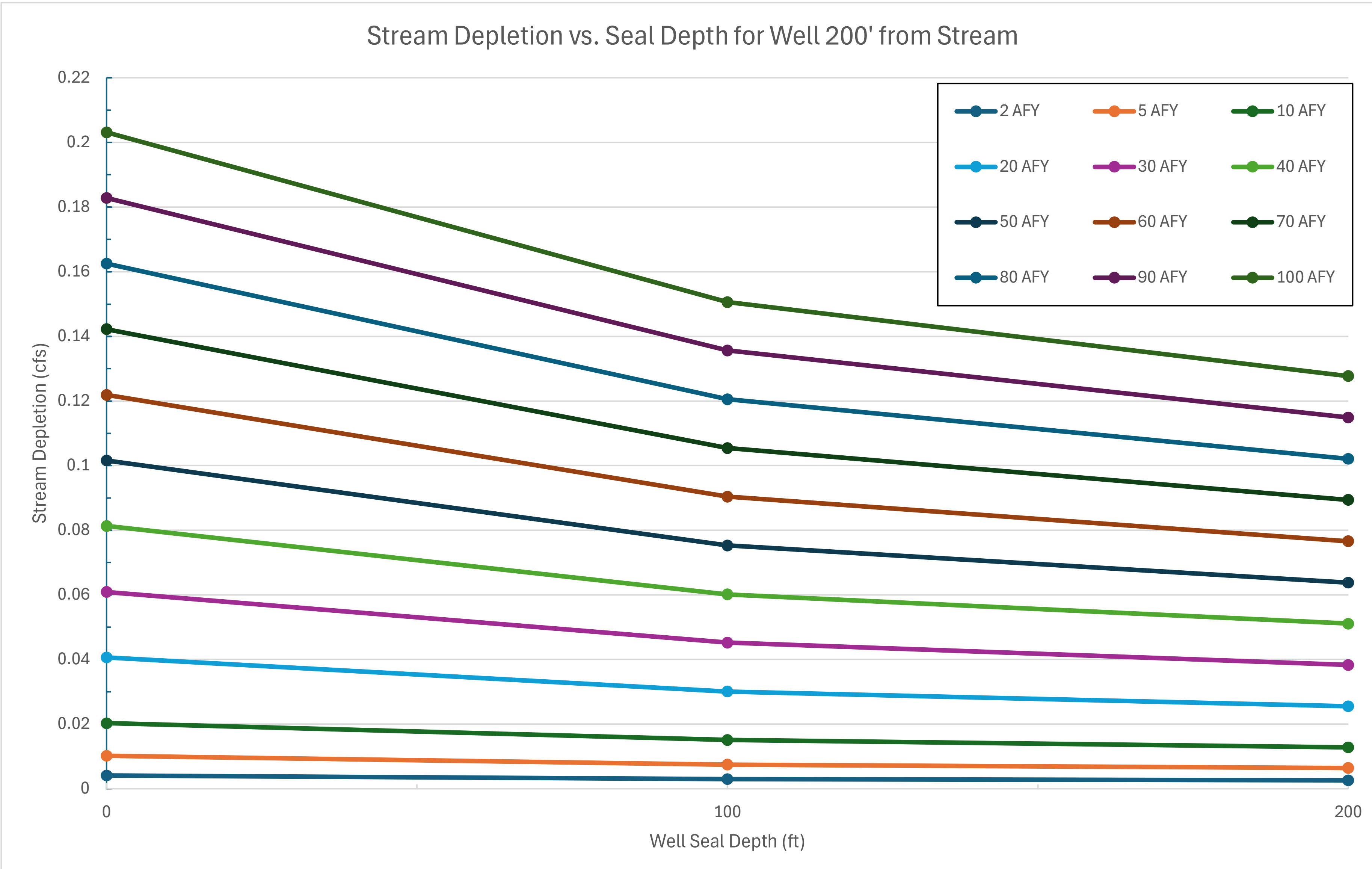
Stream depletion (cfs) after 50 years: -0.1230

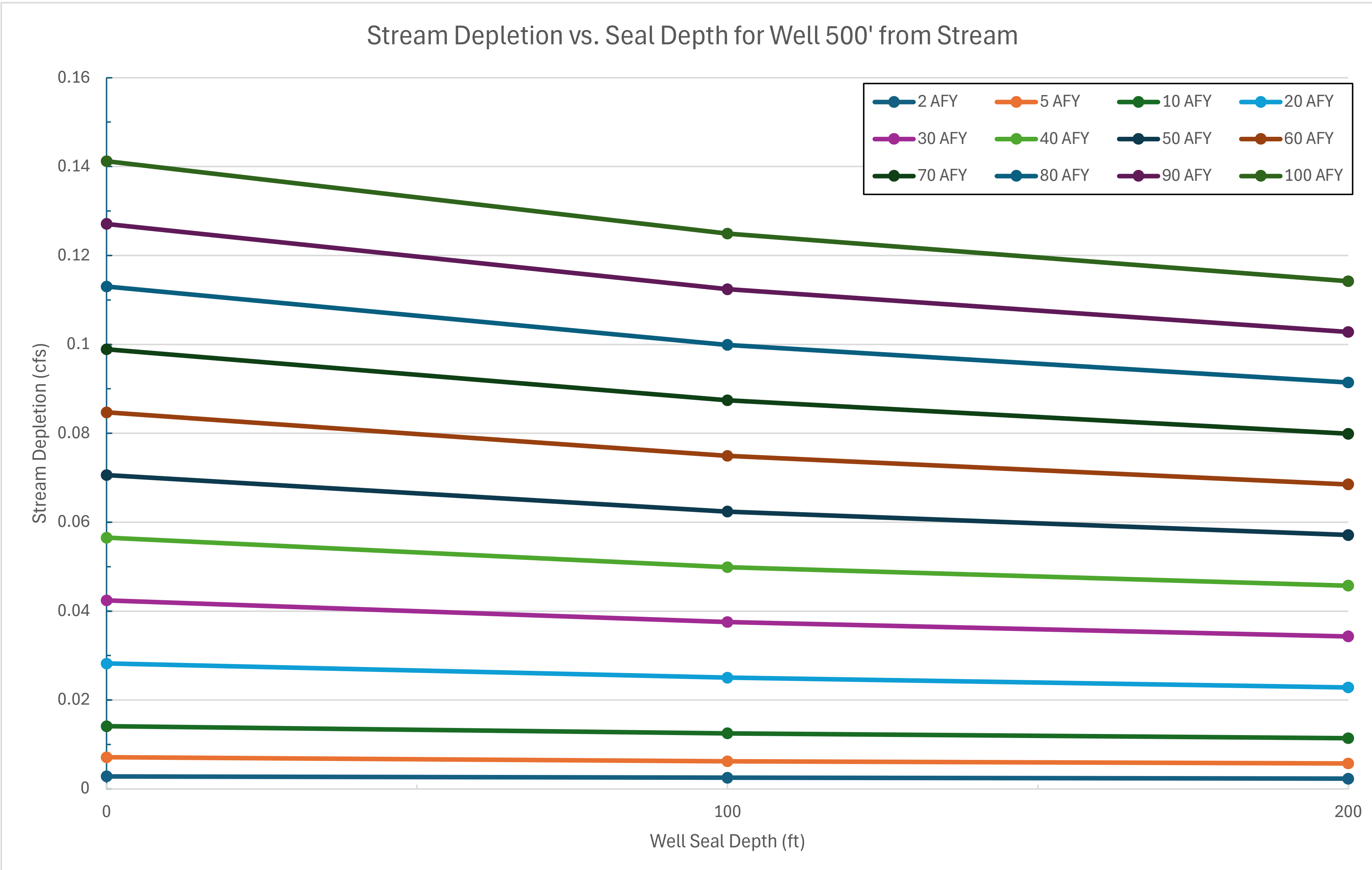
Stream depletion (cfs) after 50 years: -0.0945

Stream depletion (cfs) after 50 years: -0.0847

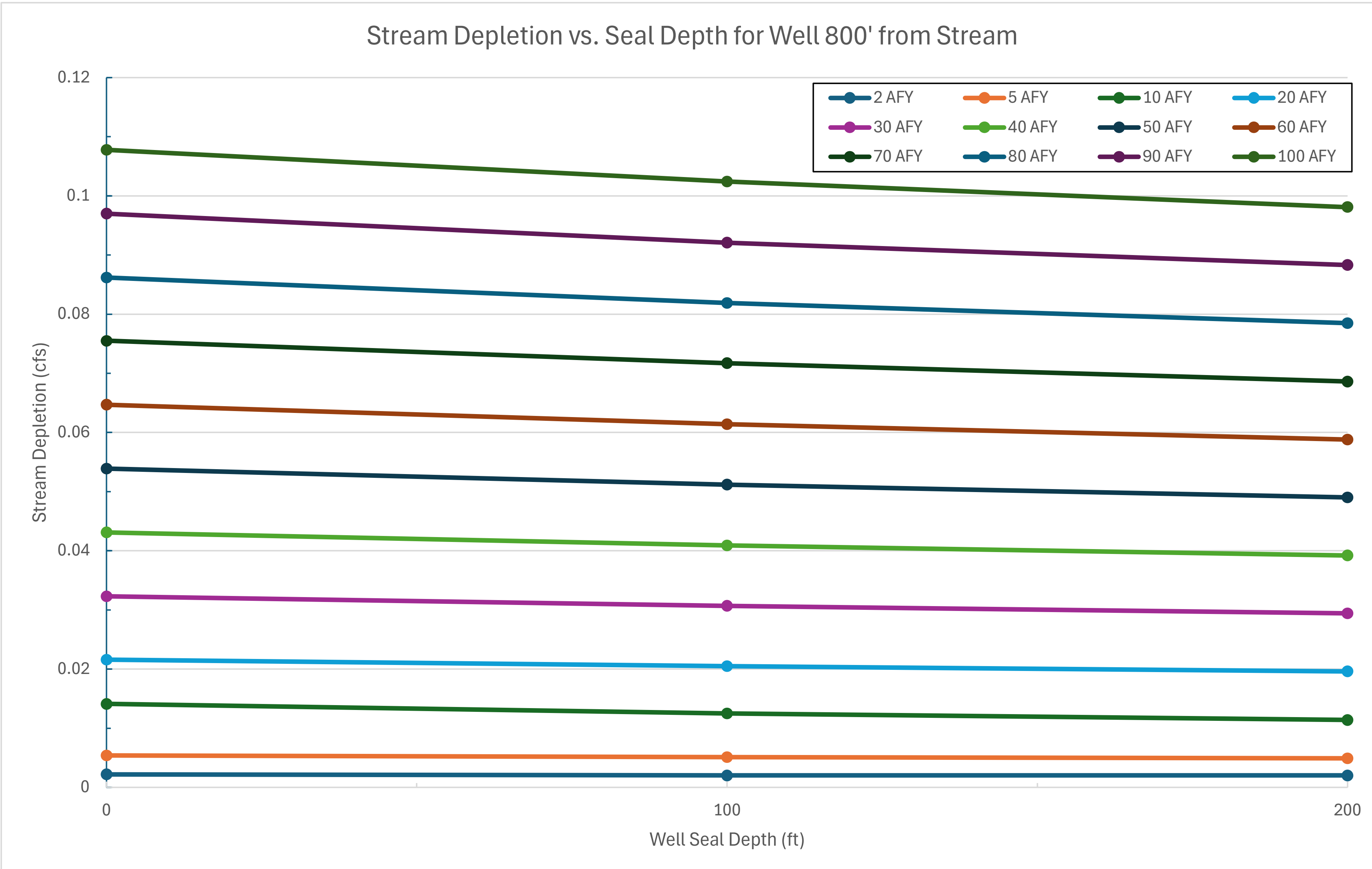


Stream Depletion vs. Seal Depth for Well 50' from Stream
Stream Depletion (cfs)
0.28
0.26
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
100
200
Well Seal Depth (ft)
2 AFY
5 AFY
10 AFY
20 AFY
30 AFY
40 AFY
50 AFY
60 AFY
70 AFY
80 AFY
90 AFY
100 AFY


Stream Depletion vs. Seal Depth for Well 200' from Stream
Stream Depletion (cfs)
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
100
200
Well Seal Depth (ft)
2 AFY
5 AFY
10 AFY
20 AFY
30 AFY
40 AFY
50 AFY
60 AFY
70 AFY
80 AFY
90 AFY
100 AFY



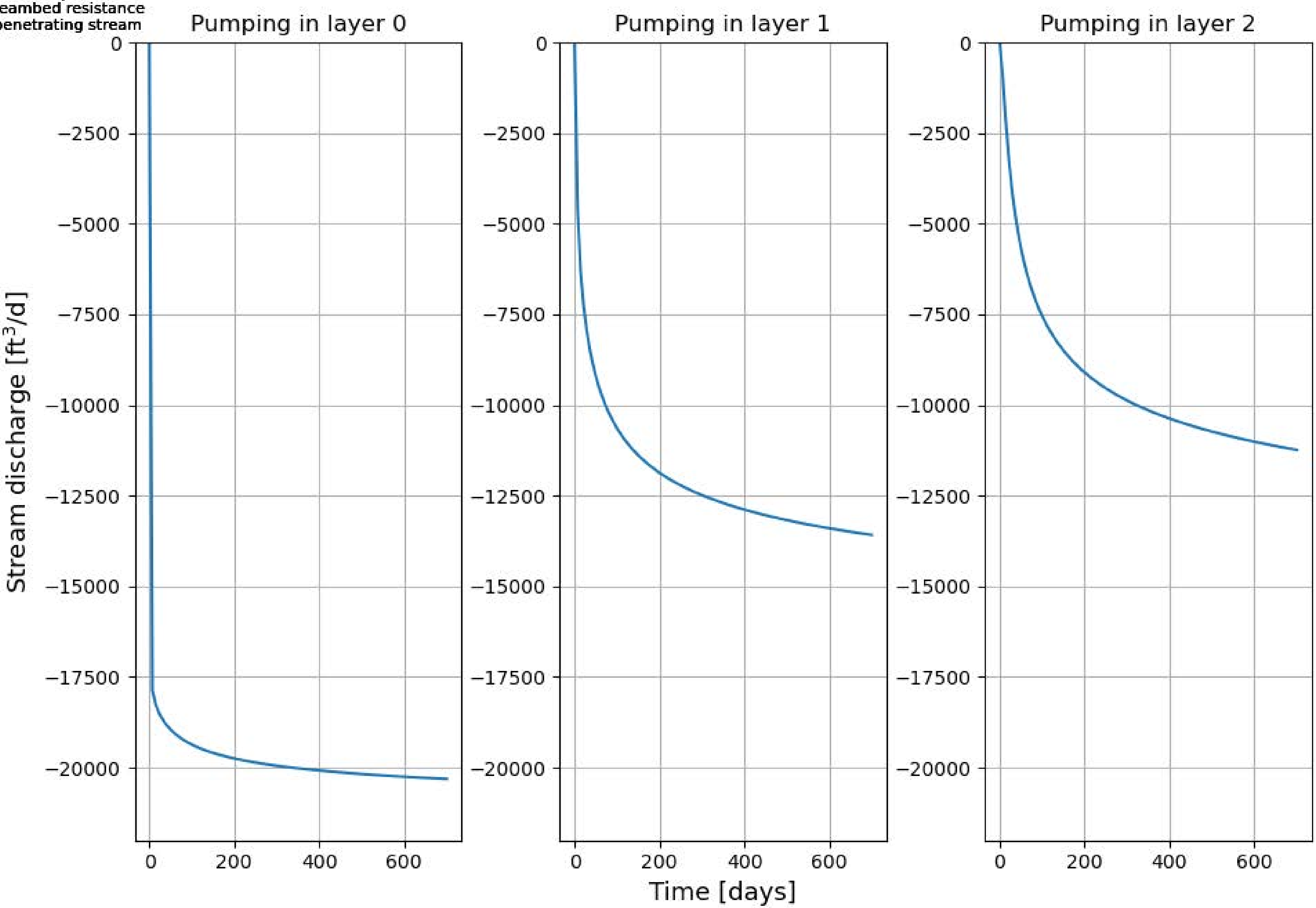
Stream Depletion vs. Seal Depth for Well 500' from Stream
2 AFY
5 AFY
10 AFY
20 AFY
30 AFY
40 AFY
50 AFY
60 AFY
70 AFY
80 AFY
90 AFY
100 AFY
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Stream Depletion (cfs)
0
100
200
Well Seal Depth (ft)



Stream Depletion vs. Seal Depth for Well 800' from Stream
Stream Depletion (cfs)
0.12
0.1
0.08
0.06
0.04
0.02
0
0
100
200
Well Seal Depth (ft)
2 AFY
5 AFY
10 AFY
20 AFY
30 AFY
40 AFY
50 AFY
60 AFY
70 AFY
80 AFY
90 AFY
100 AFY

Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

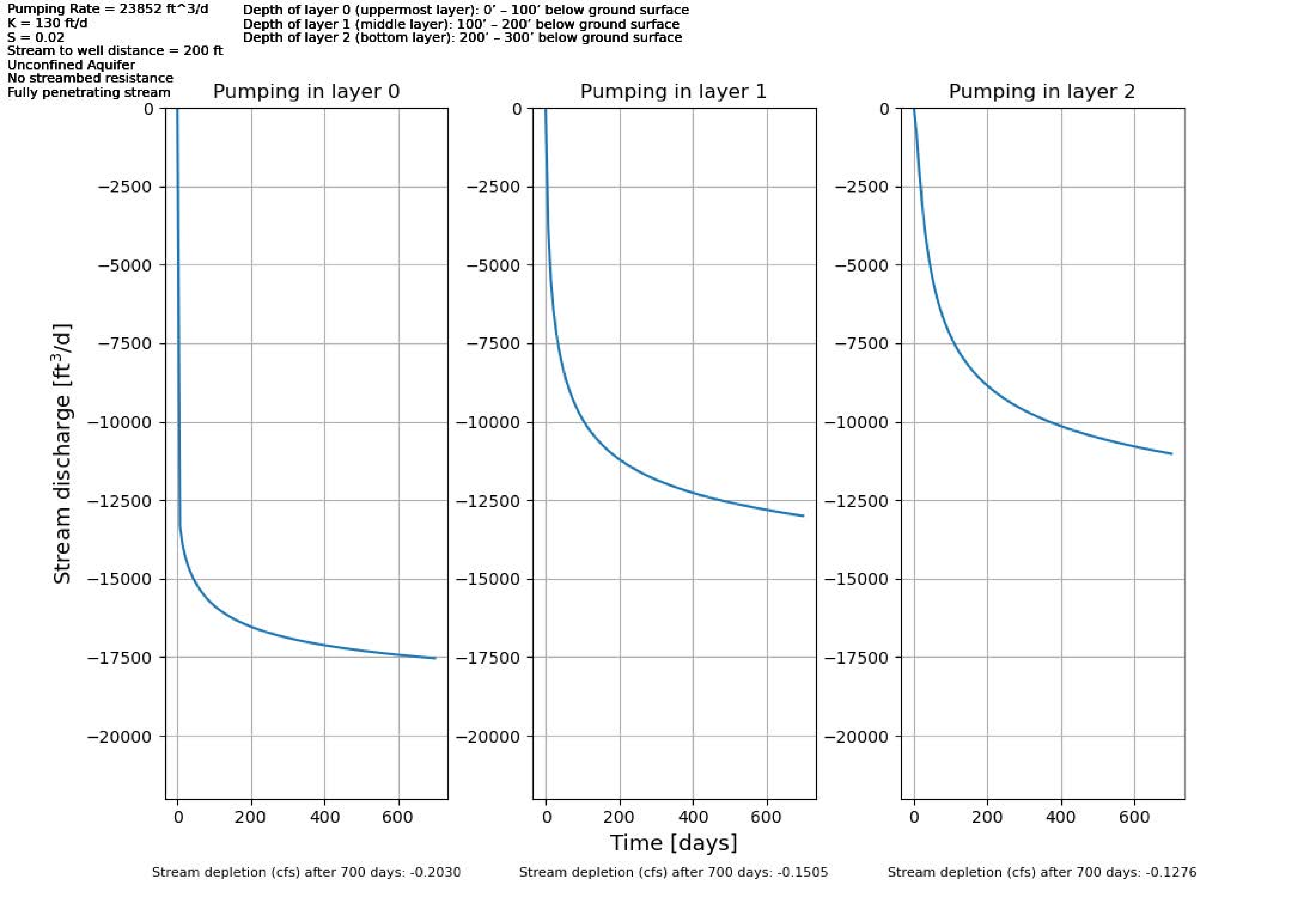
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface

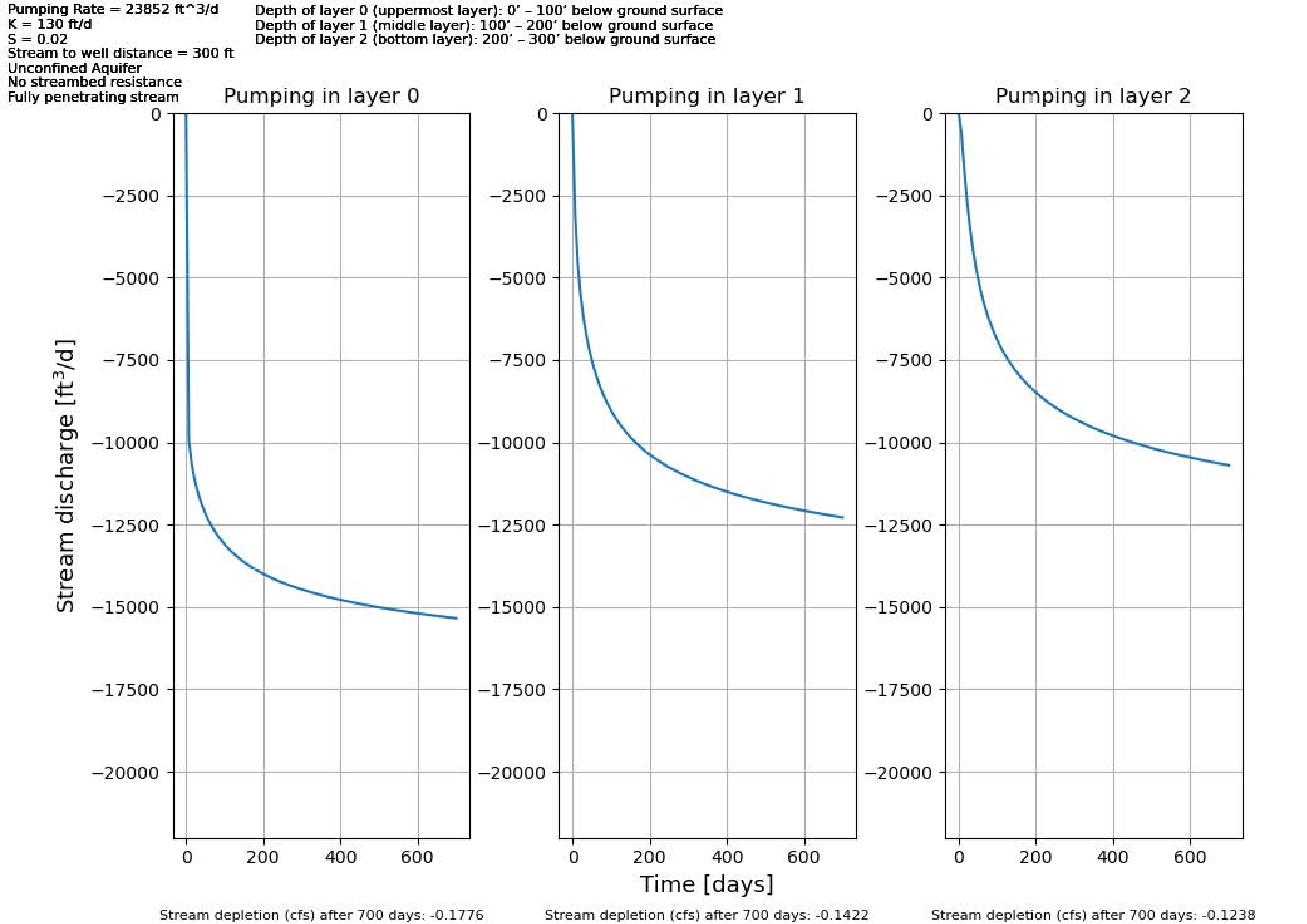


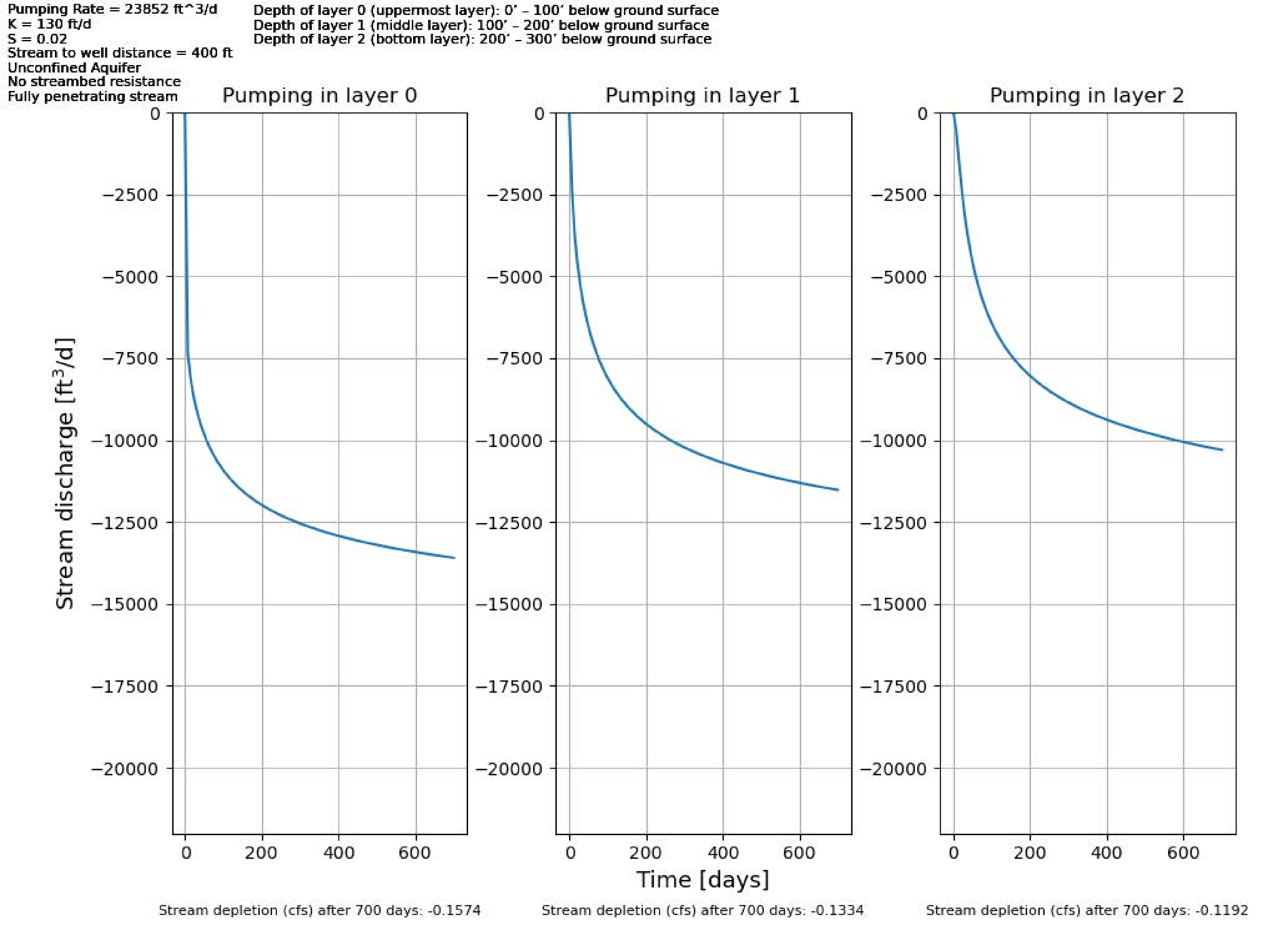
Stream depletion (cfs) after 700 days: -0.2351

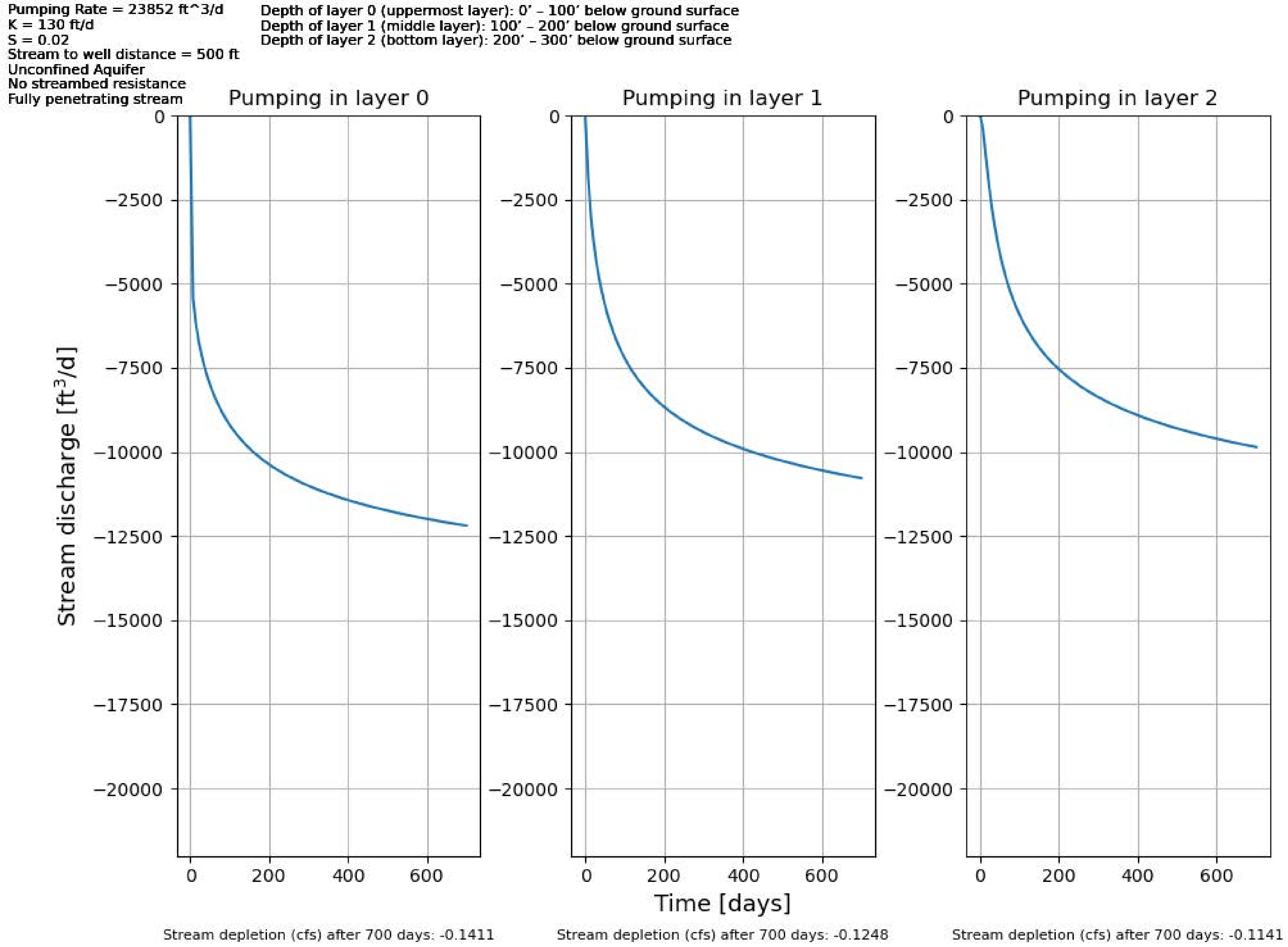
Stream depletion (cfs) after 700 days: -0.1572

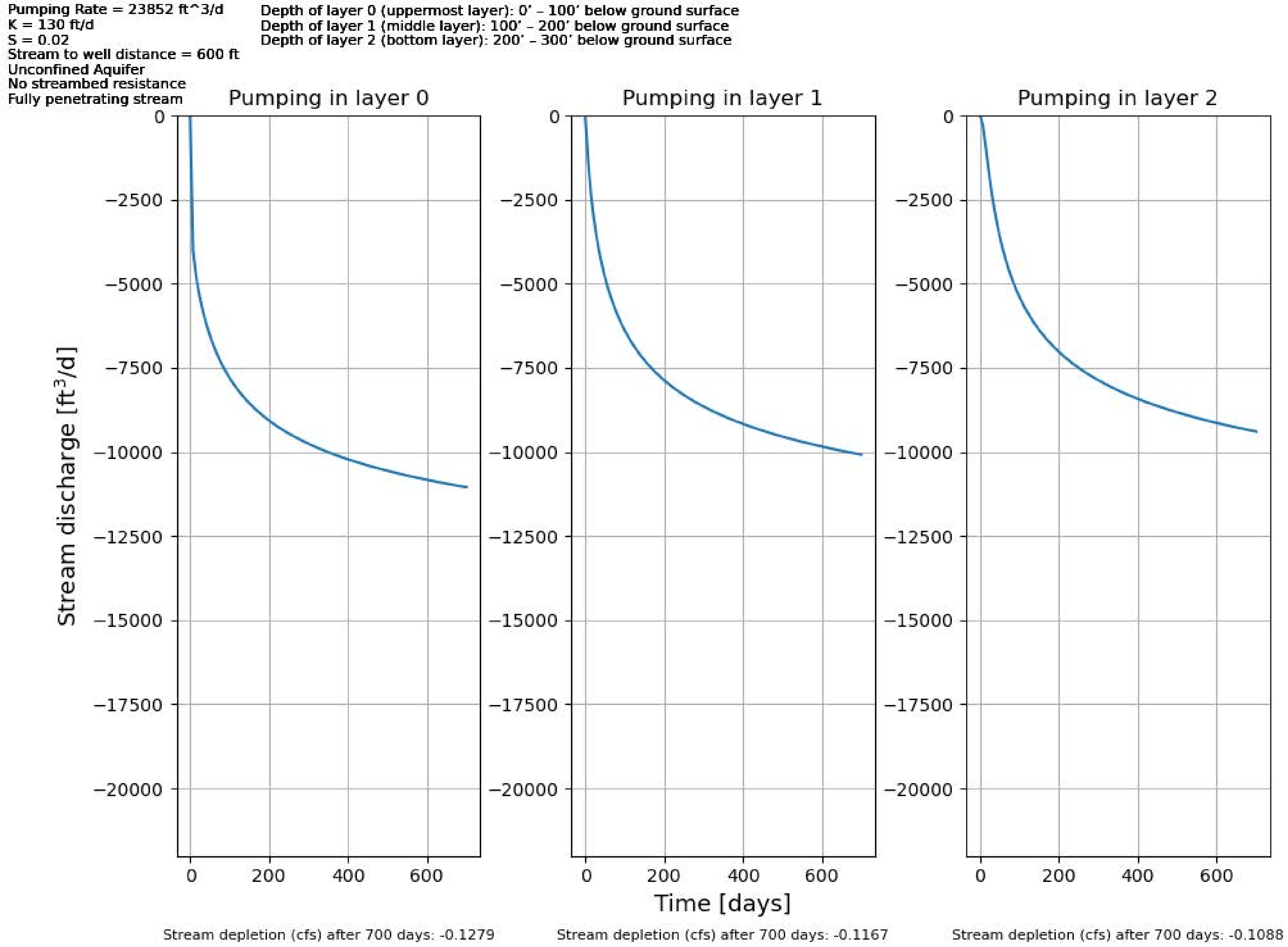
Stream depletion (cfs) after 700 days: -0.1301

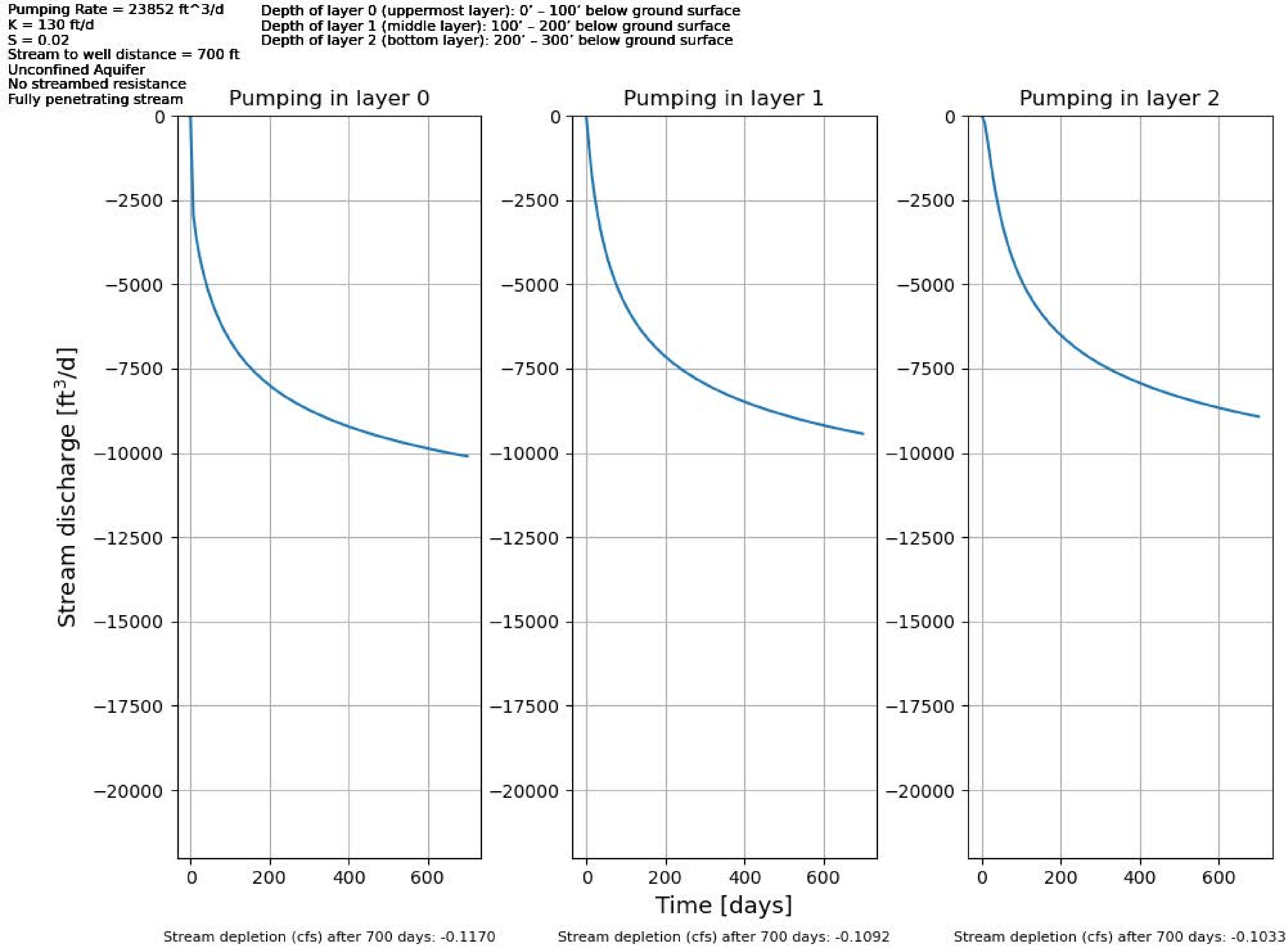

Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 200 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0’ – 100’ below ground surface
Depth of layer 1 (middle layer): 100’ – 200’ below ground surface
Depth of layer 2 (bottom layer): 200’ – 300’ below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
200
400
600
Time [days]
Stream depletion (cfs) after 700 days: -0.2030
Stream depletion (cfs) after 700 days: -0.1505
Stream depletion (cfs) after 700 days: -0.1276


Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 300 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
200
400
600
Time [days]
Stream depletion (cfs) after 700 days: -0.1776
Stream depletion (cfs) after 700 days: -0.1422
Stream depletion (cfs) after 700 days: -0.1238


Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 400 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
Time [days]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
200
400
600
Stream depletion (cfs) after 700 days: -0.1574
Stream depletion (cfs) after 700 days: -0.1334
Stream depletion (cfs) after 700 days: -0.1192

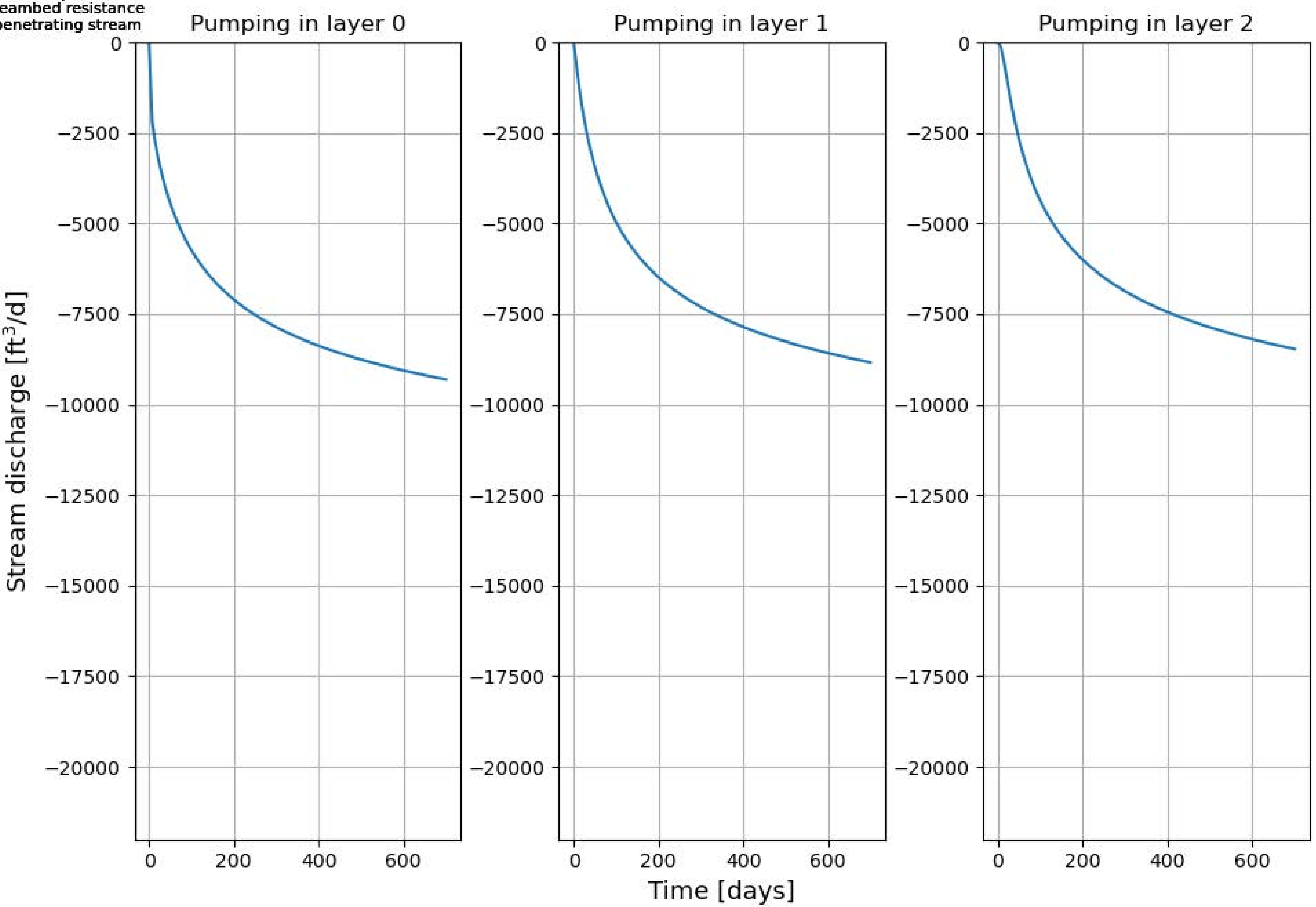

Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 500 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft3/d]
Time [days]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
200
400
600
Stream depletion (cfs) after 700 days: -0.1411
Stream depletion (cfs) after 700 days: -0.1248
Stream depletion (cfs) after 700 days: -0.1141


Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 600 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
200
400
600
Time [days]
Stream depletion (cfs) after 700 days: -0.1279
Stream depletion (cfs) after 700 days: -0.1167
Stream depletion (cfs) after 700 days: -0.1088


Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 700 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
200
400
600
Time [days]
Stream depletion (cfs) after 700 days: -0.1170
Stream depletion (cfs) after 700 days: -0.1092
Stream depletion (cfs) after 700 days: -0.1033

Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 800 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



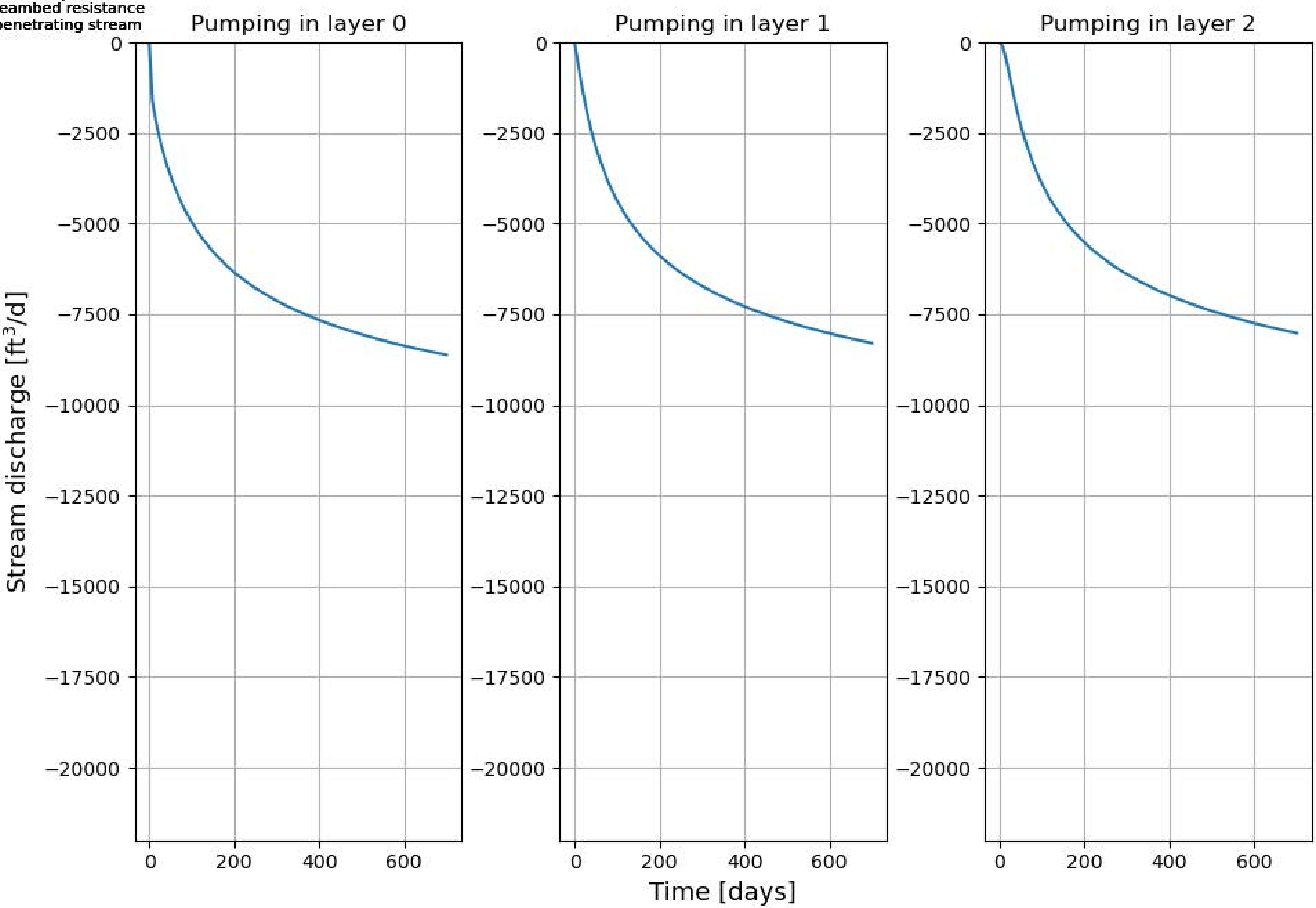
Stream depletion (cfs) after 700 days: -0.1077

Stream depletion (cfs) after 700 days: -0.1023

Stream depletion (cfs) after 700 days: -0.0980

Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 900 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

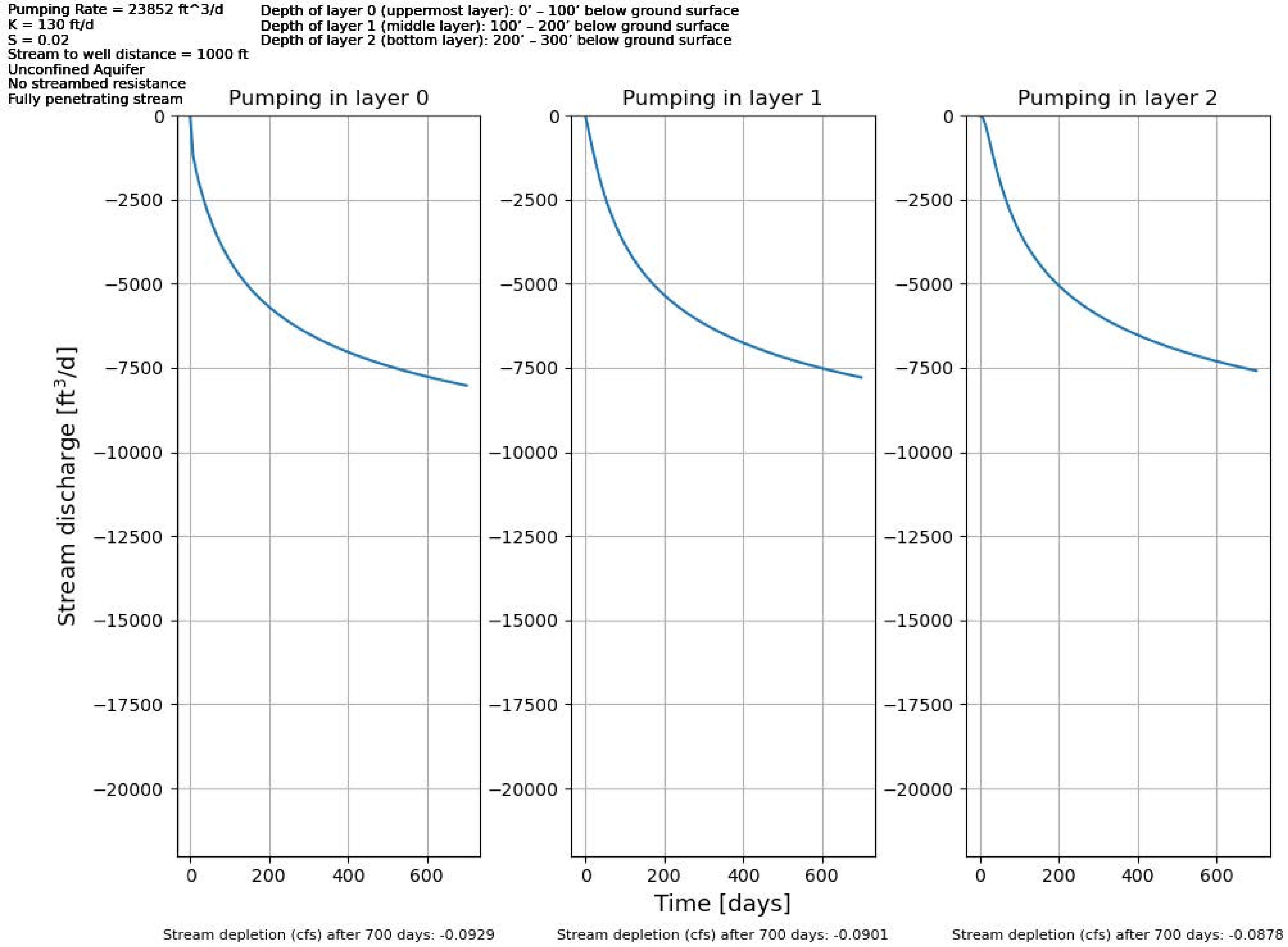
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface

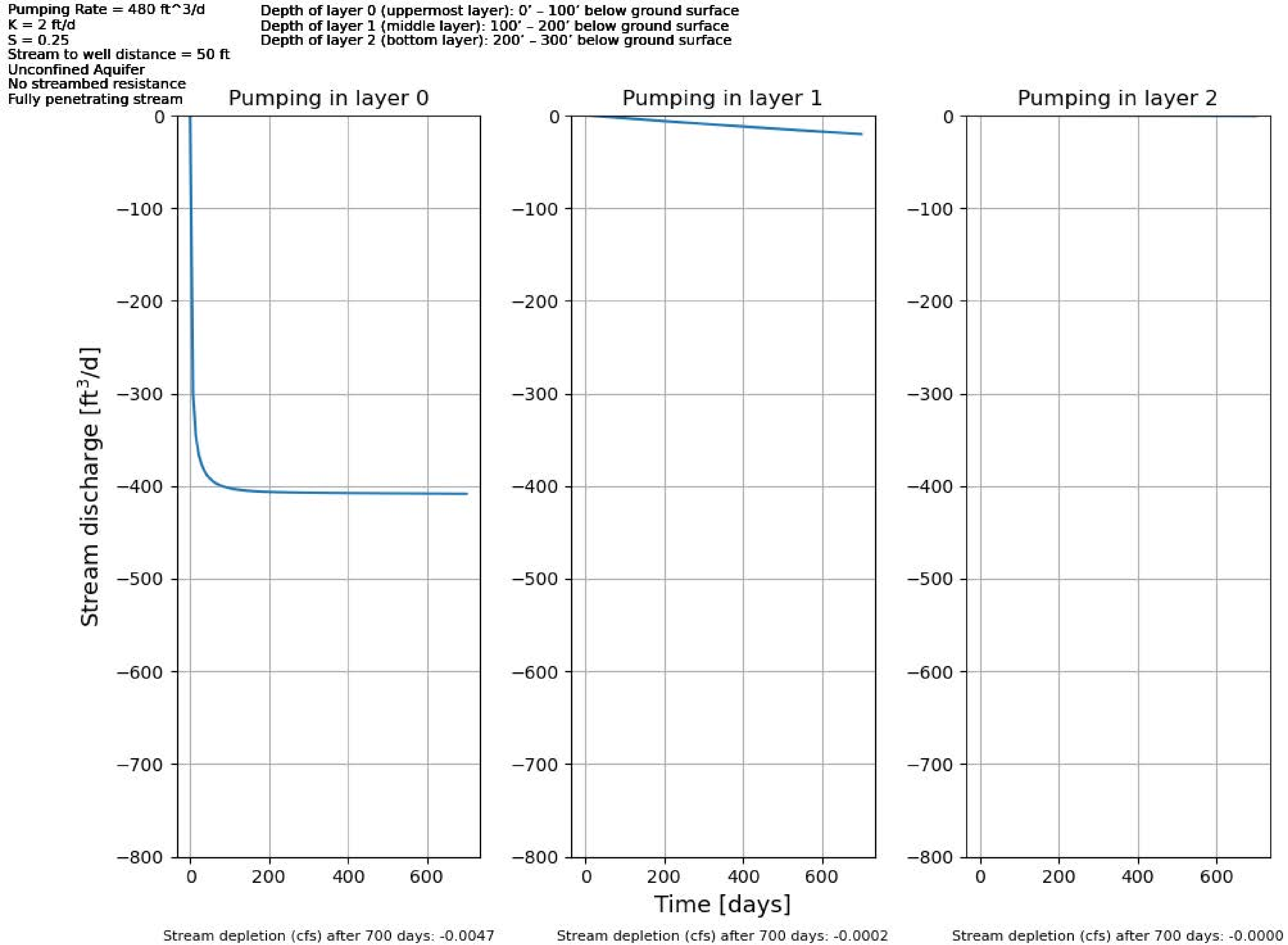


Stream depletion (cfs) after 700 days: -0.0998

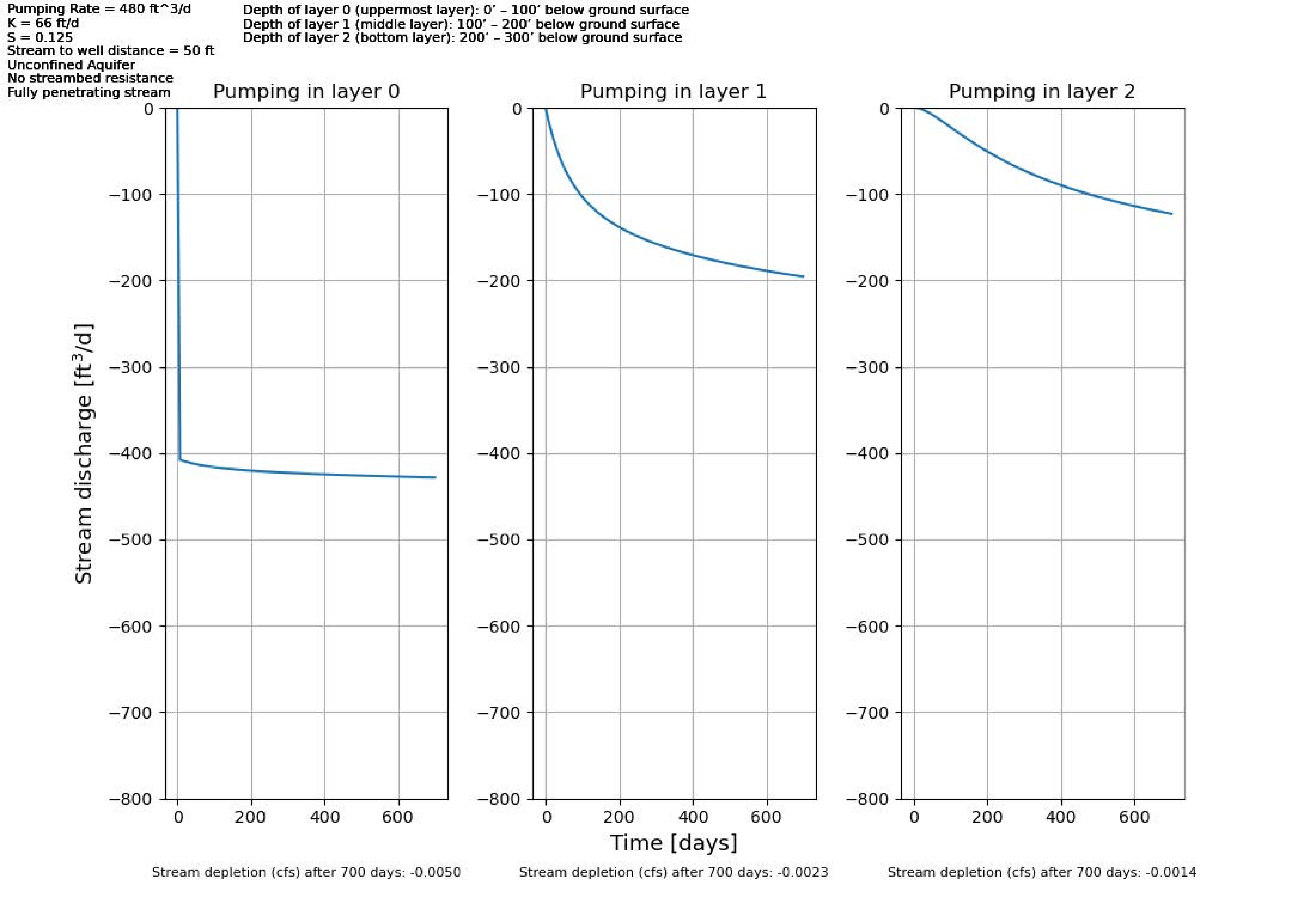
Stream depletion (cfs) after 700 days: -0.0960

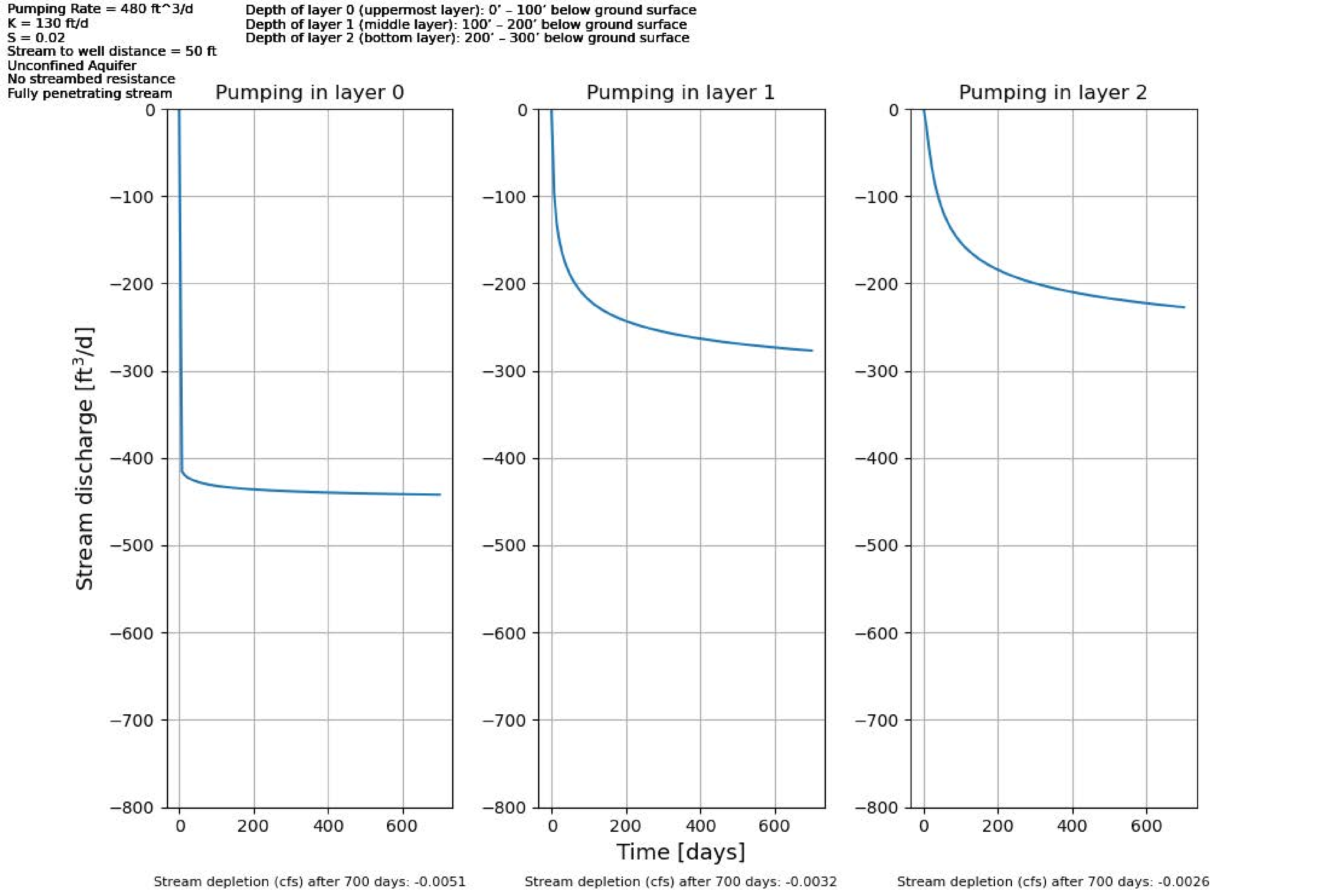
Stream depletion (cfs) after 700 days: -0.0928


Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 1000 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
Time [days]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
200
400
600
Stream depletion (cfs) after 700 days: -0.0929
Stream depletion (cfs) after 700 days: -0.0901
Stream depletion (cfs) after 700 days: -0.0878



Pumping Rate = 480 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 50 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft³/d]
Time [days]
0
−100
−200
−300
−400
−500
−600
−700
−800
0
200
400
600
Stream depletion (cfs) after 700 days: -0.0047
Stream depletion (cfs) after 700 days: -0.0002
Stream depletion (cfs) after 700 days: -0.0000

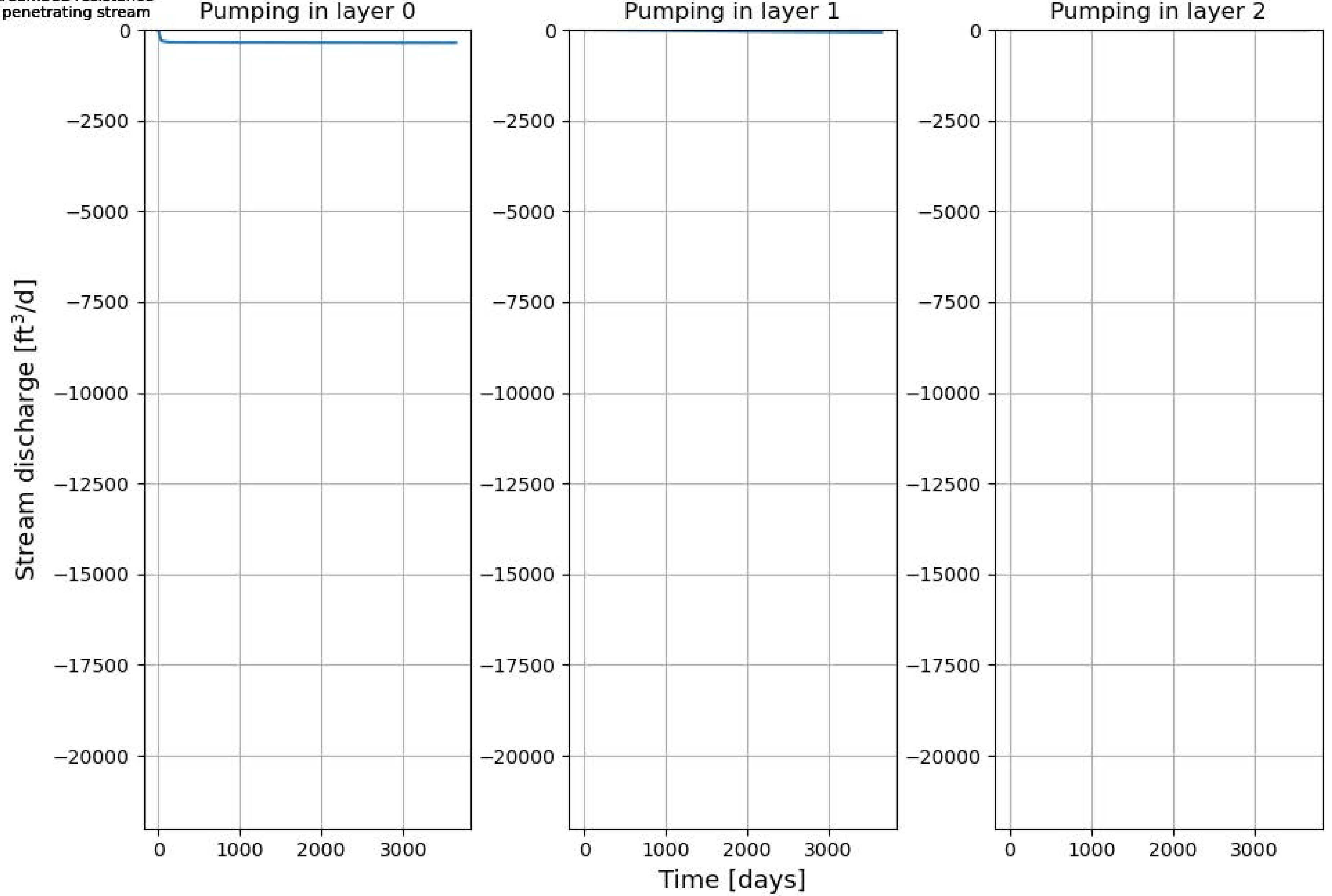

Pumping Rate = 480 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 50 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
Time [days]
0
−100
−200
−300
−400
−500
−600
−700
−800
0
200
400
600
Stream depletion (cfs) after 700 days: -0.0050
Stream depletion (cfs) after 700 days: -0.0023
Stream depletion (cfs) after 700 days: -0.0014



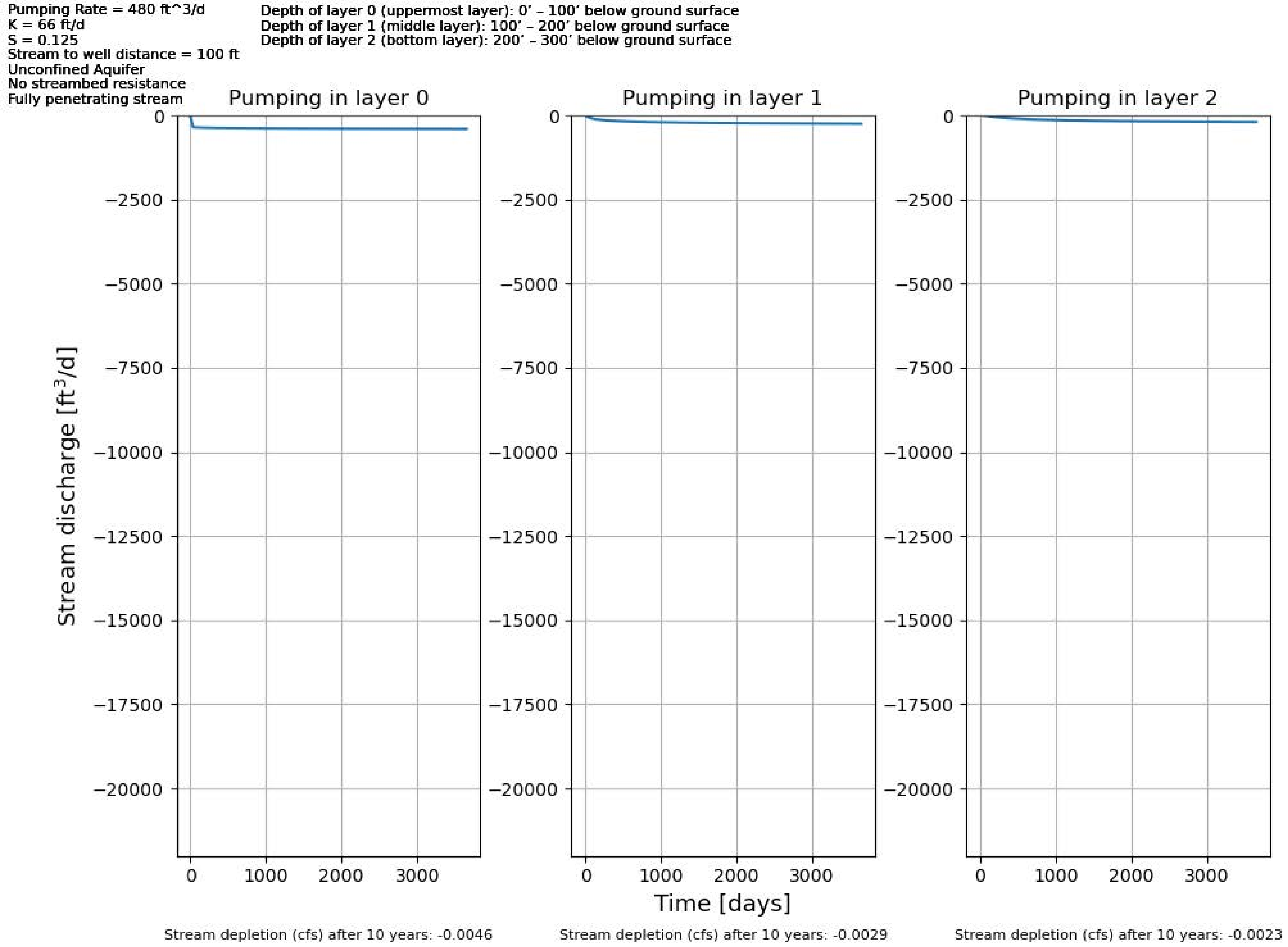
Pumping Rate = 480 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 50 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft3/d]
Time [days]
0
−100
−200
−300
−400
−500
−600
−700
−800
0
200
400
600
Stream depletion (cfs) after 700 days: -0.0051
Stream depletion (cfs) after 700 days: -0.0032
Stream depletion (cfs) after 700 days: -0.0026

Pumping Rate = 480 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

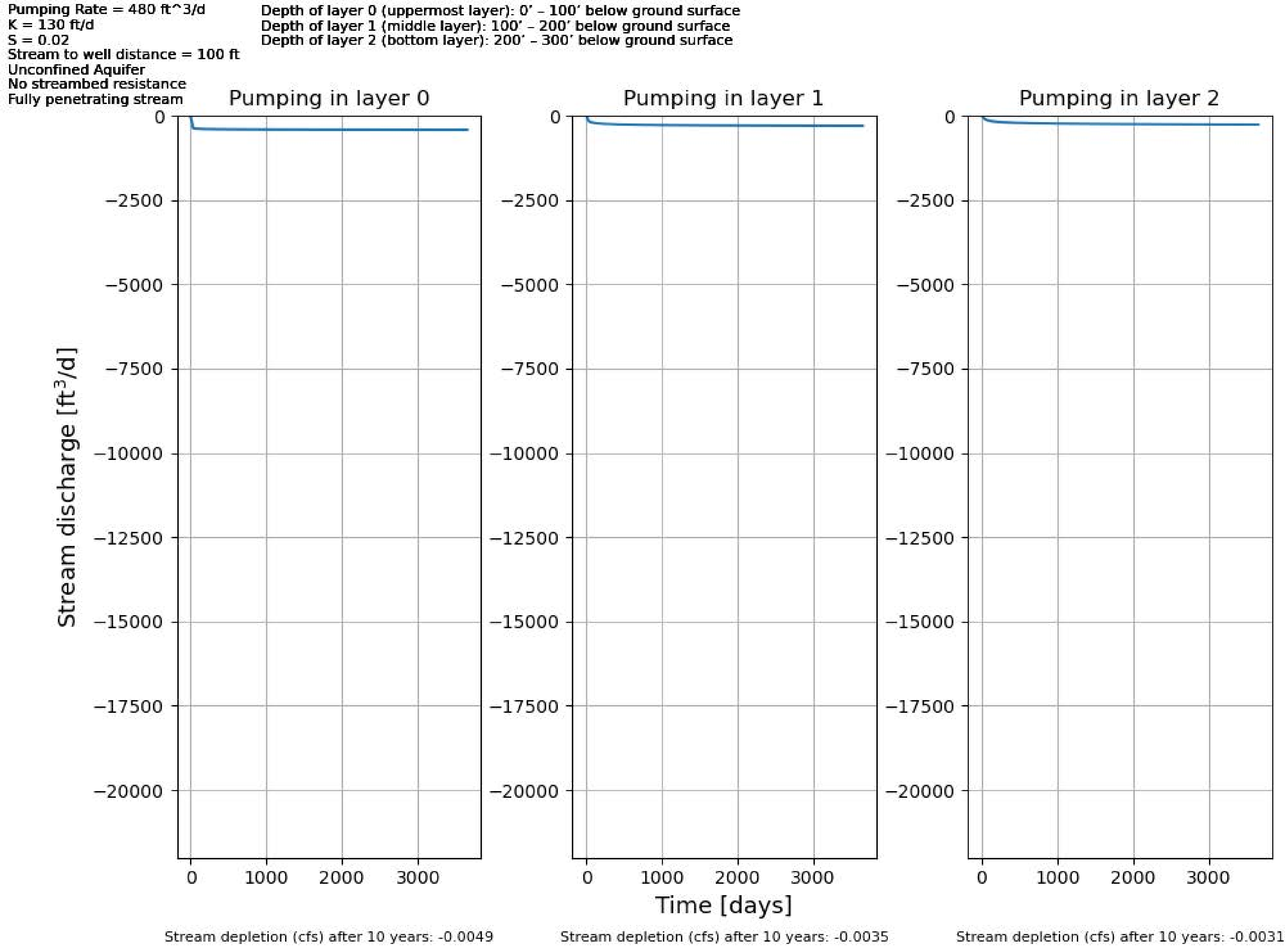
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface

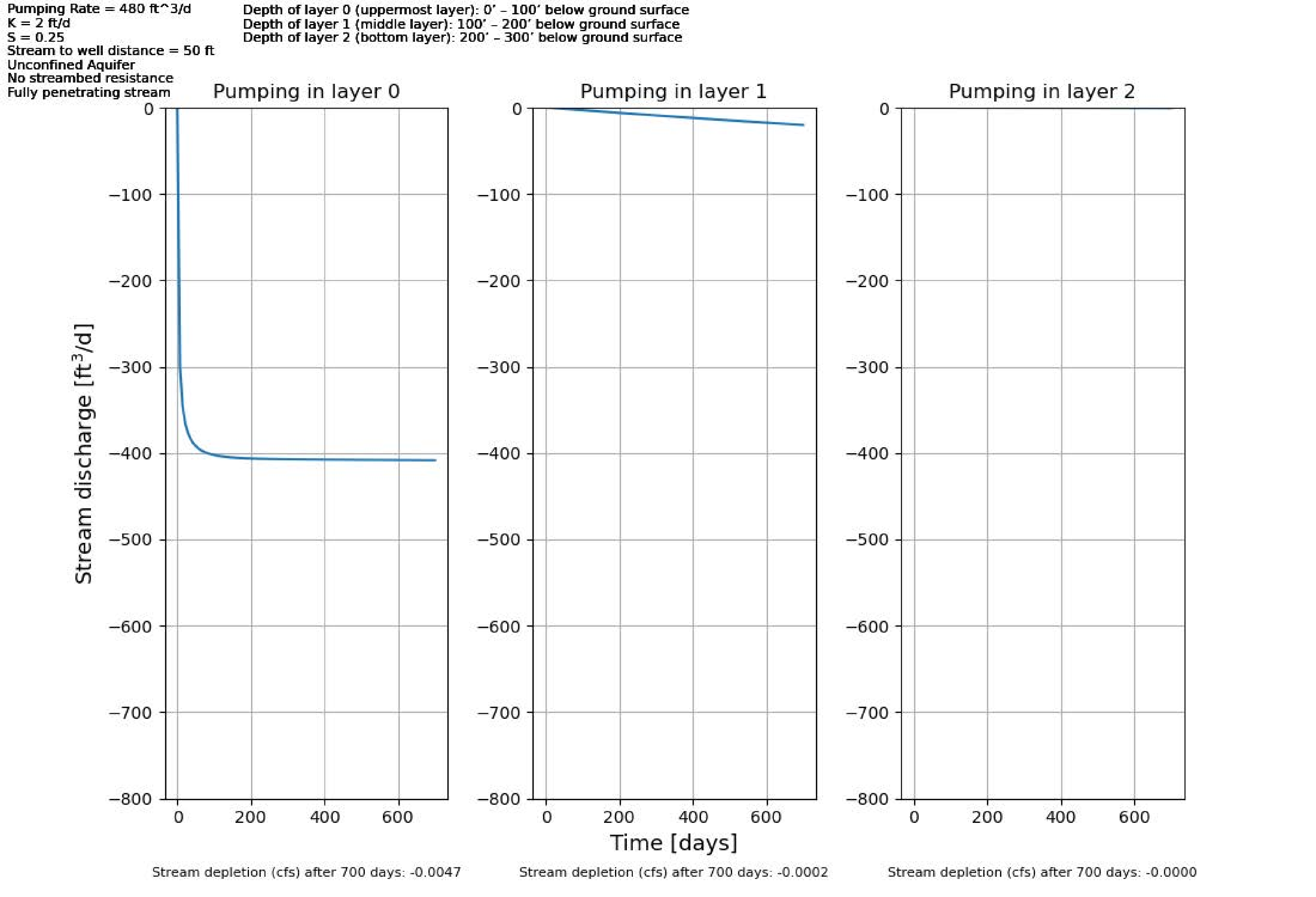


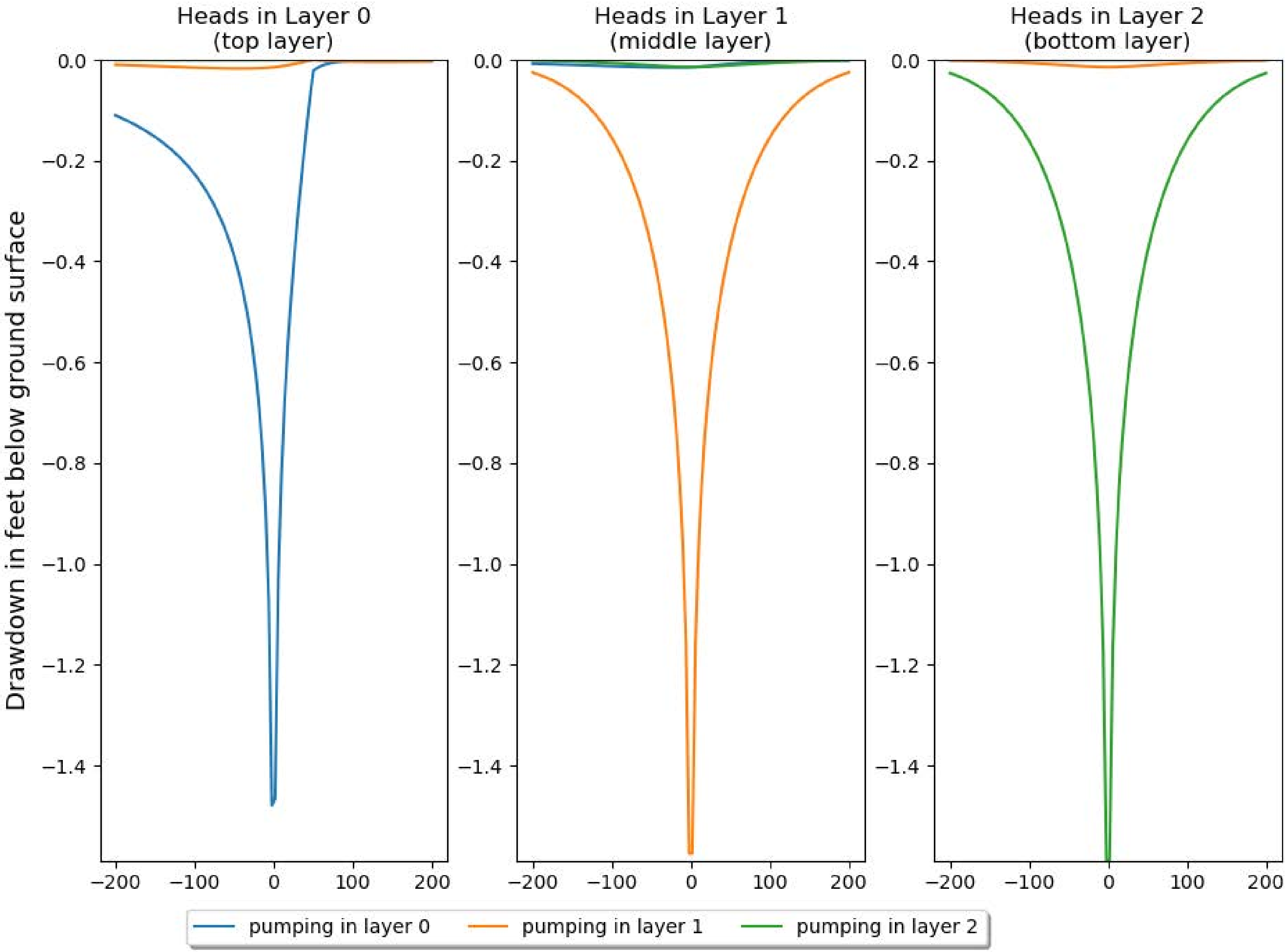
Stream depletion (cfs) after 10 years: -0.0041 Stream depletion (cfs) after 10 years: -0.0008 Stream depletion (cfs) after 10 years: -0.0001

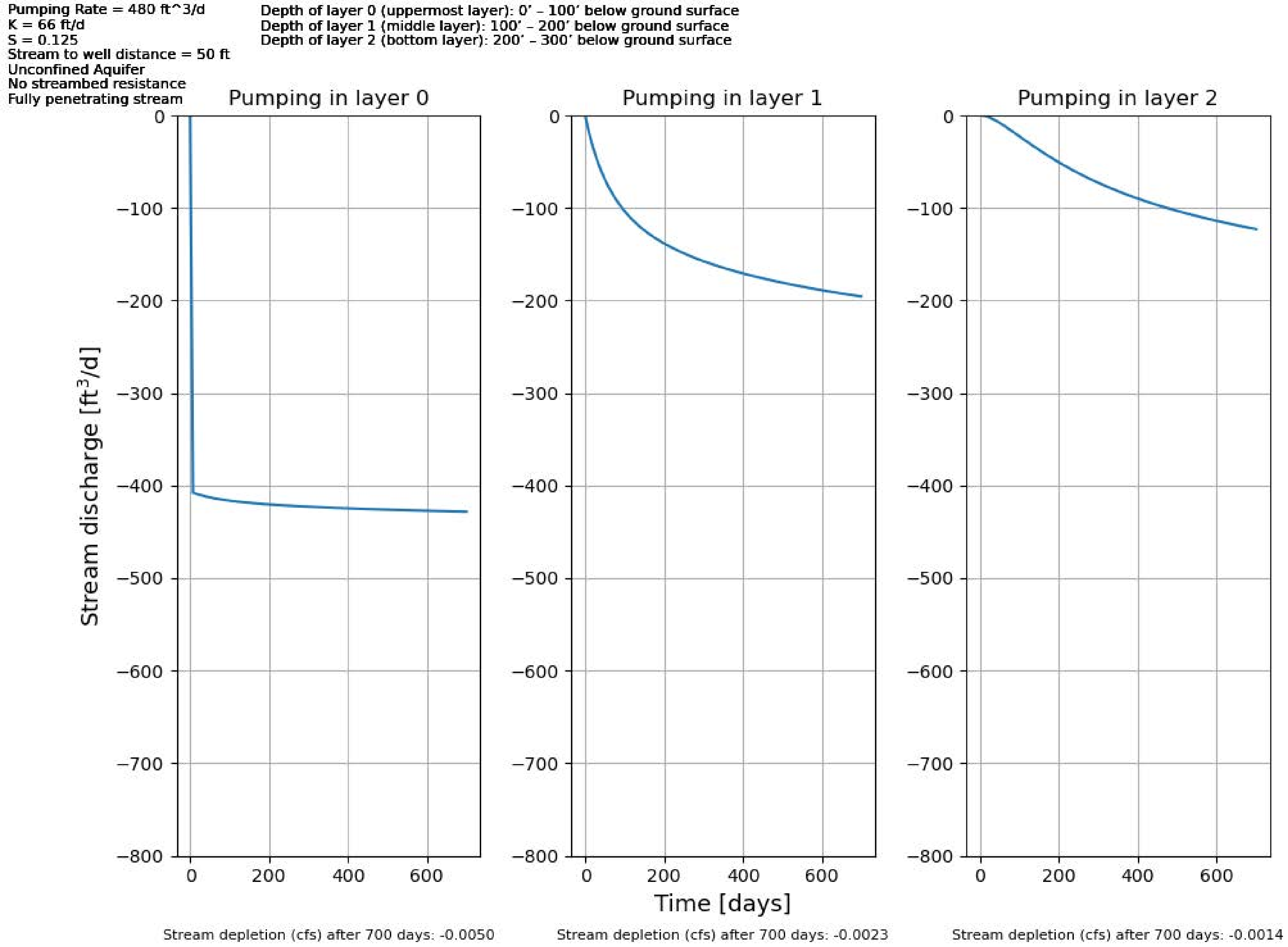


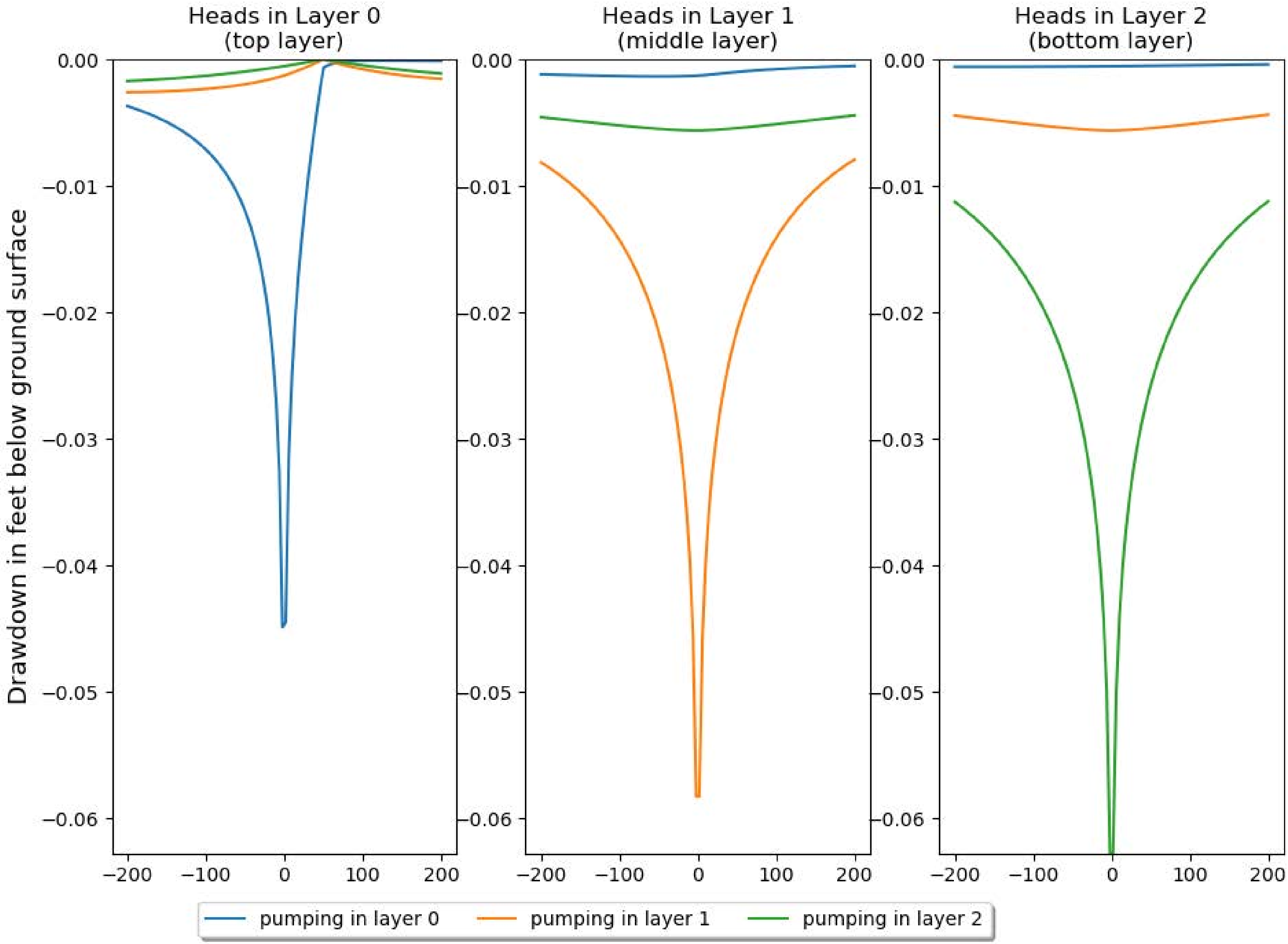
Pumping Rate = 480 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
1000
2000
3000
Time [days]
Stream depletion (cfs) after 10 years: -0.0046
Stream depletion (cfs) after 10 years: -0.0029
Stream depletion (cfs) after 10 years: -0.0023


Pumping Rate = 480 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 100 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
1000
2000
3000
Time [days]
Stream depletion (cfs) after 10 years: -0.0049
Stream depletion (cfs) after 10 years: -0.0035
Stream depletion (cfs) after 10 years: -0.0031


Pumping Rate = 480 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 50 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft³/d]
0
−100
−200
−300
−400
−500
−600
−700
−800
0
200
400
600
Time [days]
Stream depletion (cfs) after 700 days: -0.0047
Stream depletion (cfs) after 700 days: -0.0002
Stream depletion (cfs) after 700 days: -0.0000


Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

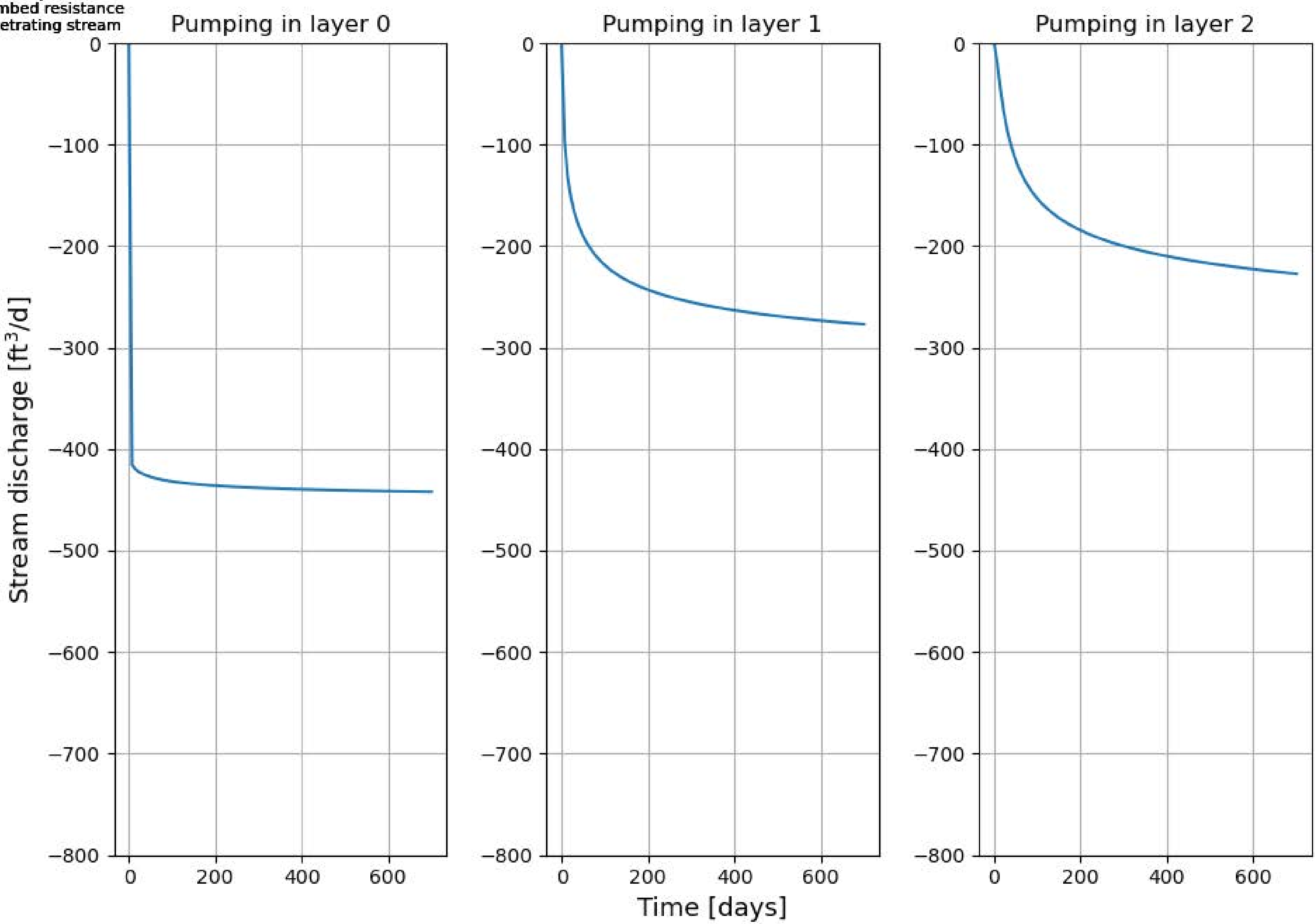

Pumping Rate = 480 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 50 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft³/d]
Time [days]
0
−100
−200
−300
−400
−500
−600
−700
−800
0
200
400
600
Stream depletion (cfs) after 700 days: -0.0050
Stream depletion (cfs) after 700 days: -0.0023
Stream depletion (cfs) after 700 days: -0.0014



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.00
−0.01
−0.02
−0.03
−0.04
−0.05
−0.06
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 480 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 50 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

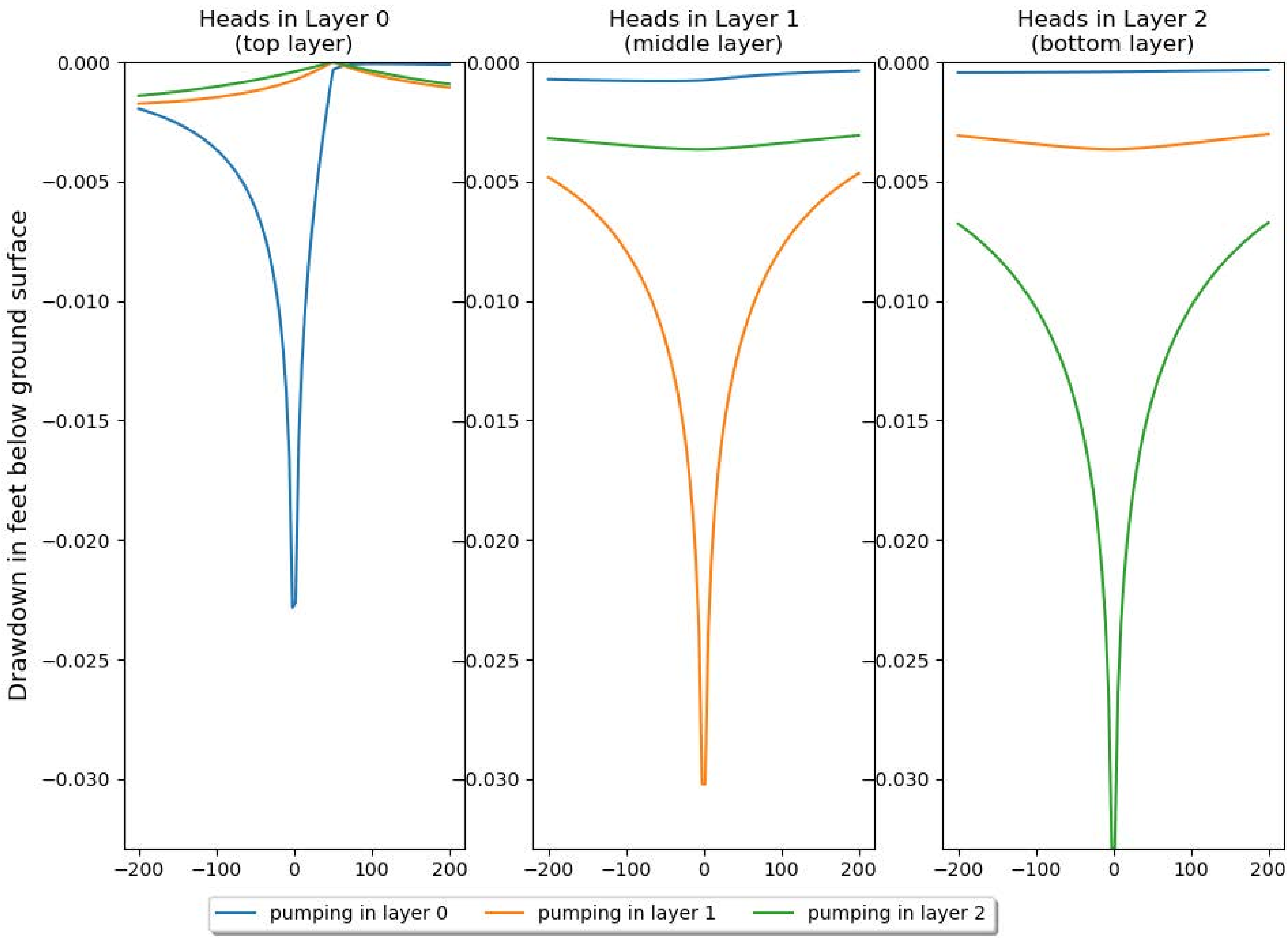
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



Stream depletion (cfs) after 700 days: -0.0051

Stream depletion (cfs) after 700 days: -0.0032

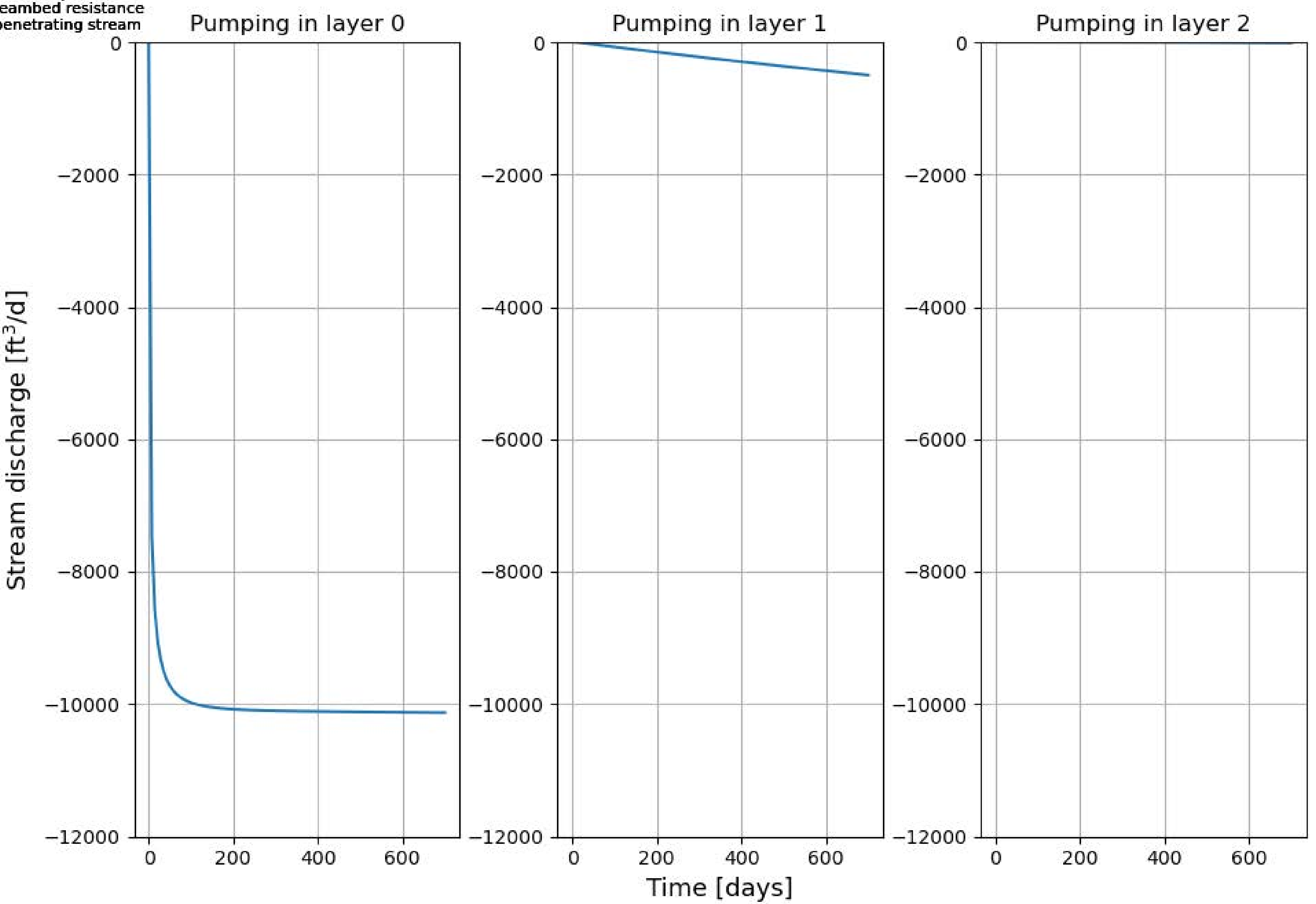
Stream depletion (cfs) after 700 days: -0.0026



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.000
−0.005
−0.010
−0.015
−0.020
−0.025
−0.030
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 11906 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 50 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

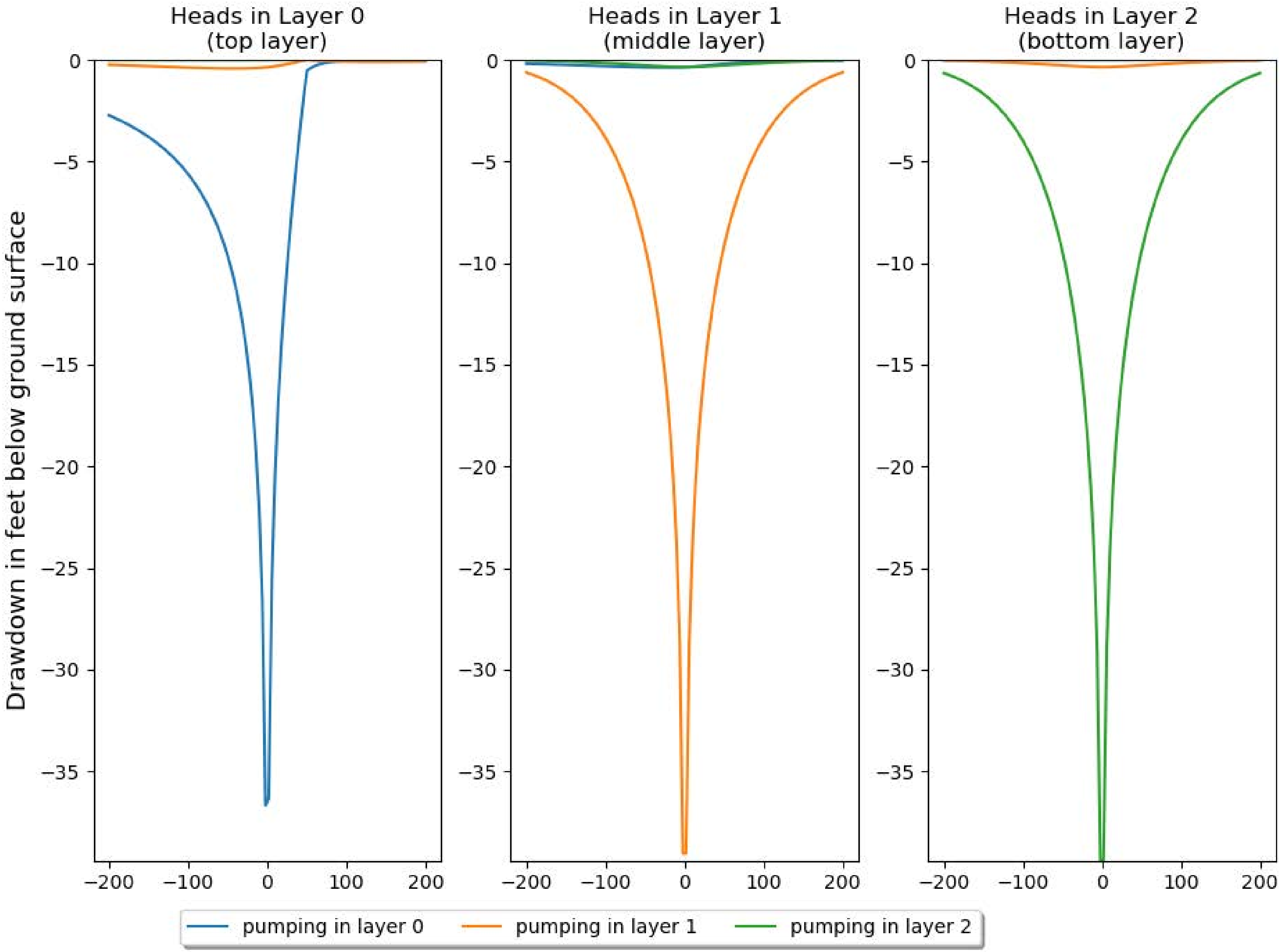
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface

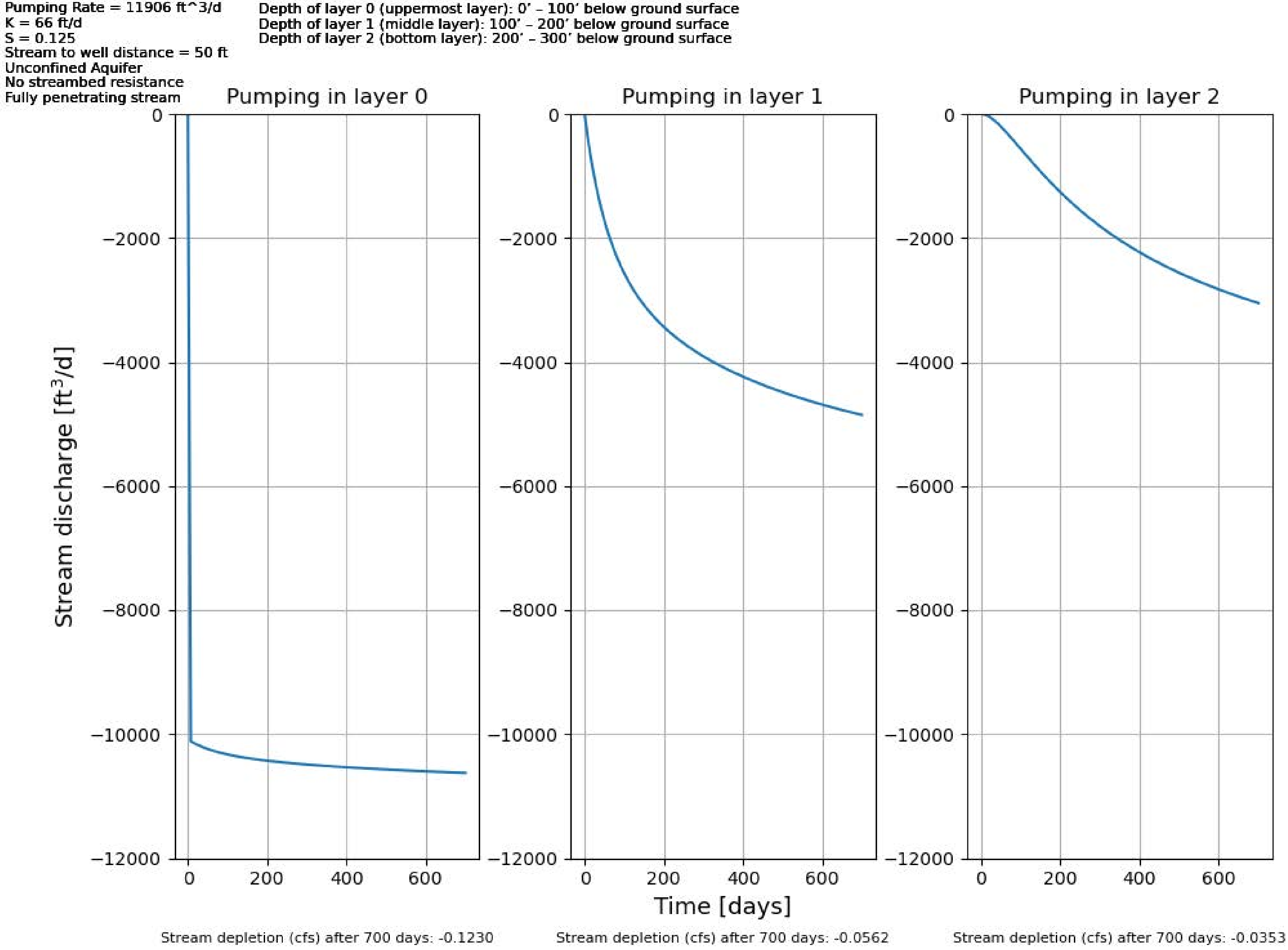


Stream depletion (cfs) after 700 days: -0.1172

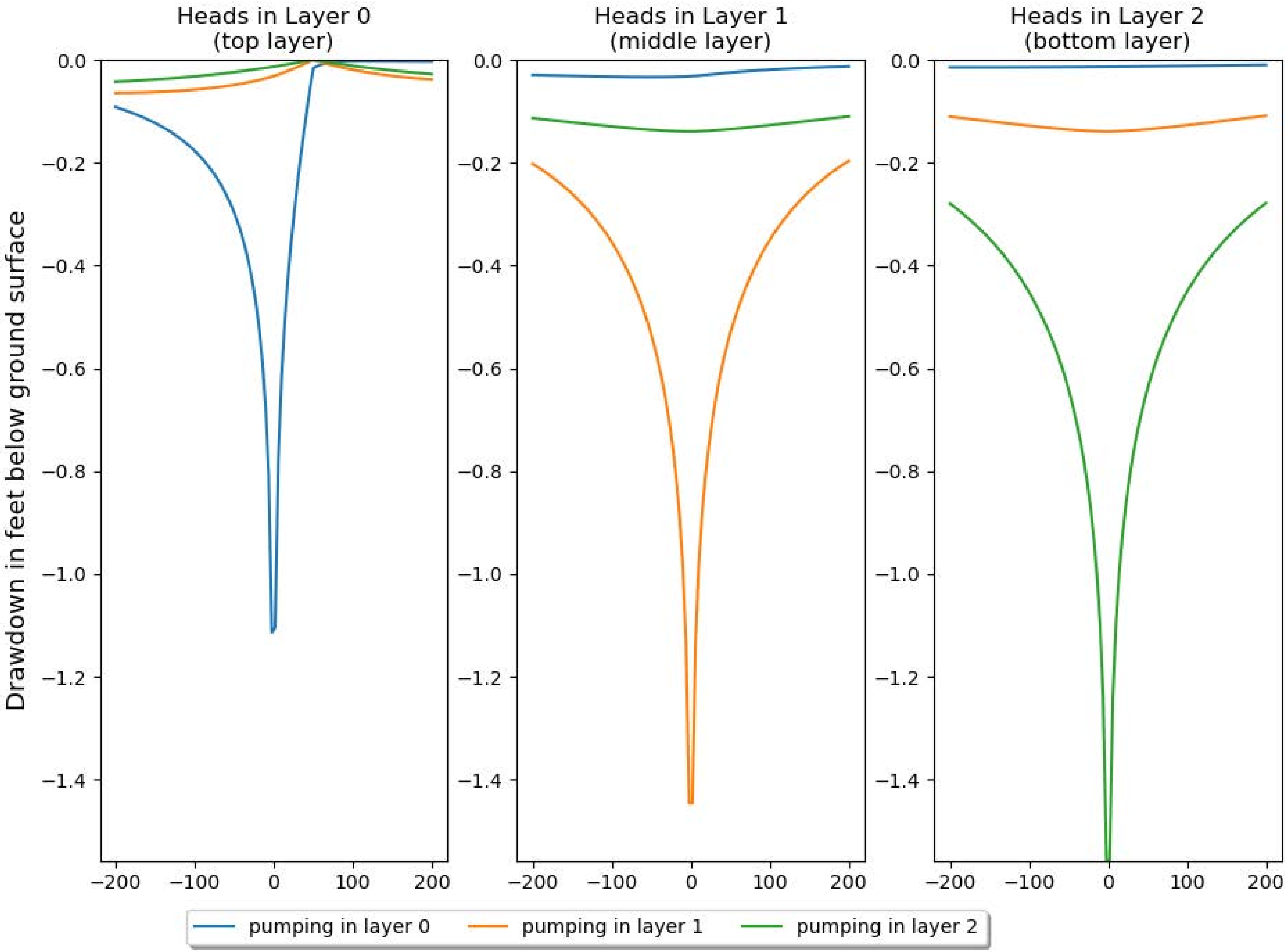
Stream depletion (cfs) after 700 days: -0.0058

Stream depletion (cfs) after 700 days: -0.0002

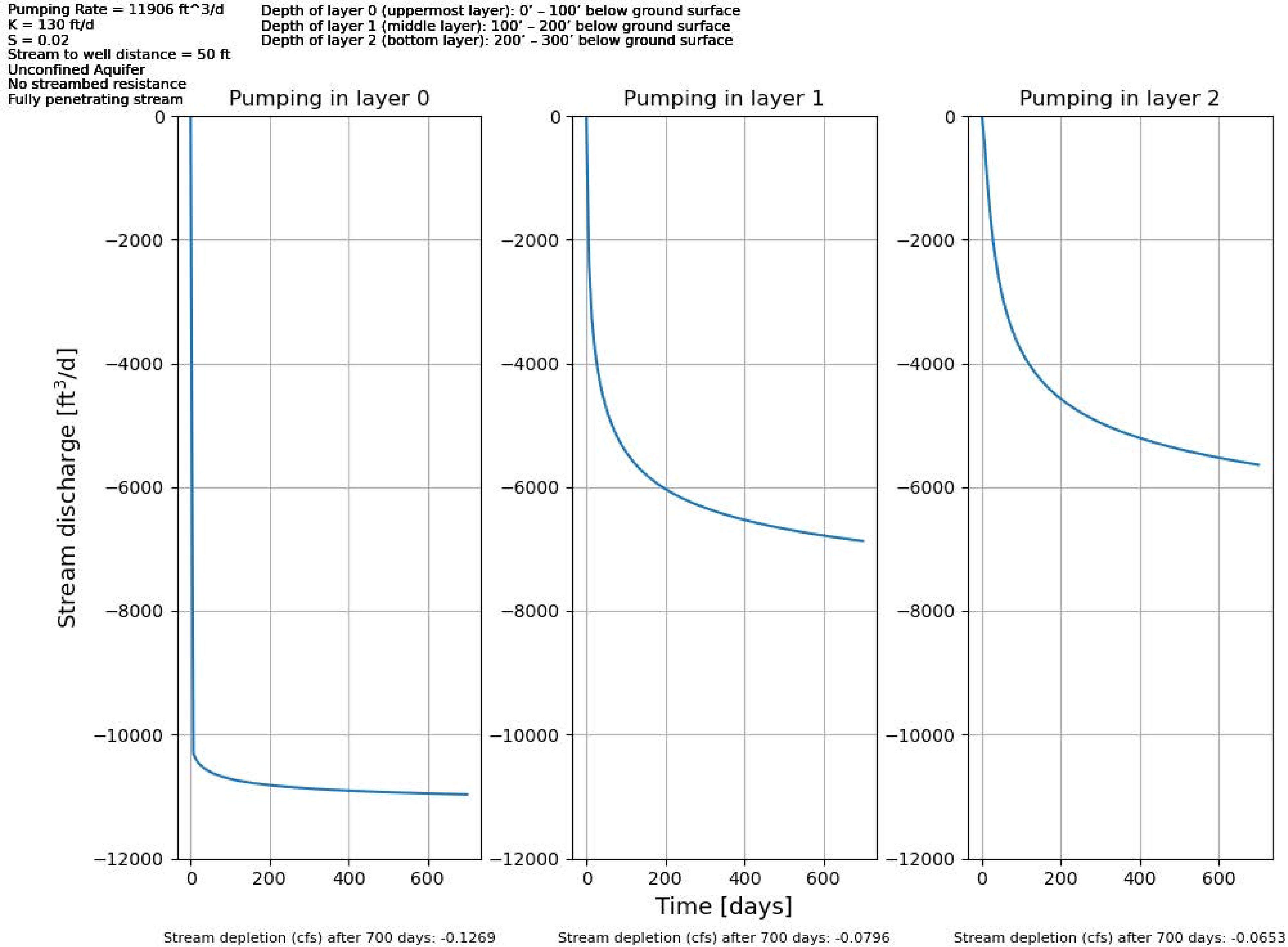

Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0
−5
−10
−15
−20
−25
−30
−35
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

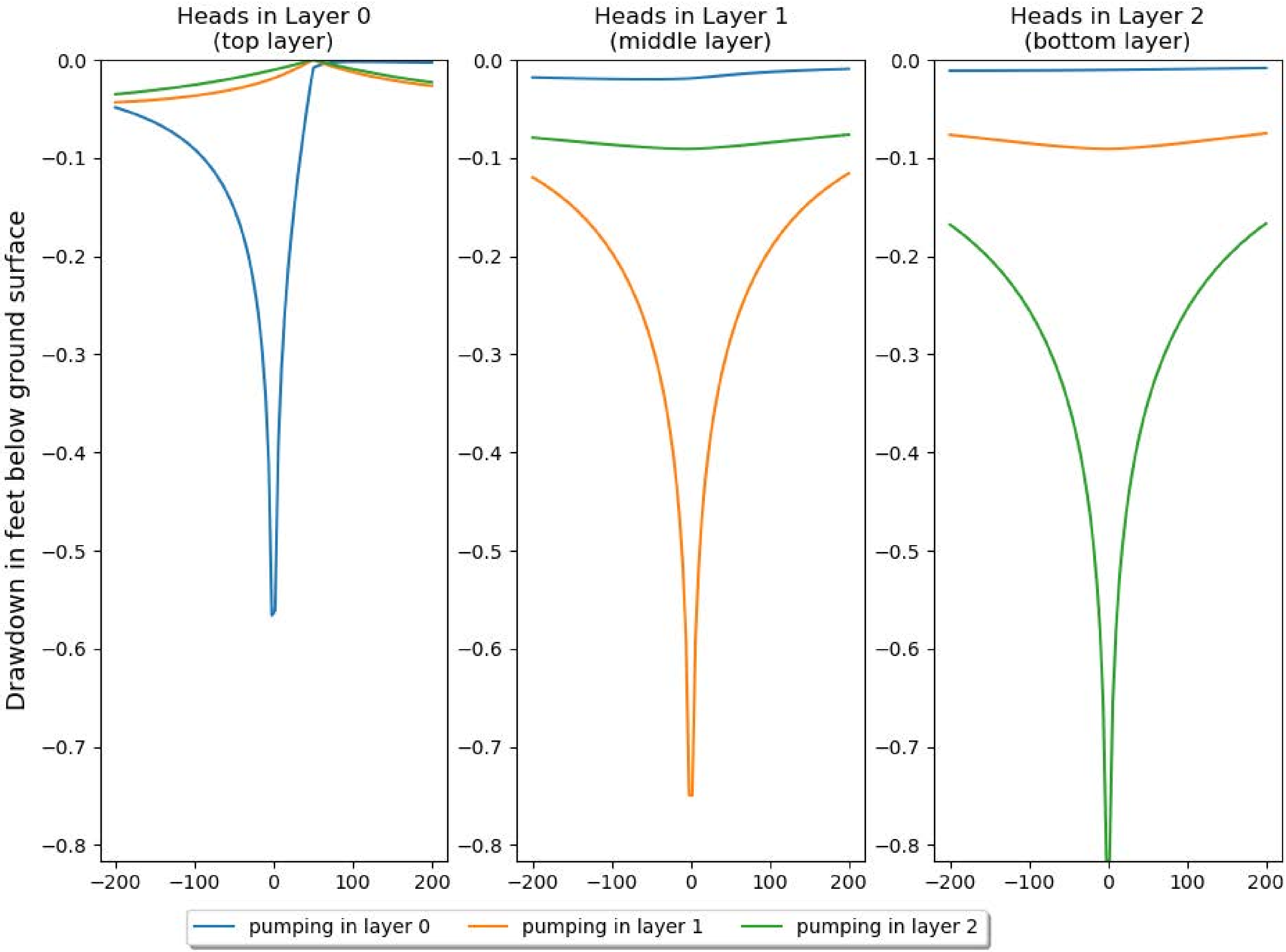


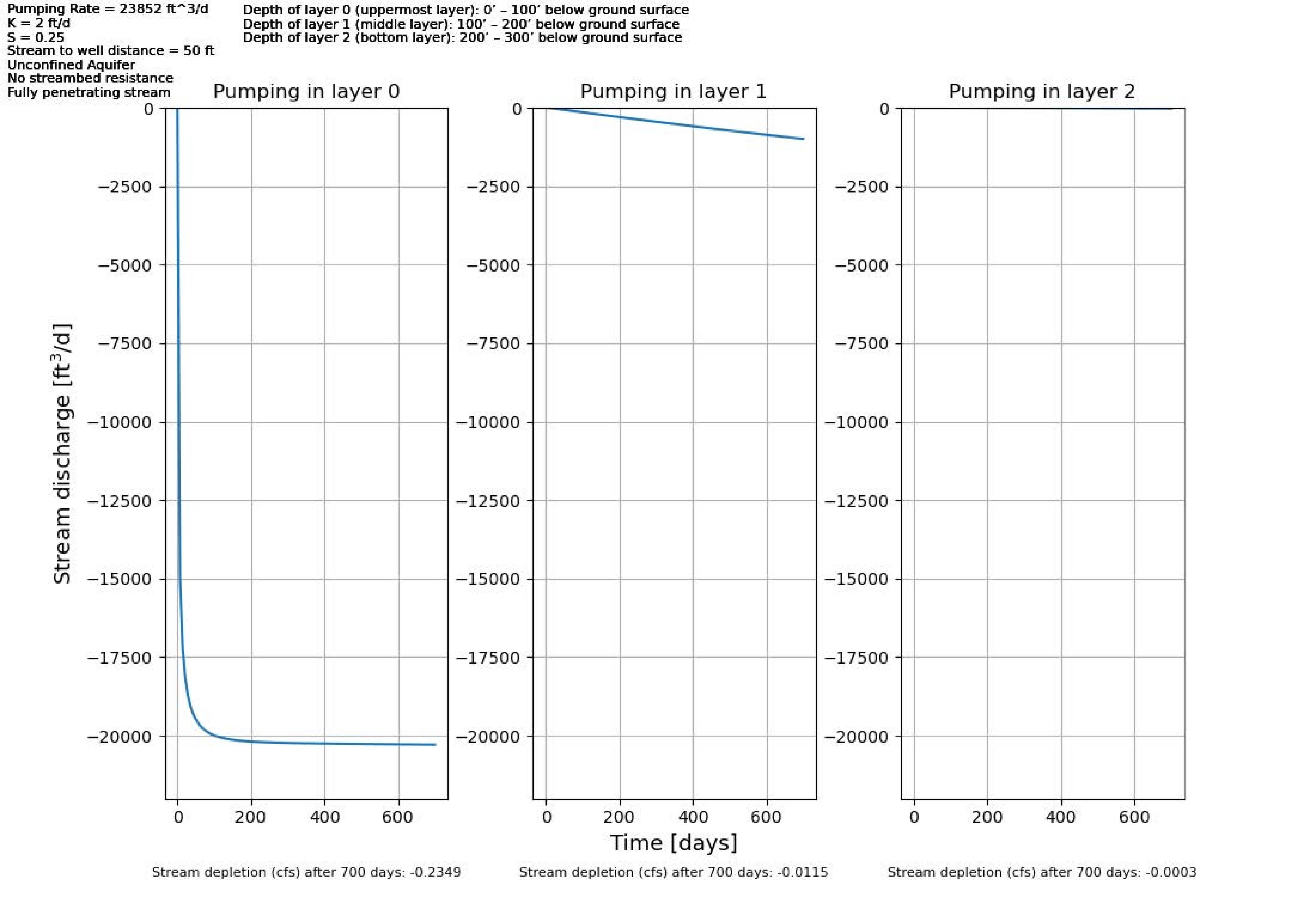
Pumping Rate = 11906 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 50 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2000
−4000
−6000
−8000
−10000
−12000
0
200
400
600
Time [days]
Stream depletion (cfs) after 700 days: -0.1230
Stream depletion (cfs) after 700 days: -0.0562
Stream depletion (cfs) after 700 days: -0.0353

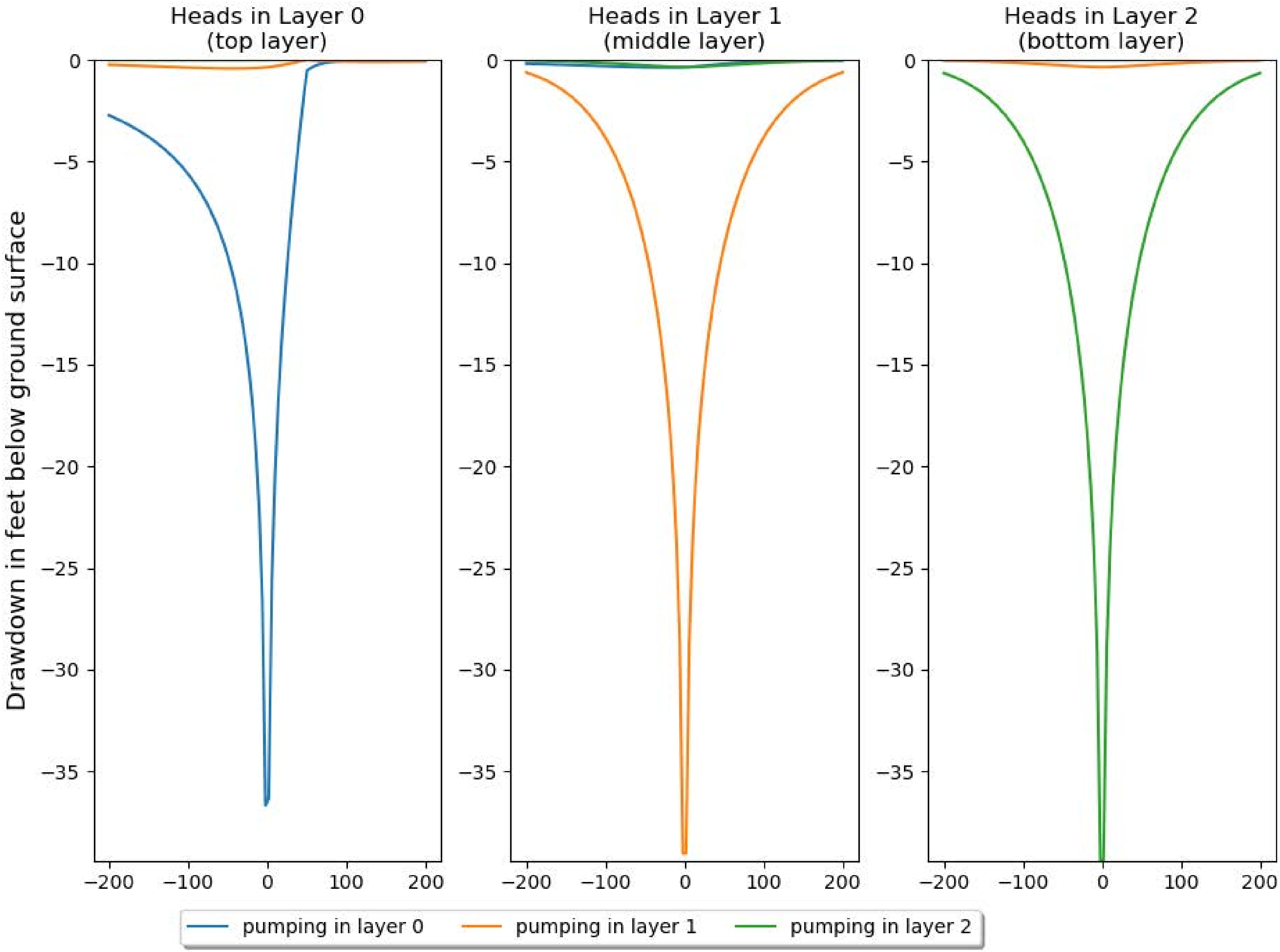


Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2


Pumping Rate = 11906 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 50 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2000
−4000
−6000
−8000
−10000
−12000
0
200
400
600
Time [days]
Stream depletion (cfs) after 700 days: -0.1269
Stream depletion (cfs) after 700 days: -0.0796
Stream depletion (cfs) after 700 days: -0.0653


Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
−0.8
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

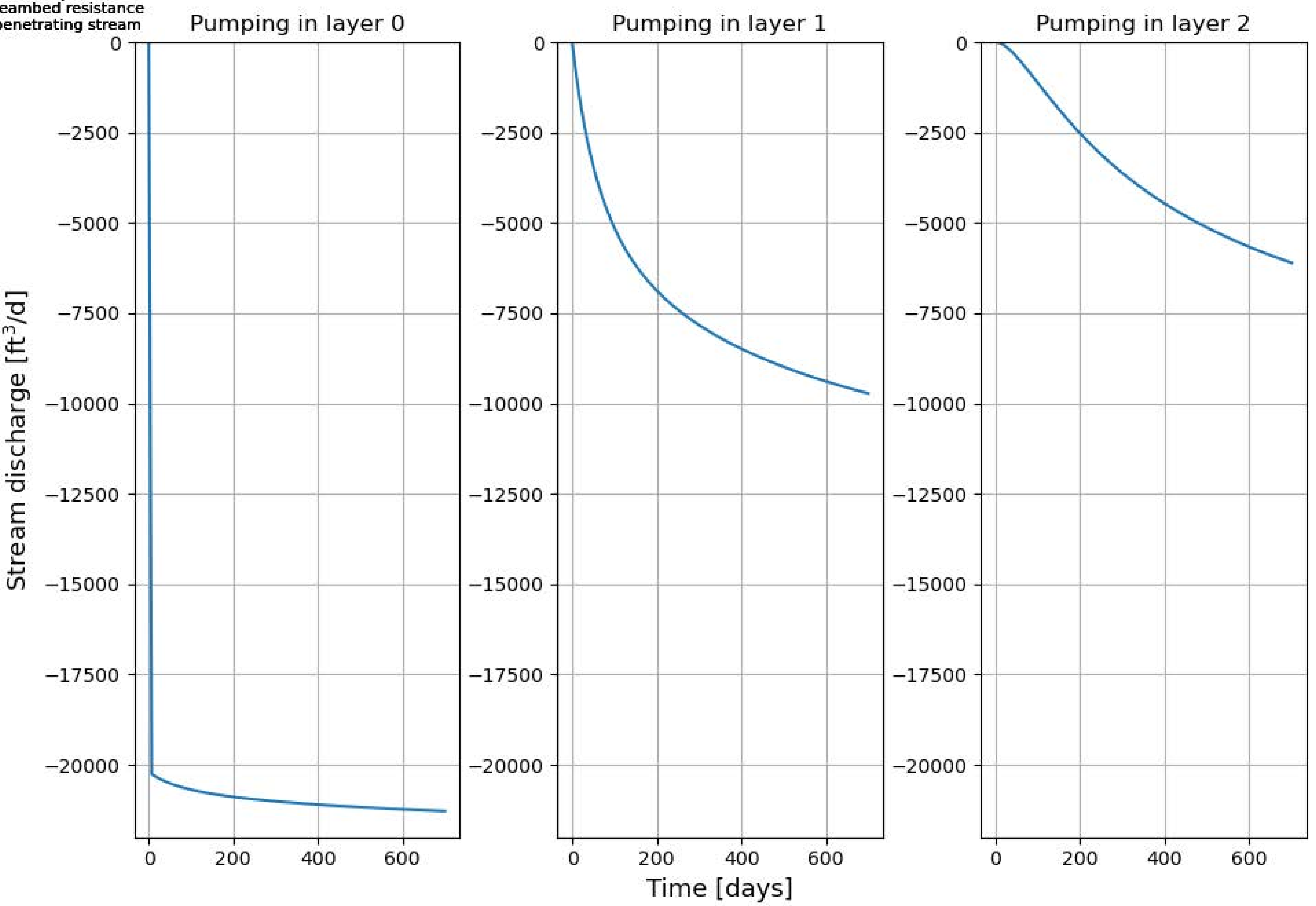

Pumping Rate = 23852 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 50 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
200
400
600
Time [days]
Stream depletion (cfs) after 700 days: -0.2349
Stream depletion (cfs) after 700 days: -0.0115
Stream depletion (cfs) after 700 days: -0.0003



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0
−5
−10
−15
−20
−25
−30
−35
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 23852 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 50 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

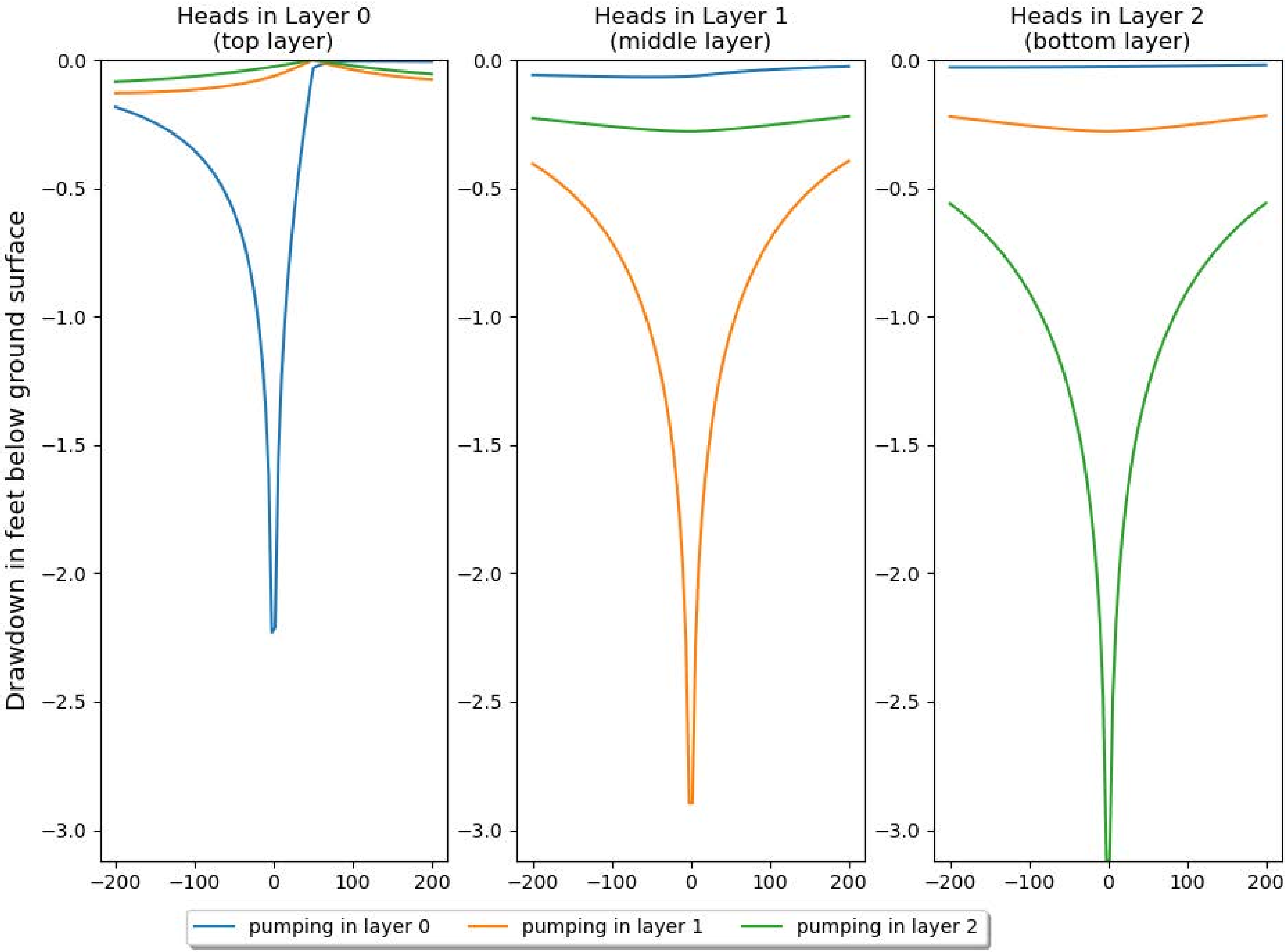
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



Stream depletion (cfs) after 700 days: -0.2464

Stream depletion (cfs) after 700 days: -0.1125

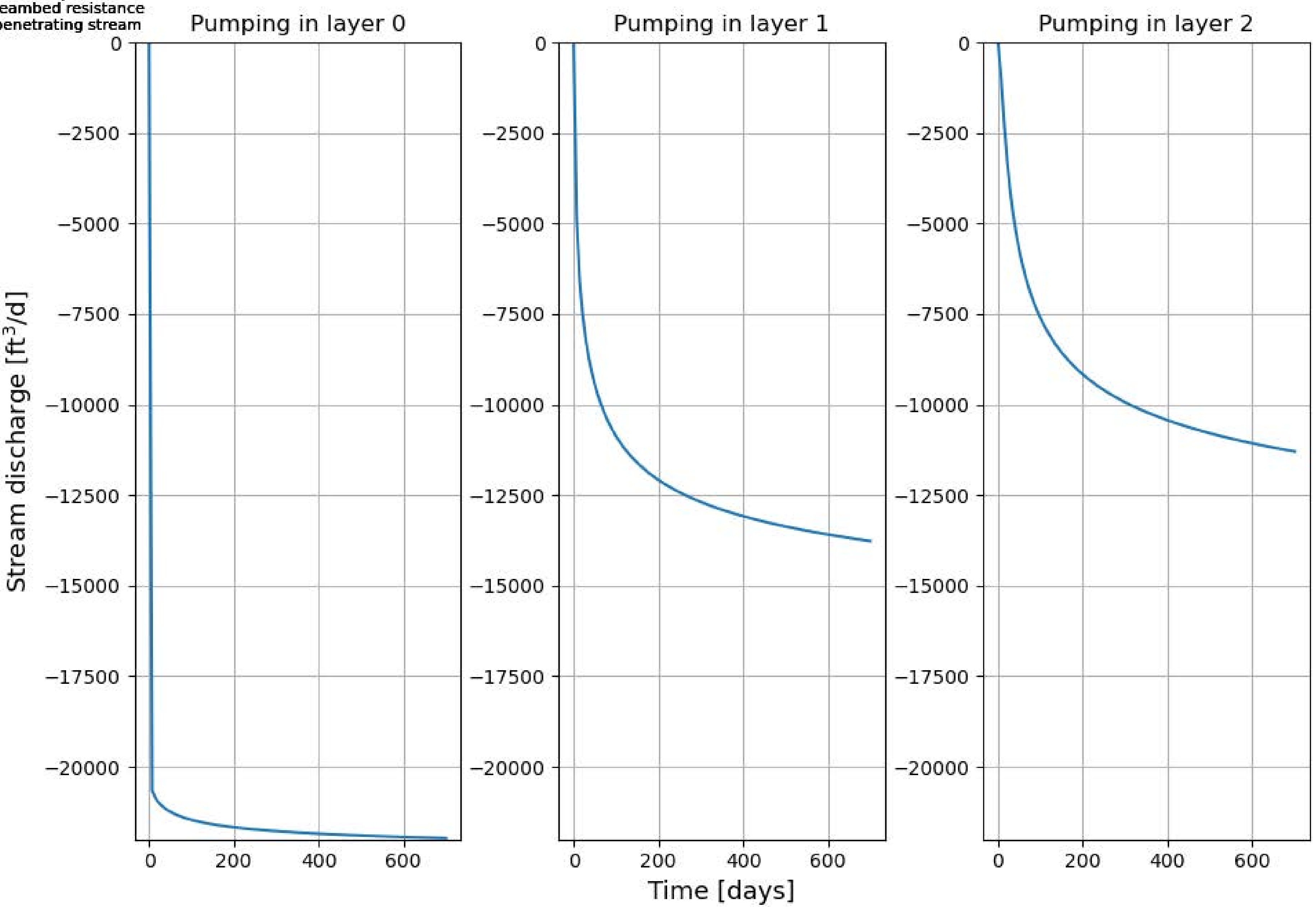
Stream depletion (cfs) after 700 days: -0.0707



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 50 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

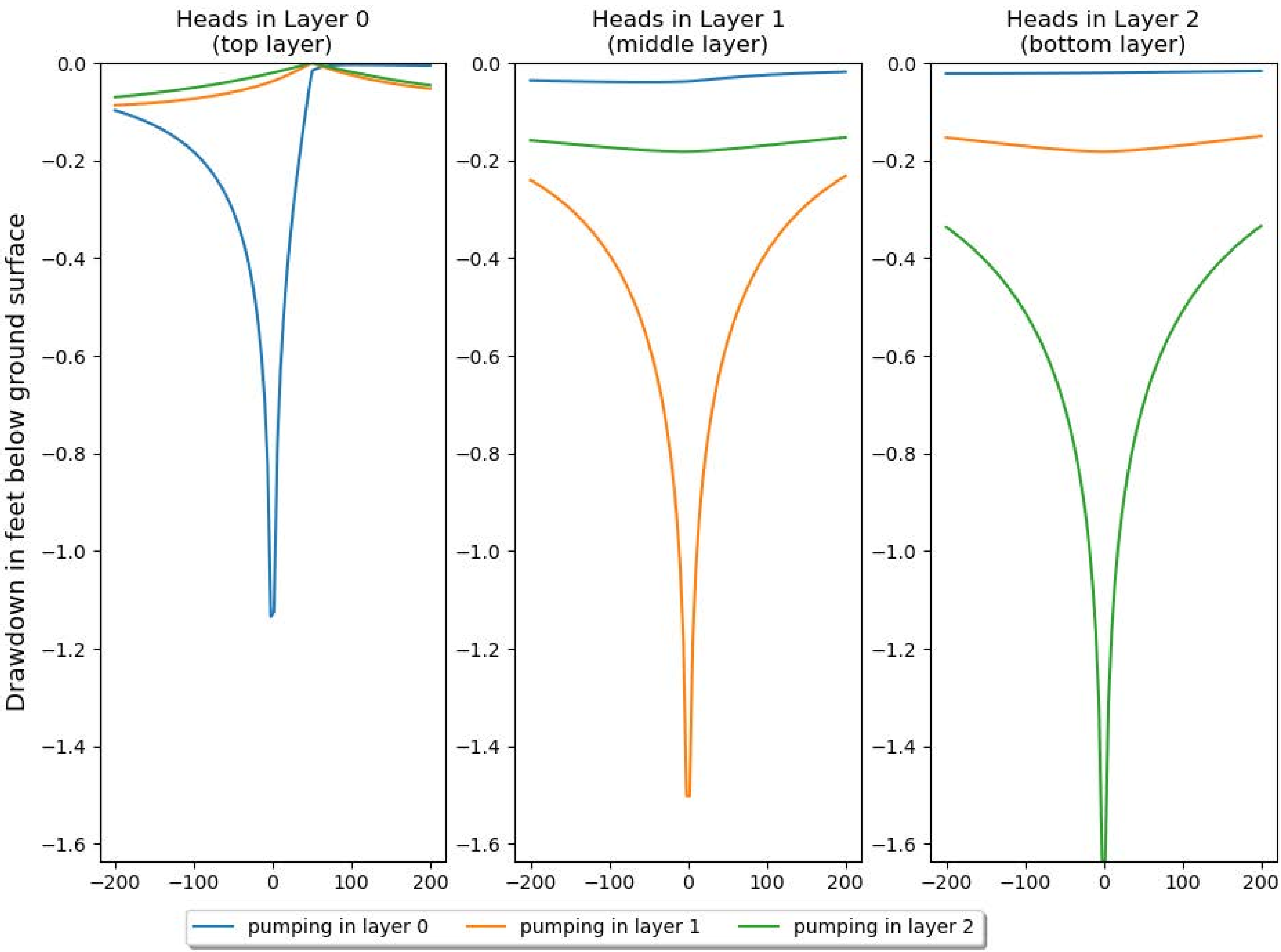
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface

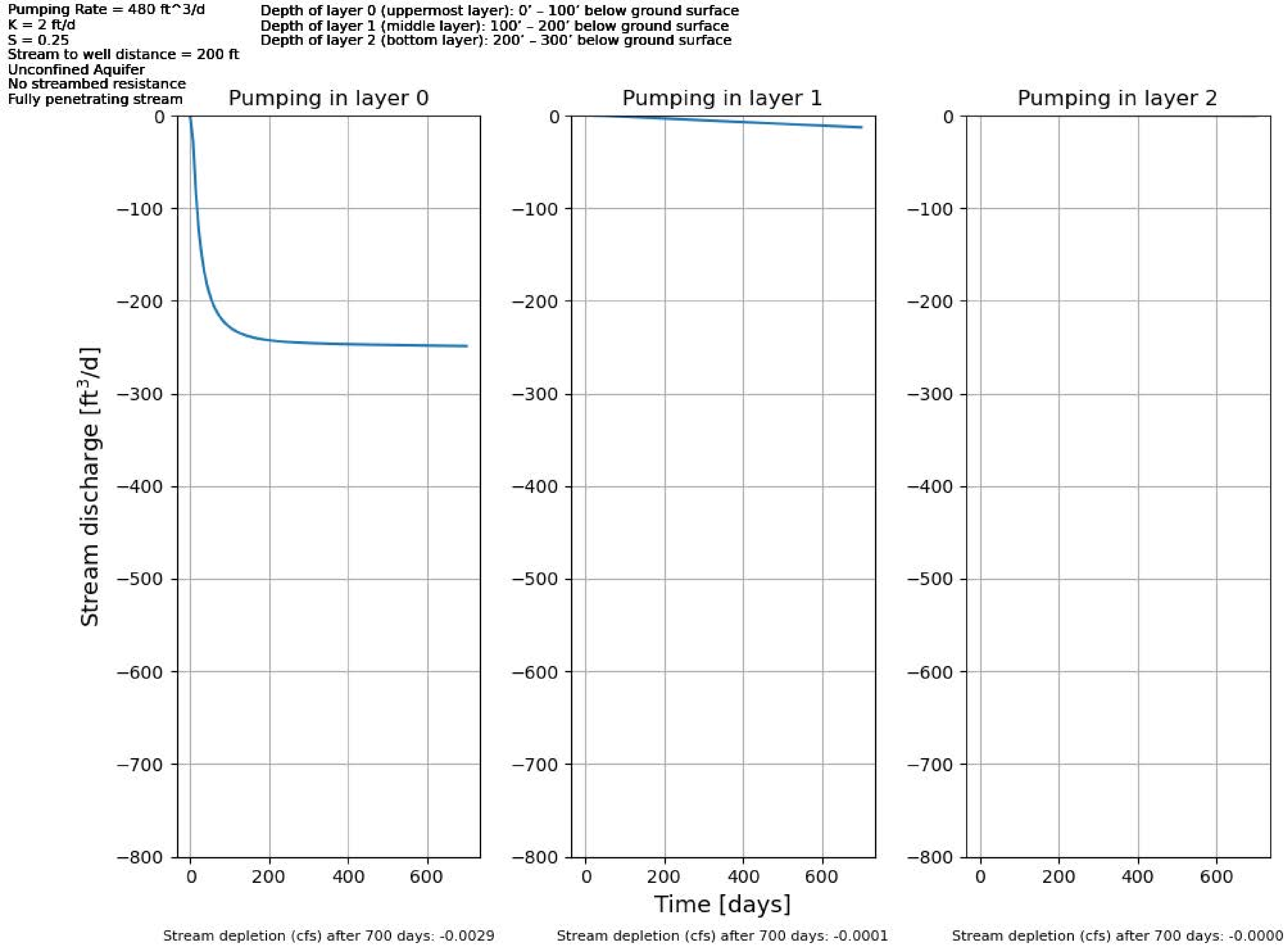


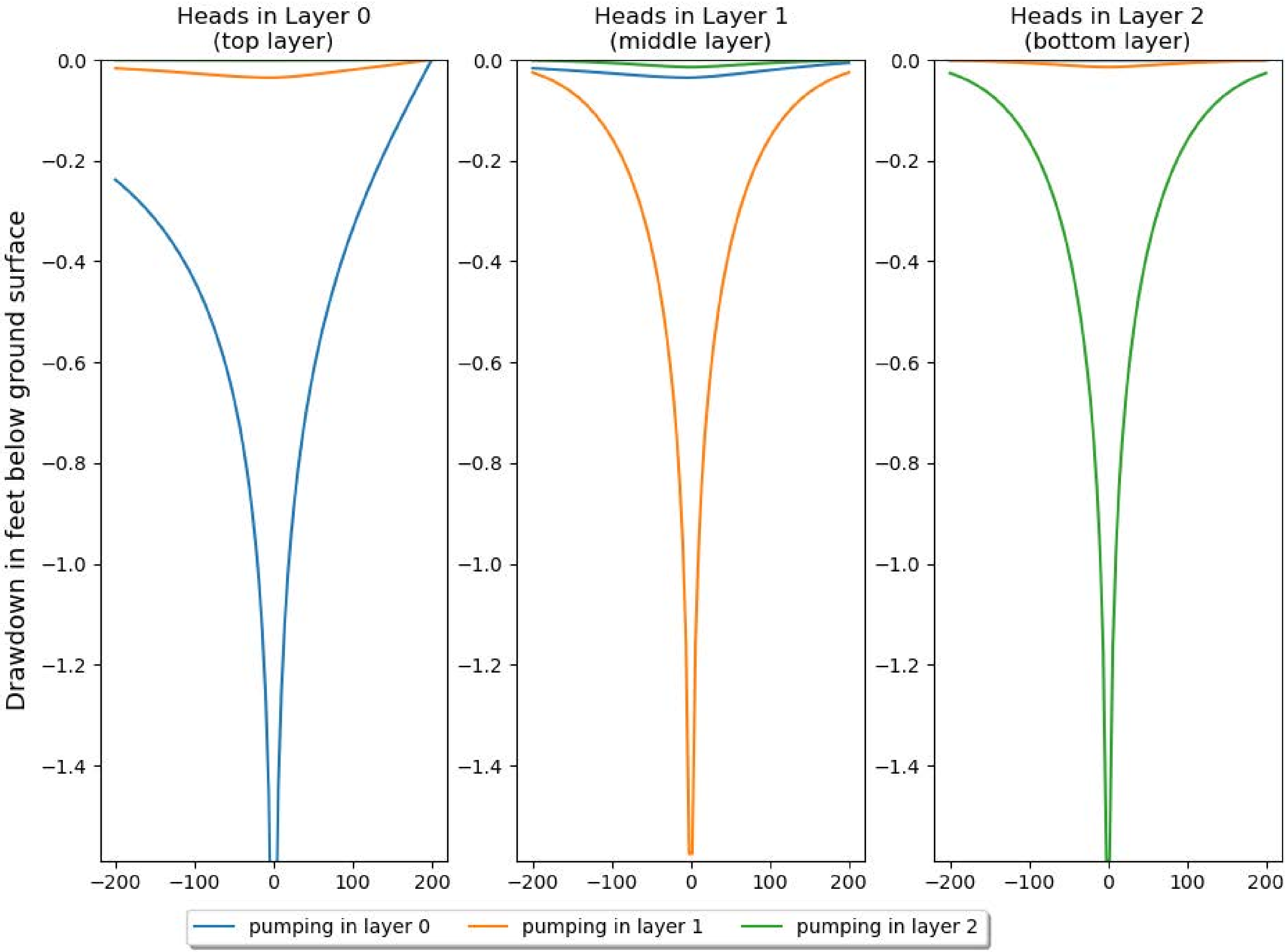
Stream depletion (cfs) after 700 days: -0.2543

Stream depletion (cfs) after 700 days: -0.1594

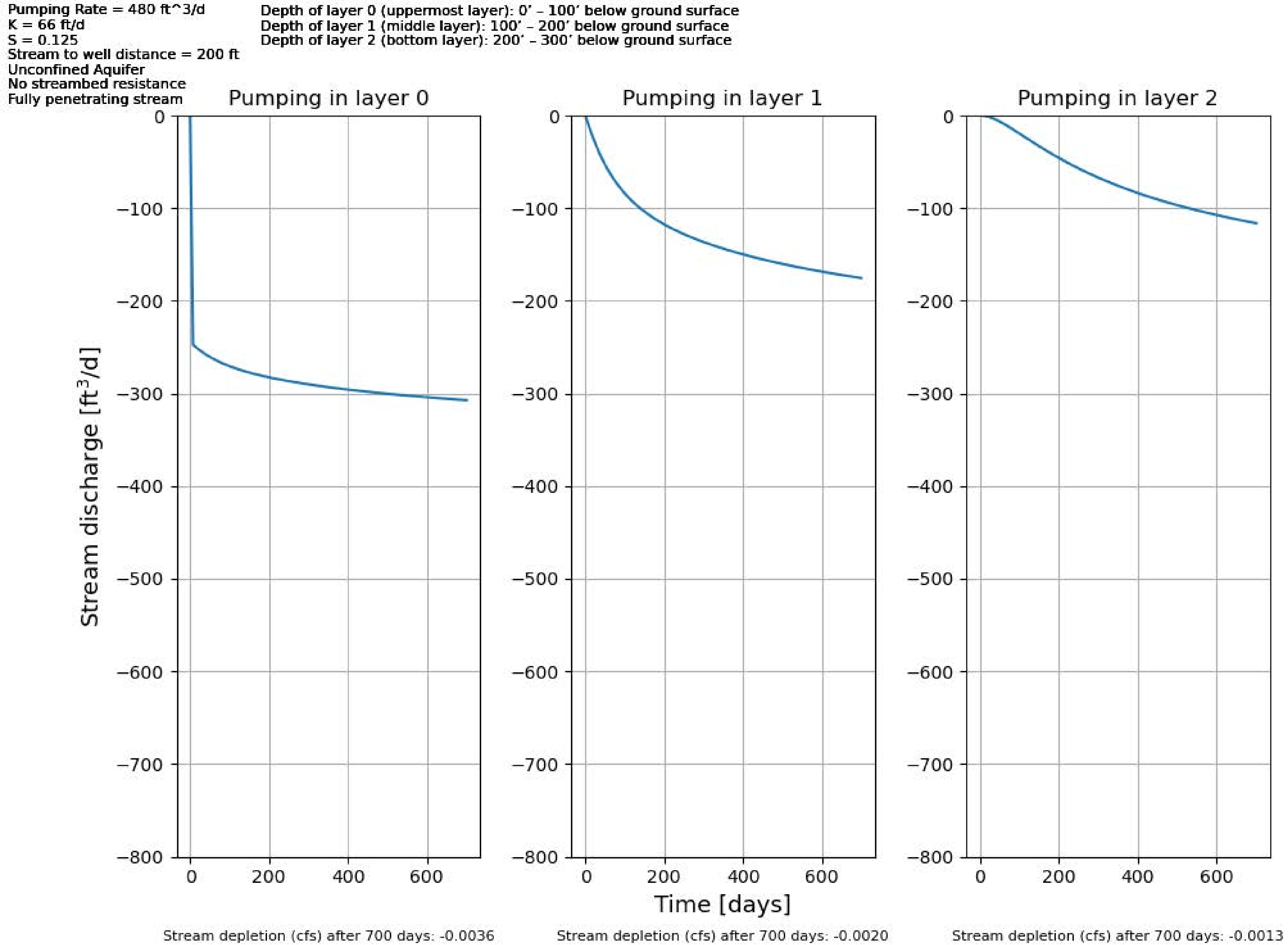
Stream depletion (cfs) after 700 days: -0.1308

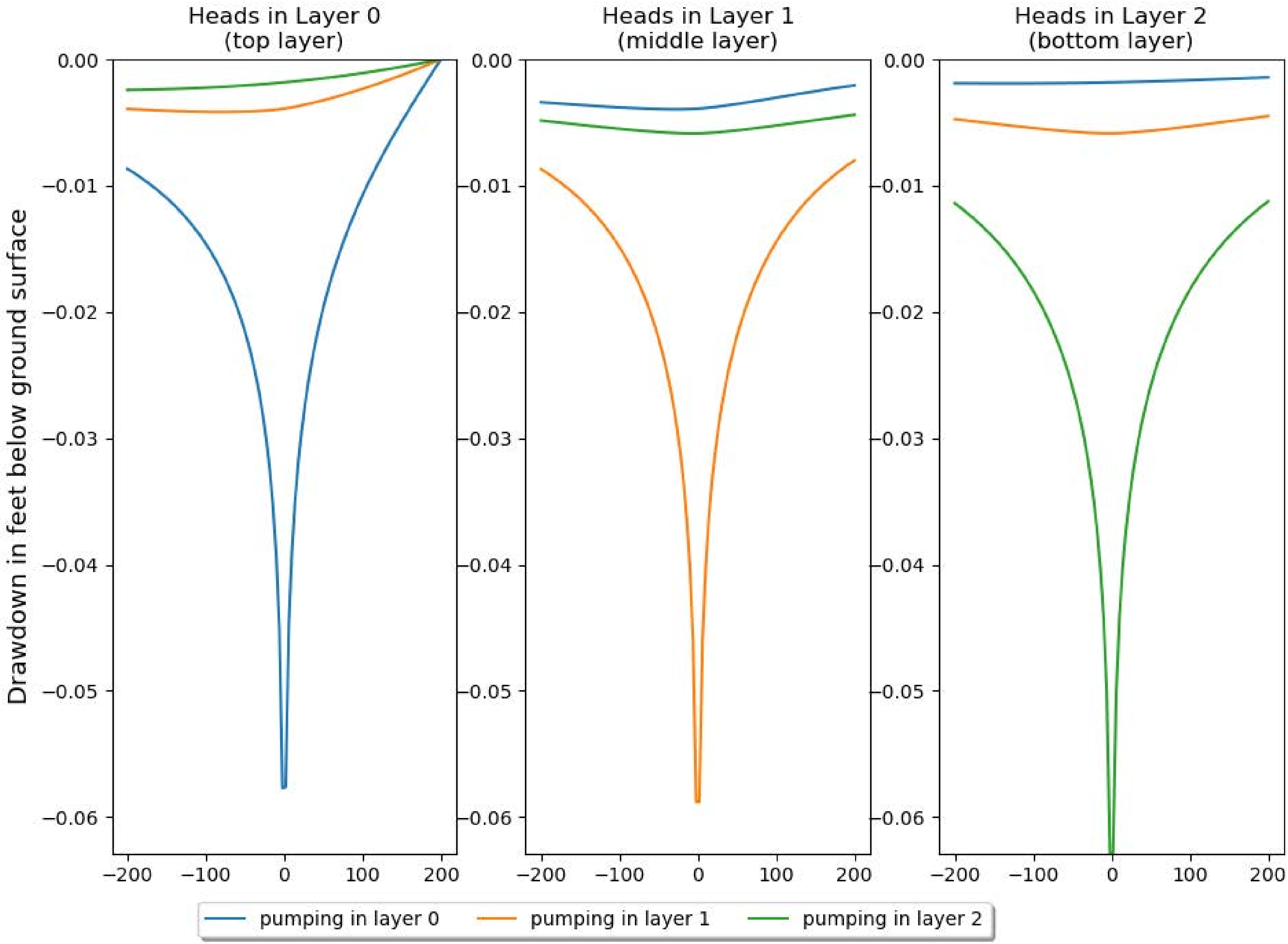

Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
−1.6
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2


Pumping Rate = 480 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 200 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−100
−200
−300
−400
−500
−600
−700
−800
0
200
400
600
Time [days]
Stream depletion (cfs) after 700 days: -0.0029
Stream depletion (cfs) after 700 days: -0.0001
Stream depletion (cfs) after 700 days: -0.0000



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

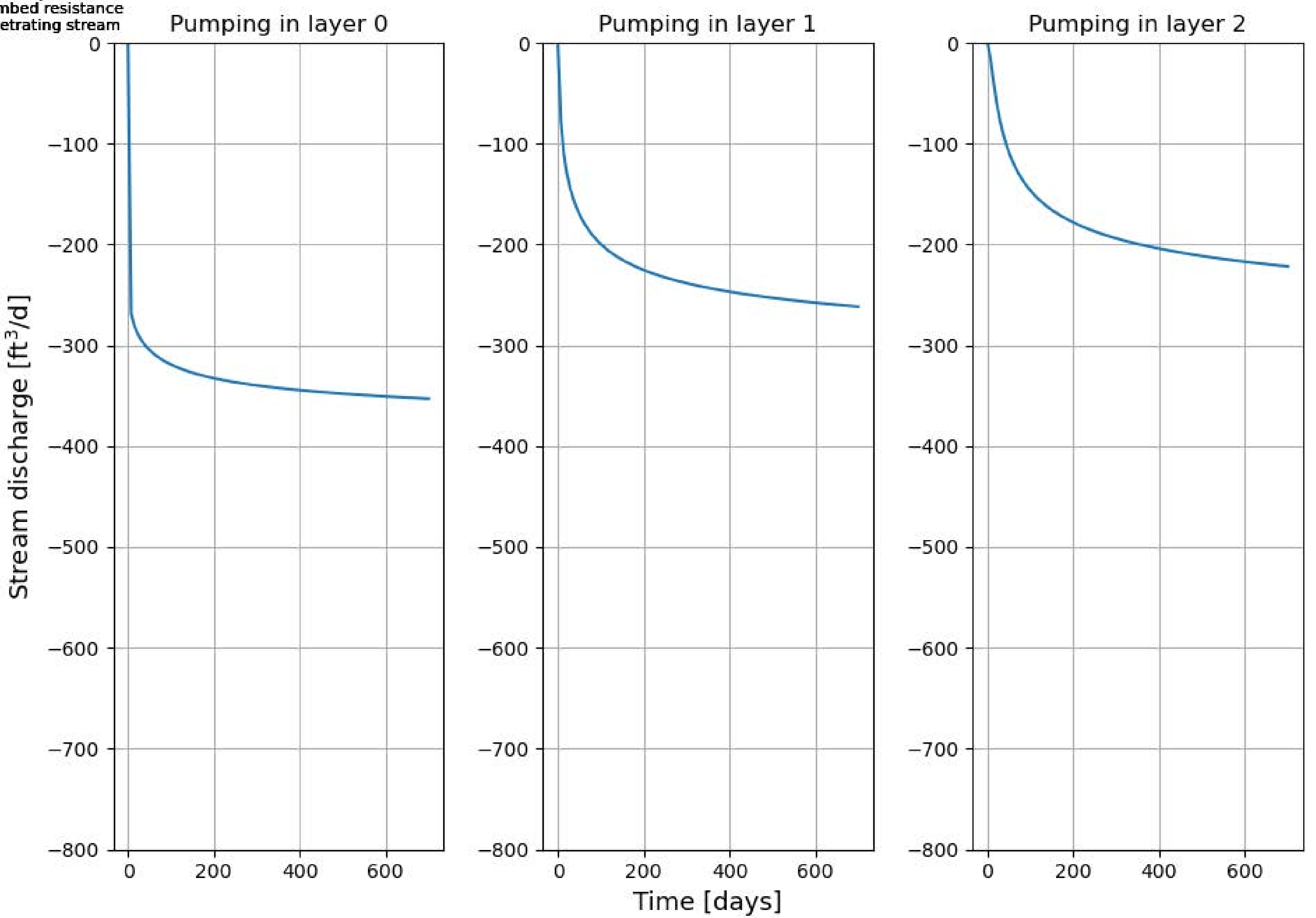

Pumping Rate = 480 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 200 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft³/d]
0
−100
−200
−300
−400
−500
−600
−700
−800
0
200
400
600
Time [days]
Stream depletion (cfs) after 700 days: -0.0036
Stream depletion (cfs) after 700 days: -0.0020
Stream depletion (cfs) after 700 days: -0.0013



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.00
−0.01
−0.02
−0.03
−0.04
−0.05
−0.06
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 480 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 200 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

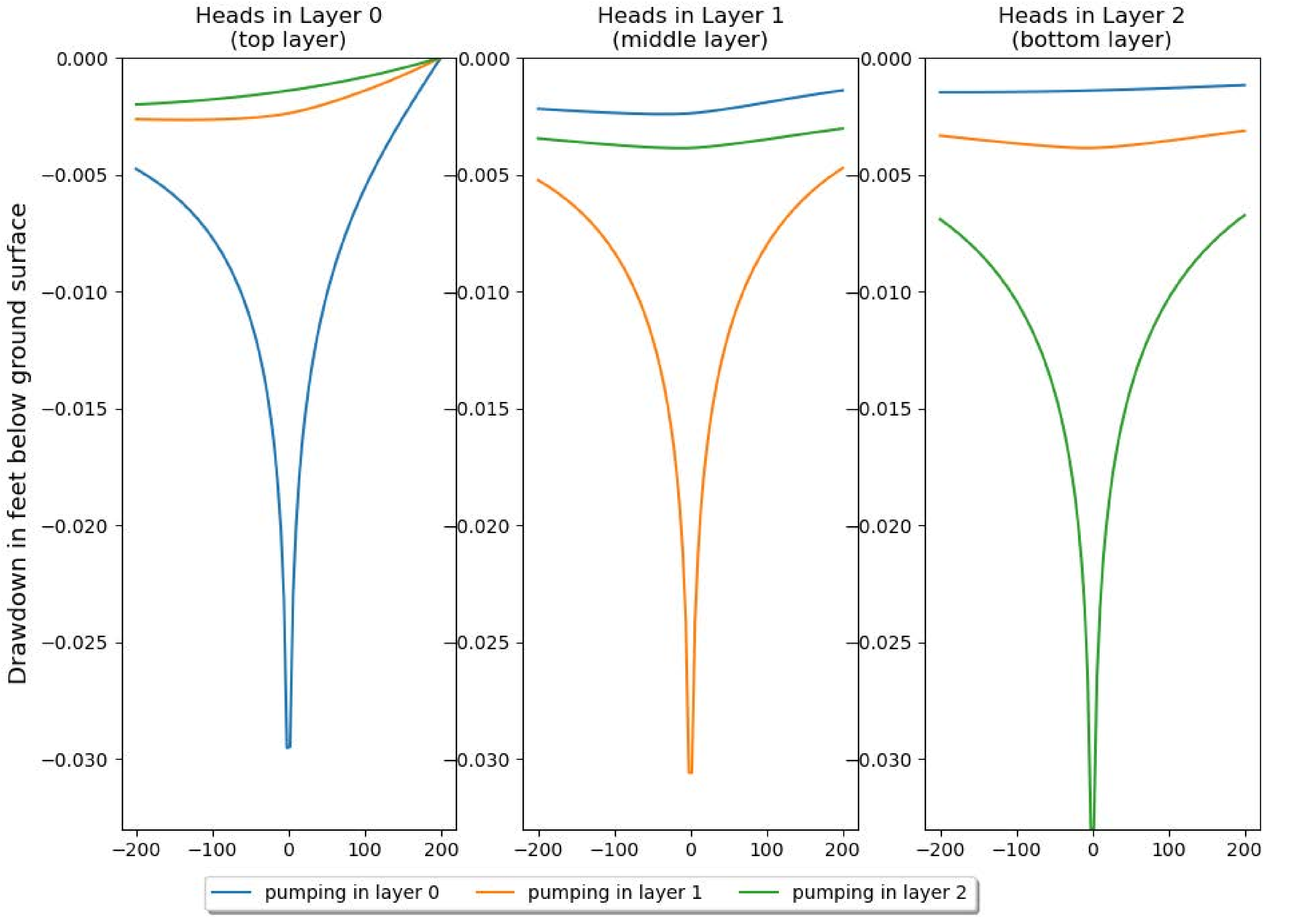
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



Stream depletion (cfs) after 700 days: -0.0041

Stream depletion (cfs) after 700 days: -0.0030

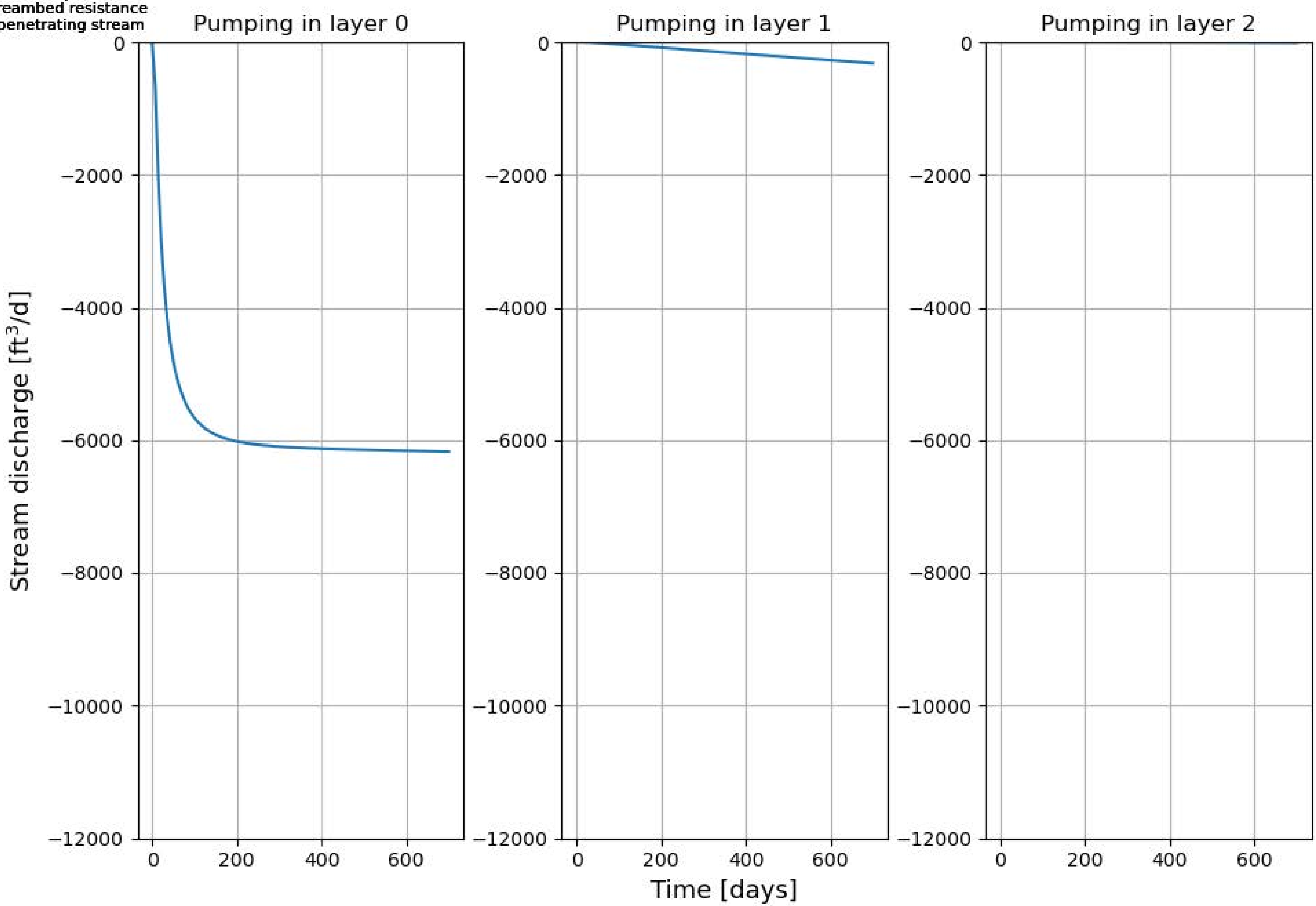
Stream depletion (cfs) after 700 days: -0.0026



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.000
−0.005
−0.010
−0.015
−0.020
−0.025
−0.030
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 11906 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 200 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

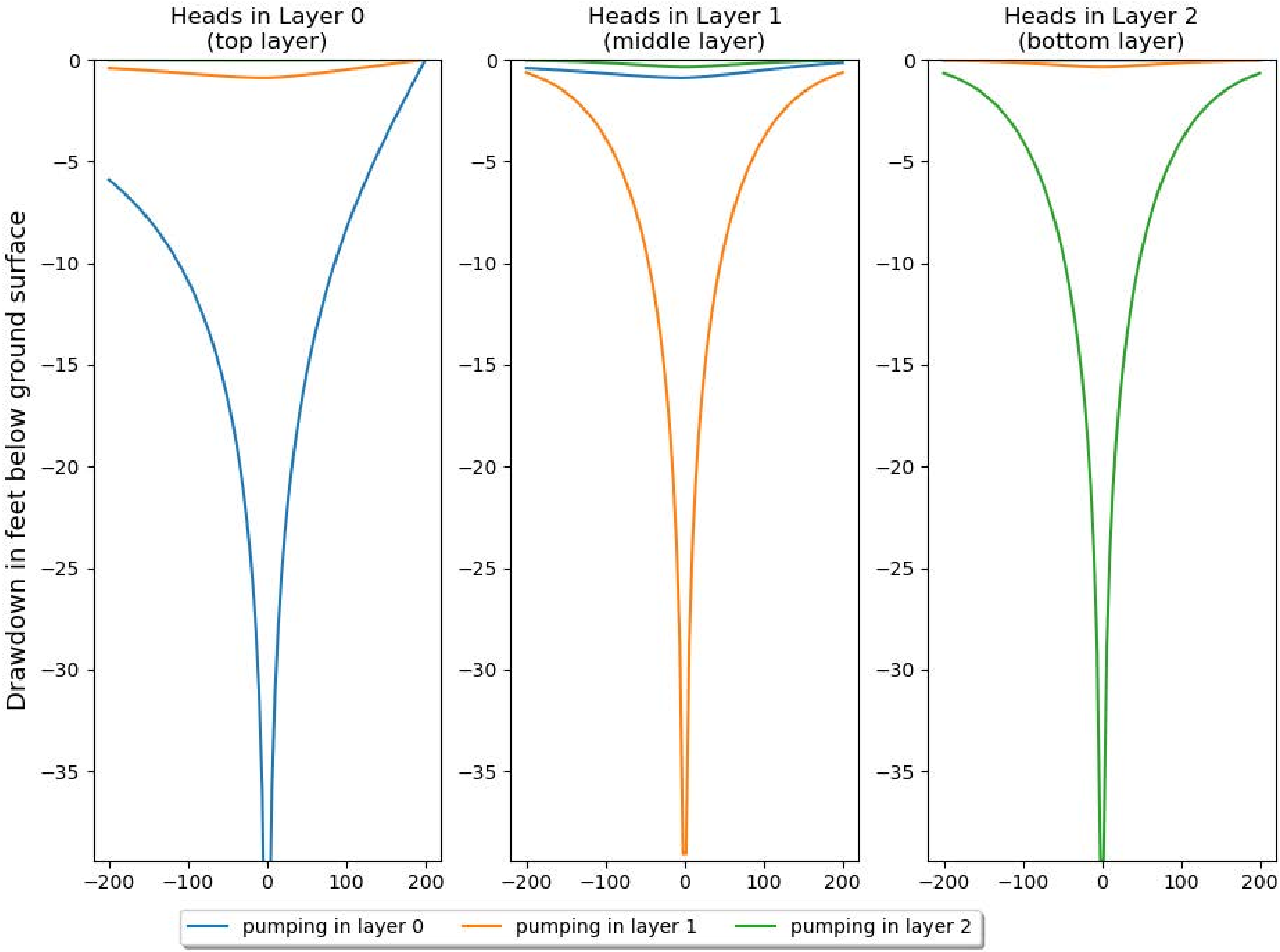
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



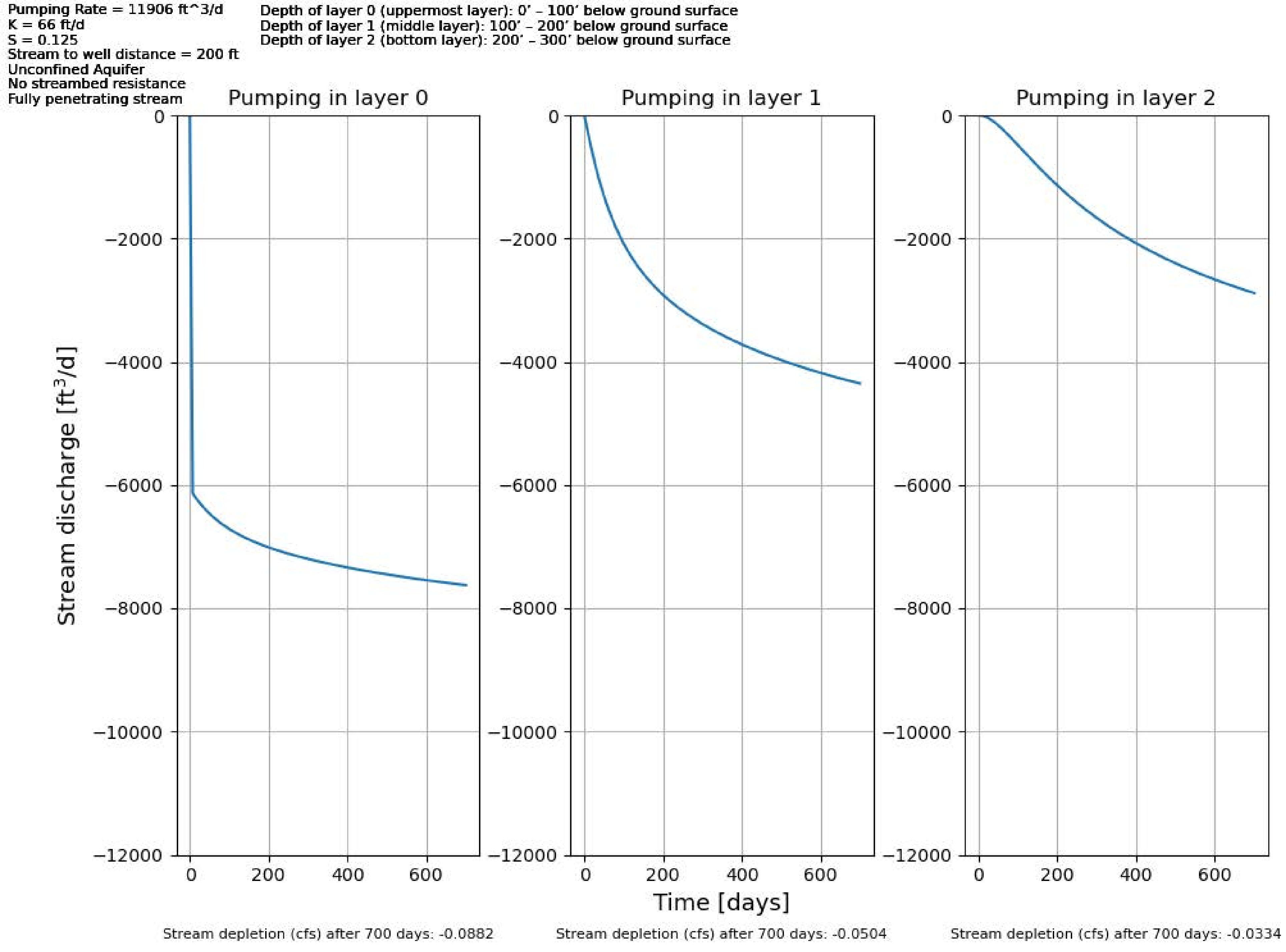
Stream depletion (cfs) after 700 days: -0.0714

Stream depletion (cfs) after 700 days: -0.0037

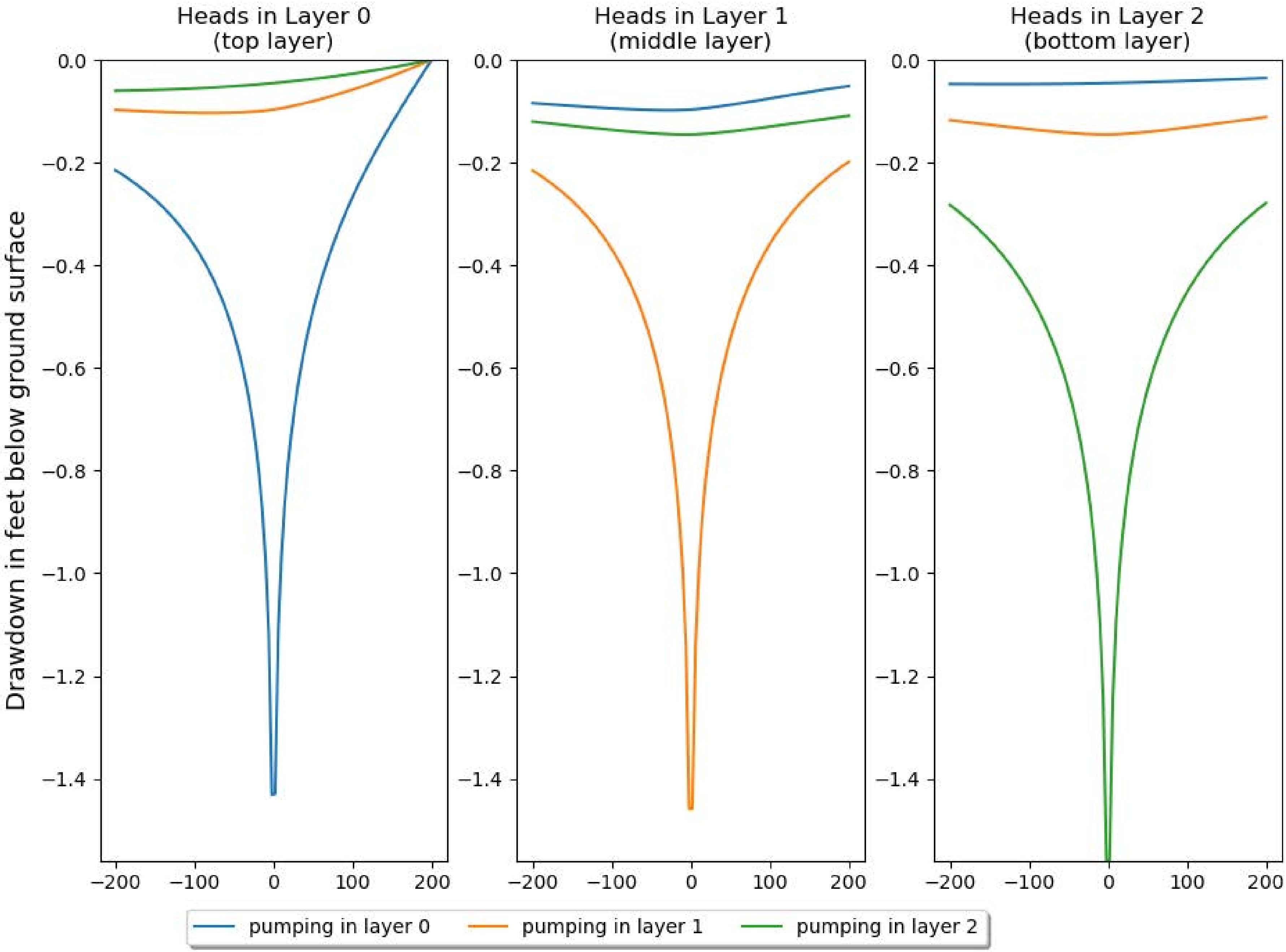
Stream depletion (cfs) after 700 days: -0.0001



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0
−5
−10
−15
−20
−25
−30
−35
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2



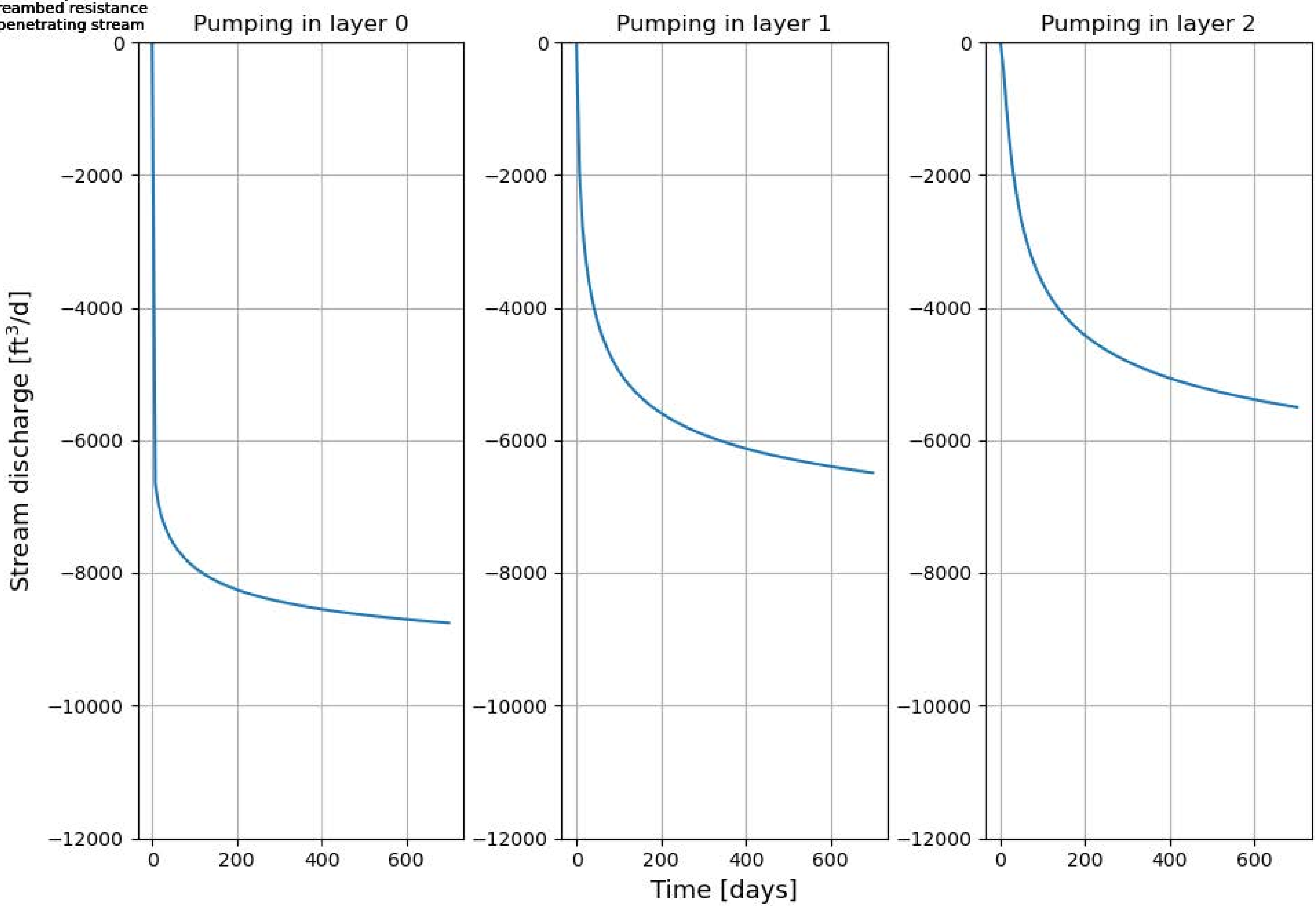
Pumping Rate = 11906 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 200 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2000
−4000
−6000
−8000
−10000
−12000
0
200
400
600
Time [days]
Stream depletion (cfs) after 700 days: -0.0882
Stream depletion (cfs) after 700 days: -0.0504
Stream depletion (cfs) after 700 days: -0.0334



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 11906 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 200 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

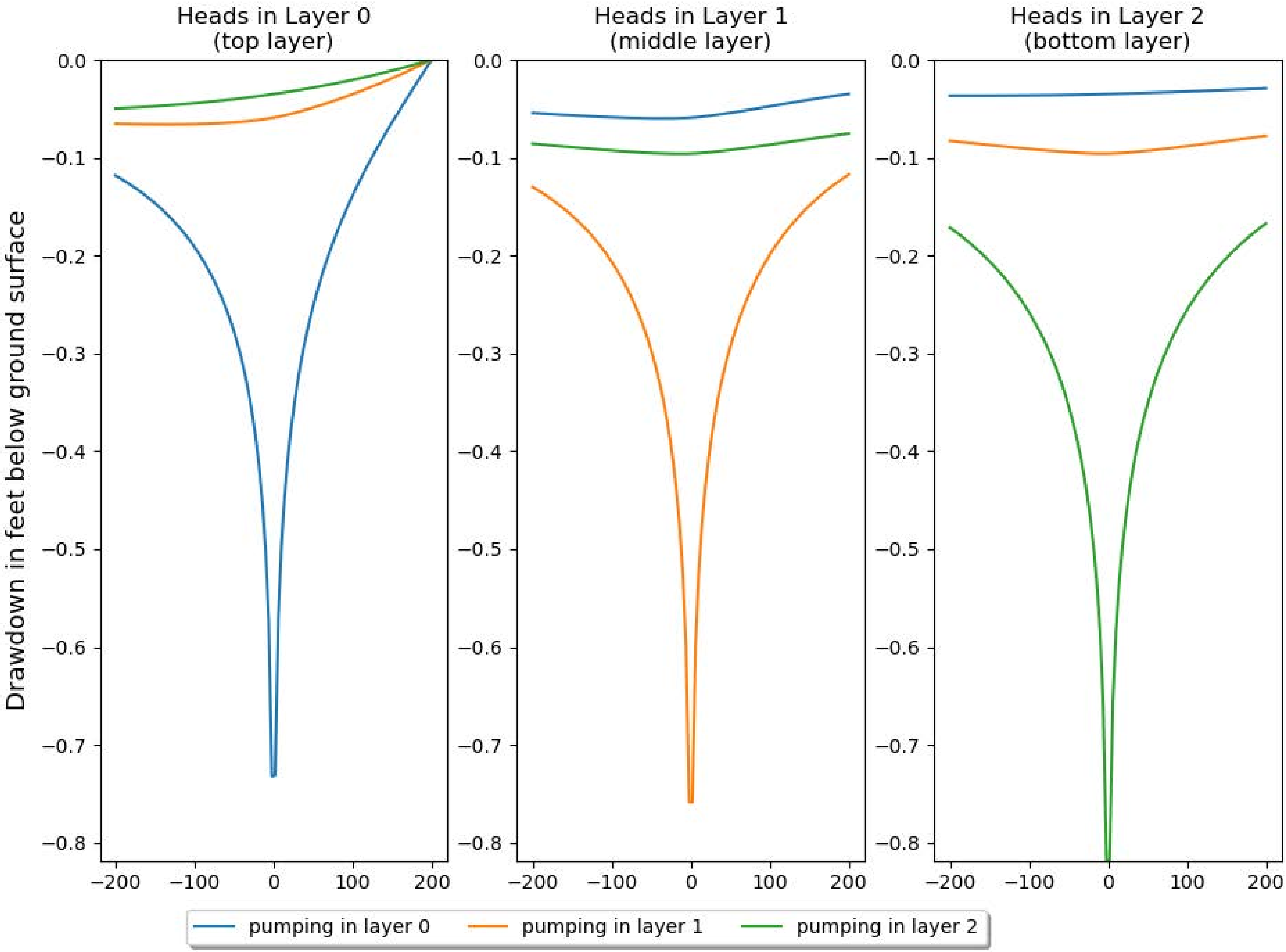
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



Stream depletion (cfs) after 700 days: -0.1013

Stream depletion (cfs) after 700 days: -0.0751

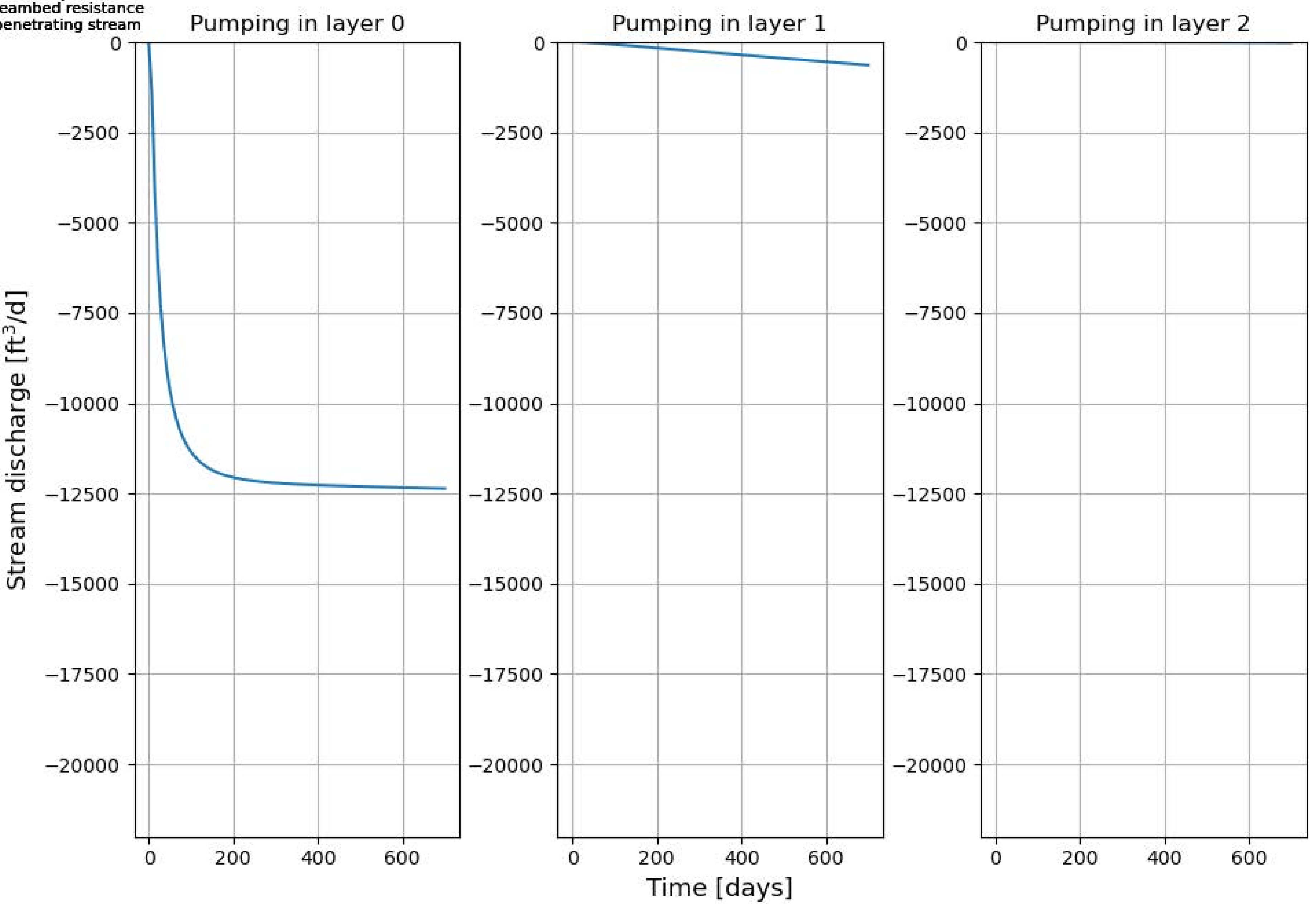
Stream depletion (cfs) after 700 days: -0.0637



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
−0.8
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 23852 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 200 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

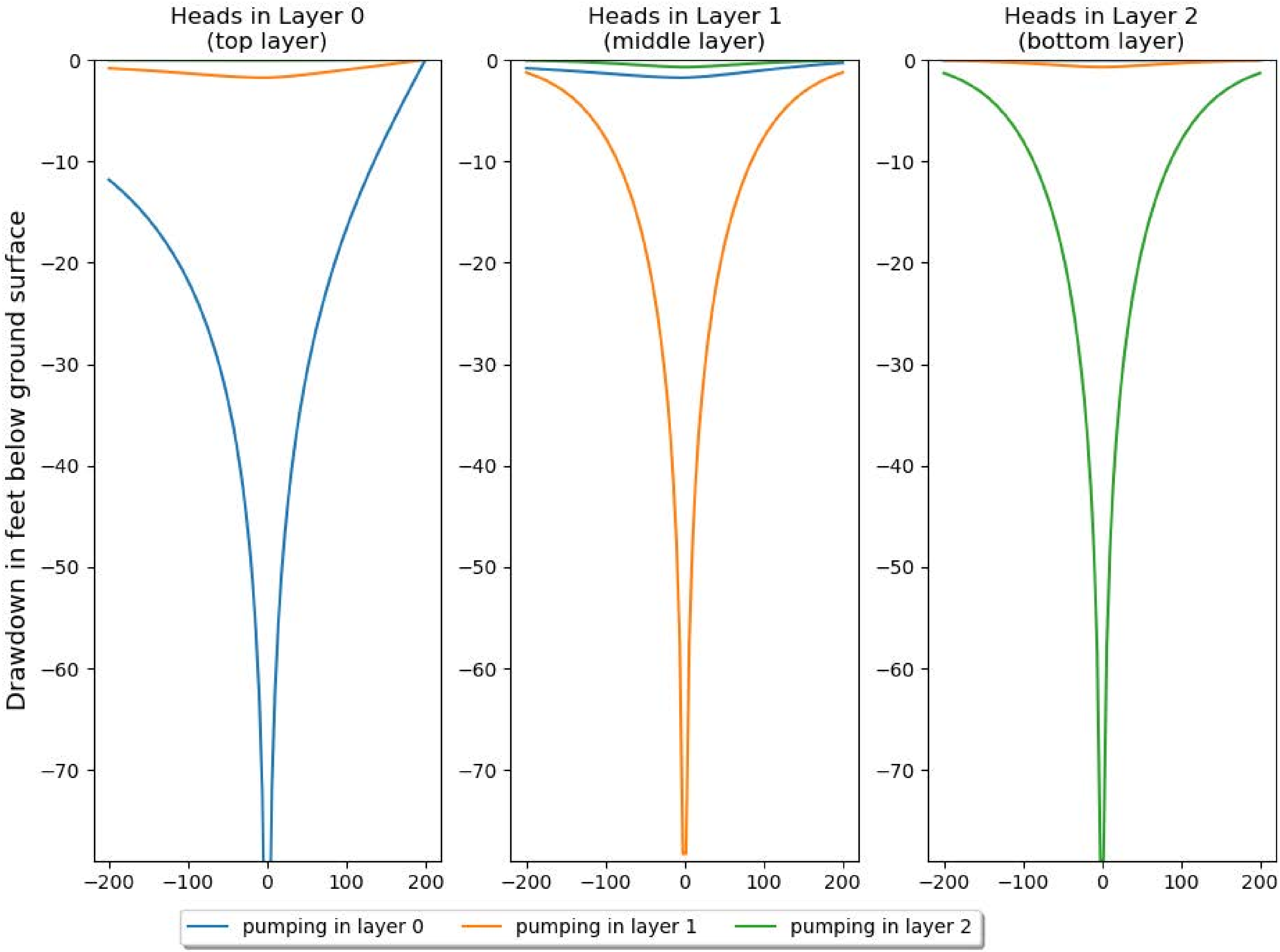
Depth of layer 0 (uppermost layer): 0’ – 100’ below ground surface
Depth of layer 1 (middle layer): 100’ – 200’ below ground surface
Depth of layer 2 (bottom layer): 200’ – 300’ below ground surface



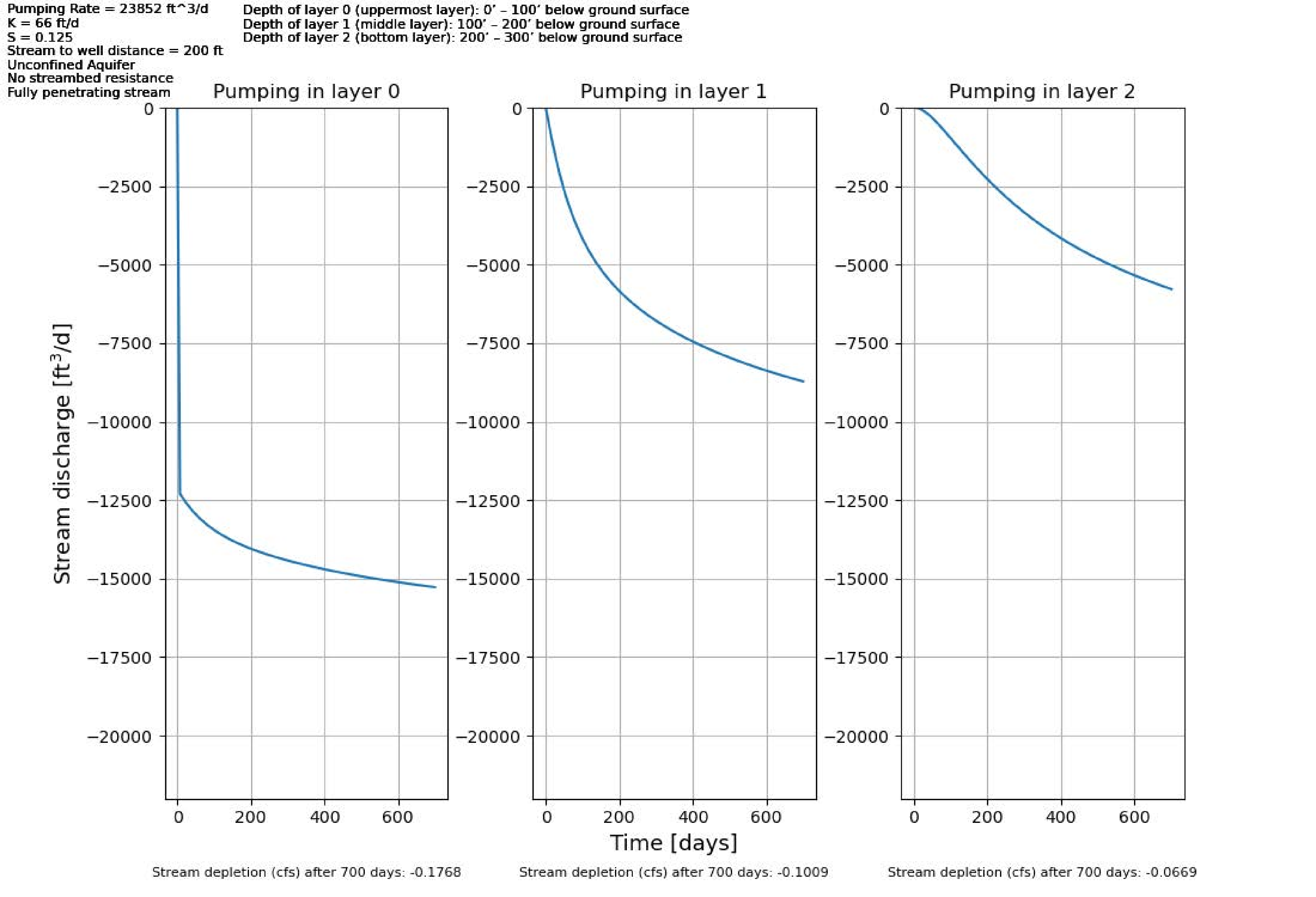
Stream depletion (cfs) after 700 days: -0.1431

Stream depletion (cfs) after 700 days: -0.0074

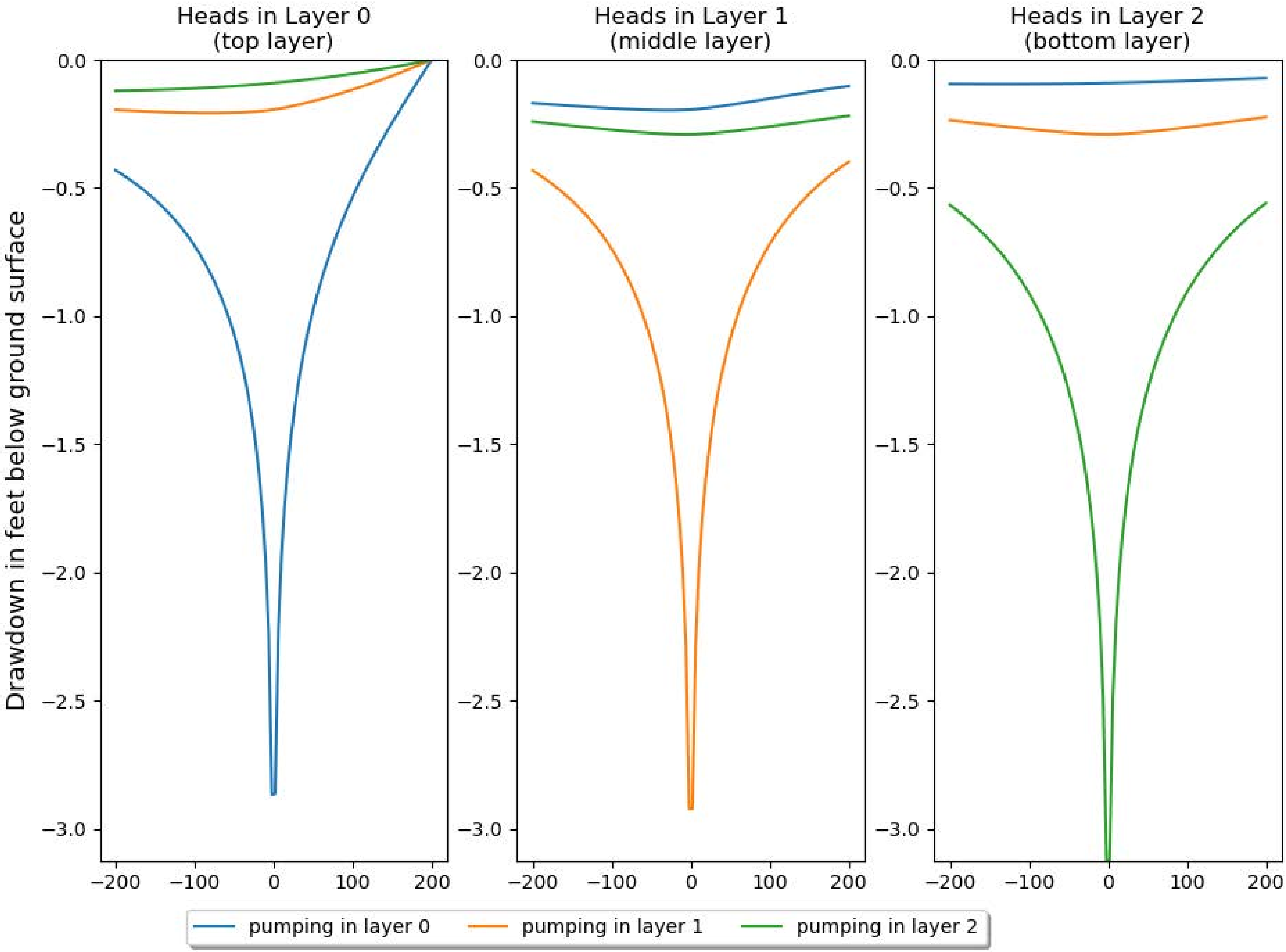
Stream depletion (cfs) after 700 days: -0.0002



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0
−10
−20
−30
−40
−50
−60
−70
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2



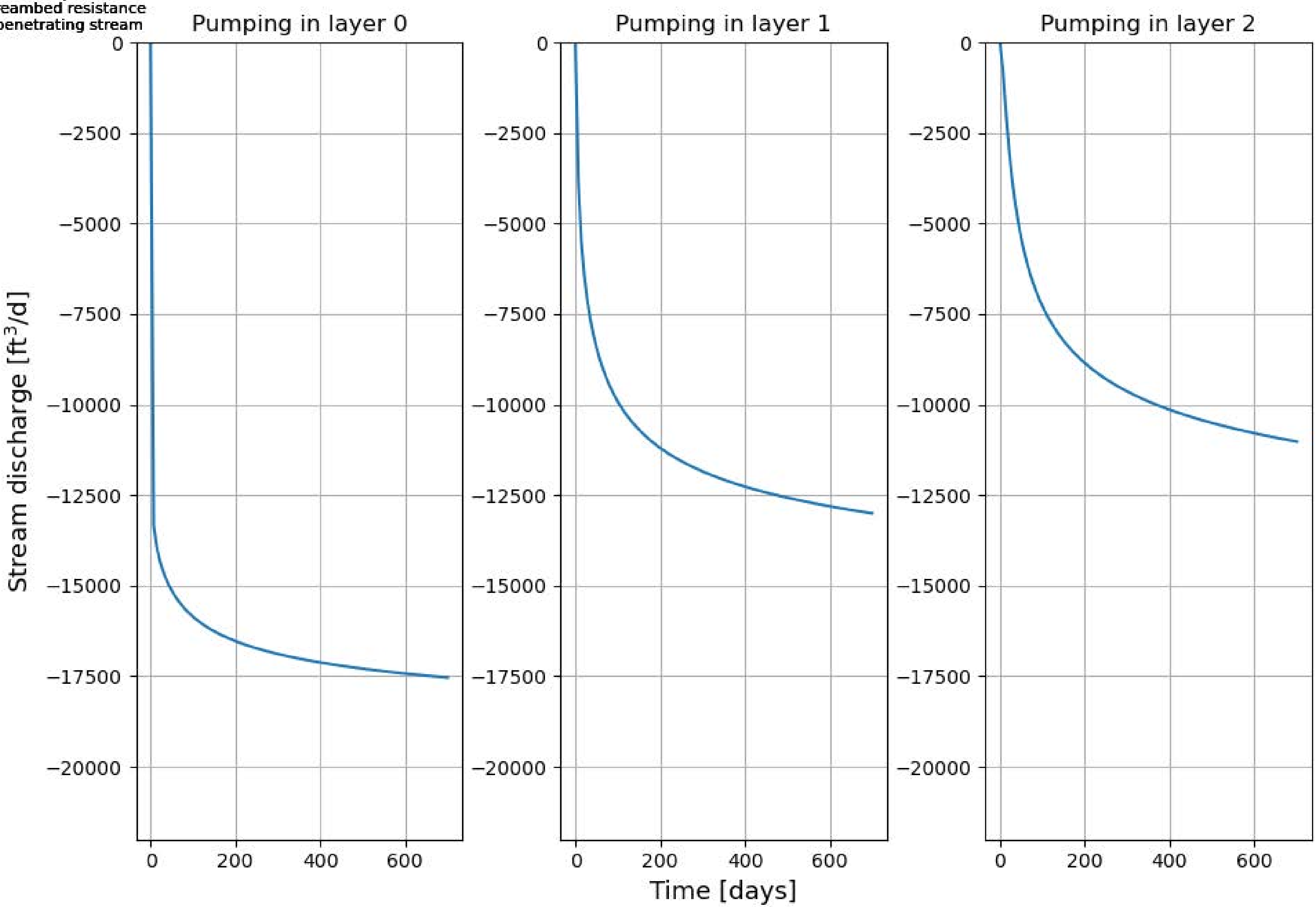
Pumping Rate = 23852 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 200 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
200
400
600
Time [days]
Stream depletion (cfs) after 700 days: -0.1768
Stream depletion (cfs) after 700 days: -0.1009
Stream depletion (cfs) after 700 days: -0.0669



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 200 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

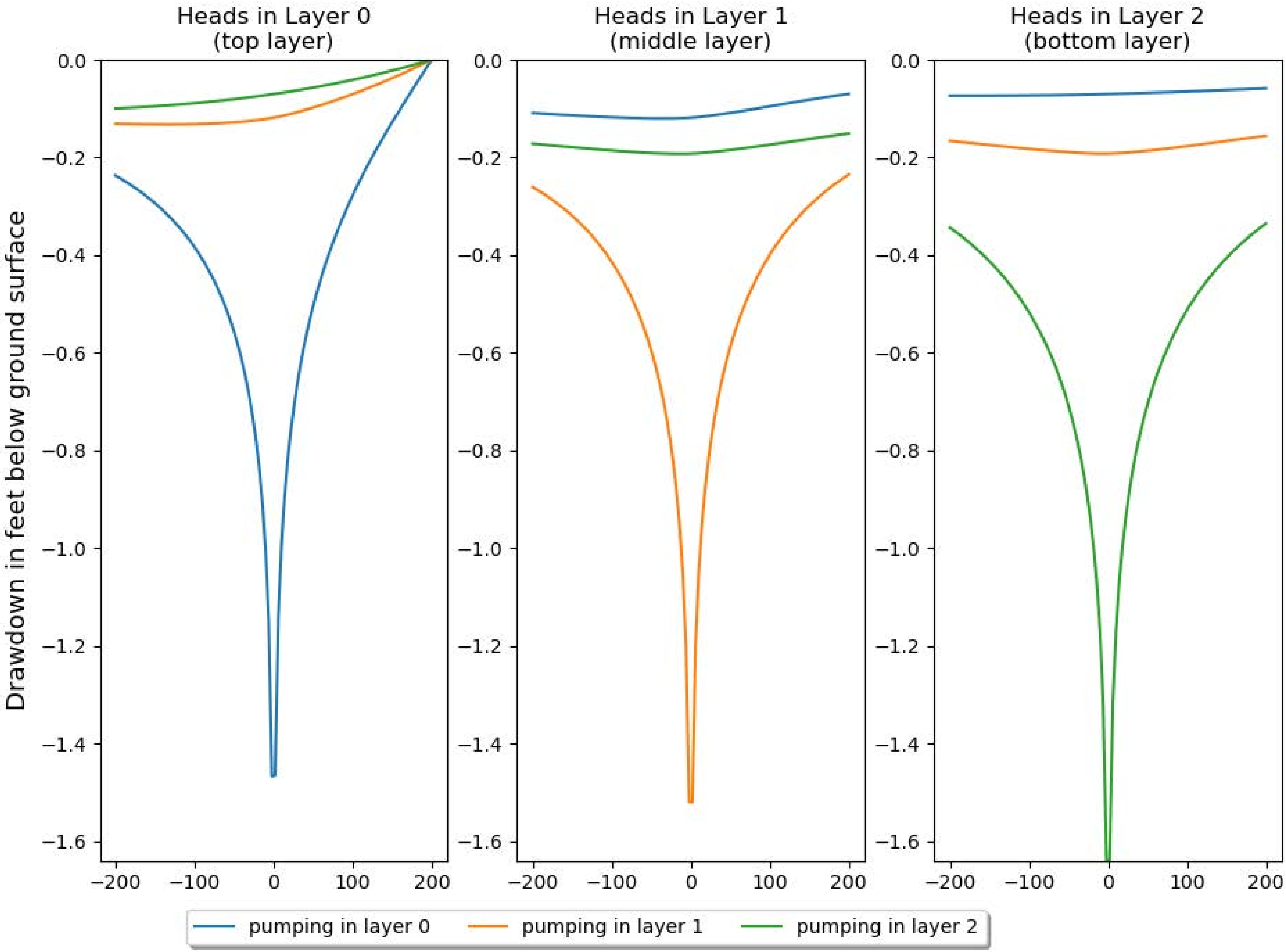
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



Stream depletion (cfs) after 700 days: -0.2030

Stream depletion (cfs) after 700 days: -0.1505

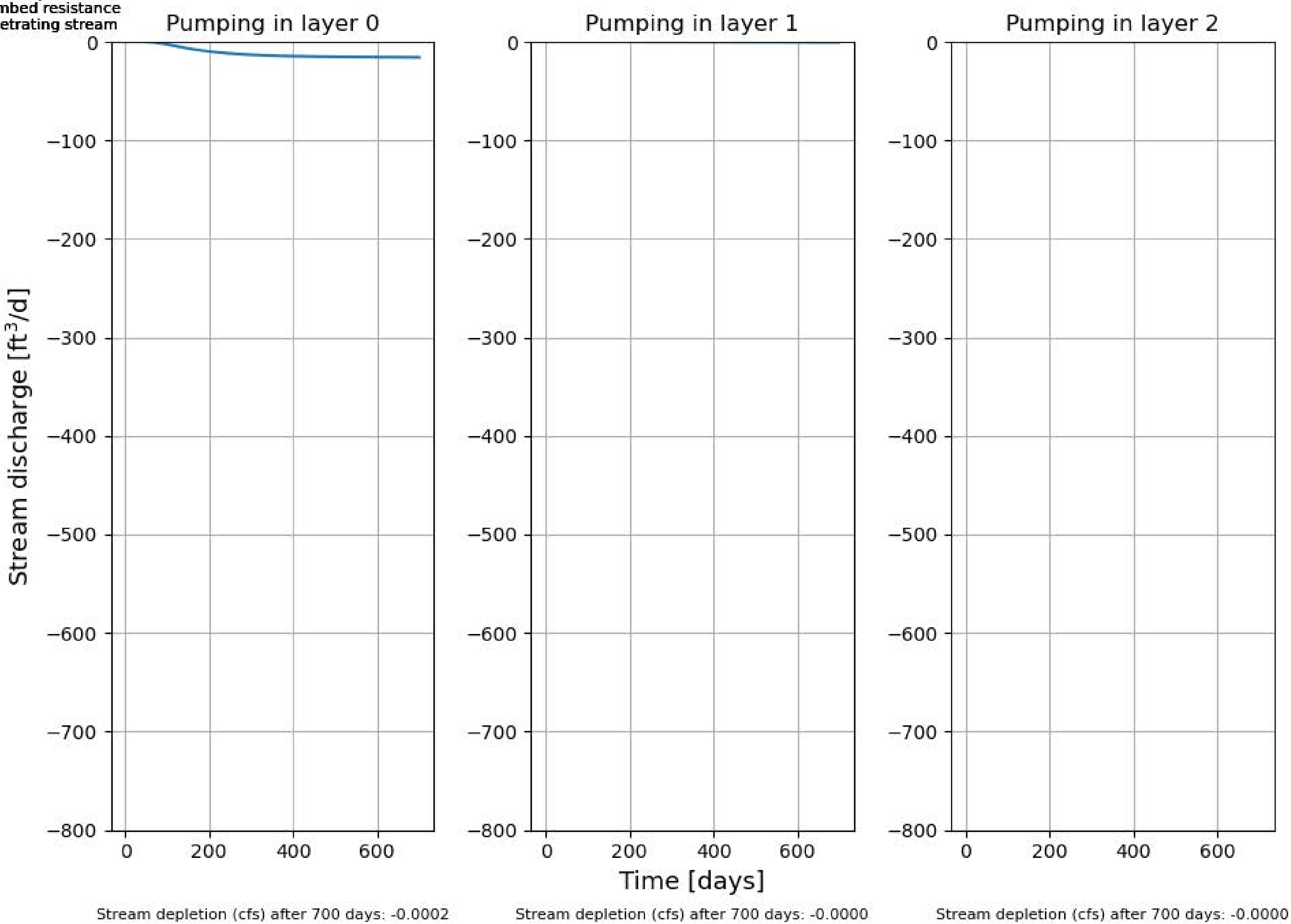
Stream depletion (cfs) after 700 days: -0.1276

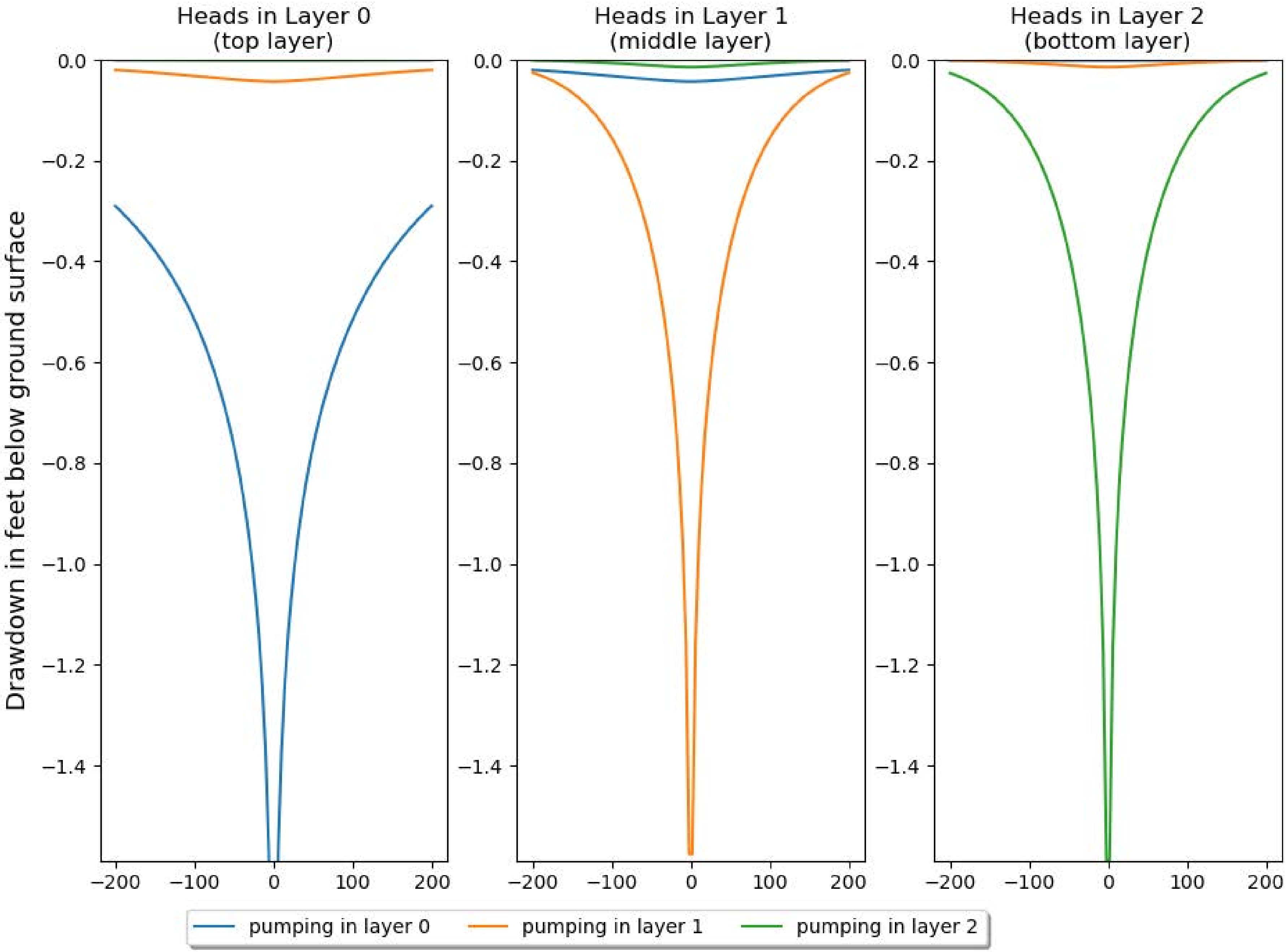


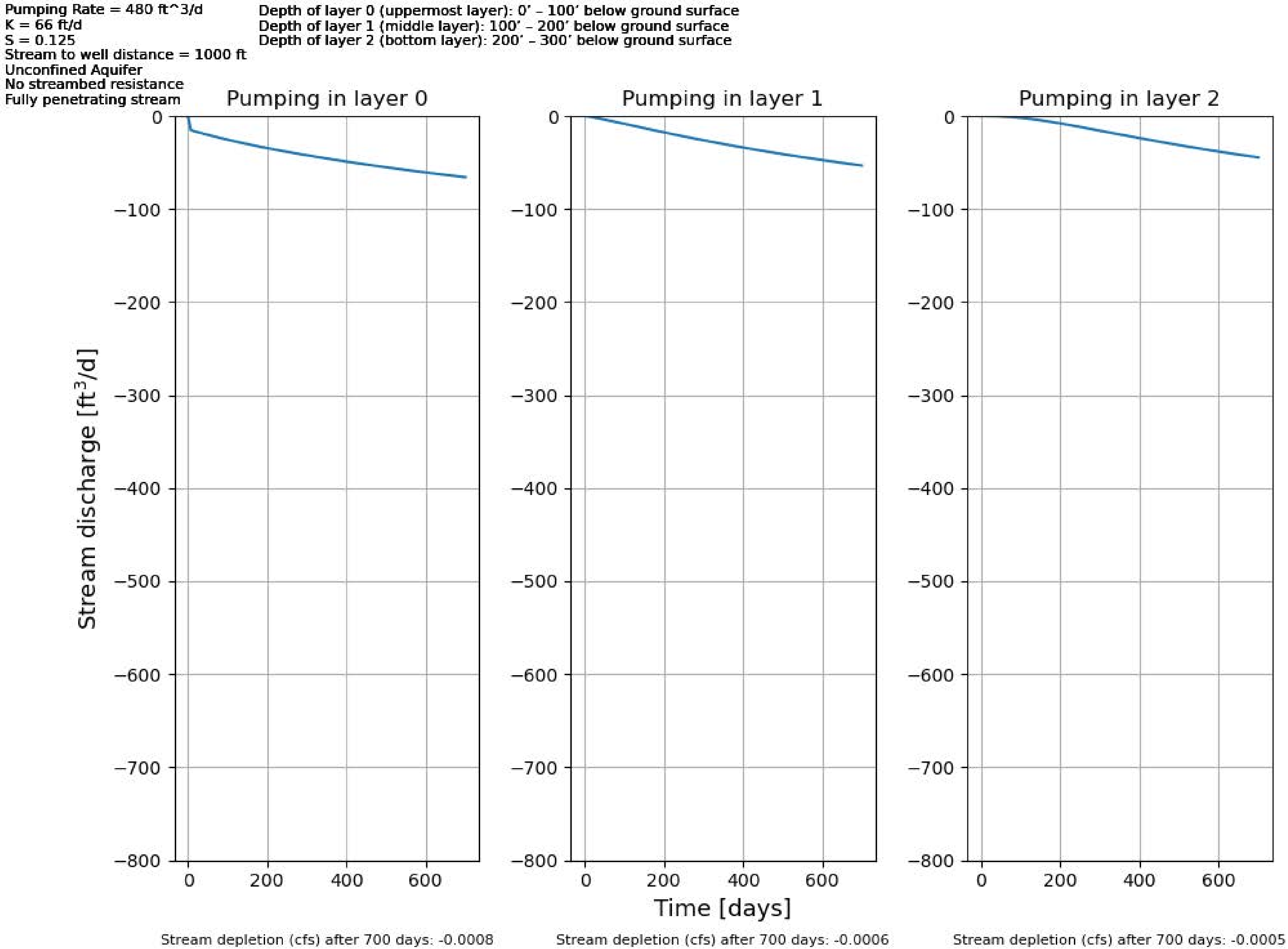
Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
−1.6
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

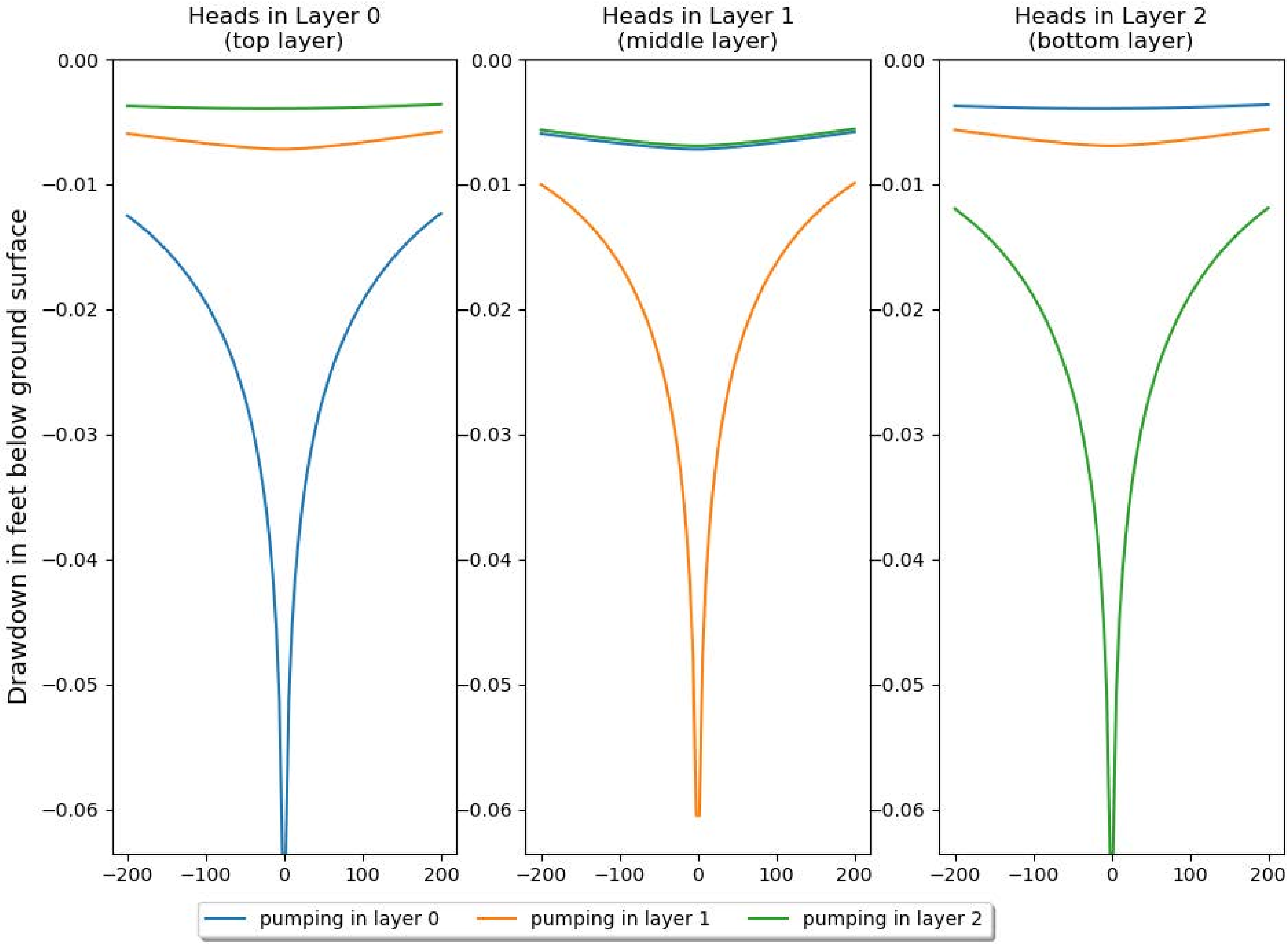
Pumping Rate = 480 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 1000 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

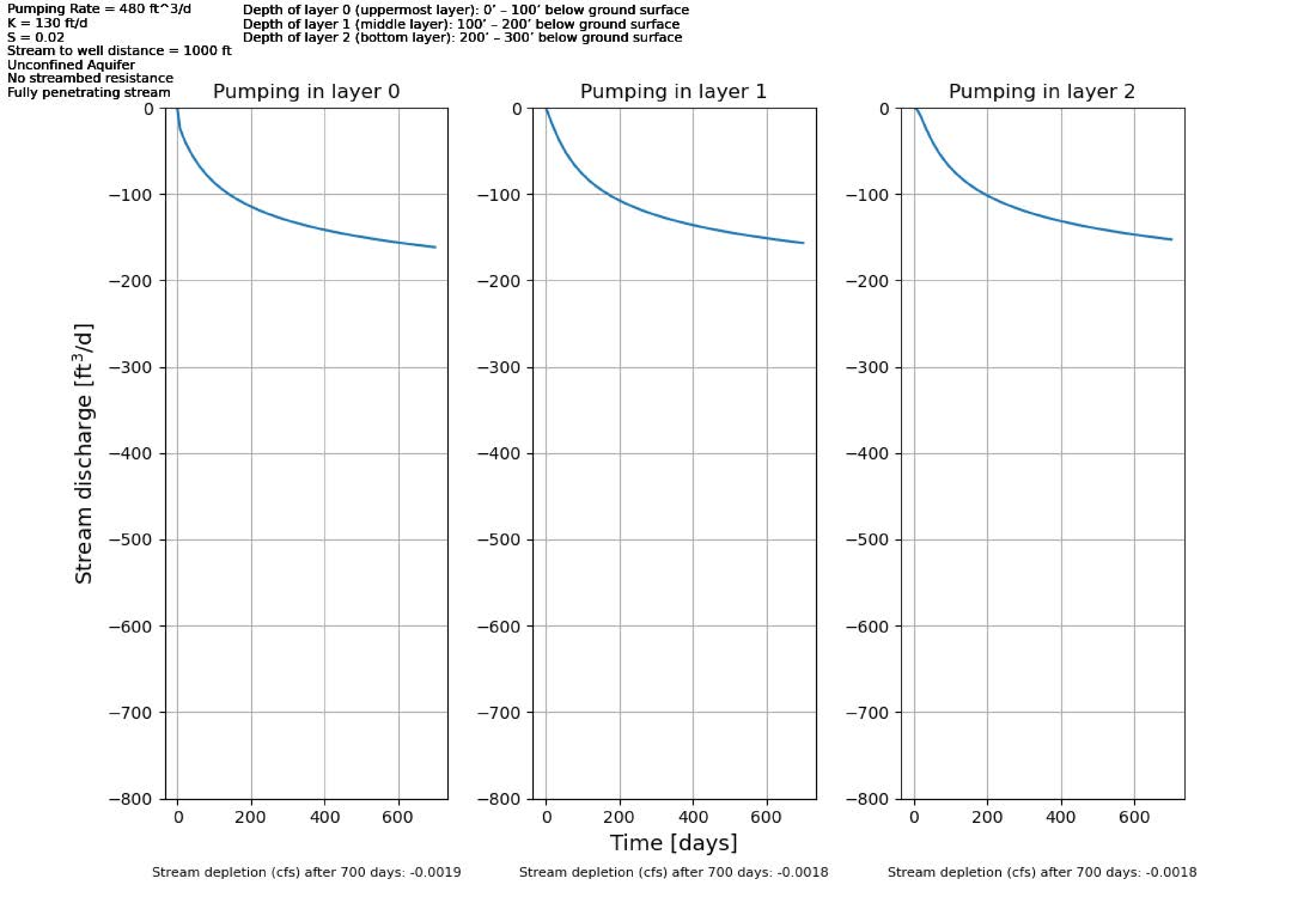
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface

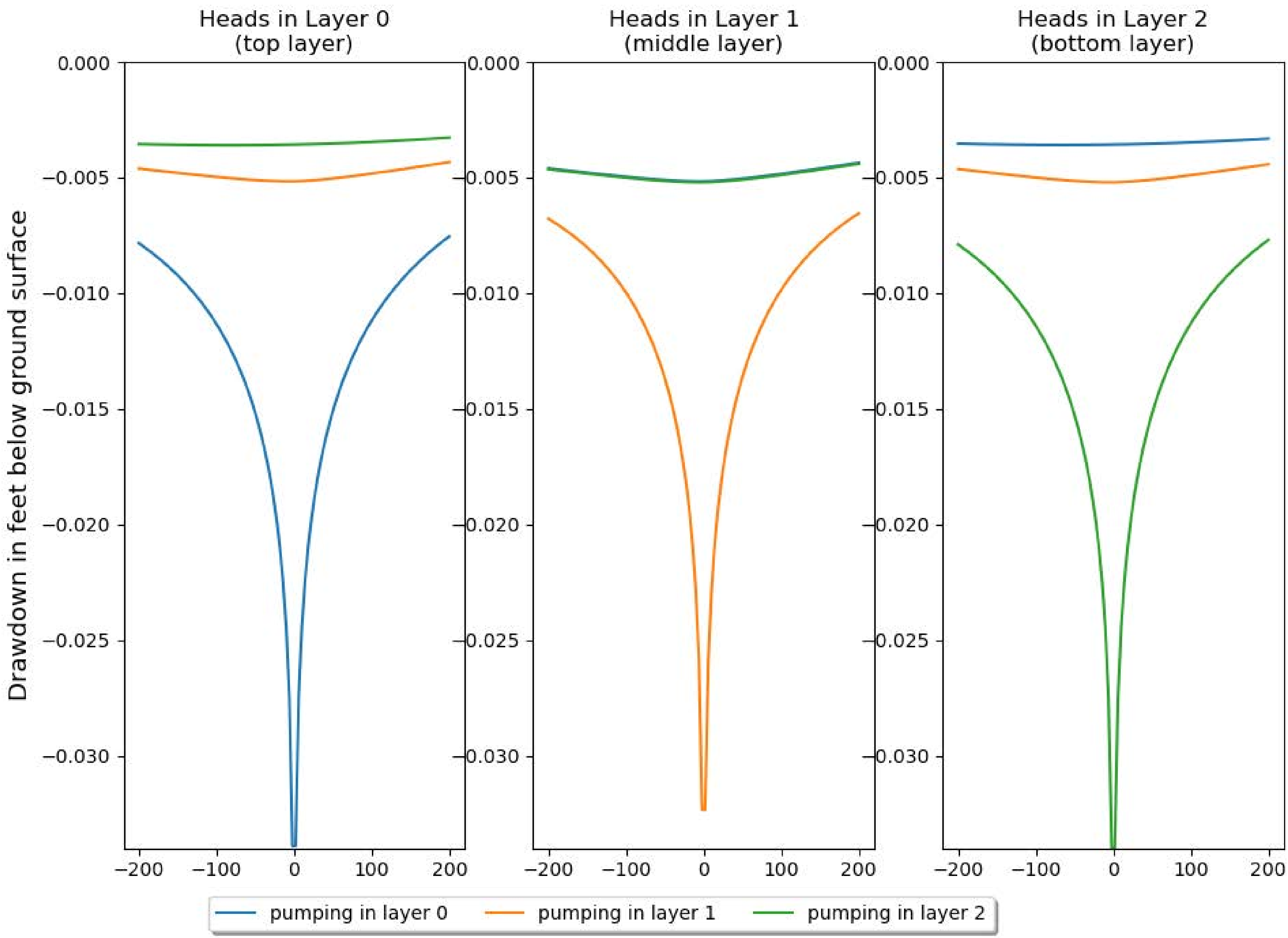



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2


Pumping Rate = 480 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 1000 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft³/d]
Time [days]
0
−100
−200
−300
−400
−500
−600
−700
−800
0
200
400
600
Stream depletion (cfs) after 700 days: -0.0008
Stream depletion (cfs) after 700 days: -0.0006
Stream depletion (cfs) after 700 days: -0.0005

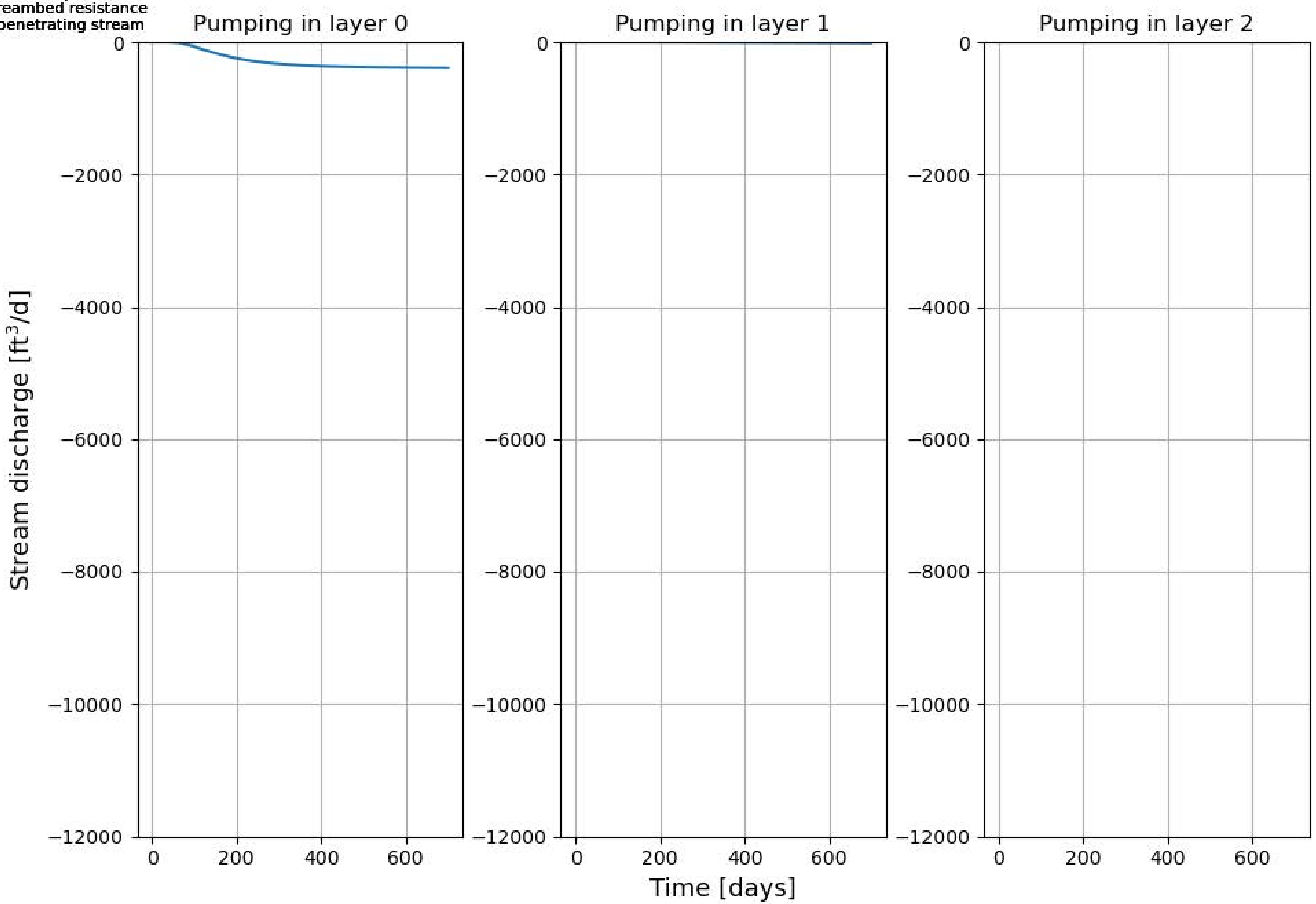

Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.00
−0.01
−0.02
−0.03
−0.04
−0.05
−0.06
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2


Pumping Rate = 480 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 1000 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
Time [days]
0
−100
−200
−300
−400
−500
−600
−700
−800
0
200
400
600
Stream depletion (cfs) after 700 days: -0.0019
Stream depletion (cfs) after 700 days: -0.0018
Stream depletion (cfs) after 700 days: -0.0018


Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.000
−0.005
−0.010
−0.015
−0.020
−0.025
−0.030
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 11906 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 1000 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

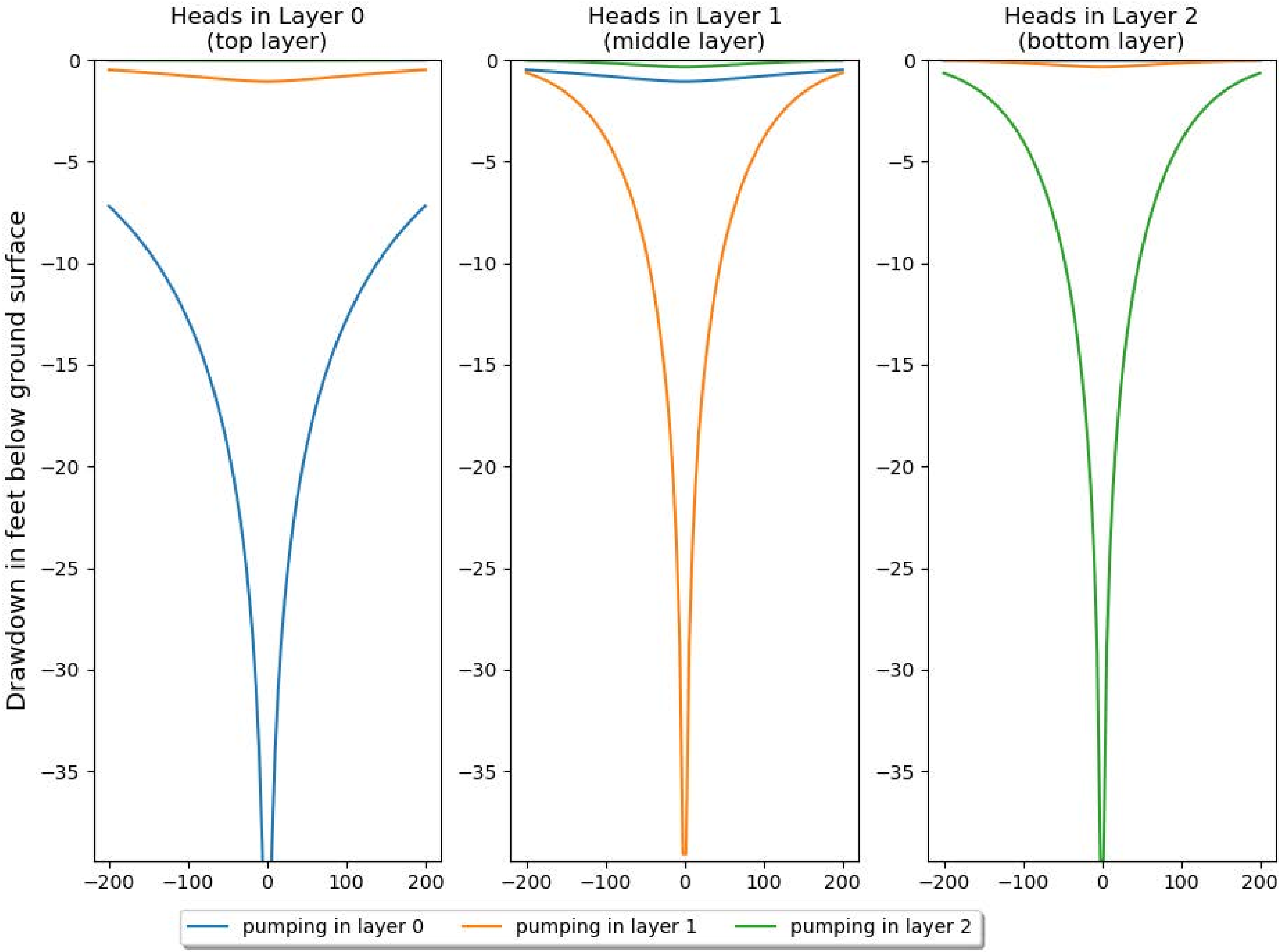
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



Stream depletion (cfs) after 700 days: -0.0045

Stream depletion (cfs) after 700 days: -0.0002

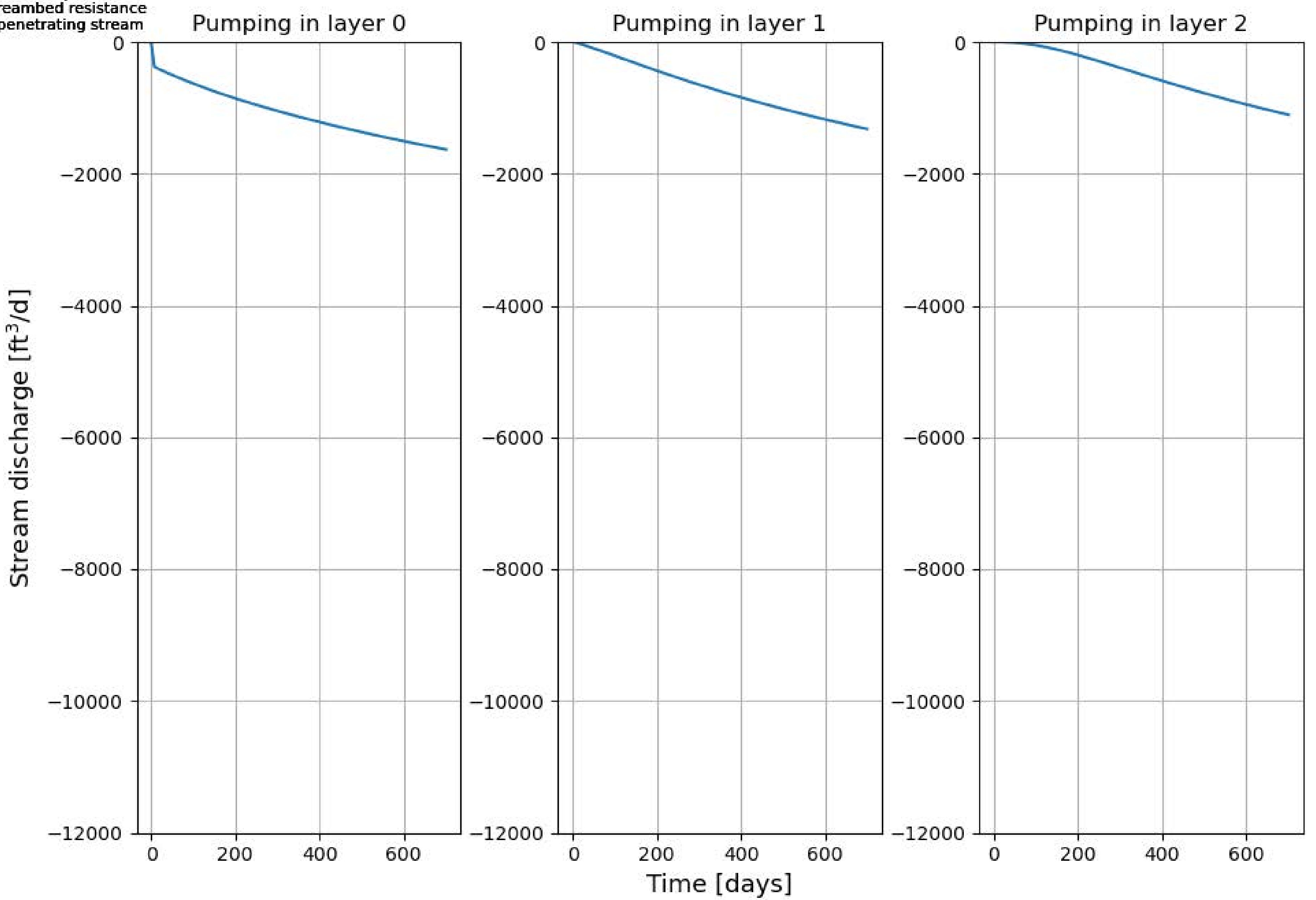
Stream depletion (cfs) after 700 days: -0.0000



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0
−5
−10
−15
−20
−25
−30
−35
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 11906 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 1000 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

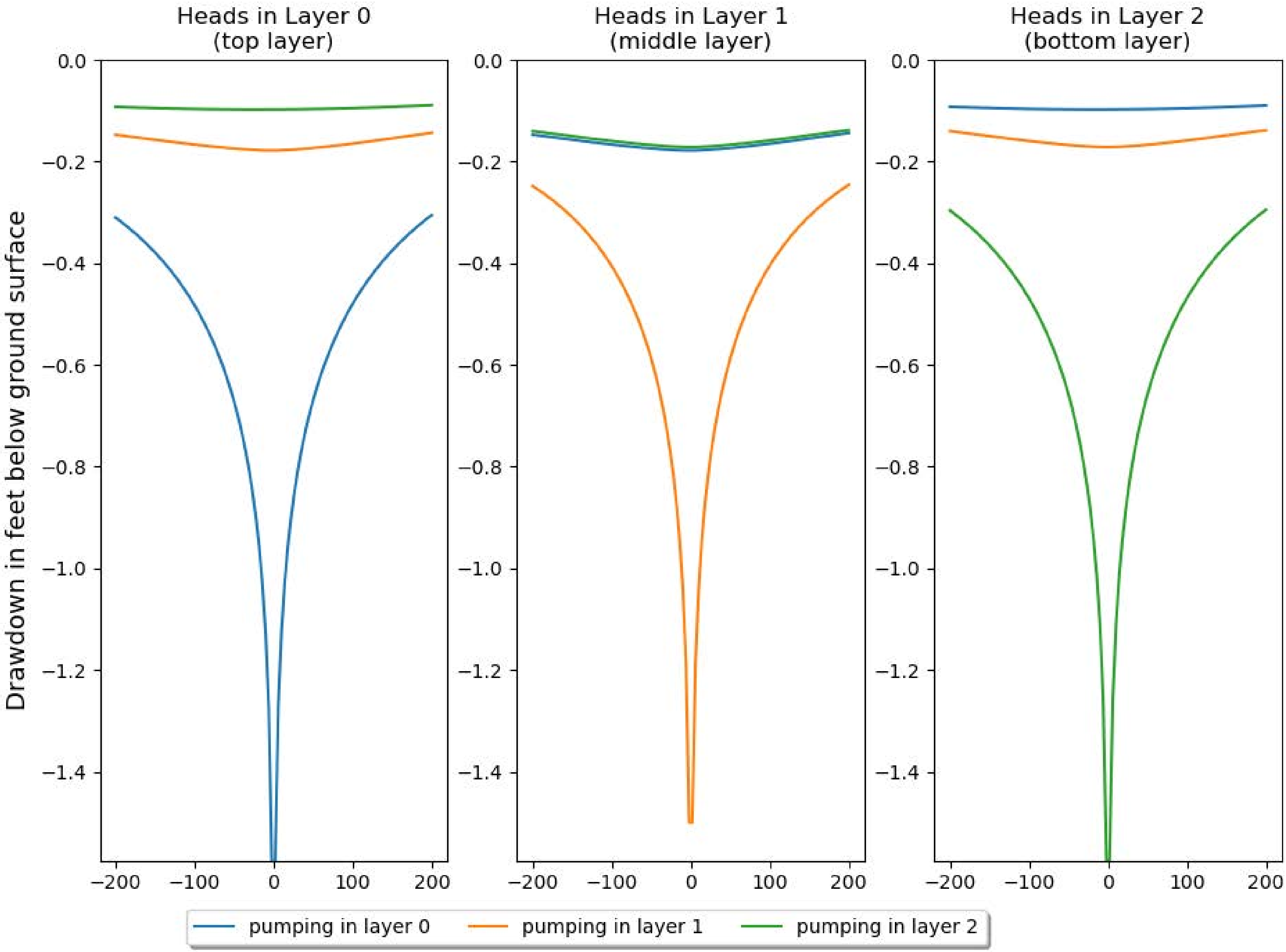
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



Stream depletion (cfs) after 700 days: -0.0189

Stream depletion (cfs) after 700 days: -0.0153

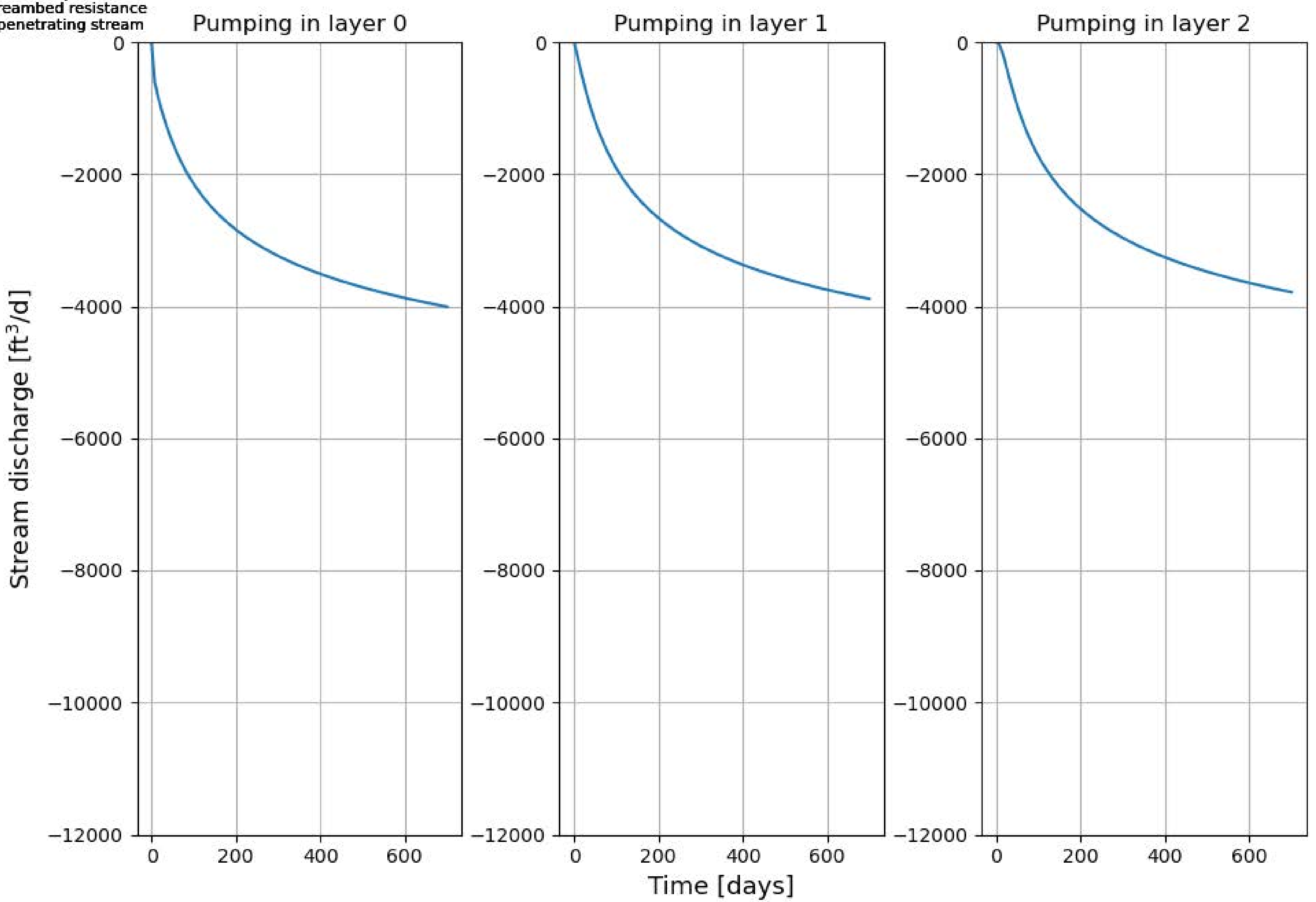
Stream depletion (cfs) after 700 days: -0.0128



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 11906 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 1000 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

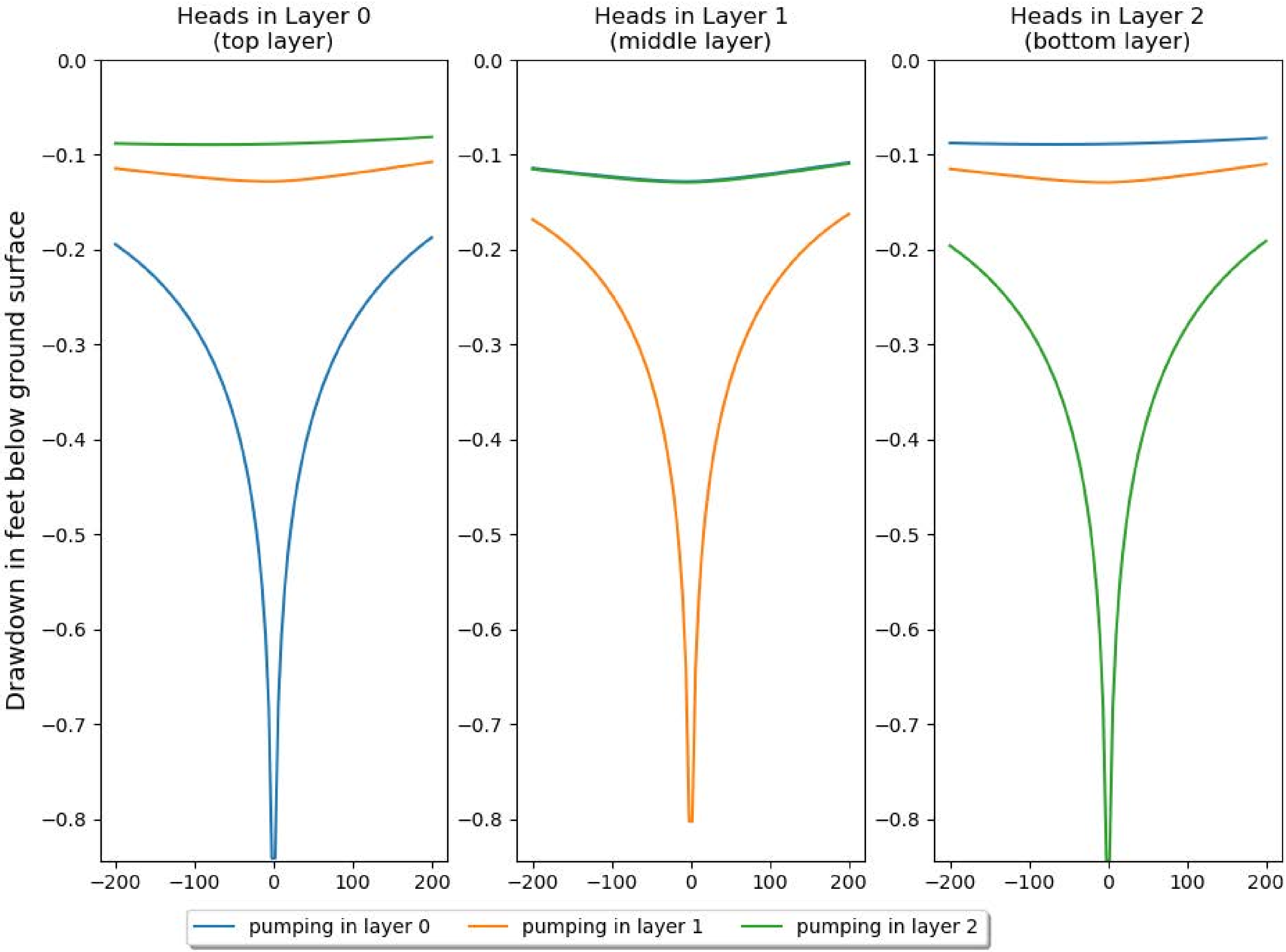
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



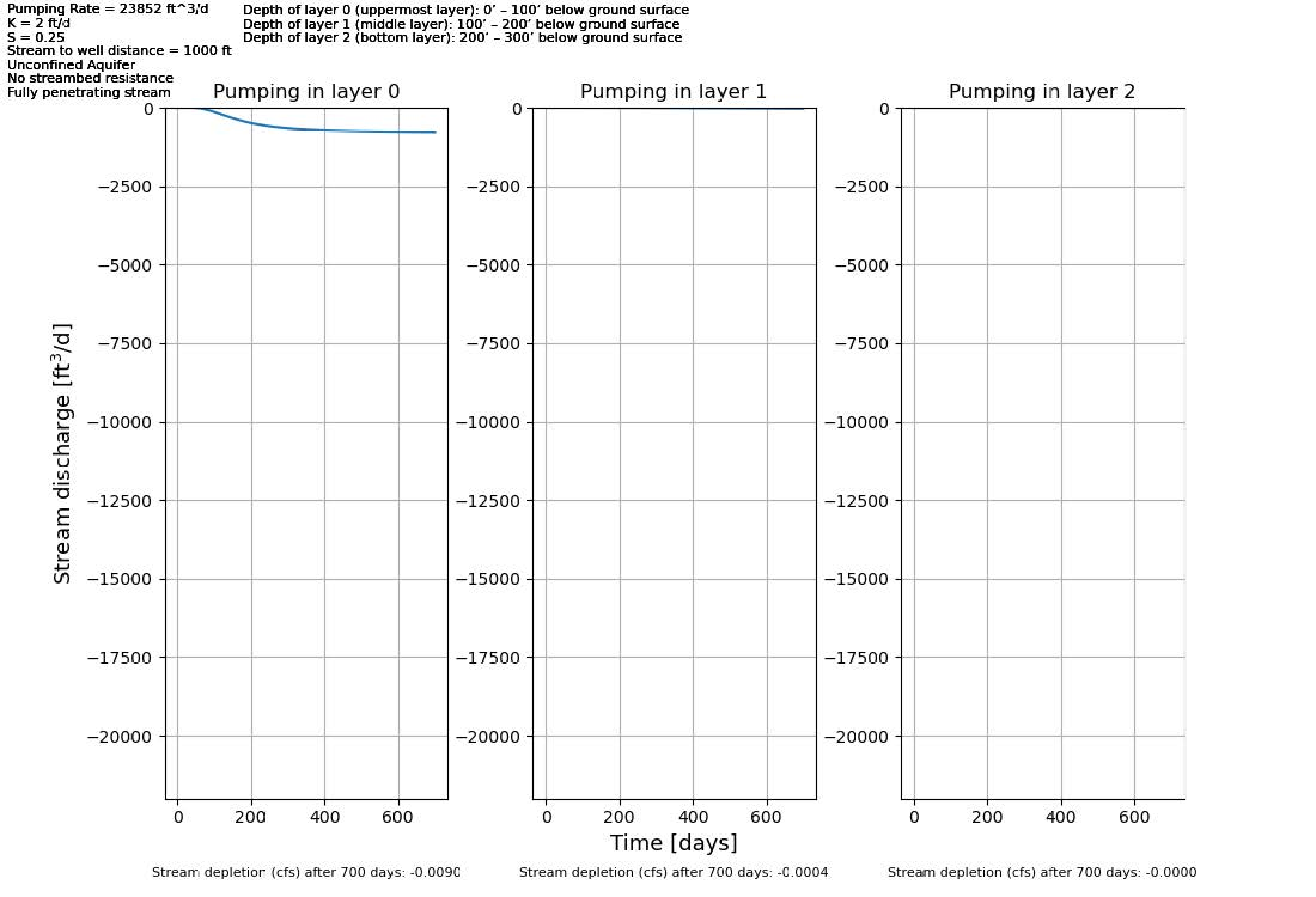
Stream depletion (cfs) after 700 days: -0.0464

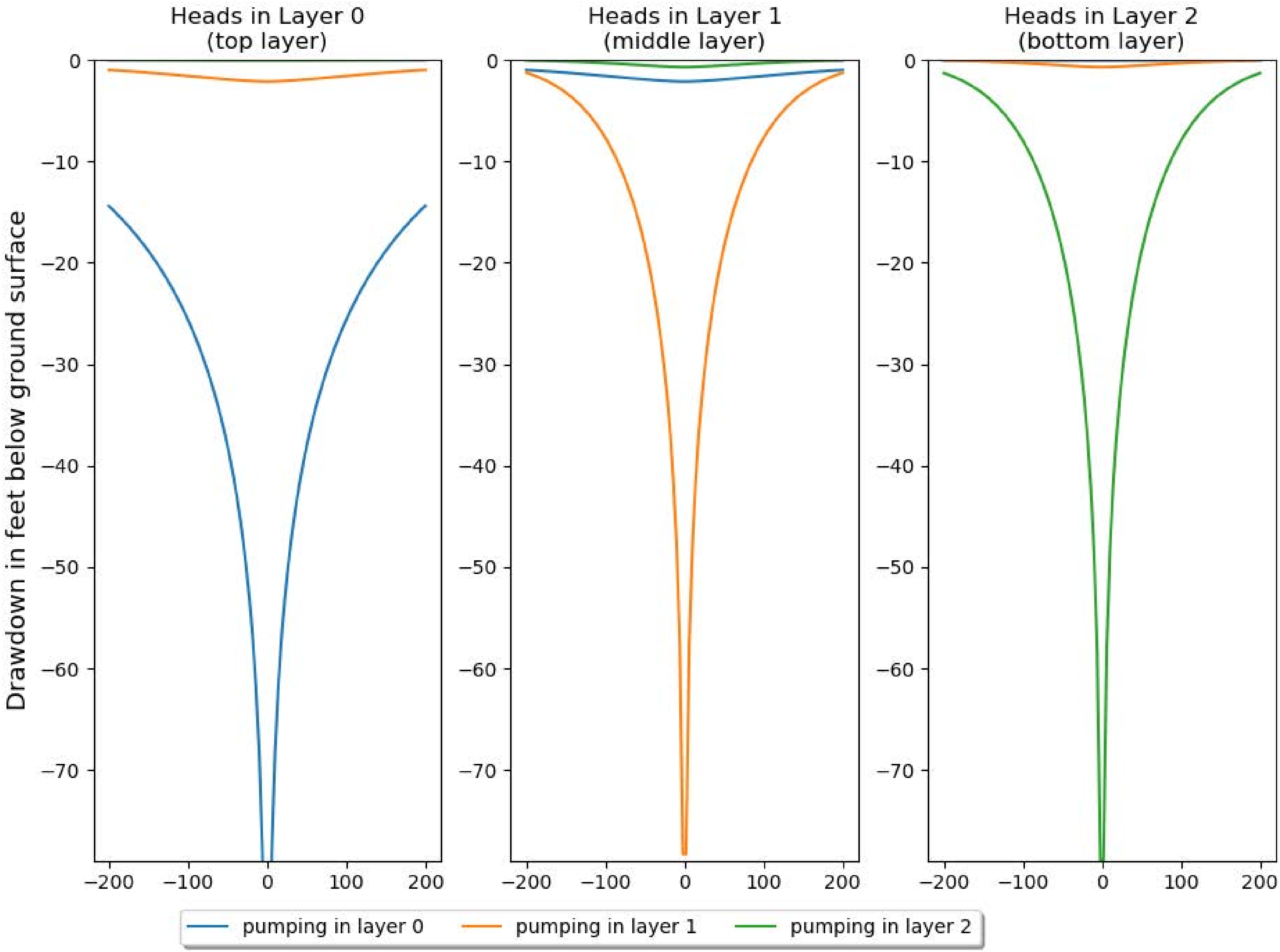
Stream depletion (cfs) after 700 days: -0.0450

Stream depletion (cfs) after 700 days: -0.0438



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
−0.8
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

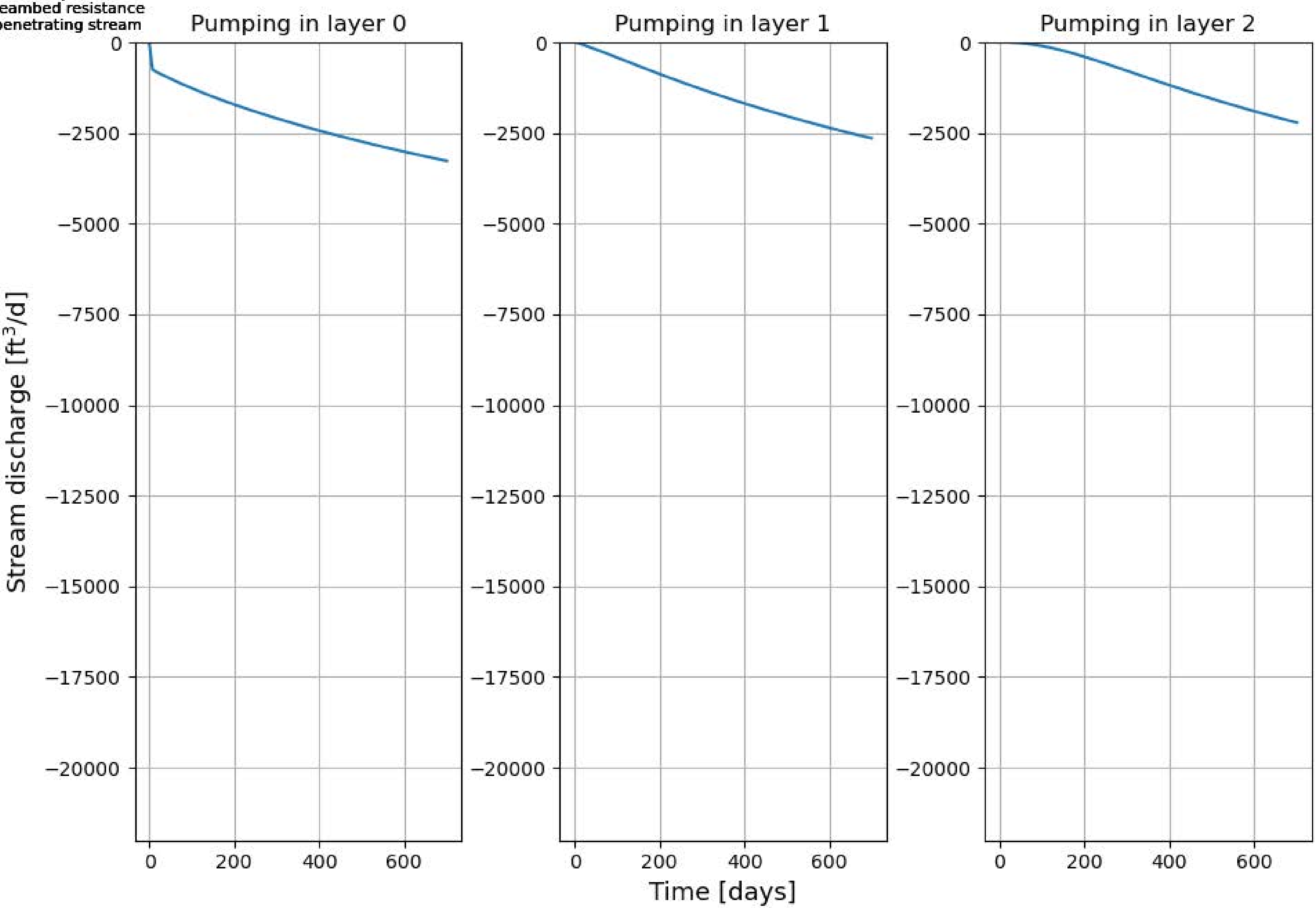

Pumping Rate = 23852 ft^3/d
K = 2 ft/d
S = 0.25
Stream to well distance = 1000 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface
Pumping in layer 0
Pumping in layer 1
Pumping in layer 2
Stream discharge [ft^3/d]
Time [days]
0
−2500
−5000
−7500
−10000
−12500
−15000
−17500
−20000
0
200
400
600
Stream depletion (cfs) after 700 days: -0.0090
Stream depletion (cfs) after 700 days: -0.0004
Stream depletion (cfs) after 700 days: -0.0000



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0
−10
−20
−30
−40
−50
−60
−70
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 23852 ft^3/d
K = 66 ft/d
S = 0.125
Stream to well distance = 1000 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

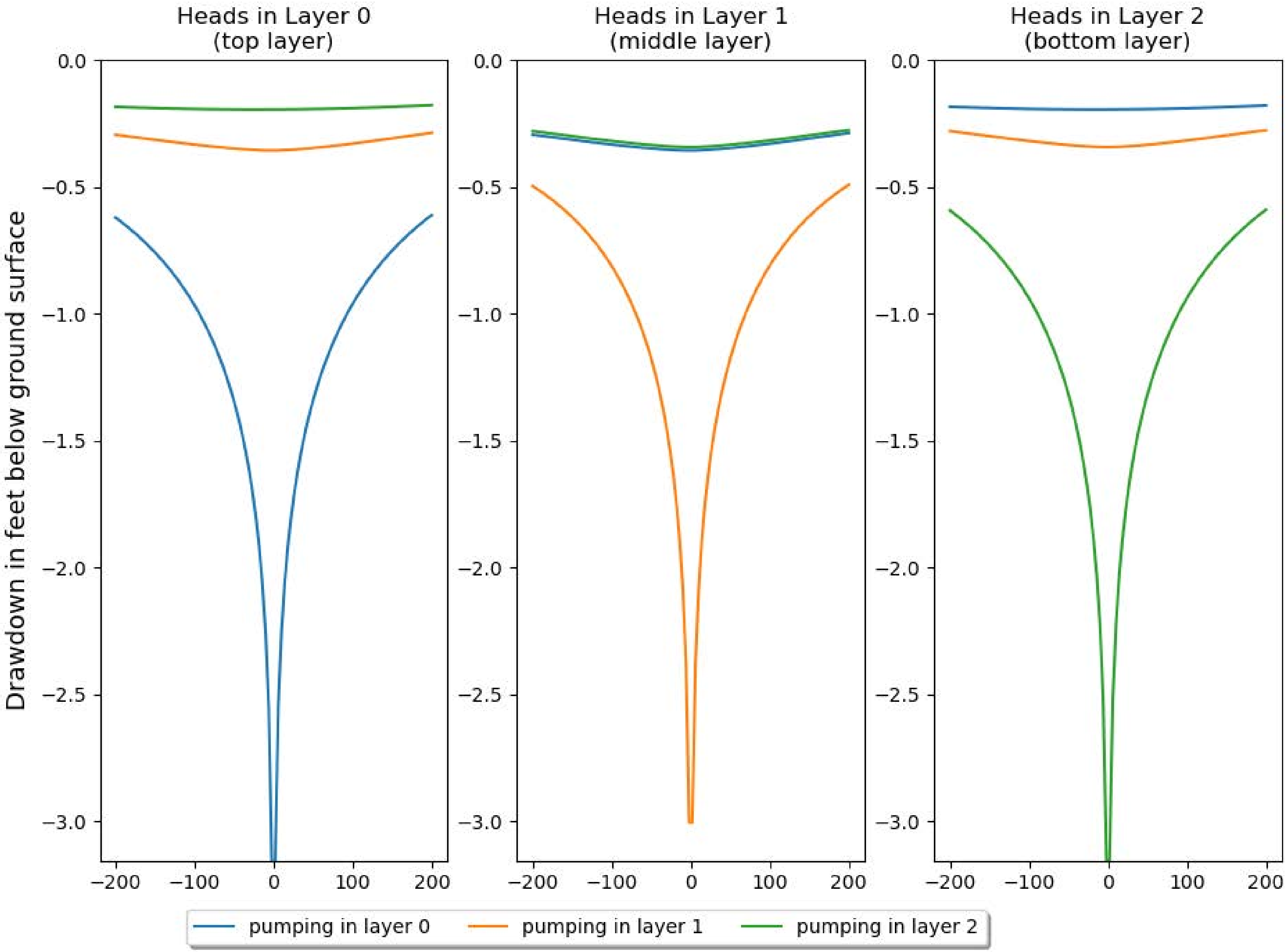
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



Stream depletion (cfs) after 700 days: -0.0378

Stream depletion (cfs) after 700 days: -0.0306

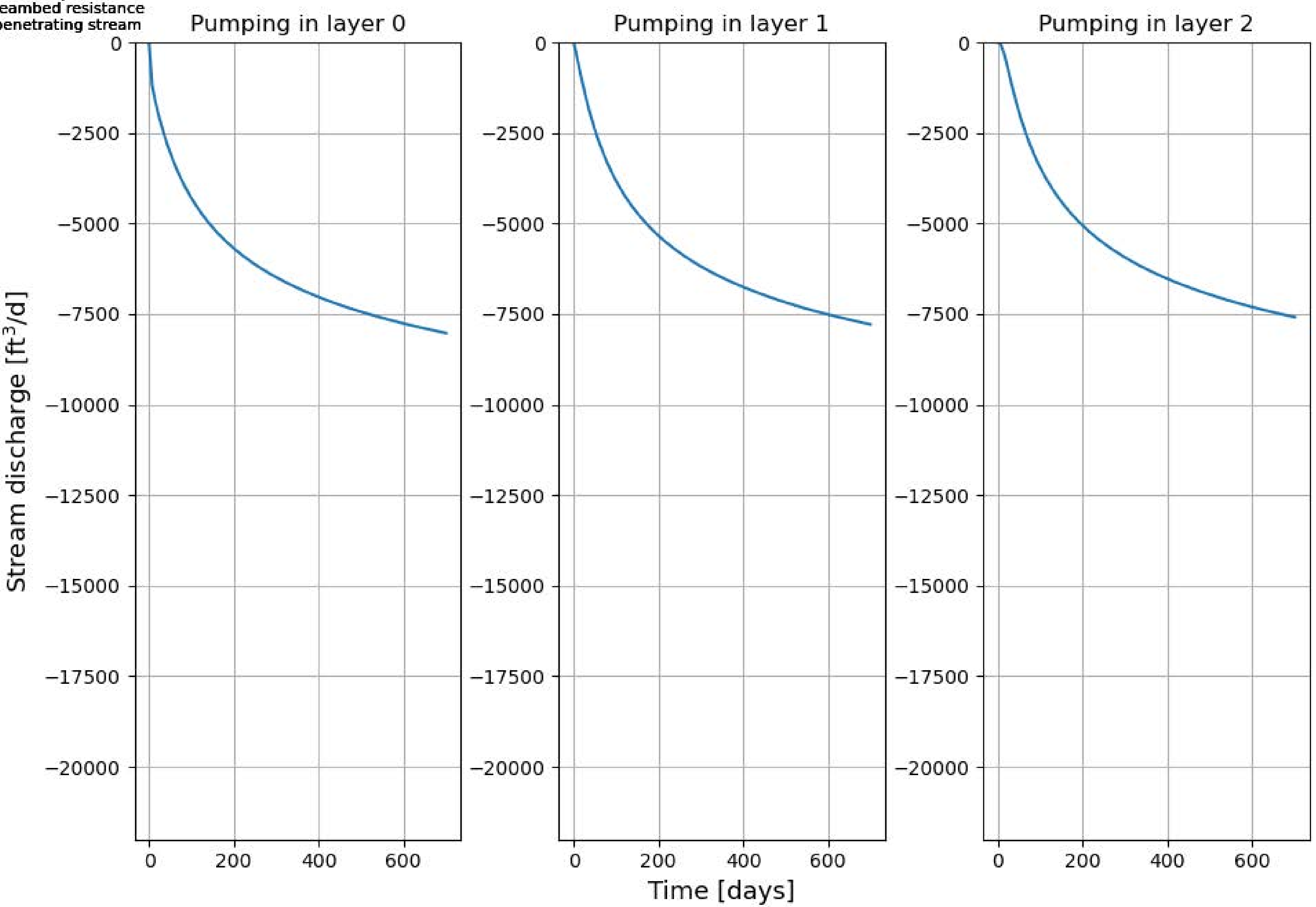
Stream depletion (cfs) after 700 days: -0.0256



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2

Pumping Rate = 23852 ft^3/d
K = 130 ft/d
S = 0.02
Stream to well distance = 1000 ft
Unconfined Aquifer
No streambed resistance
Fully penetrating stream

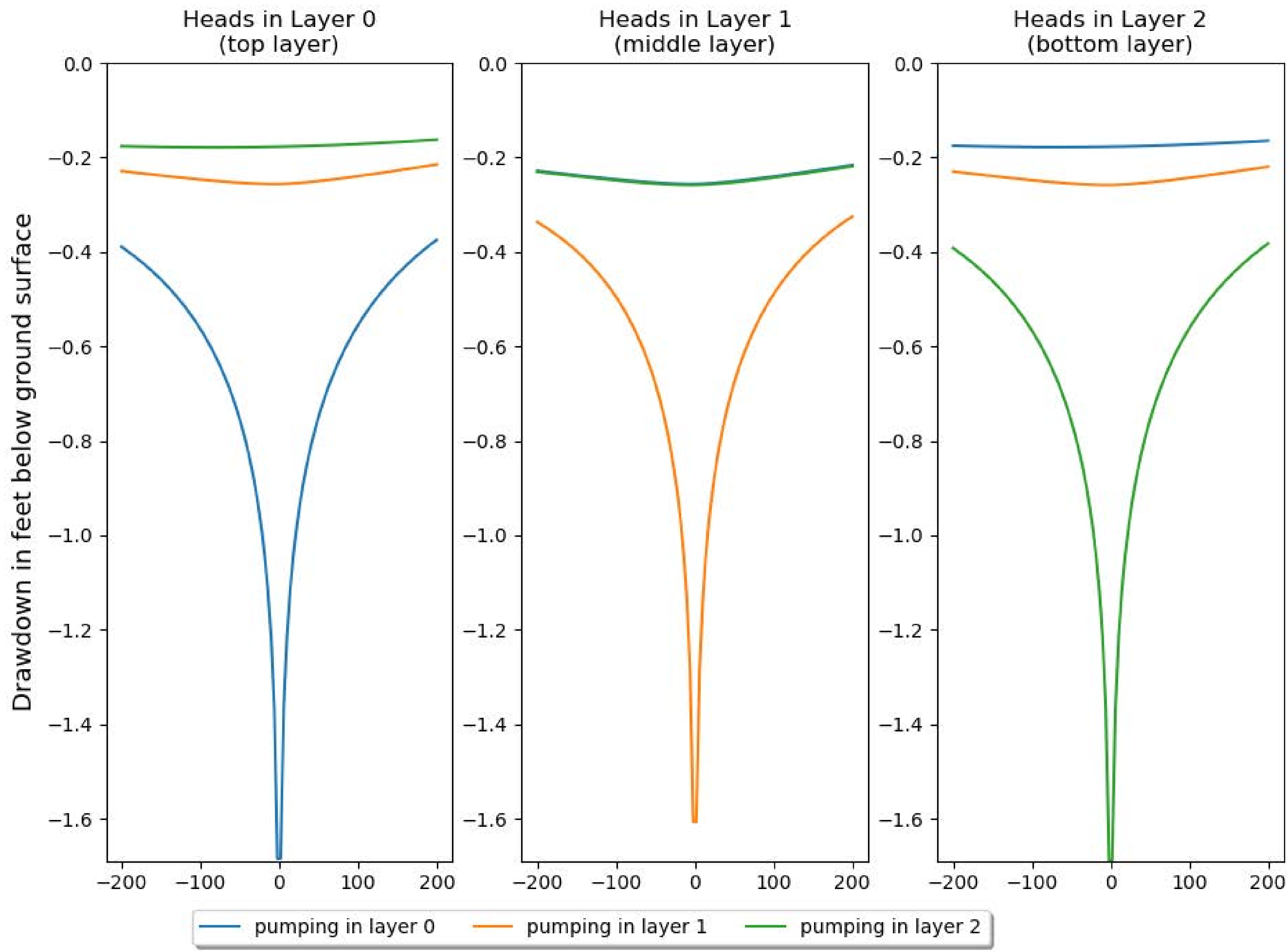
Depth of layer 0 (uppermost layer): 0' – 100' below ground surface
Depth of layer 1 (middle layer): 100' – 200' below ground surface
Depth of layer 2 (bottom layer): 200' – 300' below ground surface



Stream depletion (cfs) after 700 days: -0.0929

Stream depletion (cfs) after 700 days: -0.0901

Stream depletion (cfs) after 700 days: -0.0878



Heads in Layer 0
(top layer)
Heads in Layer 1
(middle layer)
Heads in Layer 2
(bottom layer)
Drawdown in feet below ground surface
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
−1.6
−200
−100
0
100
200
pumping in layer 0
pumping in layer 1
pumping in layer 2