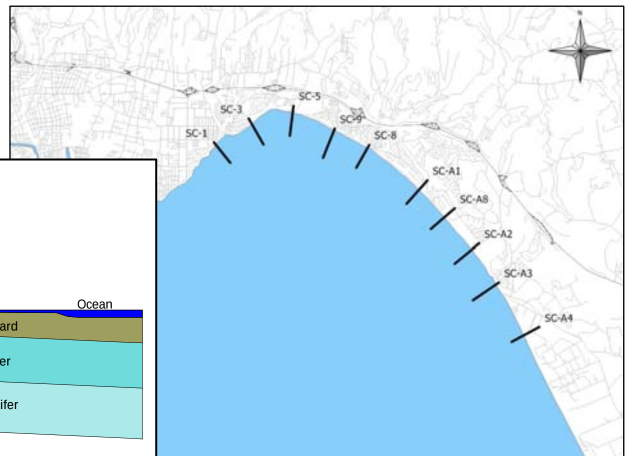
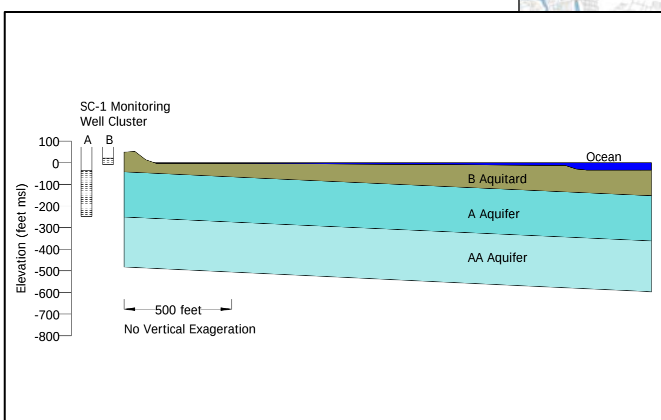
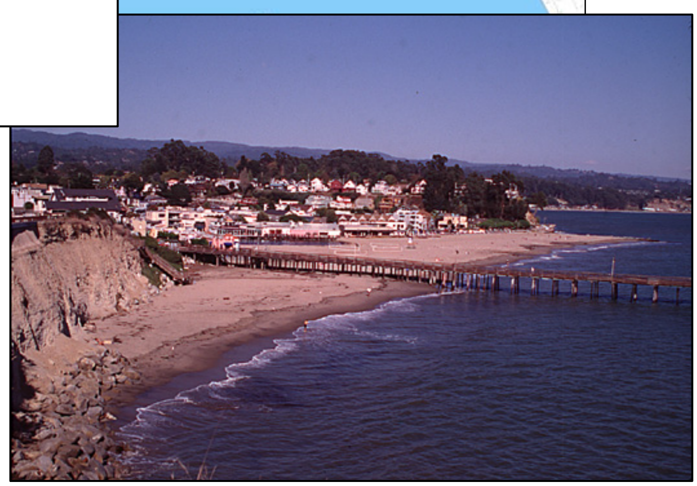
HydroMetrics LLC

Groundwater Levels to Protect against Seawater Intrusion and Store Freshwater Offshore
Appendix A







Prepared for:
Soquel Creek Water District

January, 2009

APPENDIX A

DETAILED CROSS SECTIONAL MODEL CONSTRUCTION INFORMATION AND SIMULATION RESULTS

(ON CD-ROM)

NUMERICAL FLOW MODEL CONSTRUCTION

MODEL CODE

The model code SEAWAT 2000 was selected for the groundwater flow and transport model. SEAWAT 2000 simulates variable density flow which is necessary to simulate seawater intrusion. The model code is well documented and benchmarked, and is a public domain code developed by the U.S. Geological Survey.

FINITE DIFFERENCE GRIDS

Figure A- 1 shows an example finite difference grid used by SEAWAT for a cross-sectional model. The grids are two dimensional and are oriented in a vertical plane. The two-dimensional vertical grid assumes that groundwater flows directly offshore, perpendicular to the shoreline.

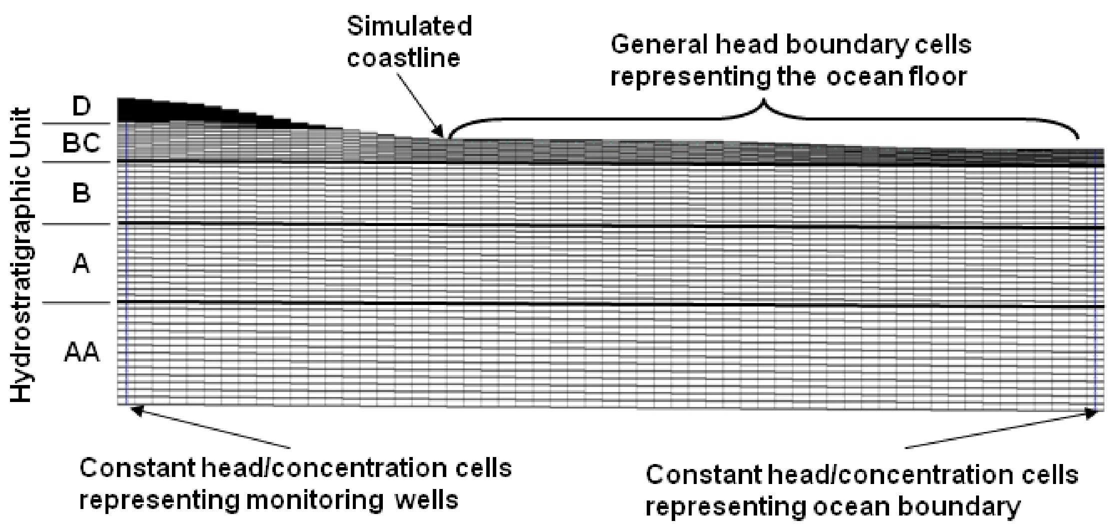


Figure A- 1: Example Finite Difference Grid for a Cross-sectional model

The layers within the finite difference grid were set parallel to the contacts between the aquifer and aquitard units. Each hydrostratigraphic unit was initially divided into minimum of ten model layers. Ten model layers are generally adequate to simulate the flow patterns that can occur in density dependent modeling (Guo and Langevin, 2002). Numerical experiments were conducted by adding model layers to see if additional layers affected model results. For some models, increasing vertical resolution improved the solution (e.g. less numerical dispersion) or decreased solution time. Based on these tests, ten layers were found to be adequate for some units, but the resolution was increased in some other units to improve the solution or run time. The final vertical resolution ranges between 10 and 28 model layers per hydrostratigraphic unit.

The default vertical extent of each model grid spans the hydrostratigraphic units between the ground surface and the lowest unit screened by the corresponding coastal monitoring well cluster. Some models required an additional unit below the lowest screened unit to allow seawater flow below the seawater interface. Flow below the seawater interface has an important impact on the elevation and slope of the interface, and must be simulated to determine the target groundwater levels.

The lengths of the cross-sectional models vary from 2500 to 3000 feet along the horizontal direction. Horizontal grid spacing is uniform and is 50 feet in all of the models.

MODEL BOUNDARY CONDITIONS

A numerical model requires boundary conditions be defined for the sides, the top, and bottom of the model. Boundary conditions along the top and sides of the model require model specific heads, and are designated explicitly in the model input; the boundary condition along the bottom surface of the model is by default no-flow. Boundary conditions for both groundwater flow and seawater transport must be defined at each boundary.

The flow and concentration boundary conditions allow for intrusion through the seafloor due to drawdown originating onshore, and intrusion from horizontal movement of water through the aquifers from offshore outcrops. These models do not account for shortened intrusion pathways, such as through paleochannels that cut into the aquifer units.

GROUNDWATER FLOW BOUNDARY CONDITIONS

There are two types of top boundary conditions in the cross-sectional models. Onshore the top boundary condition is a no-flow condition; no water leaves or enters the model through the ground surface. Offshore, general head boundaries allow flow between the ocean and the underlying aquifer. General head boundaries require a head and a resistance to flow be specified. The head specified for all general head boundaries represents mean sea level. Resistance to flow between the ocean and the aquifers is calculated from 2 components: a vertical conductivity for the aquifer and seabed resistance representing sediments accumulated on the ocean floor. The two components are combined through a harmonic mean.

Boundaries on the model's sides are simulated with constant head conditions. Water can flow into or out of the model through these boundaries. Onshore, the constant head boundary represents groundwater levels in the anchoring monitoring well clusters. This constant head boundary was generally varied in all units to identify the protective groundwater levels. The constant head condition at the ocean boundary was set to mean sea level.

The boundary conditions on the model bottoms are no-flow conditions. The bottom of the model for monitoring well SC-5 represents the granitic bedrock. For all other cross-sectional models, the model bottom occurs within a deep sedimentary unit.

Sea level in the models is defined as an elevation of zero feet. When comparing protective and target groundwater levels from the model with measured groundwater levels in monitoring wells, it will be important to know the vertical datum of the reference point elevation. Protective and target groundwater levels can be compared directly with measured groundwater levels using the NGVD29 vertical datum, because zero in the NGVD29 system is very close to mean sea level. The NAVD88 vertical datum is approximately 2.7 feet below the NGVD29 datum. If monitoring wells are surveyed to the NAVD88 system, 2.7 should be subtracted from the measured groundwater level when comparing it to protective and target groundwater levels.

CONCENTRATION BOUNDARY CONDITIONS

Concentration boundary conditions must be specified where flow into or out of the model occurs. In SEAWAT these boundaries depend on whether the direction of flow is into or out of the model. When flow is into the model these boundaries act as a source of water at a constant concentration. When water flows out of the model the concentration flowing out of the model is equal to the aquifer concentration.

On the top of the model the concentration at the general head boundaries is set to represent undiluted seawater. Full strength seawater was assigned a concentration of 1.0 in the models. When water flows into the top of the model from the ocean, it is at the concentration of undiluted seawater.

On the sides of the model constant concentrations are set at the constant head boundaries. At the inland constant head boundary the concentration is set at 0.0013. This is approximately equal to a chloride concentration of 25 milligrams per Liter (mg/L), one-tenth of the maximum contaminant limit for chloride. At the ocean constant head boundaries, the concentration is set at 1.0, representing undiluted seawater.

Model Initial Conditions

The initial conditions of the cross-sectional model simulations do not affect the final solution of the model because the simulation periods of the models are chosen so that the model reaches an approximate steady state solution.

Numerical experiments were conducted for three cases of initial conditions: the model initially filled with freshwater; the model initially filled with saltwater; and a case where the seawater interface was vertical and located in the center of the model. In all three cases an identical steady state solution was achieved, and solution time was similar for all three cases.

Model Aquifer Parameters

Flow Parameters

Table A- 1presents the base values of aquifer parameters for each hydrostratigraphic unit. These values were derived primarily from the *Draft Hydrogeological Conceptual Model* (Johnson et al., 2004). In addition, the conductivity values presented in the hydrogeology analysis for Well Master Plan EIR (Williams et al., 2008), particularly for the Purisima AA unit, were also considered. Since these models are run to equilibrium, the aquifer storage parameters will have no effect on the final solution and are therefore not presented here.

Table A- 1: Base Aquifer Flow Parameter Values

Hydrostratigraphic Unit	Horizontal Hydraulic Conductivity Kh (feet/day)	Vertical Hydraulic Conductivity Kv (feet/day)
Aromas (Upper and Lower)	3	0.15
Purisima F Aquifer	3	0.15
Purisima DEF Aquifer	2.3	0.115
Purisima D Aquitard	1	0.04
Purisima BC Aquifer	2	0.1
Purisima B Aquitard	1	0.04
Purisima A Aquifer	12	0.6
Purisima AA Aquifer	10	0.5
Purisima Tu Aquifer	5	0.25

At each general head boundary a conductance term specifying the resistance to flow from the ocean was specified based on a conductivity and a fixed thickness. This conductance term includes two components: one representing resistance through a seabed layer overlying the top aquifer unit and one representing vertical flow through the aquifer to the finite difference cell representing the top of the aquifer. The component of the conductance representing resistance through the aquifer was determined from vertical hydraulic conductivity of the top unit. The base value for the conductance component representing the seabed was set so that resistance to flow from the ocean was dominated by the aquifer component.

Parameters were varied about these base values to determine the sensitivity of target groundwater levels to the uncertainty of these parameter values.

TRANSPORT PARAMETERS

The dispersivity and molecular diffusion parameters were set equal to zero. Setting these parameters equal to zero removes mixing of freshwater and seawater at the interface, allowing the simulation of a sharp interface. Movement of the interface occurs only due to flow of groundwater.

Using non-zero transport parameters results in a mixing zone around the advective interface. The existence of a mixing zone results in diluted seawater occuring farther inland than the interface. This potentially results in higher water levels being required to protect production aquifers from seawater intrusion and store target freshwater volumes. However, the definition of seawater intrusion using the sharp interface is very conservative. Seawater intrusion is defined when the sharp interface intersects one model cell of the protected zone (see below). Water from a well at the edge of the protected zone (coastline) will likely still meet water quality standards if only one cell contains seawater. This conservative definition of seawater intrusion offsets the likelihood that seawater spreads out from the advective interface.

SOLUTION METHOD

Several solution methods are available in SEAWAT. The cross-sectional models used the Method of Characteristics (MOC) method. This method avoids the significant numerical dispersion seen in trial runs of the cross-sectional models that used the finite difference solution. The MOC solution method allowed the approximation of a sharp interface with the cross-sectional models.

SEAWAT is an intrinsically transient model. The model does not have an option for producing a steady state or equilibrium solution. However if the models are run for a sufficiently long period, the model, and thus the interface and target groundwater levels, will effectively reach a steady state or equilibrium position. The simulation period required to approximate an equilibrium state was determined by experimentation. The length of the simulation period of a model was increased incrementally until increases of the simulation period no longer significantly changed the solution. Simulation period lengths used to determine target groundwater levels was 500,000 days.

IDENTIFICATION OF PROTECTIVE AND TARGET GROUNDWATER LEVELS

The target groundwater level for each of the coastal monitoring wells is defined as the water level that protects the aquifer from seawater intrusion and stores a specified volume of freshwater offshore. This requires first defining an interface that protects the aquifer from being intruded. This protective interface is the condition in which there is no fresh water stored offshore because increasing pumping in the area would intrude the aquifer.

The protective interface occurs when the toe of the intruding seawater wedge just reaches the coastline at a specified elevation (Figure A- 2). In this case, the aquifer inland from the coastline and above the specified elevation contains freshwater. This is consistent with SqCWD's goal to protect the aquifer and any non-SqCWD production wells that may exist between the monitoring well cluster and the coastline.

A specific model cell is selected to represent the coastline at the specified elevation. The aquifer is protected if that cell contains freshwater. Freshwater is defined as a chloride concentration below the secondary maximum contaminant limit (MCL) of 250 milligrams per liter (mg/L). The model equates a simulated concentration of 1.0 with the chloride concentration of seawater, approximately 19,000 mg/L. Therefore the chloride MCL of 250 mg/L is simulated as a modeled concentration of 0.013. A cell is considered to have freshwater if it has a simulated concentrations below 0.013.

The simulated coastline is defined as where the land surface drops below 0 feet mean sea level (msl). The exact zero elevation point is unknown because the land and bathymetry elevations are only calculated at points spaced 50 feet apart. The first cell in the ocean direction with a negative elevation is selected as the coastline cell. This is also the first cell where general head boundaries are used to represent the ocean floor at the top of the model. Table A- 2 shows the cell representing the coastline for each of the cross section models and its distance from the end of the model where the monitoring well cluster is located. In general, larger distances between the monitoring well and the coastline will lead to higher water levels needed to achieve the protective interface.

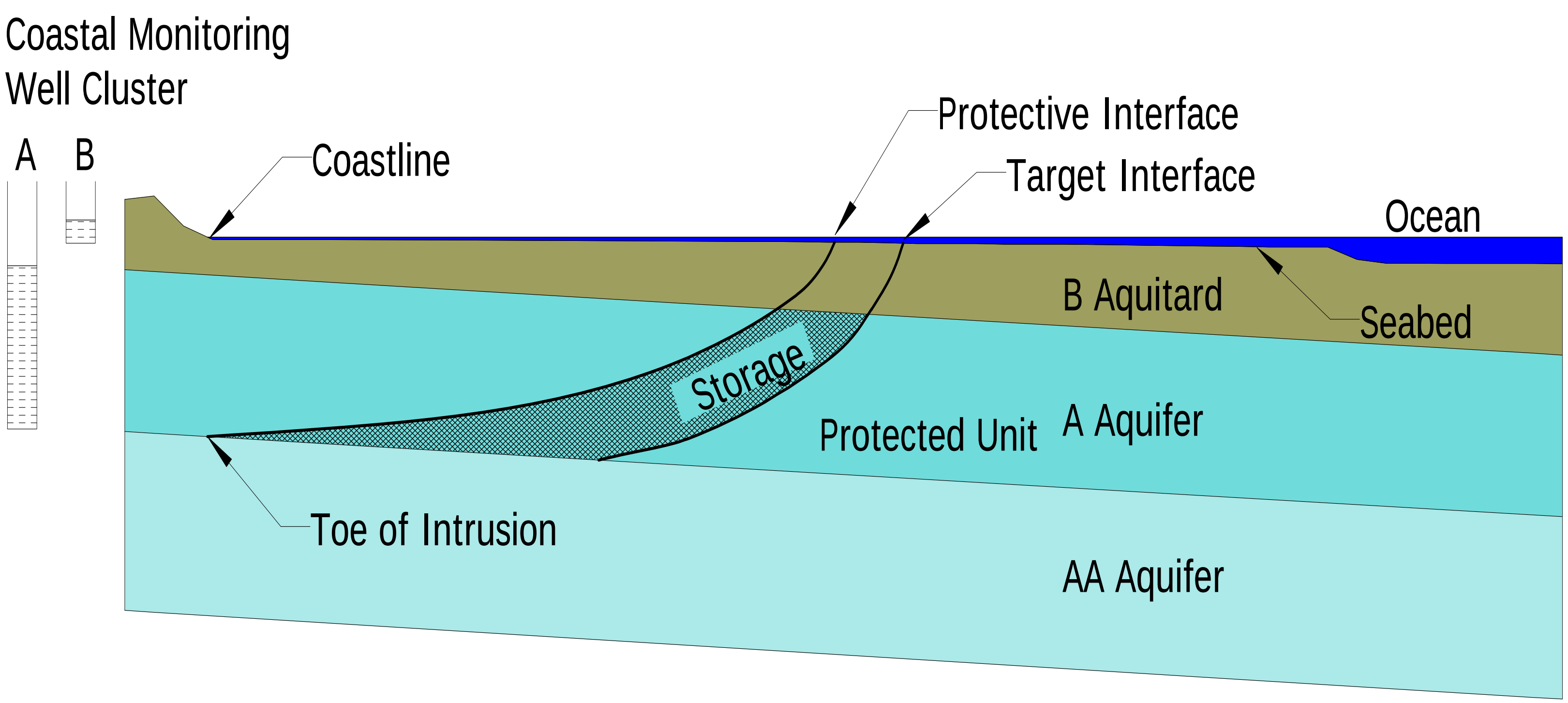


Figure A- 2: Schematic Showing Protective Interface Position and Target Interface Position

Table A- 2: Model Column Representing Coastline for Monitoring Wells: Model Column Representing Coastline for Monitoring Wells

Monitoring Well Cluster	Coastline Column for Protected Cell	Distance from Monitoring Well Cluster (feet)
SC-1	4	150
SC-3	14	650
SC-5	14	650
SC-8	12	550
SC-9	3	100
SC-A1	26	1250
SC-A2	19	900
SC-A3	5	200
SC-A4	32	1550
SC-A8	25	1200

The strategy for specifying the elevation at which intrusion is evaluated is different for the Purisima Formation monitoring wells and the Aromas Red Sands monitoring wells as discussed below.

PROTECTED ELEVATION IN THE PURISIMA FORMATION

The protected elevation for the Purisima Formation is the bottom of the lowest producing aquifer in the area. Nearby SqCWD production wells are identified, and the lowest screen interval is used to determine the lowest producing aquifer. The entire producing aquifer is protected at the coastline. Intrusion is allowed below the lowest producing aquifer. We assumed that private production wells do not extract from below the protected aquifer.

Table A- 3 lists the protected aquifer for each coastal well cluster in the Purisima Formation, the model layer corresponding to the bottom of the protected aquifer, and the elevation of that layer. Model layers are counted from the top of the model and each aquifer and aquitard unit has at least ten model layers. As mentioned earlier, the protected aquifer corresponds to the deepest producing zone, not necessarily the lowest monitoring well. Three monitoring wells exist below the protected DEF aquifer at the SC-8 well cluster and one monitoring well exists below the protected BC aquifer at the SC-9 well cluster.

Table A- 3: Purisima Monitoring Wells and Protected Elevations

Monitoring Well in Protected Unit	Nearby SqCWD Production Wells	Protected Aquifer Unit	Model Layer of Protected Cell	Protected Elevation at Coastline (feet msl)
SC-1A	Garnet	A	24	-258
SC-3A	Rosedale, Tannery II	A	38	-440
SC-5A	Estates	A	58	-652
SC-8D	Aptos Creek, T-Hopkins	DEF	20	-377
SC-9B	Ledyard, Madeline	BC	34	-460

PROTECTED ELEVATION IN THE AROMAS RED SANDS

The protected elevation for the Aromas Red Sands is the first model layer above the lowest monitoring well in any coastal monitoring well cluster. The lowest monitoring well in each cluster in the Aromas Red Sands was installed to be below the existing seawater interface. Therefore, seawater intrusion in the lowest well is likely representative of long-term historical conditions. The protected elevation is chosen to ensure seawater intrusion does not occur at shallower elevations than long-term historical conditions.

Table A- 4 lists the protected aquifer for each coastal well cluster in the Aromas Red Sands, the model layer of the protected cell, and the protected elevation at the coast.

Table A- 4: Aromas Monitoring Wells and Protected Elevations

Monitoring Well Above Protected Elevation	Aquifer Unit Of Monitoring Well	Model Layer of Protected Cell	Protected Elevation at Coastline (ft msl)
SC-A1B	F	35	-349
SC-A2B	F	22	-296
SC-A3B	Aromas	10	-181
SC-A4B	F	20	-296
SC-A8B	F	32	-412

GROUNDWATER MODEL RESULTS

WELL SC-1A MODEL RESULTS

The protective groundwater level at Well SC-1A is the minimum water level that maintains fresh water in the bottom of the A unit at the coastline. The protective groundwater level for this well ranges between 1 and 5 feet msl based on modeling the 100 parameter sets. Figure A- 3 shows the cumulative distribution of the protective groundwater levels for Well SC-1A. A groundwater level of 4 feet msl is protective for over 70% of the parameter sets.

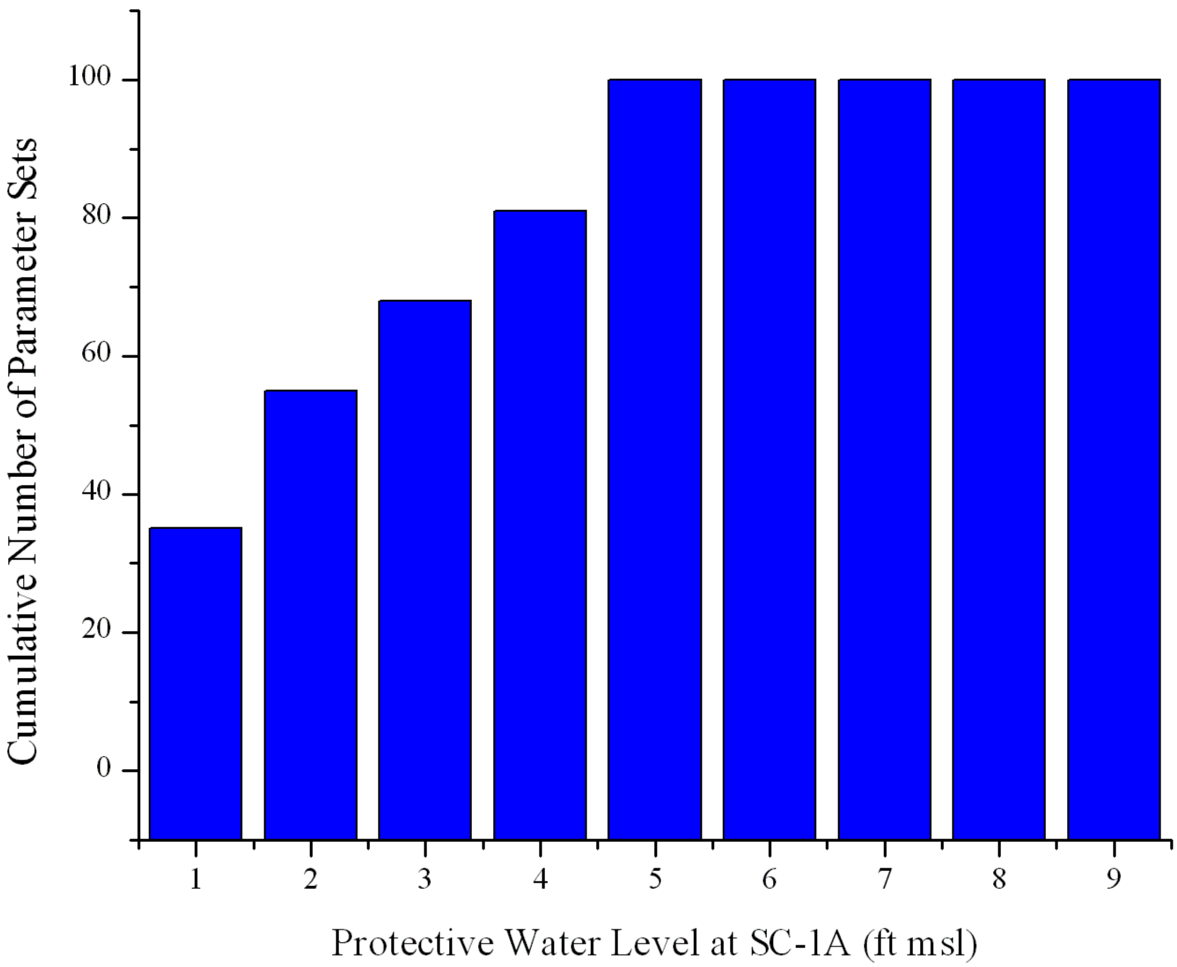


Figure A- 3: Cumulative Distribution of Protective Water Levels at Well SC-1A Resulting from 100 Random Parameter Sets

The target groundwater level at Well SC-1A is the minimum water level that stores at least 352 acre-feet of freshwater in the A-unit. The target groundwater level for this well ranges between 3 and 8 feet msl. Figure A- 4 shows the cumulative distribution of the target groundwater levels for well SC-1A. A groundwater level of 6 feet msl stores the target freshwater volume in over 70% of the parameter sets.

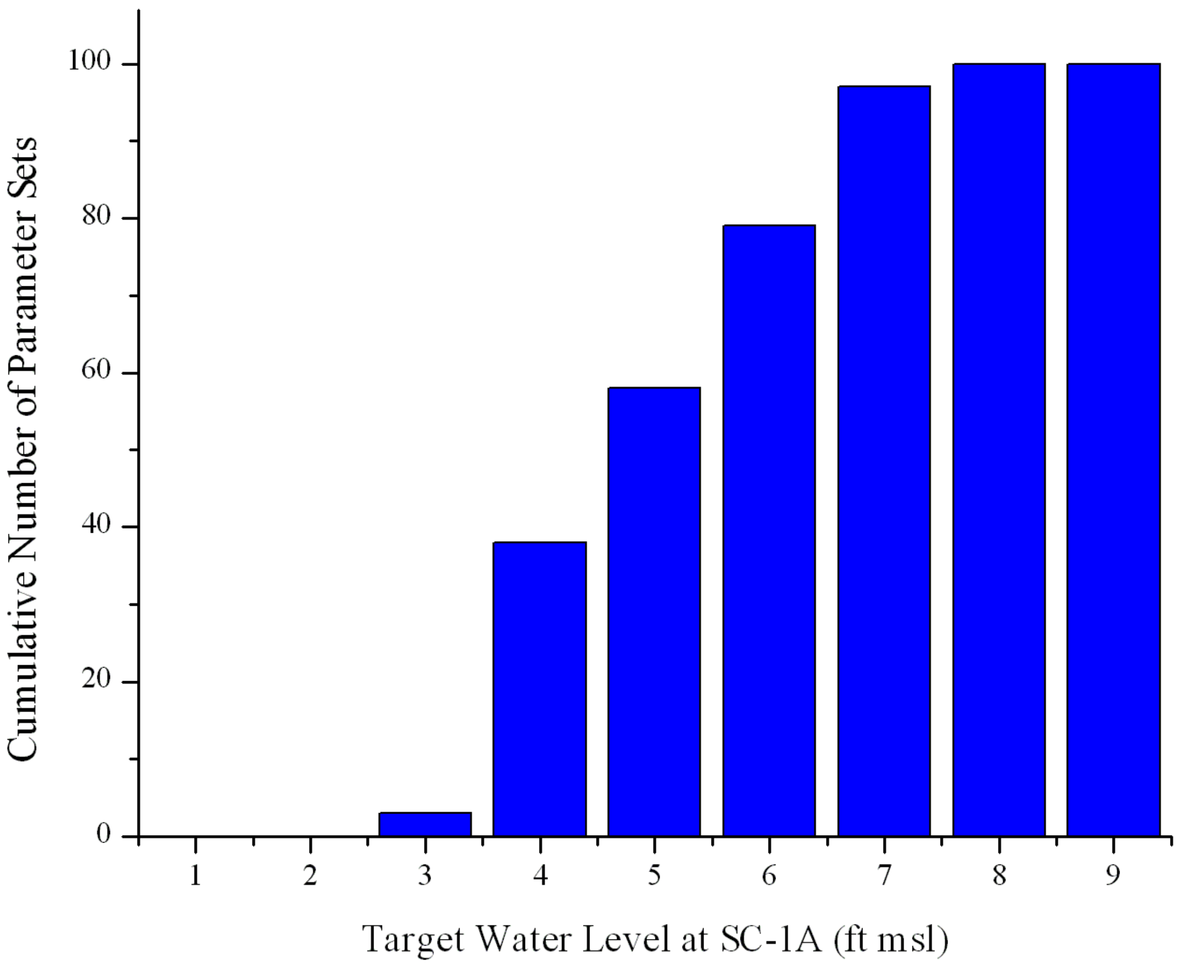


Figure A- 4: Cumulative Distribution of Target Water Levels at Well SC-1A Resulting from 100 Random Parameter Sets

The parameter that has the largest effect on the protective and target groundwater level is the conductivity of the underlying AA-unit. Figure A- 5 shows the protective groundwater levels simulated for Well SC-1A plotted against the varied parameter values. A larger hydraulic conductivity in the underlying AA-unit results in lower protective and target groundwater levels. Larger underlying conductivity leads to flows of saltwater underneath the interface, which flattens the interface and allows the protected cell at the coastline to be fresher.

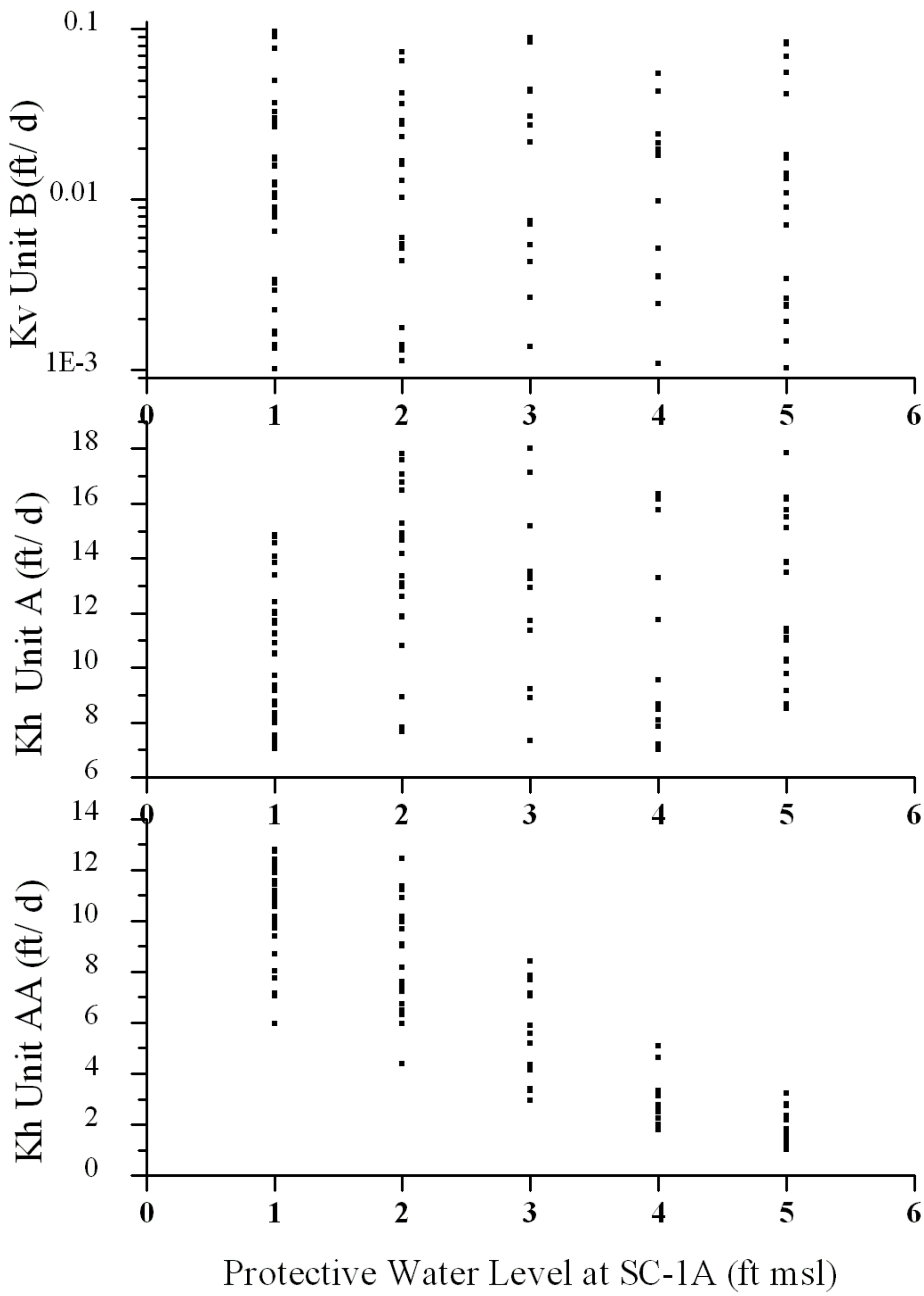


Figure A- 5: Distribution of Protective Water Levels at Well SC-1A Plotted Against Parameter Values

WELL SC-3A MODEL RESULTS

The protective groundwater level at Well SC-3A is the minimum groundwater level that maintains fresh water in the bottom of the A-unit at the coastline. The protective groundwater level for this well ranges between 8 and 11 feet msl based on modeling the

100 parameter sets. Figure A- 6 shows the cumulative distribution of the protective groundwater levels. A groundwater level of 10 feet msl is protective for over 70% of the parameter sets.

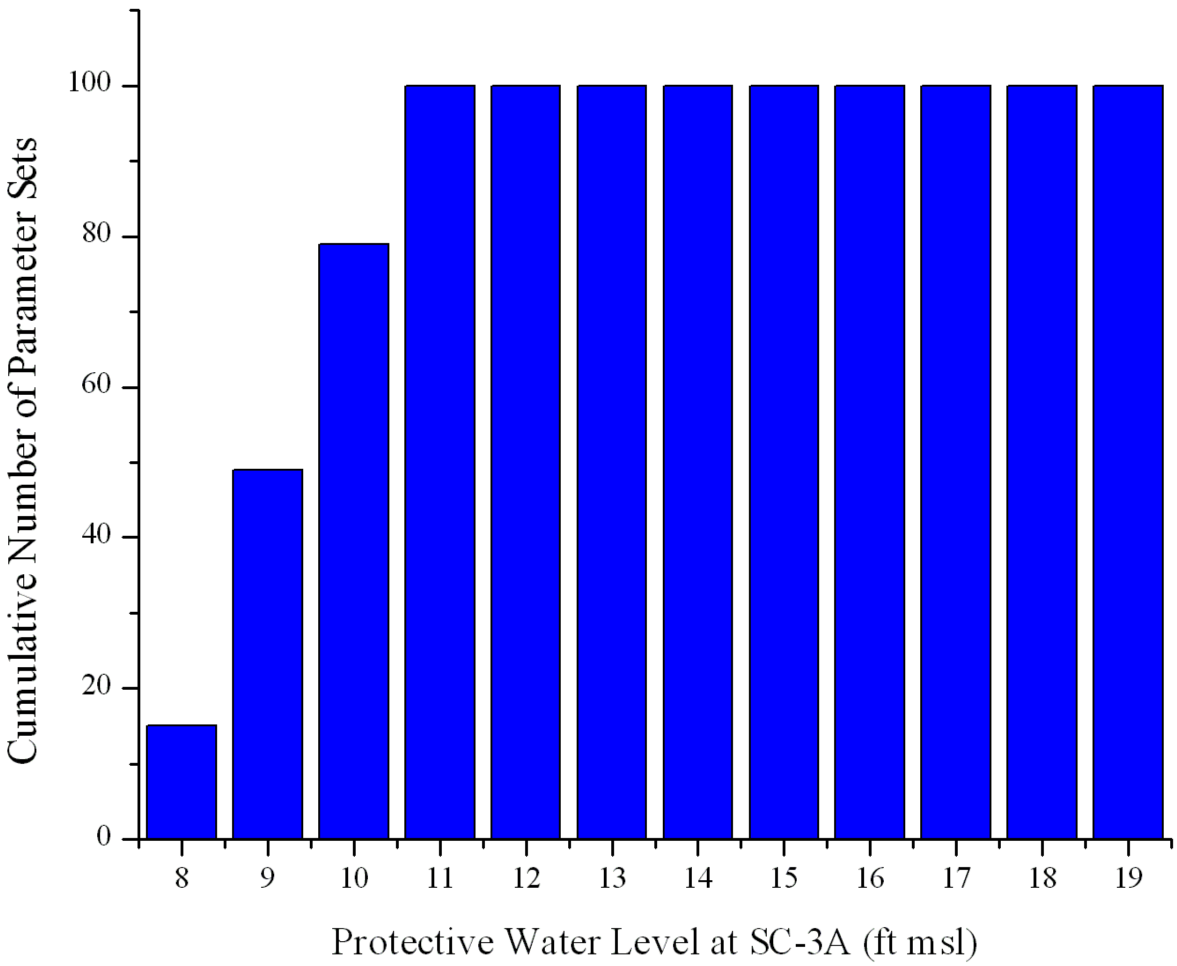


Figure A- 6: Cumulative Distribution of Protective Water Levels at Well SC-3A Resulting from 100 Random Parameter Sets

The target groundwater level at Well SC-3A is the minimum water level that stores at least 112 acre-feet of freshwater in the A-unit. The target groundwater level for this well ranges between 9 and 12 feet msl. Figure A- 7 shows the cumulative distribution of the target groundwater levels. A groundwater level of 11 feet msl stores the target freshwater volume in over 70% of the parameter sets.

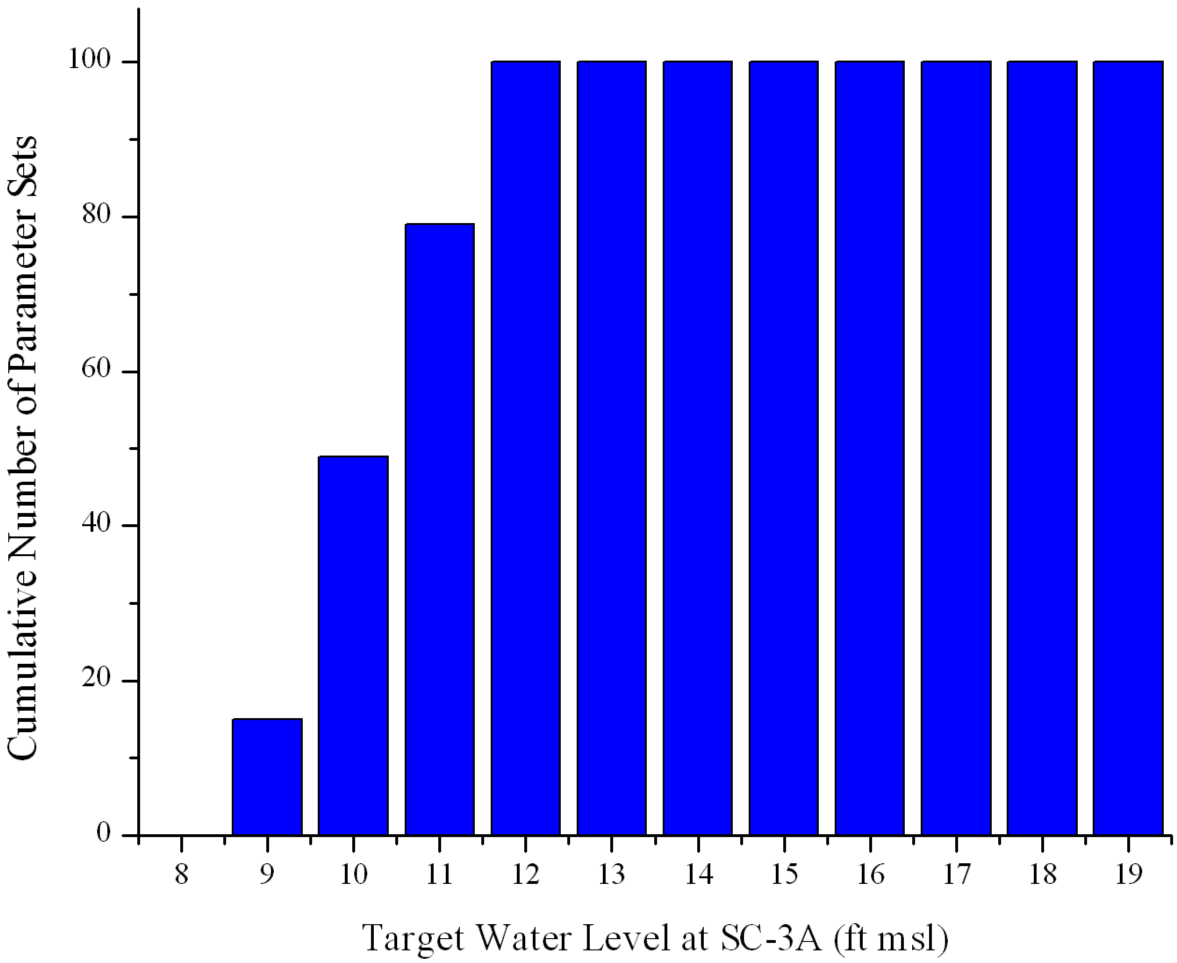


Figure A- 7: Cumulative Distribution of Target Water Levels at SC-3A Resulting from Random Parameter Sets

The alternative target storage distribution stores groundwater only in the Purisima Formation offshore of well clusters SC-3, SC-5, SC-8, and SC-9. Under this alternative distribution, the target groundwater level at Well SC-3A is the minimum water level that stores at least 369 acre-feet of freshwater in A-unit. The alternative target groundwater level for this well ranges between from 10 and 14 feet msl. Figure A- 8 shows the cumulative distribution of the alternative target groundwater levels. A groundwater level of 13 feet msl stores the alternative target freshwater volume in over 70% of the parameter sets.

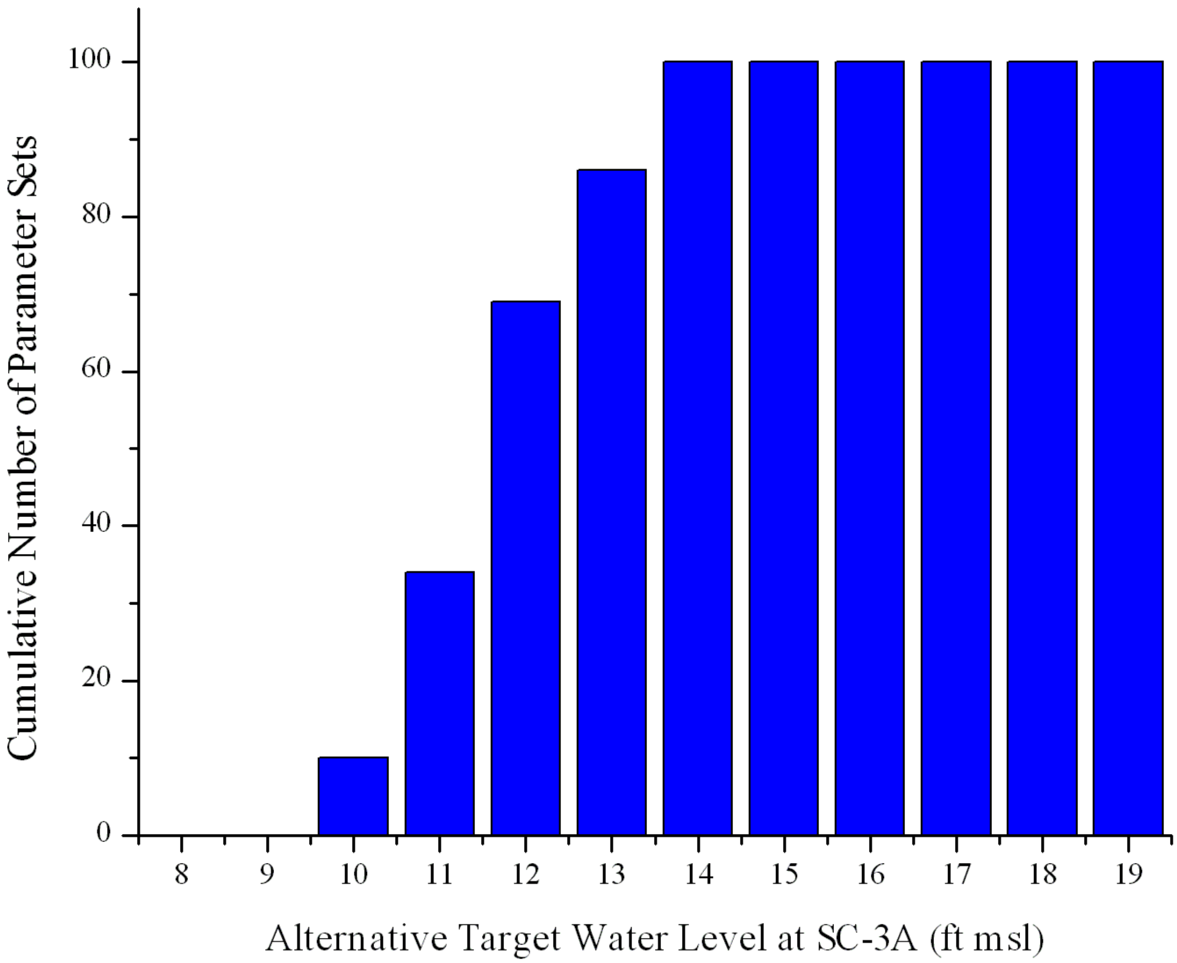


Figure A- 8: Cumulative Distribution of Alternative Target Water Levels at Well SC-3A Resulting from 100 Random Parameter Sets

The parameter that has the largest effect on the protective and target groundwater level is the conductivity of the underlying AA-unit. Figure A- 9 shows the protective groundwater levels simulated at Well SC-3A plotted against the varied parameter values. A larger hydraulic conductivity in the underlying AA-unit results in lower protective and target groundwater levels.

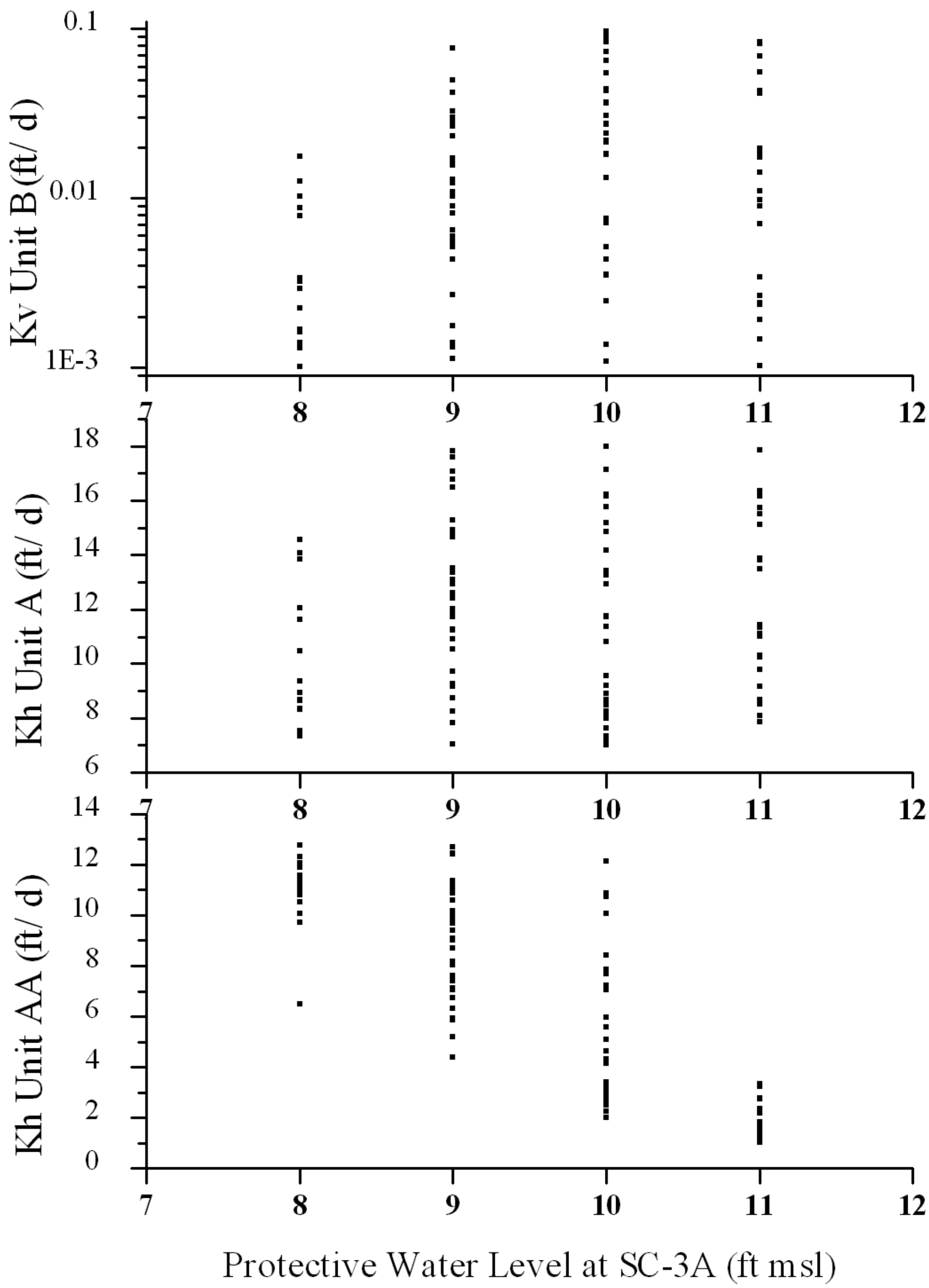


Figure A- 9: Distribution of Protective Water Levels at Well SC-3A Plotted Against Parameter Values

WELL SC-5A MODEL RESULTS

The protective groundwater level at Well SC-5A is the minimum water level that maintains fresh water in the bottom of the A unit at the coastline. The protective groundwater level for this well ranges between 11 and 15 feet msl based on modeling the 100 parameter sets. Figure A- 10 shows the cumulative distribution of the protective groundwater levels. A groundwater level of 13 feet msl is protective for over 70% of the parameter sets.

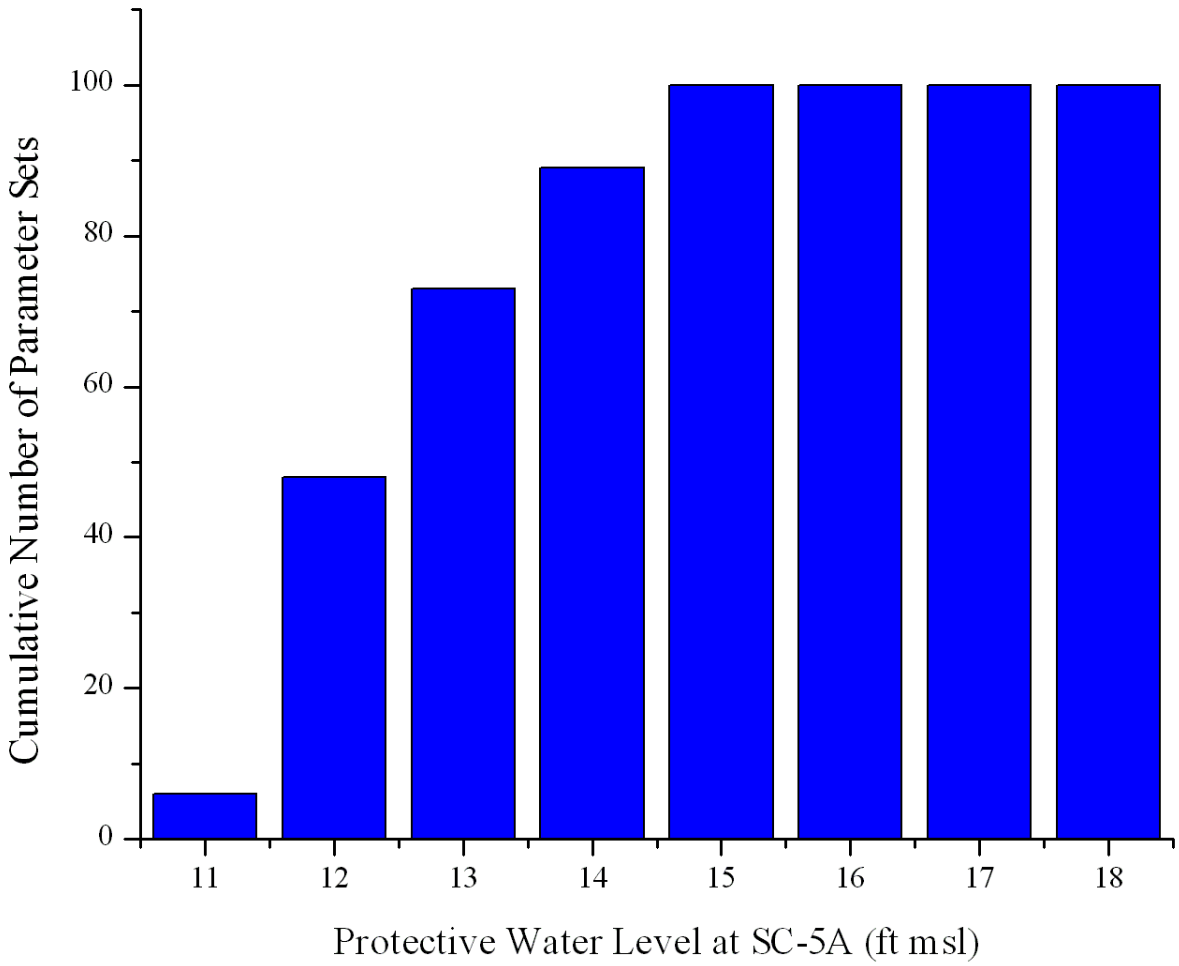


Figure A- 10: Cumulative Distribution of Protective Water Levels at Well SC-5A Resulting from 100 Random Parameter Sets

The target groundwater level at Well SC-5A is the minimum water level that stores at least 56 acre-feet of freshwater in the A-unit. The target groundwater level for this well ranges between 12 and 16 feet msl. Figure A- 11 shows the cumulative distribution of the target groundwater levels. A groundwater level of 14 feet msl stores the target freshwater volume in over 70% of the parameter sets.

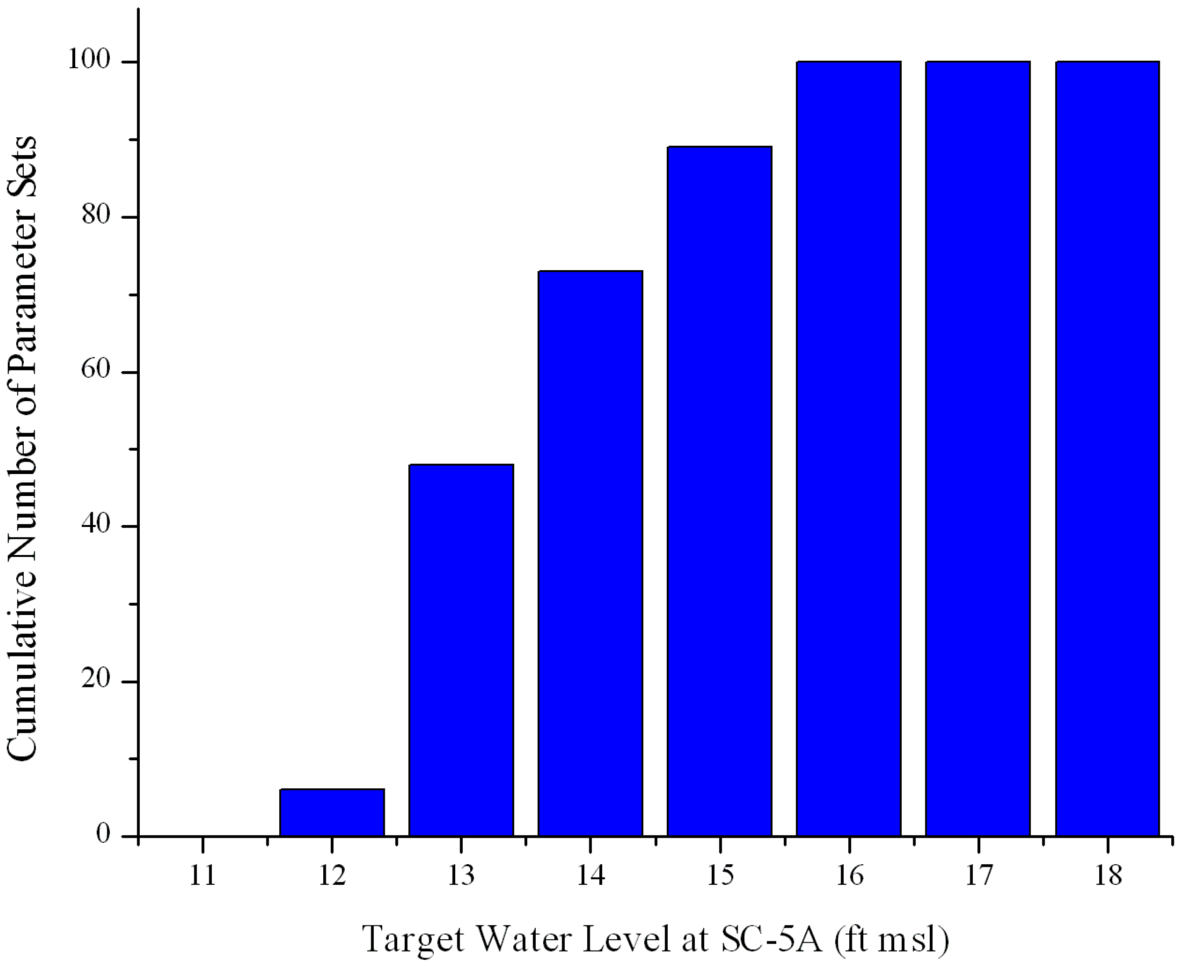


Figure A- 11: Cumulative Distribution of Target Water Levels at Well SC-5A Resulting from 100 Random Parameter Sets

The alternative target storage distribution stores groundwater only in the Purisima Formation offshore of well clusters SC-3, SC-5, SC-8, and SC-9. Under this alternative distribution, the target groundwater level at Well SC-5A is the minimum water level that stores at least 184 acre-feet of freshwater in the A-unit. The alternative target groundwater level for this well ranges between 12 and 17 feet msl. Figure A- 12 shows the cumulative distribution of the alternative target groundwater levels. A groundwater level of 14 feet stores the alternative target freshwater volume in 70% of the parameter sets.

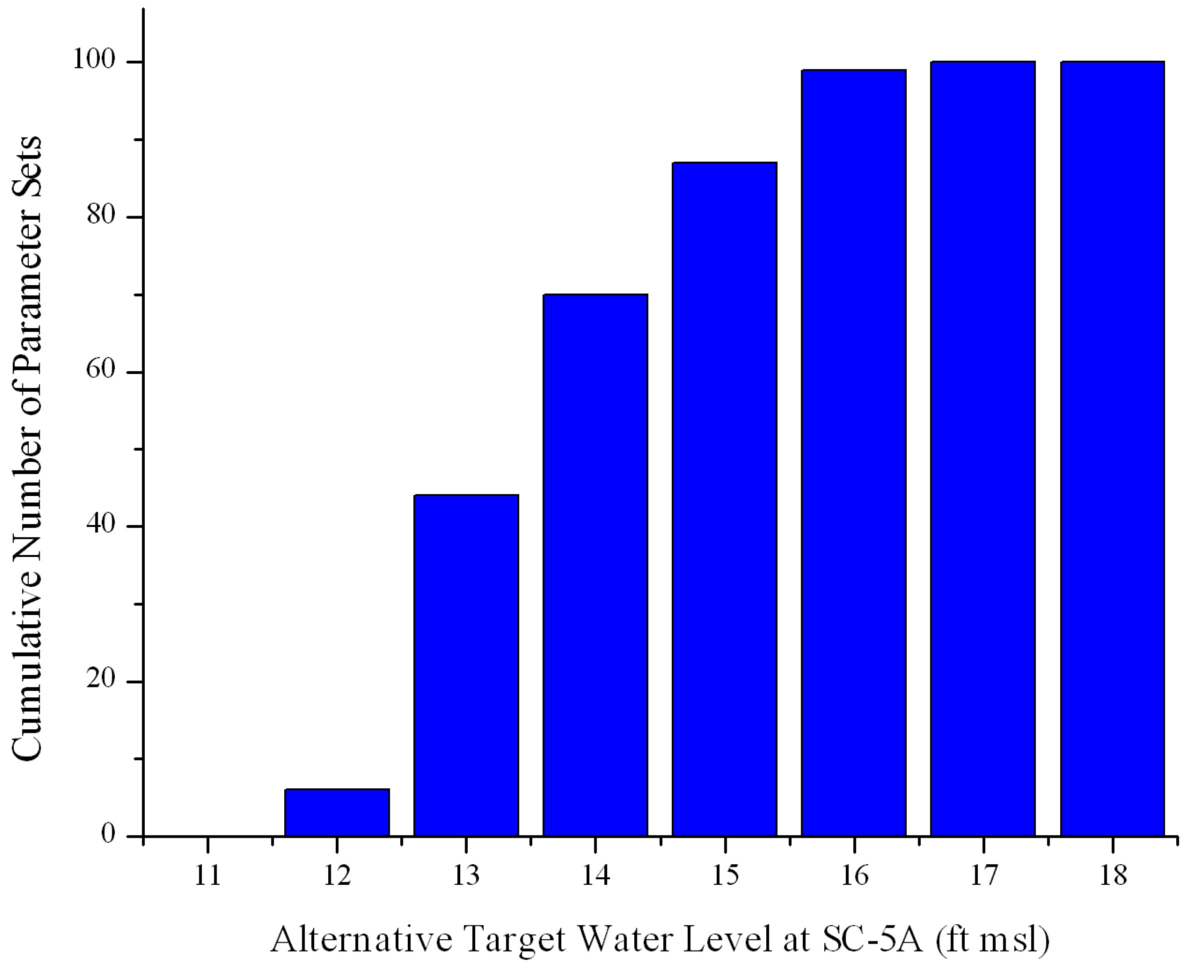


Figure A- 12: Cumulative Distribution of Alternative Target Water Levels at well SC-5A Resulting from 100 Random Parameter Sets

The parameter that has the largest effect on the protective and target groundwater level is the conductivity of the underlying AA-unit. Figure A- 13 shows the protective groundwater levels at Well SC-5A plotted against the varied parameter values. A larger hydraulic conductivity in the underlying AA-unit results in lower protective and target groundwater levels.

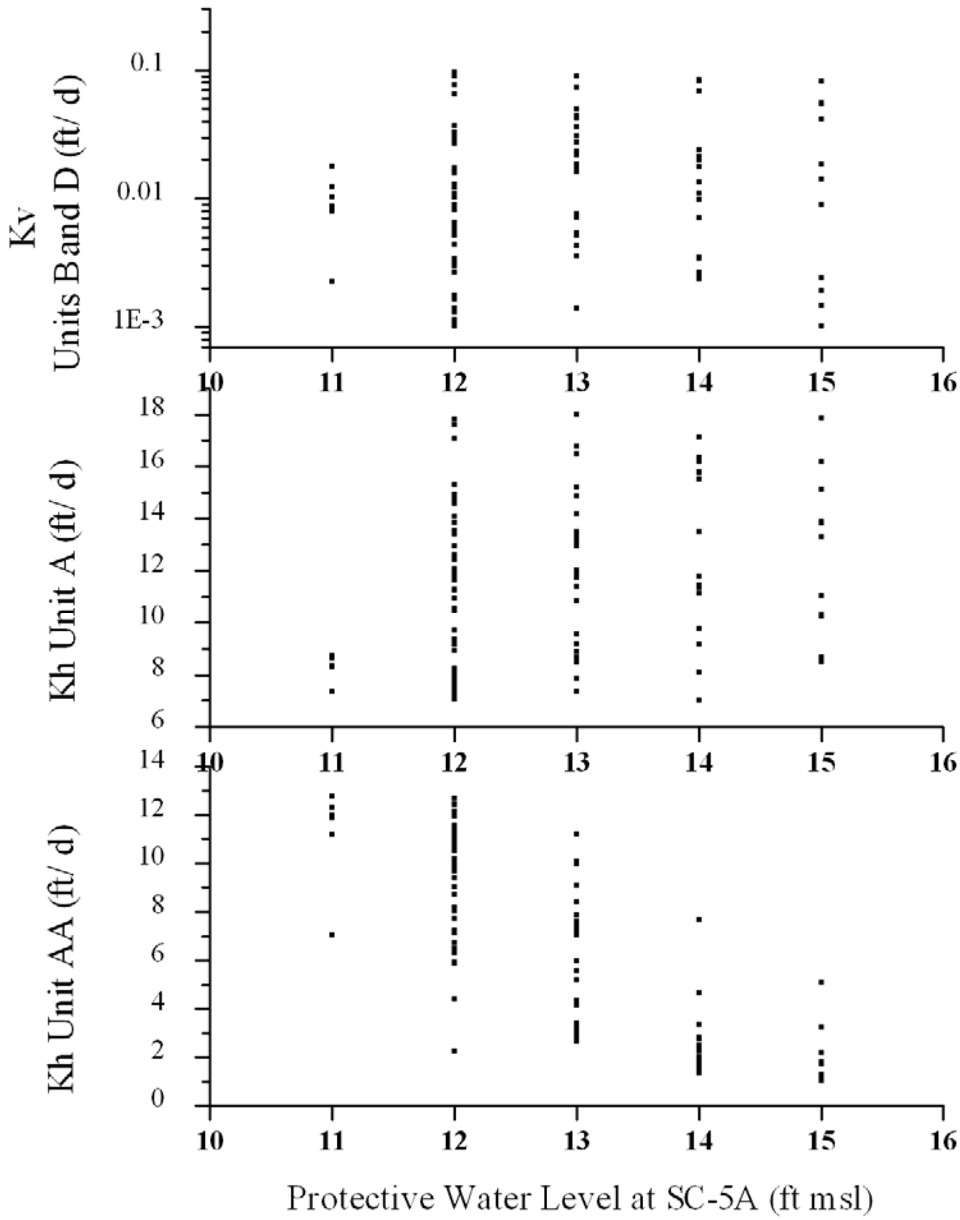


Figure A- 13: Distribution of Protective Water Levels at Well SC-5A Plotted Against Parameter Values

WELL SC-8D MODEL RESULTS

The protective groundwater level at Well SC-8D is the minimum water level that maintains fresh water in the bottom of the DEF unit at the coastline. The protective groundwater level for this well ranges between 8 and 11 feet msl based on modeling the 100 parameter sets. Figure A- 14 shows the cumulative distribution of the protective groundwater levels. A groundwater level of 10 feet msl is protective for over 70% of the parameter sets.

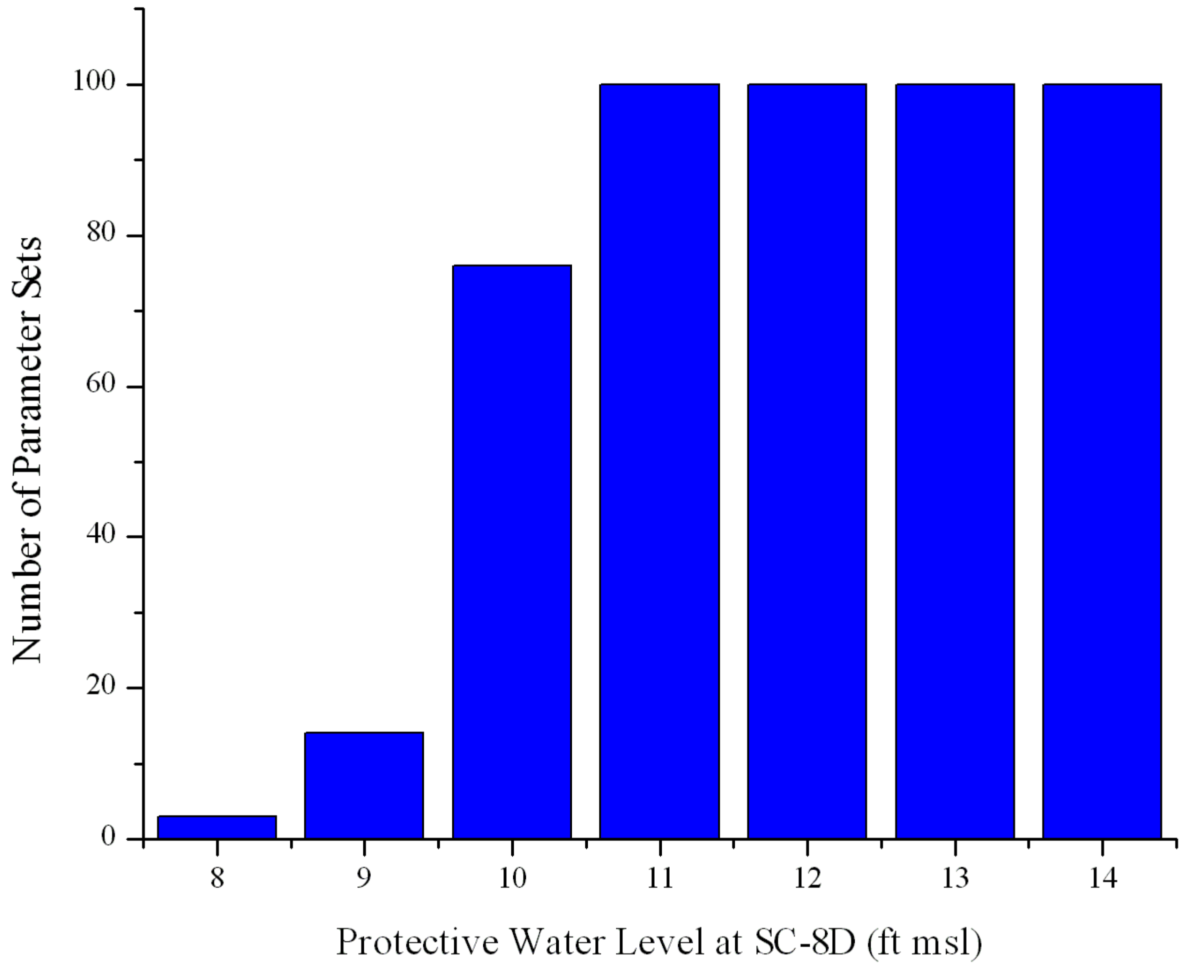


Figure A- 14: Cumulative Distribution of Protective Water Levels at Well SC-8D Resulting from 100 Random Parameter Sets

The target groundwater level at Well SC-8D is the minimum water level that stores at least 84 acre-feet of freshwater in the DEF-unit. The target groundwater level for this well ranges between 9 and 12 feet msl. Figure A- 15 shows the cumulative distribution of the target groundwater levels. A groundwater level of 11 feet msl stores the target freshwater volume in over 70% of the parameter sets.

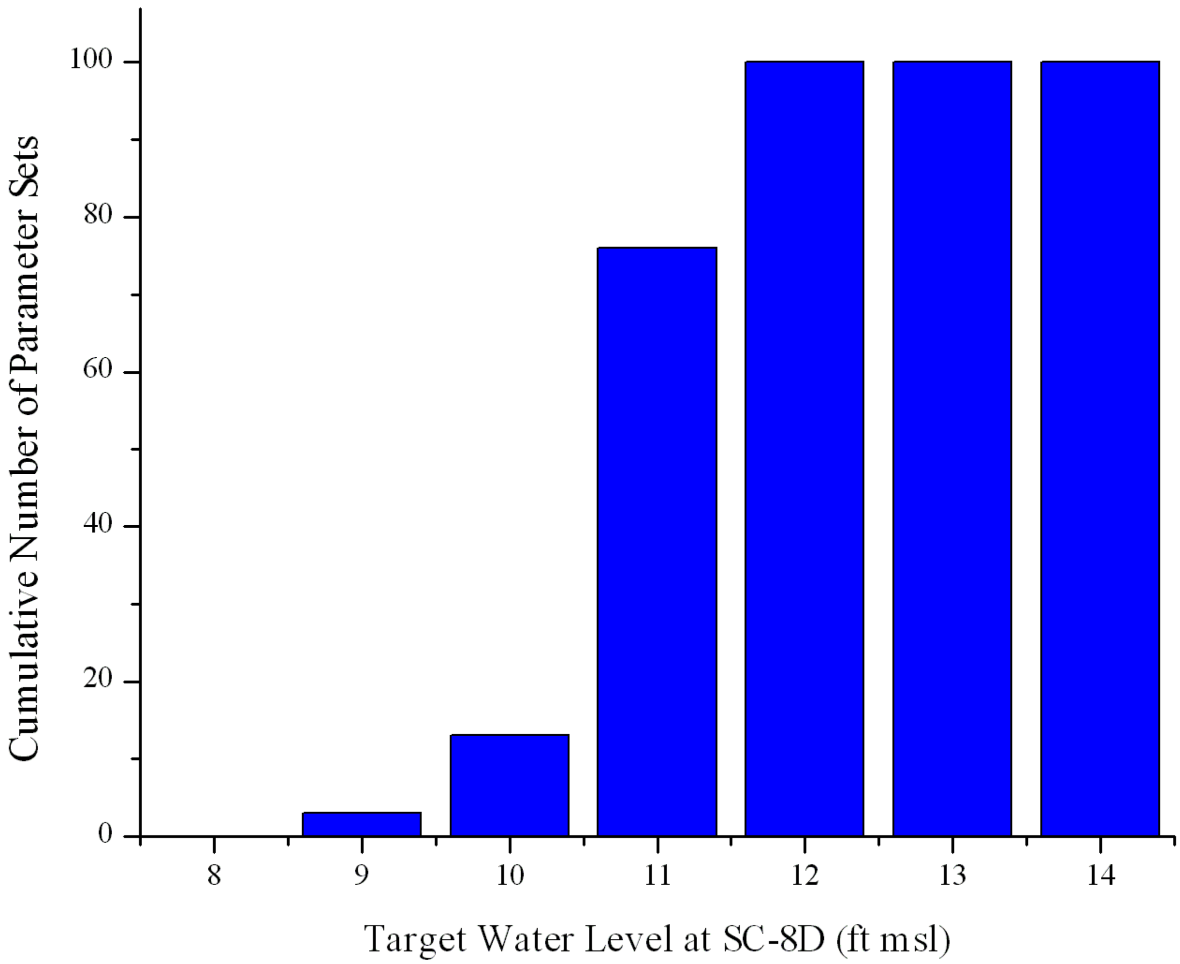


Figure A- 15: Cumulative Distribution of Target Water Levels at Well SC-8D Resulting from 100 Random Parameter Sets

The alternative target storage distribution stores groundwater only in the Purisima formation offshore of well clusters SC-3, SC-5, SC-8, and SC-9. Under this alternative distribution, the target groundwater level at Well SC-8D is the minimum water level that stores at least 275 acre-feet of freshwater in the DEF-unit. The alternative target groundwater level for this well ranges between 10 and 14 feet msl. Figure A- 16 shows the cumulative distribution of the alternative target groundwater levels. A groundwater level of 13 feet stores the alternative target freshwater volume in over 70% of the parameter sets.

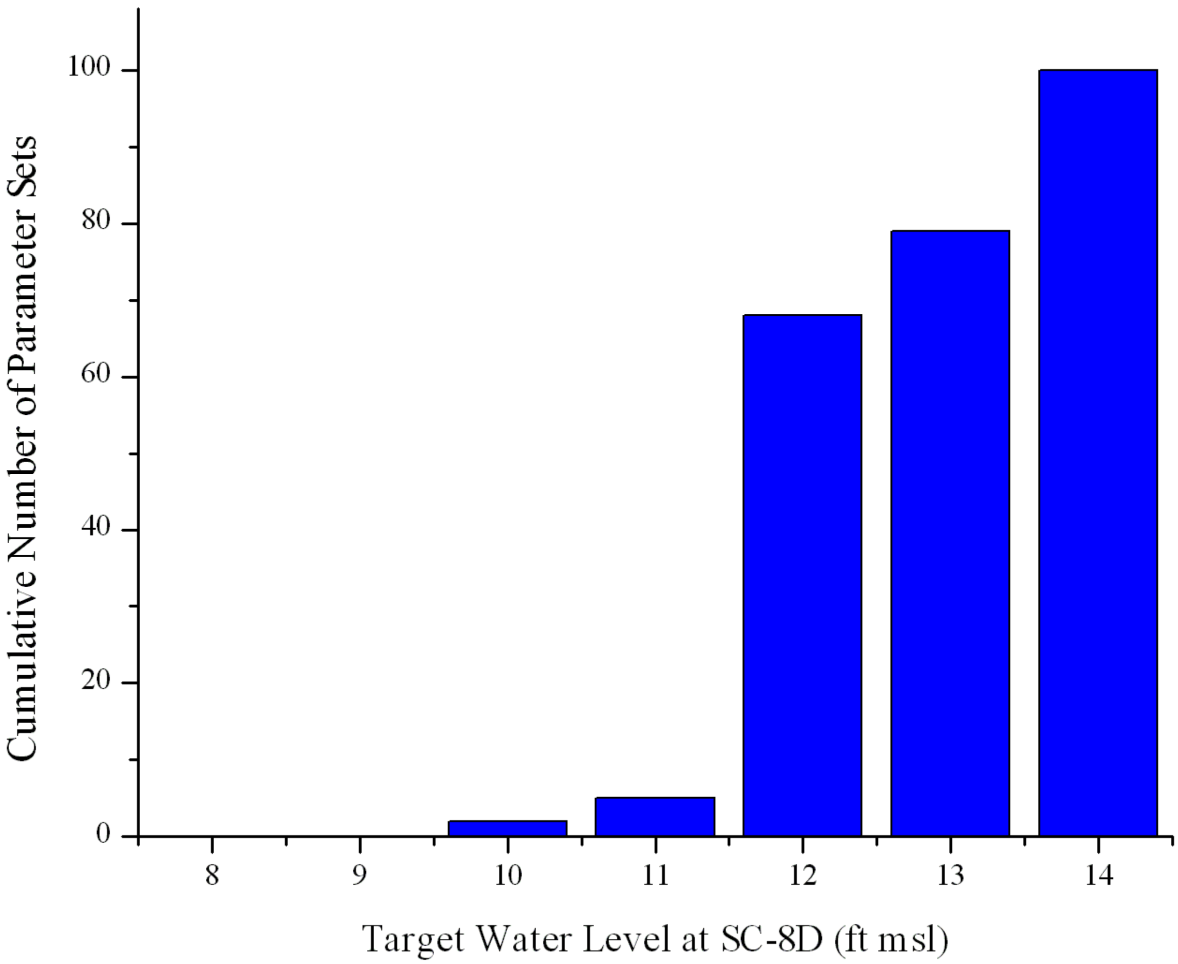


Figure A- 16: Cumulative Distribution of Alternative Target Water Levels at well SC-8D Resulting from 100 Random Parameter Sets

The parameter that has the largest effect on the protective and target groundwater levels is the conductivity of the underlying D aquitard. Figure A- 17 shows the protective groundwater levels at Well SC-8D plotted against the varied parameter values. A larger hydraulic conductivity in the underlying D aquitard results in lower protective and target groundwater levels.

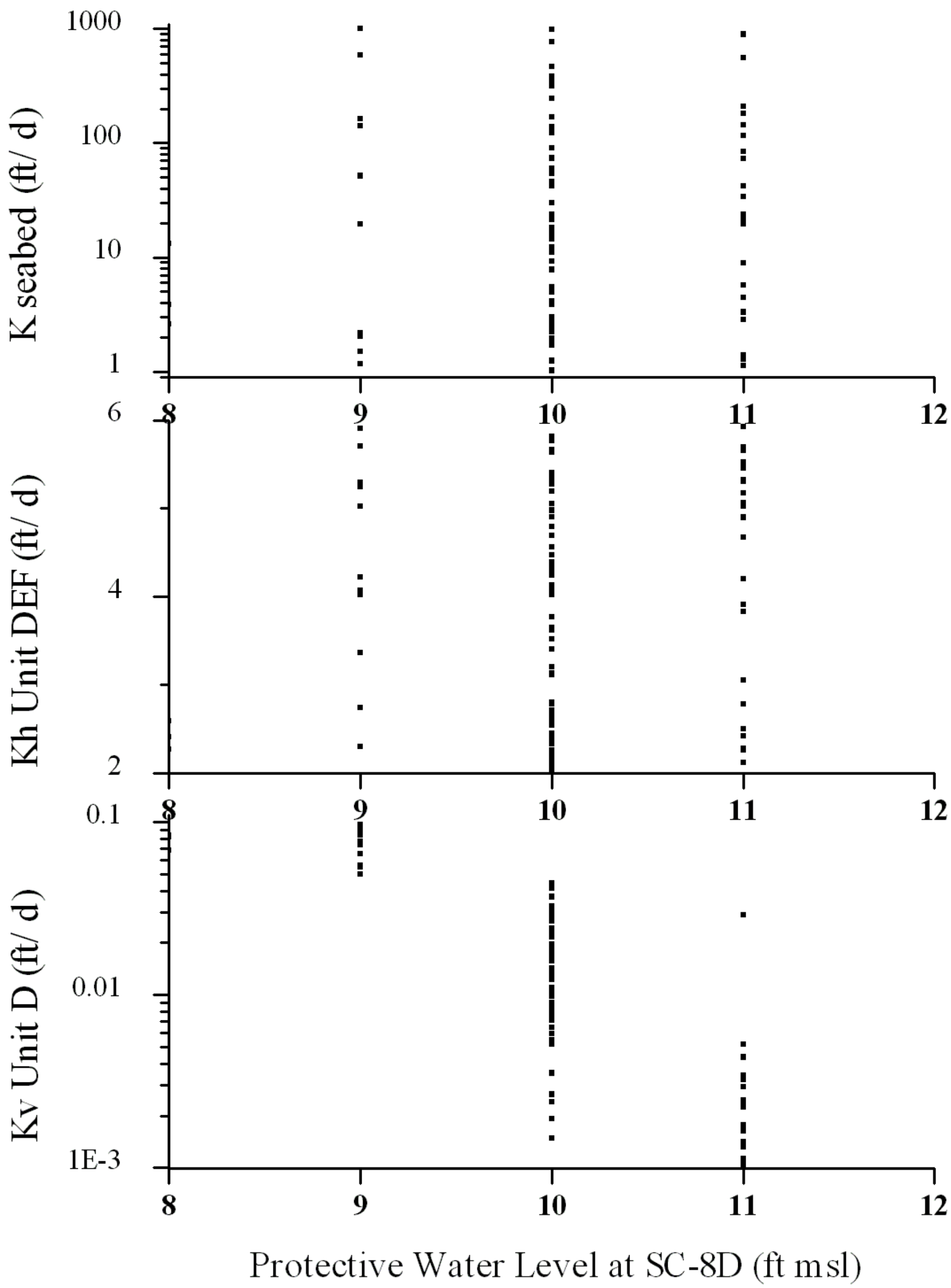


Figure A- 17: Distribution of Protective Water Levels at Well SC-8D Plotted Against Parameter Values

WELL SC-9B MODEL RESULTS

The protective groundwater level at Well SC-9B is the minimum water level that maintains fresh water in the bottom of the BC unit at the coastline. The protective groundwater level for this well ranges between 3 and 11 feet msl based on modeling the 100 parameter sets. Figure A- 18 shows the cumulative distribution of the protective groundwater levels. A groundwater level of 10 feet msl is protective for 70% of the parameter sets.

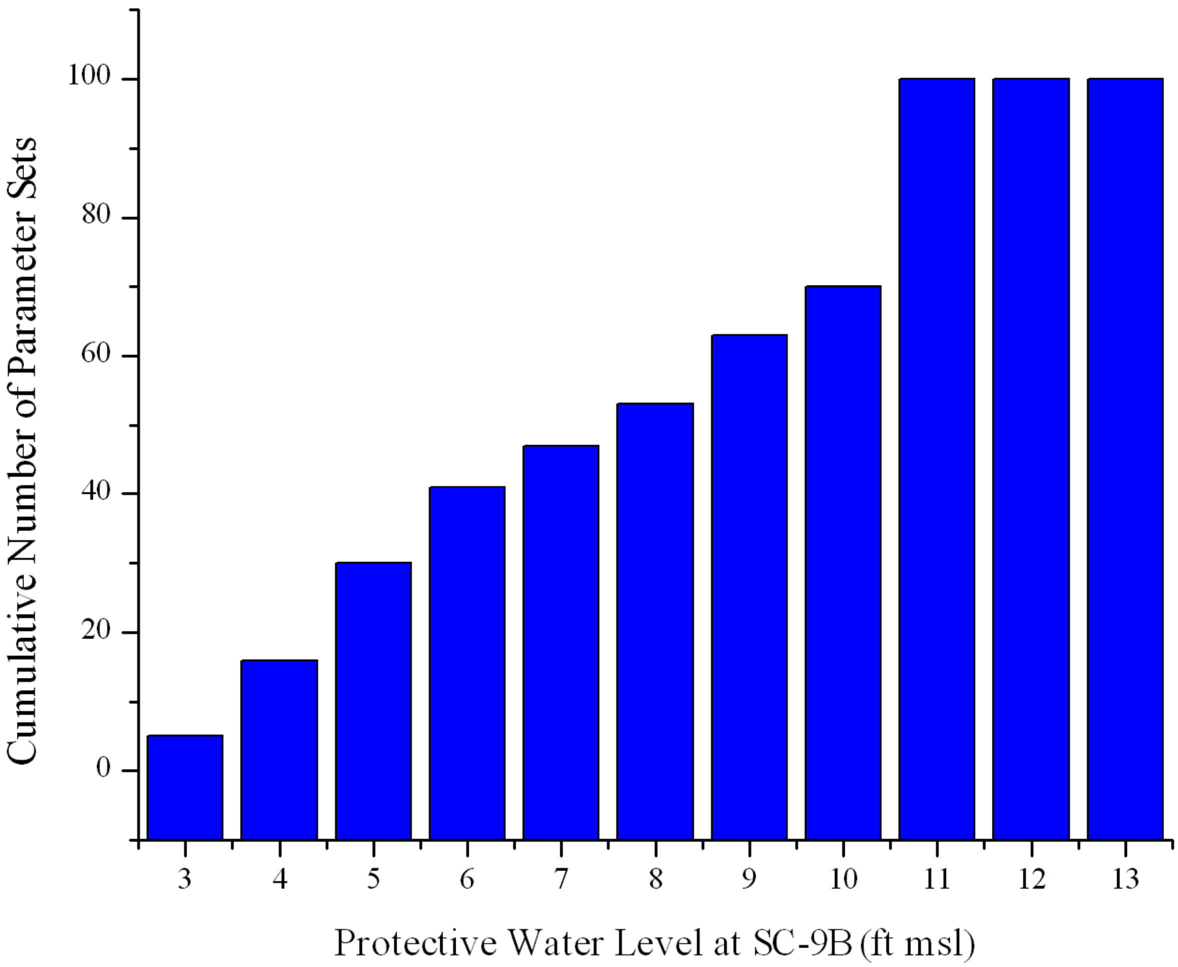


Figure A- 18: Cumulative Distribution of Protective Water Levels at Well SC-9B Resulting from 100 Random Parameter Sets

The target groundwater level at Well SC-9B is the minimum water level that stores at least 83 acre-feet of freshwater in the BC-unit. The target groundwater level for this well ranges between 4 and 12 feet msl. Figure A- 19 shows the cumulative distribution of the target groundwater levels. A groundwater level of 11 feet msl stores the target freshwater volume in 70% of the parameter sets.

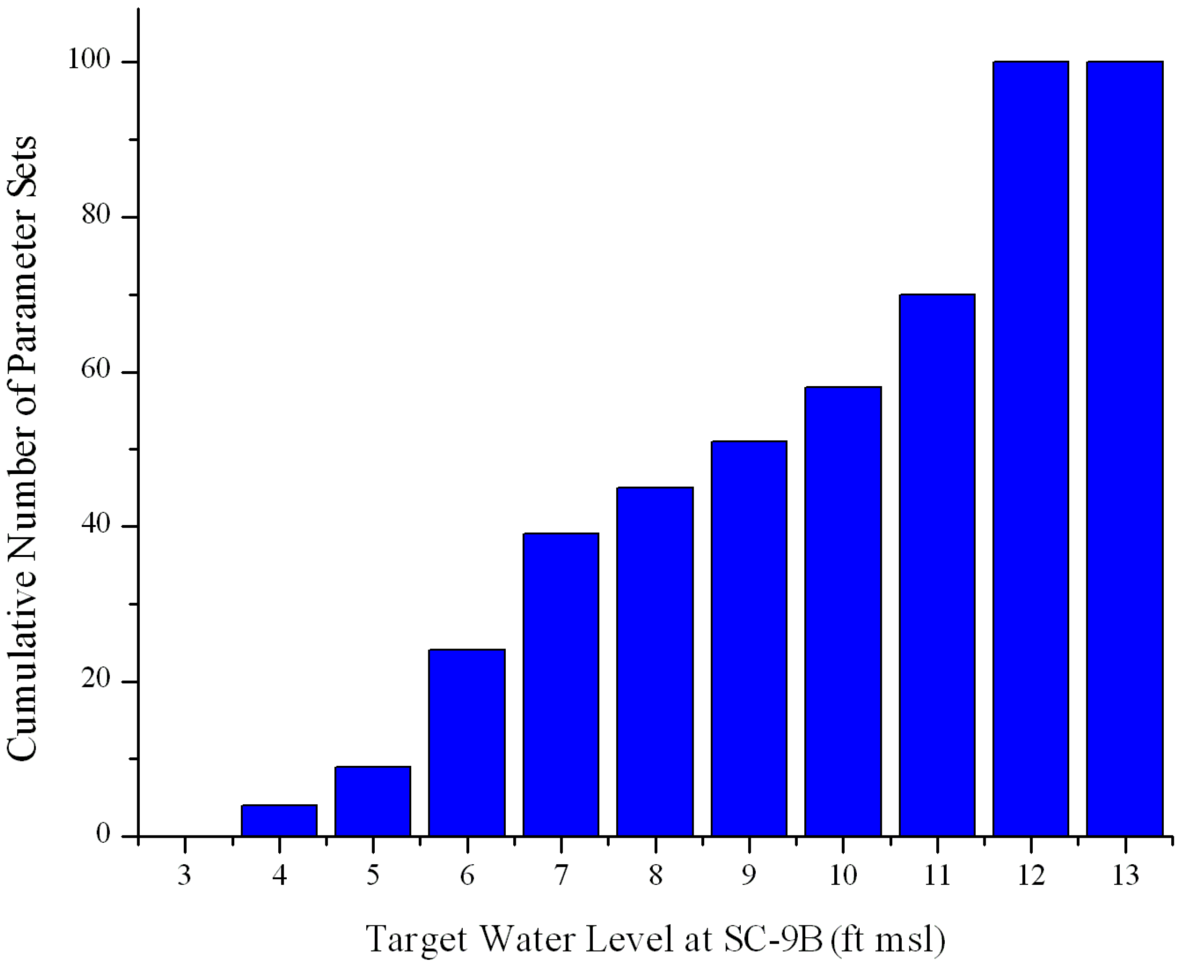


Figure A- 19: Cumulative Distribution of Target Water Levels at Well SC-9B Resulting from 100 Random Parameter Sets

The alternative target storage distribution stores groundwater only in the Purisima Formation offshore of well clusters SC-3, SC-5, SC-8, and SC-9. Under this alternative distribution, the target groundwater level at Well SC-9B is the minimum water level that stores at least 276 acre-feet of freshwater in the BC-unit. The alternative target groundwater level for this well ranges between 5 and 13 feet msl. Figure A- 20 shows the cumulative distribution of the alternative target groundwater levels. A groundwater level of 12 feet stores the alternative target freshwater volume in over 70% of the parameter sets.

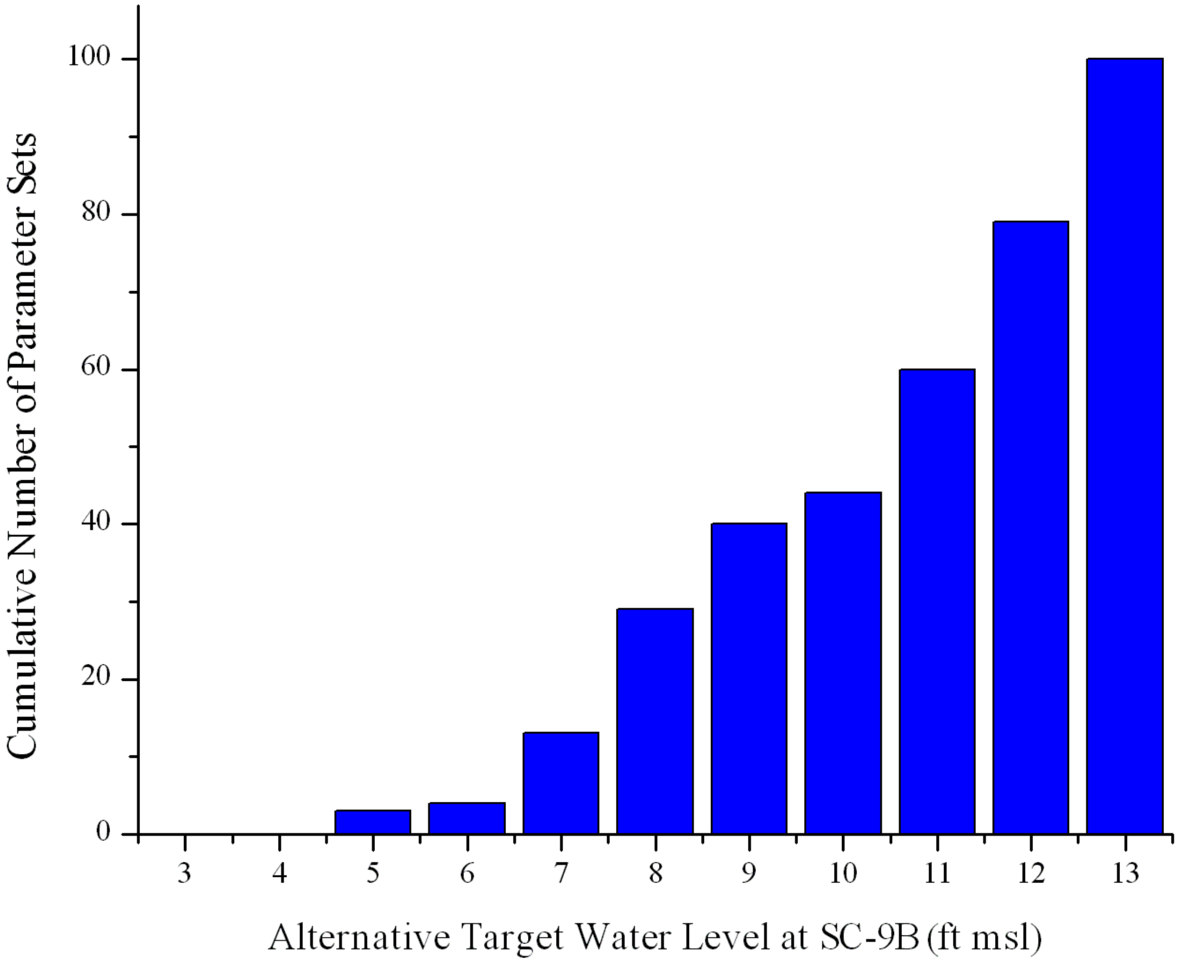


Figure A- 20: Cumulative Distribution of Alternative Target Water Levels at Well SC-9B Resulting from 100 Random Parameter Sets

The parameter that has the largest effect on the protective and target groundwater levels is the conductivity of the underlying B aquitard. Figure A- 21 shows the protective groundwater levels at Well SC-9B plotted against the varied parameter values. A larger hydraulic conductivity in the underlying B aquitard results in lower protective and target groundwater levels.

A wide range of vertical conductivities is used to simulate the underlying B aquitard. This wide range and the close coastline (100 feet) lead to the wide variation in protective and target groundwater levels.

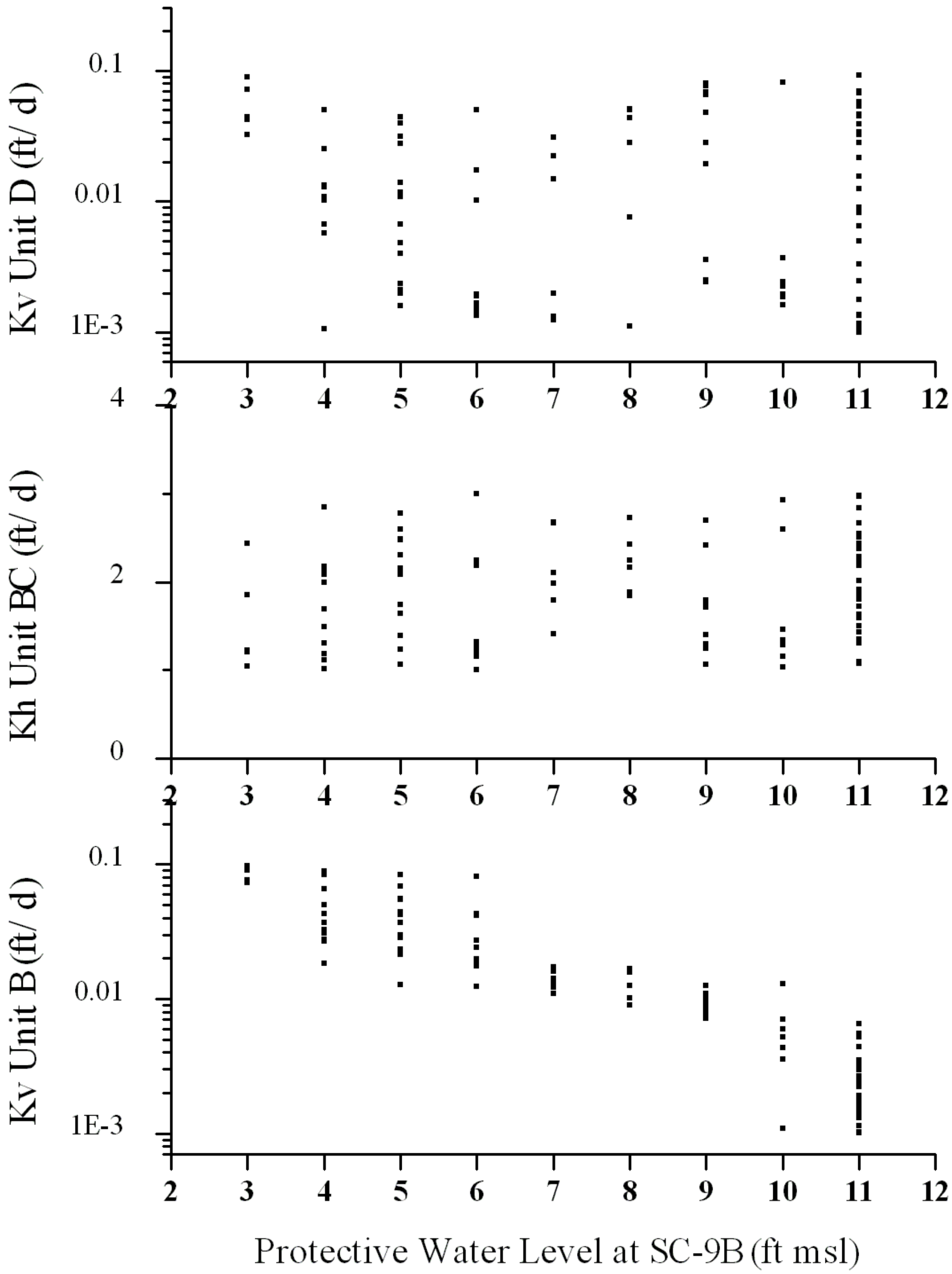


Figure A- 21: Distribution of Protective Water Levels at Well SC-9B Plotted Against Parameter Values

WELL SC-A1B MODEL RESULTS

The protective groundwater level at Well SC-A1B is the minimum water level that maintains fresh water in the model layer above the screen of Well SC-A1A at the coastline. The protective groundwater level for this well ranges between 8 and 12 feet msl based on modeling the 100 parameter sets. Figure A- 22 shows the cumulative distribution of the protective groundwater levels. A groundwater level of 10 feet msl is protective for over 70% of the parameter sets.

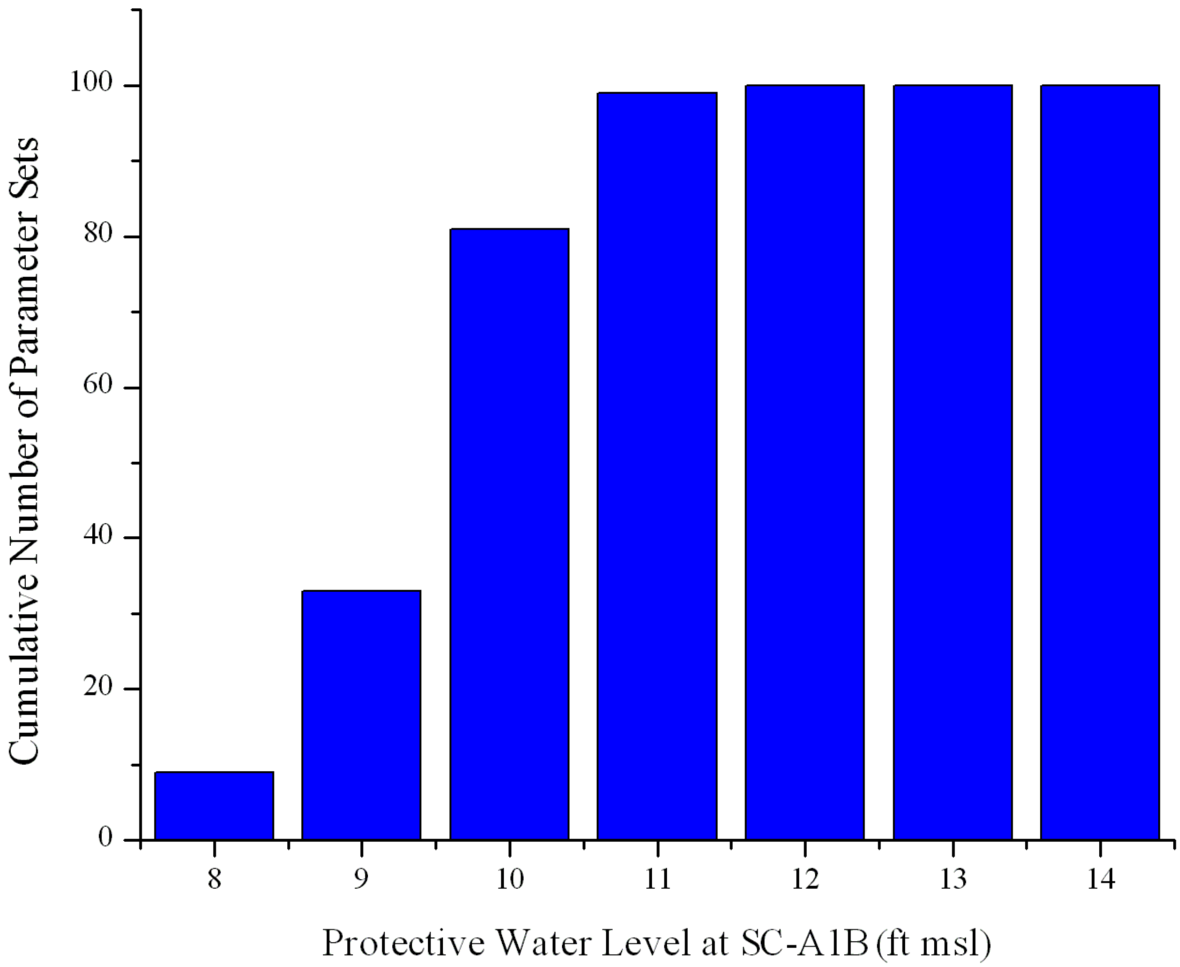


Figure A- 22: Cumulative Distribution of Protective Water Levels at Well SC-A1B Resulting from 100 Random Parameter Sets

The target groundwater level at Well SC-A1B is the minimum water level that stores at least 160 acre-feet of freshwater in the F aquifer. The target groundwater level for this well ranges between 10 and 14 feet msl. Figure A- 23 shows the cumulative distribution of the target groundwater levels. A groundwater level of 12 feet msl stores the target freshwater volume in 70% of the parameter sets.

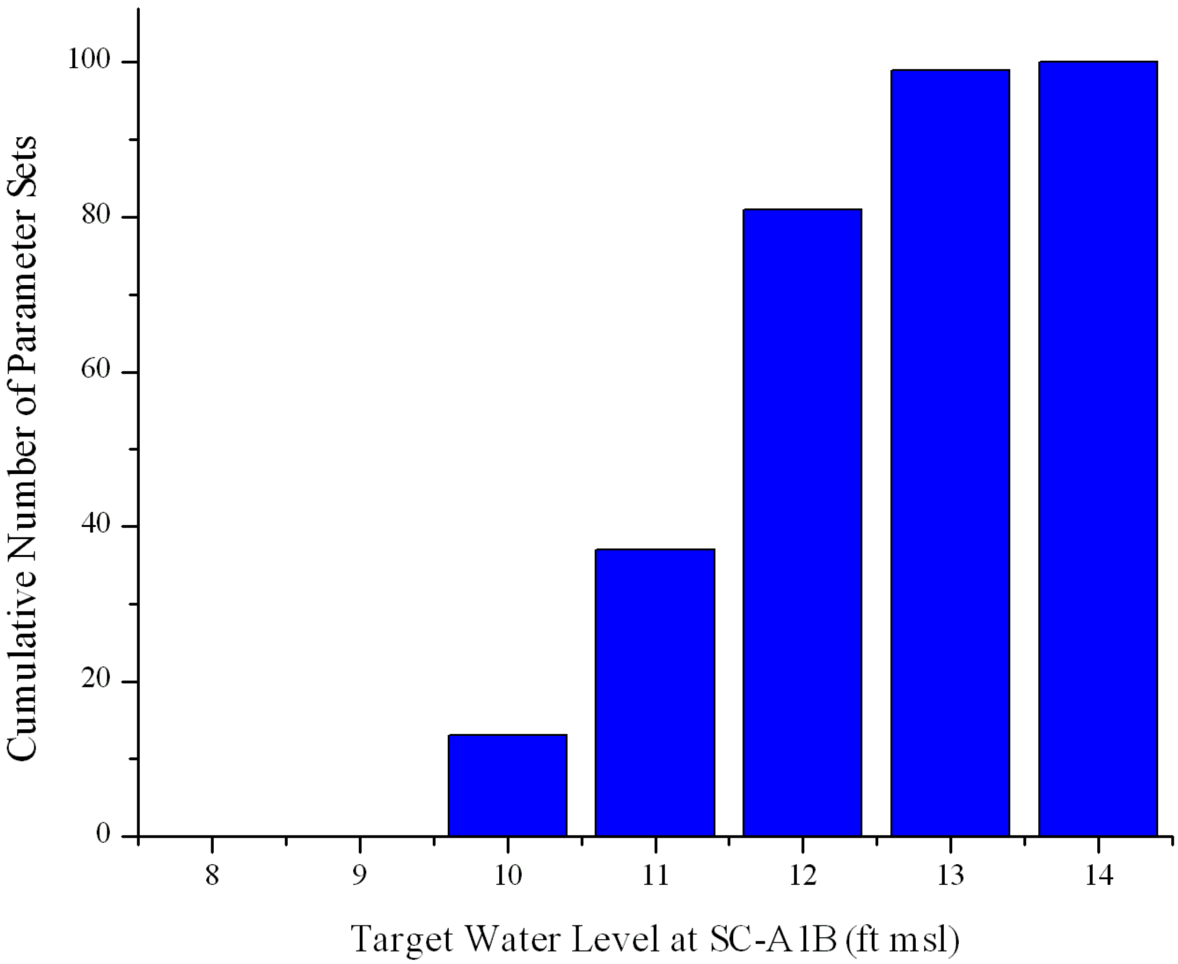


Figure A- 23: Cumulative Distribution of Target Water Levels at Well SC-A1B Resulting from 100 Random Parameter Sets

The parameter that has the largest effect on the protective and target groundwater levels is the conductivity of the underlying DEF unit. Figure A- 24 shows the protective groundwater levels at Well SC-A1B plotted against the varied parameter values. A larger hydraulic underlying conductivity in the underlying DEF-unit results in lower protective and target groundwater levels.

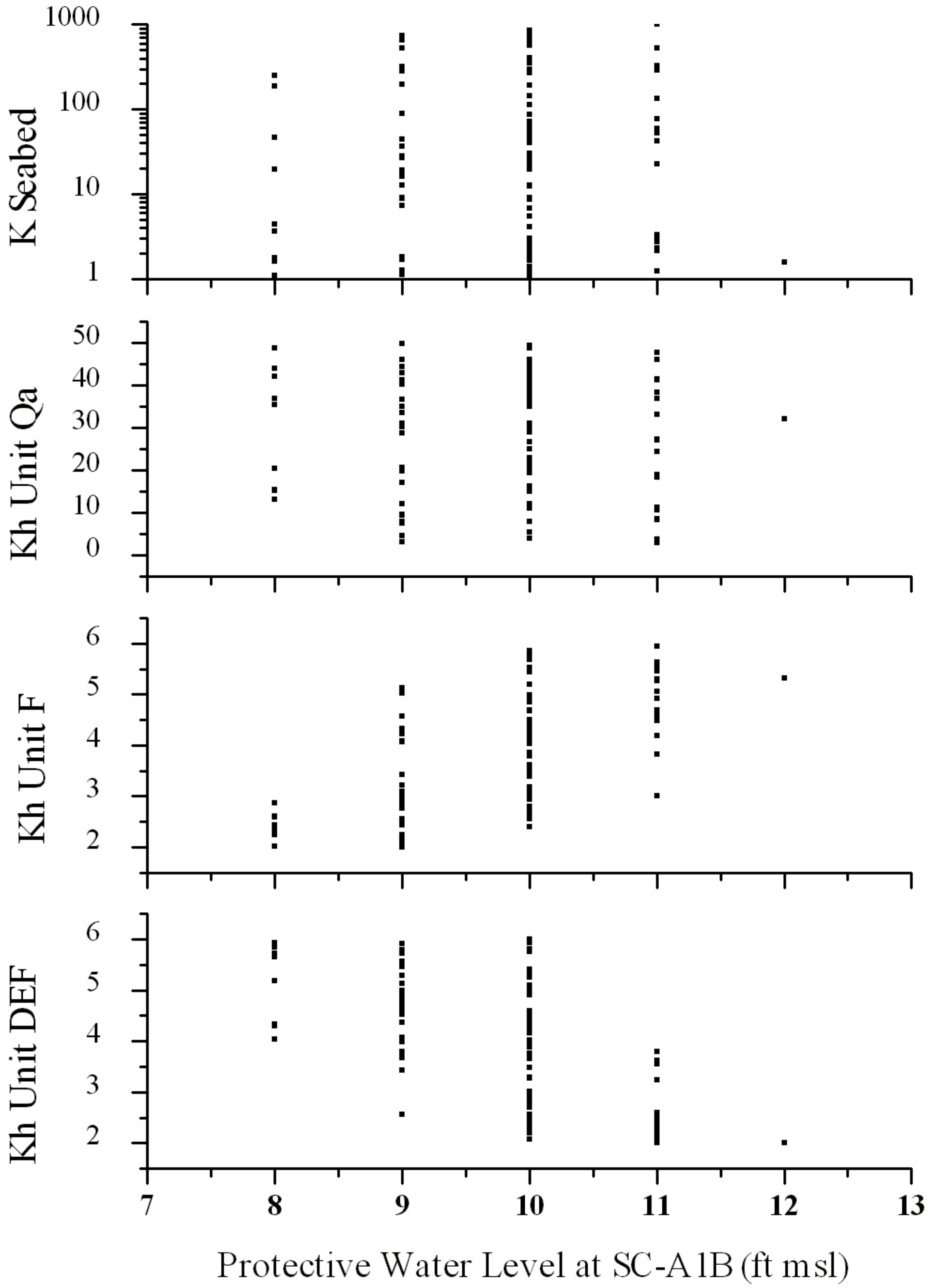


Figure A- 24: Distribution of Protective Water Levels at Well SC-A1B Plotted Against Parameter Values

WELL SC-A2B MODEL RESULTS

The protective groundwater level at Well SC-A2B is the minimum water level that maintains fresh water in the model layer above the screen of Well SC-A2A at the coastline. The protective groundwater level for this well ranges between 6 and 8 feet msl based on modeling the 100 parameter sets. Figure A- 25 shows the cumulative distribution of the protective groundwater levels. A groundwater level of 8 feet msl is protective for over 70% of the parameter sets.

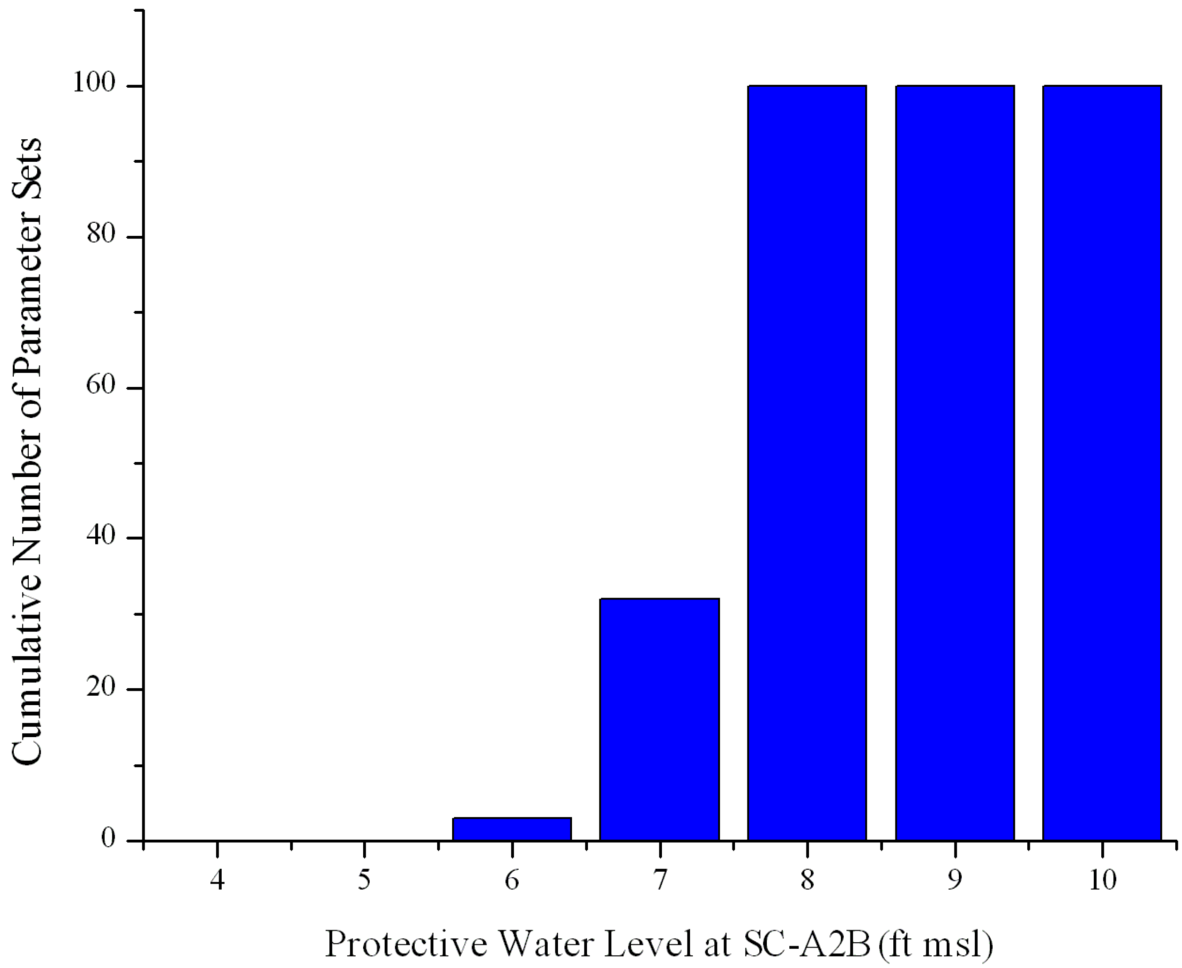


Figure A- 25: Cumulative Distribution of Protective Water Levels at Well SC-A2B Resulting from 100 Random Parameter Sets

The target groundwater level at Well SC-A2B is the minimum water level that stores at least 102 acre-feet of freshwater in the F aquifer. The target groundwater level for this well ranges between 8 and 10 feet msl. Figure A- 26 shows the cumulative distribution of the target groundwater levels. A groundwater level of 10 feet msl stores the target freshwater volume in over 70% of the parameter sets.

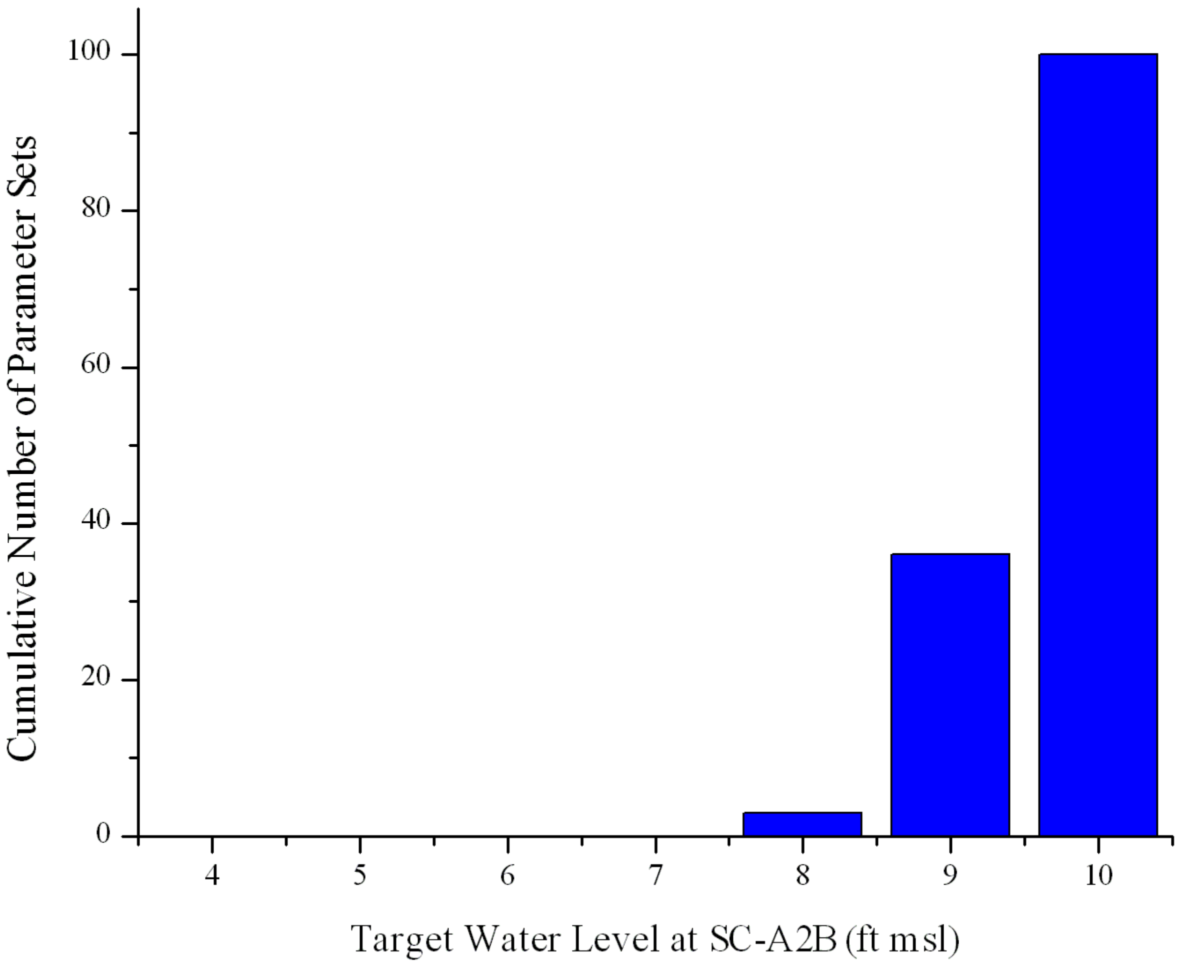


Figure A- 26: Cumulative Distribution of Target Water Levels at Well SC-A2B Resulting from 100 Random Parameter Sets

This Aromas area well is different from the Purisima wells in that the protected layer is in the lowest aquifer unit. As a result, the parameter that has the largest effect on the protective and target groundwater levels is the conductivity of the overlying Aromas aquifer. Figure A- 27 shows the protective groundwater levels at Well SC-A2B plotted against the varied parameter values. A larger hydraulic conductivity in the overlying Aromas Formation results in higher protective and target groundwater levels.

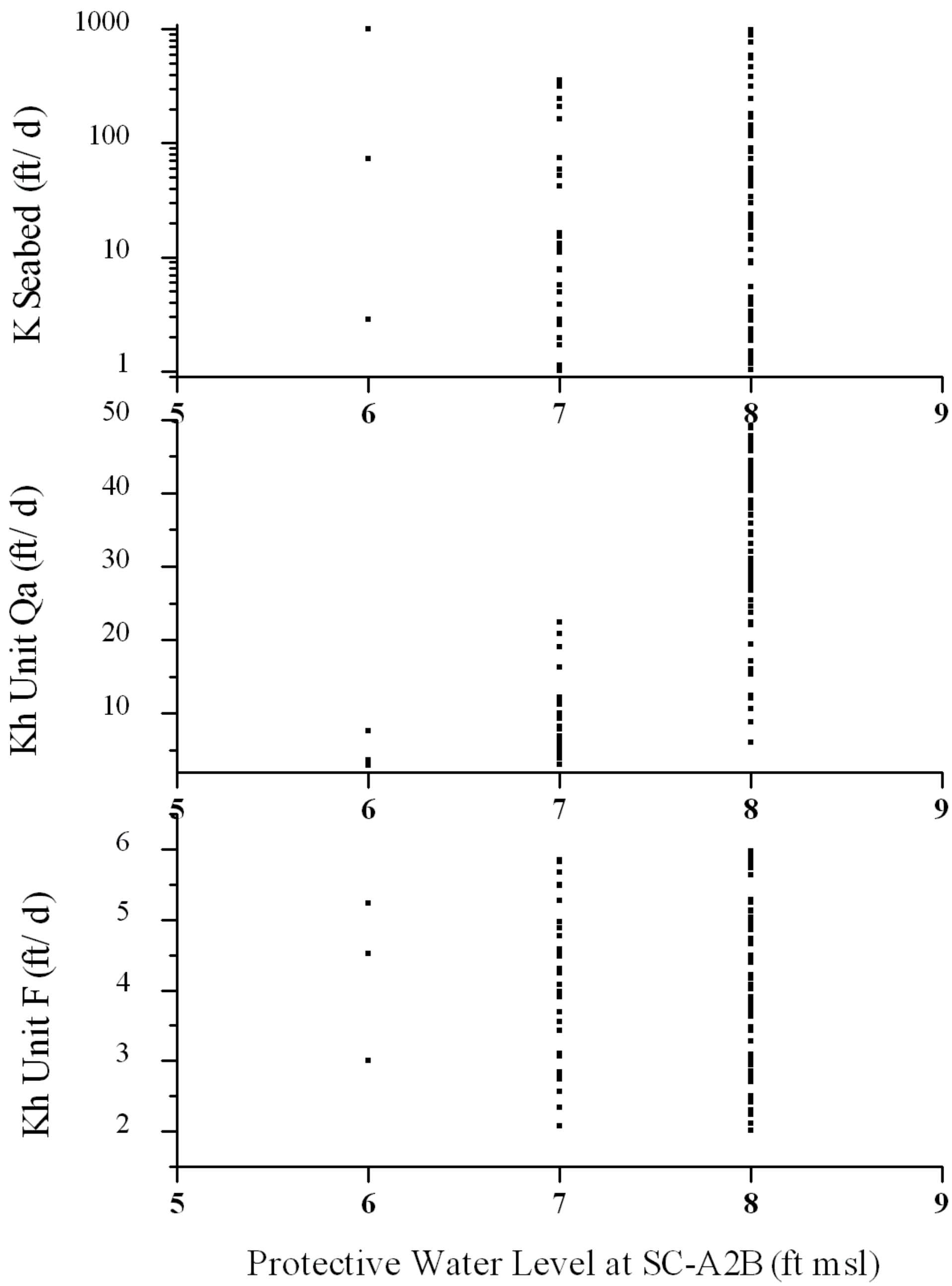


Figure A- 27: Distribution of Protective Water Levels at Well SC-A2B Plotted Against Parameter Values

WELL SC-A3B MODEL RESULTS

The protective groundwater level at Well SC-A3B is the minimum water level that maintains fresh water in the model layer above the screen of Well SC-A3A at the coastline. This protected model layer is in the Aromas aquifer. The protective groundwater level for this well ranges between 1 and 4 feet msl based on modeling the 100 parameter sets. Figure A- 28 shows the cumulative distribution of the protective groundwater levels. A groundwater level of 4 feet msl is protective for over 70% of the parameter sets.

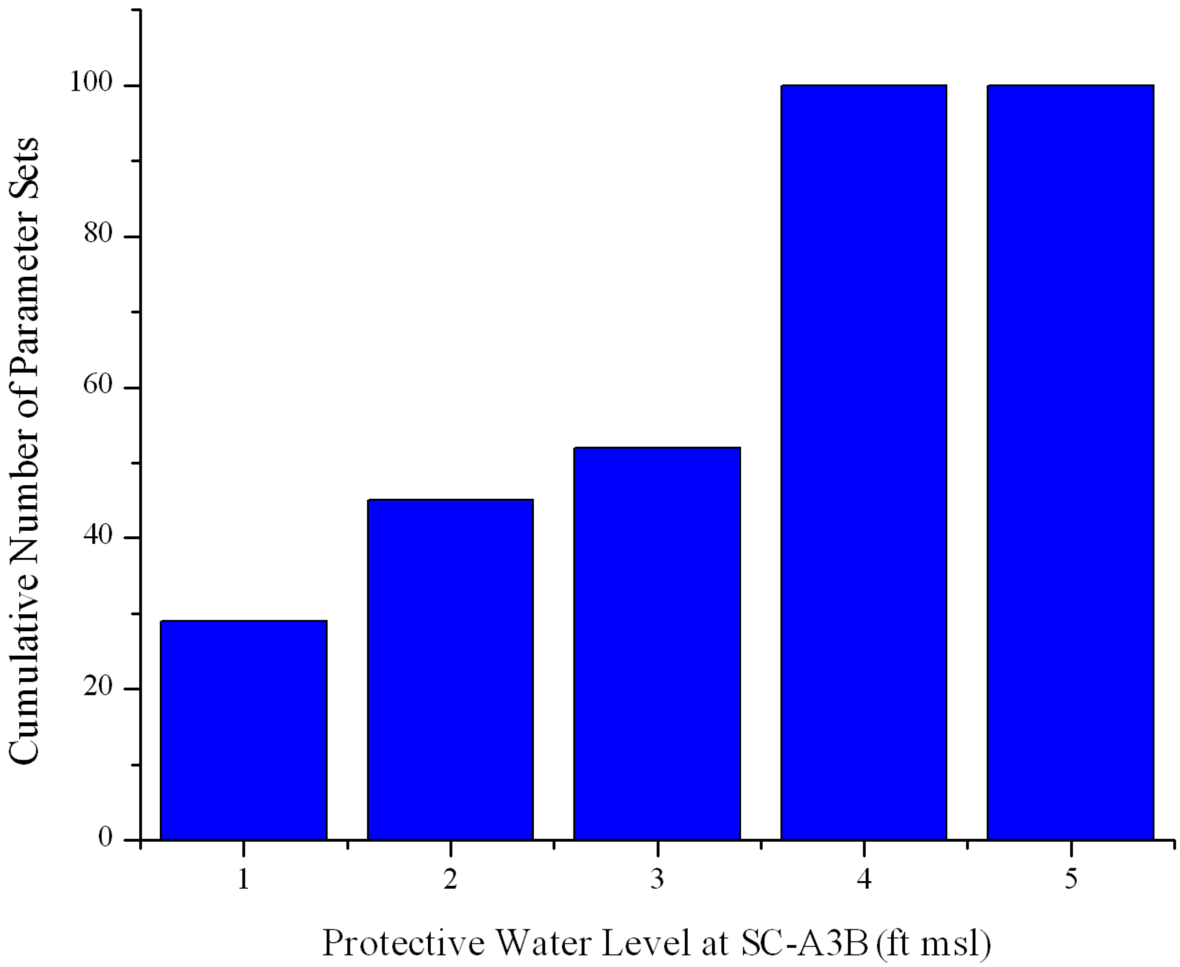


Figure A- 28: Cumulative Distribution of Protective Water Levels at Well SC-A3B Resulting from 100 Random Parameter Sets

The target groundwater level at Well SC-A3B is the minimum water level that stores at least 36 acre-feet of freshwater in the F aquifer. The target groundwater level for this well ranges between 2 and 5 feet msl. Figure A- 29 shows the cumulative distribution of the target groundwater levels. A groundwater level of 5 feet msl stores the target freshwater volume in over 70% of the parameter sets.

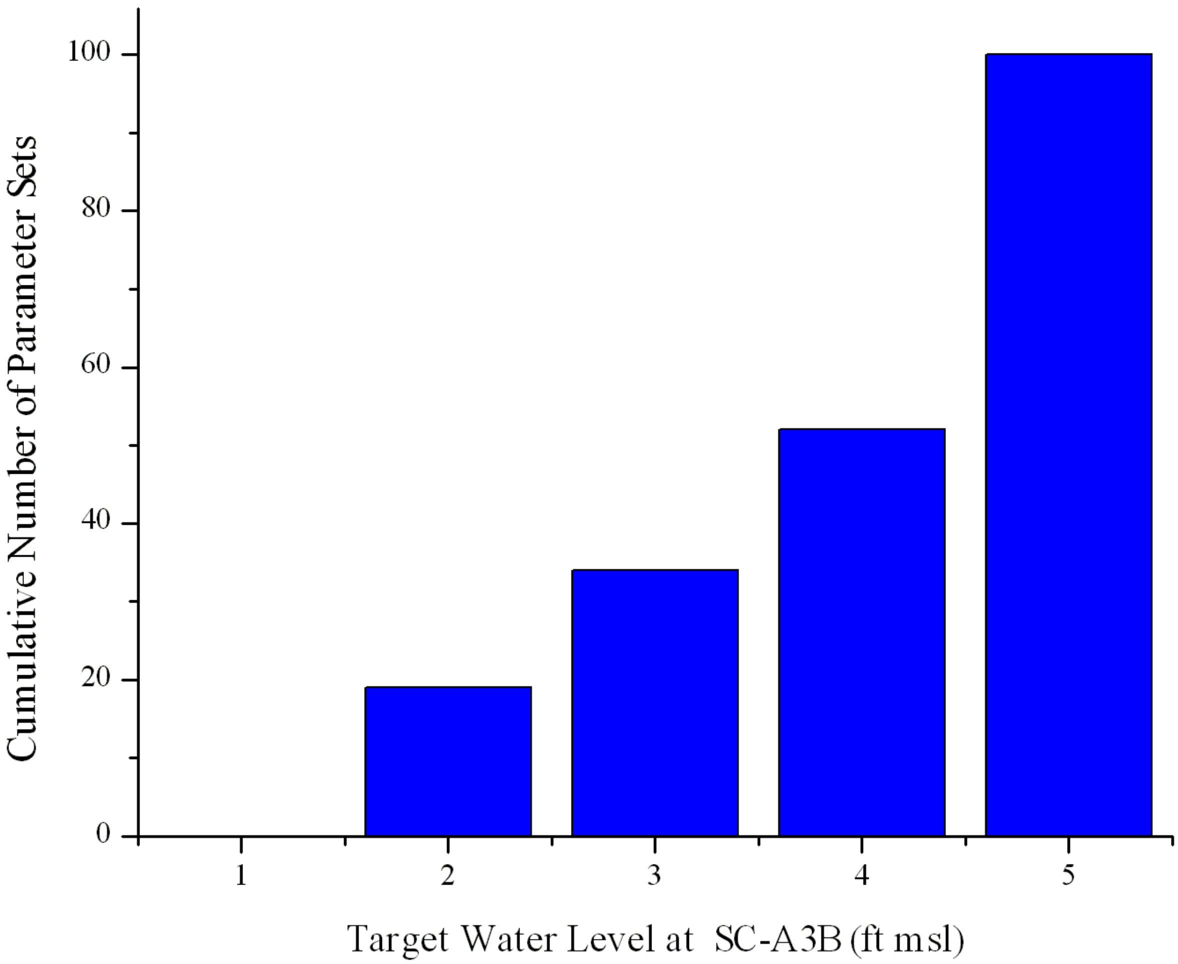


Figure A- 29: Cumulative Distribution of Target Water Levels at Well SC-A3B Resulting from 100 Random Parameter Sets

This Aromas area well is different from other wells in that the protected layer is in the shallowest aquifer unit. The parameter that has the largest effect on the protective and target groundwater level is the conductivity of the protected Aromas aquifer. Figure A-30 shows the protective groundwater levels at Well SC-A3 plotted against the varied parameter values. A larger hydraulic conductivity in the Aromas Formation results in higher protective and target groundwater levels.

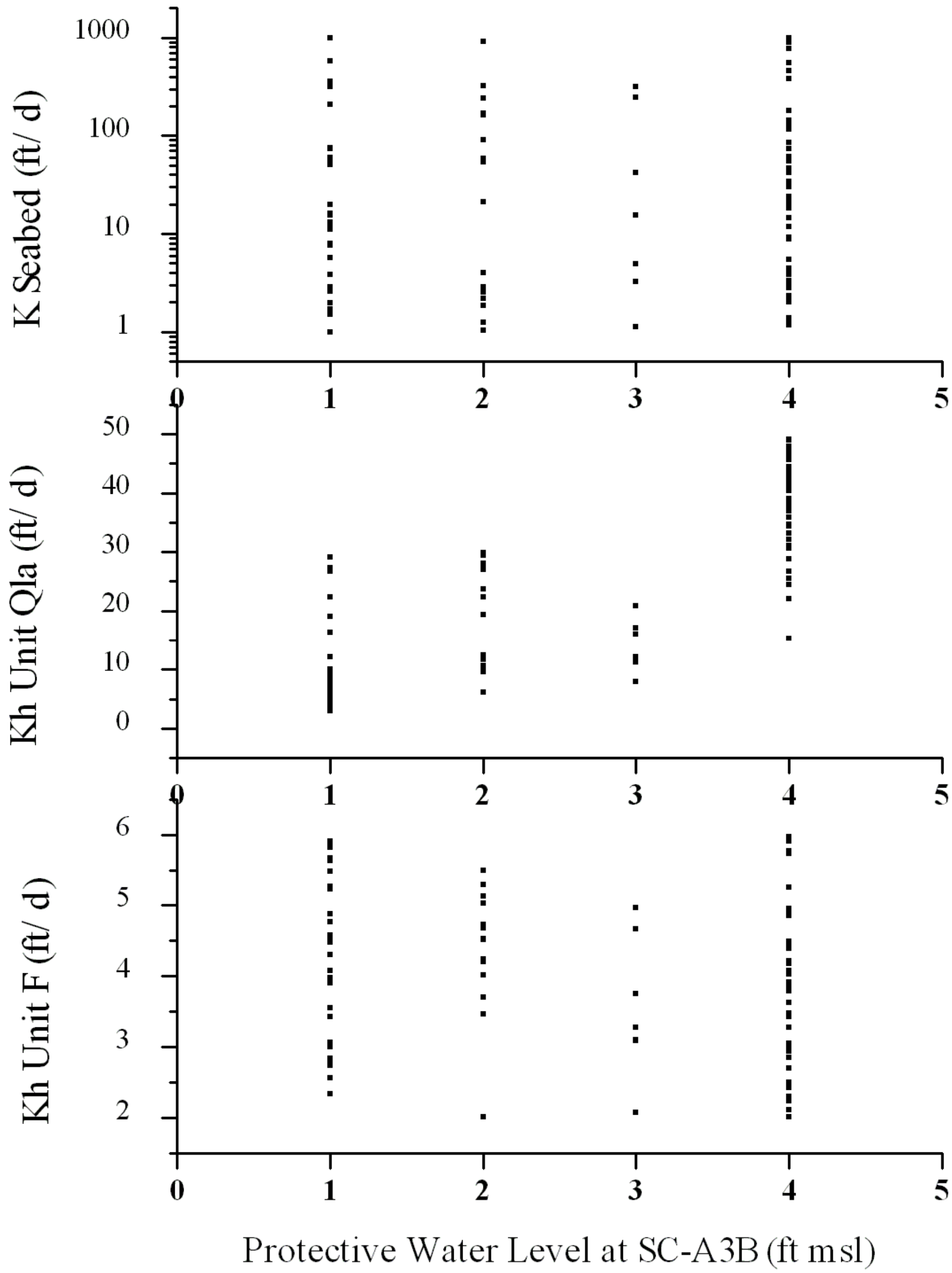


Figure A- 30: Distribution of Protective Water Levels at Well SC-A3B Plotted Against Parameter Values

WELL SC-A4B MODEL RESULTS

The protective groundwater level at Well SC-A4B is the minimum water level that maintains fresh water in the model layer above the screen of Well SC-A4A at the coastline. The protective groundwater level for this well ranges between 9 and 11 feet msl based on modeling the 100 parameter sets. Figure A- 31 shows the cumulative distribution of the protective groundwater levels. A groundwater level of 11 feet msl is protective for over 70% of the parameter sets.

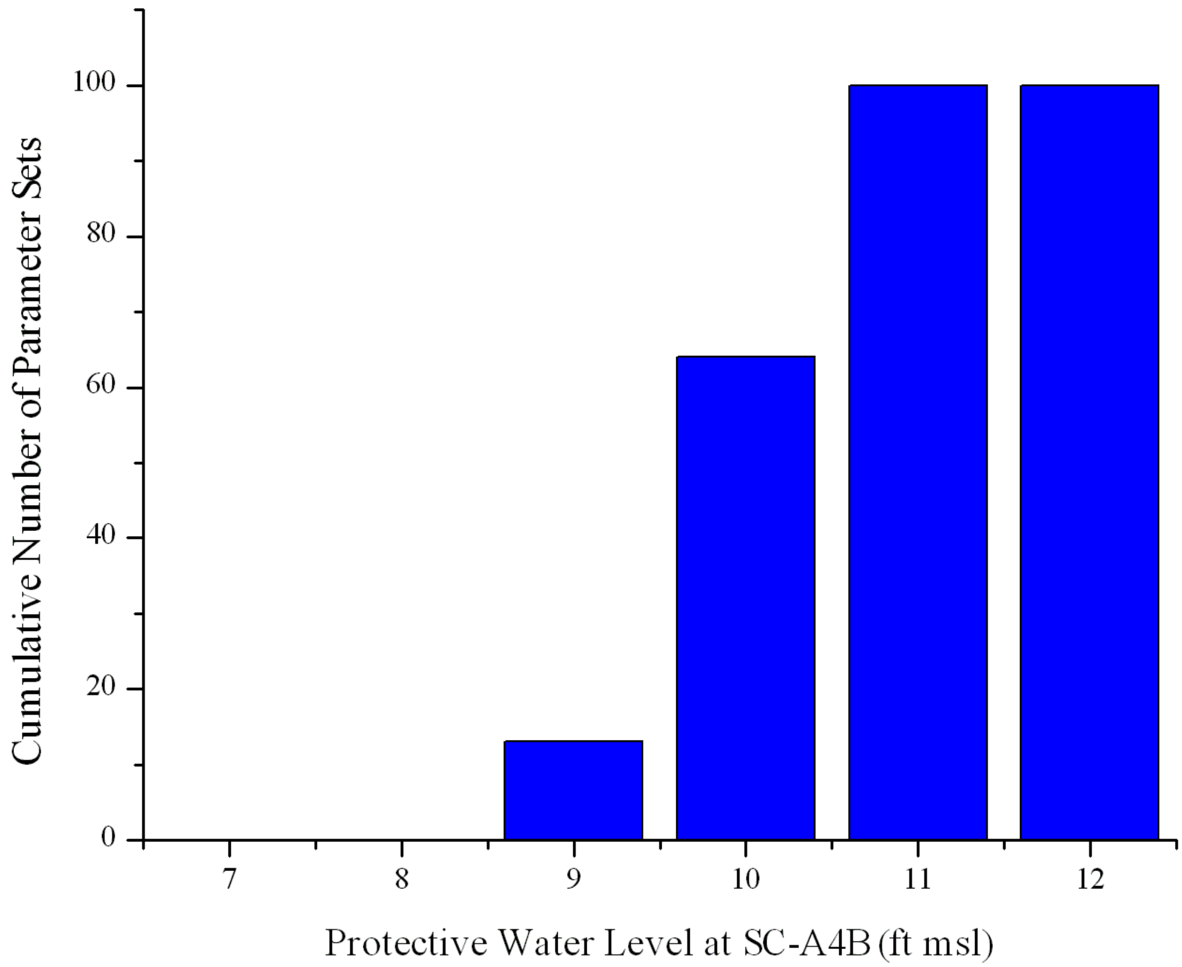


Figure A- 31: Cumulative Distribution of Protective Water Levels at Well SC-A4B Resulting from 100 Random Parameter Sets

There is no target groundwater level or target storage volume calculated at Well SC-A4B because there are no SqCWD production wells in the Canon Del Sol area.

The parameter that has the largest effect on the protective groundwater level is the conductivity of the overlying Aromas aquifer. Figure A- 32 shows the protective groundwater levels at Well SC-A4B plotted against the varied parameter values. A larger hydraulic conductivity in the overlying Aromas Aquifer results in higher protective and target groundwater levels.

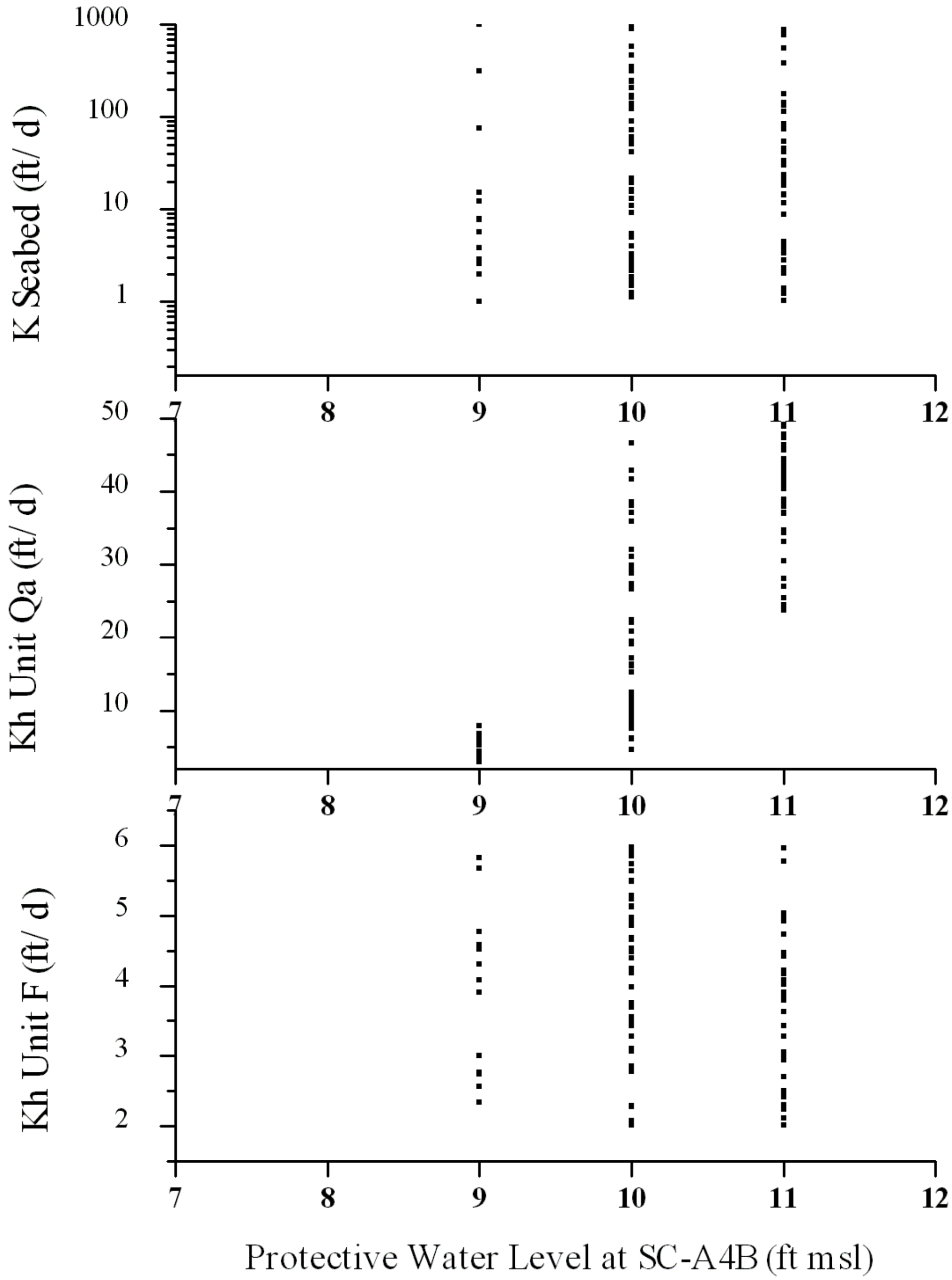


Figure A- 32: Distribution of Protective Water Levels at Well SC-A4B Plotted Against Parameter Values

WELL SC-A8B MODEL RESULTS

The protective groundwater level at Well SC-A8B is the minimum water level that maintains fresh water in the model layer above the screen of Well SC-A8A at the coastline. The protective groundwater level for this well ranges between 9 and 12 feet msl based on modeling the 100 parameter sets. Figure A- 33 shows the cumulative distribution of the protective groundwater levels. A groundwater level of 11 feet msl is protective for over 70% of the parameter sets.

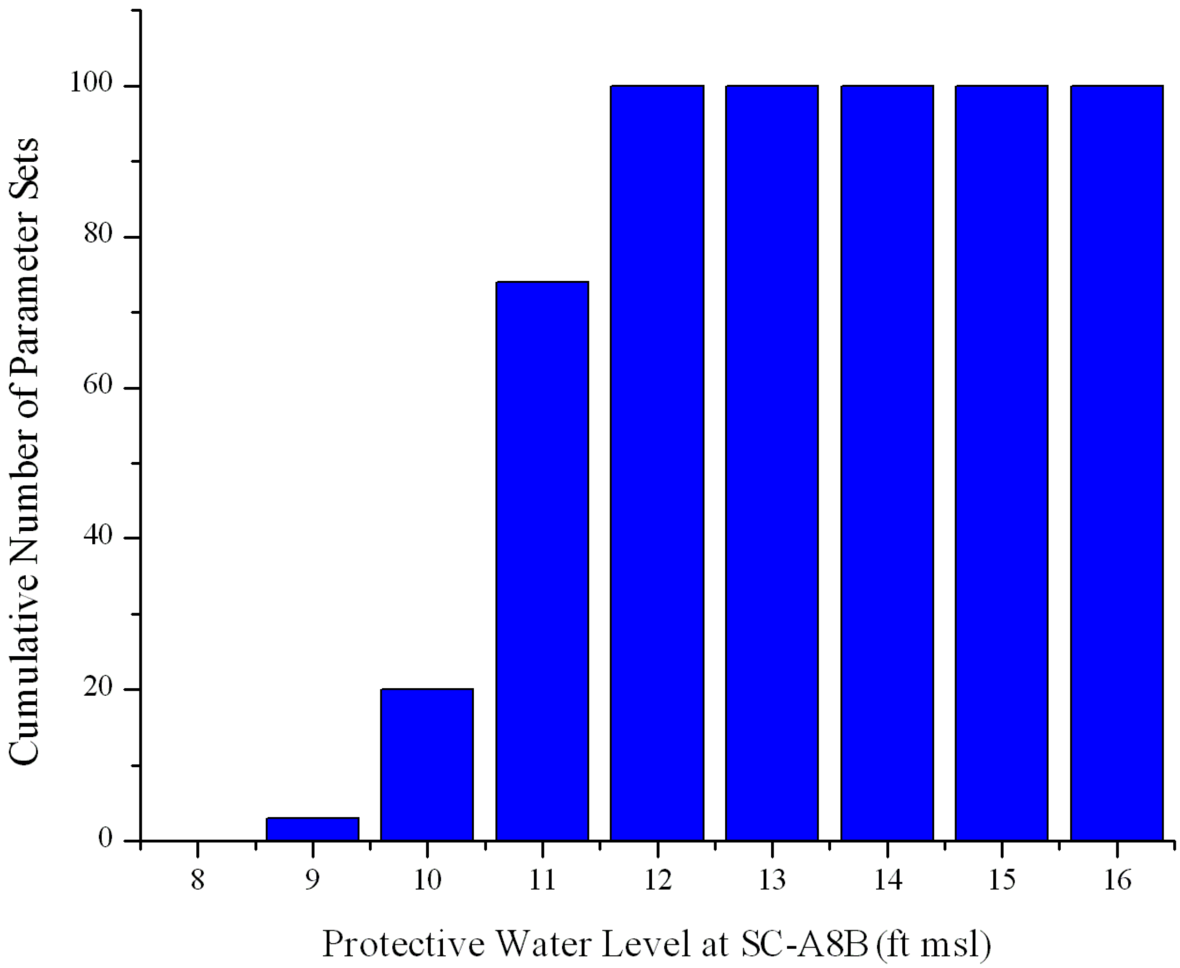


Figure A- 33: Cumulative Distribution of Protective Water Levels at Well SC-A8B Resulting from 100 Random Parameter Sets

The target groundwater level at Well SC-A8B is the minimum water level that stores at least 119 acre-feet of freshwater in the F aquifer. The target groundwater level for this well ranges between 12 and 16 feet msl. Figure A- 34 shows the cumulative distribution of the target groundwater levels. A groundwater level of 15 feet msl stores the target freshwater volume in 70% of the parameter sets.

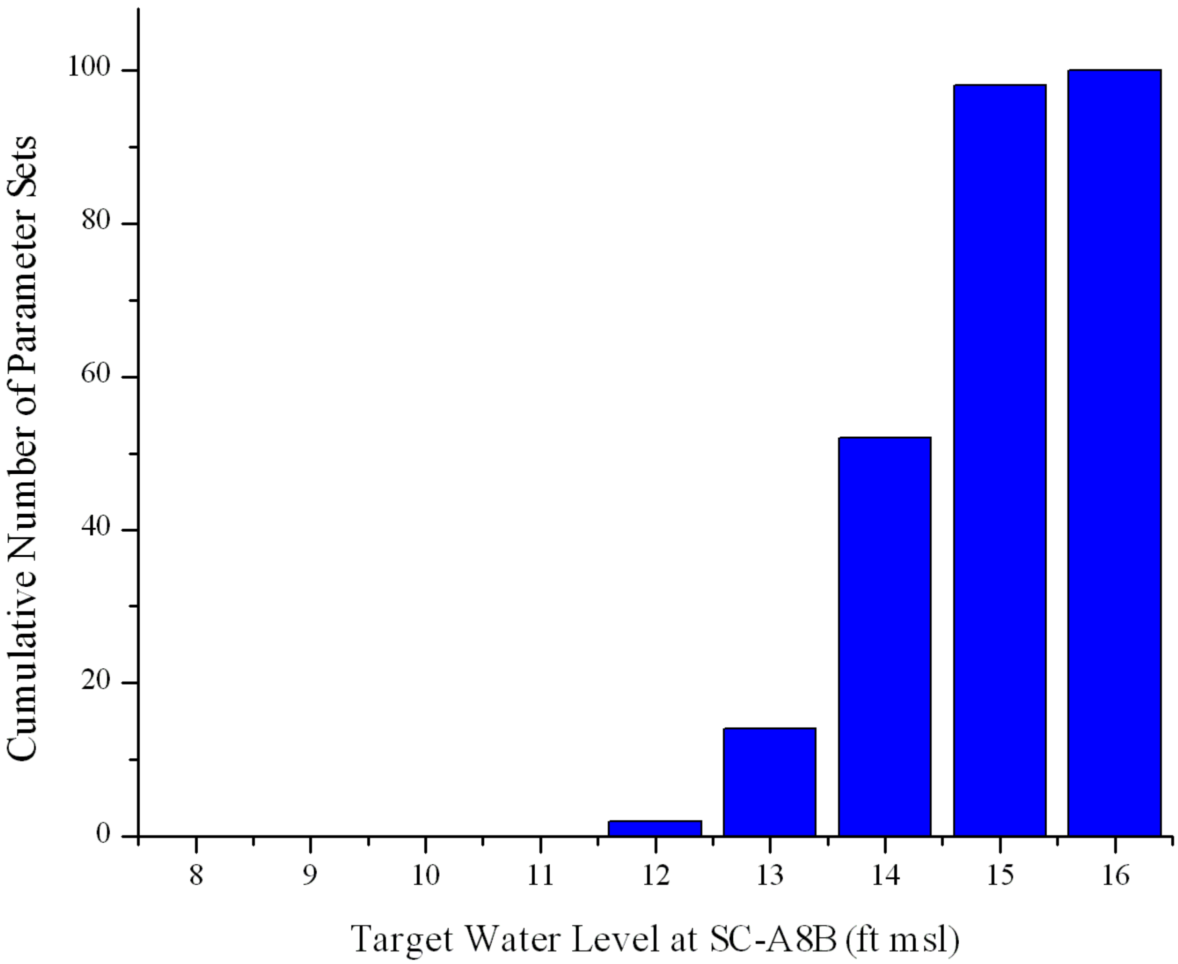


Figure A- 34: Cumulative Distribution of Target Water Levels at Well SC-A8B Resulting from 100 Random Parameter Sets

The parameter that has the largest effect on the protective and target groundwater levels is the conductivity of the underlying DEF aquifer. Figure A- 35 shows the protective groundwater levels at Well SC-A8B plotted against the varied parameter values. A larger hydraulic conductivity in the underlying DEF aquifer results in lower protective and target groundwater levels.

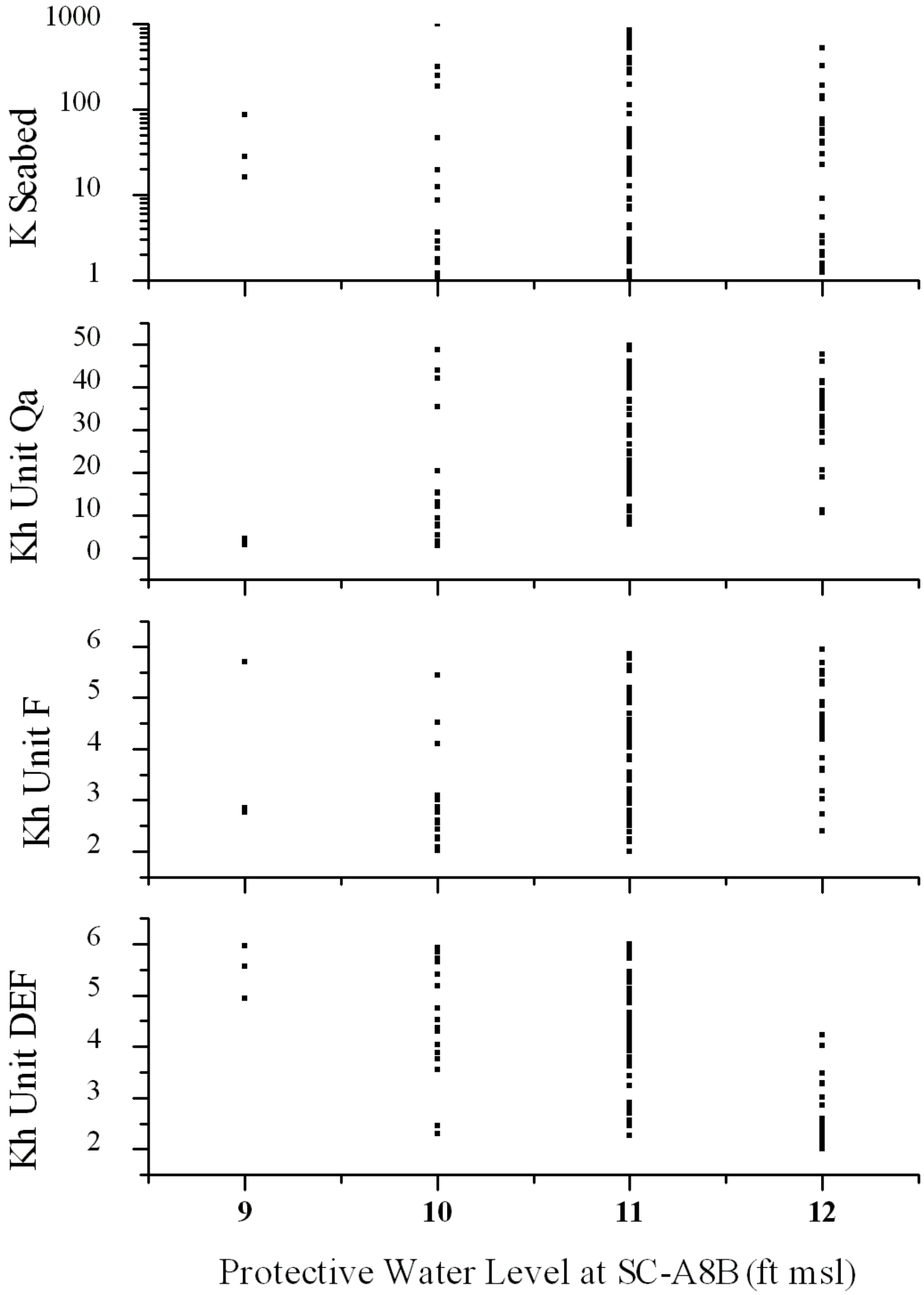


Figure A- 35: Distribution of Protective Water Levels at Well SC-A8B Plotted Against Parameter Values