Estimated Model Boundary Flows

By J.R. Harrill and M.S. Bedinger

Appendix 2 of

Death Valley Regional Ground-Water Flow System, Nevada and California—Hydrogeologic Framework and Transient Ground-Water Flow Model

Edited by Wayne R. Belcher

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APPENDIX 2. Estimated Model Boundary Flows

By J.R. Harrill and M.S. Bedinger

Introduction

Areas that contribute ground-water inflow to or receive outflow from the Death Valley regional ground-water flow system (DVRFS) model domain across the lateral boundary are called contributing areas and are defined by the gradient in the regional potential developed in Appendix 1. Estimates of the amount of lateral flow across the DVRFS model boundary from (or to) these contributing areas which will be used as components of the water budget for the calibration of the DVRFS model are presented here. The model boundary was divided into 12 segments, primarily on the basis of the hydrologic units in the contributing areas (figs. A2–1 and A2–2). Each segment of the model boundary was divided into subsegments to represent straight-line approximations of the boundary (fig. A2–3).

Approach

Two methods were used to estimate flow across segments of the lateral boundary of the DVRFS model: (1) calculations using Darcy's law, based on regional potential gradient, cross-sectional areas of each subsegment at the boundary, and hydraulic conductivities of hydrogeologic units at each subsegment cross section; and (2) calculations from water budgets of contributing areas.

Darcy's Law Estimates

Darcy's law was used to estimate boundary flow for each subsegment of the model boundary. Darcy's law (Freeze and Cherry, 1979, p. 28) states

$$Q = KiA,$$

where

Q is the flow (L^3/T),
K is the hydraulic conductivity (L/T),
i is the hydraulic gradient (L/L),

and

A is the cross-sectional area (L^2).

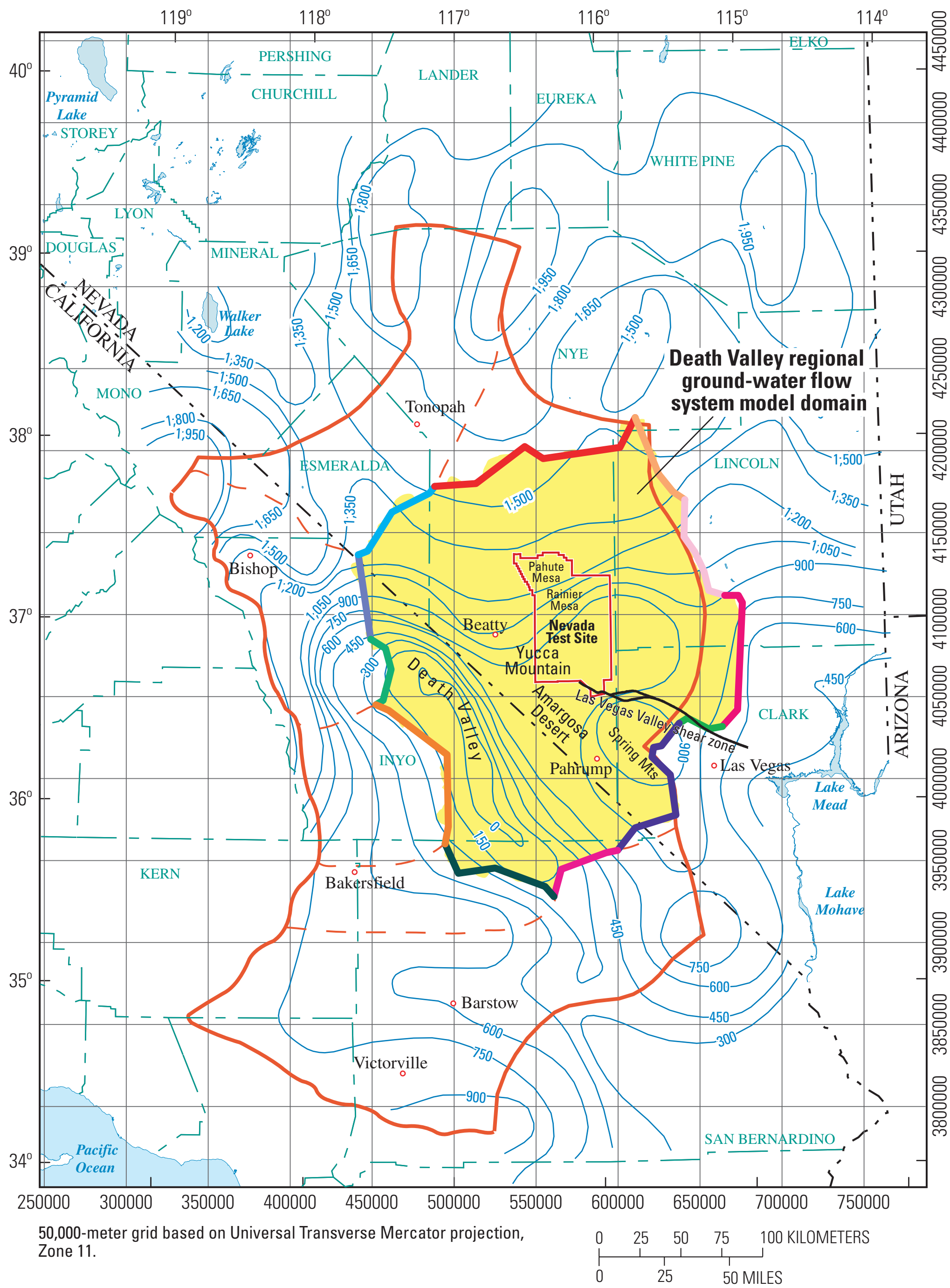
The cross-sectional flow areas were measured from cross sections prepared from the hydrogeologic framework model (HFM) (Chapter E, this volume) for each segment of the model boundary. The cross sections extend from land surface to 4,000 m below sea level, the base of the model; they are presented from the viewpoint of the model interior looking outward. The flow area of each cross section was estimated to be the area below the intersection of the regional potentiometric surface. Although ground-water flow occurs below accretion cells (mostly recharge mounds) that are present along much of the model boundary, this is considered to be a local phenomenon not associated with regional ground-water flow. The area of each hydrogeologic unit (HGU) below the regional potential was measured from each cross section.

The hydraulic gradient across each subsegment was estimated from the regional potentiometric map (fig. A2–1 and pl. 1) by calculating the hydraulic-head change over a distance measured between regional potentiometric contours. Flow lines were drawn through the ends of each subsegment to determine the flow width. If the direction of flow is not perpendicular to the subsegment, the cross-sectional area of the flow will be less than the cross-sectional area of the subsegment. The correction is calculated as the actual flow width divided by the width of the subsegment.

Hydraulic-conductivity values for each of the HGUs are based on data from Belcher and others (2001, 2002). Hydraulic conductivity values were adjusted in some areas by using professional judgment. Depth decay of hydraulic conductivity was not considered in these estimates.

Water Budget Estimates

Water budgets of hydrologic units in each contributing area (fig. A2–2, table A2–1) were used to estimate a water budget for each segment of the model boundary to calculate boundary flow (fig. A2–3). Water budgets were estimated for some of the contributing areas in California. For areas where boundaries of the contributing areas do not match exactly the hydrologic-unit boundaries for which water-budget information is available, the water-budget information is used only to indicate whether water is available to support the Darcy calculation of flow across the model boundary. For areas where water budgets are not available, the evapotranspiration (ET) areas were evaluated (based on professional judgment) to assess whether ET could account for the available recharge.



EXPLANATION

Area contributing flow to the Death Valley regional ground-water flow system, dashed line shows areas contributing flow to specific boundary segments (Bedinger and Harrill, Appendix 1, this volume)

Straight line segment that approximates model boundary. Segments are color coded—See figure A2–3 for segment names.

750 **Potentiometric-surface contour—**Shows altitude of regional potential. Interval is 150 meters. Datum is sea level. (Bedinger and Harrill, Appendix 1, this volume)

Populated location

Figure A2–1. Death Valley regional ground-water flow system regional model domain, regional potential, and contributing areas.

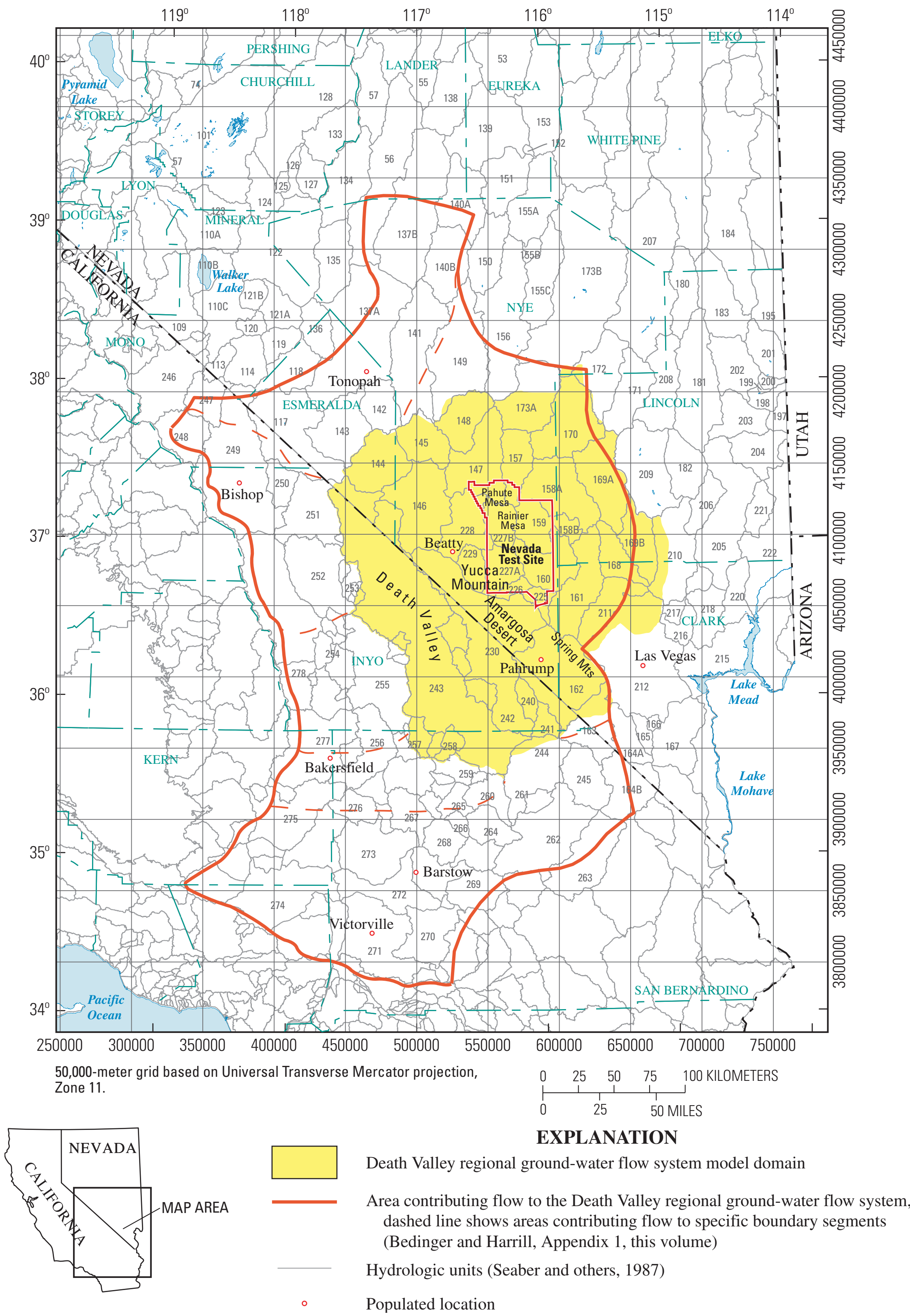


Figure A2–2. Death Valley regional ground-water flow system regional model domain, hydrologic units, and contributing areas.

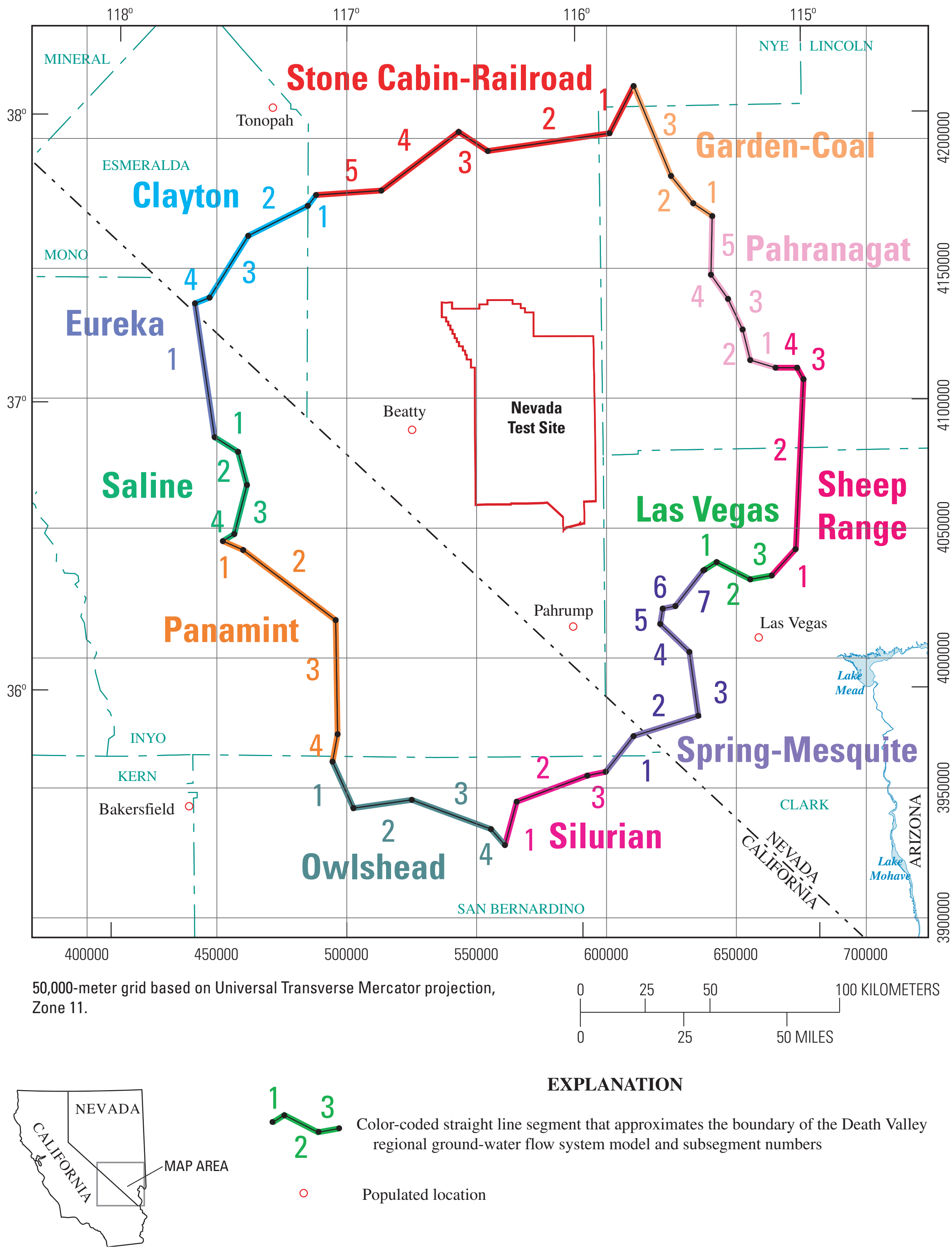


Figure A2–3. Death Valley regional ground-water flow system model boundary segments and subsegments.

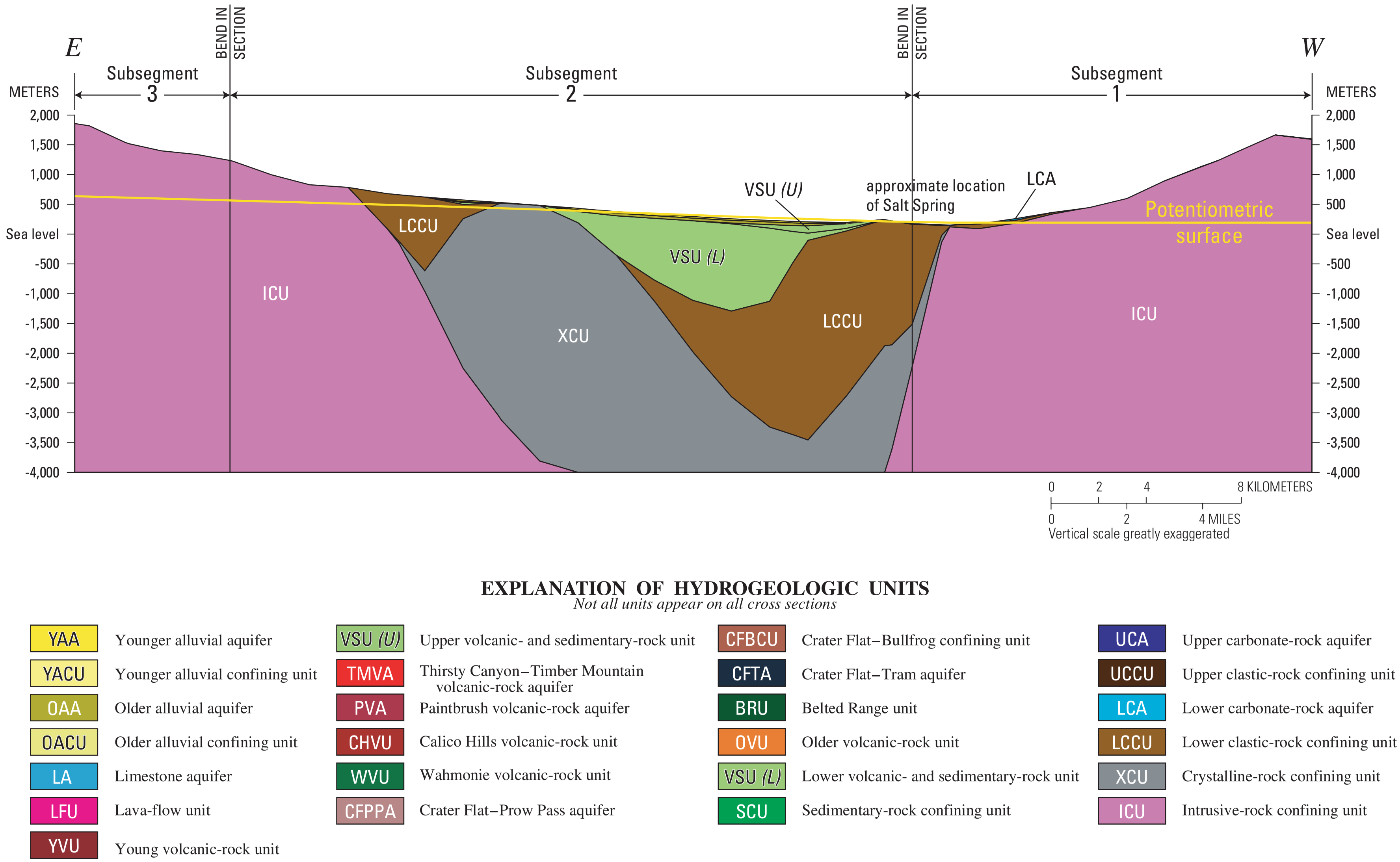


Figure A2–4. Hydrogeologic units of the Death Valley regional ground-water flow system model for the Silurian boundary segment.

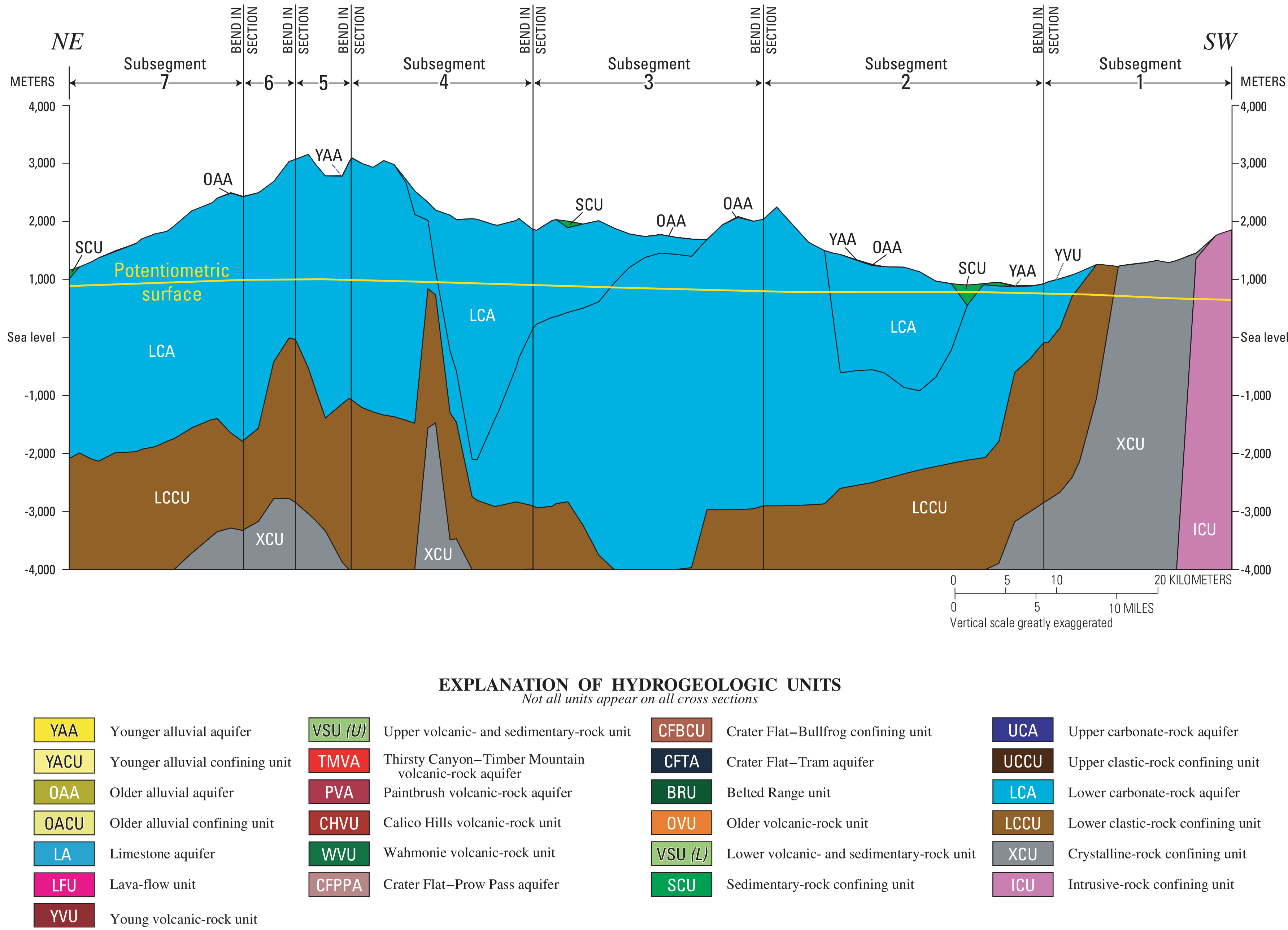


Figure A2–5. Hydrogeologic units of the Death Valley regional ground-water flow system model for the Spring–Mesquite boundary segment.

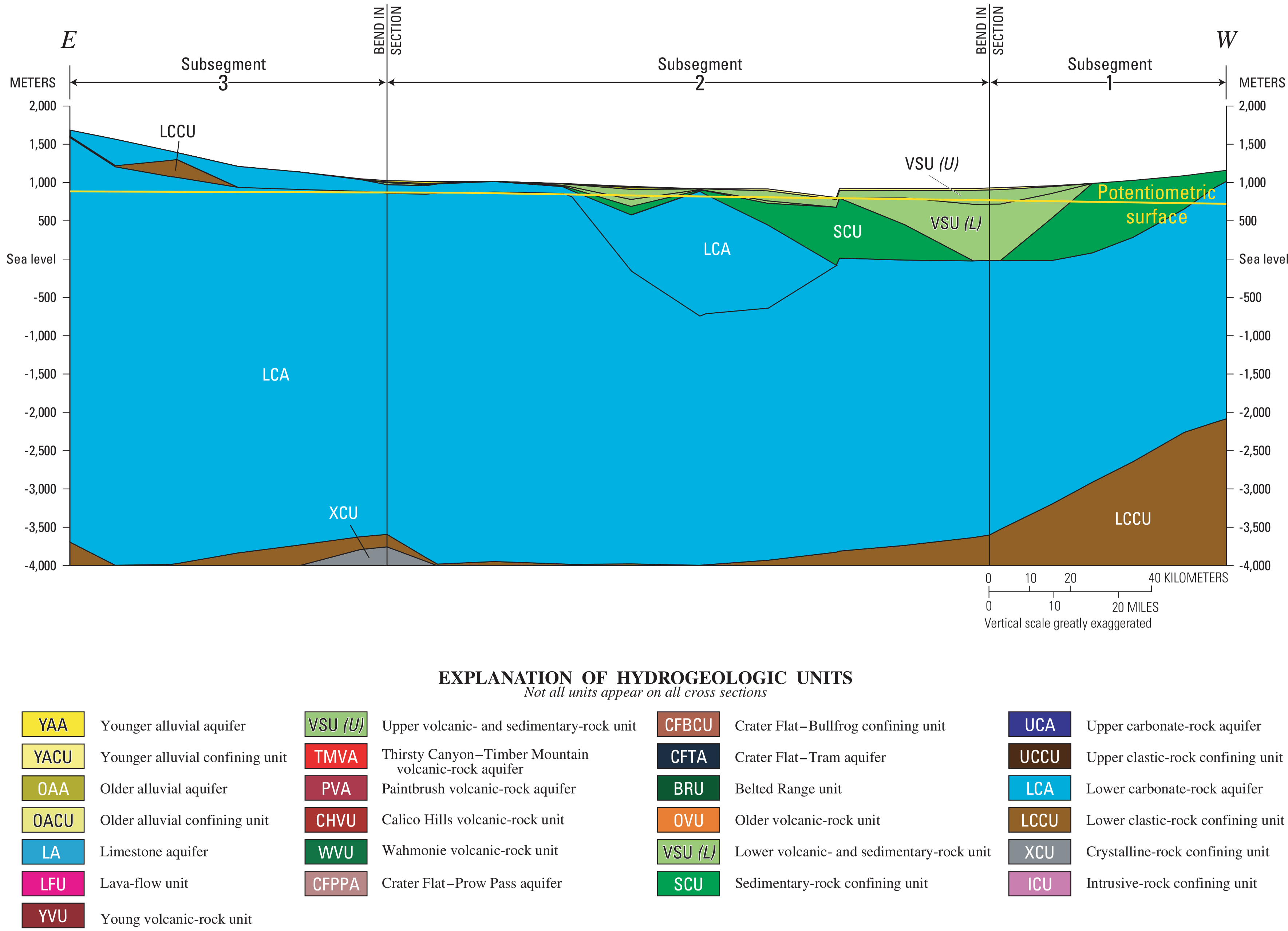


Figure A2–6. Hydrogeologic units of the Death Valley regional ground-water flow system model for the Las Vegas boundary segment.

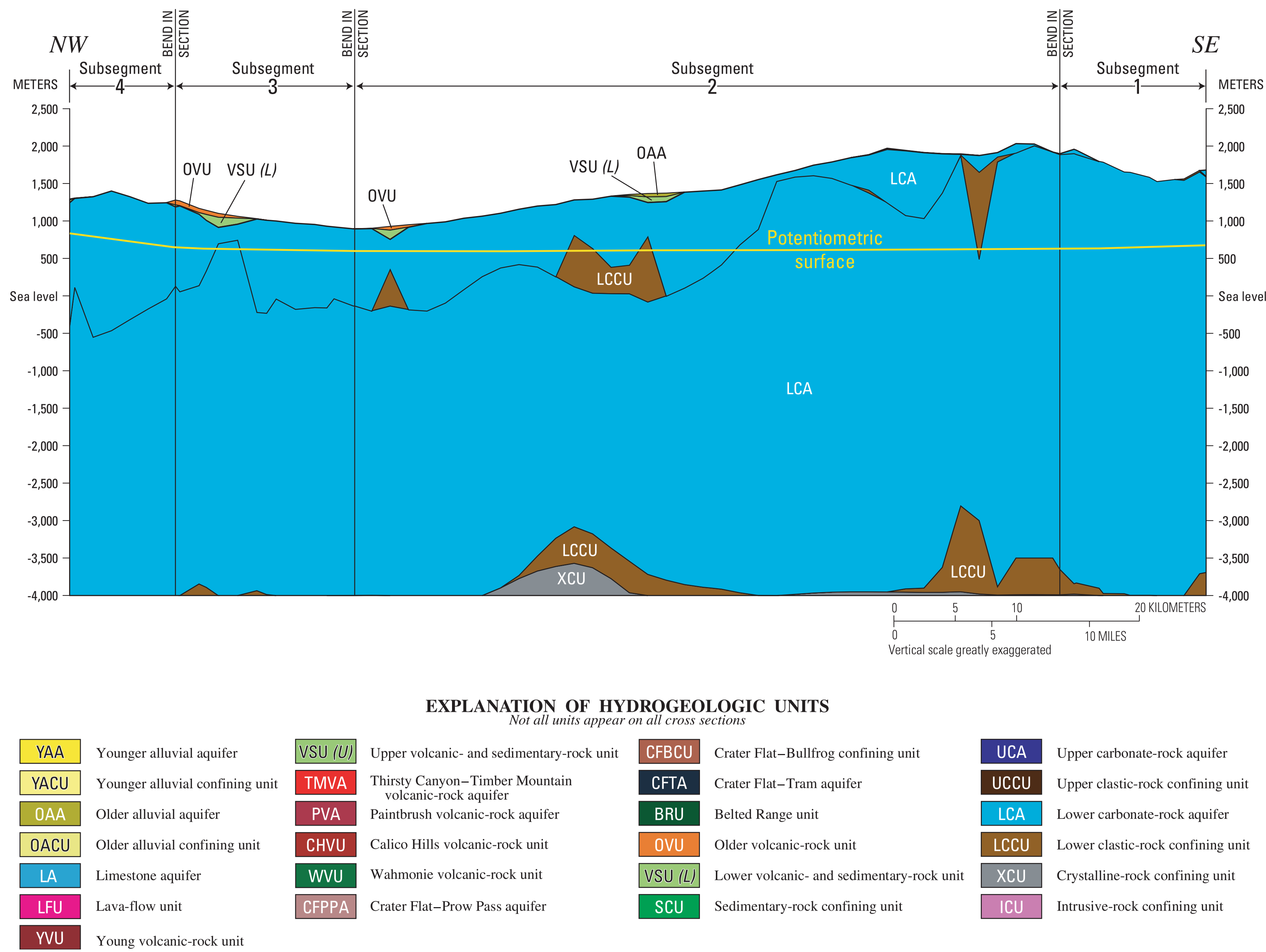
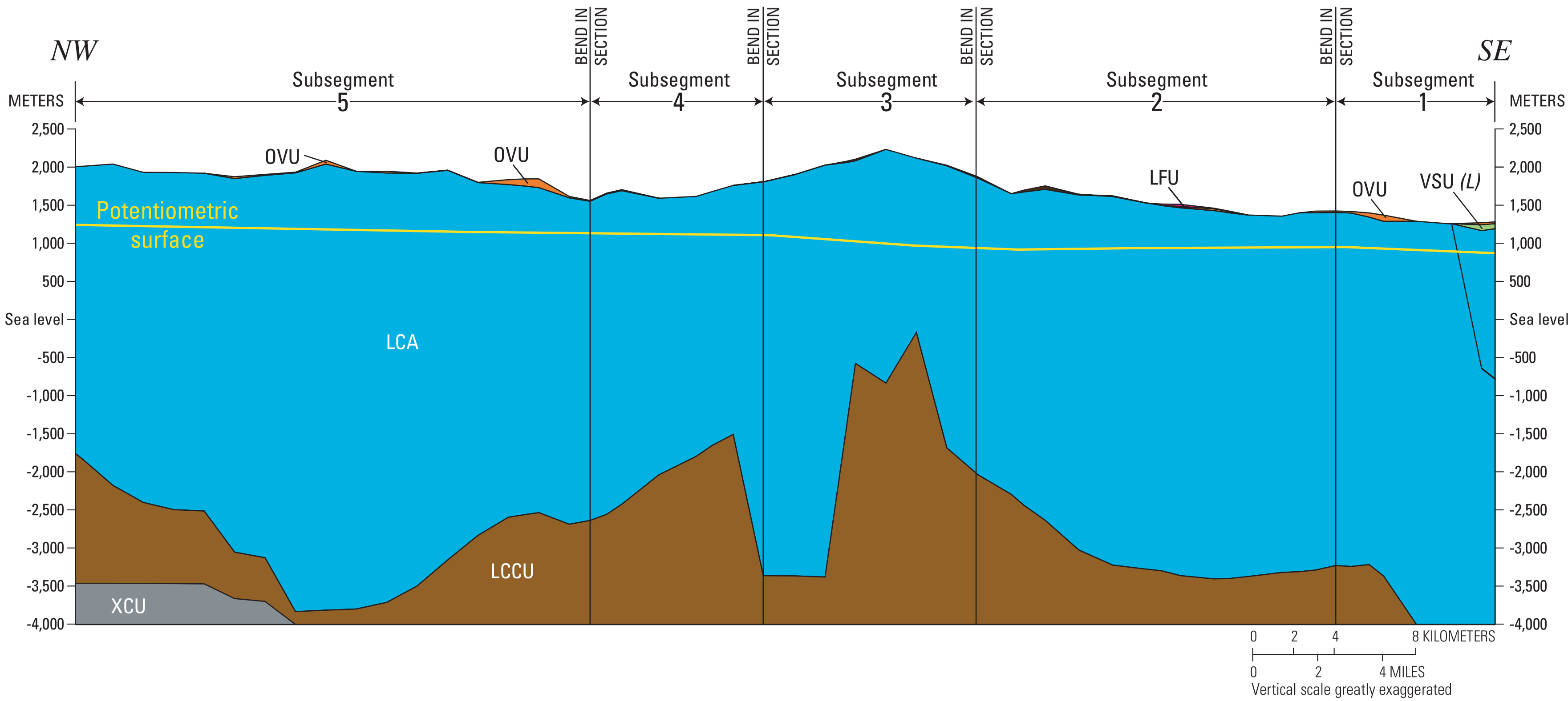


Figure A2–7. Hydrogeologic units of the Death Valley regional ground-water flow system model for the Sheep Range boundary segment.



EXPLANATION OF HYDROGEOLOGIC UNITS

Not all units appear on all cross sections

YAA	Younger alluvial aquifer
YACU	Younger alluvial confining unit
OAA	Older alluvial aquifer
OACU	Older alluvial confining unit
LA	Limestone aquifer
LFU	Lava-flow unit
YVU	Young volcanic-rock unit
VSU (U)	Upper volcanic- and sedimentary-rock unit
TMVA	Thirsty Canyon–Timber Mountain volcanic-rock aquifer
PVA	Paintbrush volcanic-rock aquifer
CHVU	Calico Hills volcanic-rock unit
WVU	Wahmonie volcanic-rock unit
CFPPA	Crater Flat–Prow Pass aquifer
CFBCU	Crater Flat–Bullfrog confining unit
CFTA	Crater Flat–Tram aquifer
BRU	Belted Range unit
OVU	Older volcanic-rock unit
VSU (L)	Lower volcanic- and sedimentary-rock unit
SCU	Sedimentary-rock confining unit
UCA	Upper carbonate-rock aquifer
UCCU	Upper clastic-rock confining unit
LCA	Lower carbonate-rock aquifer
LCCU	Lower clastic-rock confining unit
XCU	Crystalline-rock confining unit
ICU	Intrusive-rock confining unit

Figure A2–8. Hydrogeologic units of the Death Valley regional ground-water flow system model for the Pahranagat boundary segment.

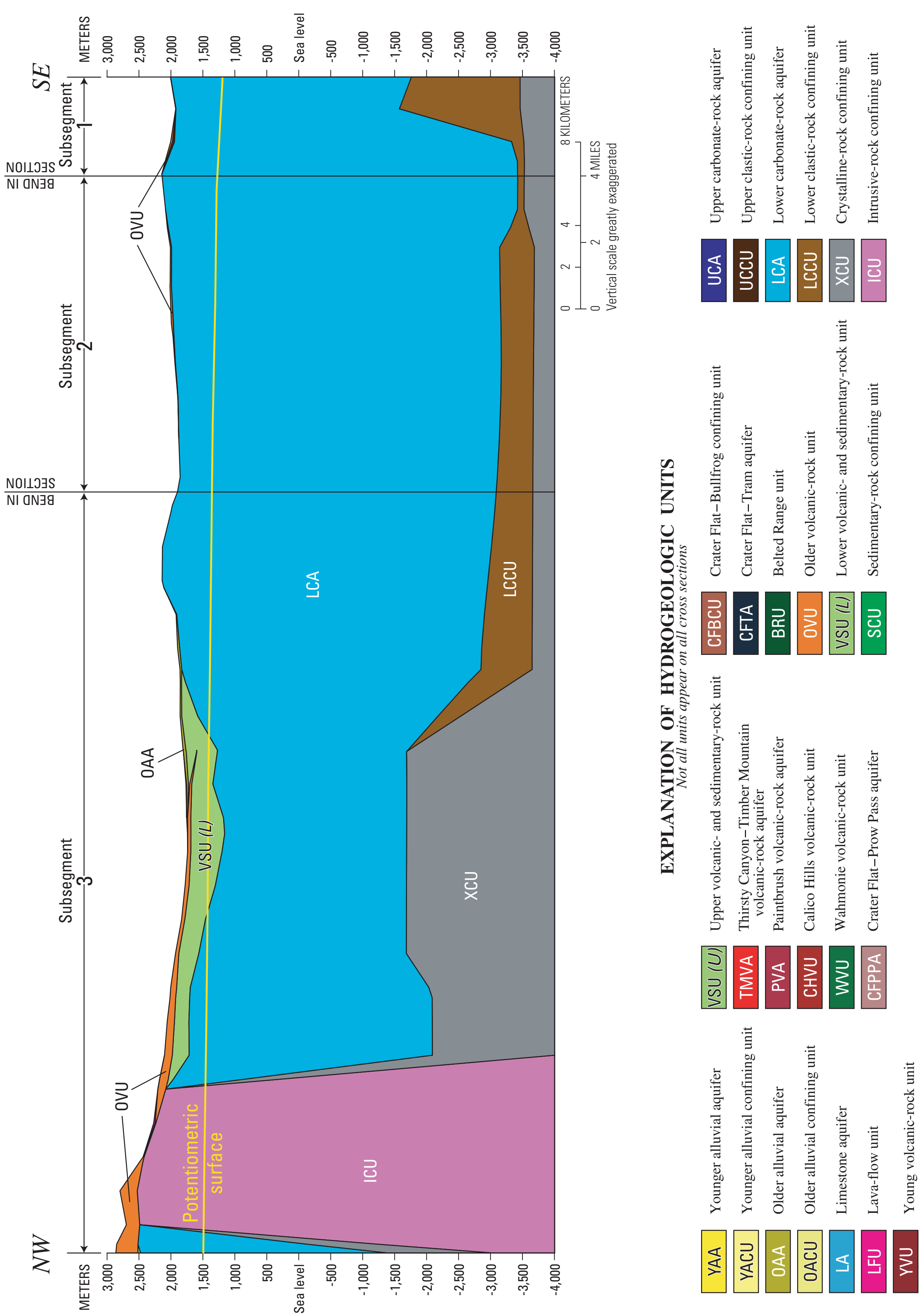
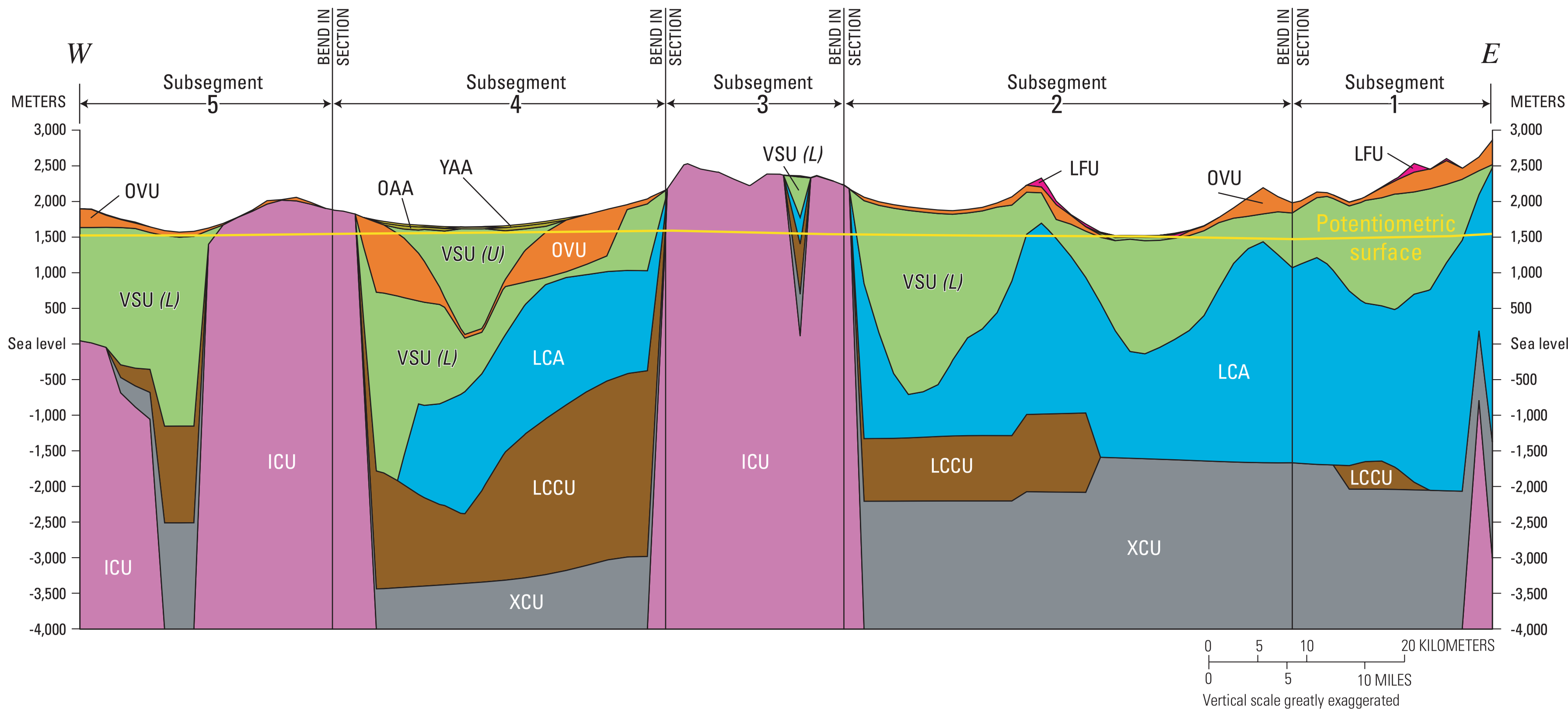


Figure A2–9. Hydrogeologic units of the Death Valley regional ground-water flow system model for the Garden–Coal boundary segment.



EXPLANATION OF HYDROGEOLOGIC UNITS

Not all units appear on all cross sections

YAA	Younger alluvial aquifer
YACU	Younger alluvial confining unit
OAA	Older alluvial aquifer
OACU	Older alluvial confining unit
LA	Limestone aquifer
LFU	Lava-flow unit
YVU	Young volcanic-rock unit
VSU (U)	Upper volcanic- and sedimentary-rock unit
TMVA	Thirsty Canyon–Timber Mountain volcanic-rock aquifer
PVA	Paintbrush volcanic-rock aquifer
CHVU	Calico Hills volcanic-rock unit
WVU	Wahmonie volcanic-rock unit
CFPPA	Crater Flat–Prow Pass aquifer
CFBCU	Crater Flat–Bullfrog confining unit
CFTA	Crater Flat–Tram aquifer
BRU	Belted Range unit
OVU	Older volcanic-rock unit
VSU (L)	Lower volcanic- and sedimentary-rock unit
SCU	Sedimentary-rock confining unit
UCA	Upper carbonate-rock aquifer
UCCU	Upper clastic-rock confining unit
LCA	Lower carbonate-rock aquifer
LCCU	Lower clastic-rock confining unit
XCU	Crystalline-rock confining unit
ICU	Intrusive-rock confining unit

Figure A2–10. Hydrogeologic units of the Death Valley regional ground-water flow system model for the Stone Cabin-Railroad boundary segment.

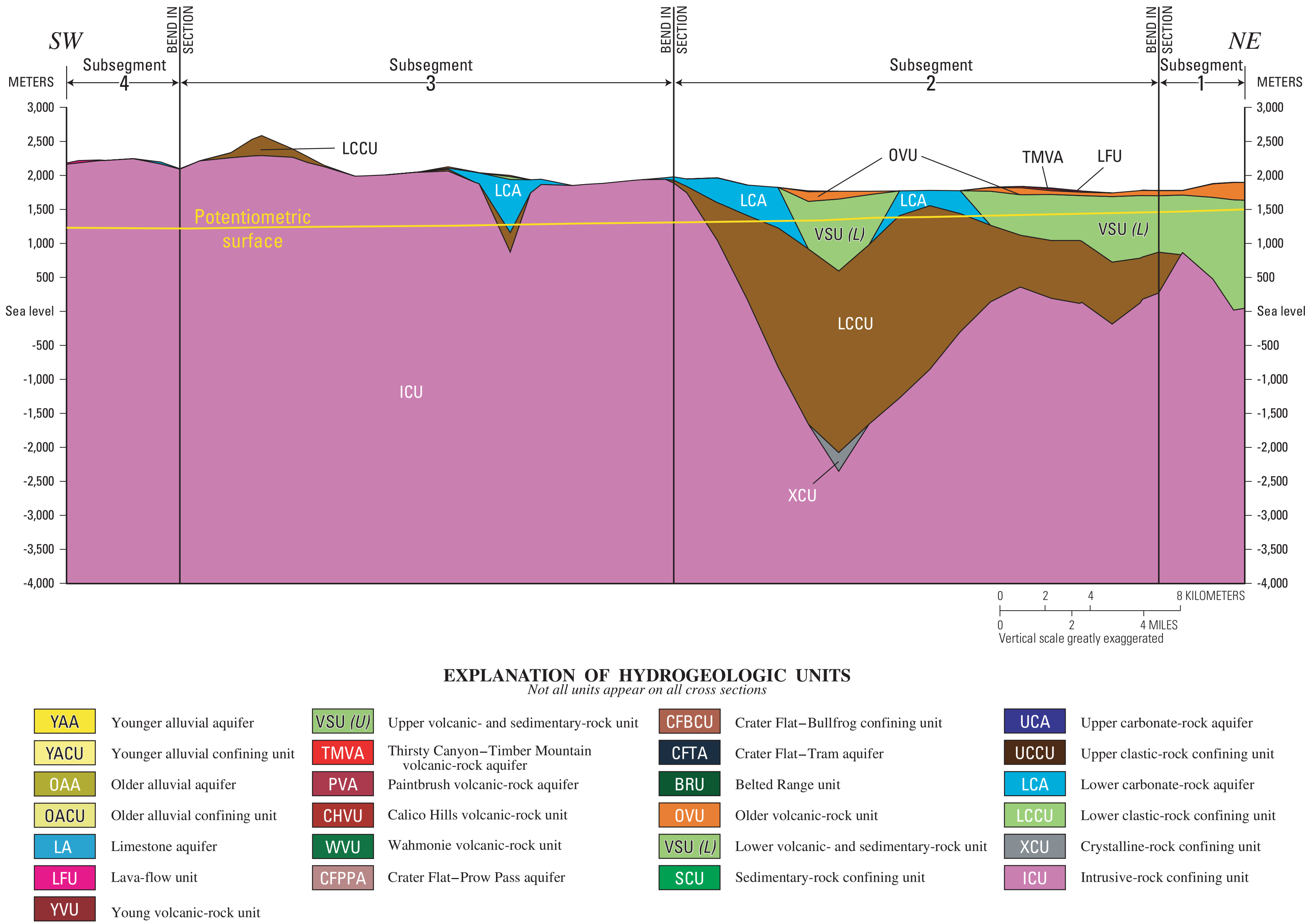


Figure A2–11. Hydrogeologic units of the Death Valley regional ground-water flow system model for the Clayton boundary segment.

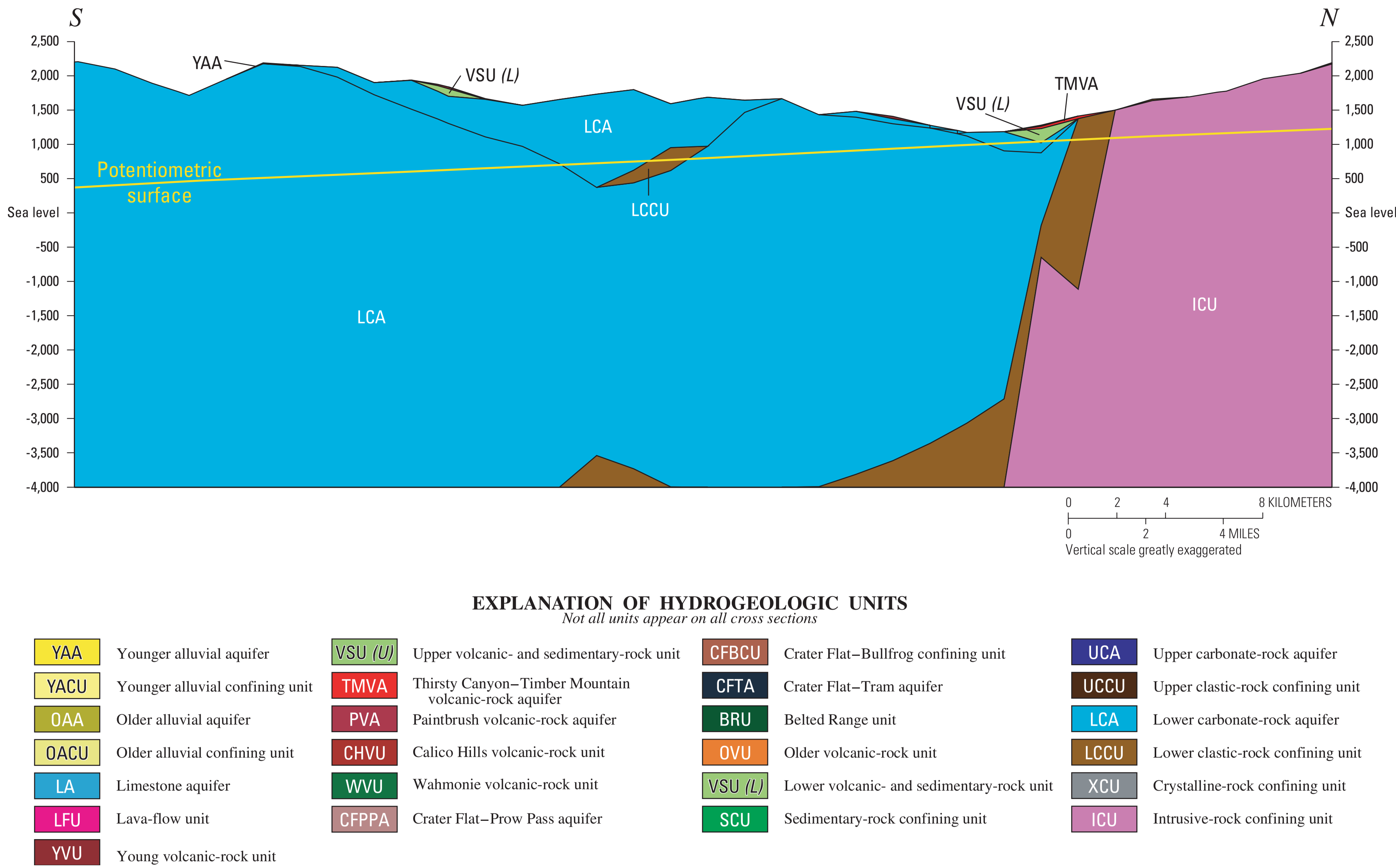
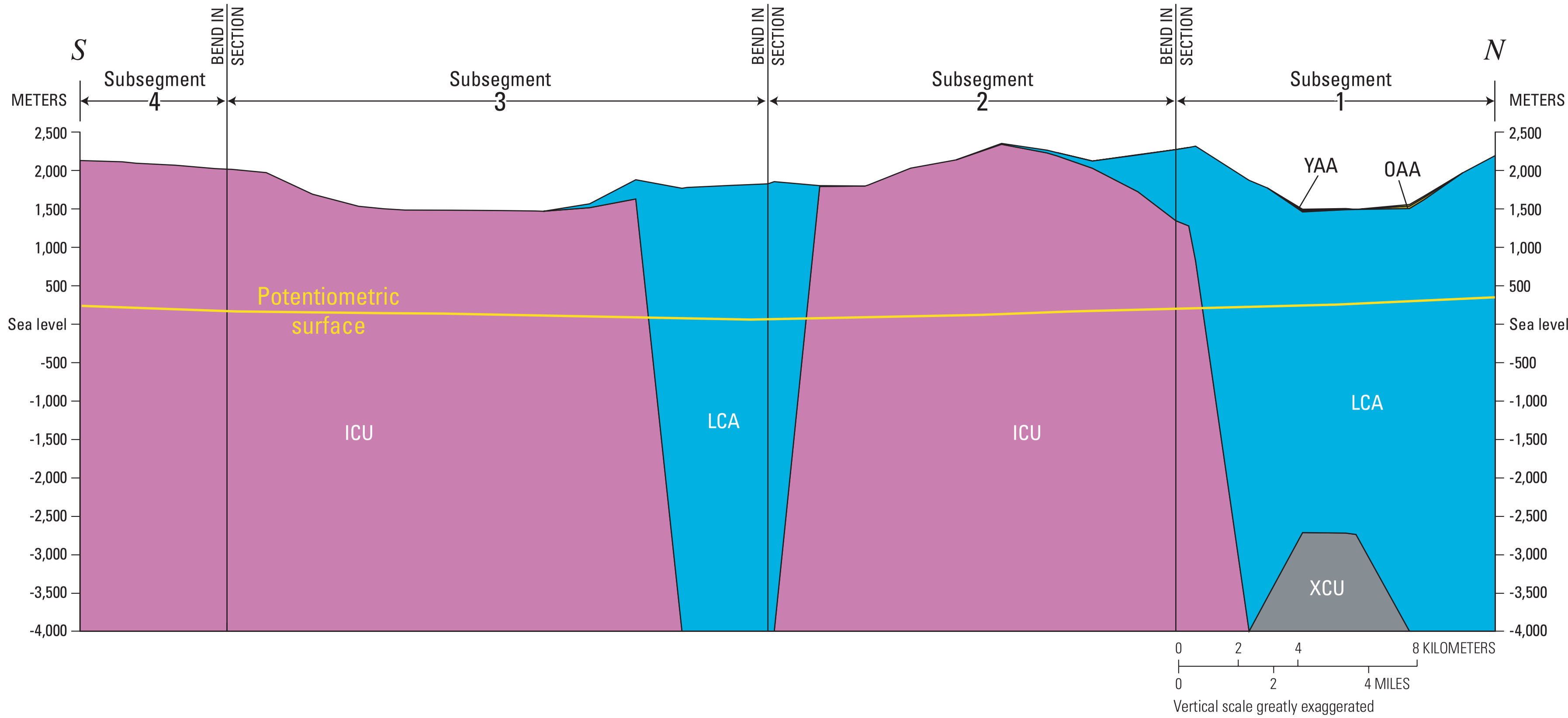


Figure A2–12. Hydrogeologic units of the Death Valley regional ground-water flow system model for the Eureka boundary segment.



EXPLANATION OF HYDROGEOLOGIC UNITS

Not all units appear on all cross sections

YAA	Younger alluvial aquifer	VSU (U)	Upper volcanic- and sedimentary-rock unit	CFBCU	Crater Flat–Bullfrog confining unit	UCA	Upper carbonate-rock aquifer
YACU	Younger alluvial confining unit	TMVA	Thirsty Canyon–Timber Mountain volcanic-rock aquifer	CFTA	Crater Flat–Tram aquifer	UCCU	Upper clastic-rock confining unit
OAA	Older alluvial aquifer	PVA	Paintbrush volcanic-rock aquifer	BRU	Belted Range unit	LCA	Lower carbonate-rock aquifer
OACU	Older alluvial confining unit	CHVU	Calico Hills volcanic-rock unit	OVU	Older volcanic-rock unit	LCCU	Lower clastic-rock confining unit
LA	Limestone aquifer	WVU	Wahmonie volcanic-rock unit	VSU (L)	Lower volcanic- and sedimentary-rock unit	XCU	Crystalline-rock confining unit
LFU	Lava-flow unit	CFPPA	Crater Flat–Prow Pass aquifer	SCU	Sedimentary-rock confining unit	ICU	Intrusive-rock confining unit
YVU	Young volcanic-rock unit						

Figure A2–13. Hydrogeologic units of the Death Valley regional ground-water flow system model for the Saline boundary segment.

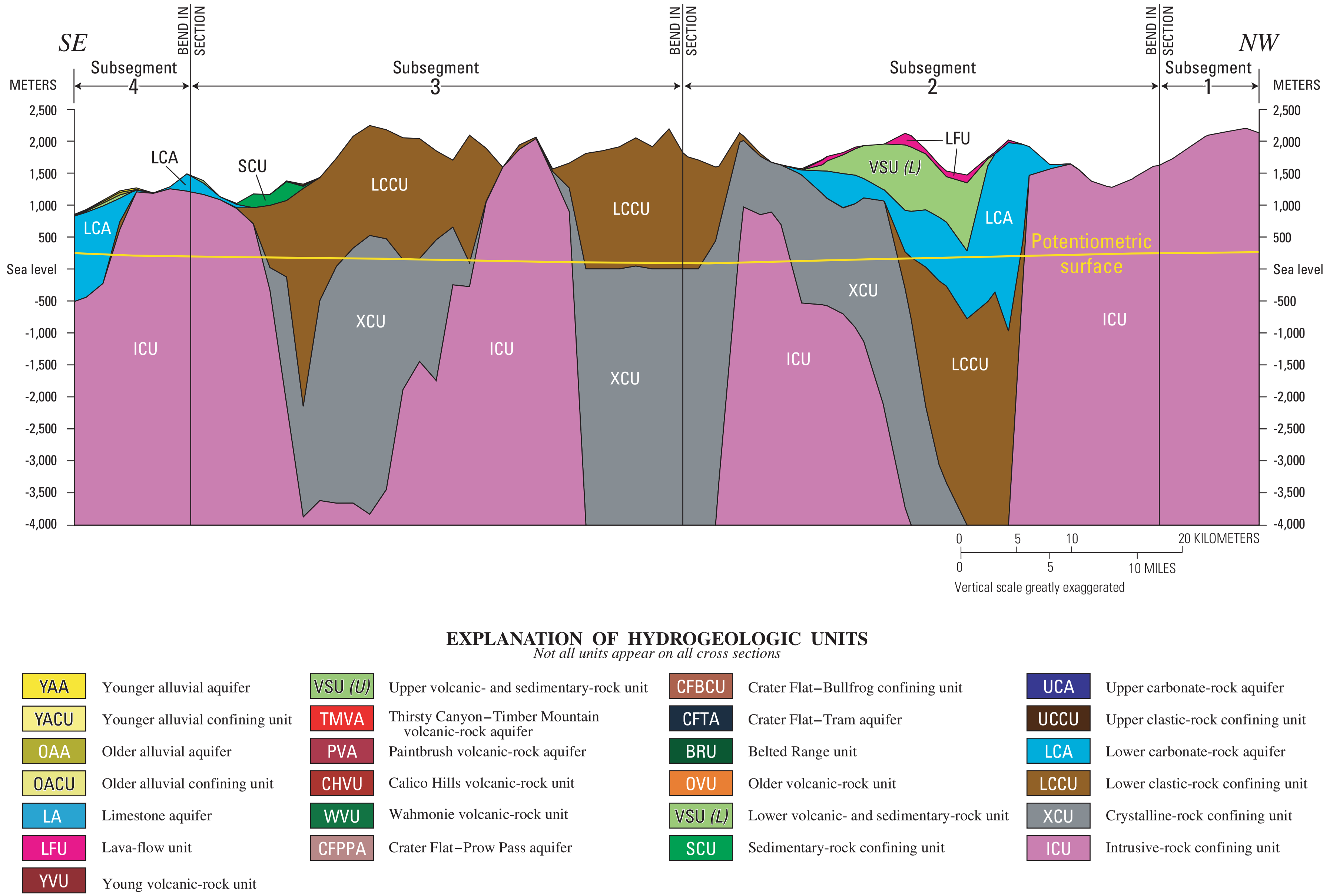


Figure A2–14. Hydrogeologic units of the Death Valley regional ground-water flow system model for the Panamint boundary segment.

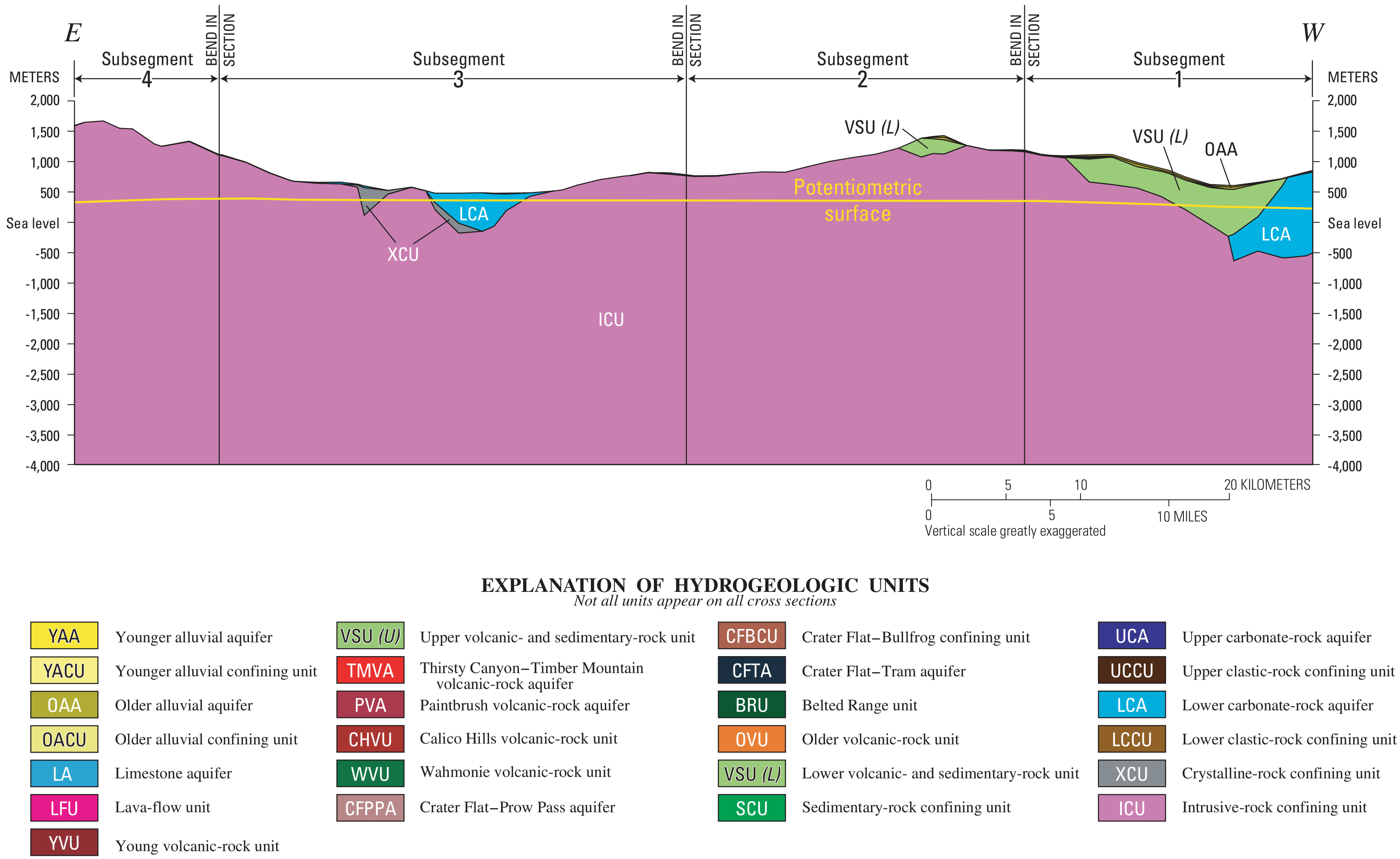


Figure A2–15. Hydrogeologic units of the Death Valley regional ground-water flow system model for the Owlshead boundary segment.

Table A2–1. Index of hydrologic units for areas contributing ground-water flow to the Death Valley regional ground-water flow system (after Seaber and others, 1987).

[Some hydrologic units have the same or similar names]

Code	Name	Code	Name	Code	Name
47	Huntington Valley	155C	Southern Little Smoky Valley	219	Muddy River Springs area
53	Pine Valley	156	Hot Creek Valley	220	Lower Moapa Valley
55	Carico Lake Valley	157	Kawich Valley	221	Tule Desert
56	Upper Reese River Valley	158A	Groom Lake Valley	222	Virgin River Valley
57	Antelope Valley	158B	Papoose Lake Valley	225	Mercury Valley
58	Middle Reese River Valley	159	Yucca Flat	226	Rock Valley
73B	Lovelock Valley	160	Frenchman Flat	227A	Jackass Flats
74	White Plains	161	Indian Springs Valley	227B	Buckboard Mesa
101	Carson Desert	162	Pahrump Valley	228	Oasis Valley
109	East Walker area	163	Mesquite Valley	229	Crater Flat
110A	Schurz subarea	164A	Northern Ivanpah Valley	230	Amargosa Desert
110B	Lake subarea	164B	Southern Ivanpah Valley	231	Grapevine Canyon
110C	Whiskey Flat-Hawthorne	165	Jean Lake Valley	232	Oriental Wash
113	Huntoon Valley	166	Hidden Valley	240	Chicago Valley
114	Teels Marsh Valley	167	Eldorado Valley	241	California Valley
117	Fish Lake Valley	168	Northern Three Lakes Valley	242	Lower Amargosa Valley
118	Columbus Salt Marsh	169A	Northern Tikaboo Valley	243	Death Valley
119	Rhodes Salt Marsh	169B	Southern Tikaboo Valley	244	Valjean Valley
120	Garfield Flat	170	Penoyer Valley	245	Shadow Valley
121A	Eastern Soda Spring Valley	171	Coal Valley	246	Mono Lake Valley
121B	Western Soda Spring Valley	172	Garden Valley	247	Adobe Lake Valley
122	Gabbs Valley	173A	Southern Railroad Valley	248	Long Valley
123	Rawhide Flats	173B	Northern Railroad Valley	249	Owens Valley
124	Fairwiew Valley	174	Jakes Valley	250	Deep Springs Valley
125	Stingaree Valley	175	Long Valley	251	Eureka Valley
126	Cowkick Valley	178	Butte Valley	252	Saline Valley
127	Eastgate Valley area	179	Steptoe Valley	253	Racetrack Valley area
128	Dixie Valley	180	Cave Valley	254	Darwin Plateau Basin
133	Edwards Creek Valley	181	Dry Lake Valley	255	Panamint Valley
134	Smith Creek Valley	182	Delamar Valley	256	Searles Valley
135	Lone Valley	183	Lake Valley	257	East Pilot Knob and Brown Mountain Valley
136	Monte Cristo Valley	184	Spring Valley	258	Lost Lake-Owl Lake Valley
137A	Tonopah Flat	185	Tippett Valley	259	Leach Valley
137B	Northern Big Smoky Valley	195	Snake Valley	260	Red Pass Valley
138	Grass Valley	197	Escalante Desert	261	Riggs Valley
139	Kobeh Valley	198	Dry Valley	262	Soda Lake Valley
140A	Northern Monitor Valley	199	Rose Valley	263	Kelso Valley
140B	Southern Monitor Valley	200	Eagle Valley	264	Cronise Valley
141	Ralston Valley	201	Spring Valley	265	Bicycle Valley
142	Alkali Spring Valley	202	Patterson Valley	266	Goldstone Valley
143	Clayton Valley	203	Panaca Valley	267	Superior Valley
144	Lida Valley	204	Clover Valley	268	Coyote Lake Valley
145	Stonewall Flat	205	Lower Meadow Valley Wash	269	Lower Mojave River Valley
146	Sarcobatus Flat	206	Kane Springs Valley	270	Lucerne Valley
147	Gold Flat	207	White River Valley	271	Upper Mojave River Valley
148	Cactus Flat	208	Pahroc Valley	272	Middle Mojave River Valley
149	Stone Cabin Valley	209	Pahranagat Valley	273	Harper Valley
150	Little Fish Lake Valley	210	Coyote Spring Valley	274	Antelope Valley
151	Antelope Valley	211	Southern Three Lakes Valley	275	Fremont Valley
152	Stevens Basin	212	Las Vegas Valley	276	Cuddleback Valley
153	Diamond Valley	215	Black Mountains area	277	Indian Wells Valley
154	Newark Valley	216	Garnet Valley	278	Rose Valley
155A	Northern Little Smoky Valley	217	Hidden Valley (north)		
155B	Central Little Smoky Valley	218	California Wash		

Estimates of Boundary Flow

Estimates of boundary flow from Darcy calculations and water budgets are summarized by model boundary segment. Results, special considerations, reliability of estimates, and the most representative value of boundary flow for each segment are discussed.

Silurian Boundary Segment

Ground-water inflow across the three subsegments from Lower Mojave River Valley (269) hydrologic unit was estimated by Darcy calculations. Figure A2–4 shows the cross section of the straight-line approximation of the Silurian boundary segment. The total Darcy estimate is 125 cubic meters per day (m^3/d) out of the flow-model domain (table A2–2).

The contributing area to the Silurian segment includes all or part of 18 hydrologic units (fig. A2–2). Most of the surface flow and ground-water recharge that is generated in the upgradient part of the contributing area is consumed before it reaches the boundary of the ground-water flow model. Consequently, only six hydrologic units in the lower part of the contributing area contribute flow and were evaluated in this estimate. Water budgets were calculated for the Valjean Valley (244), Shadow Valley (245), Mesquite Valley (163), Riggs Valley (261), Soda Lake Valley (262), and the lower part of the Lower Mojave River Valley (269) hydrologic units.

Inflow to Soda Lake Valley (262) hydrologic unit from the lower part of Lower Mojave River Valley (269) hydrologic unit includes streamflow at Afton Canyon and ground-water inflow (table A2–3). The ET from Soda Lake playa is an estimation of the maximum potential ET. The large negative balance for the Soda Lake Valley (262) hydrologic unit is an indication that all surface and ground-water inflow to Soda Lake playa is lost through ET.

The potential ET from the contributing area for the Silurian segment (table A2–3) is significantly greater than the ground-water recharge by infiltration of precipitation and stream inflow, indicating little or no inflow into the model domain. Low flow across the model boundary also is supported by the low recharge rate and the relatively flat regional hydraulic gradient. Water-budget estimates of net outflow across the Silurian segment is 11,400 m^3/d (table A2–3).

The Darcy estimate total (–125 m^3/d) and water budget estimate for the Silurian segment obviously do not agree. Recharge in Valjean Valley (244) and Shadow Valley (245) hydrologic units is not accounted for in the Darcy estimates. The regional potential contours (fig. A2–1) indicate that much of this water flows to the Soda Lake Valley (262) hydrologic unit; however, some probably flows toward Death Valley. Because of this, it was assumed, based on professional judgment, that only a small amount of ground-water inflow (about 500 m^3/d) occurs as underflow in the vicinity of Salt Spring at the junction of subsegments 1 and 2. This small inflow represents the estimated flow for the Silurian segment.

Spring–Mesquite Boundary Segment

Estimates of boundary flow for the Spring–Mesquite segment are based only on Darcy calculations because there is no water-budget information. Figure A2–5 shows the cross section of the straight-line approximation of the Spring–Mesquite boundary segment. Subsegments 3 through 7 are nearly parallel to divides and flow lines of the regional potential (fig. A2–1), so Darcy calculations of flow across subsegments 3 through 7 are zero. Subsegments 1 and 2 are subparallel to flow lines of the regional potential; inflow and outflow occur along these subsegments. Darcy calculations of outflow through subsegment 2 is 866 m^3/d. The inflow calculation for subsegment 1 is 84 m^3/d, which is considered insignificant. The net calculated flow across the Spring–Mesquite segment is about 800 m^3/d out of the model domain. The most reasonable estimate for boundary flow across the Spring–Mesquite segment, however is 0 m^3/d, because the flow in most of the segment is generally parallel to the boundary (table A2–9)

Las Vegas Boundary Segment

The Darcy estimate indicates an outflow of about 4,575 m^3/d across this segment (table A2–2), which is used as the most reasonable estimate (table A2–9). Figure A2–6 shows the cross section of the straight-line approximation of the Las Vegas boundary segment. The contributing areas to flow out of the model domain across the Las Vegas segment include a small part of the Spring Mountains and the southern part of the Sheep Range. Darcy calculations of outflow across subsegments 1 and 3 are about 900 and 3,600 m^3/d, respectively. No regional flow in or out of the model domain occurs across subsegment 2 because the regional hydraulic gradient is parallel to the subsegment, and the Las Vegas Valley shear zone (LVVSZ) is a relative barrier to flow (fig. A2–1). However, in the shallow part of the system a hydraulic gradient does exist across subsegment 2, and some outflow probably occurs in the shallow basin fill consisting of the upper and lower volcanic- and sedimentary-rock units (upper and lower VSU) (fig. A2–6) that was deposited after movement along the LVVSZ ceased.

Sheep Range Boundary Segment

Boundary flow across the Sheep Range segment was estimated from Darcy calculations. Figure A2–7 shows the cross section of the straight-line approximation of the Sheep Range boundary segment. The estimated hydraulic conductivities of carbonate rocks and confining-unit rocks are 0.02 and 0.00048 meters per day (m/d), respectively. Estimated outflow through subsegments 1, 2, and 3 is 24,674 m^3/d and estimated inflow across subsegment 4 is 5,927 m^3/d, which includes recharge from the east flank of the Sheep Range, giving a total estimated outflow of 18,747 m^3/d (table A2–2).

Table A2–2. Flow estimated using Darcy's law across the boundary for the Death Valley regional ground-water flow system model.

[Abbreviations: l, lower; K, hydraulic conductivity; LCA, lower carbonate-rock aquifer; OAA, older alluvial aquifer; OVU, older volcanic-rock rock unit; u, upper; VSU, volcanic- and sedimentary-rock unit; VSU-L, lower volcanic- and sedimentary-rock unit; VSU-U, upper volcanic- and sedimentary-rock unit; XXCU, combined crystalline-rock confining unit, lower clastic-rock confining unit, and intrusive-rock confining unit; m/d, meter per day; m^2, square meters; m^3/d, cubic meters per day. Rounding may produce difference between reported tottals for boundary flow and the sum of the subsegment flows]

Model boundary	Hydraulic conductivity (m/d) (Belcher and others, 2001)	Hydraulic gradient	Area (m^2)	Flow-width correction	Flow (m^3/d)	Remarks
Silurian segment						
Subsegment 1						
XXCU	0.00048	0.0081	70,462,242	0.58	159	
		Total subsegment 1			159	
Subsegment 2						
OAA	0.1	–0.0136	758,437	0.14	–144	
VSU	0.00101	–0.0136	10,175,910	0.14	–20	
XXCU	0.00048	–0.0136	114,724,294	0.14	–105	
		Total subsegment 2			–269	Flow approximately parallel to subsegment. Outflow may discharge at Salt Spring or flow back in through subsegment 1.
Subsegment 3						
XXCU	0.00048	–0.0054	30,194,944	0.19	–15	
		Total subsegment 3			–15	Flow approximately parallel to subsegment.
Estimated total					**–125**	
Spring–Mesquite segment						
Subsegment 1						
LCA	0.005	0.0053	1,574,606	0.32	13	
XXCU	0.00048	0.0053	86,531,361	0.32	70	
		Total subsegment 1			84	
Subsegment 2						
SCU	0.03	–0.0063	193,717	0.31	–11	
LCA	0.005	–0.0063	82,696,522	0.31	–808	
XXCU	0.00048	–0.0063	50,092,776	0.31	–47	Outflow.
		Total subsegment 2			–866	
Subsegments 3–7						
LCA	0.005	–0.0089	98,246,122	0	0	Flow nearly parallel to subsegment.
XXCU	0.00048	–0.0089	12,664,677	0	0	Flow nearly parallel to subsegment.
		Total subsegment 3			0	
Estimated total					**–782**	
Las Vegas segment						
Subsegment 1						
VSU	0.001	–0.0056	852,012	0.24	–1	
SCU	0.03	–0.0056	1,851,564	0.24	–75	
LCA	0.005	–0.0056	17,764,831	0.24	–119	
XXCU	0.08	–0.0056	6,946,448	0.24	–747	
		Total subsegment 1			–942	
Subsegment 2						
VSU	0.001	0.0056	178,038	0	0	
SCU	0.03	0.0056	2,832,562	0	0	
LCA	0.0219	0.0056	59,028,843	0	0	
XXCU	0.08	0.0056	2,774,777	0	0	
		Total subsegment 2			0	Flow parallel to subsegment.
Las Vegas segment—Continued						

Table A2–2. Flow estimated using Darcy's law across the boundary for the Death Valley regional ground-water flow system model.—Continued

[Abbreviations: l, lower; K, hydraulic conductivity; LCA, lower carbonate-rock aquifer; OAA, older alluvial aquifer; OVU, older volcanic-rock rock unit; u, upper; VSU, volcanic- and sedimentary-rock unit; VSU-L, lower volcanic- and sedimentary-rock unit; VSU-U, upper volcanic- and sedimentary-rock unit; XXCU, combined crystalline-rock confining unit, lower clastic-rock confining unit, and intrusive-rock confining unit; m/d, meter per day; m^2, square meters; m^3/d, cubic meters per day. Rounding may produce difference between reported tottals for boundary flow and the sum of the subsegment flows]

Model boundary	Hydraulic conductivity (m/d) (Belcher and others, 2001)	Hydraulic gradient	Area (m^2)	Flow-width correction	Flow (m^3/d)	Remarks
Subsegment 3						
LCA	0.0219	–0.008	36,409,119	0.5	–3,189	
XXCU	0.08	–0.008	1,385,261	0.5	–443	
		Total subsegment 3			–3,633	
Estimated total					**–4,575**	
Sheep Range segment						
Subsegment 1						
LCA-l	0.02	–0.005	55,094,466	0.8	–4,408	K est. by authors.
XXCU-l	0.00048	–0.005	836,217	0.8	–2	K est. by authors.
		Total subsegment 1			–4,410	Includes recharge from east flank of Sheep Range.
Subsegment 2						
LCA-u	0.02	–0.0139	3,238,033	0.92	–828	K est. by authors.
XXCU-u	0.00048	–0.0139	12,462,155	0.92	–76	K est. by authors.
LCA-l	0.02	–0.0033	236,813,520	0.92	–14,379	K est. by authors.
XXCU-l	0.00048	–0.0033	14,320,554	0.92	–21	K est. by authors.
		Total subsegment 2			–15,305	Includes recharge from east flank of Sheep Range.
Subsegment 3						
LCA-u	0.02	–0.0104	6,364,626	0.36	–477	K est. by authors.
XXCU-u	0.00048	–0.0104	1,622,942	0.36	–3	K est. by authors.
LCA-l	0.02	–0.0104	59,820,756	0.36	–224	K est. by authors.
XXCU-l	0.00048	–0.0104	284,208	0.36	–1	K est. by authors.
		Total subsegment 3			–4,959	Includes recharge from east flank of Sheep Range.
Subsegment 4						
LCA-u	0.02	0.0104	8,658,770	0.69	1,234	K est. by authors.
XXCU-l	0.00048	0.0104	116,074	0.69	0	K est. by authors.
LCA-l	0.02	0.0104	3,2636,808	0.69	4,684	K est. by authors.
		Total subsegment 4			5,927	Includes recharge from east flank of Sheep Range.
Estimated total					**–18,747**	
Pahranagat segment						
Subsegment 1						
LCA	0.012	0.008	35,095,853	0.54	1,819	K est. by authors.
XXCU	0.00048	0.008	3,716,562	0.54	8	
		Total subsegment 1			1,827	
Subsegment 2						
LCA	0.012	–0.0075	71,737,048	0.36	–2,324	K est. by authors.
XXCU	0.00048	–0.0075	16,456,431	0.36	–21	
		Total subsegment 2			–2,346	
Pahranagat segment—Continued						

Table A2–2. Flow estimated using Darcy's law across the boundary for the Death Valley regional ground-water flow system model.—Continued

[Abbreviations: l, lower; K, hydraulic conductivity; LCA, lower carbonate-rock aquifer; OAA, older alluvial aquifer; OVU, older volcanic-rock rock unit; u, upper; VSU, volcanic- and sedimentary-rock unit; VSU-L, lower volcanic- and sedimentary-rock unit; VSU-U, upper volcanic- and sedimentary-rock unit; XXCU, combined crystalline-rock confining unit, lower clastic-rock confining unit, and intrusive-rock confining unit; m/d, meter per day; m², square meters; m³/d, cubic meters per day. Rounding may produce difference between reported tottals for boundary flow and the sum of the subsegment flows]

Model boundary	Hydraulic conductivity (m/d) (Belcher and others, 2001)	Hydraulic gradient	Area (m^2)	Flow-width correction	Flow (m^3/d)	Remarks
Subsegment 3						
LCA	0.012	–0.0055	30,087,908	0.05	–99	
XXCU	0.00048	–0.0055	22,904,328	0.05	–3	
		Total subsegment 3			–102	
Subsegment 4						
LCA	0.012	0.0055	28,026,698	0.19	351	
XXCU	0.00048	0.0055	16,030,089	0.19	8	
		Total subsegment 4			359	
Subsegment 5						
LCA	0.012	–0.004	106,150,918	0.49	-2,497	
XXCU	0.00048	–0.004	26,311,596	0.49	–25	
		Total subsegment 5			–2,521	Outflow.
Estimated total					**–2,783**	Net outflow.
Garden–Coal segment						
Subsegment 1						
LCA	0.012	0.0108	18,067,657	0.42	983	
XXCU	0.00048	0.0108	6,964,906	0.42	15	
		Total Subsegment 1			999	
Subsegment 2						
LCA	0.012	0.0067	17,409,087	0.56	784	
XXCU	0.00048	0.0067	12,222,297	0.56	22	
		Total Subsegment 2			806	
Subsegment 3						
LCA	0.012	0.0032	102,792,919	0.57	2,250	
XXCU	0.00048	0.0032	96,263,253	0.57	84	
		Total Subsegment 3			2,334	
Estimated total					**4,139**	
Stone Cabin–Railroad segment						
Subsegment 1						
LCA	0.012	–0.0031	64,588,868	0.31	–745	
XXCU	0.00048	–0.0031	49,333,073	0.31	–23	
		Total Subsegment 1			–768	Returns through subsegment 2.
Subsegment 2						
VSU	0.05465	0.0028	8,938,182	0.84	1,149	
LCA	0.012	0.0028	120,772,098	0.84	3,409	
XXCU	0.00048	0.0028	124,674,096	0.84	141	
		Total Subsegment 2			4,698	
Subsegment 3						
LCA	0.006	0.0047	22,363	0.27	0	
XXCU	0.00048	0.0047	102,013,424	0.27	62	
		Total Subsegment 3			62	
Stone Cabin–Railroad segment—Continued						

Table A2–2. Flow estimated using Darcy's law across the boundary for the Death Valley regional ground-water flow system model.—Continued

[Abbreviations: l, lower; K, hydraulic conductivity; LCA, lower carbonate-rock aquifer; OAA, older alluvial aquifer; OVU, older volcanic-rock rock unit; u, upper; VSU, volcanic- and sedimentary-rock unit; VSU-L, lower volcanic- and sedimentary-rock unit; VSU-U, upper volcanic- and sedimentary-rock unit; XXCU, combined crystalline-rock confining unit, lower clastic-rock confining unit, and intrusive-rock confining unit; m/d, meter per day; m², square meters; m³/d, cubic meters per day. Rounding may produce difference between reported tottals for boundary flow and the sum of the subsegment flows]

Model boundary	Hydraulic conductivity (m/d) (Belcher and others, 2001)	Hydraulic gradient	Area (m^2)	Flow-width correction	Flow (m^3/d)	Remarks
Subsegment 4						
VSU-U	0.05465	0.004	10,336,774	0.79	1,785	
OVU	0.0013	0.004	11,093,052	0.79	46	
VSU-L	0.05465	0.004	25,914,727	0.79	4,475	
LCA	0.006	0.004	40,719,263	0.79	772	
XXCU	0.00048	0.004	103,662,840	0.79	157	
		Total subsegment 4			7,235	
Subsegment 5						
VSU	0.0133	0.0036	25,690,839	0.87	1,070	
XXCU	0.00048	0.0036	118,258,401	0.87	178	
		Total subsegment 5			1,248	
Estimated total					**12,476**	
Clayton segment						
Subsegment 1						
VSU	0.00101	0.0077	4,427,844	0.24	8	
XXCU	0.00048	0.0077	21,701,252	0.24	19	
		Total subsegment 1			28	
Subsegment 2						
VSU	0.00101	0.0077	6,401,160	0.34	17	
LCA	0.16	0.0077	469,502	0.34	197	K est. by authors.
XXCU	0.00048	0.0077	138,460,787	0.34	174	
		Total subsegment 2			388	
Subsegment 3						
LCA	0.16	0.0044	37,886	0.19	5	Flow parallel to northern half of segment. K est. by authors.
XXCU	0.00048	0.0044	144,638,324	0.19	58	Flow parallel to northern half of segment.
		Total subsegment 3			63	
Subsegment 4						
XXCU	0.00048	0.0119	32,892,612	1	188	
		Total subsegment 4			188	
Estimated total					**667**	
Eureka segment						
Subsegment 1						
LCA	0.16	0.0176	177,125,504	0.04	19,951	K est. by authors
XXCU	0.00048	0.0176	70,931,206	0.04	24	
Estimated total					**19,975**	
Saline segment						
Subsegment 1						
LCA	0.003	–0.0186	34,724,150	0.38	–736	
XXCU	0.00048	–0.0186	11,942,934	0.38	–41	
		Total subsegment 1			–777	
Subsegment 2						
LCA	0.003	0.0186	3,069,221	0.72	123	
XXCU	0.00048	0.0186	54,681,421	0.72	352	
		Total subsegment 2			475	
Saline segment—Continued						

Table A2–2. Flow estimated using Darcy's law across the boundary for the Death Valley regional ground-water flow system model.—Continued

[Abbreviations: l, lower; K, hydraulic conductivity; LCA, lower carbonate-rock aquifer; OAA, older alluvial aquifer; OVU, older volcanic-rock rock unit; u, upper; VSU, volcanic- and sedimentary-rock unit; VSU-L, lower volcanic- and sedimentary-rock unit; VSU-U, upper volcanic- and sedimentary-rock unit; XXCU, combined crystalline-rock confining unit, lower clastic-rock confining unit, and intrusive-rock confining unit; m/d, meter per day; m², square meters; m³/d, cubic meters per day. Rounding may produce difference between reported tottals for boundary flow and the sum of the subsegment flows]

Model boundary	Hydraulic conductivity (m/d) (Belcher and others, 2001)	Hydraulic gradient	Area (m^2)	Flow-width correction	Flow (m^3/d)	Remarks
Subsegment 3						
LCA	0.003	0.0091	14,482,916	0.9	356	
XXCU	0.00048	0.0091	62,051,113	0.9	244	
		Total subsegment 3			600	
Subsegment 4						
XXCU	0.00048	0.0017	21,136,287	0	0	
		Total subsegment 4			0	Flow parallel to subsegment.
Estimated total					**898**	
Panamint segment						
Subsegment 1						
XXCU	0.00048	0.0121	381,663,383	0.96	2,128	
		Total subsegment 1			2,128	
Subsegment 2						
LCA	0.16	0.013	5,337,688	0.88	9,770	K est. by authors.
XXCU	0.00048	0.013	174,846,484	0.88	960	
		Total subsegment 2			10,730	
Subsegment 3						
XXCU	0.00048	0.0123	185,428,139	0.91	996	
		Total subsegment 3			996	
Subsegment 4						
LCA	0.001	0.0117	1,710,262	0.75	15	
XXCU	0.00048	0.0117	42,840,019	0.75	180	
		Total subsegment 4			195	
Estimated total					**14,050**	
Owlshead segment						
Subsegment 1						
VSU	0.00101	0.0076	1,264,971	0.96	9	
LCA	0.001	0.0076	3,622,217	0.96	26	
XXCU	0.00048	0.0076	76,641,484	0.96	268	
		Total subsegment 1			304	
Subsegment 2						
XXCU	0.00048	0.0112	97,960,865	0.64	337	
		Total subsegment 2			337	
Subsegment 3						
LCA	0.001	0.0261	1,534,492	0.98	39	
XXCU	0.00048	0.0261	133,817,769	0.98	1,643	
		Total subsegment 3			1,682	
Subsegment 4						
XXCU	0.00048	0.0093	41,474,680	0.32	59	
		Total subsegment 4			59	
Estimated total					**2,382**	

Table A2–3. Estimated water budget for the Silurian boundary segment of the Death Valley regional ground-water flow system model.

[m^3/d, cubic meters per day; --, no data]

Hydrologic unit name and code (fig. A2–2)	Recharge (m^3/d)	Inflow (m^3/d)	Evapotranspiration (m^3/d)	Flow[1] (m^3/d)	Reference
Valjean (244)	1,400	0	0	1,400	Harrill and others, 1988
Shadow (245)	4,100	0	0	4,100	Harrill and others, 1988
Mesquite (163)	4,730	2,360	7,430	–340	Glancy, 1968
[2]Riggs (261)	--	--	--	--	Estimated by authors
Soda Lake (262)	1,400	[3]15,000	[4]34,000	–17,600	Estimated by authors
Lower Mojave River (269)	--	1,000	--	1,000	
Total (rounded)	**11,600**	**18,400**	**41,400**	**–11,400**	

[1]Flow estimate is the sum of recharge, inflow, and evapotranspiration. Negative values indicate flow out of the model domain; positive values indicate flow into the model domain.

[2]Budget components not estimated in this study, but no sign of significant evapotranspiration was observed during the field reconnaissance. Riggs hydrologic unit (261) may transmit small amounts of underflow to Valjean Valley hydrologic unit (244).

[3]Surface-water inflow (Mojave River) at Afton Canyon.

[4]Maximum potential evapotranspiration from the playa of Soda Lake Valley hydrologic unit (262).

The Sheep Range segment is in a part of the DVRFS model domain that is in the Colorado River flow system. Flow from Pahranagat subsegment 1 (1,827 m^3/d) and Sheep Range subsegment 4 (5,927 m^3/d) enters the flow model domain and exits through the rest of the Sheep Range segment (–18,747 m^3/d) (table A2–4). The net outflow from the Sheep Range segment is derived from inflow across these two subsegments and recharge to the Sheep Range. Based on these relations, these flow volumes appear reasonable.

Pahranagat Boundary Segment

The Darcy calculations show no significant gain or loss to the model domain from the combined inflow from the Garden–Coal segment (4,139 m^3/d) and subsegments 2 through 5 of the Pahranagat segment (–4,610 m^3/d). Figure A2–8 shows the cross section of the straight-line approximation of the Pahranagat boundary segment. The Darcy calculations show an inflow of 1,827 m^3/d across the Pahranagat subsegment 1.

Subsegments 2 through 5 of the Pahranagat segment generally are near and parallel to the boundary of the Death Valley and Colorado River flow systems. The net outflow from these subsegments is derived from inflows to the model domain across the adjacent Garden–Coal segment to the north. Flow enters the Garden-Coal segment and exits through the Pahranagat segment (table A2–4).

Garden–Coal Boundary Segment

The total inflow to the model domain across the Garden–Coal segment calculated by the Darcy method is 4,139 m^3/d, which is considered the best available estimate of inflow to the model domain for this segment. Figure A2–9 shows the cross section of the straight-line approximation of the Garden–Coal boundary segment. The inflow to this segment is the major source of ground water that moves out of the model domain through the Pahranagat segment, discussed previously (table A2–4).

Small areas of Southern Railroad Valley (173A), Garden Valley (172), and Coal Valley (171) hydrologic units contribute to flow across the Garden–Coal segment. Recharge to the Garden Valley (172) and Coal Valley (171) hydrologic units totals 40,500 m^3/d, and ET of ground water is 6,750 m^3/d (Eakin, 1963).

Table A2–4. Summary of inflow and outflow of ground water across the Sheep Range, Paharanagat, and Garden–Coal boundary segments of the Death Valley regional ground-water flow system model.

[m^3/d, cubic meters per day]

Segment	Subsegment (fig. A2–3)	Inflow (m^3/d)	Outflow (m^3/d)
Sheep Range	1		4,409
	2		15,305
	3		4,959
	4	5,927	
Pahranagat	1	1,827	
	2		2,346
	3		102
	4	359	
	5		2,521
Garden–Coal	1	999	
	2	806	
	3	2,334	
Subtotal		12,252	29,642
Total			**17,390**

Stone Cabin–Railroad Boundary Segment

The Darcy calculations (table A2–2) show a net inflow across the Stone Cabin–Railroad segment of about 12,500 m^3/d. Figure A2–10 shows the cross section of the straight-line approximation of the Stone Cabin–Railroad boundary segment. The Darcy calculated inflow is accepted as the most reasonable estimate of inflow across the boundary.

The contributing areas to this segment (fig. A2–1) include relatively small parts of the Southern Railroad Valley (173A), Hot Creek Valley (156), Stone Cabin Valley (149), Southern Monitor Valley (140B), and Ralston Valley (141) hydrologic units. The water budgets given in table A2–5 show an excess of recharge over ground-water discharge through ET. The water budgets, however, are for the entire basins and are not amenable to separation of the flows that actually cross the Stone Cabin–Railroad segment.

Clayton Boundary Segment

The Darcy calculation of flow across the segment (table A2–2) shows a net inflow to the model domain of about 667 m^3/d. Figure A2–11 shows the cross section of the straight-line approximation of the Clayton boundary segment. The flat gradient across the boundary segment and the small water balance from the basins in the contributing area indicate that the inflow across the model boundary is small.

The contributing area to the Clayton segment (fig. A2–3) includes all or parts of the Clayton Valley (143), Alkali Spring Valley (142), Fish Lake Valley (117), Ralston Valley (141), Adobe Lake Valley (247), Tonopah Flat (137A), Upper Reese River Valley (56), Northern Big Smoky Valley (137B), and Southern Monitor Valley (140B) hydrologic units and the Owens Valley ground-water basin. This is a large area that contains not only significant recharge areas but also large areas of ET. Table A2–6 lists water-budget information for the most significant contributing basins. As noted, the total area of these basins is not coincident with the contributing area of the Clayton segment. The water budgets for these basins show that although there is a great amount of recharge to basins in the contributing area, about 99 percent of this recharge is consumed by ET.

As discussed previously, the flat gradient and the small water budget indicate very little flow across the Clayton segment. Because of this, the Darcy estimate of 667 m^3/d into the model domain is accepted as the most reasonable.

Eureka and Saline Boundary Segments

The Darcy calculations show the net flow into the model from the Eureka and Saline segments is about 20,900 m^3/d (table A2–2). Figures A2–12 and A2–13 shows the cross sections of the straight-line approximation of the Eureka and Saline boundary segments. This estimated inflow appears to be sensitive to the estimated hydraulic-conductivity (0.16 m/d) of the carbonate rocks. This estimated inflow should be used with caution because of the uncertain nature of the estimate.

The regional ground-water potential map (fig. A2–1; Appendix 1) shows that the contributing basins are Saline Valley (252), Eureka Valley (251), Deep Springs Valley (250), Racetrack Valley (253), and Long Valley (248) hydrologic units, and parts of the Owens Valley (249) and Darwin Plateau Basin (254) hydrologic units. Water-budget calculations for Saline Valley (252), Eureka Valley (251), Racetrack Valley (253), and Deep Springs Valley (250) hydrologic units (table A2–7) show an excess of ground water of about 15,600 m^3/d (J.R. Harrill, written commun., 2003). It is estimated that the inflow from Owens Valley (249), Long Valley (248), and the Darwin Plateau Basin (254) hydrologic units is less than 1,000 m^3/d based on the order of magnitude Darcy calculations. The boundary flow across these segments is into the model domain except for flow out of the model in subsegment 1 of the Saline segment.

An inflow from the Saline and Eureka segments of 15,100 m^3/d is used as the most reasonable estimate on the basis of the water budget and order of magnitude Darcy estimates of inflow from the Owens Valley (249) hydrologic unit. An inflow of about 27,000 m^3/d from Saline Valley (252) and possibly part of the Panamint Valley (255) hydrologic units

Table A2–5. Estimated water budget for the Stone Cabin–Railroad boundary segment of the Death Valley regional ground-water flow system model.

[m^3/d, cubic meters per day]

Hydrologic unit and code (fig. A2–2)	Recharge (m^3/d)	Evapotranspiration (m^3/d)	Balance[1] (m^3/d)	Reference
Southern Railroad (173A)	18,600	675	17,925	Van Denburgh and Rush (1974)
Hot Creek (156)	23,600	15,500	8,100	Rush and Everett (1966)
Stone Cabin (149)	16,900	5,100	11,800	Rush (1968)
Ralston (141)	16,900	8,400	8,500	Rush (1968)
Monitor South (140B)	50,700	31,100	19,600	Rush and Everett (1966)
Total (rounded)	**126,700**	**60,800**	**65,900**	

[1]Flow estimate is the sum of recharge, inflow, and evapotranspiration.

previously was estimated by Harrill (1995, p. 91) primarily based on the focused discharge in and adjacent to Mesquite Flat (fig. A–1) in Death Valley.

Panamint Boundary Segment

The regional ground-water potential slopes rather uniformly across the Panamint segment with a gradient of about 0.01. Although there are carbonate rocks in the cross section, most of these rocks are above the zone of regional ground-water flow and do not contribute ground water from the contributing area across the Panamint segment. Figure A2–14 shows the cross section of the straight-line approximation of the Panamint boundary segment. The Darcy flow calculated through this segment to the model domain of about 14,050 m^3/d is obtained by assuming a hydraulic-conductivity value of 0.16 m/d for the lower carbonate-rock aquifer in subsegment 2.

Contributing basins to this segment include Panamint Valley (255), Rose Valley (278), and parts of Owens Valley (249), Darwin Plateau Basin (254), Indian Wells Valley (277), Searles Valley (256), and East Pilot Knob–Brown Mountain Valley (257) hydrologic units (fig. A2–2 and table A2–1). The major contribution of flow to the model domain is from the Panamint Valley (255) hydrologic unit. An estimated water budget for Panamint Valley (J.R. Harrill, written commun., 2003) includes recharge of 56,000 m^3/d and ET of 42,000 m^3/d (table A2–8). The balance of ground-water flow, 14,000 m^3/d, is tributary to the Death Valley (243) hydrologic unit in the model domain. The greatest part of

Table A2–6. Estimated water budget for the Clayton boundary segment of the Death Valley regional ground-water flow system model.

[m^3/d, cubic meters per day; --, no data]

Hydrologic unit and code (fig. A2–2)	Recharge (m^3/d)	Evapotranspiration (m^3/d)	Balance[1] (m^3/d)	Reference
Clayton (143)	5,100	81,100	–76,000	Rush (1968)
Alkali Spring (142)	330	1,350	–1,020	Rush (1968)
Fish Lake (117)	111,000	81,000	30,000	Rush and Katzer (1973)
Tonopah Flat (137A)	40,500	20,300	20,200	Rush and Schroer (1970)
Ralston (141)	16,900	8,400	8,500	Rush (1968)
Northern Big Smoky Valley (137B)	220,000	216,000	4,000	Rush and Schroer (1970)
Monitor South (140B)	50,700	31,100	19,600	Rush and Everett (1966)
Owens (249)	--	--	--	--
Total (rounded)	**445,000**	**439,000**	**6,000**	

[1]Flow estimate is the sum of recharge, inflow, and evapotranspiration. Negative values indicate flow out of the model domain; positive values indicate flow into the model domain.

Table A2–7. Estimated water budget for the Eureka and Saline boundary segments of the Death Valley regional ground-water flow system.

[m^3/d, cubic meters per day; --, no data; <, less than]

Hydrologic unit and code (fig. A2–2)	Recharge (m^3/d)	Evapotranspiration (m^3/d)	Balance[1] (m^3/d)	Reference
Deep Springs (250)	29,000	25,000	4,000	J.R. Harrill, written commun., 2003
Eureka (251)	13,000	0	13,000	Estimated by authors
Saline (252)	79,000	86,000	–7,000	Estimated by authors
Racetrack (253)	4,600	0	4,600	Estimated by authors
Owens (249) and Long Valleys (248), and Darwin Plateau Basin (254)	--	--	[2]<1,000	Estimated by authors
Total (rounded)			**14,600 to 15,600**	

[1]Flow estimate is the sum of recharge, inflow, and evapotranspiration. Negative values indicate flow out of the model domain; positive values indicate flow into the model domain.

[2]Based on order of magnitude Darcy calculations.

this 14,000 m^3/d is from the Panamint Valley (255) hydrologic unit where the most precipitation falls and recharges the ground-water system. The inflow from basins upgradient from Panamint Valley (255) and Darwin Plateau Basin (254) hydrologic units is estimated by Darcy calculations to be less than 2,000 m^3/d. Thus, the estimated flow from Panamint Valley (255) into the model domain is 14,000 to 16,000 m^3/d.

Given the uncertainty of both the Darcy flow estimate and the water budget estimate, there is good agreement between the two methods. The most reasonable estimate, based on both the Darcy flow calculations and the water budget estimate, is 15,000 m^3/d for the boundary flow across the Panamint segment.

Owlshead Boundary Segment

Darcy calculations yield an inflow across this boundary segment of about 2,400 m^3/d (table A2–2). Figure A2–15 shows the cross section of the straight-line approximation of the Owlshead boundary segment. Almost all of this calculated inflow (97 percent) is through a large area of confining-unit rocks.

The contributing area includes parts of Indian Wells Valley (277), Fremont Valley (275), Cuddleback Valley (276), Searles Valley (256), East Pilot Knob and Brown Mountain Valley (257), Superior Valley (267), Goldstone Valley (266), Bicycle Valley (265), Leach Valley (259), Lost Lake–Owl Lake Valley (258), and Harper Valley (273) hydrologic units (fig. A2–2). Considering that the contributing area for this segment is an area of low precipitation and recharge and that ET areas are present in Searles Valley (256) and Indian Wells Valley (277) hydrologic units, the Darcy calculation is considered to yield a maximum value for flow across this segment and is used as the most reasonable estimate.

Summary of Flow Estimates

Flow estimates presented herein for the boundary segments are summarized in table A2–9. These estimates were developed on the basis of Darcy calculations and water-budget calculations where adequate information was available. These estimates were used to support some aspects of the model calibration.

Table A2–8. Estimated water budget for the Panamint boundary segment of the Death Valley regional ground-water flow system.

[m^3/d, cubic meters per day; <, less than]

Hydrologic unit and code (fig. A2–2)	Recharge (m^3/d)	Inflow (m^3/d)	Evapotranspiration (m^3/d)	Balance[1] (m^3/d)	Reference
Panamint (255), Darwin Plateau Basin (254), and East Pilot Knob–Brown Mountain (257)	56,000	<2,000	42,000	14,000 to 16,000	Estimated by authors
Total				**14,000 to 16,000**	

[1]Flow estimate is the sum of recharge, inflow, and evapotranspiration.

Table A2–9. Summary of boundary flow estimates for the Death Valley regional ground-water flow system model.

[m^3/d, cubic meters per day]

Model boundary segment and subsegment (fig. A2–3)	Flow estimated by Darcy method (table A2–2) (m^3/d)	Flow estimated by water-budget method (m^3/d)	Source of water-budget estimate	Most reasonable estimate of flow (m^3/d)	Basis of most reasonable estimate	Remarks
Silurian						
1	159					
2	–269					
3	–15					
Total	–125	–11,400	Table A2–3	500	Darcy, water budget (see text)	Most water consumed in areas upgradient from boundary (table A2–3).
Spring–Mesquite						
1	84					
2	–866					
3	0					
4	0					
5	0					Flow is generally parallel to boundary. No significant flow overall, even though flow was estimated across subsegments 1 and 2.
6	0					
7	0					
Total	–782	No data		0	See text	
Las Vegas						
1	–942					
2	0					
3	–3,633					
Total	–4,575	No data		–4,575	Darcy (table A2–2)	
Sheep Range						
1	–4,410					
2	–15,305					
3	–4,959					
4	5,927					
Total	–18,747	No data		–18,747	Darcy (table A2–2)	Net value (table A2–4 and text).
Pahranagat						
1	1827					
2	–2,345					
3	–102					
4	359					
5	–2,521					
Total	–2,783	No data		–2,783	Darcy (table A2–2)	Inflow and outflow (table A2–4).
Garden–Coal						
1	999					
2	806					
3	2,234					
Total	4,139	No data		4,139	Darcy (table A2–2)	
Stone Cabin–Railroad						
1	768					
2	4,698					
3	62					
4	7,235					
5	1,248					
Total	12,476	65,900	Table A2–5	12,476	Darcy (table A2–2; see text)	Recharge exceeds discharge (table A2–5)

Table A2–9. Summary of boundary flow estimates for the Death Valley regional ground-water flow system model.—Continued

[m^3/d, cubic meters per day]

Model boundary segment and subsegment (fig. A2–3)	Flow estimated by Darcy method (table A2–2) (m^3/d)	Flow estimated by water-budget method (m^3/d)	Source of water-budget estimate	Most reasonable estimate of flow (m^3/d)	Basis of most reasonable estimate	Remarks
Clayton						
1	28					
2	388					
3	63					
4	188					
Total	667	6,000	Table A2–6	667	Darcy (see text)	Most recharge consumed by evapotranspiration (table A2–6)
Eureka and Saline						
Eureka						
1	19,975					
Saline						
1	–777					
2	475					
3	600					
4	0					
Subtotal	898					
Combined total	20,873	14,600 to 15,600	Table A2–7	15,100	Darcy, water budget	
Panamint						
1	2,128					
2	10,730					
3	996					
4	195					
Total	14,050	14,000 to 16,000	Table A2–8	15,000	Darcy, water budget (table A2–8, see text)	
Owlshead						
1	304					
2	337					
3	1,682					
4	59					
Total	2,382	No data		2,382	Darcy (table A2–2)	Maximum value

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