Ground-Water Levels in Huron County, Michigan, 1997 - 1998

U.S. GEOLOGICAL SURVEY

Open-File Report 99-186

Prepared in cooperation with Huron County, Michigan

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By M.J. Sweat

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EXECUTIVE SUMMARY

In 1990, the U.S. Geological Survey (USGS) completed a study of the hydrogeology of Huron County, Michigan (Sweat, 1991). In 1993, Huron County and the USGS entered into an agreement to continue collecting water levels at selected wells throughout Huron County. As part of the agreement, the USGS has provided training and instrumentation for County personnel to measure, on a quarterly basis, the depth to water below the land surface in selected wells. The agreement includes the operation of continuous water-level recorders, currently installed on four wells in Bingham, Fairhaven, Grant and Lake Townships (fig. 1). County personnel make quarterly water-level measurements of 23 other wells. Once each year, County personnel are accompanied by USGS personnel who provide a quality assurance/quality control check of all measurements being made.

In 1998, the USGS completed a temporal and spatial analysis of the quarterly monitoring well network in Huron County (Holtschlag and Sweat, 1998). This study found that, in general, water levels were relatively constant for the period of record, with seasonal variations in water levels in all but 1 well. Half of all the uncertainty in measured water levels could be explained by data from 6 wells. Should reductions in the network be necessary, the minimum configuration of wells required to provide reliable water-level data would be quarterly measurements in wells H6, H5r, H15B, H25Ar, H26, and H9r.

Precipitation and the altitude of Lake Huron are good indicators of general climatic conditions and, therefore, provide an environmental context for groundwater levels in Huron County. Figure 2 shows the mean monthly water-level altitude of Lake Huron, averaged from measurements made by U.S. Army Corps of Engineers at two sites, and mean monthly precipitation as recorded in Huron County, for the period October 1988 through December 1998. In general, Lake Huron water levels in 1997-98 were about the same as they were from 1992-96 (NOAA, 1988-96), although they were generally higher than the previously recorded highest levels of 1993. 1997 now represents the highest year in the period of record. Precipitation was generally within the normal to below normal range in 1997-98.

Hydrographs are presented for each of four wells with water-level recorders. Quarterly water-level measurements made during 1997-98, and the range of water levels for the period of record for the other 23 wells, are shown graphically and in a table.

In general, water levels in the glaciofluvial aquifer reflect seasonal variations, with maximum depths to water occurring in late summer and early fall and minimum depths to water occurring in late winter and early spring. In general, wells completed in the lower part of the Marshall aquifer showed a decrease in water-level altitude from the original project period (1988-90) with many at new lows for the period of record. Wells completed in the upper part of the Marshall aquifer continued to have lower water-level altitudes in 1997-98 compared to previous years. Wells completed in the Saginaw aquifer showed water-level altitudes in 1997 similar to those from 1993-96. However, water-level altitudes in 1998 tended to be lower than in previous years, with 3 of 5 wells exhibiting near record low water level altitudes. Water-level altitudes in wells completed in the Coldwater confining unit showed incremental decreases from 1996 and approached the minimum of record in all wells in 1998. Water-level altitudes throughout the County during 1997-98 were generally in the range for the period of record, with the exception of September and December 1998 when noticeable declines occurred, especially in the Marshall Formation. Water levels in wells completed in the Marshall Formation approached or set new lows in 12 of 23 wells. All wells with recorders had lower water levels near the end of 1998 than in 1996. In well H5r, water levels in March 1998 had recovered to greater than the long-term record from 1988-1997; in all other wells with recorders, levels were lower than the long-term average. Below average precipitation for much of the last 2 years likely accounts for most of the decline noted.

Glaciofluvial Aquifer Well

The Grant Township well (H2r) is completed in unconsolidated sand of the glaciofluvial aquifer. The well is 91 feet (ft) deep and cased to 87 ft. The well is screened in unconsolidated sand between 87-91 ft. A continuous water-level recorder was installed in February 1991 and has operated continuously since then. Shallow wells in unconfined glaciofluvial aquifers more closely reflect day-to-day water level changes mainly caused by recharge from precipitation than do deep wells in confined bedrock aquifers.

Figure 3 shows a hydrograph of Grant Township well H2r compared with monthly precipitation at Bad Axe, Michigan. The depth to the water table is affected mostly by evapotranspiration and recharge. In general,

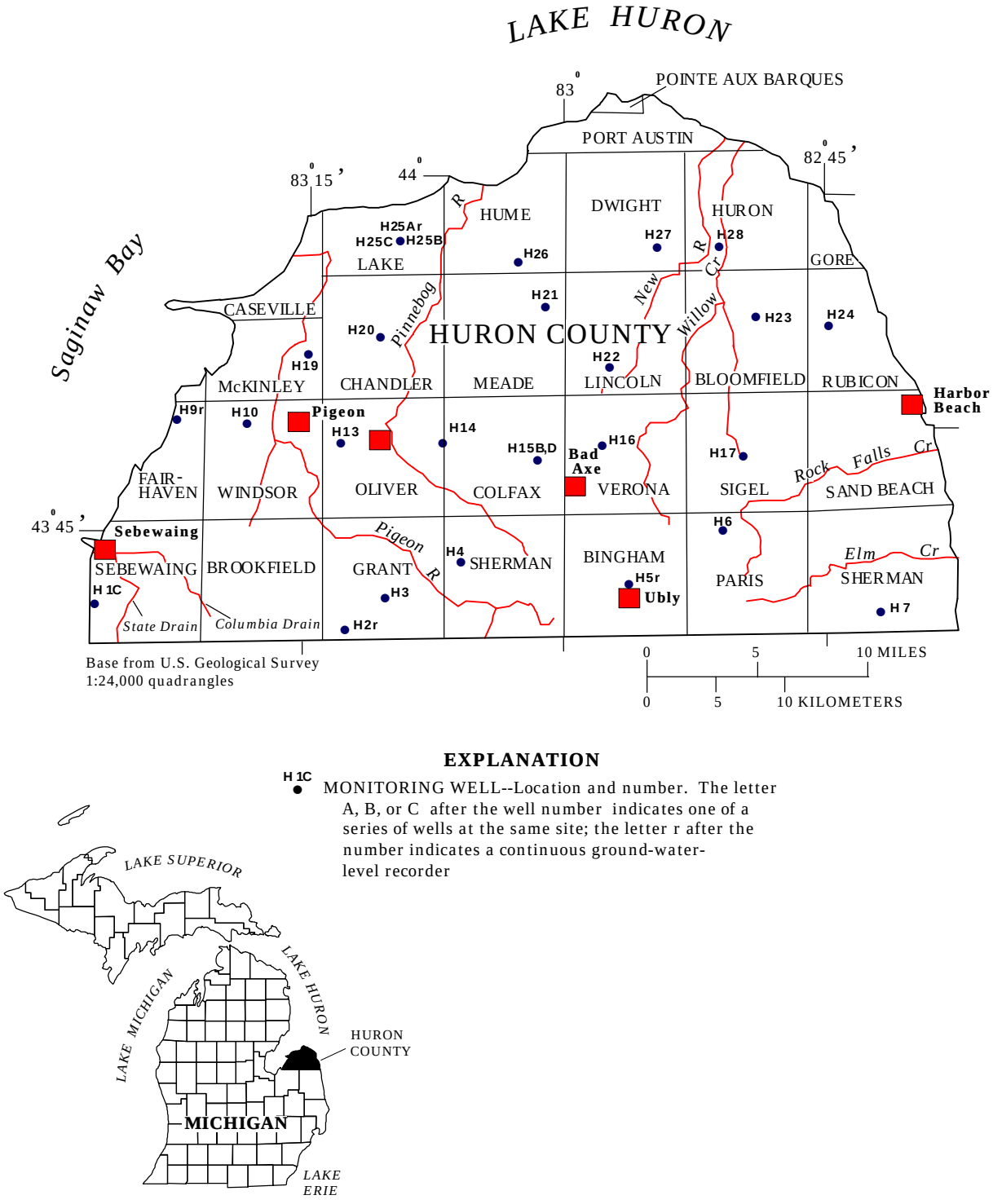

Figure 1. Location of monitoring wells in Huron County, Michigan.

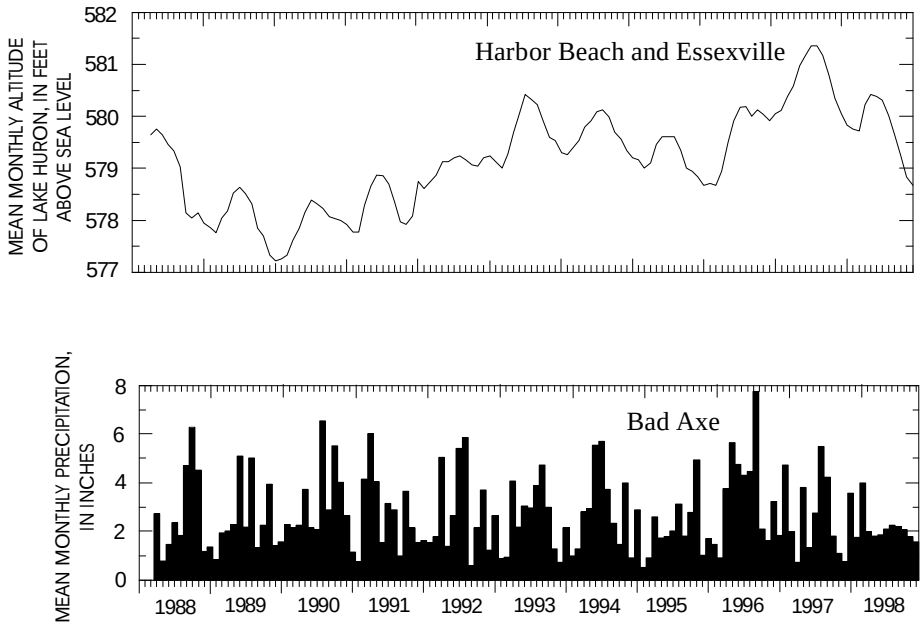

Figure 2. Mean monthly water-level altitude of Lake Huron averaged from measurements made at Harbor Beach and Essexville, and mean monthly precipitation at Bad Axe, Huron County, Michigan.

precipitation in fall through early spring exceeds evapotranspiration which allows infiltrated water to recharge the aquifer causing the water table to rise. From late spring through summer, evapotranspiration generally exceeds precipitation and infiltration to the water table is limited. Water levels in 1997-98 compared favorably to expected normals and long-term averages, although they began to decline significantly in late 1998. This is likely the result of a combination of factors, foremost among them the lesser amount of precipitation in the County from late 1997 through 1998. The decline in water levels seen in July-August 1998, normally attributed to irrigation withdrawals, is most likely aggravated in 1998 because of below normal precipitation, both preceding and during this time period. Similarly, the lower than expected December water level is likely a result of continued below-normal precipitation, which in turn causes lower than normal recharge to the aquifer.

Marshall Aquifer Wells

Wells instrumented with recorders and completed in the Marshall aquifer are in Bingham and Lake Townships. The Bingham Township well (H5r) is 160 ft deep and is cased to 112 ft below land surface. The bottom 48 ft of the hole are open to sandstone of the Marshall aquifer. It is located near the former Ubly landfill, just north of the village limits. A continuous water-level recorder was first installed in December 1988 and was operated until April 1990. A recorder was reinstalled in January 1993 and, except for a three-month period in early 1993, has been operated continuously since then. Well H5r is affected by nearby local pumpage of a supply well for the Village of Ubly, as shown by the cyclical variations of water levels on the hydrograph in figure 4. Water levels in this well also reflect normal seasonal variations: water levels are higher during late winter and early spring, and water levels are lowest during the late summer months. Maximum depth to water during 1997-98 was about 1 ft higher than during the previous year, and about 2 ft higher than during the original project period (1988-90). However, water levels failed to recover near the end of 1998 as would have been expected, based on the previous record.

The Lake Township well (H25Ar) is 200 ft deep and is cased to 180 ft. The well is open to the Marshall aquifer between 180-200 ft. Located on the southern shore of Rush Lake in northwestern Huron County, it is the deepest of three wells located at this site. A continuous water-level recorder was first installed in October 1988 and operated until September 1989. A recorder was reinstalled in December 1992 and has been operated continuously since then. Water levels in the Lake Township well are influenced by normal seasonal fluctuations and by nearby irrigation pumpage, as shown in figure 5. Winter and spring water levels during 1997-98 were about 2 ft and 1 ft higher than during the preceding

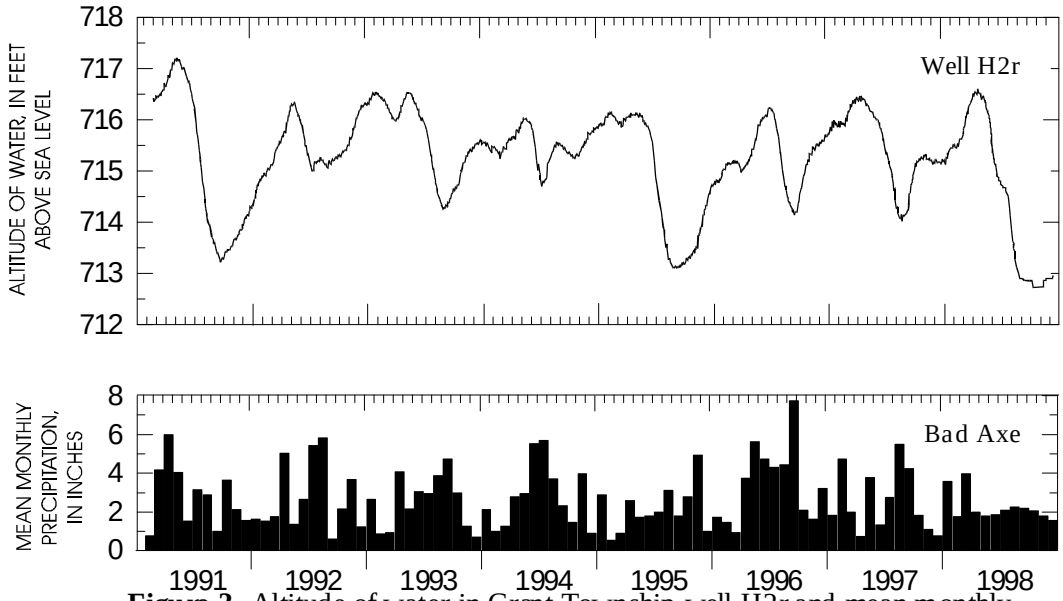

Figure 3. Altitude of water in Grant Township well H2r and mean monthly precipitation at Bad Axe, February 1991 through December 1998, Huron County, Michigan.

year, respectively, and similarly higher than during the original project period; however, water levels in September and December 1998 also approached or set new all time lows.

Eighteen wells completed in the Marshall aquifer are measured quarterly (table 1). Water levels are measured in each well by recording the distance from the top of the well casing to the water surface in each well. Depths listed in table 1 are depth to water below this measuring point. The wells are listed by their identifier (fig. 1). Depth to water generally varied by less than 4 feet from the driest to the wettest part of the year (fig. 6), although in some wells water levels varied by more than 10 ft (H4, H17, and H26). The greatest depth to water was generally measured in September and December 1998. Water levels in well H17, which in September 1995 were lower than at any time previously measured, were at greater levels in March and June 1997, and March 1998, than at any time previously measured. This is possibly due to reduced irrigation withdrawals in Sigel Township in 1997 (Solley and others, 1993, p37; Solley and others, 1995, p35; Jim LeCureux, oral communication, 1997, 1998). Well H17 is located within a quarter mile of a high volume irrigation well, and is within 1 mile of other irrigation wells.

In 1997-98, many wells either approached (1 well) or exceeded (13 wells) their lowest water-level altitudes. The lowest altitude, which was measured in September or December of each year, likely reflects the current period's below-average precipitation and resultant lower winter recharge. In March 1998, well H5r recorded it's highest water-level altitude, which is likely a reflection of changes in pumping patterns in nearby city and industrial wells.

Figure 6 shows hydrographs of quarterly water-level altitudes during the current measuring period compared to the historical high and low water-level altitudes measured during the original project period.

Saginaw Aquifer Wells

The Fairhaven Township well (H9r) is completed in the Saginaw aquifer and is located on the County's western shore (Saginaw Bay), at the eastern edge of Wild Fowl Bay. It is 181 ft deep and cased to 167 ft. The well is open to limestone, shale, and sandstone of the Saginaw aquifer between 167 and 181 ft. A continuous water-level recorder was installed in well H9r in February 1991 and has been operated continuously since then. Water levels in well H9r show normal seasonal fluctuations (fig. 7) that generally precede those on Lake Huron by 3 to 6 months. In general, water levels in well H9r continued to be lower during 1997-98 than in previous years; however, water levels measured in 1997 through mid -1998 are between 1 and 2 ft higher than the lowest water level measured in 1995. Beginning in June 1998, water levels began declining rapidly, reaching new record lows sometime in July-August, 1998. At the end of the year in 1998, water levels were still below long term averages for the period of record. Water levels in

Table 1. Periodic depth to water for selected wells, Huron County, Michigan, 1997-98

[G, indicates well in glaciofluvial aquifer; S, indicates well in Saginaw aquifer; M, indicates well in Marshall aquifer; C, indicates well in Coldwater confining unit; **BOLD** type indicates new maximum depth to water; ***BOLD*** type indicates a new minimum depth to water; --, indicates measurement not made]

Well Number	Aquifer Code	Altitude of measuring point, in ft	Depth to water below measuring point, in feet							
			3/97	6/97	9/97	12/97	3/98	6/98	9/98	12/98
H1C	S	600.00	17.41	16.65	17.34	17.25	16.78	17.28	22.93	18.85
H2r	G	747.60	32.36	31.60	33.04	32.39	31.39	32.71	**34.73**	34.64
H3	M	731.70	28.45	28.89	30.09	29.51	28.68	30.56	**32.68**	31.93
H4	M	751.60	12.03	12.81	12.94	13.10	12.06	13.57	**15.76**	**15.92**
H5r	M	796.03	12.63	11.02	12.36	12.09	10.52	11.73	13.82	13.40
H6	M	781.50	12.92	13.59	15.24	13.99	13.10	14.77	**18.11**	**18.98**
H7	C	726.80	16.55	16.69	17.37	17.35	17.12	17.18	17.93	18.07
H9r	S	584.20	4.89	4.82	5.44	4.78	4.33	4.65	8.89	7.69
H10	S	617.07	23.60	24.05	24.83	24.72	23.75	24.53	26.23	26.49
H13	S	642.35	31.26	31.82	34.36	31.80	30.58	32.58	**38.2**	34.54
H14	M	681.30	4.16	4.35	5.99	4.62	4.05	6.34	**8.75**	7.63
H15B	M	751.20	15.44	16.40	17.93	18.50	15.71	19.57	20.47	19.99
H15D[a]	M		--	--	--	***17.08***	18.88	23.06	**24.71**	23.01
H16	M	771.50	28.85	28.91	30.18	29.57	29.26	30.42	30.36	**33.65**
H17	M	751.00	5.56	5.81	10.29	6.38	***5.38***	7.49	22.02	12.27
H19	M	611.90	3.83	4.48	4.33	3.31	3.75	4.44	4.69	5.15
H20	S	631.00	13.65	***13.12***	14.16	14.15	***13.11***	13.76	15.23	**16.23**
H21	M	702.90	9.46	9.99	10.87	10.10	9.51	10.87	**13.91**	**15.11**
H22	M	695.50	13.11	13.57	14.98	14.19	13.36	14.80	**17.58**	**18.61**
H23	C	721.80	9.38	9.38	9.32	9.37	9.49	9.70	10.03	10.31
H24	C	691.50	25.24	25.55	26.34	25.92	25.64	26.10	27.42	27.89
H25Ar	M	600.80	***5.13***	5.39	6.58	6.08	5.46	6.65	**8.73**	**9.62**
H25B	M	601.00	***1.30***	1.85	3.09	2.77	1.62	3.18	**5.93**	**5.98**
H25C	M	602.20	2.71	3.51	3.41	4.08	3.06	4.45	**7.18**	6.19
H26	M	662.70	3.45	4.32	3.96	4.44	4.00	6.72	**11.42**	**12.85**
H27	M	716.50	32.06	32.43	**38.86**	33.83	32.85	34.25	**36.95**	**38.25**
H28	M	691.70	18.53	19.35	20.95	19.93	18.51	21.22	**24.62**	**25.41**

a. Well drilled September 1997.

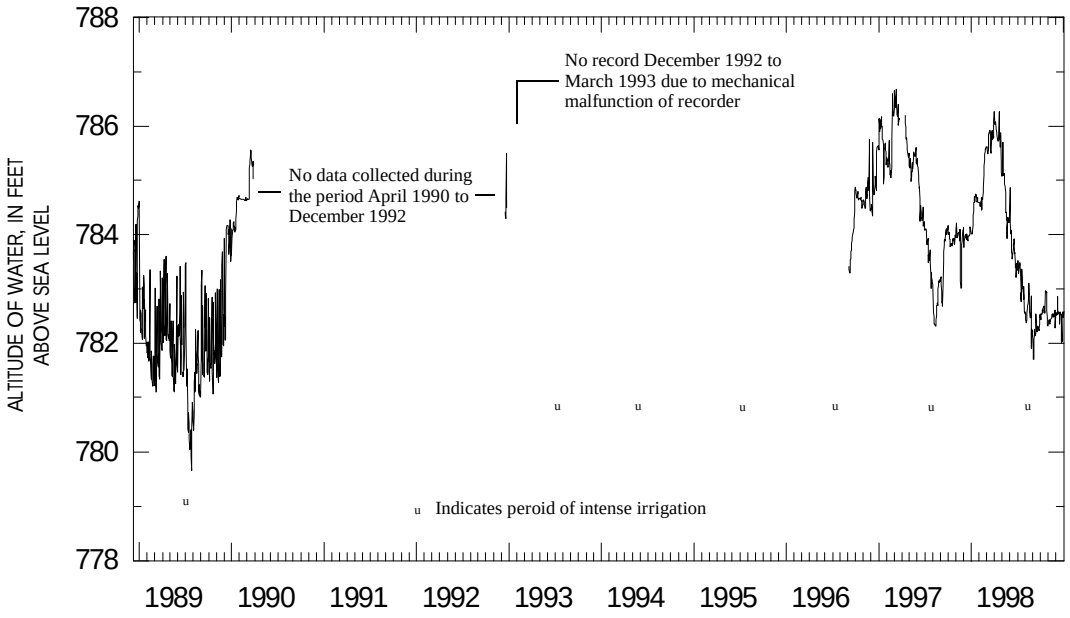

Figure 4. Altitude of water in Bingham Township well H5r, December 1988 through December 1998, Huron County, Michigan.

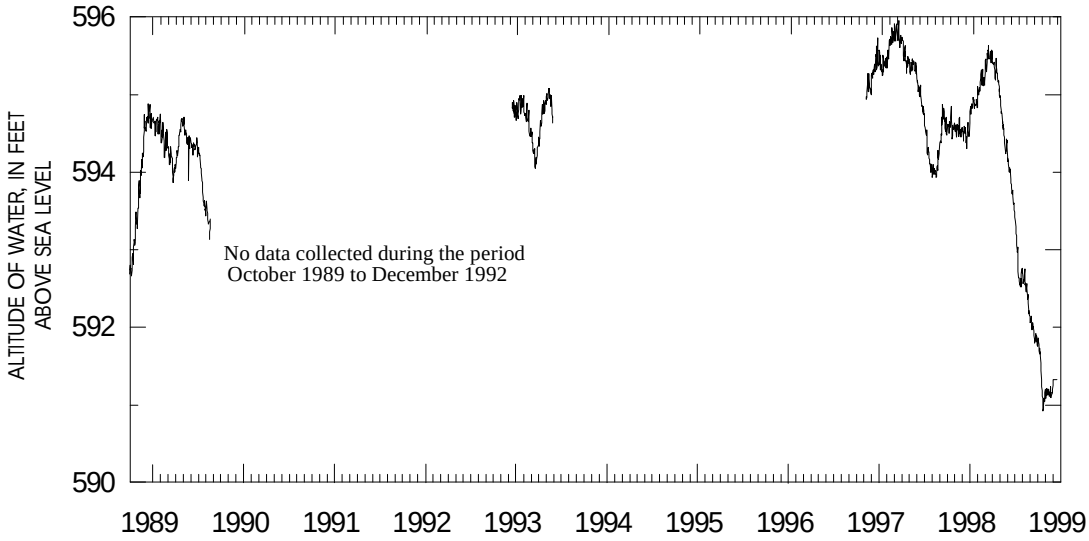

Figure 5. Altitude of water in Lake Township well H25Ar, October 1988 through December 1998, Huron County, Michigan.

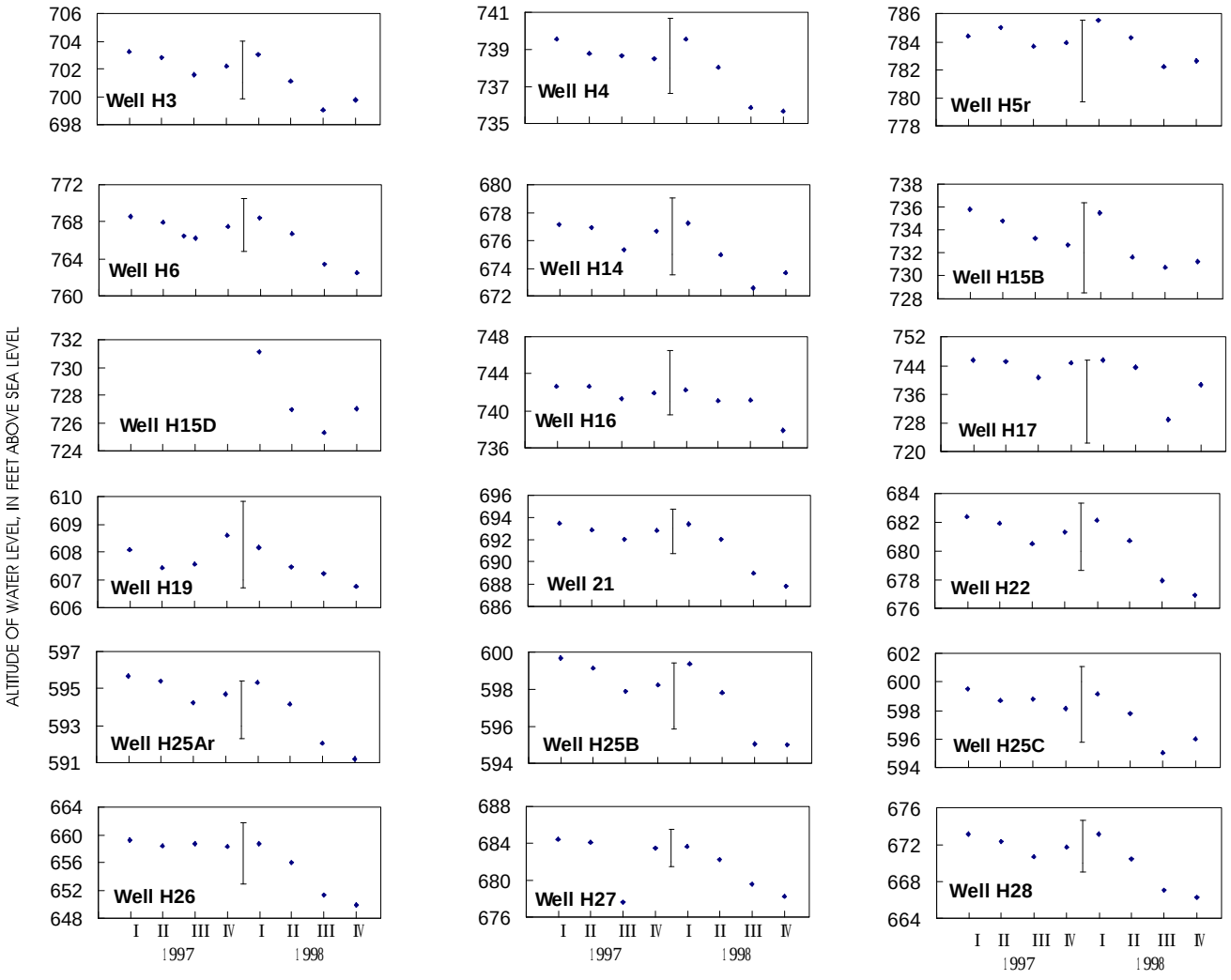

Figure 6. Altitude of water levels in wells completed in the Marshall aquifer, showing range of altitudes for the period October 1988 through December 1996, and quarterly altitudes for the period January 1997 through December 1998, Huron County, Michigan.

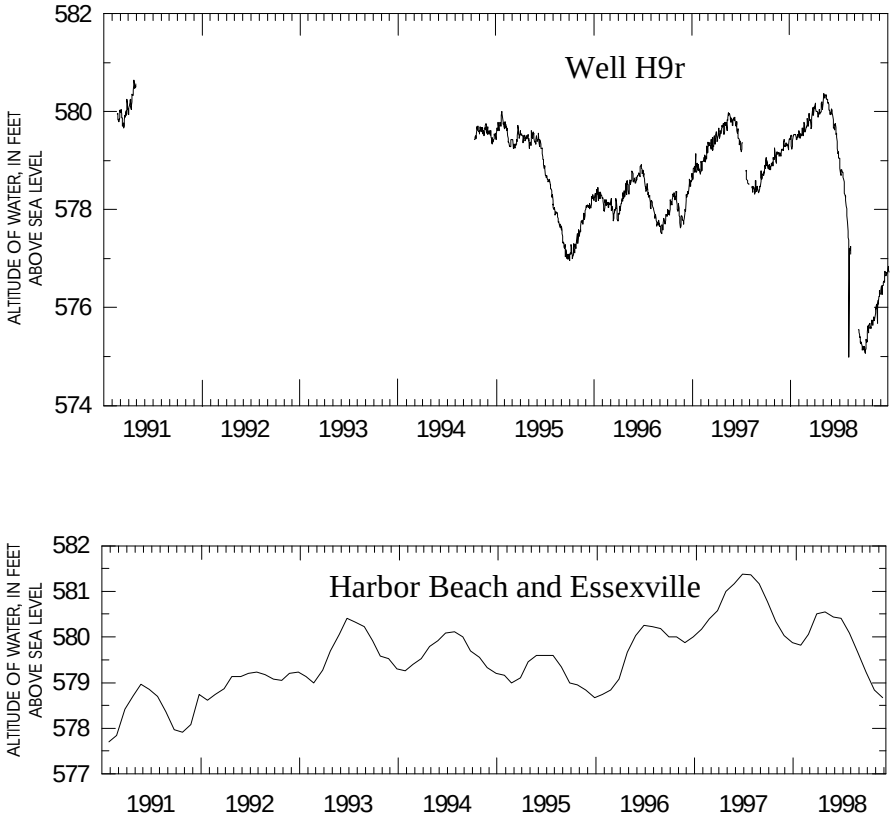

Figure 7. Altitude of water in Fairhaven Township well H9r, and mean monthly water-level altitude of Lake Huron averaged from measurements made at Harbor Beach and Essexville, February 1991 through December 1998, Huron County, Michigan.

Lake Huron rose through mid-1997 and then declined by almost 3 ft through December 1998.

Quarterly water-level altitudes (table 1) measured during 1997-98 are compared to the historical high and low water-level altitudes as previously measured (1988-96) in hydrographs presented in figure 8. These hydrographs include five wells completed in the Saginaw aquifer in Huron County (fig. 1) including well H9r for which a continuous hydrograph was previously shown (fig. 7). The historical low water-level altitude for these wells was approached in all wells during 1998, and exceeded in 2 wells in September (H13, H20).

Coldwater Confining Unit Wells

Water levels in three wells completed in shale, sandstone, and sandy shale of the Coldwater confining unit are measured quarterly (table 1). Water levels in these wells declined by one to two feet throughout the current measuring period. This is typical of wells in consolidated, low hydraulic conductivity rocks from which little if any water is produced and into or through which only small amounts of water can pass under non-stress conditions. There are no wells completed in the Coldwater confining unit with continuous recorders because water levels are not expected to vary significantly over time in this unit. Hydrographs in figure 9 show this: all wells completed in the Coldwater began to show gradual water level decreases from the previous year; all were near their respective historical low water altitudes for the period of record by the December 1998. Table 1 lists all water-level measurements made for these wells, and shows that most fluctuations in water level in the Coldwater confining unit are small and gradual.

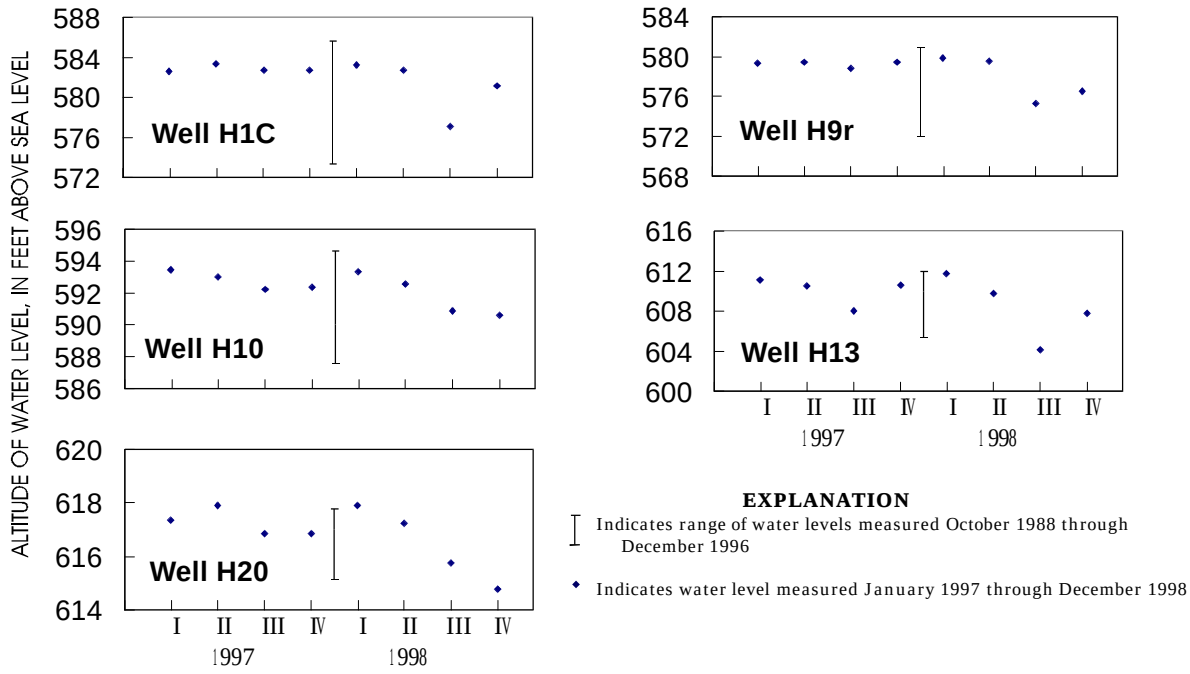

Figure 8. Altitude of water levels in wells completed in the Saginaw aquifer, showing range of altitudes for the period October 1988 through December 1996, and quarterly altitudes for the period January 1997 through December 1998, Huron County, Michigan.

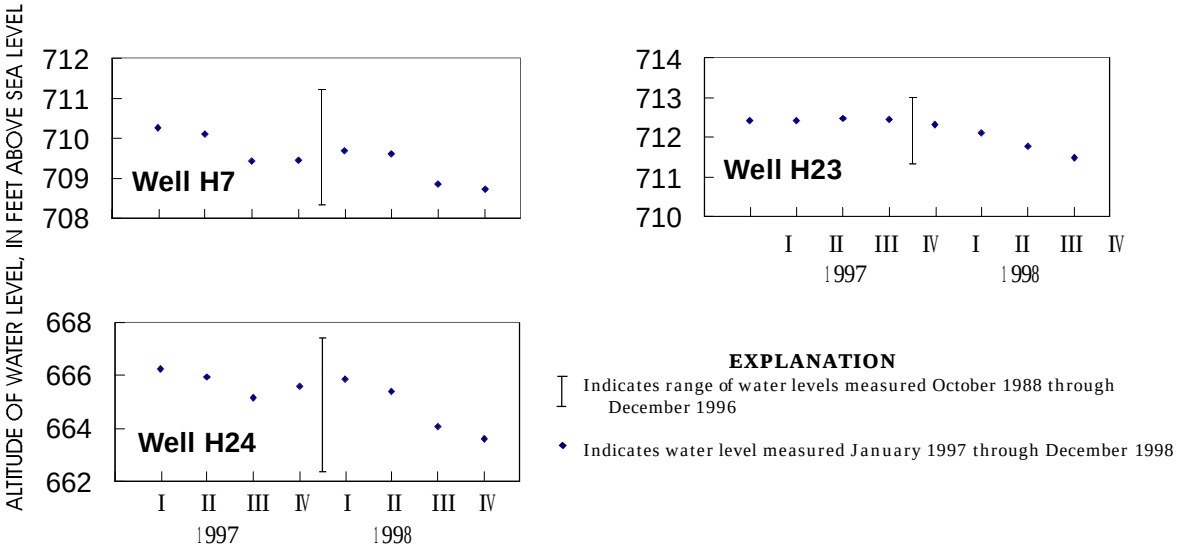

Figure 9. Altitude of water levels in wells completed in the Coldwater confining unit, showing range of altitudes for the period October 1988 through December 1996, and quarterly altitudes for the period January 1997 through December 1998, Huron County, Michigan

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