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To	Town of Mashpee Sewer Commission		
Copy to	Watershed Nitrogen Management Plan		
From	J. Jefferson Gregg, P.E.	Tel	774-470-1640
Subject	Hydraulic Load Test—Site 4 (Transfer Station)	Job No.	8612001

Developed and reviewed in 2011 by Mashpee Sewer Commission; finalized as part of CWMP in 2014.

The Town of Mashpee (Town) is undertaking a Watershed Nitrogen Management Plan to address nitrogen enrichment issues in the Town's estuaries. One management approach is to collect wastewater, treat it to a very high level, and then recharge the treated effluent back to the ground. A key element of that planning process is identifying sites in the Town where treated effluent can be recharged to the groundwater. The purpose of this memorandum is to summarize the findings of a hydraulic load test performed at one of these sites, Site 4 (Transfer Station Site). The memorandum describes the testing that was completed and estimates this site's suitability for receiving and infiltrating treated effluent.

1 Site History

1.1 Background

The Town identified a number of sites to be considered for treated effluent recharge. After a preliminary evaluation of the identified sites, the Town decided to move forward with hydraulic load testing on one site (Site 4 – Transfer Station) to determine a reasonable rate of recharge that could be expected.

1.2 Preliminary Site Characterization

Approximately 13 acres on the eastern side of the Mashpee municipal landfill/transfer station property is currently an undeveloped parcel in the Upper Mashpee River subwatershed of the Popponesset Bay watershed. The 2008 Draft Alternative Scenarios Analysis and Site Evaluation Report indicated that the site has the advantages of being Town-owned, adjacent to another municipal facility (capped landfill/transfer station), easy access, central location, flat topography, is outside of a Zone II area (contribution to an existing water supply well), and was initially identified as outside of a rare species habitat. The disadvantages of the site were its proximity to residential properties and its location within the Town-designated groundwater protection district. The site is also located within one of the more sensitive watersheds, Upper Mashpee River. In addition to these disadvantages, the site was later remapped by the Division of Fisheries & Wildlife as being located within a Priority Habitat and Estimated Habitat. The site was also identified by the Massachusetts Historical Commission as a possible location of archaeological deposits. As a result of the last finding, a detailed archaeological site study was performed by the Public Archaeology Laboratory (PAL) and the results of the testing "identified no archaeological deposits in the areas tested."

Despite the several disadvantages, the site was still favorable and the results of the PAL study and Division of Fisheries and Wildlife regulations related to site investigations still allowed for further investigation and hydraulic load tests.

A conceptual layout of open sand beds on the site indicated that approximately 1.0 million gallons per day of treated wastewater could be discharged at the site based on the standard loading rate of 5 gallons per day per square foot (gpd/sf) over approximately 4.5 acres of the parcel.

After the initial screening process, larger-scale loading tests were performed to further evaluate the infiltration capacity of the site soils. The loading tests evaluated the site's infiltration capacity using thousands of gallons of water rather than a few gallons of water, as are used for percolation tests, with the goal of either considering a greater loading or a reduction in footprint size by allowing the higher loading rates.

The Massachusetts Department of Environmental Protection (MassDEP) accepted standard application rate for recharging effluent is 5 gpd/sf. The loading tests were established to determine whether this loading rate can be increased based on actual site conditions, providing the project greater flexibility in either higher discharge volumes and/or smaller discharge footprint.

2 Field Investigation

2.1 Loading Tests

Loading tests are essentially large-scale percolation tests. They are accomplished by applying large quantities of water to basins with a specific surface area to allow the calculation of an infiltration rate in minutes per inch and in gallons per day per square foot. The general protocol for completing loading tests is described in the USEPA Process Design Manual – Land Treatment of Municipal Wastewater (1981).

2.2 Test Preparation

Empty test basin

Two locations within the site were identified to serve as test locations. After the site was cleared, monitoring wells were installed at the two test locations and at a third location to provide baseline information (see boring logs in Appendix A). Monitoring wells were drilled to a depth of 10-feet below the water table. The bottoms of the wells were set with 10 feet of PVC screened pipe. The tops of the wells were protected with steel casings. Test pits were then excavated in close proximity to each of the three monitoring wells to determine the depth to sandy materials free of loam and silt materials. Field reports for the test pits (included in Appendix B) indicate that medium sand was encountered between 26 and 64 inches.

One 10-foot diameter basin was installed at each test location. Figure 1 is a site map showing the approximate locations of the test basins and monitoring wells. The basins served as the infiltration sites for the loading tests and the observation wells were used for monitoring the water table response to the infiltration tests. The basins were provided by an outside contractor and consisted of prefabricated 10-foot diameter, 30-inch tall, 3/16-inch thick, aluminum “rings” which served as the walls of the basin as shown here.

Excavations were made that were sufficiently deep enough to allow the basins to be set in the sandy soils. After being set in place, material was placed behind the walls of the test basins to secure them in place.

Both basins were provided with water by means of a fire hydrant on the transfer station property. Fire hose was laid from the hydrant to the basins. Basin Number 1 was approximately 600 feet from the hydrant, whereas Basin Number 2 was approximately 1,200 feet from the hydrant. The Mashpee Water District provided the water meter and backflow preventer. A valve for controlling flow was located at each test basin.

2.3 Constant Head and Falling Tests

A series of tests were conducted at the basins over a one-week period. Appendix C includes selected photographs taken during the testing. One basin test was conducted at a time. Each series of tests took three days. The testing was completed on the schedule as illustrated in Table 1.

The basin testing included three phases, as indicated on the schedule: saturation, constant head testing, and falling head testing. Each phase is described below.

2.3.1 Saturation

The soils at each basin were saturated before testing began. This was done by supplying water to each basin for a 24-hour period. Flow into each basin was sustained at a rate that would keep a generally constant level of water in the test basin, although the exact level was not a factor. Prior to leaving the site for the day, it was possible to adjust the flow into the basins to a rate that kept water in the basins overnight at a relatively constant head.

Constant head test in progress

2.3.2 Constant Head Test

The constant head tests were performed first. The test was started after the basins had been saturated for approximately 24 hours. The constant head test was performed by documenting the water level in the basin and supplying enough flow to maintain this level over the course of an eight hour test period. In the early stages of the test, the flow rate had to be adjusted periodically to keep the water level in the basin

constant. During the test, the water level was recorded, the flow rate was measured, and the observation well water levels were measured throughout the testing. In the constant head tests, the infiltration capacity was measured in gallons per minute (gpm) as water was added to the 10-foot infiltration basin at the same rate that the water infiltrates out of the basin. Flow rate was measured at the spigots using containers of known volume and a stop watch. By dividing the rate of flow by the square foot area of the basin, an infiltration capacity in gallons per day per square foot is calculated.

At the end of the day of constant head testing, the basins were again supplied with a constant flow overnight to maintain saturated conditions.

For Test Basin Number 1, water level was maintained at 15 inches, and for Test Basin Number 2 the water level was maintained between 23 and 25 inches.

2.3.3 Falling Head Test

The falling head tests were started the day after the constant head tests. These tests were performed by filling the basin to a specific level (25 inches at each basin) and then cutting off the water supply and observing the rate at which the water level in the basin dropped. The falling head tests were repeated several times (4 runs for Test Basin No. 1 and 5 runs for Test Basin No. 2) by refilling the basin after the water level had dropped to the bottom of the test basin. During the falling head tests, infiltration was measured in inches per hour. This result was converted to cubic feet per hour and subsequently to gallons per day per square foot. Water levels in the monitoring wells were observed at the beginning and the end of the falling head tests.

3 FINDINGS AND CONCLUSIONS

3.1 Subsurface Conditions

The surface elevation at the two test sites is approximately 70 feet, and the bottom of each basin was located approximately 50 to 60 inches (approximately 4 to 5 feet) below the ground surface. Depth to groundwater at the sites ranges from 48 to 50.5 feet below the ground surface, depending on the surface elevation; and groundwater at the site is found in the elevation interval between 21 and 23 feet. Based on information from the Massachusetts Estuaries Project reports, groundwater is within the Mashpee River subwatershed of the Popponesset Bay watershed.

Overall, the subsurface soil conditions, as identified in the test pit logs (see Appendix B), are generally homogeneous, comprised of medium sand with traces of finer grained materials and gravels at the elevation of the bottom of the basin. The predominance of the sand suggests suitable conditions for infiltration of treated wastewater.

3.2 Constant Head Test Results

The first set of testing at each basin was constant head testing. As described above, the constant head testing entailed adding water to the basins at the same rate that water drained out of the basin.

During the testing period, flow was measured with a 5-gallon bucket and a stopwatch. The valve used for flow control was adjusted as necessary to increase or decrease the flow. As a result, conversion from gallons per minute to gpd/sf showed some variation as a result of the adjustments to the flow control valves in order to maintain a flow rate equivalent to the infiltration rate. This being considered, the infiltration rates from constant head tests remained generally consistent. The raw data from the constant head tests is presented in Table 2 and summarized in Table 3. The basins generally accepted a flow of 39 to 98 gpm. Using the lowest rate observed, 39 gpm as a conservative estimate of the loading rate, this equates to 56,200 gallons per day (gpd). The discharge of 56,200 gpd in a 10-foot diameter basin (surface area 78.5 sq. ft.) equates to approximately 720 gpd/sf.

USEPA protocols for conducting loading tests suggest that, although loading tests are probably the most accurate means of estimating loading rate, loading tests have a greater horizontal flow component than full-scale installations; therefore, loading tests overestimate full-scale capacity. Therefore, USEPA recommends design rates that are only 10 to 15 percent of observed rates in loading tests. The loading tests suggest an infiltration rate of approximately 720 gpd/sf, hence a design loading rate of up to 72 gpd/sf can be considered reasonable. MassDEP suggests a maximum design loading rate of 5 gpd/sf, but allows proponents to make a demonstration for a greater loading rate through hydraulic loading tests and through longer-term operations.

Therefore, based on the results of the constant head testing, a design loading rate of up to 72 gpd/sf would be considered, which is significantly higher than the MassDEP-recommended rate of 5 gpd/sf for rapid infiltration beds, which would appear to be very conservative for this site.

3.3 Falling Head Tests Results

As an alternate methodology to the constant head test results, falling head tests were performed in each of the basins after the constant head tests were completed. Between the test runs, water was continuously added to the basins to retain the saturated soil conditions.

To complete the falling head tests, basins were filled to a specific measured mark. The water supply was then turned off and the rate at which the water level in the basin dropped was recorded. The falling head tests were repeated as many times as possible within an 8-hour day at each basin, with the basin being refilled at the beginning of each test run. The results of the falling head tests are presented in Tables 4 and 5.

Infiltration rate is presented in three different units on the tables: minutes per inch, inches per hour, and gallons per day per square foot (gpd/sf). Infiltration rates in gpd/sf for all of the tests are summarized on Figure 2. Based on four test runs, the average infiltration rates in gpd/sf for Basin Number 1 was 970 gpd/sf;

and based on five test runs, the average was 998 gpd/sf for Basin Number 2. The average result over both sites was approximately 990 gpd/sf. Using the EPA criteria of 10 percent of the average infiltration test rate, a design loading rate of 98 gpd/sf is calculated.

3.4 Mounding Impacts

Two observation wells were located in close proximity to the test basins. The water levels in these wells were monitored throughout the three days of testing at each location. Water level data is depicted graphically on Figure 3.

There was minimal precipitation during the testing, which was initiated on April 18, 2011. Table 1 includes precipitation data for the testing period. However, the month of April saw higher than average rainfalls. Rainfall for the month of April totaled 5.40 inches, whereas the average rainfall for April is 4.25 inches (www.weather.com). Due to the excessive rain, the water tables may have been higher than normal.

A rise of 2 to 2.5 feet in the water table elevation immediately adjacent to the test basins can be seen over the course of the three days of testing. The water level in the background well also rose approximately 0.5 feet over the course of the test, although this was not likely a result of the testing, as can be seen from the rising levels beginning prior to the start of the testing. A mounding analysis will be performed and the results will be incorporated into the WNMP.

3.5 Groundwater Monitoring Analysis

Following the load testing, a groundwater modeling analysis was performed by GeoHydroCycle of Newton, Massachusetts in July 2011. The results of this analysis and associated figures are included in Appendix D.

In general, the analysis was performed on several scenarios for loading various beds. Six alternatives with an increasing rate of recharge were modeled. The 6 options were:

Option	Beds	Total Rate (gpd)	Rate Per Bed (gpd)
1	1	110,000	110,000
2	1 and 2	200,000	100,000
3	1, 2, and 3	330,000	110,000
4	1, 2, 3, 4, and 5	530,000	106,000
5	1, 2, 3, 4, and 5	500,000	100,000
6	1, 2, 3, 4, 5, 6, and 7	800,000	114,286

Bed locations are shown in Figure 1 of Appendix D. For each option, Figures 2 through 13 show the simulated mound height, and the mound added to local groundwater table. Local groundwater elevations were based on USGS data, and the unstressed groundwater table is shown in Figure 1A.

The modeling followed guidelines and procedures used for groundwater discharge permits in Massachusetts. The modeling parameters used in the mounding analysis was based on data for the constant head test based on the clear aquifer response they demonstrated. Based on this, the infiltration properties were as follows:

3.5.1 Basin No. 1

Average rate of 59.3 gpm, which converted to a daily rate over the basin area yields 144 cubic feet per day per square foot. The groundwater mound over the eight hour test was approximately 0.60 feet with the measured mound height estimated at the center of the basin. Given the loading parameters, the aquifer properties were back-calculated as a hydraulic conductivity of 250 feet per day and a saturated thickness of 50 feet. These values are consistent with those used by the USGS in their Cape modeling efforts.

3.5.2 Basin No. 2

Average rate of 59.7 gpm, which converted to a daily rate over the basin area yields 145 cubic feet per day per square foot. The groundwater mound over the eight hour test was approximately 0.45 feet. Again, it was assumed that the measured mound height was near the center of the basin. Given the loading parameters, the aquifer properties that produced a 0.45 foot mound were a hydraulic conductivity of 350 feet per day and a saturated thickness of 50 feet. These values are also consistent with those used by the USGS in their Cape modeling efforts.

Based on this information, the tests demonstrated representative infiltration properties of the soils, and representative hydraulic properties of the aquifer.

Mounding, depending on the recharge (gpd) selected could range between 0.6 feet at the beds to over three feet at the center for high discharge rate (groundwater table elevations of 23 to 26 feet); however, still well below local ground elevations of 70 feet. Actual recharge rate will be dependent on recommended plan and allowable nitrogen load is anticipated to be less than 400,000 gpd.

4 TEST SUMMARY AND CONCLUSIONS

Hydraulic loading tests were completed between April 18 and April 22, 2011. Testing was performed at two 10-foot basins. Testing was comprised of:

1. One day of saturating the soils beneath the basins for a 24-hour period by sustaining a water level in the basins equivalent to what was infiltrating out of them.
2. One day of constant head testing, during which water was fed to the basin at the same rate that water drained from the basin, as indicated by a constant water level in the basin.
3. One day of falling head testing, recording the rate at which the water level in the basins dropped. This was repeated six times.

For the constant head testing, an average infiltration rate of approximately 720 gpd/sf for the two basins was calculated. Applying the USEPA design factor of 10 percent to that result, an appropriate design loading rate is 72 gpd/sf.

In the falling head testing, an average infiltration rate of approximately 990 gpd/sf for the two basins was calculated. If this rate is used and the USEPA design factor of 10 percent is applied to that result, this would equal a design loading rate of 98 gpd/sf for the site. As part of completing their WNMP, the Town needs to estimate capacities for any potential future recharge facilities. The Town will be able to save significant amounts of money if it can avoid having to build redundant infiltration beds that would be based on an overly conservative design rate of 5 gpd/sf.

Based on the USEPA guidance for acceptable loading rates for use in design, (10% of the observed rate) it is the recommendation that these findings be reviewed with MassDEP in order to establish an agreed upon loading rate for the site between the State valued of 5 gpd/sf and the observed 70 gpd/sf.

Tables & Figures

TABLE 1
TOWN OF MASHPEE
HYDRAULIC LOADING TESTS
TESTING SCHEDULE

Friday	Monday	Tuesday	Wednesday	Thursday	Friday
4/8/2011	4/11/2011	4/12/2011	40646	40647	4/15/2011
Monitoring Well Installation					
		Test Pits			
			Basins Excavated and Set Up		
					Temporary Piping Set Up

	Monday	Tuesday	Wednesday	Thursday	Friday
	4/18/2011	4/19/2011	4/20/2011	4/21/2011	4/22/2011
Test Basin #1	Saturation	Constant Head Test	Falling Head Test		
Test Basin #2			Saturation	Constant Head Test	Falling Head Test
Precipitation		0.04"			0.01"

TABLE 2
TOWN OF MASHPEE
HYDRAULIC LOADING TESTS
CONSTANT HEAD TESTING DATA

Test Basin #1

Tuesday April 19, 2011

Time	Flow (gpm)	Water Level (inches)*	Average Infiltration Rate (gpd/sq ft)
10:00	38.8	15.0	712
12:00	46.7	15.0	857
2:00	54.1	15.0	992
4:00	97.6	15.0	1790
Average	59.3		1213

Test Basin #2

Thursday April 21, 2011

Time	Flow (gpm)	Water Level (inches)*	Average Infiltration Rate (gpd/sq ft)
8:50	46.9	25	860
10:50	72.3	25	1326
12:50	67.4	24	1237
2:50	49.2	23	902
3:50	62.8	24	1152
Average	59.7		1095

* - Refers to water level in the test basin. 0 inches of water level was set at a point above the highest point of the test basin floor.

Lowest observed value

TABLE 3
TOWN OF MASHPEE
HYDRAULIC LOADING TESTS
CONSTANT HEAD TESTING RESULTS

Basin	Final Stabilized Flow Rate in gpm (1)	Final Stabilized Flow Rate in gpd	Basin Area Square Feet (2)	Infiltration Capacity gpd/sq. ft	Allowable Loading Rate gpd/sq. ft (3)
Test Basin #1	39	55922	78	717	72
Test Basin #2	47	67500	78	865	87

(1) To be conservative, based on lowest flow rate recorded

(2) Area = 3.14 x $(5\ ft)^2$

(3) Based on EPA guidance (Process Design Manual - Land Treatment of Municipal Wastewater) indicating loading rates should be based on 10-15% of measured basin infiltration rates

Minimum value

TABLE 4
TOWN OF MASHPEE
HYDRAULIC LOADING TESTS
FALLING HEAD TEST RESULTS - BASIN #1

Test Basin #1

Basin #1 Run #1

Inches	Time (minutes, cumulative)	Minutes/Inch	Inches/Hour	Average Infiltration Rate (gpd/sf)
25	0.00			
24	0.53	0.5	112.5	1683
23	0.95	0.4	144.0	2154
22	1.42	0.5	128.6	1923
21	1.97	0.6	109.1	1632
20	2.50	0.5	112.5	1683
19	3.13	0.6	94.7	1417
18	3.85	0.7	83.7	1252
17	4.45	0.6	100.0	1496
16	5.32	0.9	69.2	1036
15	6.08	0.8	78.3	1171
14	6.80	0.7	83.7	1252
13	7.70	0.9	66.7	997
12	8.52	0.8	73.5	1099
11	9.28	0.8	78.3	1171
10	10.17	0.9	67.9	1016
9	11.32	1.2	52.2	781
8	12.18	0.9	69.2	1036
7	13.42	1.2	48.6	728
6	14.48	1.1	56.3	842
5	15.65	1.2	51.4	769
4	16.83	1.2	50.7	759
3	18.07	1.2	48.6	728
2	19.83	1.8	34.0	508
1	21.18	1.4	44.4	665
	Average	0.9	77	1158

Basin #1 Run #2

Inches	Time (minutes, cumulative)	Minutes/Inch	Inches/Hour	Average Infiltration Rate (gpd/sf)
25	0.00			
24	0.38	0.4	156.5	2342
23	0.87	0.5	124.1	1857
22	1.42	0.6	109.1	1632
21	2.03	0.6	97.3	1456
20	2.68	0.7	92.3	1381
19	3.35	0.7	90.0	1346
18	4.13	0.8	76.6	1146
17	4.97	0.8	72.0	1077
16	5.83	0.9	69.2	1036
15	6.82	1.0	61.0	913
14	7.65	0.8	72.0	1077
13	8.93	1.3	46.8	699
12	9.87	0.9	64.3	962
11	10.93	1.1	56.3	842
10	12.03	1.1	54.5	816
9	13.55	1.5	39.6	592
8	14.67	1.1	53.7	804
7	16.12	1.5	41.4	619
6	17.50	1.4	43.4	649
5	18.78	1.3	46.8	699
4	20.40	1.6	37.1	555
3	22.07	1.7	36.0	539
2	24.02	2.0	30.8	460
1	25.73	1.7	35.0	523
	Average	1.1	67	1001

TABLE 4
TOWN OF MASHPEE
HYDRAULIC LOADING TESTS
FALLING HEAD TEST RESULTS - BASIN #1

Basin #1 Run #3

Inches	Time (minutes, cumulative)	Minutes/Inch	Inches/Hour	Average Infiltration Rate (gpd/sf)
25	0.00			
24	0.55	0.6	109.1	1632
23	1.17	0.6	97.3	1456
22	1.83	0.7	90.0	1346
21	2.52	0.7	87.8	1314
20	3.20	0.7	87.8	1314
19	4.00	0.8	75.0	1122
18	4.75	0.8	80.0	1197
17	5.58	0.8	72.0	1077
16	6.45	0.9	69.2	1036
15	7.23	0.8	76.6	1146
14	8.07	0.8	72.0	1077
13	9.00	0.9	64.3	962
12	9.88	0.9	67.9	1016
11	10.82	0.9	64.3	962
10	11.88	1.1	56.3	842
9	13.00	1.1	53.7	804
8	14.12	1.1	53.7	804
7	15.33	1.2	49.3	738
6	16.52	1.2	50.7	759
5	17.73	1.2	49.3	738
4	19.22	1.5	40.4	605
3	20.90	1.7	35.6	533
2	22.72	1.8	33.0	494
1	24.42	1.7	35.3	528
	Average	1.0	65	979

Basin #1 Run #4

Inches	Time (minutes, cumulative)	Minutes/Inch	Inches/Hour	Average Infiltration Rate (gpd/sf)
25	0.00			
24	0.80	0.8	75.0	1122
23	1.53	0.7	81.8	1224
22	2.32	0.8	76.6	1146
21	3.17	0.9	70.6	1056
20	4.12	1.0	63.2	945
19	4.93	0.8	73.5	1099
18	6.00	1.1	56.3	842
17	6.95	1.0	63.2	945
16	8.13	1.2	50.7	759
15	9.28	1.2	52.2	781
14	10.40	1.1	53.7	804
13	11.68	1.3	46.8	699
12	13.05	1.4	43.9	657
11	14.50	1.5	41.4	619
10	15.80	1.3	46.2	690
9	18.03	2.2	26.9	402
8	19.52	1.5	40.4	605
7	21.60	2.1	28.8	431
6	23.12	1.5	39.6	592
5	24.67	1.6	38.7	579
4	26.10	1.4	41.9	626
3	27.90	1.8	33.3	499
2	29.97	2.1	29.0	434
1	31.98	2.0	29.8	445
	Average	1.3	50	750

Average of All Test Runs **972**

TABLE 5
TOWN OF MASHPEE
HYDRAULIC LOADING TESTS
FALLING HEAD TEST RESULTS - BASIN #2

Basin #2 Run #1

Inches	Time (minutes, cumulative)	Minutes/Inch	Inches/Hour	Average Infiltration Rate (gpd/sf)
25	0.00			
24	0.53	0.5	112.5	1683
23	1.00	0.5	128.6	1923
22	1.45	0.5	133.3	1995
21	1.88	0.4	138.5	2071
20	2.37	0.5	124.1	1857
19	2.85	0.5	124.1	1857
18	3.38	0.5	112.5	1683
17	3.90	0.5	116.1	1737
16	4.38	0.5	124.1	1857
15	4.90	0.5	116.1	1737
14	5.45	0.6	109.1	1632
13	5.97	0.5	116.1	1737
12	6.55	0.6	102.9	1539
11	7.12	0.6	105.9	1584
10	7.63	0.5	116.1	1737
9	8.27	0.6	94.7	1417
8	8.85	0.6	102.9	1539
7	9.45	0.6	100.0	1496
6	10.13	0.7	87.8	1314
5	10.87	0.7	81.8	1224
4	11.53	0.7	90.0	1346
3	12.20	0.7	90.0	1346
2	12.98	0.8	76.6	1146
1	13.67	0.7	87.8	1314
	Average	0.6	108	1616

Basin #2 Run #2

Inches	Time (minutes, cumulative)	Minutes/Inch	Inches/Hour	Average Infiltration Rate (gpd/sf)
25	0.00			
24	0.62	0.6	97.3	1456
23	1.30	0.7	87.8	1314
22	1.93	0.6	94.7	1417
21	2.65	0.7	83.7	1252
20	3.47	0.8	73.5	1099
19	4.23	0.8	78.3	1171
18	5.02	0.8	76.6	1146
17	5.83	0.8	73.5	1099
16	6.77	0.9	64.3	962
15	7.62	0.9	70.6	1056
14	8.68	1.1	56.3	842
13	9.72	1.0	58.1	869
12	10.90	1.2	50.7	759
11	11.95	1.1	57.1	855
10	13.18	1.2	48.6	728
9	14.40	1.2	49.3	738
8	15.78	1.4	43.4	649
7	17.10	1.3	45.6	682
6	18.57	1.5	40.9	612
5	20.62	2.1	29.3	438
4	22.33	1.7	35.0	523
3	24.27	1.9	31.0	464
2	26.83	2.6	23.4	350
1	28.93	2.1	28.6	427
	Average	1.2	58	871

TABLE 5
TOWN OF MASHPEE
HYDRAULIC LOADING TESTS
FALLING HEAD TEST RESULTS - BASIN #2

Basin #2 Run #3

Inches	Time (minutes, cumulative)	Minutes/Inch	Inches/Hour	Average Infiltration Rate (gpd/sf)
25	0.00			
24	0.70	0.7	85.7	1282
23	1.43	0.7	81.8	1224
22	2.12	0.7	87.8	1314
21	2.85	0.7	81.8	1224
20	3.72	0.9	69.2	1036
19	4.50	0.8	76.6	1146
18	5.30	0.8	75.0	1122
17	6.13	0.8	72.0	1077
16	6.97	0.8	72.0	1077
15	7.90	0.9	64.3	962
14	8.87	1.0	62.1	929
13	9.80	0.9	64.3	962
12	10.83	1.0	58.1	869
11	11.83	1.0	60.0	898
10	12.98	1.2	52.2	781
9	14.02	1.0	58.1	869
8	15.25	1.2	48.6	728
7	16.40	1.2	52.2	781
6	17.62	1.2	49.3	738
5	19.13	1.5	39.6	592
4	20.63	1.5	40.0	598
3	21.88	1.3	48.0	718
2	23.62	1.7	34.6	518
1	25.32	1.7	35.3	528
	Average	1.1	61	915

Basin #2 Run #4

Inches	Time (minutes, cumulative)	Minutes/Inch	Inches/Hour	Average Infiltration Rate (gpd/sf)
25	0.00			
24	0.68	0.7	87.8	1314
23	1.43	0.8	80.0	1197
22	2.13	0.7	85.7	1282
21	2.88	0.8	80.0	1197
20	3.78	0.9	66.7	997
19	4.53	0.8	80.0	1197
18	5.38	0.9	70.6	1056
17	6.25	0.9	69.2	1036
16	7.20	1.0	63.2	945
15	8.25	1.1	57.1	855
14	9.23	1.0	61.0	913
13	10.23	1.0	60.0	898
12	11.35	1.1	53.7	804
11	12.45	1.1	54.5	816
10	13.55	1.1	54.5	816
9	14.72	1.2	51.4	769
8	15.98	1.3	47.4	709
7	17.20	1.2	49.3	738
6	18.45	1.3	48.0	718
5	19.93	1.5	40.4	605
4	21.62	1.7	35.6	533
3	23.33	1.7	35.0	523
2	24.93	1.6	37.5	561
1	26.83	1.9	31.6	472
	Average	1.1	58	873

TABLE 5
TOWN OF MASHPEE
HYDRAULIC LOADING TESTS
FALLING HEAD TEST RESULTS - BASIN #2

Basin #2 Run #5

Inches	Time (minutes, cumulative)	Minutes/Inch	Inches/Hour	Average Infiltration Rate (gpd/sf)
25	0.00			
24	0.73	0.7	81.8	1224
23	1.65	0.9	65.5	979
22	2.52	0.9	69.2	1036
21	3.42	0.9	66.7	997
20	4.40	1.0	61.0	913
19	5.40	1.0	60.0	898
18	6.45	1.1	57.1	855
17	7.50	1.1	57.1	855
16	8.70	1.2	50.0	748
15	9.93	1.2	48.6	728
14	11.12	1.2	50.7	759
13	12.28	1.2	51.4	769
12	13.80	1.5	39.6	592
11	15.20	1.4	42.9	641
10	16.67	1.5	40.9	612
9	17.95	1.3	46.8	699
8	19.50	1.6	38.7	579
7	20.88	1.4	43.4	649
6	22.68	1.8	33.3	499
5	24.47	1.8	33.6	503
4	26.63	2.2	27.7	414
3	28.65	2.0	29.8	445
2	31.67	3.0	19.9	298
1	33.65	2.0	30.3	453
	Average	1.4	48	714

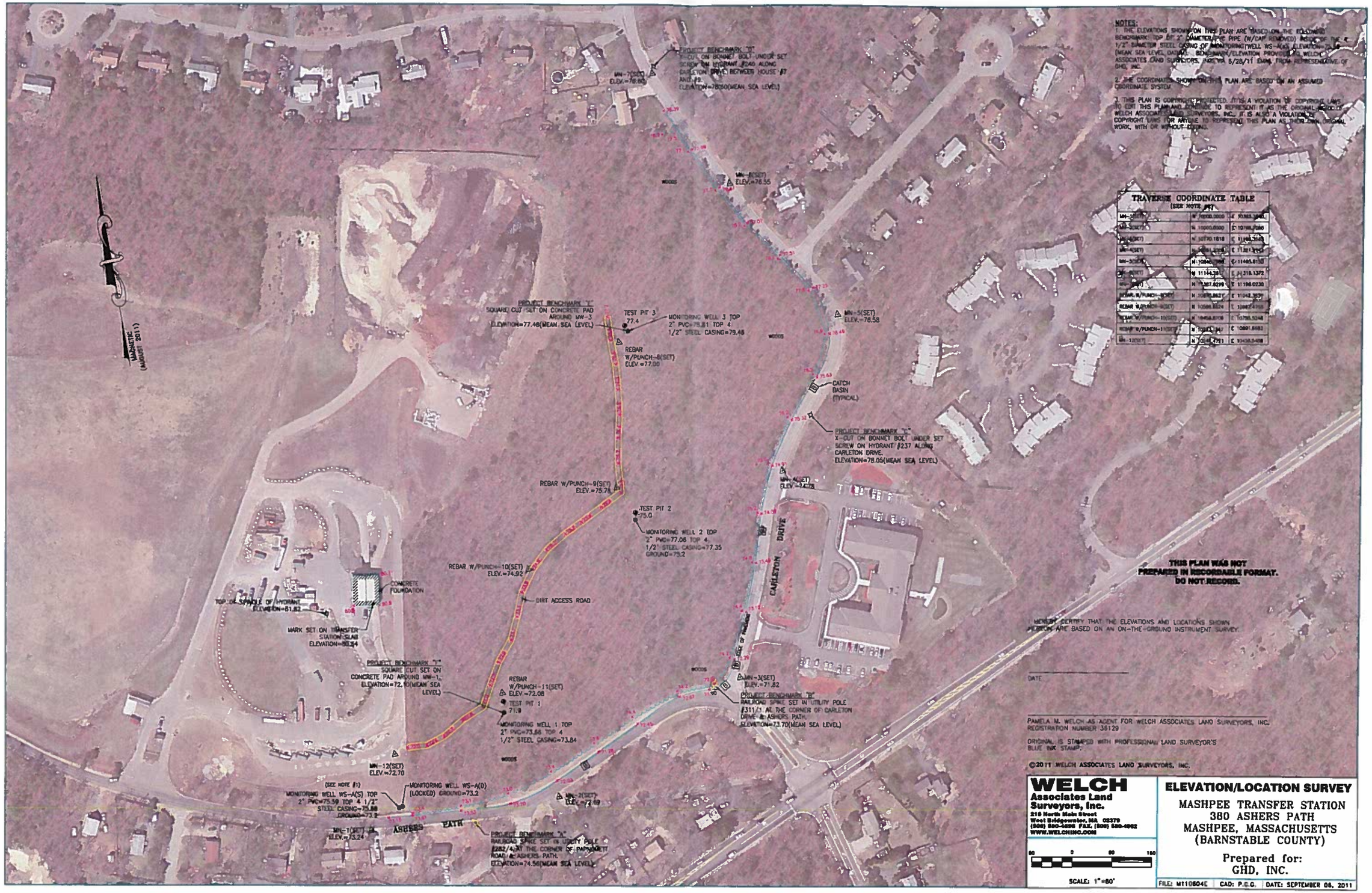
Average of All Test Runs **998**

NOTES:

1. THE ELEVATIONS SHOWN ON THIS PLAN ARE BASED ON THE FOLLOWING BENCHMARK: TOP 6" 2" DIAMETER PVC PIPE (W/CAP REMOVED) ADJACENT TO THE 1/2" DIAMETER STEEL CASING OF MONITORING WELL WS-A(S). ELEVATION=73.2 (MEAN SEA LEVEL DATUM). BENCHMARK/ELEVATION PROVIDED BY WELCH ASSOCIATES LAND SURVEYORS, INC. VIA 8/28/11 EMAIL FROM REPRESENTATIVE OF GHD, INC.

2. THE COORDINATES SHOWN ON THIS PLAN ARE BASED ON AN ASSUMED COORDINATE SYSTEM.

3. THIS PLAN IS COPYRIGHT PROTECTED. IT IS A VIOLATION OF COPYRIGHT LAWS TO EDIT THIS PLAN AND CONTINUE TO REPRESENT IT AS THE ORIGINAL WORK OF WELCH ASSOCIATES LAND SURVEYORS, INC. IT IS ALSO A VIOLATION OF COPYRIGHT LAWS FOR ANYONE TO REPRESENT THIS PLAN AS THEIR OWN ORIGINAL WORK, WITH OR WITHOUT EDITING.



TRAVERSE COORDINATE TABLE
(SEE NOTE #2)

MN-1(SET)	N 10000.0000	E 10000.0000
MN-2(SET)	N 10000.0000	E 10798.7080
MN-3(SET)	N 10770.1818	E 11198.5828
MN-4(SET)	N [illegible]	E 11391.[illegible]
MN-5(SET)	N 10946.[illegible]	E 11465.8110
MN-6(SET)	N 11144.3[illegible]	E 11318.1372
MN-7(SET)	N 11387.6299	E 11198.0230
REBAR W/PUNCH-8(SET)	N 10[illegible]	E 11042.3[illegible]
REBAR W/PUNCH-9(SET)	N 10[illegible]	E 10[illegible]
REBAR W/PUNCH-10(SET)	N 10[illegible]	E 10798.5248
REBAR W/PUNCH-11(SET)	N 10[illegible]	E 10891.8483
MN-12(SET)	N [illegible]	E 10438.3408

THIS PLAN WAS NOT PREPARED IN RECORDABLE FORMAT. DO NOT RECORD.

I HEREBY CERTIFY THAT THE ELEVATIONS AND LOCATIONS SHOWN HEREON ARE BASED ON AN ON-THE-GROUND INSTRUMENT SURVEY.

DATE

PAMELA M. WELCH AS AGENT FOR WELCH ASSOCIATES LAND SURVEYORS, INC.
REGISTRATION NUMBER 38129

ORIGINAL IS STAMPED WITH PROFESSIONAL LAND SURVEYOR'S BLUE INK STAMP.

©2011 WELCH ASSOCIATES LAND SURVEYORS, INC.

WELCH
Associates Land Surveyors, Inc.
218 North Main Street
West Bridgewater, MA 02379
(508) 580-4696 FAX: (508) 580-4962
WWW.WELCHINC.COM

SCALE: 1"=80'

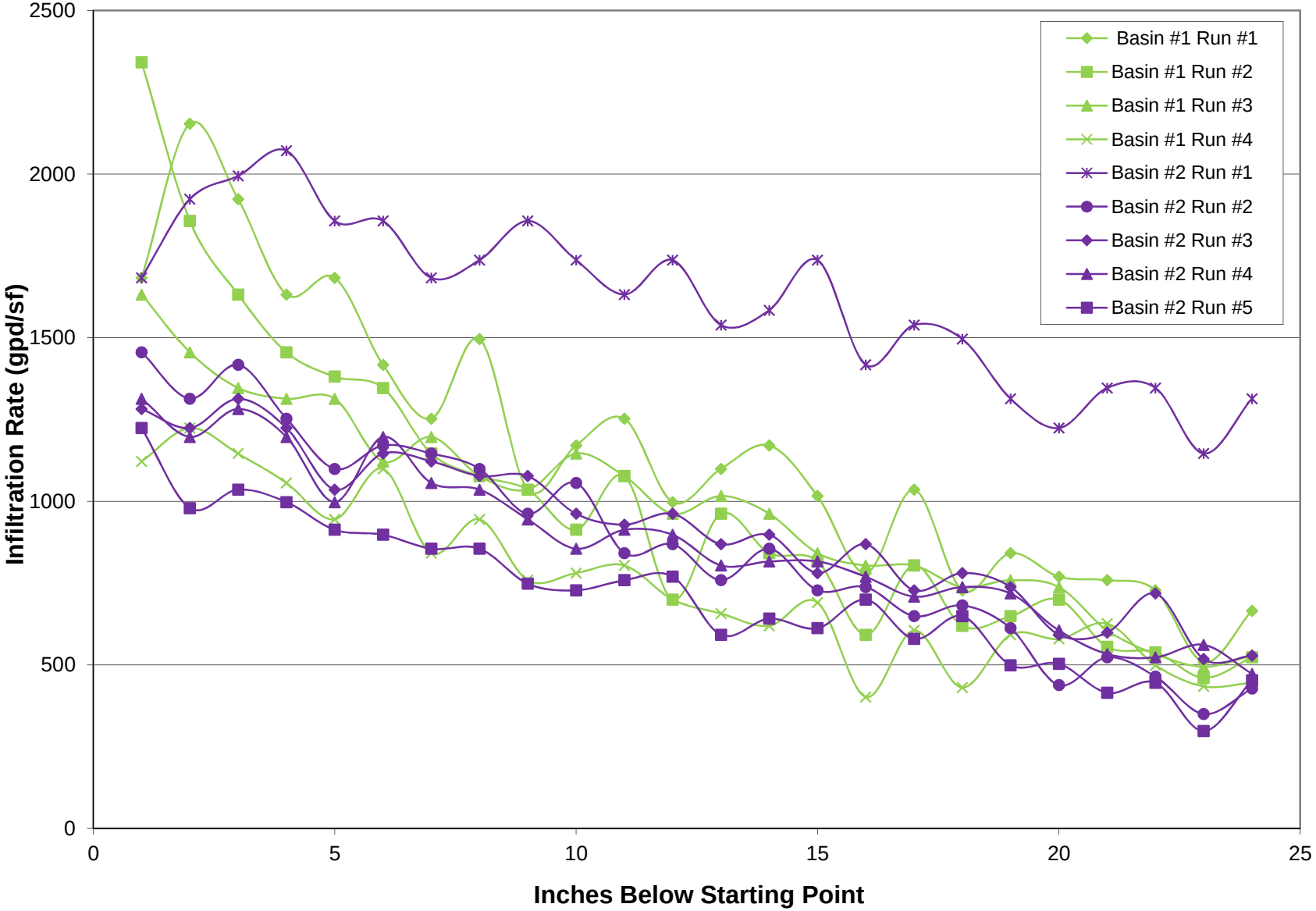
ELEVATION/LOCATION SURVEY

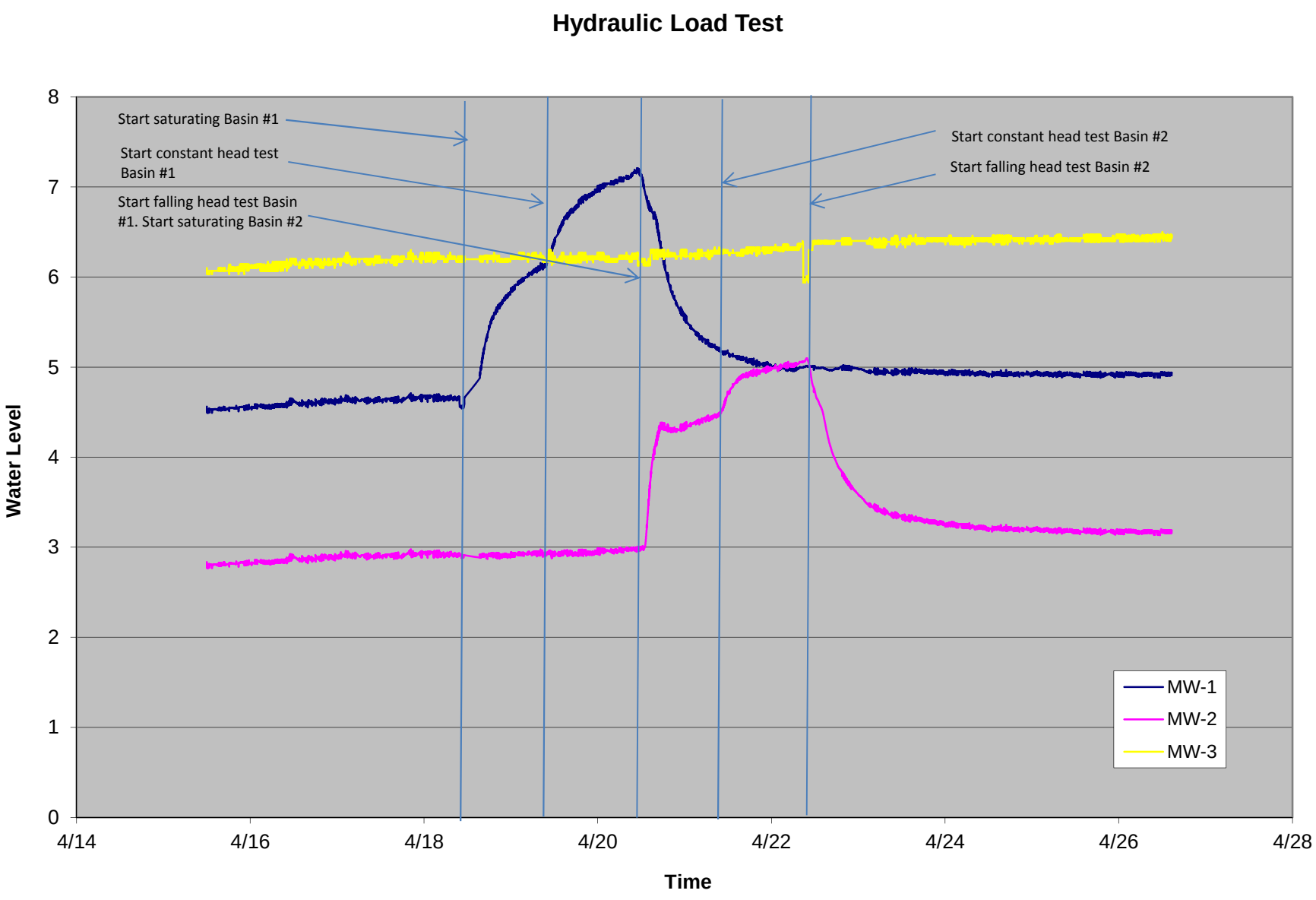
MASHPEE TRANSFER STATION
380 ASHERS PATH
MASHPEE, MASSACHUSETTS
(BARNSTABLE COUNTY)

Prepared for:
GHD, INC.

FILE: M110804E | CAD: P.G.G. | DATE: SEPTEMBER 08, 2011

FIGURE 2
TOWN OF MASHPEE
HYDRAULIC LOADING TESTS
FALLING HEAD TEST RESULTS




Hydraulic Load Test
Start saturating Basin #1
Start constant head test Basin #1
Start falling head test Basin #1. Start saturating Basin #2
Start constant head test Basin #2
Start falling head test Basin #2
MW-1
MW-2
MW-3
Water Level
Time
0
1
2
3
4
5
6
7
8
4/14
4/16
4/18
4/20
4/22
4/24
4/26
4/28

Appendix A

Boring Logs

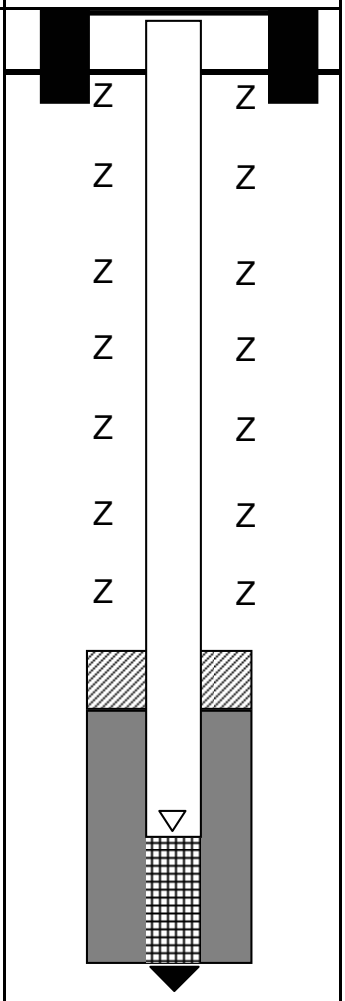
Cape Cod Test Boring 5 Rayber Road, Orleans, MA 02653 (508) 240-1000 div. Desmond Well Drilling, Inc.	Project Miranada's Excavating Mashpee Sewer Commission 360 Asher's Path, Mashpee	Boring No. MW1 Sheet 1 of 1

Driller: Thomas E Desmond III Helper: William Urqhart Inspector: Darlene Zelinski	Boring location: 41.62860° 70.47587° Ground Surface Elevation: Date start: 4/11/2011 Date end: 4/12/2011

Sampler consists of a two inch split spoon driven using a 140 lb. hammer falling thirty inches	Notes:	Auger Size: 6 1/4" x 4" H.S.A Casing Size: 2"x49' 8" SCH40 PVC FJT Screen Size: 2"x10'X.010 SCH40 PVC FJT

Depth (FT)	Sample NO	PEN/REC	DEPTH/FT	BLOWS 6"	Sample Description
2					
0					
-2					
-4	1	24/18	3 - 5	2-4-3-3	F-M brown sand, some gravel
-6					
-8	2	24/18	8 - 10	2-3-4-5	Top 4" F silty sand
-10					Bottom 14" F-M-C brown sand
-12					
-14	3	24/18	13 - 15	4-5-9-11	F-M-C light brown sand, trace
-16					gravel
-18	4	24/19	18 - 20	7-11-12-12	F-M-C light brown sand, trace
-20					gravel
-22					
-24	5	24/19	23 - 25	6-11-13-12	F-M-C light brown sand
-26					
-28	6	24/19	28 - 30	10-11-12-17	F-M-C light brown sand, trace
-30					gravel
-32					
-34	7	24/18	33 - 35	7-7-10-8	F-M-C light brown sand
-36					
-38	8	24/19	38 - 40	7-10-9-10	F-M-C light brown sand
-40					
-42					
-44	9	24/18	43 - 45	7-11-12-13	F-M-C light brown sand
-46					
-48	10	24/15	48 - 50	7-12-16-19	F-M-C light brown sand, wet
-50					
-52					
-54	11	24/14	53 - 55	9-13-11-13	F-M-C light brown sand, wet
-56					
-58	12	24/8	58 - 60	3-7-10-16	F-M-C light brown sand, wet
-60					
-62					Bentonite seal: 38' - 40'
-64					Well screen: 49' to 59' 8"
-66					

Well Installation



Well Depth: 59' 8" top of pipe
Static: 48'
End of boring: 58'
End of sample: 60'

Granular Soils BLOWS/FT	Granular Soils DENSITY	Cohesive Soils BLOWS/FT	Cohesive Soils DENSITY	Proportions Used
0 - 4	V. LOOSE	> 2	V. SOFT	Trace 0 - 10%
4 - 10	LOOSE	2 - 4	SOFT	Little 10 - 20%
10 - 30	M. DENSE	4 - 8	M. STIFF	Some 20 - 35%
30 - 50	DENSE	8 - 15	STIFF	And 35 - 50%
> 50	V. DENSE	15 - 30	V. STIFF	
		> 30	HARD	

Well Installation Key
- CONCRETE
- SAND PACK
- SOIL BACKFILL
- BENTONITE
- SCREEN
- APPROX. WATER LEVEL

CAPE COD TEST BORING **BORING NO. MW1**

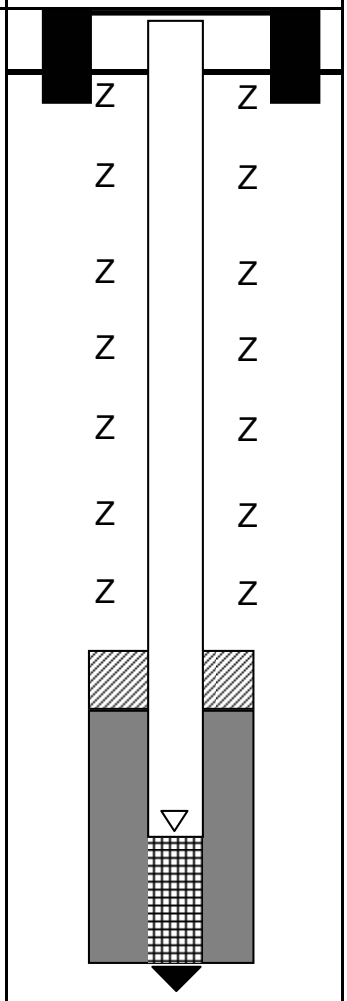
Cape Cod Test Boring	Project	Boring No. MW2
5 Rayber Road, Orleans, MA 02653	Miranada's Excavating	
(508) 240-1000	Mashpee Sewer Commission	Sheet 1 of 1
div. Desmond Well Drilling, Inc.	360 Asher's Path, Mashpee	

Driller: Thomas E Desmond III	Boring location: 41.62980° 70.47380°
Helper: William Urqhart	Ground Surface Elevation:
Inspector: Darlene Zelinski	Date start: 4/11/2011 Date end: 4/11/2011

Sampler consists of a two inch split spoon driven using a 140 lb. hammer falling thirty inches	Notes:	Auger Size: 6 1/4" x 4" H.S.A Casing Size: 2"x51' SCH40 PVC FJT Screen Size: 2"x10'X.010 SCH40 PVC FJT

Depth (FT)	Sample NO	PEN/REC	DEPTH/FT	BLOWS 6"	Sample Description
2					
0					
-2					
-4	1	24/18	3 - 5	2-3-3-4	F-M brown sand, trace silt
-6					
-8	2	24/16	8 - 10	1-3-3-3	F-M light brown sand
-10					
-12					
-14	3	24/17	13 - 15	3-4-4-5	F-M-C light brown sand, trace gravel
-16					
-18	4	24/18	18 - 20	5-6-7-6	F-M-C light brown sand, trace gravel
-20					
-22					
-24	5	24/19	23 - 25	4-5-6-8	F-M-C light brown sand, trace gravel
-26					
-28	6	24/18	28 - 30	3-5-8-11	F-M-C light brown sand
-30					
-32					
-34	7	24/17	33 - 35	5-6-6-8	F-M-C light brown sand
-36					
-38	8	24/20	38 - 40	9-7-8-12	F-M-C light brown sand
-40					
-42					
-44	9	24/19	43 - 45	7-9-11-17	F-M-C light brown sand
-46					
-48	10	24/19	48 - 50	6-7-7-7	F-M-C light brown sand, wet
-50					
-52					
-54	11	24/13	53 - 55	5-10-13-12	F-M light brown sand, wet
-56					
-58	12	24/5	58 - 60	4-4-8-9	F-M light brown sand, trace C light brown sand, wet
-60					
-62					
-64					Bentonite seal: 38' - 40'
-66					Well screen: 51' to 61'

Well Installation



Well Depth: 61' top of pipe
Static: 50'
End of boring: 58'
End of sample: 60'

Granular Soils BLOWS/FT	Granular Soils DENSITY	Cohesive Soils BLOWS/FT	Cohesive Soils DENSITY	Proportions Used
0 - 4	V. LOOSE	> 2	V. SOFT	Trace 0 - 10%
4 - 10	LOOSE	2 - 4	SOFT	Little 10 - 20%
10 - 30	M. DENSE	4 - 8	M. STIFF	Some 20 - 35%
30 - 50	DENSE	8 - 15	STIFF	And 35 - 50%
> 50	V. DENSE	15 - 30	V. STIFF	
		> 30	HARD	

Well Installation Key
- CONCRETE
- SAND PACK
- SOIL BACKFILL
- BENTONITE
- SCREEN
- APPROX. WATER LEVEL

CAPE COD TEST BORING **BORING NO. MW2**

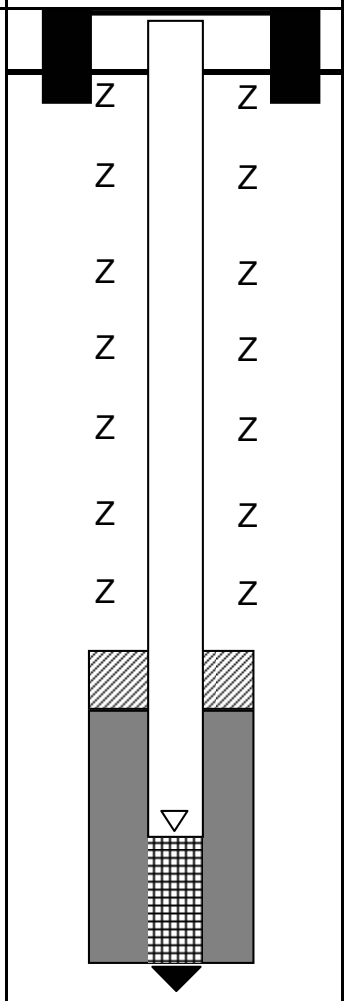
Cape Cod Test Boring	Project	Boring No. MW3
5 Rayber Road, Orleans, MA 02653	Miranada's Excavating	
(508) 240-1000	Mashpee Sewer Commission	Sheet 1 of 1
div. Desmond Well Drilling, Inc.	360 Asher's Path, Mashpee	

Driller: Thomas E Desmond III	Boring location: 41.63066° 70.47375°
Helper: William Urqhart	Ground Surface Elevation:
Inspector: Darlene Zelinski	Date start: 4/8/2011 Date end: 4/8/2011

Sampler consists of a two inch split spoon driven using a 140 lb. hammer falling thirty inches	Notes:	Auger Size: 6 1/4" x 4" H.S.A Casing Size: 2"x52' SCH40 PVC FJT Screen Size: 2"x10'X.010 SCH40 PVC FJT

Depth (FT)	Sample NO	PEN/REC	DEPTH/FT	BLOWS 6"	Sample Description
2					
0					
-2					
-4	1	24/17	3 - 5	4-10-13-19	F-M brown sand, trace silt, trace gravel
-6					
-8	2	24/14	8 - 10	3-4-4-3	F-M-C light brown sand
-10					
-12					
-14	3	24/15	13 - 15	4-5-6-7	F-M-C light brown sand, trace gravel
-16					
-18	4	24/17	18 - 20	5-7-9-11	F-M-C light brown sand
-20					
-22					
-24	5	24/16	23 - 25	4-8-8-9	F-M-C light brown sand
-26					
-28	6	24/18	28 - 30	5-5-10-13	F-M-C light brown sand, trace gravel
-30					
-32					
-34	7	24/18	33 - 35	6-10-11-12	F-M-C light brown sand
-36					
-38	8	24/17	38 - 40	5-8-12-15	F-M-C light brown sand
-40					
-42					
-44	9	24/18	43 - 45	7-9-11-12	F-M light brown sand, trace C light brown sand
-46					
-48	10	24/18	48 - 50	7-10-12-14	F-M light brown sand, wet
-50					
-52					
-54	11	24/11	53 - 55	5-9-12-21	F-M-C light brown sand, wet
-56					
-58	12	24/1	58 - 60	3-4-7-9	F-M-C light brown sand, wet
-60					
-62					
-64					Bentonite seal: 38' - 40'
-66					Well screen: 52' to 62'

Well Installation



Well Depth: 62' top of pipe
Static: 50' 5"
End of boring: 58'
End of sample: 60'

Granular Soils BLOWS/FT	Granular Soils DENSITY	Cohesive Soils BLOWS/FT	Cohesive Soils DENSITY	Proportions Used
0 - 4	V. LOOSE	> 2	V. SOFT	Trace 0 - 10%
4 - 10	LOOSE	2 - 4	SOFT	Little 10 - 20%
10 - 30	M. DENSE	4 - 8	M. STIFF	Some 20 - 35%
30 - 50	DENSE	8 - 15	STIFF	And 35 - 50%
> 50	V. DENSE	15 - 30	V. STIFF	
		> 30	HARD	

Well Installation Key
- CONCRETE
- SAND PACK
- SOIL BACKFILL
- BENTONITE
- SCREEN
- APPROX. WATER LEVEL

CAPE COD TEST BORING **BORING NO. MW3**

Appendix B

Field Reports

Commonwealth of Massachusetts
City/Town of Mashpee

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

A. Facility Information

Town of Mashpee
Owner Name

C/o GHD 1545 Iyannough Road
Street Address

61-3
Map/Lot #

Hyannis
City

MA
State

02601
Zip Code

B. Site Information

1. (Check one) ☒ New Construction ☐ Upgrade ☐ Repair

2. Published Soil Survey Available? ☒ Yes ☐ No If yes: 1993 (Year Published) 1:25000 (Publication Scale) EnA (Soil Map Unit)

   Enfield Silt Loam
   Soil Name

   Soil Limitations

3. Surficial Geological Report Available? ☒ Yes ☐ No If yes: 1986 (Year Published) 1:100000 (Publication Scale) Qmp (Map Unit)

   Glacial Outwash
   Geologic Material

   Mashpee Pitted Plain Deposits
   Landform

4. Flood Rate Insurance Map

   Above the 500-year flood boundary? ☒ Yes ☐ No Within the 100-year flood boundary? ☐ Yes ☒ No

   Within the 500-year flood boundary? ☐ Yes ☐ No Within a velocity zone? ☐ Yes ☒ No

5. Wetland Area: National Wetland Inventory Map — Map Unit: ____ Name: ____

   Wetlands Conservancy Program Map — Map Unit: ____ Name: ____

6. Current Water Resource Conditions (USGS): 4/11 (Month/Year) Range: ☐ Above Normal ☒ Normal ☐ Below Normal

7. Other references reviewed: ____

Commonwealth of Massachusetts
City/Town of Mashpee

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserved disposal area)*

Deep Observation Hole Number: 1 | 4/12/11 (Date) | 9:10 (Time) | Clouds (Weather)

1. Location

Ground Elevation at Surface of Hole: _____ Location (identify on plan): See Sketch

2. Land Use: Woodland (e.g., woodland, agricultural field, vacant lot, etc.) | none (Surface Stones) | 0-3 (Slope (%))

Pine & Oak (Vegetation) | Outwash (Landform) | See Sketch (Position on Landscape (attach sheet))

3. Distances from:

Open Water Body	>500 feet	Drainage Way	>500 feet	Possible Wet Area	>500 feet
Property Line	200 feet	Drinking Water Well	NA feet	Other	_____ feet

4. Parent Material: Glacial Outwash Unsuitable Materials Present: ☐ Yes ☒ No

If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: _____ (Depth Weeping from Pit) _____ (Depth Standing Water in Hole)

Estimated Depth to High Groundwater: 50 feet _____ (elevation)

Commonwealth of Massachusetts
City/Town of Mashpee

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (continued)

Deep Observation Hole Number: DOH #1

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-1	O										
1-6	A	10YR2/1				Loamy Sand				Friable	
6-30	B	10YR4/4				Loamy Sand				Friable	
30-64	C1	2.5Y6/2				Silt Loam				Firm	
64-132	C2	2.5Y5/6				Medium Sand	10%				

Additional Notes:

Commonwealth of Massachusetts
City/Town of Mashpee

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (continued)

Deep Observation Hole Number: DOH #2 | 4/12/11 (Date) | 840 (Time) | Clouds (Weather)

1. Location

Ground Elevation at Surface of Hole: _____ Location (identify on plan): See Sketch

2. Land Use: Woodland (e.g., woodland, agricultural field, vacant lot, etc.) | None (Surface Stones) | 0-3 (Slope (%))

Pine & Oak (Vegetation) | Outwash Plain (Landform) | See Sketch (Position on Landscape (attach sheet))

3. Distances from:

Open Water Body	>500 feet	Drainage Way	>500 feet	Possible Wet Area	>500 feet
Property Line	200 feet	Drinking Water Well	NA feet	Other	_____ feet

4. Parent Material: Glacial Outwash Unsuitable Materials Present: ☐ Yes ☒ No

If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Estimated Depth to High Groundwater: 50 feet _____ elevation

Commonwealth of Massachusetts
City/Town of Mashpee

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: DOH #2

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-1	O										
1-3	A	10YR2/1				Loamy Sand				Friable	
3-8	E	10YR4/1				Loamy Sand				Friable	
8-24	B	2.5Y5/6				Loamy Sand				Friable	
24-60	C1	2.5Y6/2				Silt Loam				Firm	
60-132	C2	2.5Y6/4				Medium Sand	<5%				

Additional Notes:

C. On-Site Review (continued)

Commonwealth of Massachusetts
City/Town of Mashpee

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserved disposal area)*

Deep Observation Hole Number: DOH#3 | 4/12/11 (Date) | 8:30 (Time) | Clouds (Weather)

1. Location

Ground Elevation at Surface of Hole: _____ Location (identify on plan): See Sketch

2. Land Use: Woodland (e.g., woodland, agricultural field, vacant lot, etc.) | None (Surface Stones) | 0-3 (Slope (%))

Pine & Oak (Vegetation) | Outwash Plain (Landform) | See Sketch (Position on Landscape (attach sheet))

3. Distances from:

Open Water Body	>500 feet	Drainage Way	>500 feet	Possible Wet Area	>500 feet
Property Line	>200 feet	Drinking Water Well	NA feet	Other	_____ feet

4. Parent Material: Glacial Outwash Unsuitable Materials Present: ☐ Yes ☒ No

If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: _____ (Depth Weeping from Pit) _____ (Depth Standing Water in Hole)

Estimated Depth to High Groundwater: 50 feet _____ (elevation)

Commonwealth of Massachusetts
City/Town of Mashpee

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (continued)

Deep Observation Hole Number: DOH #3

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-1	O										
1-5	A	10YR2/1				Loamy Sand				Friable	
5-26	B	2.5Y6/4				Silt Loam				Firm	
26-53	C1	2.5Y6/6				Medium Sand	50%				
53-144	C2	2.5Y5/4				Medium to Coarse Sand	10%				

Additional Notes:

Commonwealth of Massachusetts
City/Town of Mashpee

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method Used: Monitoring Wells

☐ Depth observed standing water in observation hole	A. _____ inches	B. _____ inches
☐ Depth weeping from side of observation hole	A. _____ inches	B. _____ inches
☐ Depth to soil redoximorphic features (mottles)	A. _____ inches	B. _____ inches
☐ Groundwater adjustment (USGS methodology)	A. _____ inches	B. _____ inches

2. _____ Index Well Number _____ Reading Date _____ Index Well Level

_____ Adjustment Factor _____ Adjusted Groundwater Level

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material
   a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

      ☒ Yes ☐ No

   b. If yes, at what depth was it observed? Upper boundary: _____ inches Lower boundary: _____ inches

Commonwealth of Massachusetts
City/Town of Mashpee

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

Signature of Soil Evaluator	4.12.11 Date
ROBERT FITZGERALD SE 759 Typed or Printed Name of Soil Evaluator / License #	5/1996 Date of Soil Evaluator Exam
NA Name of Board of Health Witness	Board of Health

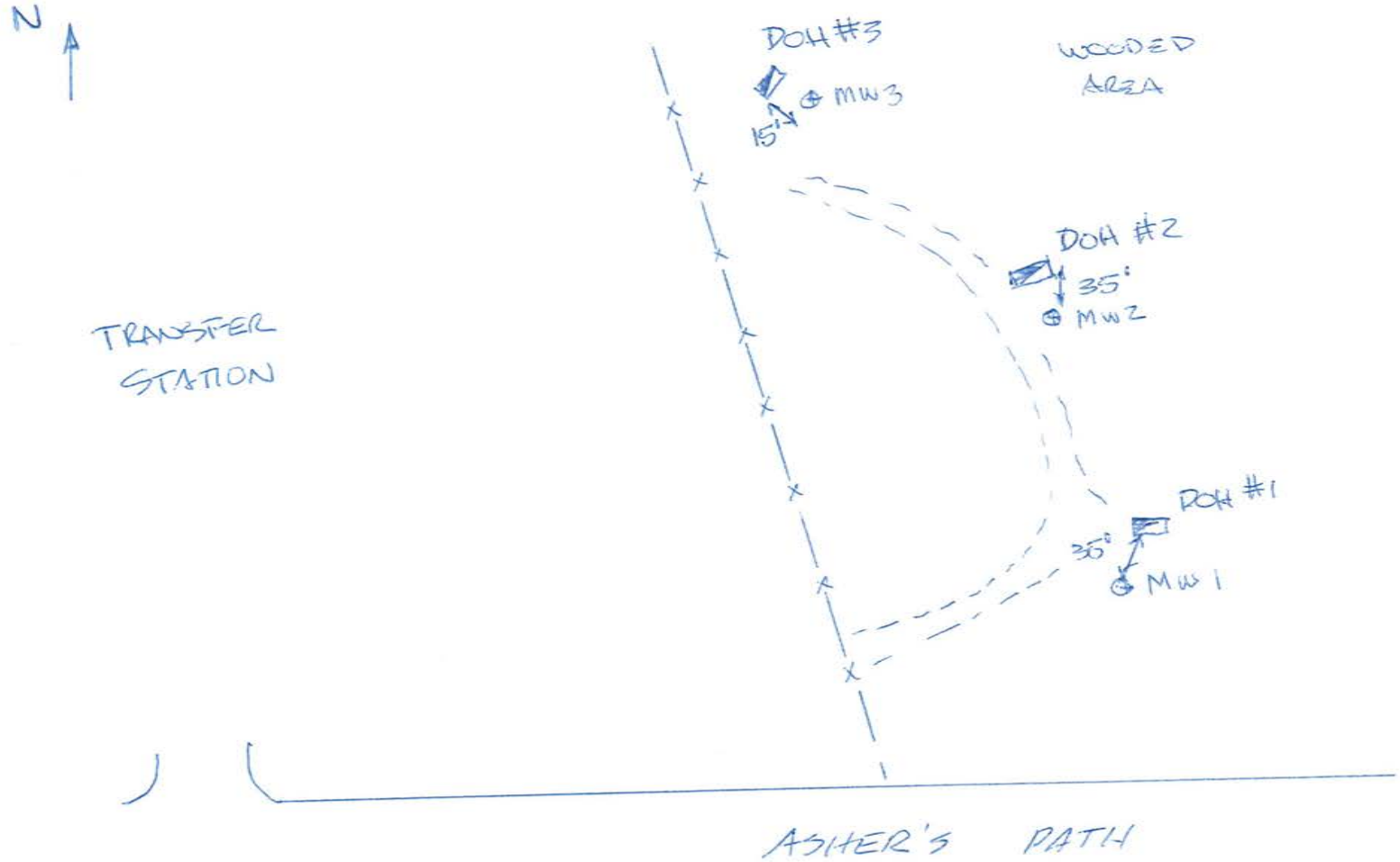
Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Commonwealth of Massachusetts
City/Town of Mashpee

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

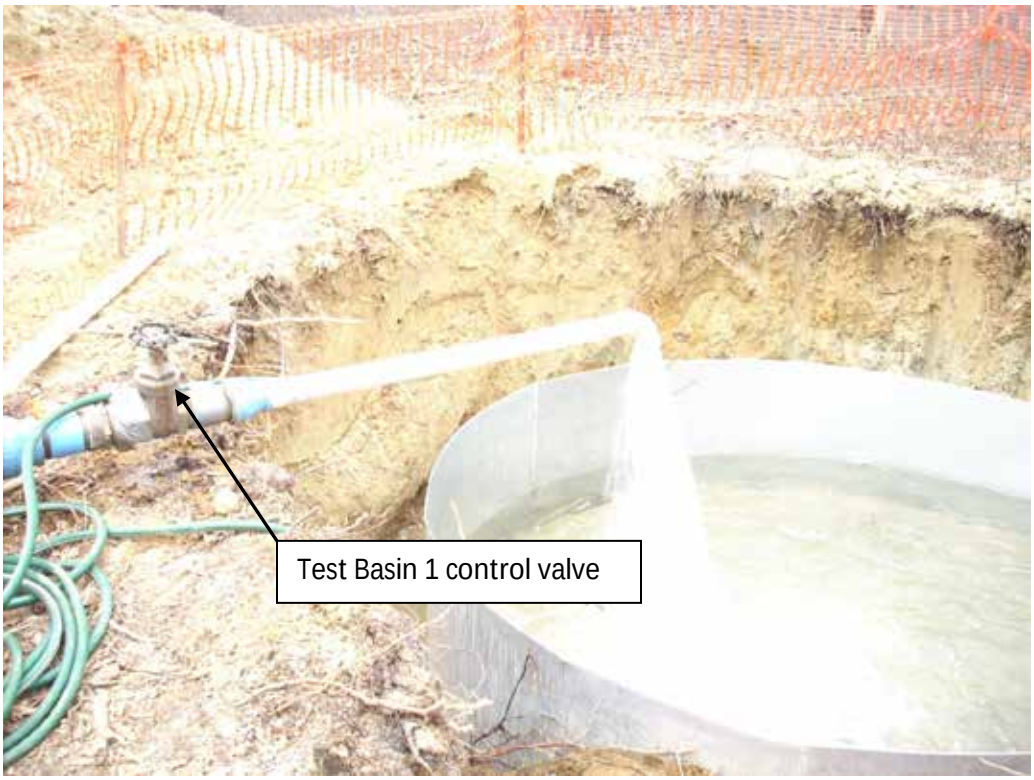
Field Diagrams

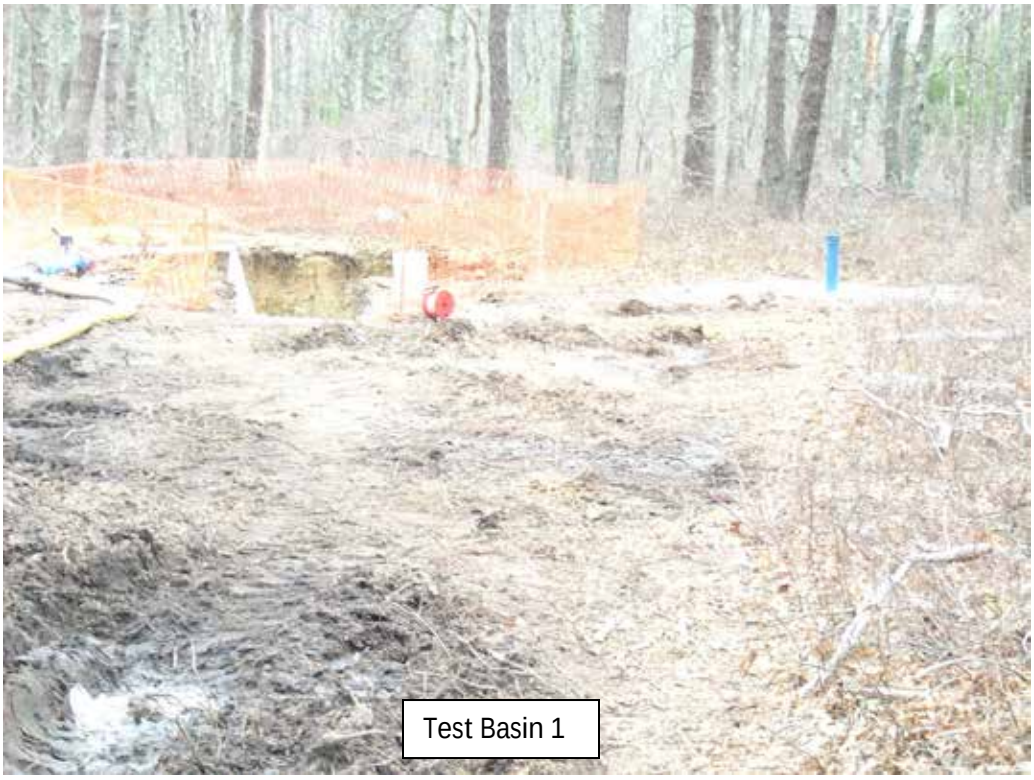
Use this sheet for field diagrams:



Appendix C

Additional Photographs

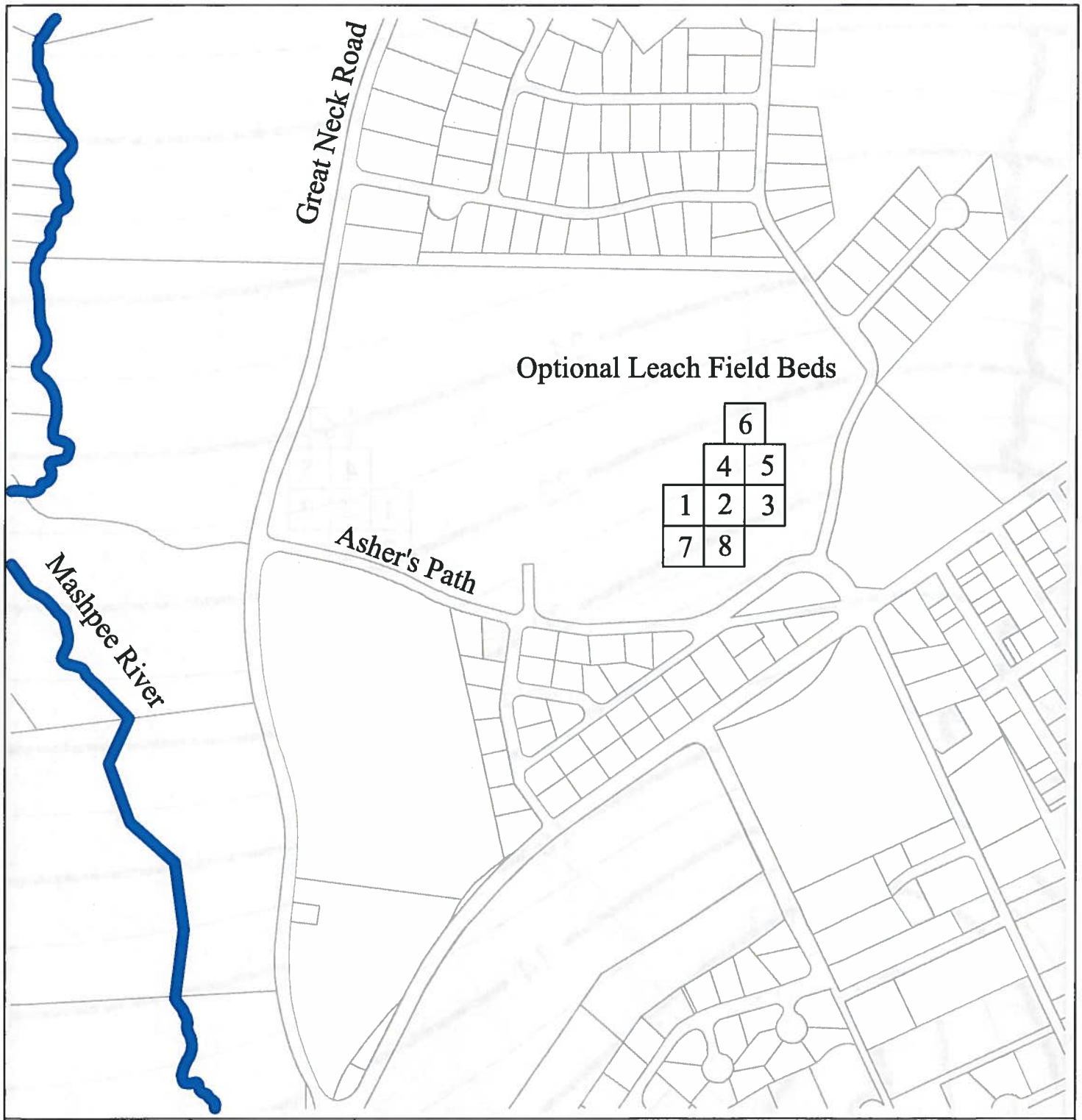

Test Basin 1 control valve


Test Basin 1

Test Basin 2

Appendix D

Groundwater Modeling Results



0 500
Scale in feet

Figure 1. Area Features.

Base Map: See Reference.

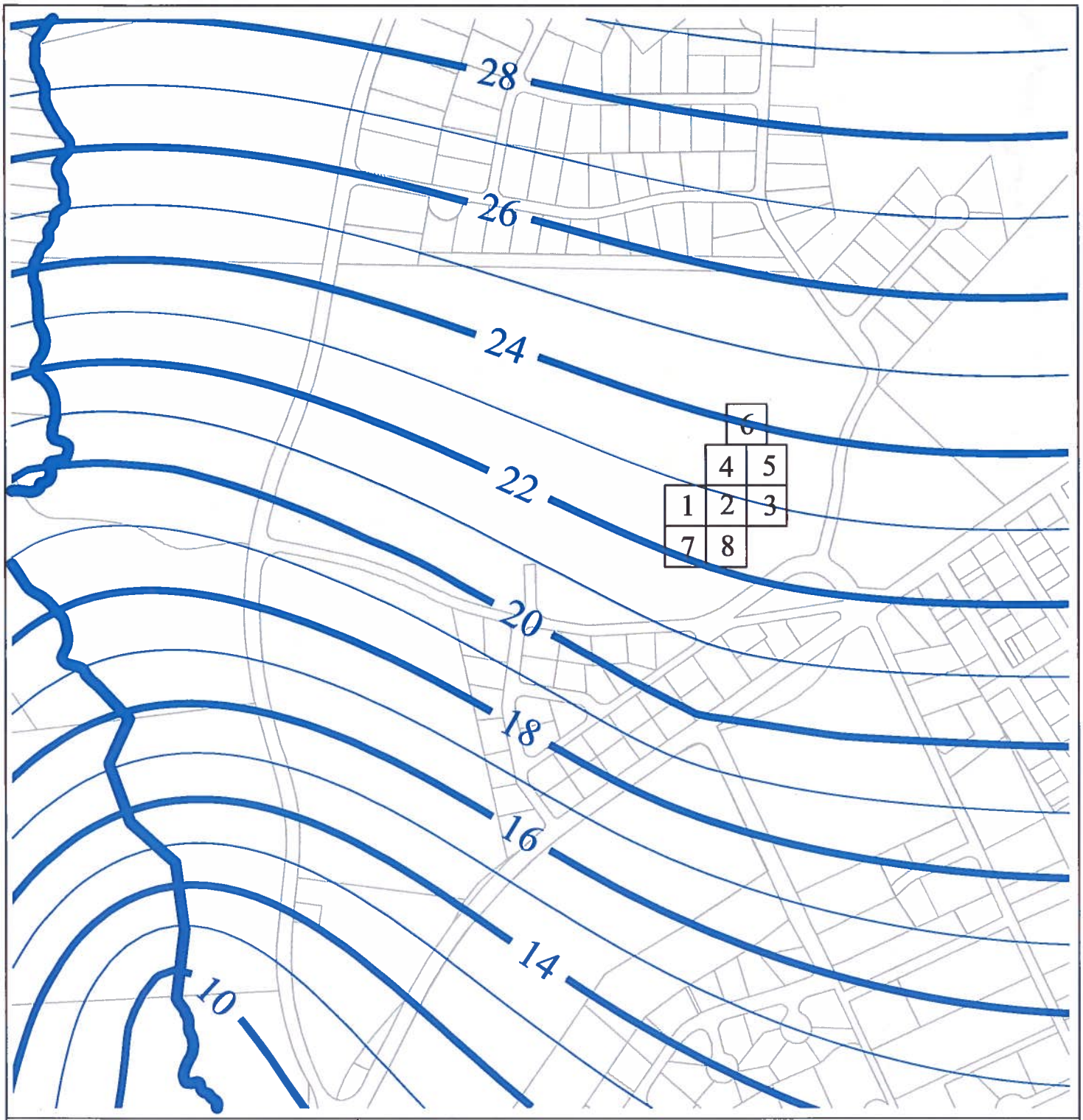
GeoHydroCycle, Inc.

Project No. GHC#11007

Drafted SWS Checked

Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



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Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

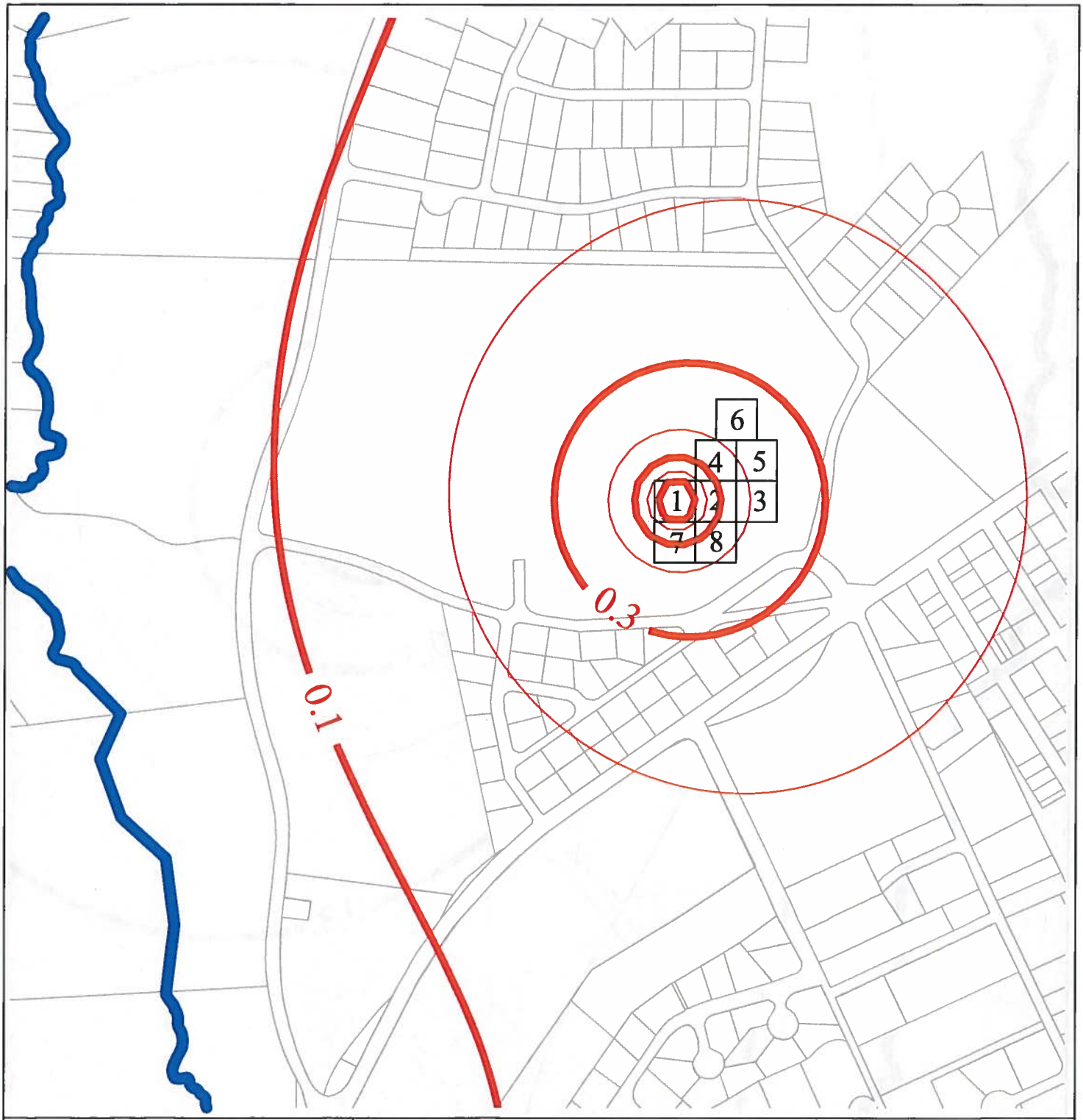
Figure 1A. Unstressed Groundwater Elevation Contours Based on USGS Data.

Project No. GHC#11007

Drafted SWS Checked

Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



0 500
Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

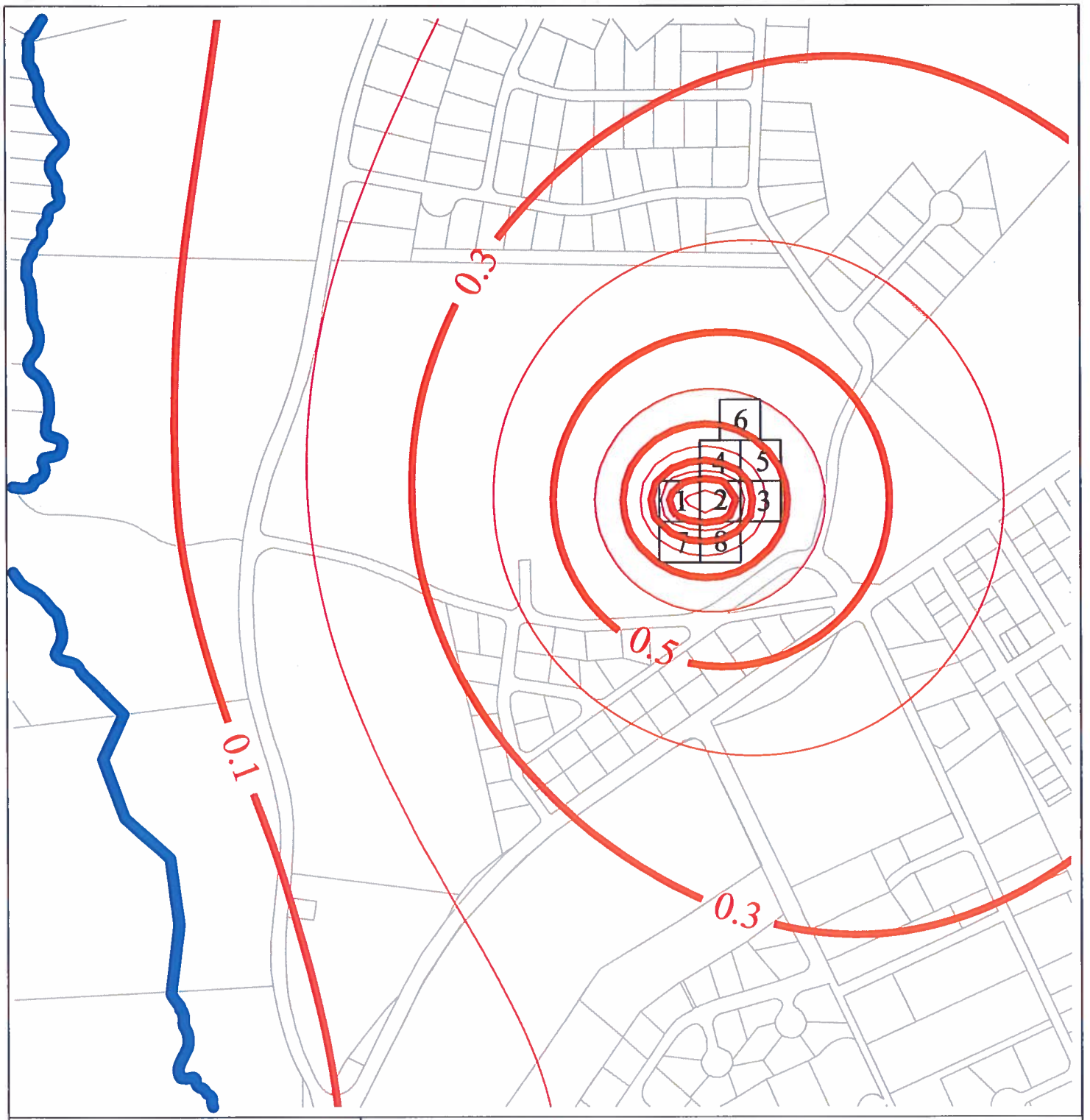
Figure 2. Simulated Groundwater Mound, Option 1.

Project No. GHC#11007

Drafted SWS Checked

Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



0 500
Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

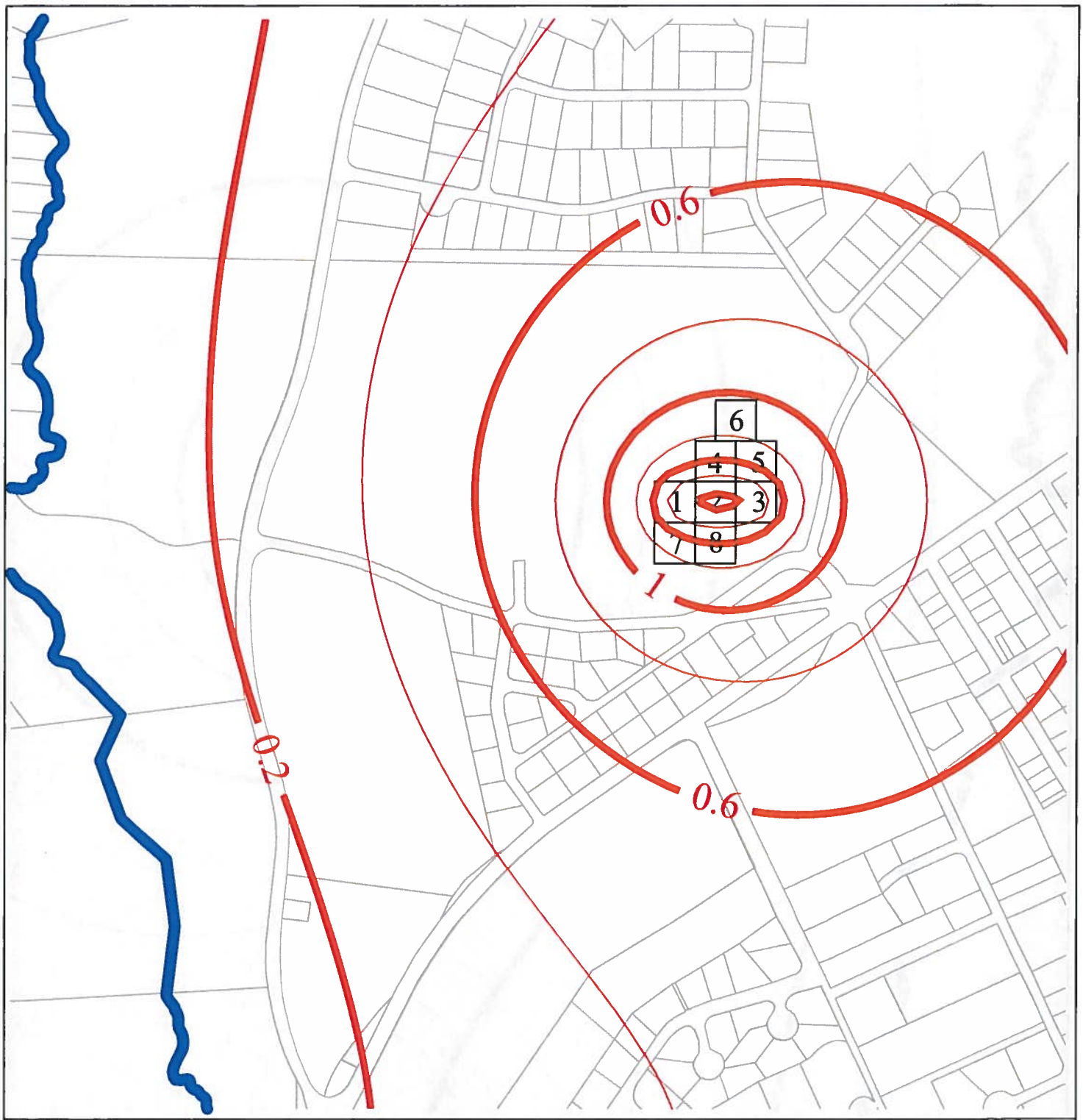
Figure 3. Simulated Groundwater Mound, Option 2.

Project No. GHC#11007

Drafted SWS Checked

Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



0 500
Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

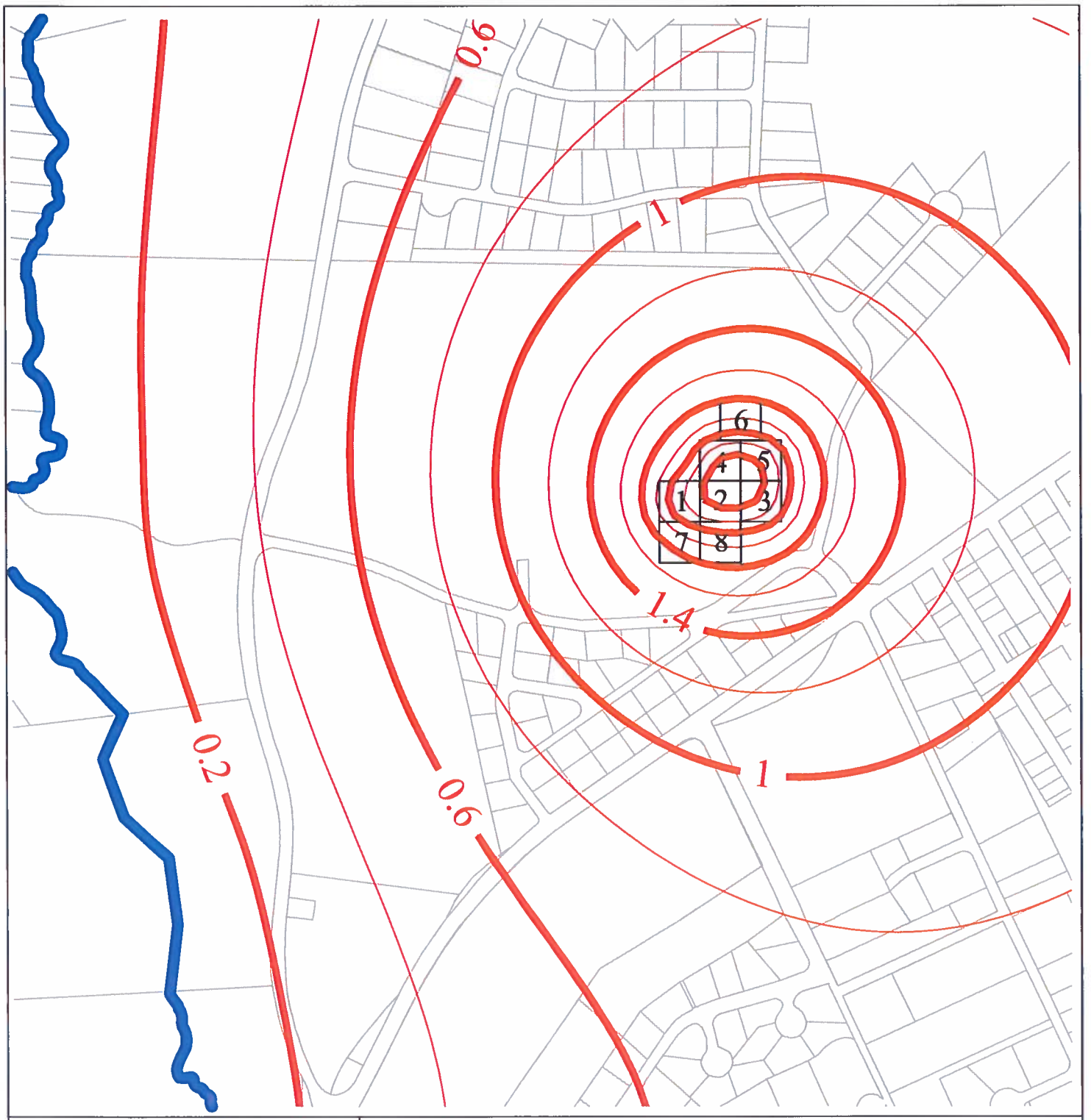
Figure 4. Simulated Groundwater Mound, Option 3.

Project No. GHC#11007

Drafted SWS Checked

Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



0 500
Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

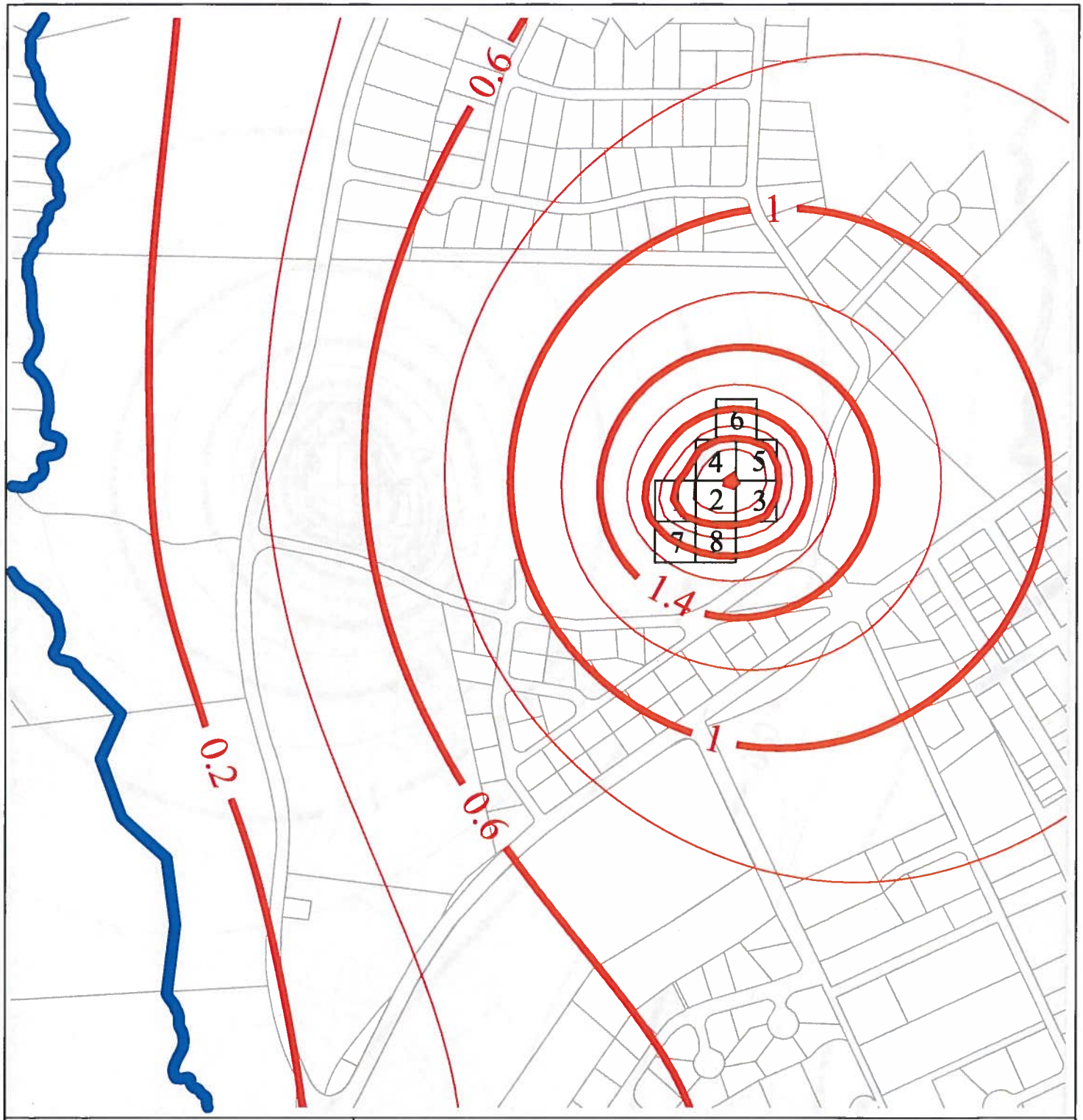
Figure 5. Simulated Groundwater Mound, Option 4.

Project No. GHC#11007

Drafted SWS Checked

Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



0 500
Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

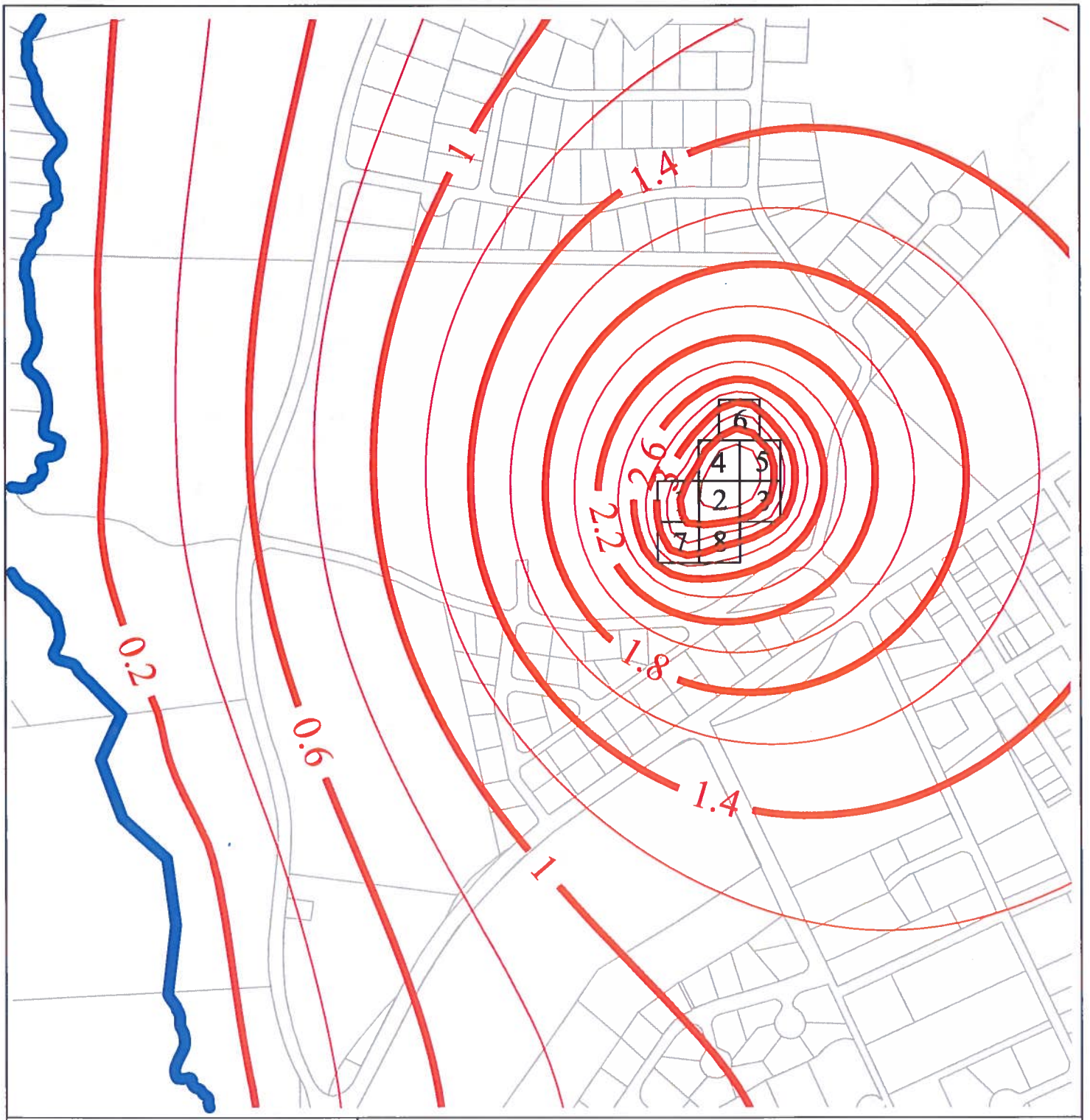
Figure 6. Simulated Groundwater Mound, Option 5.

Project No. GHC#11007

Drafted SWS Checked

Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



0 500
Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

Figure 7. Simulated Groundwater Mound, Option 6.

Project No. GHC#11007

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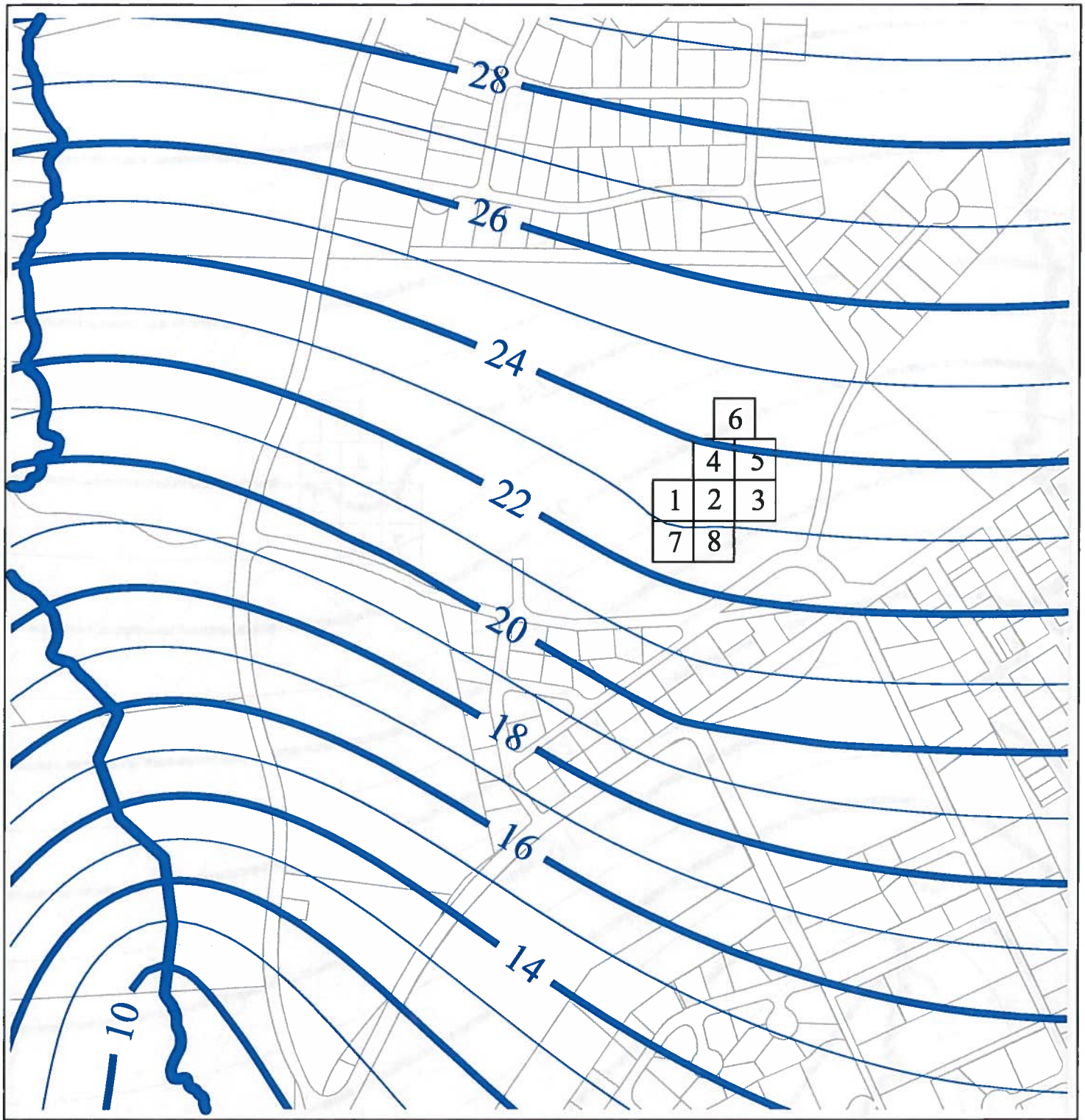
Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



0 500
Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

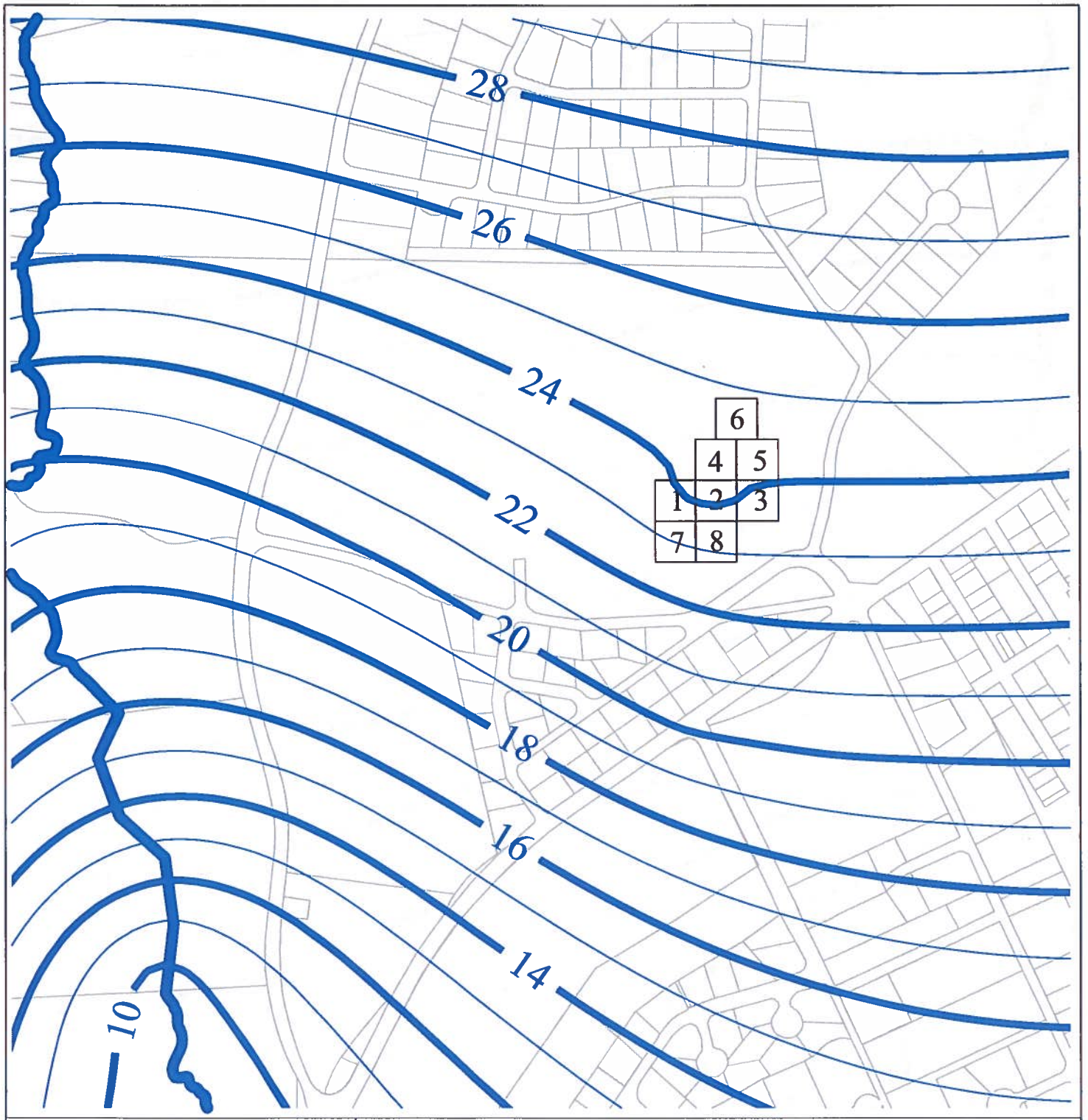
Figure 8. Simulated Mounded Groundwater Elevation Contours, Option 1.

Project No. GHC#11007

Drafted SWS Checked

Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



0 500
Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

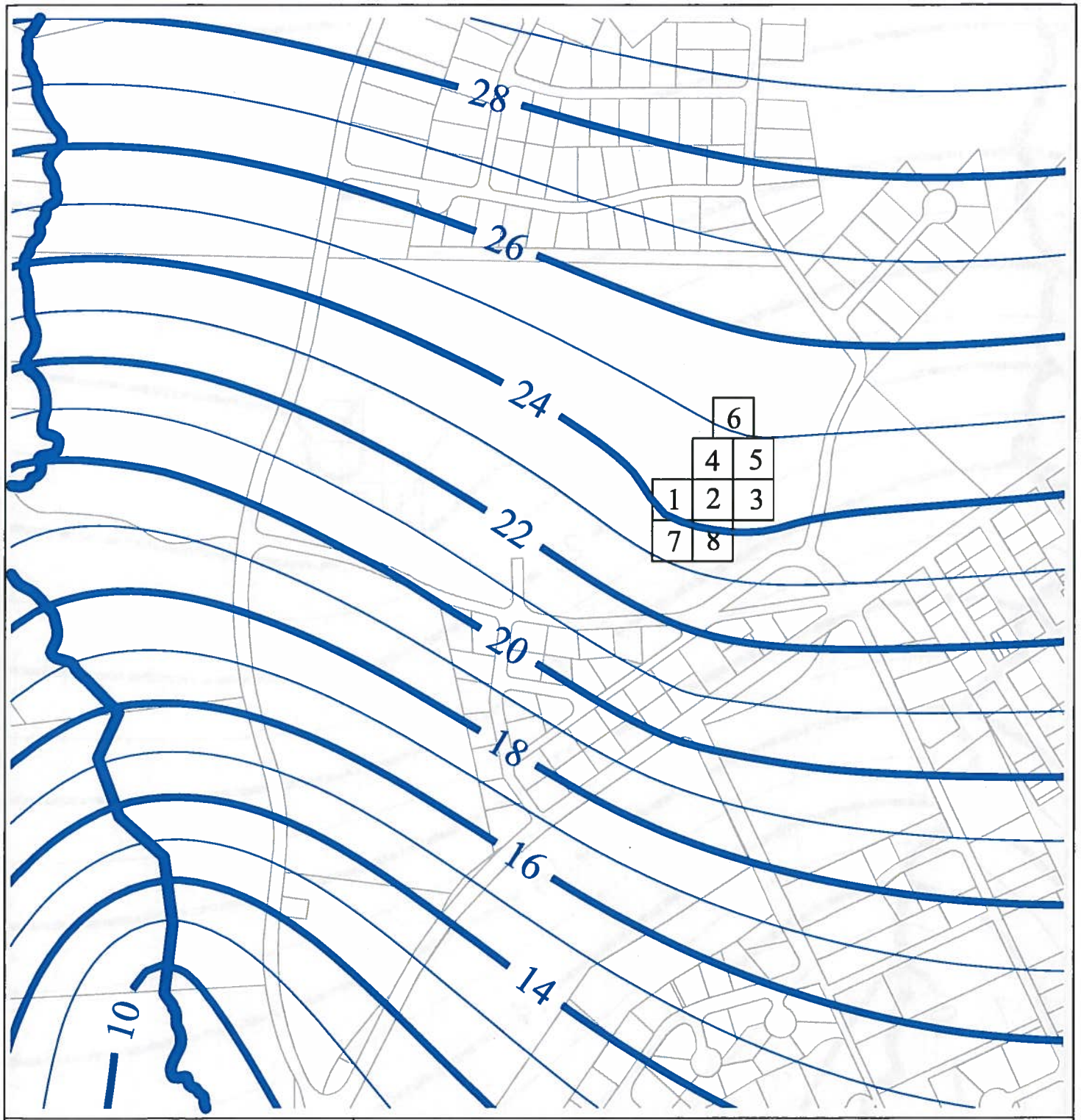
Figure 9. Simulated Mounded Groundwater Elevation Contours, Option 2.

Project No. GHC#11007

Drafted SWS Checked

Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



0 500
Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

Figure 10. Simulated Mounded Groundwater Elevation Contours, Option 3.

Project No. GHC#11007

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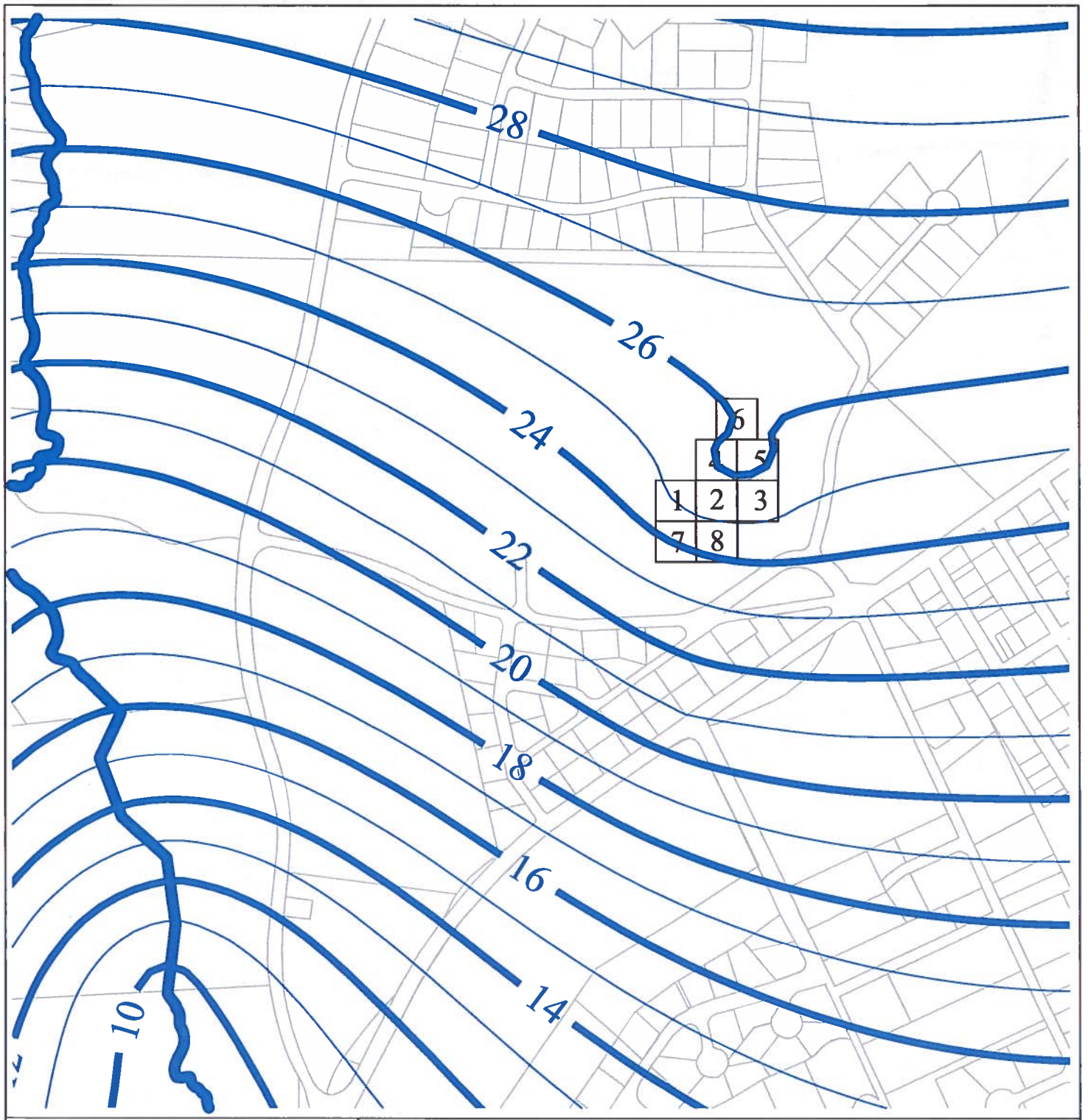
Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



0 500
Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

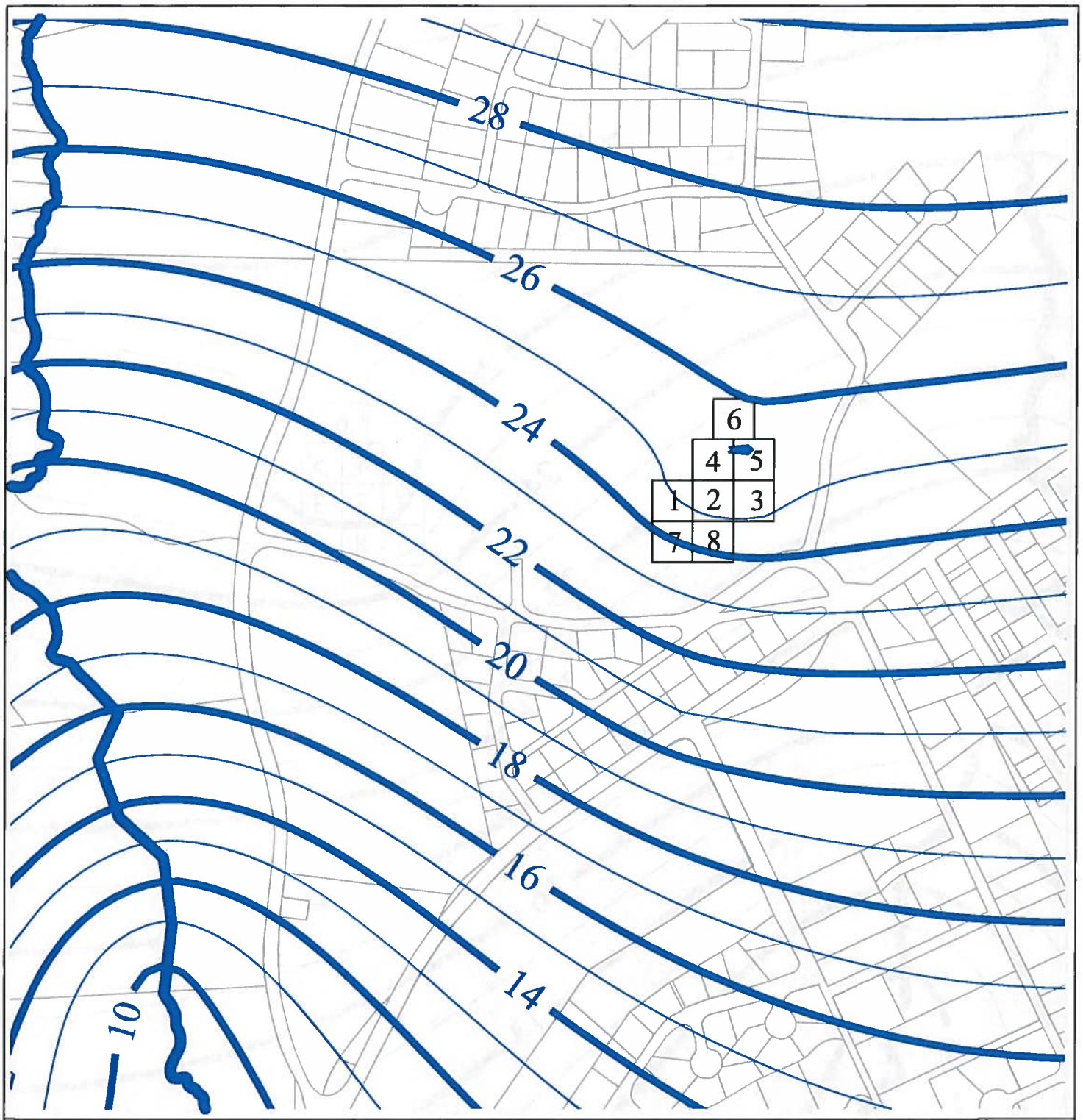
Figure 11. Simulated Mounded Groundwater Elevation Contours, Option 4.

Project No. GHC#11007

Drafted SWS Checked

Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



0 500
Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

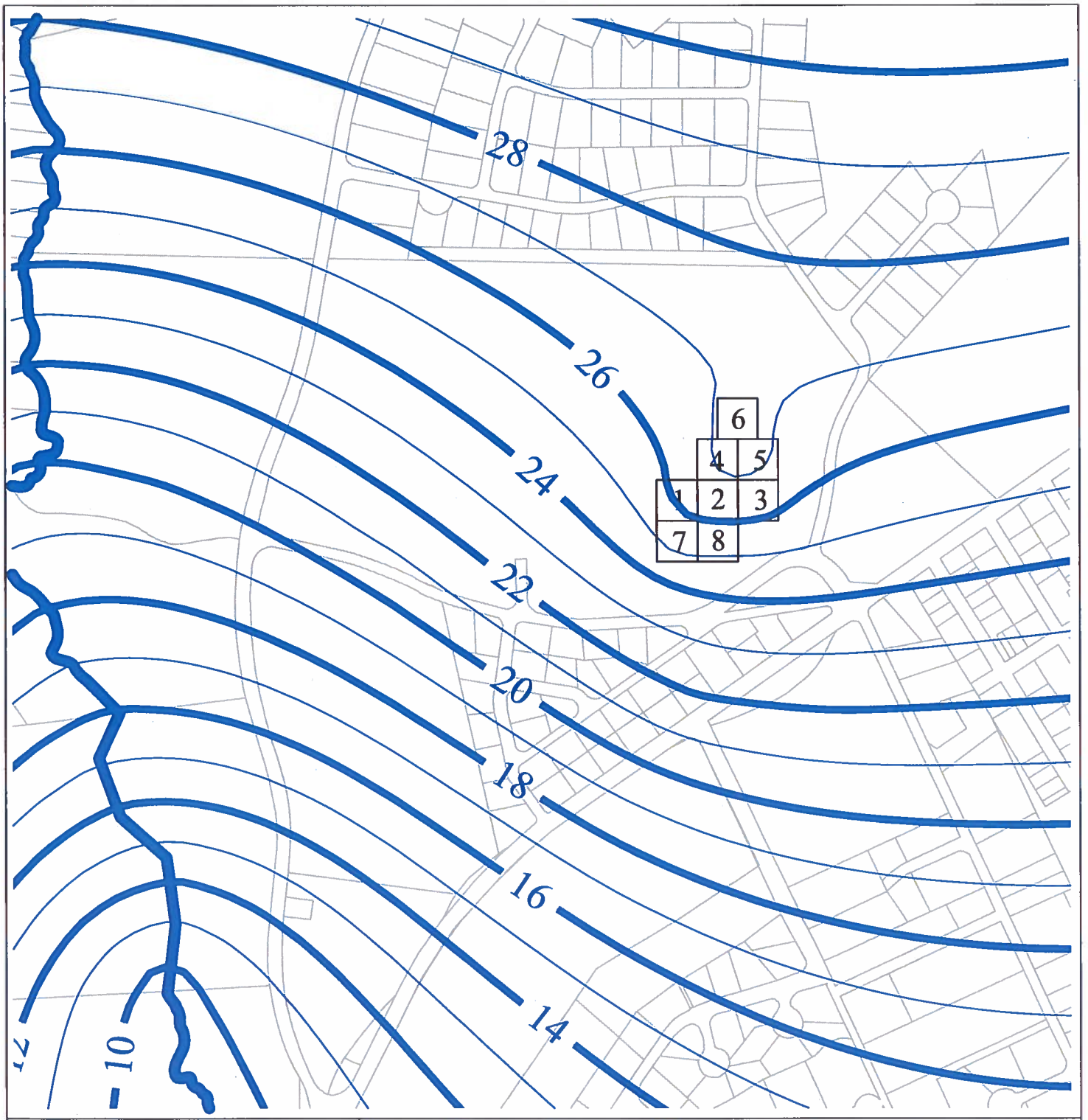
Figure 12. Simulated Mounded Groundwater Elevation Contours, Option 5.

Project No. GHC#11007

Drafted SWS Checked

Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA



0 500
Scale in feet

Base Map: See Reference.

GeoHydroCycle, Inc.

Figure 13. Simulated Mounded Groundwater Elevation Contours, Option 6.

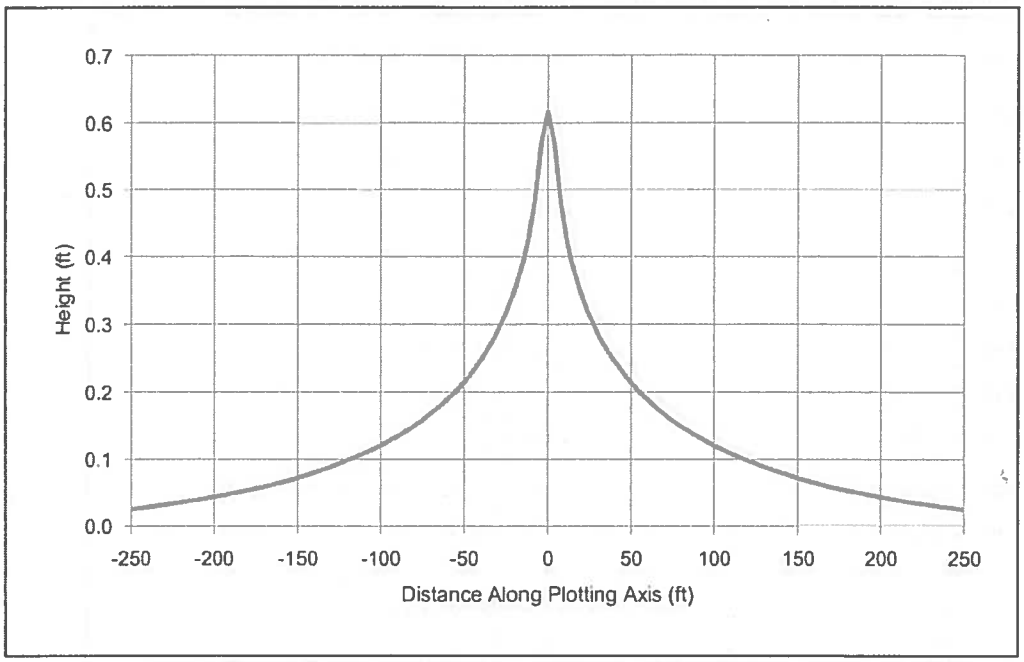
Project No. GHC#11007

Drafted SWS Checked

Date 11/14/11 Rev

Groundwater Modeling
Asher's Path Landfill
Mashpee, MA

Groundwater Mounding Analysis (Hantush's Method using Glover's Solution)



COMPANY: GeoHydroCycle, Inc.

PROJECT: Mashpee - Basin #1

ANALYST: SWS

DATE: 7/11/2011 TIME: 9:09:38 AM

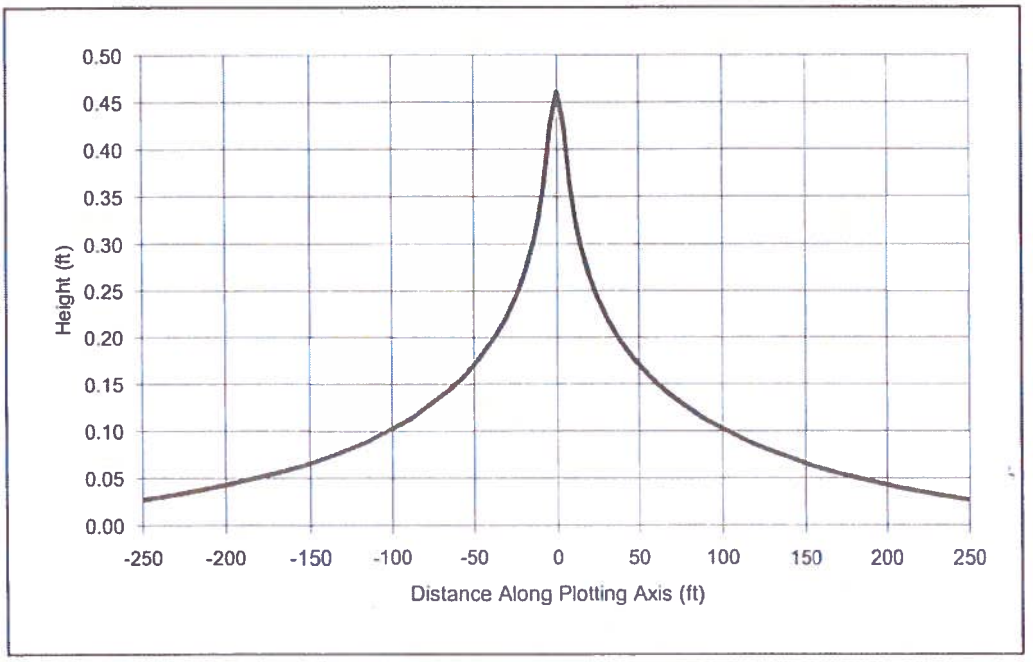
INPUT PARAMETERS

Application rate: 144.1238 c.ft/day/sq. ft
Duration of application: 0.3333 days
Fillable porosity: 0.2
Hydraulic conductivity: 250 ft/day
Initial saturated thickness: 50 ft
Length of application area: 8.9 ft
Width of application area: 8.9 ft
No constant head boundary used
Plotting axis from Y-Axis: 90 degrees
Edge of recharge area:
positive X: 4.4 ft
positive Y: 0 ft
Total volume applied: 3804.968 c.ft

MODEL RESULTS

X (ft)	Y (ft)	Plot Axis (ft)	Mound Height (ft)
-250	0	-250	0.02
-210.2	0	-210	0.04
-170.5	0	-170	0.06
-130.7	0	-131	0.09
-99.5	0	-99	0.12
-75.2	0	-75	0.16
-55.4	0	-55	0.2
-38.7	0	-39	0.25
-24.2	0	-24	0.32
-14.5	0	-14	0.39
-7.9	0	-8	0.48
0	0	0	0.62
7.9	0	8	0.48
14.5	0	14	0.39
24.2	0	24	0.32
38.7	0	39	0.25
55.4	0	55	0.2
75.2	0	75	0.16
99.5	0	99	0.12
130.7	0	131	0.09
170.5	0	170	0.06
210.2	0	210	0.04
250	0	250	0.02

Groundwater Mounding Analysis (Hantush's Method using Glover's Solution)



COMPANY: GeoHydroCycle, Inc.

PROJECT: Mashpee - Basin #2

ANALYST: SWS

DATE: 7/11/2011 TIME: 9:15:43 AM

INPUT PARAMETERS

Application rate: 145.0959 c.ft/day/sq. ft
Duration of application: 0.3333 days
Fillable porosity: 0.2
Hydraulic conductivity: 350 ft/day
Initial saturated thickness: 50 ft
Length of application area: 8.9 ft
Width of application area: 8.9 ft
No constant head boundary used
Plotting axis from Y-Axis: 90 degrees
Edge of recharge area:
positive X: 4.4 ft
positive Y: 0 ft
Total volume applied: 3830.632 c.ft

MODEL RESULTS

X (ft)	Y (ft)	Plot Axis (ft)	Mound Height (ft)
-250	0	-250	0.03
-210.2	0	-210	0.04
-170.5	0	-170	0.06
-130.7	0	-131	0.08
-99.5	0	-99	0.1
-75.2	0	-75	0.13
-55.4	0	-55	0.16
-38.7	0	-39	0.2
-24.2	0	-24	0.25
-14.5	0	-14	0.3
-7.9	0	-8	0.36
0	0	0	0.46
7.9	0	8	0.36
14.5	0	14	0.3
24.2	0	24	0.25
38.7	0	39	0.2
55.4	0	55	0.16
75.2	0	75	0.13
99.5	0	99	0.1
130.7	0	131	0.08
170.5	0	170	0.06
210.2	0	210	0.04
250	0	250	0.03