ATTACHMENT 1

HYDROFOCUS INC.
Solutions for Land and Water Resources

26 October 2011

Bill and Harriet Newman
7300 Camino Tassajara
Danville, CA

Subject: Creekside Memorial Park Cemetery Draft Environmental Impact Report—Review of Water Use and Supply Calculations

Dear Mr. and Mrs. Newman:

We reviewed the hydrology chapter of the Draft EIR (section 3.9) and the associated material in Appendix D. Our focus was on the groundwater balance calculations under existing and project conditions and its potential influence on Tassajara Creek and groundwater storage. Our analysis indicates that groundwater recharge is likely much less than the projected groundwater use required by the project. Furthermore, the DEIR substantially under-estimates the project groundwater use because it ignores the additional consumptive use from the enhanced riparian vegetation once it becomes established. The excessive drawdown caused by the new pumping can potentially reduce Tassajara Creek flows and lower off site groundwater levels. Although the DEIR mentions these potential impacts in its proposed monitoring tasks (DEIR pp 3.9-27 through 31), there is no mention of mitigation for impacts. We also reviewed the DEIR discussion of potential groundwater quality impacts due to burials and the associated literature and find that there is potential for groundwater quality impacts and that additional analysis is required.

Groundwater recharge is likely substantially less than the estimated water use for the project.

The DEIR reported estimated project groundwater use as 45 acre-feet per year (AF/yr). The DEIR cites two studies that estimated average annual groundwater recharge at the site. The first study assumed recharge is 15% of annual rainfall, which resulted in an estimate of 45 acre-feet per year (AFY). The second study applied the Thornthwaite-Mather method and obtained a much smaller recharge estimate of 10.3 AFY. The latter method is a more physically based approach and therefore provides a more reliable recharge estimate. However, the recharge value reported in the DEIR needs correction because there was an incorrect interpretation of line 12 ("Detention") in Appendix D Table 3 as representing groundwater recharge (the Thornthwaite-Mather calculations). That row simply translates estimated recharge, which is represented by deep percolation beneath the root zone (row 9 of Table 3 which is "Surplus") over the subsequent months of the year. The correct estimate of average annual rainfall recharge is therefore 1.28 in/yr and not 0.55 in/yr. This increases the recharge estimate from 10.3 AFY to 24.0 AFY over the project site, but even after this correction estimated recharge is still only about half of the DEIR's estimated project groundwater use. Furthermore, the Thornthwaite-Mather method does not consider that this recharge can be stored in the aquifer, pumped by wells, extracted by phreatophytes, or move offsite as subsurface flow. As a result, the amount of recharge available to the project is likely less than 24.0 AFY.

New riparian consumptive use almost doubles estimated project water demand but was not included in the DEIR water budget calculations.

The project water balance in Table 7 of Appendix D needs to include the consumptive use of groundwater by new riparian vegetation. The only consumption presently listed for that land use category is the small amount of irrigation needed to establish the plants. However, many of the proposed riparian plant species are phreatophytic and have roots that draw water directly from the water table.

Table 3b of Appendix D indicates annual potential evapotranspiration (PET) for Turf, Riparian, and Wetland areas is about 49 inches per year (in/yr). The tabulated differences between precipitation (P) and PET are less than zero during the months when rainfall is insufficient to meet the plant water needs. During these deficit months, the phreatophytes will extract and use groundwater to make up the difference which totals about 38 in/yr in Table 3b. The remaining annual water requirement (about 11 in/yr) will be met by rainfall.

Multiplying estimated phreatophyte groundwater use by the 13.6 acres of proposed new oak/riparian woodland produces an estimated annual consumptive use of about 43 AFY. The DEIR concluded that consumptive use of groundwater would increase from about 1.3 AFY under existing conditions to about 45 AFY under project conditions. After including the additional groundwater use by riparian plants to meet their annual consumptive water requirement, we estimated that total consumptive use of groundwater by the project would increase to 88 AFY (45 AFY plus 43 AFY).

In other areas of the cemetery, conversion of vegetation might not increase consumptive use of groundwater, but it would likely decrease recharge—which has the same net effect on the water balance. This includes areas where annual grasses are converted to oak woodland (31.5 acres) or xeriscape (20.8 acres). These plants will decrease recharge because their roots are deeper than the roots of the existing annual grasses. For example, the Thornthwaite-Mather calculations (Table 3a of Appendix D) do not document the assumed root depth used for the calculation, but the value used appears to be approximately 36 inches for annual grasses (6 inches on average of total soil moisture storage – as cited on page 7 of the DEIR and indicated by the soil properties reported in Table 2 – divided by a typical available water capacity for clay loam of 0.17 in/in). With 6 inches of total storage in clay loams, Table 3a shows surplus water occurring only in one month (1.28 inches in February). If soil moisture storage capacity increases by a minimum of only 1.28 inches, the calculation would show no surplus during the year, and as a result zero annual groundwater recharge. This increment of additional root zone storage can be achieved with an increase in root depth of only 7.5 inches relative to the existing annual grasses (that is, roots reaching down more than 43.5 inches). Oak trees have roots tens of feet deep, and many native shrubs have roots 4-12 feet deep[1]. Accordingly, groundwater recharge could decrease to zero over 52.3 acres of the site (24-percent) after establishing additional oak trees and xeriscape plants (a decrease in estimated recharge for the site from 24.0 AFY to 18.3 AFY). This has the same net effect of increasing the consumptive use of groundwater by the project from 88 AFY to almost 94 AFY – more than double the estimated project consumptive use of groundwater reported in the DEIR.

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[1] Blaney, H.F., P.R. Nixon, G.P. Lawless and E.J. Wiedman. 1963. Utilization of the waters of the Santa Ynez River basin for agriculture in southern Santa Barbara County, California. U.S. Dept. of Agriculture, Agricultural Research Service.

Project pumping may increase percolation from Tassajara Creek.

The ability of wells to capture greater recharge is fundamental to the conclusion that groundwater levels would decline initially and then "equilibrate" at a new lower level (DEIR p. 3.9-29). This can occur if pumping induces greater percolation out of Tassajara Creek.

ENGEO (April 10, 2009) estimated the percolation capacity of the creek as 0.01-0.03 cfs (850 ft channel length, 8 ft channel width, and 0.06 to 0.20 in/hr permeability). Over a 7-month flow season, this percolation capacity amounts to 13 AF of percolation, or one-third of the estimated groundwater use – one-sixth of the estimated groundwater use if the consumptive use of riparian vegetation is included. Thus, site pumping wells will have to induce and capture additional creek percolation beyond the 13 AF in order for groundwater levels to equilibrate at a new level after the initial pumping decline as stated in the DEIR. In order to induce greater percolation from Tassajara Creek, all of the following creek characteristics must be confirmed: 1) there is and will be a hydraulic connection maintained between groundwater and the creek; 2) the creek bed percolation capacity is sufficient to transmit the increased percolation; and, 3) the amount of flow in the creek has to be large enough to supply the additional percolation. None of these characteristics have been addressed in the DEIR analysis.

The project pumping cone of depression may extend substantial distances beyond the site.

The ability of wells to capture greater recharge is fundamental to the conclusion that groundwater levels would decline initially and then "equilibrate" at a new lower level (DEIR p. 3.9-29). This can occur if the pumping cone of depression expands and captures additional rainfall recharge from an area that extends off site to the north and south.

We utilized groundwater-flow equations and developed a superposition model representative of the alluvial groundwater system to calculate potential drawdown from the extraction and consumption of groundwater at the proposed project site. The groundwater system was modeled as a 1,265 feet wide valley of water-bearing alluvial deposits bounded by non-water bearing rock. We bracketed the calculated potential drawdown between two potential end members – maximum drawdown will occur in a confined aquifer[2], and the minimum drawdown will occur in an unconfined aquifer[3]. The simulated aquifer conditions were as follows:

- Thickness of water bearing sediment = 30 feet (DEIR, Appendix D, pg-11).
- Aquifer transmissivity of 400 gpd/ft (representative of the reported range of 330 to 432 gpd/ft; DEIR p. 3.9-10).
- Todd (2011) reported that storativity values greater than 0.005 indicate unconfined conditions, while values less than 0.005 indicate semi-confined to confined conditions. The reported pumping tests (ASE, 2008) were insufficient for estimating aquifer storage properties beneath the site. ENGEO (2008) concluded the water-bearing sediments beneath the site are likely unconfined to semi-confined, and ASE (2008) described conditions as leaky (semi-confined). We therefore employed storativity values ranging from 0.10 (unconfined) to 0.005 (confined) to represent this possible range in aquifer properties. Based on the log for site well PW-4 (ASE, 2008), the aquifer consists of poorly sorted water-bearing sands and

[2] Theis, C.V., 1935, The relation between lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage. *Transactions American Geophysical Union, 2,519-524.*
[3] Neuman, S.P., 1972, Theory of flow in unconfined aquifers considering delayed response in the water table, *Water Resources Research, 8(4), 1031-1045.*

gravel overlain by 85 feet of relatively low-yielding fine-grained sediments, which suggests groundwater is semi-confined.

- Groundwater use of 43.75 AF/yr, which equals 45 AF/yr of gross groundwater use less the 1.25 AF/yr of indoor use that is assumed to return as recharge (DEIR, Appendix E, Preliminary Anticipated Maximum Yearly Water Demand and Water Source Availability).
- Monthly water use distributed based on average precipitation and potential evapotranspiration data provided in Table 3 of Appendix D to the DEIR:
  - October (3.65 AF).
  - November through March l (no significant groundwater consumption).
  - April (3.65 AF).
  - May through September (7.3 AF per month).
- Pumping assumed distributed equally between seven wells located equidistant from each other across the eastern portion of the property that overlies the alluvial aquifer (individual pumping rates ranged from 3.9 gpm in October and April, to 7.7 gpm during May through September).
- The pumping wells are oriented in a line and located 265 feet from the western contact between water-bearing alluvial deposits and non-water bearing rock, and 1,000 feet from the eastern contact between water-bearing alluvial deposits and non-water bearing rock. These boundaries were simulated as “no-flow” boundaries using standard image well theory.[4]

The calculated drawdowns indicate project groundwater use will likely substantially lower groundwater levels and deplete groundwater storage. After one annual irrigation cycle, the drawdown in the pumping wells ranged from 67 to 87 feet for assumed confined aquifer conditions, and 22 to 23 feet for assumed unconfined aquifer conditions. The cone of depression extends significant distances beyond the site boundaries. Under assumed confined conditions, the cone of depression extends almost one mile to the northeast and southwest past the site boundaries (See attached Figure 1). Under unconfined conditions, the cone of depression extends on average about 500 feet to the northeast and southwest past the site boundaries (See attached Figure 2).

Groundwater impacts would be worse during droughts than under average annual conditions

The water balance calculations in the DEIR use average annual rainfall amounts. However, recharge is not proportional to rainfall throughout the range of annual rainfall amounts. In semiarid climates, groundwater recharge is threshold-dependent: little recharge occurs until the seasonal soil moisture deficit in the root zone has been replenished, after which additional rainfall percolates past the root zone and generates recharge. In addition, the average is heavily influenced by high rainfall years that occur somewhat infrequently. The net result of these two effects is that there is little or no rainfall recharge in most years having relatively low rainfall, and substantially higher amounts of recharge in the few intervening wet years. Accordingly, pumping can conceivably consume all available groundwater storage during a few successive years when there is little to no recharge. For example, groundwater storage capacity beneath the 31 acres of alluvium on the project site is estimated to be 58 AF (DEIR, Appendix D, pg. 11), which represents 1.3 years of project groundwater use – if all the water were available for extraction. The DEIR needs to consider this inter-annual variability in recharge because available groundwater storage at the project site is small relative to annual project water demand, planned pumping rates, and anticipated groundwater level declines.

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[4] R. Allan Freeze and John A. Cherry, “Groundwater”, 1979, Prentice-Hall.

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Groundwater quality can be affected by contaminants associated with burials.

The DEIR (p. 3-9 26) states that the possible contaminants from burials are formaldehyde used for embalming; varnishes, sealers, and preservatives used on wood coffins; and lead, zinc, copper, and steel from metal coffins. The DEIR concludes that there is no significant impact due to the presence of clayey soils that will adsorb organic chemicals and metals. The available literature on groundwater quality effects of cemeteries indicates potential contamination due constituents besides formaldehyde. For example, in a 1998 summary of the literature, the World Health Organization stated that "In cemeteries, human corpses may cause groundwater pollution not because of any specific toxicity they possess, but by increasing the concentrations of naturally occurring organic and inorganic substances to a level sufficient to render groundwaters unusable or unpotable."[5] Several factors influence the potential for groundwater quality degradation which include burial practices, density of burials and depth of unsaturated zone.

In summary, our evaluation of the DEIR and associated analyses and preliminary modeling of project impacts on groundwater reveal the following.

- Project water demand was underestimated in the DEIR due to exclusion of phreatophyte evapotranspiration.
- Recharge will decrease under project conditions as a result of water use by the planned oak woodlands and xeriscape landscaping, which has the same net effect as an increase in groundwater consumption.
- Project water use will be substantially greater than recharge.
- Project pumping may increase infiltration from Tassajara Creek.
- The DEIR assertion that groundwater levels will decline and reach a new equilibrium level is not well founded due to uncertainties about induction of recharge from Tassajara Creek.
- Annual groundwater recharge can be substantially less than estimated by the long-term average. Accordingly, groundwater impacts will be more severe during droughts.
- Effects of project pumping will extend beyond site boundaries, impacting existing neighboring wells if located in the cone of depression.
- Groundwater quality can be affected by burials beyond what is described in the DEIR. This issue requires further attention and analysis to determine possible impacts.

[5] World Health Organization, 1998, *THE IMPACT OF CEMETERIES ON THE ENVIRONMENT AND PUBLIC HEALTH*, Copenhagen, Denmark

Thank you for the opportunity to review and provide comment. We can discuss our comments with you and/or complete additional analysis, as needed. Also, please call or email with any questions or concerns.

Sincerely,
HydroFocus, Inc.

John Fio
Principal Hydrologist

Steve Deverel, Ph.D., P.G.
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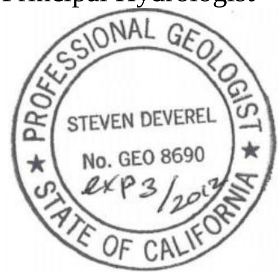

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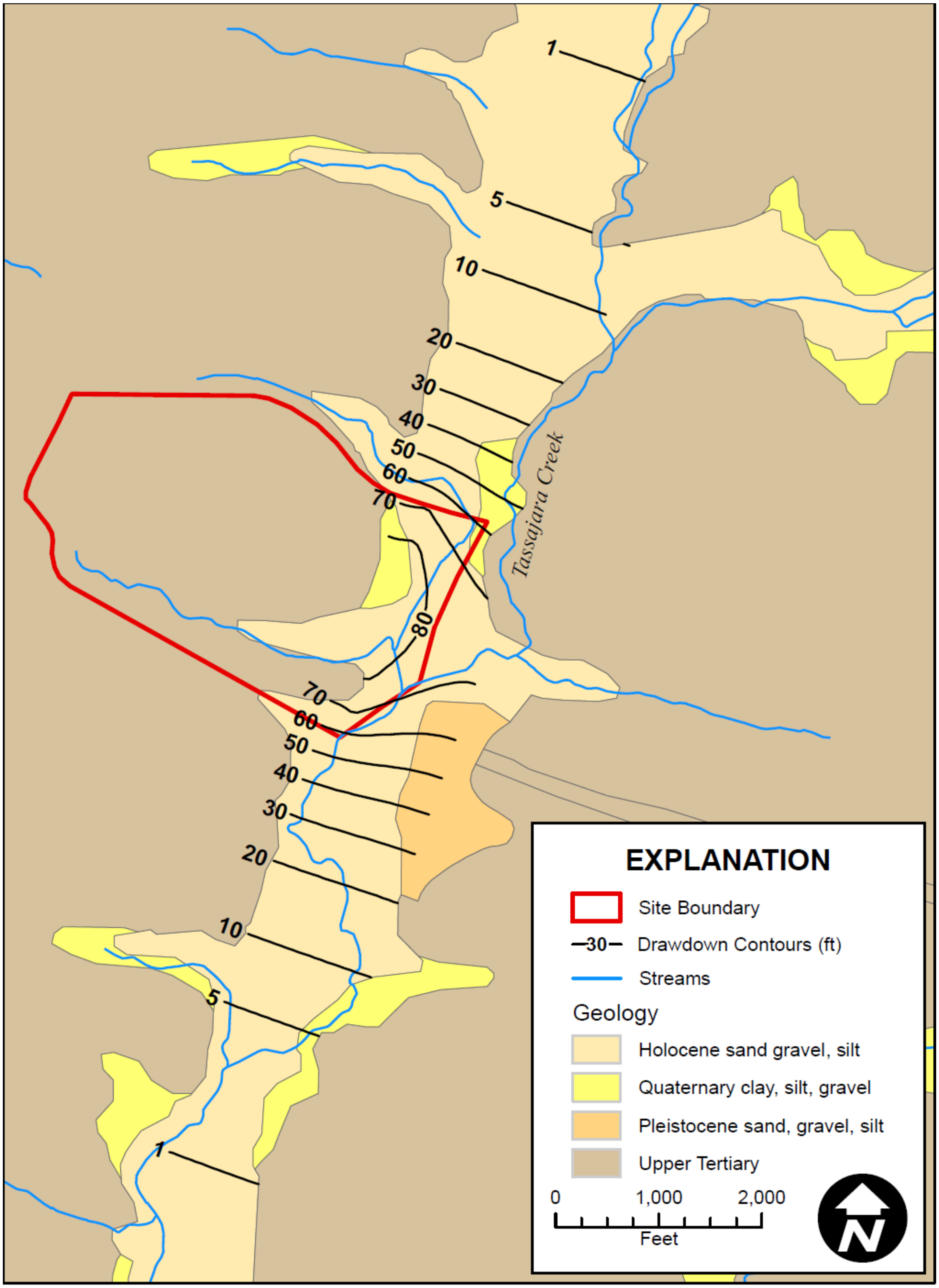

Figure 1. Confined aquifer: drawdown contours after one annual irrigation cycle.

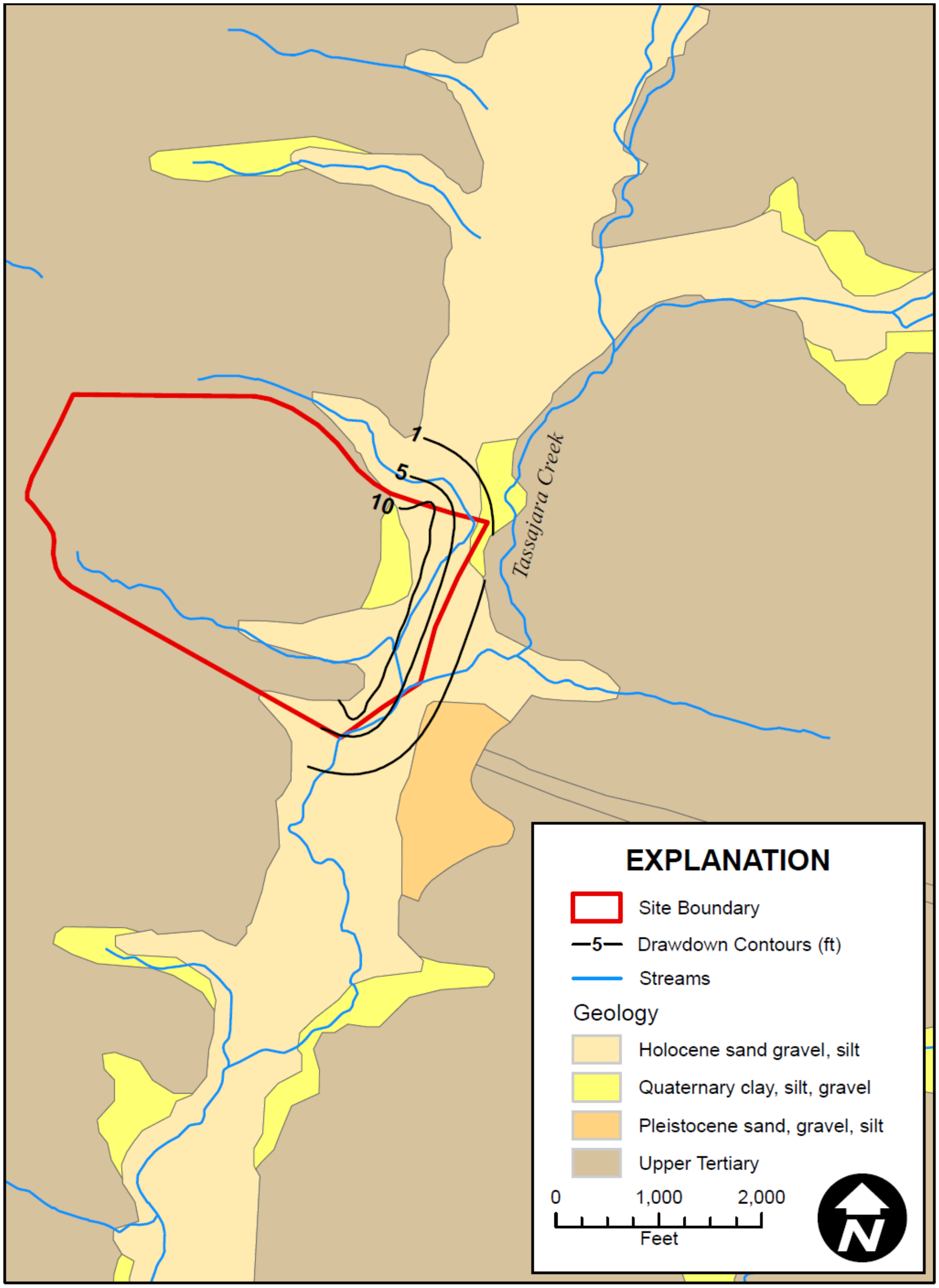

Figure 2. Unconfined aquifer: drawdown contours after one annual irrigation cycle.