



The

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES

hereby issues

LARGE GROUNDWATER WITHDRAWAL PERMIT

NO. LGWP-2016-0001

to the permittee

CITY OF DOVER COMMUNITY SERVICES DEPARTMENT
DOVER WATER DEPARTMENT
288 CENTRAL AVENUE
DOVER, NH 03820
(603-516-6450)

for the withdrawal of the following volumes of groundwater from the following wells for the purpose of community water supply:

Well DPH #1: 720,000 gallons over any 24-hour period; and

Well DPH #1, the Ireland Well, and the Griffin Well: a combined total of 1,123,200 gallons over any 24-hour period.

Date of Issuance: June 15, 2016

Date of Expiration (if the withdrawal is not activated): June 15, 2021

Date of Expiration (if the withdrawal is activated): June 15, 2026

Pursuant to authority in N.H. RSA 485-C:21, the New Hampshire Department of Environmental Services (NHDES), hereby grants this permit to withdraw groundwater from Well DPH #1 subject to the following conditions:

1. The permittee shall comply with the requirements of Env-Wq 403 and RSA 485-C at all times.
2. Water Conservation: The permittee shall implement the approved Water Conservation Plan, signed May 12, 2014, in accordance with Env-Wq 2101 and NHDES' approval dated June 10, 2014.
3. Metering Requirements: Withdrawals from the wells must be metered at all times. All meters must be selected, installed, tested, and maintained in accordance with Env-Wq 2101. The permittee shall read source water meters to adequately report the following volumes to the reporting program referenced in condition No. 8 of this permit:
 - a) The 24-hour peak day volume withdrawn from each source during each month and the date the water use occurred; and
 - b) The cumulative total volume withdrawn from each source during each month.
4. Monitoring Well Installation: At least three months prior to the intended start date of DPH #1, the permittee shall retain a NH-licensed water well contractor to install monitoring well DPH-MW10 at the location proposed in the Final Report titled "Final Hydrogeologic Report, City of Dover – Pudding Hill Aquifer Groundwater Development, Production Well DPH #1" (Final Report) prepared for the permittee by Emery & Garrett Groundwater Investigations, LLC, dated February 19, 2016. Any changes to the proposed location of the well shall require prior approval by NHDES. Well installation shall be overseen by a person who can demonstrate, by education or experience, competency in collecting and reporting hydrogeologic measurements. A hydrogeologic/well construction log and a copy of the Well Completion Report filed with the NH Water Well Board by the NH-licensed water well contractor that constructed the well shall be provided to NHDES prior to initiating a withdrawal from DPH #1.
5. Monitoring and Reporting Requirements: The permittee shall establish and maintain the monitoring and reporting program as described below:
 - a) Groundwater Level Monitoring
 - i. Production well: The permittee shall install a pressure transducer and data logger and measure water levels at a frequency of at least once every four hours in DPH #1. Water level monitoring shall commence upon initiating a withdrawal from DPH #1 and shall continue indefinitely as a condition of this permit.
 - ii. Monitoring wells: The permittee shall install pressure transducers and data loggers and measure water levels at a frequency of at least once every four hours in monitoring wells DPH-MW6, DPH-MW10 [new well], DP-105, and DPH-MW2d. Water level monitoring shall commence at least three months prior to the intended start date of DPH #1 and shall continue indefinitely as a condition of this permit.
 - iii. All wells: The permittee shall measure water levels in all wells (that the permittee has permission to access) listed in Table 1, and depicted in Figure 1, of the Final Report twice every year between April 15th and May 15th and between August 15th and September 15th, at the same time water quality samples are collected per condition No. 5b below. Water levels shall be measured manually using an electronic water level meter. At least one comprehensive water level monitoring round shall be conducted prior to initiating a withdrawal from DPH #1 and monitoring shall continue indefinitely as a condition of this permit.

- b) Groundwater Quality Sampling: The permittee shall collect groundwater quality samples as described below:
- i. Monitoring wells DPH-MW6, DPH-MW10 [new well], and DP-105: Volatile organic compounds (VOCs), 1,4-Dioxane, Perfluorinated Compounds (PFCs), RCRA 8 metals, iron, and manganese.
 - ii. Monitoring well DPH-MW2d: VOCs and 1,4-Dioxane.
 - iii. Monitoring wells DPH-4 and DPH-6: Nitrite, nitrate, chloride, sodium, arsenic, zinc, and VOCs.

Initial water quality samples shall be collected from the monitoring wells three months prior to the intended start date of DPH #1. After initiating a withdrawal from DPH #1, samples shall be collected at least twice every year between April 15th and May 15th and between August 15th and September 15th. Sampling shall continue after initiating a withdrawal from DPH #1 indefinitely as a condition of this permit.

Samples shall be collected using low-flow sampling methods. All samples for VOCs shall be analyzed using EPA Method 8260B. All samples for 1,4-dioxane shall be analyzed using a low level analysis method [with a detection level no greater than 0.25 µg/l (ppb)]. PFC samples shall be collected using the attached sampling protocols or equivalent methods. All samples for metals shall be field filtered. VOC, 1,4-dioxane, and inorganic samples shall be analyzed by a laboratory accredited in NH for the required analysis method/sample matrix. PFC samples shall be analyzed using USEPA Method 537 or an equivalent method.

All water level monitoring and water quality sampling shall be completed by a person who can demonstrate, by education or experience, competency in collecting and reporting hydrogeologic measurements.

Monitoring well and sampling locations and frequencies may be added or changed if the data obtained contradict the information provided in the permittee's application, or if additional data points are required to assess the potential for adverse impacts to occur.

An annual monitoring report and all monitoring data shall be submitted to NHDES by January 31 of each year. The annual monitoring report shall include groundwater elevation contour maps depicting generalized groundwater flow directions based on the water level measurements collected under condition No. 5a)iii; and shall provide text, tables or figures that present a summary of all previously collected data and note any relevant observations that may affect the measurements made from the preceding year inclusive of pertinent field notes or observations that document the annual monitoring activities undertaken to comply with this permit.

The annual monitoring report shall be submitted in an electronic format and hard copy format. All water level and water quality monitoring data collected shall be submitted in an electronic format only.

6. Notification Requirements: The permittee shall notify NHDES within 15 days of receiving results from water quality sampling conducted in accordance with condition No. 5b as described below:

- a) For any VOC, 1,4-Dioxane, or PFC water quality result at any concentration above analytical detection limits; or
- b) For all other parameters at concentrations equivalent to or greater than New Hampshire ambient groundwater quality standards or drinking water standards.

7. Mitigation Requirements

- a) In the event that an adverse impact occurs, the permittee shall comply with all of the requirements below and with the impact mitigation and source replacement requirements of Env-Wq 403.
 - b) Where the status of an unanticipated impact is not clear, the permittee shall gather information needed to quantify the impact and determine its status relative to the adverse impact criteria defined under RSA 485-C:21, V-c and provide this information to NHDES within 48 hours of being notified by NHDES. A verified adverse impact shall be mitigated in accordance with Env-Wq 403.
 - c) NHDES will routinely review the results of all monitoring data, and if water level monitoring data indicates that groundwater is being extracted at a rate that exceeds natural recharge on average, then NHDES will modify the permit in accordance with Env-Wq 403 in order to prevent adverse impacts from occurring. In addition, the permittee shall operate DPH #1 in accordance with this permit.
8. The permittee shall register its new source of water with the NHDES Water Use Registration and Reporting Program and maintain the water use reporting requirements established by RSA 488, Env-Wq 2102 and this permit.
9. The permittee shall apply for renewal of this permit at least 365 days prior to its expiration date in accordance with Env-Wq 403. The permittee shall continue to comply with all conditions in this permit until the permit is renewed or the facility is closed in accordance with all applicable requirements, regardless of whether a renewal application is filed.

Any person aggrieved by any terms or conditions of this permit may appeal in accordance with RSA 21-O:7, IV within 30 days.



Eugene J. Forbes, P.E.,
Director Water Division

PROJECT NARRATIVE

Large Well Siting Approval/Large Groundwater Withdrawal Permit LGWP-2016-0001 City of Dover Water Department, PWS ID 0651010 Production Well DPH #1 Dover, New Hampshire

June 15, 2016

BACKGROUND

The City of Dover Water Department (Dover) has submitted an application to the New Hampshire Department of Environmental Services (NHDES) requesting approval of one new large community production well and issuance of a large groundwater withdrawal permit for the withdrawal of up to 720,000 gallons per day (gpd) or 500 gallons per minute (gpm) over a 24-hour period for the purposes of municipal water supply.

The purpose of developing the new community production well, designated DPH #1, is to: 1) offset a loss in production capacity of the city's nearby Griffin Well that has been impacted by residual groundwater contamination; 2) provide source redundancy for production wells that currently serve the water system; and 3) accommodate potential increases in water demand based on historic water use trends and projected future growth in areas served by the water system.

Production well DPH #1 is located in the far west portion of the city of Dover, about 2,000 feet from the Dover-Madbury town line. The well site is within an active sand and gravel borrow pit that is nearing the end of its operational lifetime and moving towards closure. To the immediate south of the pit is Pudding Hill-Mast Road, farther to the south and east resides a commercially developed corridor along NH Route 108. Within the pit also resides two of the city's active large community wells, the Griffin Well located about 2,500 feet southwest of DPH #1 (within the town of Madbury), and the Ireland Well located along the edge of the pit's excavated area approximately 700 feet northwest of DPH #1. Just north of the Ireland Well, about 900 feet north of DPH #1, is the Bellamy River, beyond which (farther north) is a densely developed mixed commercial/residential corridor along NH Route 155.

Much of the immediate area surrounding the well site is disturbed (gravel pit) and is not in its original/natural state. Although somewhat indistinct, along the southern boundary of the pit, roughly parallel to Pudding Hill-Mast Road, is a topographically higher ridge that acts as a local surface water divide between the Bellamy River to the north and Oyster River/Great Bay to the south. The wellhead protection area (WHPA) for the withdrawal from the well borders on this boundary and expands to the north and east, encompassing an area slightly greater than three square miles that includes a significant portion of the lower Bellamy River watershed.

The overburden sediments screened by DPH #1 consist of relatively coarse sand and gravel with lesser amounts of finer grained material (silt, etc.). This surficial unit is known as the Pudding Hill aquifer and is interpreted as a deltaic unit deposited into a shallow marine setting via glacial meltwater from a slowly retreating or near-stagnant ice sheet/lobe. In general, the areal extent of this sand and gravel deposit is locally constrained to between the Mast Road area and the Bellamy River, however, it's about 75 to 100 feet thick in the vicinity of DPH #1/Ireland Well and thins to the south/southwest to about 40 feet in an area where the elevation of bedrock increases. North of DPH #1 and the Ireland Well, the Pudding Hill aquifer abruptly transitions to the fine-grained Presumpscot Formation, a widely present marine deposit of regional significance comprised of clays, silts and fine sand. This unit is about 70+ feet thick immediately north of the Ireland Well where it tends to act as a confining unit to a relatively thin underlying till unit that overlies bedrock. The reworking of the Presumpscot Formation by the river and its flood events tend to make it the predominant constituent of the surficial overbank deposits (alluvium) that form the floodplain of the river and its bordering wetlands. The fine-grained characteristics of these reworked

deposits tend to perch the wetlands and the river (deposits) and limit the vertical infiltration of recharge to lower units, thereby cutting off the direct hydraulic connection between the surface the Pudding Hill aquifer.

The saturated thickness of sand and gravel near DPH #1 is on the order of 40 to 50 feet, this degree of saturation coupled with the relatively coarse-grained nature of the unit provides significant volumes of storage available to the proposed water supply well. That being said, up until the early 2000s, lower lying areas within the pit were used as recharge locations for surface water obtained from a diversion on the nearby Bellamy River. The recharge water was used to both wash aggregate material and augment groundwater stored in the formation for later withdrawal via the Ireland Well and Griffin Well.

WITHDRAWAL TESTING AND CONCLUSIONS

A withdrawal testing program was conducted by Emery & Garrett Groundwater Investigations LLC (EGGI) from September 16 through approximately October 16, 2015. The purpose of withdrawal testing is to provide data to estimate long-term sustainable water quantity and quality; observe the response of the aquifer to pumping; evaluate the degree of hydraulic connection with overlying deposits; and, assess the potential for adverse impacts to water resources and users that may result from the proposed withdrawal. The withdrawal testing program included monitoring during pre-pumping, pumping, and water level recovery periods, where DPH #1 was pumped at approximately 500 gpm between September 24 and 29, 2015. Discharge from the well was metered during the withdrawal testing program to maintain a near-constant pumping rate, and water quality samples were collected during the pumping period to characterize the quality of the groundwater derived from the proposed production well. As a measure to assess the influence of pumping within the source formation under a more severe stress condition, both of the existing wells in the well field (the Griffin Well and Ireland Well), were continuously pumped prior to and during the test at rates of approximately 370 and 383 gpm, respectively, for 20 and 22 days.

Water Level Monitoring and Observations

During the withdrawal testing program, water level measurements were collected at:

- The proposed new production well DPH #1;
- The two existing production wells (Griffin and Ireland Wells);
- 18 onsite overburden monitoring wells;
- 10 offsite overburden monitoring wells;
- One offsite overburden private water supply well;
- Two shallow groundwater piezometers; and,
- Four stream gauges.

The one private water supply well is approximately 3,000 feet from the production well in a residential area south of the well field off of Mast Road. Groundwater levels at deeper onsite groundwater monitoring wells were recorded to observe the zone of influence of the production well, while shallow groundwater and surface water level measurements were recorded to assess the degree of hydraulic connection between the production zone of the deeper sand and gravel unit and the shallow water table, surrounding wetlands, and the river. Monitoring water levels at one monitoring well couplet located north of the Bellamy River was conducted to assess if the production well influenced water levels in overburden north of the river.

Because the Griffin and Ireland Wells were pumping continuously for multiple days before the pumping test, no static water level condition in the formation/well field was established before the start of pumping of DPH #1. Based on historical water level records from the site and surrounding area, however, groundwater flow across the site under non-stress conditions is believed to be towards the north, from a local groundwater divide around Mast

Road to the Bellamy River, with a hydraulic gradient of about 0.008 ft/ft. Groundwater flow across the stressed, pre-startup water table (Griffin and Ireland Wells pumping) showed groundwater flow across most of the northern portion of the Pudding Hill aquifer (north of Mast Road) to be convergent on either the Griffin Well or the Ireland Well. Drawdowns induced by the Griffin and Ireland Wells appear to be on the order of 30+ feet.

The pumping test water level measurements indicate that ten on-site monitoring wells and one off-site monitoring well responded to pumping with drawdowns ranging from 0.01 to 7.9 feet. Water level drawdown at the one offsite well was approximately 0.7 feet and occurred at the deep overburden (till) monitoring well located approximately 150 feet north of the Bellamy River; it is significant to note that water levels at this location were also substantially influenced by the continuous pumping of the Ireland Well. No drawdown or hydraulic effects occurred at any of the shallow monitoring wells, piezometers or surface water staff gauges present within shallow deposits proximate to or within the Bellamy River, implying that the fine-grained sediments in this area of the site act as a restrictive layer to horizontal and vertical groundwater flow. Drawdown in production well DPH #1 at the end of the test was 17.7 feet.

Based on a distance-drawdown analysis of water level responses in the monitored wells that responded to pumping of DPH #1 only, pumping-induced effects occurred on the order of 800 feet from the well at the end of the test. Assuming 180 days of continuous pumping effects from all three wells (DPH #1, Ireland and Griffin) with no net recharge from precipitation to the aquifer, projected effects are estimated to extend on the order of 3,000 feet from the well site.

Water Quality Monitoring and Observations

Results of water quality sampling conducted during the withdrawal testing program indicate acceptable water quality, with all drinking water parameters below applicable Maximum Contaminant Levels (MCLs). Water derived from DPH #1 was below the secondary MCL range for pH of 6.5–8.5 and may need to be chemically adjusted prior to supplying to consumers. Due to the presence of contaminated groundwater in areas west of DPH #1, some additional samples were collected from the proposed production well, the Ireland Well and a monitoring well; no contaminants were detected in these samples.

PUBLIC NOTIFICATION AND INVOLVEMENT

Pursuant to RSA 485-C:21, II through V-a, materials submitted in support of the large groundwater withdrawal permit (the preliminary application, final report, and supplemental materials) were sent (via certified mail) to municipalities and public water suppliers in the potential impact area of the withdrawal. Copies of the above-referenced materials were sent to the towns of Dover and Madbury. No public hearings were requested by notified parties following submittal of the preliminary application or final report.

Following submission of the final report NHDES received a comment letter from Ransom Consulting, Inc. (Ransom) on behalf of Electrocraft New Hampshire, Inc. (Electrocraft). Ransom is the environmental consulting firm for Electrocraft, a former manufacturer of small precision motors previously located at a facility off of NH Route 155 in Dover, north of the Bellamy River approximately 2,500 feet northwest of DPH #1. Electrocraft is the responsible party for a groundwater contamination site at its former Route 155 manufacturing facility that resulted from the discharge of facility-derived chlorinated solvents to the ground in the early to mid-1980s. The groundwater contaminant plume from the Electrocraft site resides primarily below land proximal to the footprint of the facility building located on the north side of Route 155; however, groundwater contamination from the site extends to some bedrock wells downgradient (southwest) of the facility building, on the south side of Route 155. Currently there is an active remediation system (thermal desorption) in place at the site in the presumed source area for the solvents; and, groundwater quality monitoring is being conducted at a network of wells around the site under NHDES Groundwater Management Permit Number 198705067-D-001.

Ransom's letter provided comments for NHDES' consideration during review of Dover's permit application, and recommended that NHDES not grant Dover final approval for DPH #1 without a longer duration pumping test, further hydrogeologic study, and a more expansive groundwater monitoring network. Ransom's concerns are summarized as follows:

- Hydrogeologic data described in the final report for the well indicate more transmissive soils to the north of the well field, in the vicinity/direction of industrially developed areas;
- Hydrogeologic data described in the final report support the idea that groundwater flow in bedrock needs to be evaluated in industrial areas north of the well field because observations during pumping the overburden unit screened by DPH #1 indicate it may hydraulically influence bedrock groundwater flow;
- The Electrocraft facility, i.e. its groundwater contamination plume, may be in the influence area of DPH #1 and the Ireland Well based on projected water level drawdowns after extended pumping periods (i.e., 180 days of constant rate pumping with no recharge from precipitation); and
- Multiple potential contamination sources (the Electrocraft site being one of them) exist in industrially developed areas along Route 155 and within the estimated wellhead protection area (WHPA) of the well(s) that was developed in the final report; the presence of the potential contamination sources within the well field's WHPA could increase the risk to groundwater quality in the area.

Overall, site-related data used to characterize geologic units at the site and develop the conceptual hydrogeologic model, as well as water level data collected during the pumping test of DPH #1, do not indicate a direct hydraulic connection to groundwater contamination at the Electrocraft site or activities proximal to Route 155 north of Dover's well field; nor does the data collected during the pumping test indicate an imminent increase in risk to groundwater quality at the well field. The extent of the Pudding Hill aquifer that is source to DPH #1 (and the Ireland and Griffin Wells) is areally limited and largely pinches out along the boundary of the less transmissive, fine-grained silt/clay rich Presumpscot Formation, the predominant overburden unit bounding the northern limit of the wellfield, under the Bellamy River, and north of the river under Route 155. One overburden monitoring well located about 500 feet north of the Ireland Well, north of the Bellamy River, showed a limited hydraulic response to pumping by the end of the test (approximately 0.7 feet); however, this well is about 2,000 feet from the Electrocraft facility remediation system and about 1,300 feet from the farthest impacted bedrock wells downgradient of the Electrocraft site, and is side-gradient to the apparent predominant flow direction from the Electrocraft site. As a prudent measure, NHDES has included as part of the long-term monitoring network established in Dover's large groundwater withdrawal permit, a requirement to monitor water levels and water quality at the overburden monitoring well on the north side of the Bellamy River, between the well field and Route 155 corridor.

Concerns about large scale effects on groundwater flow in shallow bedrock north of the well field's source formation (Pudding Hill aquifer) and the Bellamy River are also not validated by the conceptual hydrogeologic model of the withdrawal or available groundwater level observations collected during the withdrawal testing program. In areas where bedrock is directly overlain by the Pudding Hill aquifer, and groundwater levels in the aquifer are influenced by pumping from DPH #1, there may be some degree of localized hydraulic connection with shallow bedrock or groundwater discharging from the shallow fractured bedrock; however, as noted previously, the Pudding Hill aquifer doesn't substantially extend north of the well field, nor is it present under the Electrocraft site or other sites along Route 155.

Regarding the issue with the Electrocraft facility and other potential contamination sources along Route 155 being within the estimated influence area/WHPA of DPH #1/Ireland and Griffin Wells; under the community well siting regulations, an applicant must estimate the potential influence area of a new well assuming a worst-case scenario of continuous pumping for six-months (180 days) during drought conditions. Once projected 180-day water level drawdowns are developed for each monitoring location, a projected cone of depression (potential influence area) is developed for the withdrawal that necessarily extends to areas substantially outside of areas where pumping

effects were actually observed during the test. The WHPA is then delineated as the area likely to contribute recharge to the potential influence area and, for a large community well like DPH #1, is routinely on the scale of a sub-watershed or watershed of a regional surface water feature near the well's location. As with other new well applications, this assessment was completed for DPH #1 by extrapolating the amount and rate of water level drawdown observed at the end of the pumping test forward, 180-days, while assuming no recharge from rainfall or snowmelt at all monitoring locations influenced by pumping.

Also, in reference to Ransom's/Electrocraft's concerns, it is important to note that the drawdowns measured (and used for projections) during the DPH #1 pumping test exceeded typical testing criteria because they included effects of pumping DPH #1 continuously at 500 gpm for 5-days *and* the Ireland and Griffin Wells at their maximum pumping rates for 19 and 20 days, respectively. The continuous and long-duration pumping of all wells at maximum rates will not be an operational practice implemented by Dover for any situation other than this testing program; therefore, the potential influence area derived by the method described above is not the *likely* influence area of the well under typical use conditions. This method of using projected drawdowns to infer the potential influence area and delineate the WHPA, as opposed to using end-of-test measured drawdowns only, is valid and purposely conservative because it's used to establish a wide areal buffer around a well site for implementation of a water system's wellhead protection program.

NHDES issued a response letter to Ransom, in conjunction with the permit referenced herein, responding to the issues presented in their comment letter.

LARGE GROUNDWATER WITHDRAWAL PERMIT MONITORING, REPORTING AND WITHDRAWAL REQUIREMENTS

The large groundwater withdrawal permit issued to Dover allows the withdrawal of up to 720,000 gpd (500 gpm) from DPH #1; however, the permit also establishes a limit on the volume of groundwater that Dover may withdraw from DPH #1, the Ireland Well, and the Griffin Well in any 24-hour period to a combined total of 1,123,200 gallons, which represents the estimated available recharge to the aquifer in the contributing area to the wells.

The large groundwater withdrawal permit also requires Dover to conduct a groundwater level and groundwater quality monitoring program that includes the production well and monitoring wells. General monitoring requirements are summarized as follows:

- The permit requires that water levels in DPH #1 be monitored continuously so that water level fluctuations in nearby wells can be compared to the operation of the production well;
- The permit requires that water levels in three on-site monitoring wells and one off-site monitoring wells be monitored continuously to infer the extent of potential water level effects on nearby wells within the influence area of the production well under typical use conditions;
- The permit requires that water levels in all wells used for the withdrawal testing program be monitored twice every year to infer groundwater flow directions in the aquifer; and
- The permit requires that water quality samples be collected from five on-site monitoring wells and one off-site monitoring well to assess for the presence of groundwater contamination.

The large groundwater withdrawal permit also requires notification in the event water quality results meet certain trigger concentrations.

In the event that an adverse impact is reported and verified, an impact mitigation program would be implemented in accordance with conditions of the large groundwater withdrawal permit and Env-Wq 403. The program would implement actions necessary to mitigate the impact including reducing the withdrawal volume, establishing water use restrictions for customers of the water system, modifying or replacing an impacted source at no initial capital cost to the user, and expanding (or establishing) a monitoring network to assess the effectiveness of the mitigation program. More information concerning these requirements is provided in the large groundwater withdrawal permit under condition No. 7.

Dover is required to submit an annual monitoring report in hard copy and electronic format to NHDES by January 31st of each year. As stipulated in the permit, the annual report shall include a summary of trends and variability observed in the monitoring data, all monitoring data and records required by the permit, and an assessment of the potential impacts associated with the withdrawal from DPH #1. The annual report will be available to the public for review. A complete description of monitoring and reporting requirements is presented in more detail in the large groundwater withdrawal permit under condition No. 5.