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March 19, 2003

Mr. Brandon Kernen
New Hampshire Department of Environmental Services
6 Hazen Drive
P. O. Box 95
Concord, New Hampshire 03302-0095

RE: Comments regarding USA Springs' Large Groundwater Withdrawal Permit Application dated February 3, 2003, ENSR Project Number 10154-001

Dear Mr. Kernen:

ENSR International (ENSR) presents these comments to the New Hampshire Department of Environmental Services (NHDES) under our contract (signed by NHDES 1/9/02) to provide technical support to the NHDES in review of applications for Large Groundwater Withdrawal Permits. The comments apply to USA Springs' "Large Groundwater Withdrawal Permit Application Report, Proposed USA Springs Bottling Plant" (dated February 3, 2003), which consists of three volumes (Volume I, Text, Tables, and Figures; Volume II, Appendices A through G; and Volume III, Appendices H & I) (hereinafter Report). ENSR received the Report from NHDES on 2/6/03. The current review constitutes part of Task 4 in ENSR's approved Scope of Work for the USA Springs Large Groundwater Withdrawal Permit application.

1.0 INTRODUCTION

1.1 Scope of ENSR Review

ENSR has conducted a detailed review of the Report relative to the "Major (Large) Groundwater Withdrawal" regulation Env-Ws 388. ENSR has also reviewed the report relative to the "Groundwater Sources of Bottled Water" regulation (Env-Ws 389). Env-Ws 389 also references Env-Ws 379 (Site Selection of Large Production Wells for Community Water Systems) regarding specific pumping test requirements. ENSR's review relative to Env-Ws 379 has been limited to the specific elements of the regulation referenced in the bottled water source regulation (Env-Ws 389). ENSR has not reviewed the Report relative to New Hampshire Department of Health and Human Services regulation of bottled water. ENSR's review regarding wetlands has been limited to hydrogeologic aspects of possible wetlands impacts due to pumping the wells, per Env-Ws 388.

The present letter includes ENSR's findings regarding the VOC contamination and also documents a broader suite of items concerning USA Springs' application. ENSR's conclusions are based primarily on written, graphical, tabular, and map representations presented in the Report.

1.2 Professional Consideration

ENSR recognizes the responsibilities associated with critiquing the work of other professionals. ENSR realizes that almost all consulting reports may contain some elements that another professional could find fault with, and that certain aspects of hydrogeological studies are open to interpretation; professional hydrogeologists can reasonably disagree, in some cases. ENSR acknowledges that USA Springs' consultants have conducted a large amount of hydrogeologic work in a complex hydrogeologic setting for a highly scrutinized and controversial project. However, ENSR believes that there are serous questions concerning the site, the proposed withdrawal, and the Report.

1.3 Organization of This Letter

ENSR has focused (Sections 2.1 through 2.5 of this letter) on items that relate directly to the regulations involved and the decision that the NHDES must make as to whether to grant permits. In addition, ENSR identifies (Section 2.6 of this letter) smaller items or items that may relate only indirectly to permit decisions, because it may be useful for NHDES to be prepared for technical objections that may be raised by project opponents.

1.4 Project Background

The USA Springs site is located at 145 Old Turnpike Road (U. S. Route 4) in Nottingham, New Hampshire (Tax Map 3, Lot 10). USA Springs is seeking a Large Groundwater Withdrawal Permit for 215 gallons per minute (309,600 gallons per day), combined, from three bedrock wells, USA-1, USA-2, and USA-4, located at the site.

ENSR assumes (although the Report does not specifically state) that USA Springs also intends this Report to constitute an application to approve wells USA-1, USA-2, and USA-4 as bottled water sources. USA Springs has included a "Source Classification Statement", one of the items required for bottled water source approval, in Appendix A. Many other requirements for bottled water source approval overlap with requirements for Large Groundwater Withdrawal permitting, as discussed below.

ENSR has previously provided technical support to the NHDES in connection with the USA Springs project. ENSR's previous activities have included review of previous reports and pumping test plans by current USA Springs' consultants, Gradient Corporation and Aries Engineering, and former USA Springs' consultant, Geosphere Environmental. These submittals included Preliminary Reports under both the Large Groundwater Withdrawal program and the bottled water permitting process for NHDES (regulations Env-Ws 388 and 389, respectively). ENSR has also provided technical support to NHDES at several meetings with the applicant, other reviewers, and concerned citizens and local officials. ENSR conducted site visits with the NHDES and others on 1/22/02, 9/26/02, and 11/21/02; the latter site visit occurred during the pumping test for bedrock wells USA-1, USA-2, and USA-4. As NHDES explicitly stated to USA Springs, ENSR's and NHDES' attendance at meetings and site visits did not constitute a formal endorsement of any Withdrawal Testing Program (per Env-Ws 388.09), Source Evaluation Program (per Env-Ws 389.11), or Proposal for Pumping Test Program (per Env-Ws 379.11).

ENSR notes that although the NHDES provided extensive comments regarding earlier USA Springs' submittals and withdrawal test plans, USA Springs proceeded with the pumping test

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without having submitted a final plan that received NHDES' approval. Also, USA Springs did not provide pre-test water level and water quality data for monitoring wells to NHDES before the pumping test. This lack of submission and lack of final NHDES approval of the withdrawal test plan does not constitute a violation of Env-Ws 388 or 389, but represents a risk that the test procedures and related aspects of the investigation might not be adequate.

2.0 REVIEW FINDINGS

2.1 VOC Contamination

Several monitoring wells in the western portion of the USA Springs site produced groundwater contaminated with volatile organic compounds (VOCs), before and after the pumping test (pumping test dates: 11/19/02 to 11/29/02). The contamination may derive from Eagle Industries (a. k. a. Harnum Metals), located on the adjacent property (Tax Map 3, Lot 9; Landowner: K&B Realty Trust; 155 Old Turnpike Road, Nottingham; RCRA generator; facility ID No. NHD510132772). ENSR understands that the Eagle Industries site is subject to a separate, ongoing investigation (1/24/03 letter from the attorney for the property owner to John Regan of NHDES). ENSR received additional information regarding the study at the 155 Old Turnpike Road site on February 13, 2003, but is not including analysis of that information in this letter.

VOCs were detected in the following wells on the USA Springs' property, as documented in the Report Tables 3-11 and 3-12: USA-2, USA-4, New Barn Well, OW-1, OW-1D, OW-3, and OW-4. (For the New Barn Well and USA-2, the only VOC detections were for toluene.) ENSR notes the detection (1.7 micro-grams per liter) of 1,1 dichloroethane in USA-4 in the final pumping sample. This detection may represent the encroachment of the leading edge of a contamination plume at USA-4. 1,1 dichloroethane was found in much larger quantities in OW-1, OW-1D (a bedrock well), and OW-4 (Report Table 3-12). Various VOC detections are reported in Table 3-12. Of these, 12 detections exceed drinking water maximum contaminant levels (MCLs), per Env-Ws 317.01, and one detection was at the drinking water MCL. Four detections of 1,1 Dichloroethane exceeded Ambient Groundwater Quality Standards (AGQSs) set by the NHDES (Env-Wm 1403.05); 1,1 Dichloroethane does not have a drinking water MCL.

2.1.1 Discussion Relative to Bottled Water Source Permitting, Env-Ws 389

Regardless of the source of the VOCs, the bottled water regulation (Env-Ws 389.17) requires the establishment of a contamination control program for known sources of contamination. This applies if the contamination occurs within the Wellhead Protection Area. Env-Ws 389.17(b) requires that the contamination control program "shall include provisions and a schedule for remediation and/or monitoring of residual contamination from all known contamination sources (within the Wellhead Protection Area) which ensures that contamination shall not reach the groundwater source of bottled water." Since the contaminated wells are located within USA Springs' proposed Source Water Protection Area (Figure 3-15), Env-Ws 389.17(b) clearly applies. (The term "Source Water Protection Area" is assumed to be synonymous with "Wellhead Protection Area" for well water supplies.) Thus, remediation and/or monitoring are clearly required. While monitoring and other characterization investigations are clearly needed, monitoring alone is not sufficient to "ensure that contamination shall not reach the groundwater

source of bottled water", since drinking MCLs are exceeded in monitoring wells and detection has already occurred in one of the proposed bottled water sources (pumping well USA-4).

Env-Ws 389.17(c) indicates that compliance with a "groundwater management permit in accordance with Env-Ws 410 or successor rules shall constitute an adequate control program." (As of May 2000, Env-Wm 1403 is the successor rule that covers groundwater management permits in New Hampshire.) Env-Ws 389.17(d) requires that the Report (Large Groundwater Withdrawal Permit application) describe the contamination control program and provide "supporting evaluations and documentation." To ENSR's knowledge, a groundwater management permit with contamination control program is not in place.

The contamination control concept described on Report page 34 is very general and is not sufficiently supported for NHDES to evaluate its potential efficacy. Details of the program itself, and basic hydrogeologic characterization of the OW-1 area, needed to design an adequate program, are lacking. (Even though a (Env-Wm 1403) groundwater management permit is not strictly required as the only way to comply with Env-Ws 389.17, a comparable level of detail should be offered with any contamination control plan prepared outside the 1403 process.) With present information, it is impossible to evaluate whether the general contamination control concept proposed on page 34 of the Report would work in either overburden or bedrock. When a more detailed program is proposed, extensive testing may be required, and, given the challenges inherent to this particular scenario, significant risks are expected to remain.

Contamination also exists on the adjoining property (155 Old Turnpike Road), but insufficient information exists to map any plume(s) at this time. The Report concludes (p. 33-34) that releases occurred several years ago and that "the associated groundwater conditions are no doubt stable." Even the limited data presented in Tables 3-11 and 3-12 show major fluctuations in VOC levels, contradicting the conclusion that conditions are stable.

Clearly, the addition of pumping wells will add further instability. Pumping the USA Springs wells is shown in the Report to affect groundwater in the overburden in nearby well P-8D and in bedrock in a number of domestic wells beyond the OW-1 area (on the westward fracture trend from the pumping wells). The P-8S/D couplet is located about 300 feet southeast of OW-1, and antecedent measurements of water levels before the pumping test (Report Table 3-6) showed that water levels in P-8D are consistently higher than those in P-8S (range 0.01 feet to 0.79 feet). The Report's projections of uncorrected water level responses to 180 days of pumping (with no recharge) showed a 0.5-foot drop in P-8D and no response in P-8S. This indicates a reduction or even reversal in the vertical head gradient between shallow and deep overburden in this area. The Report concludes that response to pumping occurs preferentially along east-west fractures. Projected water level declines in domestic bedrock wells west of the 155 Old Turnpike Road site range from 22 to 61 feet after 180 days of pumping. USA Springs pumping would clearly add instability to groundwater conditions in the area.

Finally, Env-Ws 389.20(c) states that "the proposed source shall be denied ... if an inadequately controlled contamination source is present in the source water protection area." Assuming that the source of contamination is at 155 Old Turnpike Road (within the source water (Wellhead)

protection area), the Report does not document any control of the contamination source, at present.

2.1.2 Discussion Relative to Large Groundwater Withdrawal Permitting, Env-Ws 388

The Large Groundwater Withdrawal regulations (Env-Ws 388.18(d)(10)) state that if pumping the proposed new bottled water wells causes "the contamination of groundwater obtained from wells ... from groundwater whose flow has been altered by the withdrawal", this is considered an "adverse impact" due to pumping. If this definition of an adverse impact includes an impact on **one of USA Springs' own wells (USA-4)**, an adverse impact has already occurred (1,1 dichloroethane detection in USA-4 at end of pumping). Thus, a mitigation plan would be required, per Env-Ws 388.21. As described above, only a broad, conceptual mitigation approach is included in the Report. Additionally, Env-Ws 388.20(a)(1) indicates that conducting an impact monitoring and reporting program does not satisfy Large Groundwater Withdrawal Permit requirements if the impact is immediate or irreversible. Since an impact has already occurred at USA-4, the immediacy criterion seems to preclude obtaining compliance by conducting an impact monitoring and reporting program.

On the other hand, if 388.18(d)(10) applies only to contamination of **other water supplies**, an adverse impact due to USA Springs' pumping has not yet been demonstrated. In this case, an "impact monitoring and reporting program" is required when "work completed in accordance with these rules is not sufficient to verify that adverse impacts will not occur" (Env-Ws 388.20(a)(1)). Groundwater contamination is clearly present in both overburden and bedrock, and the evidence presented in the Report is not sufficient to determine that an adverse impact to other water supplies will not occur, due to pumping the USA Springs' wells. Thus, the program is required per Env-Ws 388.20(d), but not included in the Report.

2.1.3 Conclusion

The current lack of contaminant distribution information precludes a confident prediction that the contamination can be effectively isolated and/or remediated. The hydrogeological complexities of the site, combined with the proposed water withdrawals, make achieving effective containment or remediation very challenging.

In summary,

- Contaminated groundwater exists in both overburden and bedrock in the western portion of the USA Springs property.
- A number of detections of VOCs are above drinking water MCLs.
- A detection of 1-1 dichloroethane occurred in USA-4 near the end of the pumping test.
- The contaminated wells are located between the USA Springs pumping wells and domestic bedrock wells that experienced significant drawdowns during pumping.
- The adjoining property at 155 Old Turnpike Road is thought to be a potentially significant source of contamination, and it lies west of the pumping wells. Reported east-west fractures pass through the area of concern. These fractures may also intersect one or more

of the pumping wells. These points support the likelihood of a hydraulic connection between the pumping wells and the adjoining site.

- Detailed information on the following key elements is currently lacking:
  - Spatial distribution of contamination and water levels at the adjoining property
  - Water level information at the new wells in the western part of the USA Springs site (OW-1D, OW-3, OW-4)
  - Hydraulic connection (or lack thereof) between bedrock well OW-1D and the pumping wells.
- The Report presents only a very general contamination control concept that is not comparable in detail or supporting information to contamination control plans referred to in Env-Ws 389 and Env-Wm 1403 and does not meet the requirements for mitigation or monitoring plans required by Env-Ws 388.
- Investigations are apparently in progress at 155 Old Turnpike Road, with the knowledge of the NHDES Solid Waste Remediation Bureau.
- Characterization, transport prediction under ambient or pumping conditions, and remediation of contamination in fractured bedrock are known to be challenging.
- Allowing significant pumping to occur, with the present level of knowledge, presents significant risks that contaminants will spread, possibly to a sensitive receptor, and may increase the technical complexity and expense of remediation.
- USA Springs appears not to have notified NHDES within 60 days of discovering the groundwater contamination on its property. (Lab reports dated 11/27/02; report to NHDES dated 2/3/03).
- A contamination source appears to be present within the Source Water (Wellhead) Protection Area. If this source is uncontrolled, Env-Ws 389.20(c)(1) stipulates that the new wells be denied a bottled water source permit.

2.2 Potential Impacts on Homeowner Wells

ENSR recognizes that USA Springs has conducted an extensive pumping test designed to accomplish a number of objectives. However, USA Springs proceeded without a pre-approved pumping test plan. Also, a number of items regarding the test itself and regarding test analysis, may, in combination, raise questions regarding the interpretations that USA Springs has made using the pumping test data. These items are discussed as a separate section of this letter, "Withdrawal Testing" (Section 2.4). For the present discussion, however, ENSR takes the 180-day projected drawdowns for homeowner wells at face value, as presented in the Report.

Projected 180-day drawdown results show (Report Table 4-1) that four of the domestic wells monitored would experience a drawdown greater than or equal to 10% of the available water column in the well. All of these wells (Brett and Stephanie Gillespie, Irene Gillespie, James Page, Jr. and John Pierce) are located along Rt. 4 (Old Turnpike Road), west of the USA Springs site (Figure 3-13). The Brett and Stephanie Gillespie well has a projected drawdown of 61 feet, and the Page well shows a projected drawdown of 39 feet and is more than 3000 feet away from the

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nearest USA Springs pumping well. Additional wells in this vicinity have projected drawdowns that are greater than 5% of the water column. Other wells in the area were not monitored during the test, and some of these may also experience significant drawdowns during USA Springs' pumping.

Of the four wells with greater than 10% projected drawdown, none has a Well Completion Report in Appendix C, and Appendix C contains a questionnaire only for the Pierce well. This questionnaire indicates that a new pump motor was installed in March 2002, but does not provide pump depth or other information. The Report asserts (p. 35) that "anticipated depth of pump intakes (is) expected to be ... at sixty to seventy-five percent of the well depth", but provides no evidence. The Report predicts "no loss of available water to the users of these wells." This assertion has not been justified.

Also, several wells at homes on Lincoln Drive, east of the site show projected drawdowns of 10 feet or more and/or drawdowns consisting of greater than 5% of the available water column (Table 4-1 and Figure 3-13). Lincoln Drive wells that were not monitored may also experience significant drawdowns.

Env-Ws 388.18(c)(1) defines an "adverse impact" to a private water supply well in terms of capacity (yield), not water level or drawdown. The Report provides no assessment of possible capacity reduction (or lack thereof), except the statement (p. 35) that "No adverse impacts ... on well yield were reported at any location". This lack of reporting is not a substitute for direct measurement or indirect assessment, necessary to follow the letter of the regulation. ENSR recognizes that water levels are much more amenable to direct measurement than capacity (yield) in a private, domestic well. However, capacity decrease could be estimated if the pump make and model were identified, the pump curve were obtained from the pump installer or manufacturer, and the reduction in yield of the pump were estimated from the pump curve, based on increased drawdown. Considering the precipitation that occurred before and during the pumping test, ENSR recommends that every effort be made to identify the pump model and obtain the pump curves for the four wells that may experience 10% or greater drawdown. If this is not possible, it is difficult to justify a conclusion that there will be no adverse impact on private wells.

Additionally, groundwater levels at the 155 Old Turnpike Road site (probable source of VOC contamination) are unknown. With a 61 foot projected drawdown at the Gillespie well, a few hundred feet to the west of the 155 Old Turnpike Road site, contaminant transport to this well, under USA Springs pumping conditions, cannot be ruled out.

USA Springs proposes to monitor three of the four wells that are projected to experience 10% or greater drawdown after 180 days of pumping with no recharge. If necessary, USA Springs would implement minor mitigation measures such as lowering the pump intake for these or other wells. Based on the above discussion, ENSR believes that this proposed monitoring and mitigation program is inadequate, per Env-Ws 388.21. A stronger monitoring program is needed per Env-Ws 388.20(a). Monitoring should include the four wells with 10% drawdown impact, other wells in the immediate vicinity of these four wells, and one or more Lincoln Drive wells. Monitoring should continue as long as the withdrawal continues, with an option to reduce the monitoring if data

warrant, not vice versa as proposed on page 42. For the first year of operation, reporting to the NHDES should occur more frequently than proposed on page 42. Unless the further analysis (involving pump curves) described above indicates otherwise, an "immediate" mitigation program may be required, per Env-Ws 388.21. It may be necessary to undertake mitigation steps for the four wells that show 10% impact, as an immediate permit condition, before pumping begins.

2.3 Wetlands Impacts Assessment

As stated above, ENSR recognizes that USA Springs has conducted an extensive pumping test designed to accomplish a number of objectives, including wetlands impacts assessment. However, USA Springs proceeded without a pre-approved pumping test plan, and only Barrington Prime Wetlands #40 (BPW40) was assessed in any detail. Also, a number of items regarding the test itself and regarding test analysis (discussed as Section 2.4 of this letter, "Withdrawal Testing"), may, in combination, raise questions regarding the interpretations that USA Springs has made using the pumping test data. Of particular concern for the wetlands impacts assessment is the relatively high flows due to significant precipitation before and during the test.

The relatively high flows and surface water levels during the test constitute one of several factors that call the wetlands leakage analysis (p. 38 – 40 and Table 4-2) into question. The Report's analysis concludes that "potential loss in groundwater discharge to the on-Site Beaver Pond (BPW40) is insignificant compared to the storage in the Pond and the flow rate observed in the Unnamed Creek during the test" (p. 38). The Report's wetlands leakage analysis estimates the amount of upward flow from shallow overburden to the wetland under non-pumping conditions, and it also estimates the amount of downward flow from the wetlands to shallow overburden after 180 days of pumping with no recharge. The Report's analysis then combines these two results to obtain the "total difference in leakage" (Table 4-2) of 0.16 cu. ft./min.

Assessing wetlands impacts was identified very early as a key concern for this particular Large Groundwater Withdrawal Permit application. However, the Report presents almost no data characterizing the geologic deposits beneath BPW40. The drilling and boring logs in Appendix E contain geologic information for only one point (DP-1) in BPW 40, and this log indicates only that 4 feet of muck (loose, wet, brown, suspended fine organic material with sticks) is underlain by 3.5 feet of "wetland deposits" that were not sampled or described. With this nearly non-existent geologic characterization, one cannot predict accurately the magnitude of leakage that would occur in response to head differences between the wetlands and the shallow overburden.

During low flow in the Unnamed Creek, the percentage of groundwater loss relative to Creek flow would be much higher than that presented on page 38. Also, as described in another section (2.4.4) of this letter, the weirs were improperly constructed and monitored, thereby casting doubt on the stream flow results. (With the high flows that existed during the test, however, flow reductions due to pumping may not have been expected to be measurable regardless of weir construction and measurement.)

Additional observations affecting the wetlands leakage analysis include:

- Geologic characterization of the deposits beneath BPW40 is almost completely lacking, as described above. A thickness of pond or wetland bottom sediments of 3 feet was used in

Table 4-2, based on DP-1S. Even if one accepts the very limited description in the log for DP-1S as generally applicable to BPW40, the log indicates that 3.5 feet of wetland bed deposits underlie 4 feet of muck.

- The vertical hydraulic conductivity value used in the calculations is taken from a single triaxial permeability test on a sample collected from OW-1D, located outside of wetlands and more than 1000 feet away from BPW40. (This sample is described in the OW-1D well log as "medium dense, light brown, fine to medium sand and silt, trace gravel. moist" (Appendix E). The Report acknowledges (p. 39) the discrepancy, but states that the vertical permeability result "is conservative because the fine-grained, organic-rich wetland/pond deposits are expected to have a lower vertical conductivity". This may be true, but is not sufficiently justified by the available information.

- The Report's conclusion that the leakage rate will be reduced by 0.16 cu. ft./min is deceptive. If the calculations are correct, there is not just a reduction in upward leakage; there is actually an elimination of the upward vertical gradient that might drive groundwater discharge to the wetland under non-pumping conditions. Thus, even under the relatively high flow conditions under which the pumping test was conducted, pumping the USA Springs wells may cause groundwater discharge to the wetlands to cease.

- Item #4 on Report page 39 states that use of a pre-test water level measurement from SG-1 is probably conservative, because actual measurements during a 180-day, no recharge scenario would be lower, "hence resulting in a smaller gradient and a smaller recharge rate." This is incorrect and contrary to the effect on the calculation result that should be expected due to using a lower starting pond water level. With the same head in groundwater in the shallow overburden, lower surface water level would result in a greater, not a smaller, vertical upward gradient. In this case, possibly more drawdown of shallow groundwater would occur before groundwater and surface water in the wetlands reached equilibrium. (See below.)

- The Report (p. 40) concludes, "both the large flow volume in the Unnamed Creek and the large storage of the Pond are expected to minimize any potential effect of the proposed withdrawal on the wetland system and Pond." The conclusion that Pond storage will help minimize pumping effects implies that USA Springs believes that infiltration of water from the Pond may occur during pumping. The Report does not discuss the effect that pumping the wells during a time of reduced (or even zero) flows in the Unnamed Creek would have on the amount of water in the Pond. If stream flow were reduced or eliminated, and if groundwater discharge to the wetland ceased, the Pond would lose storage due to evaporation, surface water outflow, and possible infiltration into the ground under pumping stress. These potential wetland effects are not assessed in the Report.

Selected surface water information is illustrated in the "Surface Water Elevations" graph in Appendix H. This graph shows that prior to the pumping test, groundwater levels in shallow overburden (DP-1 interior) are greater than surface water levels in BPW40 (DP-1 outside and SG-1). This illustrates the upward head gradient that existed prior to pumping. After one day of

pumping (11/20/02), groundwater and surface water levels were nearly coincident throughout the remainder of the test. Thus, the upward gradient was eliminated, and an equilibrium condition was apparently established. One possible interpretation of these data is that under pumping conditions, water is drawn toward the pumping wells from the shallow overburden in the vicinity of BPW40; once the upward gradient is eliminated, induced infiltration from the wetland may occur. The wetland may be acting as a hydrogeologic recharge boundary during pumping conditions. The Report should assess this possibility and the consequences for the wetland during dry conditions.

The information presented in the Report supports USA Springs' observation (p. 40) that there was no response noted in overburden deposits near Nottingham Critical Wetlands (CI)/Barrington Prime Wetlands #39 and Barrington Prime Wetlands #10. The Report does not discuss whether this would be true under drought conditions. Also, the Report extends the observations for these two wetlands to make the conclusion that "there will be no adverse impacts to any far-field wetlands located within the Study Area." This conclusion may not be true under dry conditions and/or for wetlands that may overlie certain bedrock fracture zones (and thus experience preferential drawdowns). Also, PS-2S, located near a small wetland near pumping well USA-2, showed a slight response (rise in water level) at the time of pumping shutdown (graph in Appendix H).

ENSR recognizes the logistical difficulty and expense of postponing a pumping test of this magnitude. However, running the test following and during significant precipitation places an extra burden on the data analysis, in order to characterize the impact of pumping on a wetland (or defend the claim of no adverse impact) (Env-Ws 388.16(e)). Because of the conditions under which the pumping test was conducted and the apparent lack of data correction for these conditions, a more stringent monitoring and mitigation plan than might otherwise be required is appropriate in this case.

The Report proposes a long-term wetlands monitoring program. ENSR recommends that the groundwater/surface water-monitoring program (p. 42-43) add DP-1S (inside and outside) to the list of monitoring points, since observations at this point were key to the wetlands leakage analysis. ENSR recognizes that conditions may not always allow access to DP-1S, but the ability to assess vertical head gradients between shallow groundwater and surface water will be very important.

The water level monitoring proposed on page 43 appears to occur only during the growing season. However, dry conditions differing from those that prevailed during the pumping test, may occur at any time of the year. USA Springs' proposed program has no provision for monitoring to increase in frequency if precipitation drops below a certain level and/or if upward flow gradients (from shallow groundwater to surface water) are eliminated. The Report proposes annual monitoring reports to the NHDES; reporting should occur immediately (within 5 days, per Env-Ws 388.19)) if an adverse impact (per Env-Ws 388.18(7)) is detected in BPW40. The Report does not propose a threshold criterion for mitigating action (e.g. pumping rate reduction), should this become necessary.

2.4 Withdrawal Testing

ENSR enumerates a series of items regarding the withdrawal (pumping) test on USA-1, 2, and 4. Although taken alone, many of these items might be minor; the items taken in combination may be more serious.

2.4.1 Precipitation Before and During Pumping Test

Reportedly, 1.79 inches of precipitation fell in the three days immediately prior to the test. Although some of the precipitation fell as snow and was not immediately available as recharge, melting during the test probably allowed significant infiltration of water into the ground. (Temperature data are not supplied with the Report.) Also, 0.55 inches of precipitation fell during the 10-day test. (Drawdown graphs in Appendix H show water level increases in a number of on-site wells between 5000 and 6000 minutes after pumping began. Also, off-site wells that were not impacted by pumping generally showed a rise in water levels before and during the pumping test.) Precipitation data were obtained from a weather station in Durham, New Hampshire, approximately 7.5 miles away, according to the Report, page 13; precipitation should have been measured on site.

Env-Ws 379.15 requires that "the pumping test shall be postponed or prolonged if high recharge conditions prohibit the ability to use test data to meet the intent of this rule. This determination shall be made based on site-specific conditions at the time of testing. Where postponing or prolonging the test is not reasonably feasible, ...data (shall be) adjusted using conservative assumptions...". (Env-Ws-379 governs pumping tests, by reference in both Env-Ws 388 and 389.) Although the pumping test extended beyond the duration required by the regulations, the precipitation and high flow conditions render conclusive analysis regarding impacts on homeowner wells and wetlands difficult, especially without data correction.

Proceeding with the test during the November 19 – 29, 2002 time frame increased the importance of data corrections for influences other than pumping. Env-Ws 379.11(e)(3)b.3 requires water level measurements in a background well outside the zone of influence. This was done, but not documented or used to correct for precipitation effects. Clear and well-documented corrections for precipitation would lend increased confidence to the Report's conclusions regarding impacts on homeowner wells and wetlands. As it is, the claim that the Report's 180-day with no recharge projections constitute a "worst case analysis" is difficult to justify because pumping test results during a time of active recharge are used in the projections. Thus, the projections implicitly assume a continuing level of recharge, not 180 days with no recharge.

The Report makes the argument that water pumped from USA-1, -2, and -4 is derived from short-term "recharge" and not from "storage". Therefore, precipitation before and during the pumping test would be expected to produce significantly different results than if the test were conducted during a time of no recharge.

Precipitation may have masked pumping-induced drawdown that might otherwise have been observed in the New Barn Well (NBW). The Report (page 28) predicted no response at the NBW, even though Geosphere's step tests showed that in only a few hours of pumping there was a response. The Report's results for the NBW show no response due to pumping, as depicted on the arithmetic-scale graph of transducer data (Appendix H), but the vertical scale is not suitable

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and may have hidden a response. The semi-log plots for both manual and transducer data show apparent responses to both precipitation and pumping shutdown in NBW.

In summary, because the test was conducted during a time when active recharge was likely occurring, and because precipitation corrections were apparently not made during data analysis, it is difficult to determine whether domestic wells and BPW#40 would experience adverse impacts and whether proposed monitoring and/or mitigations plans are appropriate and adequate.

Even if re-analysis of the data using a precipitation correction indicates that there are no immediate and irreversible impacts (per Env-Ws 388.20) due to pumping, detailed monitoring and mitigation plans may still be required. Unless data analysis can indicate convincingly that adverse impacts will not likely occur, detailed mitigation action plans should be offered regarding both domestic wells and BPW#40. Such plans should propose both triggering thresholds for domestic wells and wetland observations, and also specific responses in each case. In its present form, the Report is probably overly optimistic in its assessment of potential impacts, and lacking sufficient monitoring and mitigation plans.

2.4.2 Discharge Measurement

Env-Ws 379.11(e)(2)c (referenced by both Env-Ws 388 and 389) stipulates that "the discharge rate from the test well shall be measured using a circular orifice weir or other device which provides measurements of equal precision." The present test used flow meters instead of orifice weirs, and the calibration certification for the meters had expired (Appendix H.9). When flow meters are used, it is common practice to allow for bucket-stopwatch calibrations at some point in the discharge line and/or to use orifice weirs to verify the accuracy of the flow meters. This was not done. Therefore, the discharge measurements are in non-compliance with the regulatory requirements for this critical parameter.

Assuming that quantity of water pumped is tied to the degree of impact on domestic wells, wetlands, and contamination migration, greater confidence in the precision of the discharge measurements would be beneficial. For example, if a series of pumping rate reductions were stipulated as part of a response plan to adverse impacts, the reductions could be selected with more confidence if there were greater confidence in the accuracy of the flow measurements made during the test.

Env-Ws 379.11(e)(2)e requires that the "test well shall be pumped at a single, constant rate", but does not specify a tolerance limit. ENSR acknowledges that under field conditions with bedrock wells, some fluctuation is inevitable and that equipment breakdowns can occur. After installing the new meter on USA-1 on 11/22/02, no interruptions were recorded, and all three wells had constant "target rates" for the rest of the test. However, significant (>10%) fluctuations relative to the target rates are noted in Appendix H.1. Presentation of average pumping rates (and deviations) for each well for the last 7 days of the test would be instructive, as would a discussion of the effects (or lack) of the discharge deviations on the key interpretations for the analysis.

2.4.3 Data Presentation and Analysis

Env-Ws 379.11(e)(8) requires that water level data be presented in tabular form. The table(s) must include appropriate corrections to the groundwater levels. In addition to data corrections for

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precipitation effects, because many of the wells monitored during the USA Springs test are constructed in semi-confined aquifers, correction for barometric efficiency is also appropriate. Further, depending upon the types of transducers used, barometric pressure variation effects on water level instrument reading may also be necessary if the pressure transducers were not vented.

Both recorded and corrected water levels are to be plotted versus time, as spelled out in detail in Env-Ws 379.11(e)(8)c. For the large volume of data collected, it may not be reasonable to show all of the graphs, both corrected and uncorrected; nor is it appropriate to show log-log plots for bedrock wells. On the other hand, it is not acceptable to completely omit corrections due to precipitation. The effect of the precipitation corrections on domestic wells and wetlands should be discussed, as described above.

Env-Ws 379.11(8) requires a table providing the horizontal distances between observation points and the pumping well(s). This has not been provided. The same regulation requires that drawdown be plotted versus the log of distance. This has not been included in the Report and should be added for selected well profiles, especially west of the pumping wells. The plots should use measurements corrected for precipitation and other effects described above. Both end-of-pumping test results and 180-day results should be considered. As a result of this analysis, it is likely that the Wellhead Protection Area should be expanded to the west. (ENSR notes that outcrop #4 (Figure 3-1), located along Route 4 west of the site has approximately east-west fracturing.

All data presentations, figures, and discussion are based on 180-day projections of the pumping test results. The Report should provide a summary table of water levels at the end of the end of the pumping period. End-of-test figures analogous to Figures 3-13, 3-14, 3-16 and 3-18 should also be provided.

2.4.4 USA Springs V-Notch Weir Installations

On 11/21/02, ENSR and NHDES examined two weirs (Weir-1 and Weir-2 on the Unnamed Stream) near the USA Springs site. Their construction and apparent methods for measurement were sub-standard, likely producing erroneous stream discharge estimates.

Discharge estimates produced from measurements employing a V-Notch weir are subject to a range of errors largely influenced by the construction and placement of the weir in the stream channel and the method and location of stream-stage measurements. Some critical elements of weir design and installation include:

- Stage needs to be measured in the pool upstream of the weir at a distance of 3 to 4 times the maximum head (3 to 4H) anticipated in the crest.
- The upstream edge of the weir should be smooth, extending a minimum distance of 2H from the maximum anticipated head to the channel banks and 2H from the bottom of the crest to the bottom of the pool.
- The crest of the V should be a minimum of 0.2 feet above the maximum downstream water surface level.

In the case of the two weirs examined at USA Springs, numerous problems were observed, including:

- The staff gage (yard stick) used to measure stage behind the weir was located in the nape (the sloping area of the water surface, where it converges to flow through the V), adjacent to the notch.
- The downstream sides of the notch were submerged, preventing a free-flow condition.
- Numerous obstructions were present immediately upstream of the weirs including branches, tree roots, and, probably most importantly, the sand bags used in the construction.
- The weirs were leaking.

With the high flow conditions that prevailed during the pumping test, observable impacts to stream flow due to pumping may not have been expected. However, under low flow conditions, stream flow impacts may occur. If the weirs are to be part of the ongoing monitoring infrastructure, their construction and staff gage placement should be improved, as described in Water Measurement Manual, Third Edition (U.S. Department of the Interior, Bureau of Reclamation, 1997).

2.5 Well Construction

Env-Ws 389.18 requires that wells to be used as bottled water sources comply with We 600, "Standards for the Construction, Maintenance and Abandonment of Wells." This rule (We 602.02(f)(6) requires that "The void outside the casing shall be filled with cement grout, bentonite or ledge drillings or cuttings." Drive shoes are also required when steel casing is used. The well logs in Appendix E for USA-1; -2, and -4 do not contain this information. If the void spaces were not filled as required and drive shoes were not used, the wells do not meet the regulatory requirements for approval as bottled water sources. If the void spaces were filled as required and drive shoes were used, proper Well Completion Reports or well logs that show this need to be submitted.

2.6 Conceptual Hydrogeologic Model and Other Items

Env-Ws 388 and Env-Ws 389 both require the development, refinement, and presentation of a conceptual hydrogeologic model. However, the regulations do not provide for either approving or denying a permit based on the content of the model. Models are based both on observations and on interpretations, and professional hydrogeologists could reasonably disagree on certain aspects of a conceptual model for a particular groundwater withdrawal at a particular site. In other words, disagreement over the model is probably not grounds for denying a permit. However, the conceptual model is fundamental to the development of an adequate withdrawal test and the interpretation of resultant data. It is therefore critical to an accurate forecast of impacts due to pumping. There are, in particular, certain aspects of the conceptual hydrogeologic model that are subject to question.

2.6.1 The Source of Pumped Water

The Report repeatedly states that the water pumped from the wells is derived from "recharge" and not "storage". If one accepts the Report's calculations, it may be true that the net amount of water pumped is less than that recharged in the Study Area. However, this does not mean that the water necessarily derives from one source or the other. A pumped groundwater system is dynamic, and the proportions of water flowing to a well from prevailing recharge

mechanisms is likely to vary with time.

2.6.2 Effect of Precipitation During the Test

The statement on page 17 that the "precipitation received during the test ... was small and did not have any appreciable effect on the data" appears to contradict both the data presented and the claim that the pumped water is derived from recharge (not storage). Several wells (NBW, OW-1, PS-2S, PS-3S) showed water level rises probably due to precipitation. (Although it has been suggested that these water level rises may be due to leakage from the discharge pipes, OW-1 is not near a discharge line.) The Report's statement (p. 17) regarding recharge during the test appears to contradict the claim that water pumped from the wells derives entirely from recent recharge. The statement on page 31 that "the effect of recharge events are manifested within the bedrock aquifer within days", appears to contradict the claim that precipitation received during the test had no appreciable effect. The data presented on the top of page 31 indicate that piezometric head increases in bedrock fractures are an order of magnitude greater than the amount of precipitation received.

The degree to which the bedrock may be isolated from short-term recharge is critical to all aspects of the required analysis. In two places (pages 32 and 34), the report asserts that bedrock is insulated or vertically isolated from events that occur on the surface (barn fire or VOC contamination). Again, this conceptual analysis appears to contradict the notion that recharge to the bedrock is so rapid as to prevent the wells from tapping storage. Furthermore, whether a particular bedrock fracture is isolated from the surface or shallow overburden at any particular location depends on the nature of the overburden and the attitude, morphology, extent, and connectivity of the fracture.

2.6.3 Bedrock Portion of Conceptual Model

Pumping wells in a fractured-bedrock aquifer derive water directly from water flowing through the bedrock fractures, which are typically recharged from water that is stored within overlying sediments and in some cases from related surface waters. Water stored in the overlying sediments and surface waters is replenished by precipitation. As such, the geometry and orientation of primary fractures in communication with (connected to) the wells is a key controlling factor in how, when, and where pumping impacts are experienced by other bedrock wells and environments overlying the bedrock aquifer. A thorough conceptual and quantitative treatment of the location and hydraulic attributes of the fractures is, therefore, essential to an accurate prediction of impacts.

ENSR finds two significant shortcomings with the bedrock portion of the conceptual model, as presented in the Report. First, the model is not fully presented or illustrated. The reader is referred to previous reports for detailed discussions of geophysical surveys, fracture trace analysis, and field measurement of bedrock fractures. Results from these three studies should be integrated, and a detailed conceptual model should be presented as a stand-alone in the Final Report (and/or key sections of previous reports should be appended.) Second, some of the technical discussion regarding bedrock structures is unclear. The Report (p. 24) refers to "minor faults ... consistent with the secondary bedrock strike orientation", but does not specify which "secondary bedrock strike orientation" they follow. Also, the report does not describe or show on

a map where these minor faults are located. These minor faults may be important because they may significantly influence groundwater flow in some portions of the Study Area. A three-dimensional block diagram of the study area would serve to illustrate the key features of the conceptual hydrogeologic model, especially the fractured bedrock portion of the model.

2.6.4 Water Quality

Preliminary (post-drilling; discharge permit) water quality results should be included in the conceptual hydrogeologic model discussion, per Env-Ws 388.06(c)(1). Also, the last two lab reports in Appendix G (samples 75790 and 75791) both are labeled as collected from well OW-1, but show very different results.

3.0 SUMMARY of CONCLUSIONS

1. **VOC contamination** of groundwater exists within the proposed Source (Wellhead) Protection Area, in monitoring wells in the northwestern portion of the property; in wells in the property that abuts to the northwest; and in USA-4, after ten days of pumping. Since the contamination is currently not controlled, Env-Ws 389 requires that permits to use the wells as bottled water sources be denied. More complete characterization of the nature and extent of the VOC contamination and of overburden and bedrock geology is needed in order to propose an "impact monitoring and reporting program", required before a large groundwater withdrawal permit can be granted under Env-Ws 388.
2. **Withdrawal test data** (see item 5) collected during a time of active recharge are used, without correction, in the Report's forecasts of impacts. Used in such a manner, the forecasts **implicitly assume a continuing level of recharge**, not 180 days with no recharge.
3. Reported effects of pumping, projected to 180 days, but with no precipitation correction, indicate that four **homeowner wells** located west of the site may experience drawdowns equal to or greater than 10% of their water column. This may be true of additional wells not monitored. Significant drawdowns were also noted for some Lincoln Drive wells. Assessments of the effects on well yield (required by Env-Ws 388) were not included in the Report. If these assessments cannot be made using pump curves, a much more aggressive mitigation and monitoring program should be proposed.
4. During pumping, groundwater levels beneath the western portion of **Barrington Prime Wetland #40** showed a significant decline. An ambient, upward gradient from shallow overburden to surface water existed prior to the test and was eliminated during pumping. The pumping test occurred during relatively high flow conditions, and low flow analysis is lacking. The leakage analysis is flawed and not based on conservative assumptions. Therefore, the conclusion of no adverse impact on wetlands is poorly founded. If a permit is granted, extensive monitoring requirements and detailed mitigation plans should be required.
5. Significant amounts of **precipitation** and associated recharge occurred before and during the test. To lend confidence that the 180-day analyses are truly conservative, data corrections must be made. USA Springs may be able to address other items regarding the pumping test with a supplemental submittal.

6. Well yield fluctuated significantly during the last seven days of the test, and **discharge measurements** did not meet regulatory requirements for accuracy.
7. **Proper well construction** (grout and drive shoes) is not documented for the three proposed bottled water sources, as required by We-600 and Env-Ws 389.
8. Additional items noted by ENSR are provided for the NHDES' information and may not necessarily directly impact the decision to approve or deny a permit. The NHDES may or may not choose to communicate these items to the applicant, but should be aware of the items because of the intense scrutiny that is likely to be forthcoming. For example, the conceptual model is not fully developed and integrated, especially regarding bedrock. Internal inconsistencies, unclear explanations of minor faulting, and lack of illustration cast doubt on the Report's forecasts. A detailed and well-founded conceptual model is necessary in order to address the VOC contamination and other issues in an appropriate manner.

We hope that you find this review helpful, and we would be pleased to discuss any of these items with you or provide additional opinions as needed. We look forward to continuing to work with the NHDES on this project.

Very truly yours,

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