Water Systems Study Committee Report

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Introduction

The WSSC has assumed the task of preparing a range of options for the Town of Harvard to supplement its currently active supply of potable water. The task is no small theoretical or practical challenge. Earlier studies by professional engineering and consulting firms as well as other volunteer committees have offered their efforts in the past. Each has chosen a different approach or segment of the question and this committee has feasted on their results. We thank them all.

In our review of the town's water assets the WSSC examines the current challenges to the security of our system and recommends responses to stabilize our water resources. We believe that by shielding and preserving our available wells we can continue to pump from both wells and maintain a safe and quality water supply. Following this we can activate another source to diversify our well recharge locations and contamination risk exposure. With these sequential efforts completed we believe we will have provided the town with a water supply with the best available security and quality at the most affordable cost possible.

State of the Current Supply

Harvard currently supplies its 22,000 GPD water requirement through the production of two DEP permitted wells known as well #2 and well #5 which can pump at rates of 43,000 and 23,000 GPD respectively. These are located near the town center along the lower reach of Pond Road just below the intersection of Whitman Road. Each of these bedrock wells is greater than 250 feet deep and can pump in excess of the towns' minimum daily requirement of approximately 15 GPM. Because of increasingly elevated levels of total dissolved solids (TDS), particularly applied road salts, in up-slope Well #2, the town uses both wells to supply its reservoir. We do this to blend the flows of both wells to alleviate concerns about health and palatability due to these solids.

Well #3 is on town property along Bolton Road, not far from the town reservoir and was last measured at a rate of 22,000 GPD. It is now inactive and currently available as an emergency back up only.

Well # 4 was drilled at a location adjacent to the tennis courts and never used because of high levels of uranium. Subsequent retests of this site reconfirmed the earlier results and the town has abandoned the well. (Camp Dresser & McKee, Phase One Feasibility Study, 2010)

Risk Analysis of the Current Supply

The table below expresses our view of the overall risk to our current wells #2 and #5 as well as our emergency backup well #3, and highlights recommended actions, including some already taken, to mitigate the current risk.

Sodium, chloride and total dissolved solids (TDS) are all listed as EPA secondary standards and defined as "not health threatening" at the recommended maximum level. However, they may cause water to "appear cloudy or colored, or to taste or smell bad", and the EPA issued a health advisory of 30-60 mg/L for people on sodium restricted diets. Individually our operating wells have reached this 30 mg/L in either three or four of the last fifteen years of measurement with one of them reaching this range in four of the last five years. According to the World Health Organization, the palatability of water with a TDS level of less than

600 mg/L is generally considered to be good, with palatability becoming unacceptable above 1000 mg/L. The TDS in seven individual samples from wells # 2 and # 5 have exceeded 500 mg/L over the last six years with two of those readings in the 800-900 mg/L range.

In discussing our levels of salt as an important concern we must place these numbers in perspective. Eating a pickle can reward you with almost 2000 mg/L of salt compared to drinking a liter of 30-60 mg/L water from our wells. For some with health concerns this 60 mg/L is a significant level. For many it is not. However, it is the measurement of total dissolved solids (TDS) which is the more stubborn concern for our general health. These TDS not only include our increasing levels of salt but other organic and inorganic contaminants which are primarily the residue of residential runoff and waste disposal processes. Both speak to a problem with system vulnerability.

Tight management of water quality and blending of water from wells # 2 and # 5 represents a first operational strategy for health and palatability risks. Expanding the supply with another source gives the town the ability to blend from another less challenged supply and provide a constantly optional source for blending water. The town will also be able to provide a safe supply even with the interruption or loss of one existing source.

Current Well Risk Remediation Plan	WELL #2	WELL #5	WELL #3
Contaminant Risk: Sodium and Chloride	Town Road Salt Reduction (complete), State Road Salt Reduction; Pond Road Runoff Diversion Project	Town Road Salt Reduction (complete), State Road Salt Reduction; Pond Road Runoff Diversion Project	No Action Needed
Contamination risk: Total Dissolved Solids	Town Road Salt Reduction (complete), State Road Salt Reduction; Pond Road Runoff Diversion Project	Town Road Salt Reduction (complete), State Road Salt Reduction; Pond Road Runoff Diversion Project	No Action Needed
Contamination risk: Coliform	Pond Road Runoff Diversion Project	Pond Road Runoff Diversion Project	No Action Needed
Contamination risk: Petrochemical Spill	No parking zones (complete)	No parking zones (complete)	No Action Needed
Contamination risk: Transformer Coolant	No action needed	No action needed	No action needed
Contamination risk: As-yet-unknown future contaminant	Monitor	Monitor	No Action Needed
Risk: Emergency backup	No action needed	No action needed	#3 Well Survey Proposed

Figure 1. Risk table for current active and backup wells showing risk level and recommended mitigating action. (Green=very low risk, yellow=low risk, orange=moderate risk

Other lower risks shown in the risk table include petrochemical contamination due to a truck turnover or the compromise of the oil or gas tanks of a boat or vehicle. The introduction of coliform from either the up-gradient landscape or septic systems via above ground stream flow or storm sewer discharge rates a moderate risk level, but this risk level was difficult to assess given the infrequent sampling rate for coliform. The EPA rules are intolerant of any positive count for a public water supply with less than 40 readings per month, and our current practice averages one reading per month. Risks we categorize as Very Low include the compromise of a transformer in the vicinity of the wells, and the introduction of any as-yet-unknown contaminant into the groundwater such as 1,4-dioxane and PPCP (pharmaceutical personal care products) that are just coming into the environmental consciousness. We also see the interruption of supply from natural causes such as drought or other unforeseen events as very low. The risk of using well # 3 as an emergency supply is low, but in considering the possibility of an extended emergency, in October 2015 we recommended a survey of the well's current condition.

Protection Initiatives for the Current Supply

The next line of operational management is a reduction of salt exposure through a reduction of the salt source and a more vigorous defense against infiltration.

The WSSC prepared an action plan for the BOS in October 2015. This earlier report focused on the risks which threaten each well and the steps the town should take to secure our existing water resources.

The WSSC believes that to mitigate the risk to currently operating wells # 2 and # 5 we should reduce the use of salt on Mass. Ave. (Rte. 111). One approach is for the DPW to assume control of the section of this road where salt application most threatens to flow toward the wells and let our DPW regulate the application of salt. The DPW is also trying to negotiate with the Mass DOT to abate their application of salt on the relevant stretch of Rte. 111. The DPW should provide regular written updates on this discussion to both the Water Commission and Town Administrator. To mitigate the risk of petrochemical spills the WSSC oversaw the erection of no parking signs along the edge of Pond Road at crucial stretches near the wells and the junctions where the streams and current drainage channels converge. We have also initiated a request to fund the "Pond Road Runoff Diversion Project" (Cost: $69,000). By constructing berms along the North/West edge of Pond Road the salt runoff and containment spills will now flow into a petroleum separator, then a new conduit system and project this runoff along with the flow of local streams to an area less connected to the recharge area of wells # 2 and # 5. This project will also serve to mitigate risk of potential coliform contaminants from storm water and stream sources.

Predicting a track of groundwater pollutants such as salt is challenging work for the scientists and hydrogeologists who tackle the problem. However, researchers have done work successfully describing the terrain wide absorption and release of salts on a seasonal basis. (e.g. Rhodes & Guswa, 2015) Understanding the implications of such work and our set of circumstances such as a clear topographic slope, visible fault line fractures adjacent to our wells along with the known sources of contamination gives us the confidence we have the contending elements in clear focus and that, over time, our mitigation efforts will succeed. The WSSC believes these actions will have the predicted effect on any external challenges to the system which may appear hereafter. Their immediate impact will also be physically apparent in the diversion of road runoff. The long term reduction of current and near term incursions of pollutants entering the ground should appear in the future data collected by the DPW and then provided to the DEP and the town's water district customers. The Water Commission should require a schedule of more frequent reports on these TDS and salt contamination levels than current practice requires. We should be able to evaluate the results of our actions as soon as meaningful (or lack of) information is available. Data which reflects the success of our approach will take time, perhaps years, to appear as the bulk of present contaminants move through the surrounding recharge area of the wells.

A separate recommendation in our October report put forth a plan requesting funds to investigate the structural status of well # 3 and test its water quality. This is the first step in the direction of well # 3 as a more substantial source for the town. It would also bypass the need to consider further construction for the delivery of water in the event of well failures. A discussion of investigation and planning surrounding well # 3 follows in our presentation of recommended sites later in this report.

The WSSC believes the risk of losing our wells is low, but the cost of any failure would be painfully expensive. Each listing of a possible new site has an illustrative cost attached.

The Current Search: Criteria and Means

Massachusetts Water Resources Authority (MWRA) regulations restrict the amount of water any jurisdiction may withdraw from the ground. Harvard's DEP permit limits us to 22,000 GPD. Since each of Harvard's two operating wells can produce in excess of the towns current needs, any future sources are chosen without access to their full production until currently operating sources of supply withdraw from production. In addition, the town has a sewer system which will only dispose of 20,000 GPD so a search for wells with greater production only generates another safety reserve, not necessarily an active contributor.

To achieve our goal of a safe and suitable future water supply the WSSC determined that the search for new water sources must always be described by certain criteria:

1. Control of the use of the land within what is referred to as the Zone 1 protective radius of the well.

2. The closest proximity possible to current infrastructure which will help achieve the lowest possible costs beneath the cost ceiling of a connection to the wells at Devens which we call the Devens option.

3. Achieve a minimum 15 GPM pumping rate or abandon the test well being considered. Any effort to provide a supplemental water source must achieve a sustainable rate of daily output equal to the town's daily consumption and as a stand-alone source.

4. The search for a new drilling site is limited to the area south of Route 2. The purpose of our search is to provide water solely for the town center water district.

To minimize the chance of repeating past encounters with naturally occurring contamination the WSSC paid particular attention to the potential water chemistry profile of Harvard's possible drilling locations. Uranium (Well#4) and iron/manganese (Well #3) impacts on previous wells have compelled us to absorb the results of a study by USGS scientist John Colman which deals with limited sampling of private bedrock wells in East-Central Massachusetts and the estimation of correlated probabilities of finding uranium and arsenic in various types of bedrock. (Colman J.A., 2011) This study delineates a zone of elevated risk for well contamination to the west of a roughly NE/SW line which passes almost directly through the center of the town of Harvard. (See attached maps.) The developed model estimates the probability of arsenic occurring in groundwater in this area at concentrations greater than the Public Drinking Water Standard of 10 micrograms per liter ranges from 10% to 25% and the associated probability for uranium contamination runs from 4.8% to 13%. To help us understand the implications of the USGS study Mr. Colman attended our Jan 21st meeting.

Attending with him was USGS scientist Leslie A. DeSimone who was co-author of a separate study on the yield of bedrock wells in the central Massachusetts geological feature known as the Nashoba Terrane which lies beneath the town of Harvard. (DeSimone and Barbaro, 2012) Their further explanations of their work provided us with confirmation that our developing opinions on site selection were on the right course. Our USGS hydrological maps predicting well yields present certain data biases because of limited numbers of test sites and locations. Yet even in the presence of these limitations the discussion of data at the meeting generally encouraged the WSSC. Harvard's requirement for a well which will yield 15 GPM is a modest one. With the maps predicting no large contiguous areas of town which will yield less than 10 GPM, there seems to be no area which we could not consider as a drilling site based on this criterion.

Harvard has explored the locations for groundwater wells in previous studies. Available locations with suitable geological features are not currently available and the WSSC now finds only one possible location which is at the Bolton town line at the end of Stow Road. The committee has omitted this location. Its connection construction costs for installing pipe alone @ 200 per linear foot are roughly $1,800,000 and rival any effort toward Devens without the benefits while incurring possible extra liabilities of landfill contamination.

The use of Bare Hill Pond has borne inspection and, while possible, would require a modular treatment plant on a suitable location, a part or even full time operator and a full and slightly different complex approval process from Mass DEP. While this choice intrigues the committee we have not given it in-depth evaluation since even rough price estimates have been difficult to obtain and because of its likely operation and maintenance costs which suitable stand-alone bedrock well should not incur.

The Question of Devens: Our Model of Benefits and Cost

The water supply available at Devens represents one of the most favorable accumulations of groundwater within the extended surrounding area. Devens currently has a 700,000 GPD pumping permit from Mass DEP with the potential for daily extractions of more than a million gallons when all potential future users complete their commitments in the 2030's. A Harvard connection to this source would end the constant search for new and ever more expensive sources. A connection to this source based on our current use of 22,000 GPD would fit comfortably into the existing Devens extraction permit. It could provide safe water with an economy of scale for any needed future treatments, added construction or maintenance costs. It could also provide a secure source Harvard may not otherwise enjoy during any unforeseen and extended natural shortages.

These advantages are substantial. All substantial benefits have costs and the costs associated with a connection to Devens were, until recently, estimated to be approximately $ 1.7 million. Over the relatively short time since that cost was made available the infrastructure at Devens has changed. The southeastern-most cluster of base housing which was the point for a Harvard connection has been demolished along with the existing sewer and water lines. The result has been a new connection point farther NNE along the town boundary lines and railroad track to a new point 9800 feet or 1.86 miles distant from the closest connection point in Harvard. Conversations with the Devens DPW have provided a new construction figure based on $ 200/ linear foot, through ledge. Including pumping stations, extra permitting etc., the new total is $2.7 million. The benefits as a secure and stable source are unmatched locally. The source, from Harvard's perspective, is inexhaustible. But it is not eternal. Citizen unwillingness is its only Achilles heel; a two decade delay in adopting this source could remove its potential permanently. The various jurisdictions and contenders that will create demands for Devens future utility resources will begin to fill them by the mid 2030's. When those resources are spoken for the access can end and the water asset can vanish.

Using this Devens option as the greatest cost of a new and comprehensive source, the WSSC has proceeded to evaluate a range of options to compare with the cost of the Devens option. These options could offer the town years in which to evaluate these less expensive approaches and witness their viability before the loss of the Devens option.

Recommendations for Future Action and the Search for Well # 6

Well sites which meet our general criteria stated earlier must then meet Mass DEP criteria specific to any prospective site. The radius describing the protective recharge area around a well is known as the Zone 1 of a well. To pump at Harvard's necessary withdrawal rate of 22,000 GPD any new well would require a radius of 301 ft. or 6.5 acres. This constrains our choices further. A second protective radius that Mass DEP considers is referred to as the Interim Wellhead Protection Area (IWPA). The size and shape of the IWPA is site-dependent, although a default size and shape can be applied in the absence of site-specific data. Mass DEP restricts many activities such as agriculture, recreational activity and industry, etc. within this type of area. With these givens we began our search.

After extended examination the WSSC established a hierarchy of actions and choices which it feels will offer the best opportunity to supplement our future water needs.

1. Pending encouraging results of tests the WSSC has previously requested, the WSSC recommends the upgrade of the treatment system of Well #3. This well is listed in the Mass DEP database as Well #2125000-03G. Because of iron and manganese contamination this well was downgraded in 2009 by Mass DEP to an emergency supply of water only. This well is located on town land just off Bolton Road and close to the town reservoir. It is an 8" diameter bedrock well drilled in 1949. One report gives its depth as 51 feet with a casing of 42.5 feet and a 2 foot long screen. Another source provides a depth of 250 feet. The tests we requested in our October, 2015 report should resolve these discrepancies. Provided the well is sound, an upgrade to this system would allow the town to maintain it as an emergency well or file an Application for New Source Approval with the Mass DEP, a twenty five step process which precedes the activation of any new permitted water source. This choice is not without its limitations. Its location within the outer boundary of the protective zone of the town's sewer treatment plant that may prevent its use or limit its permitted pumping rate. However, differences in elevation between the two facilities and the depth of the well may allow this approach to proceed. Requests for estimates for an upgrade to the

treatment system for this well have been met with silence from contractors reluctant to provide an estimate for a complex system distant in time. Completion of the Well #3-related tasks we had previously recommended to the BOS would provide sufficient information upon which to develop a preliminary cost estimate for upgrading the treatment system for this well. We must also hope the costs of treatment through technological advances have declined significantly since the last estimate in 1989 of $320,000- 350,000 plus annual operation. We are uncertain how well this figure translates into equivalent modern capabilities and what projected GPM flow was to move through this proposed earlier system. Given the potential of well # 3 as a fully permitted well adjacent to the town reservoir with no connection cost we believe this is the appropriate first choice.

2. Our least expensive new construction option would be to drill a new well on the collective of town owned lots 9, 10, 11, 12, &13 as shown on the assessors map. These are wedged between Whitman Road and Pond Road. This new site is adjacent to a three phase power supply, in an area above the surface salt runoff slope which plagues our two primary wells and has a projected recharge area free of any other current use. The distance to a closest point for connection to the system is minimal. We have placed a stake at the anticipated site and taken the latitude/longitude reading to forward to the Mass DEP for preliminary review. We will need to secure well water tests from the owners of assessors plot plan numbers 6, 7, 63, and 64. These tests would be for arsenic and radionuclides predicted to be at elevated risk levels in this area by John Colman's USGS arsenic and uranium report mentioned earlier. These properties sit adjacent to the proposed site and the test results of the water chemistry should reflect the recharge source for the proposed new well. A preliminary approval by Mass DEP would put us on an encouraging footing to file an Application for a New Source Approval. The cost to lay water pipe from a new well at this location to the existing water system infrastructure is approximately $50,000-100,000.

3. If well # 3 is no longer useable and our Whitman Road choice does not provide useable results we recommend that the town return to the town

property of abandoned well # 3 and drill a new well at this location. The advantages remain the same with only the expense of a new well. The treatment facility would still likely need to be upgraded to contend with expected similar levels of iron and manganese and the annual costs of operation of this treatment facility would continue. The cost to lay water pipe from a new well at this location to the existing water system infrastructure should be less than $50,000.

4. Should all the above choices fail as workable solutions the town will need to travel much farther to find a useable drilling location. First on the list of these is the Williams Conservation Land on Stow Road which offers an unobstructed space for exploration. This area offers the advantage of numerous drilling sites on a single location. Water from this area is predicted to have a low probability for arsenic and uranium contamination. The great distance from a site connection point to the water system places this option further down our list because of cost. It may be possible to reduce this connection cost by obtaining easements and going overland directly to the reservoir. The cost to lay water pipe from a new well at this location to the existing water system infrastructure approaches $ 800,000.

5. The 32 acre conservation land site adjacent to Littleton Road just past Whitney Road offers a clear expanse for drilling. Current use for agriculture with the application of manure as fertilizer is a complication as is the lack of suitable power. The cost to lay water pipe from a well at this location to the existing water system infrastructure is approximately $700,000.

6. A last choice would be any of the accessible parcels of conservation land along Still River Road. Most offer sufficient land but all are susceptible to arsenic and uranium contamination risks addressed earlier. The healthy costs associated with connection to these next closest sites leaves them last in order of consideration. The cost to lay water pipe from a well at this location to the existing water system infrastructure is at least $ 800,000+.

The WSSC believes that our recommendations will allow the town to protect its existing water resources and provide for continued management of a safe and diverse water supply.

Submitted by vote of the WSSC in its meeting on March 8th, 2016.