CHAPTER 4.....

GROUNDWATER SUPPLY DEVELOPMENT.....

Acronyms used in this chapter:

API - American Petroleum Institute
ASTM - American Society for Testing and Materials
AW - available water
AWWA - American Water Works Association
AY - approvable yield
BWSC - Bureau of Waste Site Cleanup
CFS - cubic feet per second
CFSM - cubic feet per square mile
DCAM - Division of Capital Asset Management and Maintenance
DCR - Department of Conservation and Recreation
DWP – Drinking Water Program
DWW - Division of Wetlands and Waterways
EIR - environmental impact report
ENF - environmental notification form
EPA - US Environmental Protection Agency
FEIR - final environmental impact report
GPD - gallons per day
GPM - gallons per minute
GQ - geologic quadrangle
GWR - Groundwater Rule
HIA - hydrologic investigations atlas
IWPA - interim wellhead protection area
MassDEP – MA Dept. of Environmental Protection
MCL - maximum contaminant level
MDL - method detection limits
MEPA – MA Environmental Policy Act
MESA - Massachusetts Endangered Species Act
MPA - microscopic particulate analysis
NHESP - Natural Heritage and Endangered Species Program
NOI - notice of intent
ORW - outstanding resource water
O&M - operation and maintenance
ORS - Office of Research and Standards
SC - specific capacity
SMCL - secondary maximum contaminant level
SOC - synthetic organic chemicals
SWTR - Surface Water Treatment Rule
TCR - Total Coliform Rule
TNC - transient non-community
USGS - US Geological Survey
WMA - Water Management Act Program
7Q10 - seven-day period that will occur on average once in 10 years

Chapter 4
Groundwater Supply Development and the Source Approval Process

The development of a public groundwater source in Massachusetts is governed by the Source Approval process. Regulations governing this process are set forth in the Groundwater Supply Protection section of the Massachusetts Drinking Water Regulations (310 CMR 22.21). The process is a step-by-step exploratory and development procedure that culminates in MassDEP approval of a public water system. The process differs for *wells with yields less than 100,000 gallons per day (gpd)* and *wells with yields 100,000 gpd and greater*. The process also differs depending upon whether the groundwater source is developed in a bedrock aquifer, confined sand and gravel aquifer, unconfined sand and gravel aquifer, or spring.

Prior to commencement of the development of a *new public water supply source with a planned yield of 100,000 gpd and greater*, the proponent shall conduct a thorough analysis of system demand and have a viable water conservation program in place. Conservation shall include the full range of water supply conservation, demand management, and water reuse activities and devices. Water conservation is a requirement of the Water Management Act. Additional information about water conservation and Water Management Act Program (WMA) requirements can be found in Chapter 10.0 of this document.

Impacts to natural resources are evaluated throughout the water supply development process. The Source Approval process, in conjunction with the WMA permitting process, requires detailed information regarding potential withdrawal impacts. MassDEP coordinates WMA Withdrawal Permit application reviews with Source Approval reviews and solicits comments and recommendations from other state environmental agencies. The WMA Withdrawal Permit application further solicits comment from stakeholders within the community through the Public Notification process.

Section 4.1 provides a synopsis of the requirements for new public water supply source approvals. A more detailed explanation of these requirements can be found in subsequent sections.

Chapter 4 also addresses requirements for obtaining source approval for springs as public water supplies, the delineation of aquifer protection zones, zoning and non-zoning controls for aquifer protection, well abandonment and decommissioning procedures, and requirements by other state and federal agencies for source development.

Some activities in the source development process and the delineation of Zone IIs will require a permit. For a list of activities, the proponent is referred to 310 CMR 4.00. Assistance can also be obtained from MassDEP Infoline (1-800-462-0444) or the Regional Service Center located in each MassDEP regional office.

To Whom the Source Approval Process Applies:

The Source Approval process, including applicable permits, shall be applied by MassDEP when considering the following:

1. A new public water supply source or well (includes existing private wells converted to public water supply use)

2. An increase in the approved yield of an existing public water supply source, or an exceedance of the approved yield

3. The reactivation of a public water supply source that has been off-line per order of MassDEP

4. The reactivation of a public water supply source not in use for the last 5 years

5. The Source Final Report Approval permit application package (BRP WS 15 or 19) has not been submitted within 3 years of MassDEP approval of the Request for Site Exam/Pumping Test Proposal permit application (BRP WS 13 or 17).

6. The pumping test is not conducted within 2 years of MassDEP approval of BRP WS 13 or 17.

7. An approved source that was not developed and used within 5 years of the date of approval and for which the Zone I is not owned or controlled and wellhead protection requirements have not been met. For sources meeting the Zone I and bylaw requirements, additional testing or other work may be required by MassDEP before the source can be brought on-line.

8. The installation of a replacement well including satellite wells. Replacement wells are subject to the new source requirements as deemed applicable by MassDEP.

The level of effort required to satisfy the Source Approval requirements for Numbers 2 through 8 will depend on the quality and applicability of existing hydrogeologic data and shall be left to the discretion of the Drinking Water Program in the regional office.

4.1 Synopsis of the Source Approval Process for all Public Water Supply Wells

The following section outlines the major components of the Source Approval process for *all public water supply wells*. For informational purposes we have included components that are not administered by the Drinking Water Program. An in-depth description of the technical requirements for each step of the Source Approval process is described in subsequent sections for the specific type of aquifer supplying the well. MassDEP-approved well yields are expressed in gallons per day (gpd).

Step 1: Explore Potential Sources of Groundwater

A public water supplier or potential supplier may conduct exploratory test drilling for selection of a well site(s) without seeking approval of MassDEP Drinking Water Program.

If, during the exploratory phase of the Source Approval process, contaminants listed in the Massachusetts Primary Drinking Water standards or MassDEP's Office of Research and Standards (ORS) guidelines are discovered in the test well, the sequence of the Source Approval process will be altered. Pumping and redevelopment of the test well, followed by re-sampling and analysis using applicable sampling protocols, will be required. If contaminants are still present, alternative sources shall be considered.

In addition to maximum contaminant level (MCL) exceedances, exceedances of secondary contaminants (SMCL), guidelines, or standards may require treatment for removal to acceptable concentrations/limits.

The concentrations of contaminants found and the availability of alternative sources will determine whether the test site should be abandoned and/or referred to MassDEP's Bureau of Waste Site Cleanup (BWSC) for investigation. For contaminants that do not have drinking water standards or guidelines, the Drinking Water Program will contact ORS and request an evaluation of the health effects of the detected chemicals to determine the necessary treatment.

If treatment is necessary, the following must be performed:

1. Design and conduct a pumping test

2. Conduct standard pumping test water quality sampling

3. Review of water quality results by ORS, if appropriate

4. Design and construct wellhead treatment facility (pilot testing may be necessary)

5. Design and implement raw water monitoring program to assure early warning of dramatic changes in raw water quality that may adversely impact treatment

6. Refer site to BWSC for investigation of contaminant source

It is **imperative** that water suppliers communicate with the Drinking Water Program at MassDEP when contaminants are discovered in exploratory wells.

In addition to MassDEP Drinking Water Program requirements, it may also be necessary to obtain permits from the local conservation commission and possibly MassDEP Wetlands and Waterways Program, if the exploratory work is to be conducted in or near wetlands. If the work is to be conducted on state owned property, the proponent must apply for Special Use Permits from the Department of Conservation and Recreation (DCR). For a more detailed discussion see Section 4.19 1.b.

Step 2: Water Management Program Site Screening Requirements

MassDEP Water Management Act Program requires that proponents submit a Site Screening package (Appendix F) for all new source approvals with a *planned yield of 100,000 gpd or greater*. The Site Screening submittal package is also required when a proponent is seeking an increase in the approved yield of a public water supply source for sources that are already approved for 100,000 gpd or greater, or in the event that the increased yield being sought will result in a revised approved yield that equals or exceeds 100,000 gpd. The proponent shall submit two copies of the completed Site Screening package with the Request for Site Exam/Pumping Test Proposal to MassDEP Drinking Water Program. The Site Screening package consists of the following components:

1. Early Notice
   The proponent shall place a notification in the Environmental Monitor indicating the location where a Site Exam/Pumping Test is being requested, the intent to conduct a pumping test, and the planned withdrawal volume for the proposed new source. The Early Notice provides a 30-day public comment period so that potential issues regarding the proposed source can be identified and incorporated into the pumping test design as needed.

2. Water Conservation Plan
   Prior to commencement of the development of a new public water supply, the proponent shall conduct a thorough analysis of system demand and have a viable water conservation program in place. In addition, the proponent shall complete the Water Conservation Plan. (Refer to MassDEP/Water Management Act Program conservation guidelines, *Guidelines and Policies for Public Water Systems, Volume 1: Guidelines,* Section 10, as amended; and *Water Conservation Standards* updated 2006 (or as further revised))

3. Site Screening Worksheet
   Site Screening allows proponents to estimate the impact on flow from a proposed withdrawal on streams, thus enabling them to make informed decisions in selecting sites and evaluating alternatives for new source development. The Site Screening guidance should be used as a

planning tool, and applicants are encouraged to select alternatives that minimize environmental impact and meet other water supply planning objectives for water quality and productivity. The proponent shall complete the Site Screening Worksheet for Siting a New or Expanding Source of Public Water Supply for each source.

4. Alternative Analysis
   For the proposed withdrawal noted in the Site Screening Worksheet, explain the alternative analysis used to select potential sites and water sources, including regional sources. Discuss public supply needs, water supply system interconnection(s) and public health considerations. Costs must be discussed in terms of economic considerations including the cost of source development, treatment requirements and distribution improvements. Additional guidance on Alternative Analysis may be found in the MEPA regulation, Alternatives to the Project, 301 CMR 11.07(6)(f). If the Request for Site Exam involves an Interbasin Transfer application, the proponent must meet with DCR/Office of Water Resources before completing the Alternative Analysis.

Step 3: Application for Approval to Site a Source and Conduct a Pumping Test

The proponent must submit a Request for Site Exam/Pumping Test Proposal to the appropriate Drinking Water Program in accordance with these guidelines. The primary objective of the pumping test is to resolve questions concerning the potentially approvable yield and existing/potential water quality. At MassDEP's discretion, the objectives may be expanded. This request must be accompanied by two (2) copies of the following information:

1. Request for Site Exam/Pumping Test Proposal

   The requirements for the Request for Site Exam are described in Section 4.3.1.2. The Request for Site Exam/Pumping Test Proposal shall include maps showing nearby well locations, land uses, potential sources of contamination, surface water features, and Zone I ownership. It shall also include the planned pumping rate and duration of the pumping test, location of pumping test discharge, frequency of water level measurements and water quality sampling, exploratory well logs, a plan showing the location of observation wells (if applicable), chemical analytical results, and a discussion/evaluation of potential contamination threats.

   For *wells with planned yields 100,000 gpd and greater*, the following must also be submitted: a preliminary estimate of the Zone II (using the boundary flow-line equation (Todd[1]) or other MassDEP-approved analytical or numerical methods from the literature and a conceptual knowledge of the aquifer system); existing local wellhead protection controls; proposed local control measures to meet the requirements of 310 CMR 22.21(2); a discussion of monitoring well locations, and a discussion of methods for delineation of the Zone II (see Section 4.5.2) or Zone III.

2. Other Requirements

   Wetlands Permit / Massachusetts Wetlands Protection Act (MGL ch 131, s. 40) (310 CMR 10.00) – The Massachusetts Wetlands Protection Act is administered by MassDEP and local conservation commissions. A wetlands permit is required for any work completed within a wetlands resource area or within the 100-foot wetlands buffer zone. Work requiring a permit would include creating an access way to observation well or test well locations, drilling activities, conducting a pumping test, and any wetlands filling or other alteration that may be required. This work will likely involve the filing of a Notice of Intent (NOI) with the local conservation commission, a public hearing, and the issuance of an Order of Conditions by the local conservation commission.

[1] Todd, D. K., 1979, *Groundwater Hydrology*, John Wiley & Sons, Inc., New York, p. 535.

Massachusetts Endangered Species Act (MESA) Permit Application (for sources with planned yields of 100,000 gpd or greater) – Proponents must file with the Massachusetts Department of Fish and Game, Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program (NHESP), if the proposed project is subject to NHESP regulations. Depending upon the outcome of that filing (Information Request form), a proponent may need to file for a *Conservation & Management Permit*. If the project requires an NOI due to its location within an Estimated Habitat for Rare Wildlife under the MA Wetlands Protection Act Regulations, a copy of the NOI must be sent to NHESP.

Army Corps of Engineers 404 Permit –This permit is required when any filling of wetlands occurs in the process of well site exploration or well development. To meet the requirements for a Section 404 Permit, an Alternative Analysis must be conducted. This analysis will primarily be conducted in two phases. The first phase will be conducted at the time of the Request for Site Exam/Pumping Test Proposal, and the second phase will be submitted with the Source Final Report.

Step 4: Conduct Site Exam/Pumping Test Proposal Approval

MassDEP will not conduct the site examination until after the Early Notice public comment period, where applicable. The site exam is conducted by MassDEP's Regional Drinking Water Program staff, the water supplier, the consultant, and other stakeholders. It includes a land use/sanitary survey of the IWPA or preliminary Zone II and a review of proposed observation well locations for the pumping test. Special conditions for pumping test design and performance are also discussed. The status of Zone I ownership or control shall be discussed.

It is the proponent's responsibility to inform local officials that approval of a new drinking water well will require protection of the Zone II with municipal controls (bylaws, ordinances or health regulations) that meet MassDEP Wellhead Protection Zoning and Non-Zoning Controls 310 CMR 22.21(2). Upon MassDEP approval of the Request for Site Exam/Pumping Test Proposal, the proponents (both municipal and non-municipal systems), should provide local officials with a copy of 310 CMR 22.21(2) and inform them of the wellhead protection requirements.

Step 5: Federal Notice of Intent (NOI) Application 404 Permit / MassDEP 401 Water Quality Certification Program *(314 CMR 9.00)*

A 404 Permit from the U.S. Army Corps of Engineers may be required for filling or dredging vegetated wetlands or waters of the Commonwealth. The proponent should contact the Corps of Engineers for details. Public water supply wells that are physically located within wetlands are an example of a project that would require a 404 Permit.

A water quality certificate is intended to facilitate review of projects with the potential for large or cumulative impacts to ensure compliance with the surface water quality standards. Actions involving, but not limited to, any one activity listed below, require a 401 application review:

1. Loss of greater than 5,000 square feet of wetlands
2. Within an outstanding resource water (ORW)
3. Any real estate subdivision
4. Any wetlands alteration not subject to the Wetlands Protection Act
5. Rare or endangered species habitat in isolated vegetated wetlands

6. A salt marsh

7. Dredging greater than 100 cubic yards

Step 6: Conduct Pumping Test

This test must be conducted according to these guidelines and the conditions of the pumping test proposal approval letter.

Step 7: Pumping Test Shut Down

Recovery readings shall be taken in accordance with these and the approved pumping test proposal. The pumping test may be shut down only after consultation with MassDEP, in order to assure that MassDEP agrees that stabilization has been achieved.

Step 8: Submit Source Final Report to MassDEP Regional Office

The proponent must submit a Source Final Report as described in Section 4.6. Two copies of the report must be submitted to the appropriate MassDEP regional office. In summary, the Source Final Report shall include all data collected during the pumping test in both tabular and graphical formats; calculated aquifer characteristics; groundwater contour maps before pumping and at the end of the pumping test; calculated approvable yield (See Section 4.3.1.5.); water quality analysis results presented and explained; a discussion of treatment options (if applicable); a discussion of hydraulic connections to nearby surface water features; and, a discussion of how the well's proposed pumping schedule will affect the water table and nearby sensitive receptors.

Step 9: Assess Capacity (Community and NTNC systems only)

A new public water system (community or non-transient-non-community) must demonstrate the managerial, technical and financial ability to comply with the Safe Drinking Water Act and other drinking water requirements pursuant to 310 CMR 22.00. The applicant must submit a business plan *(and/or other financial assurance mechanisms as determined by MassDEP)* in a format approved by MassDEP. The documents must demonstrate the system's proficiency in all three capacity areas: technical, managerial and financial. The draft plan must be submitted during initial stages of the Source Approval process. A complete plan shall be submitted prior to obtaining final on-line approval (See Chapter 1, *Submission of Water Works Plans*). If a water system is part of a larger enterprise, only the water supply portion of the enterprise needs to be included in the business plan. Visit MassDEP Drinking Water Program web site at www.mass.gov/dep/water for a detailed water supply business plan.

Note: MassDEP may require parts of this step earlier in the Source Approval process. This step does not apply to existing systems that are developing a new source.

MassDEP staff will incorporate its capacity assessment and assurance comments into the Site Exam/Pumping Test approval letter and will continue the Source Approval process according to MassDEP.

Step 10: Water Management Permit Application

If applicable, an application for a Water Management Act permit or permit amendment must be submitted to MassDEP Water Management Act Program at the same time the Source Final Report is submitted. A permit amendment is required for existing permit holders adding a new source where system wide withdrawal volumes are not being increased. The WMA regulations can be found in *310 CMR 36.00.* A water withdrawal permit is required for new or expanded water withdrawals above the threshold volume.

Water withdrawal uses may include, but not be limited to public water supply, industrial uses, agricultural uses (i.e., cranberry growers), irrigation uses (i.e., golf courses), snowmaking, and hydropower. The threshold volumes are:

1. An average daily volume of 100,000 gallons for any period of three consecutive months (90 days), for a total withdrawal of not less than 9,000,000 gallons; or,

2. An average daily volume of 100,000 gallons for periods which exceed three consecutive months, calculated by dividing the total withdrawal by the period of operation.

Step 11: Submit Interbasin Transfer Application to DCR *(MGL ch 21 ss. 8B-8D)*

An interbasin transfer is defined as any transfer of the surface and groundwaters, including wastewater, of the Commonwealth outside a river basin. If a city or town partially situated within a river basin takes waters from that basin, extension of water services to a portion of the same city or town outside the basin shall not be deemed an interbasin transfer of water. If your proposed withdrawal involves an interbasin transfer, refer to Department of Conservation and Recreation (DCR) Office of Water Resources, Interbasin Transfer Act, water conservation measures in *Interbasin Transfer Act Performance Standards Guidance* and *A Guideline to the Application of the Interbasin Transfer Act and Regulations*, as amended. Any necessary Interbasin Transfer Act approval must be obtained before MassDEP will issue the WMA permit or permit amendment. Where interbasin transfer may be an issue, MassDEP recommends beginning discussions with DCR early in the Source Approval process.

Step 12: Submit Environmental Notification Form (ENF) to MEPA *(MGL ch 30 s. 61 through 62H) (301 CMR 11.00)*

All proposed new groundwater withdrawals or expansion of existing groundwater withdrawals of 100,000 gpd or greater require that an Environmental Notification Form (ENF) be filed with the Massachusetts Environmental Policy Act (MEPA) Program. The filing initiates a 30-day public review period, which commences with a notification in the Environmental Monitor of the availability of the ENF. During the ENF review, the environmental impacts associated with the proposed well are evaluated. For projects with significant environmental impacts, the ENF review can result in a requirement for the preparation of an Environmental Impact Report (EIR). However, if an EIR is not required, the MEPA review is complete at the end of the public comment period. An EIR is always required for any proposed new groundwater withdrawal or expansion of existing groundwater withdrawal of 1.5 million gpd and greater. An EIR is also required for any new groundwater withdrawal of 1 million gpd and greater that also requires an interbasin transfer. The latest, the ENF should be submitted is at the time of the WMA permit application and Source Final Report. No WMA or Source Approval permits will be issued until the MEPA process is completed.

Step 13: Submit MassDEP 401 Application

At the same time that the Source Final Report is submitted to MassDEP, the proponent shall submit a 401 Application, if required. The 401 Application process will involve a public notice and public comment period and a successful application will result in a major project certification.

Step 14: Submit Environmental Impact Report (EIR) to MEPA (if required)

Step 15: Submit Final Environmental Impact Report (FEIR) to MEPA (if required)

Step 16: Submit 404 Permit Application to Army Corps of Engineers (*Clean Water Act of 1977)*

If the new source development project involves any dredging or filling-in of a waterway or wetland the proponent may be required to apply for a 404 Permit from the U. S. Army Corps of Engineers. Section 404 of the Clean Water Act defines the landward limit of jurisdiction as the high tide line in tidal waters

and the ordinary high water mark as the limit in non-tidal waters. When adjacent wetlands are present, the limit of jurisdiction extends to the limit of the wetlands.

Step 17: Source Final Report Approved

Both the Source Final Report and the Water Management Act permit approvals occur at this step.

Step 18: Submit Design Plan for Permanent Works to MassDEP Regional Office

For *wells with approved yields of less than 100,000 gpd*, the proponent must submit the design plans and specifications to construct the new source concurrent with the submittal of the Source Final Report. For *wells with approved yields of 100,000 gpd or greater*, the proponent may submit the permit application to construct the new source either concurrently with the Source Final Report or after MassDEP has approved the Source Final Report. MassDEP will not approve construction of the source until the water supplier has demonstrated ownership or control of the Zone I. MassDEP cannot approve construction of the source until the MEPA process has been completed.

Step 19: Begin the Wellhead Protection and/or Best Effort Compliance Process

Once the Zone II has been approved, the public water system must provide a copy of the Zone II delineation and a copy of the Wellhead Protection Zoning and Non-Zoning Regulations (310 CMR 22.21(2)) to local officials. Compliance must be achieved prior to the new source going on-line.

Step 20: Submit Notice of Intent (NOI) to Local Conservation Commission

Following the approval of the Source Final Report, additional wetlands or 100-foot wetlands buffer work may be required to install a permanent road to the source, for the construction of the pump house, for construction of the finished production well or wellfield, and/or for the installation of water main. This may require the submittal of a NOI to the local conservation commission.

Step 21: Notify Appropriate MassDEP Regional Office When Construction is Complete

Any design modifications must be noted. In addition, the design plan must identify the owner and party responsible for the public water system. A public water system certified operator staffing plan shall be submitted demonstrating compliance with 310 CMR 22.11B. Any changes in designees must be reported to MassDEP.

Step 22: Site Inspection of Permanent Works

MassDEP will inspect the completed pumping facilities including any water treatment.

Step 23: Final Source Approval

MassDEP will issue a Final Source Approval after the proponent has received the following approvals (where applicable) and MassDEP has determined from its site inspection that the completed pumping facilities are acceptable for use:

1. MassDEP has issued the public water system a Wellhead Protection and/or Best Effort Compliance notification letter.

2. MassDEP Wetlands 401 Major Project Certification

3. Permanent Works Installation Approval

4. Water Management Act Approval
5. MEPA Approval
6. Interbasin Transfer Approval
7. Army Corps Section 404 Approval
8. MESA Approval

A proponent for a new source shall not bring that source on-line prior to receiving written approval from the appropriate MassDEP regional office for the permanent well and pumping facility (see Section 4.17).

Step 24: Meet Requirements of the Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR), an amendment to the federal Safe Drinking Water Act, requires MassDEP to notify the U.S. Environmental Protection Agency (EPA) of groundwater sources determined to be under the direct influence of surface water and at risk for carrying waterborne contaminants such as *Giardia*, legionella, *Cryptosporidium*, and viruses. Water suppliers developing groundwater sources must demonstrate compliance with the SWTR by either receipt of a MassDEP SWTR exemption; institution of appropriate wellhead/watershed protection and adequate disinfection; or installation of adequate filtration, disinfection, and disinfection contact time. Exemptions are granted based upon well siting, well construction, or the results of microscopic particulate analysis (MPA). The proponent of a new source should consider the location of the well relative to the nearest surface water feature and the screened interval, as those decisions will determine whether or not MPA testing is required. The MPA testing that result in a determination of whether the well complies with the SWTR is not done until after the well is constructed and on-line. See Section 4.18 for more details.

Step 25: Implications of the Groundwater Rule

The Groundwater Rule (GWR) is an amendment to the SDWA, which requires Public Water Suppliers that rely in whole or in part on groundwater sources for drinking water to determine if they are being impacted by human pathogens (viruses), usually of wastewater origin. Systems currently collect samples under the Total Coliform Rule (TCR). Under the GWR, when a distribution sample tests positive for total coliform, source sampling will be required. For new wells, if the proposed source tests positive for total coliform, then the sample must be analyzed for *enterococci* (and/or coliphage at MassDEP's discretion). Proposed sources that test positive for *enterococci* (and/or coliphage) are advised that treatment may be needed. Furthermore, the public water system must attempt to correct significant deficiencies under the GWR (for example: nearby failing septic systems or leaking sewer lines) prior to the collection of the initial assessment monitoring sample. Assessment monitoring will be required under the GWR for all new sources at startup.

Additional Requirements:

Certain hydrogeological, geological, or logistical situations may exist that cause MassDEP to require activities during the Source Approval process that may exceed the minimum requirements of these guidelines.

1. In certain complex hydrogeologic situations, it is difficult to predict the zone of contribution for a well without employing a numerical computer model. Based on the geologic and hydrogeologic complexity of the aquifer, MassDEP may require that a specific modeling approach be used to delineate the Zone II.

2. In situations with several independent wells pumping simultaneously, a numerical computer model may be necessary.

3. When water quality problems are known to exist proximal to or at a proposed public supply well, the need for water quality information obtained from a pumping test increases.

4. In the aforementioned situations, MassDEP may **require**:

   a. The use of a numerical computer model;

   b. The installation of as many monitoring or observation wells as are necessary to properly characterize the aquifer and impacts of the withdrawal, to validate the assumptions used in the computer model and/or to assess existing or suspected water quality problems;

   c. All of the wells within the same aquifer be pumped at their approved yield for the duration of the pumping test;

   d. The proposed well be pumped at the rate for which source approval is sought;

   e. The duration of the pumping test exceed the minimum requirements of these guidelines; and,

   f. Additional water quality parameters be examined, or more frequent sampling be employed than is called for in these guidelines.

   It shall be left to the discretion of MassDEP to decide when these supplemental activities are required.

4.2 Site Screening for Siting a New or Expanding Source of Water Supply

Site Screening for Siting New or Expanding Source of Water Supply allows proponents to screen each site under consideration, enabling them to make informed decisions in selecting sites and evaluating alternatives for new source development. Project proponents of new *sources with planned yields 100,000 gpd or greater* shall apply the screening criteria to each source under consideration. This guidance shall not be considered to be a final determination of the approvability of sites, but is intended to provide direction regarding significant issues that will have to be addressed if a particular site is pursued. Applicants are encouraged to select alternatives that minimize environmental impact and meet other water supply planning objectives for water quality and productivity.

The proponent shall complete the Site Screening Package (Appendix F) for Siting a New or Expanding Source of Public Water Supply for each source and shall submit two copies with the Request for Site Exam/Pumping Test Proposal to MassDEP Drinking Water Program. The Site Screening Package requirements for the Water Management Act Program consist of four components: 1) the Early Notice, 2) the Site Screening Worksheet, 3) the Water Conservation Plan, and 4) the Alternative Analysis. Guidance and/or forms for all of these components are available on MassDEP website.

Impacts on streamflow are best determined through physical characteristics of the watershed, site hydrology and pumping tests. However, the site screening criteria provides guidance concerning a withdrawal's potential for impact on flow. Further data collection during the pumping test and analysis will be necessary to determine the potential impact of all proposed withdrawals and mitigating circumstances.

Generally, for a withdrawal pumping rate of less than the minimum streamflow that is predicted over a 7-day period that will occur on average once in 10 years (7Q10), no significant impact is anticipated. Proposed withdrawals that exceed the following criteria may be unapprovable or severely restricted by permit conditions.

1. Withdrawals that are greater than the 7Q10 streamflow have the potential to increase the frequency and duration of low flow and may result in moderate to significant environmental impact.

2. Withdrawals that are 50% of the August Median or greater are considered to have the potential to significantly reduce streamflow.

Since the August Median statistic may reflect wide ranging and relatively high flows, particularly in small watershed drainage areas, the more conservative 50% of August Median flow was selected as the screening threshold level to protect impacts on river flow from withdrawals.

Low flow stream statistics (7Q10 and August Median) measured in cubic feet per second (cfs), may be obtained from the U.S. Geological Survey (USGS) website. However, statistics obtained from this website are based on unregulated (naturally flowing) streams and do not take into account cumulative effects on streamflow from existing withdrawals or other impacts, and the proposed withdrawal may require further site screening assessment. Stream threshold indicators may also be more restrictive in basins that MassDEP has determined to be hydrologically stressed.

MassDEP assumes 100% hydrogeologic communication between the well and the stream so that every drop of water pumped from the well comes from the stream. See the steps provided in the Site Screening Worksheet to calculate the withdrawal's potential impact on streamflow. MassDEP will also consider applied site-specific stream depletion methodologies (Jenkins[2], Barlow[3], etc.), that attempt to quantify streamflow depletion by wells under Zone II conditions (180 days of continuous pumping at the Calculated Approvable Yield). The reduced streamflow impact obtained through one of these site-specific methods may be substituted for the assumed 1:1 withdrawal to streamflow depletion impact. In such cases, the reduced streamflow impact may be used to compare with stream indicators 7Q10 and 50% of August Median.

4.3 Source Approval Components

This section describes the Drinking Water Program's Source Approval process and the data requirements for each step of the process. See Section 4.19 for source approval requirements from other programs within MassDEP and other state and federal entities. Water suppliers contemplating groundwater exploration activities should contact the appropriate MassDEP regional office to discuss the Source Approval process.

It is MassDEP's policy to accept hydrogeological reports submitted by engineers or geologists skilled in groundwater exploration or contaminant transport hydrogeology as the situation warrants the need for that

[2] Jenkins, C.T., 1968, *Computation of rate and volume of stream depletion by wells*: U.S. Geological Survey Techniques of Water-Resources Investigations, chap. D1, book 4, 17 p.

[3] Barlow, P.M., 2000, *Documentation of computer program STRMDEPL—A program to calculate streamflow depletion by wells using analytical solutions*, in Zarriello, P.J. and Ries, K.G. III, 2000, *A precipitation-runoff model for the analysis of the effects of withdrawals on streamflow, Ipswich River Basin, Massachusetts*: U.S. Geological Survey Water-Resources Investigation Report 00-4029, 73-89 p.

skill. If the submittal includes plans for pump facilities and appurtenances related to a Source Approval or for the design of a treatment system for a contaminated water supply, a Massachusetts Registered Professional Engineer must stamp the plans.

Groundwater exploratory or development work in or near vegetated wetlands, or other environmentally sensitive areas, may require filing a Notice of Intent with the local conservation commission. The commission should be contacted to determine if this will be necessary.

The process of implementing appropriate zoning and non-zoning controls prior to bringing a source on-line *with planned yields 100,000 gpd or greater* should commence early during the Source Approval process (See Section 4.8). It is recommended that the town add to the town meeting warrant an article or resolution describing the Source Approval process being entered into, the zoning and non-zoning control requirement, the importance of water resource protection, and a notice to the meeting that the passage and adoption of the appropriate controls will be voted on at the next annual town meeting. A public education/awareness campaign to assist in a favorable reception at the town meeting should commence at this time.

Pursuant to 313 CMR 3.00, all well drillers doing business in the Commonwealth must be registered with the Department of Conservation and Recreation's Well Driller Registration Program.

4.3.1 Source Approval Process for Wells (not including spring sources)

4.3.1.1 Groundwater Exploration

Due to the complex nature of bedrock fracture systems and the generally difficult task of determining the recharge area to a well constructed in bedrock, MassDEP requires that all viable unconsolidated aquifer deposits be considered prior to proposing development of a bedrock public supply well. It shall be left to the discretion of MassDEP regional Source Approval staff to evaluate the applicability of this requirement.

Water suppliers contemplating development of a source should review all hydrogeologic information for the area being considered before undertaking costly subsurface explorations. This information includes USGS Hydrologic Atlases and Data Reports, USGS Surficial Geologic and Bedrock Geologic Quadrangle Maps, Mass Office of the State Geologist maps and related information, MassDEP Water Quality data, academic reports, historical USGS water level data, consultant reports addressing the specific area, and reports on commercial, industrial, and private water supply uses. Specific sources of information are compiled in MassDEP's Massachusetts Hydrogeologic Information Matrix.

During the exploratory phase (2-1/2-inch diameter or larger test well) pumping test, the following parameters should be tested for:

1. Field Tests
   On-site determinations for pH, odor, specific conductance, and temperature at the beginning and at the end of the pumping test.

2. Lab Tests
   The volatile organic chemicals listed in Appendix A, nitrate, nitrite, and secondary contaminants must be sampled for at the end of pumping test.

If the proposed source is proximate to a surface water feature, the proponent should be aware of the potential that the source may be Groundwater Under the Direct Influence of Surface Water and subject to surface water treatment regulations. It is recommended that a microscopic particulate analysis (MPA) test be conducted at the end of the pumping test to ascertain susceptibility of the source to be under the influence of surface water. MPA testing may be required at the discretion of MassDEP.

The samples collected for laboratory analyses shall be analyzed by a laboratory that is certified by Massachusetts or EPA to conduct these analyses.

Because of the expense of drilling bedrock wells, a test well for a proposed bedrock well site does not have to be drilled until MassDEP has approved the Site Exam/Pumping Test Proposal. If the well is drilled after the site exam, the preliminary water quality samples must be collected and the results submitted to MassDEP prior to the start of the pumping test.

4.3.1.2 Request for Site Exam/Pumping Test Proposal

1. Transient Non-Community Sources (TNC) With Planned Yields Less Than 10,000 gpd

   Transient non-community groundwater sources (excluding spring sources) with planned yields of less than 10,000 gpd are not required to submit a Request for Site Exam/Pumping Test Proposal. However, the proponent shall schedule a meeting with MassDEP prior to conducting the pumping test. Subsections 4.3.1.2.2. and 3. contain requirements for the pre-meeting and subsequent pumping test. See Appendix G for MassDEP's standard operating procedure for a new source of this category.

2. Request for Site Exam Requirements

   The Request for Site Exam/Pumping Test Proposal must contain a characterization of land use within a ½-mile radius around the well, or within the preliminary Zone II. Proponents of TNC *wells with yields of less than 10,000 gpd* shall provide land characterization for the IWPA associated with the planned yield at the pre-Source Final Report meeting. The following must be included in the Request for Site Exam/Pumping Test Proposal:

   a. A map showing:

      (1) Current land uses and zoning

      (2) Approved water withdrawals, registered and/or permitted by MassDEP, and any other private, commercial, or industrial wells

      (3) Existing and potential sources of contamination, including landfills and hazardous waste sites

      (4) Location of and geologic logs (depth, yield, lithology) for all exploratory wells

   b. A discussion/evaluation of potential impacts of existing and potential sources of contamination to the new water supply. Where applicable, evaluate compliance with Nitrogen Loading Limitations 310 CMR 15.214.

   c. For test wells at potential production well sites, the following must be provided:

      (1) Water quality analysis results (See Section 4.3.1.1.)

      (2) Estimate of well yield

      (3) Well log and as-built construction diagram

d. A map showing ownership of all land within Zone I. If the proponent already owns all of the land within Zone I, this must be clearly stated in the text or on a map.

e. For new public water systems discuss water needs for the project and method for estimating water needs.

Requests for *wells with planned yields 100,000 gpd and greater* **must** also include:

f. Preliminary conceptual model of the aquifer, including:

(1) Stratigraphic cross-sections, boundary conditions, recharge areas, etc. (for unconfined and confined aquifer wells only);

(2) Field evaluation of structural trends, fracture traces and orientation, presence of faults in bedrock outcrops, and the morphologic landscape features relating to these (for bedrock aquifer wells only);

(3) Initial estimate of the Zone II or Zone III area (see Section 4.10 *Conceptual Zone II for an Existing Source* for a methodology that may also be used to determine an initial estimate of Zone II).

g. Location and type of potential contamination sources in the preliminary Zone II;

h. A map depicting all great ponds, streams, and wetlands within a 1,000-foot radius of the well;

i. Estimate of potential production well yield based on initial pumping test conducted on a test well or test/production well;

j. Strategy for meeting wellhead protection requirements of 310 CMR 22.21(2). This will include, at a minimum:

(1) Name, title, and phone numbers of lead local contacts who will be pursuing changes to the board of health and/or zoning regulations, pursuing such protection with neighboring communities, and implementing existing controls that meet MassDEP requirements;

(2) Timeframes for drafting any needed changes to bring local controls up to MassDEP requirements, for bringing regulatory changes to planning board, board of health, Town Meeting, etc., and a plan for public education that will ensure success in these forums;

(3) Proposed schedule and contacts for ensuring protection of any part of the Zone II that extends into a neighboring community;

(4) Any relevant existing/proposed control measures.

k. A surveyed site plan including Zone I, well locations, and elevations;

l. Results of Site Screening.

In addition to the above requirements, all potentially harmful activities within the preliminary Zone II and Zone III must be identified. It is the responsibility of the proponent and the proponent's consultant to alert MassDEP to the existence of such hazards. This information shall be shown on a USGS map at a scale of 1:25,000 and submitted as part of the Request for Site Exam/Pumping Test Proposal.

3. Pumping Test Proposal Requirements

The following subsections discuss pumping test design requirements for the Pumping Test Proposal including the pumping test requirements for TNC wells with planned yields less than 10,000 gpd.

a. Planned Pumping Rate

(1) Pumping tests of final unconfined and confined aquifer production wells shall be conducted at the rate for which approval is sought. Pumping tests of bedrock production wells shall be conducted at 133⅓ % of the approval rate being sought.

(2) A pumping test that is conducted on a test well completed in an unconfined or confined aquifer shall be conducted at a minimum of 50% of the design rate for the production well (only for wells with planned yields of 100,000 gpd or greater). A pumping test for an unconfined or confined aquifer test well with a planned yield of less than 100,000 gpd shall be conducted at a minimum of 100% of the design rate for the final production well.

(3) A step-drawdown test is highly recommended for unconfined and may, in some cases, be required for confined aquifer wells. A step-drawdown test is required for bedrock aquifer wells (except TNC bedrock wells with planned yields of less than 10,000 gpd). The proponent for a bedrock well may submit a proposed pumping test plan, for MassDEP approval, that the proponent wishes to substitute for the step-drawdown test requirement. The following step-drawdown requirements apply:

(a) A step-drawdown test shall be conducted at 50, 100, 150, and 200% of the proposed pumping test rate (these specific pumping rate requirements only apply to bedrock aquifer wells).

(b) It is recommended that each step be sustained for a minimum of one hour.

(c) Data and information generated during the step-test shall be used to predict an appropriate pumping rate that will comply with the stabilization criteria.

(d) The well shall not be approved or disapproved by MassDEP based upon the results of the step-drawdown test.

(e) Documentation and discussion of the results (e.g., water level fluctuations) of the step-drawdown test shall be presented in the final report with an explanation of the pumping rate chosen for the prolonged pumping test.

(4) Water levels shall be allowed to recover between the step drawdown test and the prolonged pumping test. For bedrock aquifer wells, the water level in the production well shall be allowed to recover at least 95% of the drawdown prior to the commencement of the prolonged pumping test.

(5) MassDEP shall be notified of any changes in the pumping rate and of significant precipitation events in the last 24-hours of the test.

(6) The pumping rate shall be recorded every 2 hours.

b. Observation Wells

In most cases observation wells are not required for wells with planned yields less than 100,000 gpd. However, for confined aquifer wells in this well yield category (except TNC wells with planned yields of less than 10,000 gpd), a minimum of one observation well shall be screened in the confining layer and one well in the confined aquifer close to the pumping well to determine aquifer transmissivity and storativity.

All wells with planned yields of 100,000 gpd and greater require a sufficient number of observation wells to accurately determine aquifer characteristics and the hydrologic interactions between the aquifer and nearby surface water bodies that are necessary to delineate an accurate Zone II wellhead protection area and to assess potential impacts on nearby wells and other sensitive receptors. The exact number and location of observation wells depends upon geologic/hydrogeologic conditions encountered on a site-by-site basis. However, for confined aquifer wells, a minimum of 5 observation wells is required. One well shall be located in the confining layer, one well in the unconfined aquifer, and three wells in the confined aquifer.

(1) Location
Observation wells should be placed between the pumping well and any significant hydrogeologic boundaries such as no flow boundaries, constant flux boundaries or constant head boundaries. Additional wells may also be necessary to measure the effects of partial penetration (not applicable to bedrock aquifer wells).

(a) Well placement shall allow for the calculation of aquifer transmissivity by distance-drawdown and time-drawdown methods.

(b) A plan of the proposed locations and frequency of measurement of all observation wells to be used for drawdown and recovery recordings must be included in the pumping test design.

(c) Elevations and locations of all observation wells must be surveyed to a USGS benchmark relative to mean sea level.

(d) The following additional requirements apply to bedrock wells:

(i) The consultant shall report whether any private bedrock wells could be influenced by the pumping test. If private wells may be affected, then these private wells or a representative well or wells shall be monitored during the pumping test. If this is not feasible, then one or more bedrock observation wells will be drilled in the vicinity of the private wells and will be monitored during the pumping test. If there are no potential private bedrock well impacts, there may still be a need for the installation of bedrock observation wells for the purpose of completing an adequate Zone II delineation or WMA Permit application.

(ii) In most instances overburden observation wells will also be required to assess the interaction between the bedrock aquifer and overburden aquifer and to predict potential surface water impacts.

(2) Construction Details
The depth, diameter, and screened interval must be provided for each observation well.

(3) Ambient Well (not required for TNC wells with planned yields of less than 10,000 gpd
To assist in determining stabilization, an additional observation well shall be located outside the area of influence of the pumping well but within the same geologic formation. This well will be used to measure ambient conditions within the aquifer during the pumping test.

(4) Static Water Level Fluctuation Trends (not required for TNC wells with planned yields of less than 10,000 gpd):

(a) Confined and Unconfined Aquifer Wells
Daily water level measurements shall be measured in all observation wells (including production well and ambient well) for the 5-day period immediately preceding the commencement of the pumping test.

(b) Bedrock Aquifer Wells:

(i) All Bedrock Aquifer Wells
The water level in the production well shall be monitored at least twice daily (minimum 8 hour increments) for a 10-day period ending no more than 5 days prior to the start of the prolonged pumping test. Step tests may not be conducted during this 10-day period. The water level fluctuation trend shall be used during evaluation of the pumping test and application of the stabilization criteria. Long-duration rainfall events may cause postponement of the pumping test. This decision shall be at the discretion of MassDEP.

(ii) Wells with Planned Yields 100,000 gpd and Greater

In addition to the requirements above, daily water level measurements shall be recorded for all overburden observation wells used in a pumping test for a bedrock aquifer well for the 5-day period immediately preceding the commencement of the pumping test. The 5-day overburden measurement period is not required to coincide with any of the 10-day bedrock static water level measurements.

(5) Response Test
The response to changing water levels shall be tested for all wells to be used as observation wells by either injecting or removing a known volume of water into or out of each well and measuring the subsequent rise or decline of the water level. The initial rise or fall of water level should be dissipated within a reasonable amount of time.

(6) Site Control
Site control measures that ensure that no contamination is introduced into the aquifer must be employed during the drilling and installation of the observation wells. Any observation well permanently abandoned subsequent to completion of the pumping test shall be filled in such a manner that vertical movement of water within the well bore, including movement within the annular space surrounding the well casing, is effectively and permanently prevented, and the water is permanently confined to the specific zone in which it originally occurred (See Section 4.21, Well Abandonment and Decommissioning).

c. Induced Infiltration

For wells located near a surface water body, the amount of induced infiltration caused by pumping the well must be evaluated and quantified. The requirement for assessing induced infiltration may not be necessary for certain confined aquifer well locations where the nature

and lateral extent of the confining layer is well defined and would be expected to preclude significant amounts of induced infiltration from nearby surface water bodies. The amount of induced infiltration will affect the size and shape of the Zone II, and may affect water quality at the well site. The amount and impact of induced infiltration may affect the permittable WMA withdrawal volume. The following methods are recommended for quantifying induced infiltration:

(1) Staff Gauges
When measuring the stage of a river or stream, at least two gauges shall be used. One shall be located beyond the anticipated 5-day cone of depression to monitor ambient river stage trends. The second shall be located in the reach of the stream closest to the pumping well. When measuring the stage of a pond, lake, or wetland, at least one gauge shall be located in the surface water at the location that is closest to the pumping well. Measurements shall be made frequently during the pumping test and recovery periods.

Staff gauges should be secured to prevent movement during flood, ice flow, etc. Use of a stilling well will increase measurement accuracy. Staff gauge elevations should be surveyed at the same time as the observation well network.

(2) Additional Data Collection May Be Required
Examples include the use of Shelby tubes and/or seepage meters in order to better define hydraulic conductivity in streambed/lakebed/wetland sediment.

(3) Field Measurement of Water Quality
Measure specific conductance, pH, temperature, and other indicator parameters in samples from the surface water body, production well discharge, and appropriate observation wells before and during the pumping test. Appropriate mass balance equations shall be used to estimate the extent of induced infiltration under pumping test conditions.

(4) Vertical Hydraulic Conductivity
Estimate the vertical hydraulic conductivity of the sediment deposits at the base of the surface water feature with field or laboratory techniques and install streambed/lakebed/wetland piezometers. Measure the hydraulic gradient between the surface water feature and the aquifer at frequent intervals throughout the test.

(5) Stream Profiling and Stream Gauging
May be required to supplement induced infiltration evaluations when large volume wells are located near a stream, brook, river, or other surface water feature.

d. Flow Measuring Device

A flow measuring device capable of providing instantaneous flow measurements accurate to within ±3% of the pumping rate shall be used. A flow measurement device capable of providing accurate flow measurements shall be used for TNC wells with planned yields of less than 10,000 gpd.

e. A discussion of methodology for delineating Zones II or III shall be provided (see Sections 4.5.2. and 4.5.4. respectively, for Zone II Delineation and Protection and Waiver of Zone II Delineation/Delineation of Zone III).

f. Pumping Test Discharge Line

The discharge from the pumping test shall be located to minimize the recirculation of water. In order to decrease fluctuations in the pumping rate at pump startup, it is recommended that the discharge line be filled with water prior to commencement of the pumping test. Check valves shall be used for all pumps installed in bedrock wells for prolonged pumping tests.

g. Correction for Barometric Pressure (only required for Confined Aquifer and Bedrock Aquifer Wells except TNC wells with planned yields of less than 10,000 gpd)

Continuous readings of barometric pressure (to a sensitivity of ± 0.01 inch of mercury) shall be made to establish water level trends prior to and during the testing periods. Where appropriate, drawdown data shall be adjusted for atmospheric pressure changes occurring during the pumping test.

h. Precipitation

Precipitation during the pumping test shall be measured on site to the nearest one-hundredth (.01) of an inch. Precipitation measurements shall commence 5 days prior to startup of the pumping test. Precipitation measurements for TNC wells with planned yields of less than 10,000 gpd shall commence 2 days prior to the startup of the pumping test.

i. Notice of Intent

Pumping tests conducted in or near vegetated wetlands, or other environmentally sensitive areas, may require filing a Notice of Intent with the local conservation commission.

j. Water Quality Sampling and Testing

Samples shall be collected as close to the pump as feasible to minimize possible pipe contamination of the sample.

During the prolonged pumping test the following will apply:

(1) Field Tests
On-site determinations for pH, odor, specific conductance, carbon dioxide, and temperature minimally at the beginning of the test, after 24 hours, and every two days thereafter until the end of the test. For TNC wells with planned yields of less than 10,000 gpd these same parameters, with the exception of carbon dioxide, shall be determined at the beginning and end of the test. Said determinations shall be recorded in the Source Final Report.

(2) Lab Tests
The consultant supervising the prolonged pumping test shall be responsible for coordination of the sample analyses with a Massachusetts or EPA certified laboratory. Under certain circumstances split samples or duplicates may be required by MassDEP. The following samples must be collected and analyzed using appropriate sampling equipment and protocols, and delivered to the State-certified or EPA-certified laboratory. See MassDEP's website for a list of MassDEP certified laboratories.

The laboratory must be certified in all applicable potable water categories, use approved testing methods, and achieve all required method detection limits (MDLs) and holding times set by the Commonwealth of Massachusetts.

(a) For unconfined and confined aquifer wells, samples of water for total coliform bacteria shall be collected at the projected midpoint, every 5 days thereafter (if applicable) and the end of the test. For bedrock aquifer wells, samples for total coliform bacteria shall be collected once every five days and at the end of the test. For all TNC wells with planned yields of less than 10,000 gpd, a sample for total coliform bacteria shall be collected at the end of the test.

If the result of any analysis is positive for total coliform, then the sample must be analyzed for enterococci (and/or coliphage at MassDEP's discretion). Contact MassDEP immediately if the results of the enterococci (and/or coliphage) test(s) are positive.

(b) Water samples for radionuclides shall be collected at the end of test. Refer to Appendix A for specific requirements.

(c) Water samples for inorganic chemicals, nitrate, nitrite, perchlorate, and all regulated and unregulated volatile organic compounds (see Appendix A) shall be collected on the final day of the pumping test prior to shutdown.

(d) Water samples for secondary contaminants shall be collected 1 hour after commencement of the pumping test, every other day thereafter and on the final day of the pumping test prior to shutdown.

(e) One sample for synthetic organic chemicals (SOC) analysis (refer to Appendix A for details) shall be collected on the final day of the pumping test prior to shutdown. If a proponent is conducting pumping tests simultaneously on multiple proposed new sources, then MassDEP may allow for the collection of composite samples for a maximum of five (5) wells per sample provided that the detection limit of the method used for analysis is less than one-fifth the MCL and the compositing is done in the laboratory. New source testing and future compliance testing for SOCs is not normally required for transient-non-community (TNC) systems.

(f) Microscopic Particulate Analysis (MPA) - Testing may be required if the source fails to meet the Surface Water Treatment Rule exemption criteria set forth in Section 4.18. Testing must be conducted in accordance with EPA's Consensus Method for Groundwater Under the Direct Influence of Surface Water.

(g) Required analysis for contaminants not described herein shall be at the discretion of MassDEP and shall be based on site history, well type, regional water quality, and geology/hydrogeology. MassDEP may require testing of observation wells to evaluate whether certain nearby land uses are potential sources of contamination to the well(s).

k. Zoning/Non-Zoning Controls (only applies to wells with planned yields of 100,000 gpd or greater)

A draft of the proposed zoning and non-zoning controls must be submitted to MassDEP for review. The draft shall be consistent with requirements set forth in 310 CMR 22.21(2) of the Drinking Water Regulations and apply to the preliminary Zone II for the potential source. Water suppliers subject to "best efforts" criteria (see Section 4.8), shall submit a schedule for meeting these requirements.

l. Additional Source Approval Requirements Resulting From Site Screening Analyses (only applies to wells with planned yields of 100,000 gpd or greater)

The New Source Approval process requires a Site Screening evaluation be completed and submitted with the Request for Site Exam/Pumping Test Proposal. Based upon the results of the Site Screening evaluation, additional analysis may be required to help determine potential impacts to streamflow from future withdrawals. See MassDEP document titled Site Screening for Siting a New or Expanding Source of Public Water Supply (Appendix F) for the Site Screening evaluation requirements. The additional requirements described below will provide for a more detailed evaluation of the pumping test. Further monitoring and evaluation may be required on a case-by-case basis.

(1) For proposed withdrawals that exceed the calculated natural probable minimum streamflow in cubic feet per square mile (cfsm) of watershed over a 7-day period that will occur on average once in 10 years (7Q10) but do not exceed 50% of the calculated natural August median streamflow (in cfsm), the following additional steps must be added to the Source Approval process:

(a) The pumping test discharge shall be located a minimum 350 feet downgradient or downstream of the well or adjacent point on the stream. This will prevent or limit the effects the discharge may have on the flow of the stream adjacent to the well (Kruseman4).

(b) A series of nested staff gauges and piezometers/observation wells shall be placed, at a minimum, along the near-bank side of the stream (at the stream's closest point to the pumping well), just upgradient of the well's discharge point, and a distance upgradient of the well where impacts to the stream are projected to be insignificant. Each nested set shall consist of a secure staff gauge and a piezometer/observation well screened within the aquifer. The observation well in the cluster shall be located within 20 feet of the staff gauge. The near-bank nest will probably yield the largest water level fluctuations and provide data that strongly represents the surface water/groundwater interaction. The downgradient nest will provide coverage of the surface water/groundwater impact area and the upgradient nest will be used to represent conditions not impacted by pumping. Placement of these nests may be adjusted due to the presence of confining or semi-confining layers.

(c) Five days of daily measurements shall be taken prior to the pumping test at the nested sites detailed above. This will provide background data on non-pumping conditions at the nests and allow a comparative analysis with the data generated during the pumping test. At a minimum, daily flow measurements shall also be taken during the test, and five days after the test is shut down.

(d) Additional data collection may be required. Examples include the use of Shelby tubes and/or seepage meters in order to better determine the streambed hydraulic conductivity.

(e) Staff gauge readings must be calibrated to flow measurements prior to the test. Flow measurements must be recorded at a minimum of three locations across the stream (near-bank, middle, and opposite-bank) and averaged in order to get a reasonably accurate estimate of the flow. This shall be done at each nested location with flows measured daily starting five days prior to the pumping test and ending five days after shutdown. The calibrated staff gauge readings taken during the pumping test can then be transformed into flow measurements for data analysis. If possible, a calibrated weir

[4] Kruseman, G.P., and Ridder, N.A., 1970, *Analysis and Evaluation of Pumping Test Data, Bulletin 11*, International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands, 200p.

may be used upstream and downstream of the segment of the stream most likely to be impacted by the water withdrawal during the test.

(f) A 3-dimensional numerical model may be required to evaluate the impacts of the pumping test on streamflow, along with potential future impacts to the stream as a result of the permanent water withdrawal. It will then be used to delineate the Zone II. The numerical model will allow the proponent to calibrate the stream/groundwater interaction to the data collected from the nested locations and other observation wells used during the pumping test. Once calibrated, the model projected streamflow impacts will yield more realistic stressed streamflow conditions than those produced through the Site Screening process. Model calibrations of actual groundwater levels and surface water stage elevations will provide a level of detail in which model runs can more accurately characterize long term pumping conditions. The resultant surface water stage model outputs can be converted to flow so that streamflow depletion due to pumping can be determined.

(g) Cumulative impacts on the stream from the proposed well and existing wells, discharges, dams, etc., must be evaluated and compared to low flow periods, and discussed in the Source Final Report.

(h) Comparison between present and future pumping conditions on the annual hydrograph shall be discussed in the Source Final Report, particularly pumping conditions during low flow summer periods.

(i) The Source Final Report shall clearly characterize stream depletion with discussion of induced infiltration and intercepted baseflow. One-to-one communication between the proposed well and the stream will be assumed unless otherwise demonstrated.

A proponent may apply a site-specific stream depletion methodology (Jenkins5, Barlow6, etc.), in an attempt to estimate whether impacts to the stream flow are expected to occur during the pumping test. If no impacts are anticipated during the pumping test, MassDEP may allow a reduction in the number of required staff gauges and observation wells. However, in the event that stream flow impacts are not anticipated to occur during the pumping test, the use of Shelby tubes and/or seepage meters may be required to determine the hydraulic conductivity value of the stream-bed in order to assess long term pumping impacts on stream flow.

(2) For proposed withdrawals that exceed 50% of the natural August median in cfsm, as calculated through the Site Screening Process, these additional requirements will apply:

(a) A minimum 15-day pumping test is required. The need for a lengthened test is due to the potential for extreme streamflow impacts (as determined through the Site Screening Process) that may result due to pumping a well. Better data can be generated from the 15-day test than from a 5 or 10-day test. Streamflow depletion may not be recognized over the course of a pumping test of shorter duration.

(b) The pumping test must be run during the low flow time of the year (June 1 – September 30).

[5] Jenkins, op. cit.
[6] Barlow, op. cit.

4.3.1.3 MassDEP Site Exam/Pumping Test Proposal Review

1. Site Exam/Pumping Test Proposal submittal deemed by MassDEP to be satisfactory shall result in written approval from MassDEP to proceed with the pumping test. The site exam and MassDEP review of the pumping test proposal will include, but not be limited to, the following:

   a. A land use/sanitary survey of the entire preliminary Zone II or IWPA shall be conducted by MassDEP regional staff, the water supplier, and the consultant.

   b. MassDEP shall review the pumping test proposal, considering all factors discussed in Section 4.3.1.2.

   c. For sources seeking approval for less than 100,000 gpd, MassDEP shall use Title 5 design flow criteria in assessing minimum pumping test source approval rates, absent other appropriate design flow criteria, such as the limit imposed by the size of the Zone I.

   d. Pumping test startup dates shall be selected based on discussion with MassDEP staff.

   e. The laboratory selected to analyze all water samples, a water quality sampling schedule, and water quality parameters to be tested for, shall be discussed in the proposal and shall follow the criteria outlined in Section 4.3.1.2.3.j. The laboratory shall be instructed that the samples must be analyzed using drinking water analytical methods, detection limits, and holding times.

   f. MassDEP reserves the right to change the number of observation wells, and their proposed location, or other factors influencing the successful completion of Sections 4.3.1.2 and 4.3.1.4 of these guidelines.

   g. MassDEP reviews and comments on the proposed zoning/non-zoning controls. If there are any deficiencies they are noted to the water supplier. MassDEP then continues to work with the town/supplier to facilitate passage of required controls.

   h. The site generally will not be approved for further testing unless the following conditions can be satisfied:

      (1) The site cannot be subject to a significant risk from floods or other disasters unless the finished wells can be properly protected.

      (2) The site can be made readily accessible during all seasons of the year.

      (3) The site is not Groundwater Under the Direct Influence of Surface Water unless the proponent is prepared to meet the requirements of the Surface Water Treatment Rule (see Section 4.18).

      (4) The site can meet Zone I requirements (see Section 4.5.1 and 310 CMR 22.21).

      (5) MassDEP may deny a site located within 1/2 mile of potentially serious sources of pollution such as active or abandoned sanitary landfills, major fuel storage and/or transmission facilities, automobile graveyards and junkyards, road salt stockpile areas lacking adequate containment structures, hazardous substances storage areas, etc. Approved sites are subject to such additional monitoring requirements as may be considered necessary by MassDEP. Coordination with other MassDEP programs/bureaus such as Bureau of Waste Site Cleanup and Bureau of Waste Prevention may be required to determine the impact of the pumping test on other regulated sites/areas.

4.3.1.4 Pumping Test Performance

1. Records

   Accurate records of the pumping rate, rainfall, (and barometric pressure for confined and bedrock aquifer wells) and drawdown of all observation wells, must be maintained during the pumping test and recovery period. Accurate records of the drawdown in larger diameter pumping wells must also be maintained during the pumping test and recovery period. All drawdown and recovery readings shall be recorded to the nearest 1/4-inch (0.02 feet).

2. Static Water Level Determination

   Following the step-drawdown test, the test well and all other pumping wells in the vicinity shall be shut down until the previously recorded static water level is reached or for as long as possible. For bedrock wells, 95% recovery of the drawdown is acceptable. Water levels in all observation wells shall then be measured and recorded.

3. Pumping Rate

   For all finished overburden production wells and wellfields, all overburden test wells built to final production well specifications, and all *overburden wells with planned yields of less than 100,000 gpd*, the prolonged pumping test must be conducted at the pumping rate for which approval is sought. All pumping tests for bedrock wells must be conducted at 133⅓ % of the pumping rate for which approval is sought. Pumping tests for overburden test wells, where the planned yield of the final production well is 100,000 gpd or greater, may be conducted at half the pumping rate for which approval is sought.

   The pumping rate shall be measured and recorded every two hours for all well types.

4. Drawdown Measurements

   MassDEP recommends the use of stilling tubes for collecting water level measurements from pumping wells. Stilling tubes minimize the risk that measurement equipment may become stuck or damaged.

   a. *TNC Wells with Planned Yields Less than 10,000 gpd*

      Water level readings shall be taken in the pumping well every minute for the first 10 minutes, every 10 minutes for the first hour and once per hour until shutdown.

   b. *Wells with Planned Yields Less than 100,000 gpd*

      Following are the minimum drawdown measurement requirements:

      (1) For unconfined and confined aquifer wells, readings shall be taken every minute for the first 10 minutes, every 10 minutes for the first hour and once per hour until shutdown. Wells shall be constructed in a fashion allowing for the measurement of water levels in the well casing or borehole. If the pumping test continues beyond 48 hours, water level measurements must be collected at least twice daily (frequency of measurements at least 8 hours apart) for the remainder of the pumping test.

(2) For bedrock aquifer wells, readings shall be measured every 5 minutes for the first 2 hours and once per hour thereafter. If the pumping test continues beyond 48 hours, water level measurements must be collected once every 6 hours for the remainder of the pumping test.

c. *Wells with Planned Yields of 100,000 gpd and Greater*

(1) For unconfined and confined aquifer wells, drawdown shall be measured in all appropriate observation wells with the initial measurement recorded at t = 0.5-minute after the commencement of the pumping test. Water levels will then be measured at consistent intervals to include 10 data points for every log cycle beginning with 1 minute, 10 minutes, and 100 minutes, respectively, and at least twice daily thereafter (frequency of measurements at least 8 hours apart) until the termination of the pumping test. Continuous electronic recording devices or other mechanical or acoustical methods of measurement may be necessary at critical observation wells expected to experience significant early time drawdowns.

(2) For bedrock aquifer wells, readings shall be measured every 5 minutes for the first 2 hours and once every 6 hours thereafter.

d. Wellfield Pumping Test

A minimum of three pumping wells shall be designated as drawdown measurement points, in addition to appropriate observation wells. Drawdown in the designated pumping wells shall be measured by means of a small diameter drop pipe installed through the top cap of the pumping well or the drawdown shall be measured in an observation well located within two feet of the pumping well. The designated wells shall be representative of the average well depth and geologic conditions at the well locations and shall be representative of conditions throughout the wellfield. One well shall be located at or near the center of the wellfield, and one each at or near the opposite extremities. Frequencies of measurements are the same as for overburden wells.

5. Pumping Test Duration and Stabilization

The duration of pumping tests for all wells will be lengthened if the drawdown has not met the following stabilization criteria or if water quality is questionable or changing. For *wells with planned yields 100,000 gpd and greater*, MassDEP recommends that the proponent submit stabilization data to MassDEP for review prior to shutdown to determine whether MassDEP concurs that stabilization has been met. During the pumping test, no more than 3 hours total shutdown shall be permitted every 5 days; however, no shutdowns shall be permitted during the final 72-hours of the pumping test. For overburden wells, the pumping rate must not vary during the final 24 hours. See 4.3.1.4 5. e. and f. below for permissible pumping rate variations for bedrock wells.

a. *TNC Wells with Planned Yields Less than 10,000 gpd*

The pumping test shall be conducted for a minimum of 24 hours. The well will be considered stable when water level fluctuation is less than two inches over the final four hours of the pumping test or using a semi-logarithmic plot extrapolation of the time-drawdown curve derived from the pumping test and projected over a 180-day period, 10% of the water column between the top of the pump and the static water level remain (minimally 15 feet for bedrock wells and 5 feet for overburden wells).

b. *Overburden Wells with Planned Yields Less than 100,000 gpd*

(1) Forty-eight (48) Hour Pumping Test - The well will be considered stabilized when water level fluctuation is less than 0.04-foot in any 12-hour period. This criterion applies to the test/production well(s) or in special cases to an outlying observation well(s), **or**

(2) The production well shall be considered stabilized if, using a semi-log plot extrapolation of the time-drawdown curve (time on the logarithmic scale) derived from the pumping test (minimum 48 hours) and projected over a 180-day period, 10% of the water column between the top of the pump and the static water level remains above the pump, if a submersible pump, or the top of the screen if a vertical turbine pump (minimally 5 feet). The pumping test will be extended until stabilization criteria are achieved.

c. *Overburden Wells with Planned Yields 100,000 gpd and Greater*

(1) The prolonged pumping test shall be conducted a minimum of 5 consecutive days. The well(s) will be considered stabilized when the drawdown reading recorded at the pumping well(s) or 2-foot observation well has not varied more than 0.04-foot during the final 24 hours; **or**

(2) Ten (10) Day Pumping Test - The test/production well shall be considered stabilized if, using a semi-log plot extrapolation of the time-drawdown curve (time on a logarithmic scale) derived from the final days of the test and projected over a 180-day period, 10% of the water column remains above the intake of the pump if a submersible pump, or the top of the screen if a vertical turbine pump (minimally 5 feet). The pumping test will be extended until stabilization criteria are achieved; **or**

(3) A minimum of a 15-day pumping test shall be conducted when required by the site screening process (See Section 4.3.1.2.3.l.(2)(a)). Stabilization shall be determined by either the 0.04-foot change over the final 24-hour period method or the 180-day extrapolation method described above.

d. Wellfields

(1) The prolonged pumping test shall be conducted a minimum of 48 hours for wellfields with planned yields less than 100,000 gpd, and a minimum of 5 days for wellfields with planned yields of 100,000 gpd or greater. The wellfield will be considered stabilized when the drawdown readings do not vary more than 0.08-foot during the final 24 hours of the pumping test in an observation well located in the middle of the wellfield. No shutdowns are permitted during the final 24 hours of the test; **or**

(2) A minimum of a 15-day pumping test shall be conducted for wellfields with planned yields of 100,000 gpd or greater when required by the site screening process (See Section 4.3.1.2.3.l.(2)(a)). Stabilization shall be determined by the 0.08-foot change over the final 24 hours described above.

e. *Bedrock Wells with Planned Yields Less than 100,000 gpd*

(1) The production well shall be considered stabilized if, using a semi-log plot extrapolation of the time-drawdown curve derived from the pumping test (minimum 48 hours) and projected over a 180-day period, 10% of the water column between the top of the pump and the static water level remains above the pump (minimally 15 feet). In addition, a minimum of 35 feet of borehole must be maintained below the top of the pump; **and**

(2) The pumping rate shall not fluctuate more than 25% during the initial 12 hours of the test. The pumping rate shall also not fluctuate more than 10% during the final 36 hours of the pumping test.

(3) No pump shutdowns will be allowed for the duration of the test. If shutdowns occur, MassDEP will require the pumping test be rerun.

f. *Bedrock Wells with Planned Yields 100,000 gpd and Greater*

(1) The production well will be considered stabilized if, using a semi-log plot extrapolation of the time-drawdown curve derived from the final days of the pumping test (minimum 10 days (15 days when the site screening process dictates (See Section 4.3.1.2.3.l. (2)(a)) and projected over a 180-day period, 10% of the water column remains above the pump intake (minimally 15 feet). In addition, a minimum of 35 feet of borehole must be maintained below the top of the pump; **and**

(2) The production well pumping rate shall not fluctuate more than 10% during the final 3 days of the pumping test. If the pumping rate is intentionally reduced to meet the stabilization criteria, pumping must continue for an additional 3 days.

6. Precipitation Events (for bedrock aquifer wells only)

a. *Wells with Planned Yields Less than 100,000 gpd*
Precipitation events during the pumping test that result in water level fluctuations in the production well may require terminating the pumping test, allowing water levels to stabilize, and conducting another 48 hour pumping test without recharge from precipitation.

b. *Wells with Planned Yields 100,000 gpd and Greater*
Precipitation events that result in water level fluctuations in the production well may require terminating the pumping test or extending the pumping test until drawdown meets the stabilization criteria.

7. Recovery

All Wells - Recovery readings shall be taken in appropriate pumping wells and observation wells at the same frequency as drawdown readings. In addition the following requirements shall be met:

a. *TNC Wells with Planned Yields Less than 10,000 gpd*
Readings shall be taken for 8 hours; **or**

b. Unconfined Aquifer Wells
Readings shall be taken for as many days as the pumping well was pumped, or until the water level in the well recovers 95% of drawdown at stabilization, whichever occurs first; **or**

c. Confined Aquifer Wells
Readings shall be taken for as many days as the pumping well was pumped, or until the change in any 24-hour period is less than 2% of maximum drawdown in the pumping well, whichever occurs first; **or**

d. Bedrock Wells
Water level in the production well shall be measured, following shutdown of the pumping test, once every 5 minutes for the first 2 hours, every 10 minutes for the next 100 minutes, and twice

per day thereafter for at least as long as the pumping test was conducted. For *bedrock wells with planned yields of 100,000 gpd and greater*, the recovery measurements may be terminated when the water level in the well recovers 95% of drawdown at stabilization. All bedrock wells that do not recover at least 75% of the total drawdown within the same number of days for which the prolonged pumping test was conducted shall require reassessment.

4.3.1.5 Pumping Test Analyses and Calculated Approval Yield

1. When applicable, corrections shall be made to the drawdown data to account for ambient water level trends, recharge events, barometric pressure effects, and partial penetration effects.

2. Determine aquifer transmissivity and storativity for Zone II delineation. Time-drawdown, distance-drawdown, and time-recovery methods shall be used, and the results compared and discussed in the Source Final Report.

3. Calculated Approvable Yield

   a. All Wells
   The approved daily volume is the approved pumping rate (gpm) times 1,440 minutes/day and is the maximum allowable volume in any 24-hour period. All MassDEP Source Approvals shall be issued as an approved daily volume in gallons per day (gpd).

   b. Overburden Wells with Planned Yields less than 100,000 gpd
   The approved pumping rate for a new source shall be approved based upon the rate at which the pumping test was conducted. The approvable yield will be calculated in the same manner as discussed below in 4.3.1.5.3.c., except that the specific capacity (SC) must be calculated based upon the drawdown in the test well or final well and under no circumstances will be based upon the drawdown in an observation well located in close proximity to a test well. MassDEP-approved pumping rate shall not exceed the rate at which the pumping test was conducted, regardless of whether it is conducted on the final production well or a test well.

   c. Overburden Wells with Planned Yields 100,000 gpd and Greater
   The approved pumping rate for a new source shall be approved based upon the rate at which the pumping test was conducted. If the pumping test is conducted on a test well, MassDEP-approved pumping rate may potentially be as much as twice (2x) the rate at which the pumping test was conducted, provided that the proposed well's calculated approvable yield as determined by the pumping test is not exceeded. If the pumping test is conducted on the final production well, the calculated approvable yield will be the rate at which the pumping test was conducted, provided that a 5-foot safety margin exists when the applicable stabilization criteria is met.

      (1) Calculate Available Water (AW):

      AW = depth of pumping well - length of screen - static water level - 5 foot safety factor

      (2) Calculate Specific Capacity (SC) of the pumping well:

      $$SC\ (gpm/ft) = \frac{\text{pumping rate}}{\text{drawdown at stabilization}}$$

      (*Note*: Drawdown is measured in the production well or, in the case where the pumping test is conducted on a test well, drawdown is measured in the observation well that is located 2 feet from the test well.)

(3) Calculated Approvable Yield (AY):

AY (gpm) = AW x SC x 0.75 (safety factor)

Note: the 0.75 multiplier is only applied if the pumping test was conducted on a test well rather than the final production well.

d. Wellfields

(1) Calculate Available Water (AW) in the monitored wells:

If top of screen is greater than or equal to 28 feet below ground surface, then

AW = 26 feet - ambient water level

If top of screen is less than 28 feet below ground surface, then

AW = average depth of test wells - screen length - ambient water level
- 2 foot safety factor

(2) Calculated Approvable Yield (AY):

AY = Average Specific Capacity x Available Water x 0.75 (safety factor) x number of pumped wells

Note: the 0.75 multiplier is only applied if the pumping test was conducted on less than 100% of the proposed final wells in the wellfield .

e. Bedrock Wells

The approvable well yield shall be the rate in gallons per day (gpd) at which the stabilization criteria were met times (x) 0.75 safety factor. For example, if the well meets the stabilization criteria when pumping at 100 gpm, the approvable well yield (100 gpm x 0.75 safety factor x 1440 min/day) is 108,000 gpd.

4. Protective Radius and Combined Approved Yield

The protective radius (Zone I) of all wells shall be determined based on the equation as defined in 310 CMR 22.02. Also see the graph "Zone I Radius vs. Pumping Rate" (Appendix D). For wells going through the Source Approval process, if two or more wells are located within 50 feet of one another, then the Zone I radii will be based upon the combined approved yield of those wells. The Zone I radius will be applied to each of these wells. If the Zone I is based upon a combined pumping rate then the water supplier may pump the sources at any combination of withdrawal rates, as long as the combination does not exceed the approved daily yield.

If one or more of the sources going through the Source Approval process are located at a distance greater than 50 feet from any of the other sources, then MassDEP will determine which wells, if any, are to be assigned combined yields. Under this scenario certain wells may be assigned the same Zone I radius based upon a combined pumping rate, and others will be assigned a Zone I radius based upon the approval rate for each individual well.

In the case of bedrock wells that are located within 50 feet of each other, individual approval rates and Zone I areas may be assigned if the proponent can demonstrate that no hydrogeologic connection exists between the wells.

4.3.1.6 Source Final Report

See Section 4.6 for a discussion of the information that must be submitted with the Source Final Report.

4.3.2 Source Approval Process for Springs as Public Water Supplies

This section provides guidance in determining the yield of springs and evaluating water quality as well as establishing protective areas (Zone I and Zone II) around springs used as public water supplies.

A spring is a natural discharge point where groundwater issues from soil or rocks in concentrated flow. Public water supply springs are perennial or intermittent springs of nonthermal origin. A source is not considered a spring if mechanical methods are used to enhance the flow of water and/or the collection system hydraulically affects the water table.

Due to the shallow nature of the groundwater that contributes to a spring source, MassDEP shall not approve spring locations that are in areas susceptible to flooding.

1. Spring Types:

   a. Type I Spring:
   The intake from the spring is above ground surface in a springhouse or other form of enclosure where water is collected from storage (water in the structure above ground surface), while at the same time, prohibiting alteration of the water table through pumping or siphoning.

   b. Type II Spring:
   Piped water naturally flows from the spring to a collection system from which it is then pumped to the distribution system.

   c. Type III Spring:
   The intake from the spring is below ground surface. However, a drawdown-limiting device prohibits water levels in the enclosure from dropping below land surface.

   d. Type IV Spring:
   The intake to the spring structure is below land surface, water is gravity fed to the system, and water continues to, at least intermittently, discharge at the land surface.

   e. Type V Spring:
   Naturally emerging springs have been altered by construction of an enclosed sanitary collection structure. Backfill is then placed to surround the structure so that the new land surface is higher than the original land surface. In these instances, the water table is now below the present man-made land surface. The source can still be labeled a spring as long as water discharges from the structure via gravity feed, while at the same time, prohibiting any lowering of the natural water table.

2. Non-Spring Designations:

   A source is not considered a spring when:

   a. A pump or siphon alters the natural groundwater flow while in the process of water collection;

   b. Gravity feed from the collection system to the distribution system permanently lowers the natural groundwater table.

4.3.2.1 Request for Site Exam and Flow Test Proposal

A report shall be submitted requesting a site exam and presenting a proposal for the conductance of the flow test. Specifically, the report shall include:

1. A description of the spring (e.g. depression, contact, joint, etc.) and the geologic/hydrologic features that presumably control the spring flow such as type of surficial materials, location of bedrock outcrops, and orientation of bedrock fractures;

2. A description of the regional geology;

3. A flow test proposal to include:

   a. Proposed method of measuring flow over the maximum and minimum flow 10-day measuring periods;

   b. Proposed dates of maximum and minimum flow measurements;

   c. Supporting data or reasoning used to determine maximum and minimum flow dates; and

   d. If available, historical maximum and minimum flows shall be reported.

4. A preliminary discussion of the proposed water collection system;

5. A site plan at 1:6000 scale or larger, including significant topographic features, land ownership, and land uses in the estimated Zone I;

6. A location map at 1:25000 scale with land uses within the estimated Zone II;

7. A listing of land uses within the estimated Zone I and the estimated Zone II and a discussion of the associated potential impacts on water quality and quantity;

8. Discussion of potential impacts to sensitive receptors such as streamflow, wetlands, etc.

4.3.2.2 Flow Test Performance

1. Determination of Maximum and Minimum Flows

   a. The flow of a spring shall be determined during potential maximum (March – May) and minimum (June – August) flow conditions. During the maximum flow measuring periods, flow shall be determined by measuring the discharge for a 10-day period. The same procedure shall be used to determine the discharge during minimum flow periods.

b. Flow measurements shall be recorded at least twice per day allowing a minimum 8 hours between flow measurements. A flow measuring device capable of providing instantaneous flow measurement accurate to within ±3% of the pumping rate shall be used.

c. Precipitation and/or recharge events shall be recorded during flow tests.

d. Daily fluctuations of flow shall be estimated.

e. All flow measurements shall be taken at or near the natural point of discharge, prior to inflow of additional sources, and not within the water bearing formation.

f. Under no circumstances shall mechanical methods be used to induce flow from the spring.

2. Water Quality Testing

Fluctuation of groundwater levels may allow certain contaminants to reach the water table during high groundwater periods. Therefore, water quality testing shall be conducted during each 10-day flow measurement test. The schedule for water sampling must be approved by MassDEP.

The consultant supervising the prolonged flow measurement test shall be responsible for coordination of the sample analyses with a Massachusetts or EPA certified laboratory. Under certain circumstances, split samples or duplicates may be required by MassDEP. The following samples must be collected using appropriate sampling equipment and protocols, and must be delivered to the Massachusetts or EPA certified laboratory. Please note that the laboratory must be certified by both analyte and methodology, and achieve all required method detection limits (MDLs) and holding times set by the Commonwealth of Massachusetts.

a. Samples for total coliform bacteria shall be collected once every day during the test. If the result of any analysis is positive for total coliform, then the sample must be analyzed for enterococci (and/or coliphage at MassDEP's discretion). Contact MassDEP regional office immediately if the results of the enterococci (and/or coliphage) test(s) are positive.

b. Samples for radionuclides shall be collected at the end of each test (refer to Appendix A).

c. Samples for inorganic chemicals, including nitrate and nitrite, and all regulated and unregulated volatile organic compounds (see Appendix A) shall be sampled on the final day of each test.

d. Samples for secondary contaminants shall be collected on the final day of each test.

e. One sample for synthetic organic chemicals (SOC) analysis (refer to Appendix A for details) shall be collected on the final day of the pumping test prior to shutdown. If a proponent is conducting pumping tests simultaneously on multiple proposed new sources, then MassDEP may allow for the collection of composite samples for a maximum of five (5) wells per sample provided that the detection limit of the method used for analysis is less than one-fifth the MCL and the compositing is done in the laboratory. New source testing and future compliance testing for SOCs is not normally required for transient non-community systems.

f. Microscopic Particulate Analysis (MPA) - Testing will be required during both flow periods. Testing must be conducted in accordance with the EPA's Consensus Method for Groundwater Under the Direct Influence of Surface Water.

g. Required analysis for contaminants not described herein shall be at the discretion of MassDEP and shall be based on site history, regional water quality, and geology/hydrogeology.

If bacteria are present, a proposal addressing the type of treatment technique to be used shall be submitted to MassDEP.

4.3.2.3 Flow Test Analysis

1. Variability Determination

Variability is defined by Meinzer[7] as "the ratio of discharge fluctuation to its average discharge within a given period of record."

$$\text{Thus:} \quad V = 100 \frac{(a - b)}{c}$$

Where: V = variability in percent
a = maximum flow
b = minimum flow
c = average flow

The variability shall be calculated separately for both 10-day periods of measurement. A total variability calculation must then be done on the whole data set (information obtained from both testing periods). All three variability results will be used to help determine the approved withdrawal.

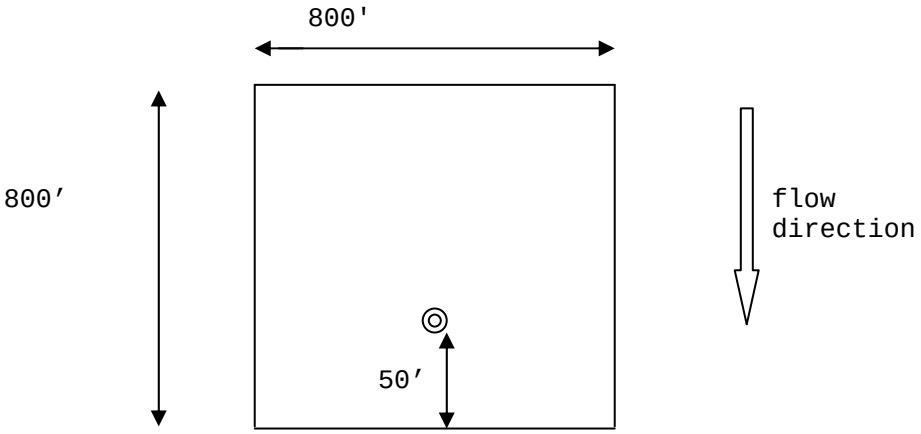
2. Protective Area (Zone I) and Approved Withdrawal Volume

a. Zone I

The protective area for a spring is a square with sides equal to twice (2x) the radius required by the graph, "Zone I Radius vs. Pumping Rate" (Appendix D), (*i.e.*, if the flow rate is 100,000 gpd, the protective radius from the graph in Appendix D is 400 feet, therefore the protective area for this spring would be a square 800 feet on a side). The protective area shall be arranged such that the spring's outlet is 50 feet upgradient and centered in relation to the downgradient side of the square.

The maximum flow (highest recorded flow measured) shall be used to determine the size of the Zone I from the graph. However, based on variability of the spring, the approved withdrawal may be less than the maximum yield established.

[7] Meinzer, O.E., 1923. *Outline of Groundwater Hydrology*, USGS Water Supply Paper #494, pp. 50-55.



The requirement to own or control land within the Zone I is the same as for all groundwater sources (Section 4.5.1).

2. Zone II

   For springs, the Zone II is that area of an aquifer, which contributes water to the spring under naturally flowing conditions. Zone IIs are required for all spring sources regardless of planned yield. Useful data to be considered in determining Zone II area includes, but is not limited to, the following: topographic setting, geologic controls such as bedrock fractures and confining strata, groundwater and surface water elevations, and flow and variability of the spring. For springs yielding 100,000 gpd or greater, MassDEP may require the institution of wellhead protection controls or "best efforts" for all or part of the Zone II.

4.3.2.4 Source Final Report

The Source Final Report shall include:

1. A description of the spring and the regional geology;
2. A description and discussion of flow including:
   a. Maximum, minimum, and average yields;
   b. Variability of spring yield;
   c. Daily fluctuations of spring yield;
   d. Precipitation and/or recharge events during yield tests; and
   e. Demand requirements, water use, and storage required.
3. A discussion of water quality and proper treatment techniques if necessary;
4. A discussion of potential impacts to sensitive receptors;
5. Listing and discussion of land uses within the Zone I and Zone II that could potentially impact the quality or quantity of the spring water;

6. A surveyed Zone I map at a 1:6000 scale or larger, including significant topographic features, land ownership, and land uses;

7. A location map at 1:25000 scale with land uses within Zone II;

8. Zone II delineation with Title Block on 11" x 17" paper;

9. Preliminary discussion of construction of the proposed water collection system;

10. Discussion of approved daily volume being sought by project proponent.

4.3.2.5 Construction

All new springhouses shall be constructed utilizing steel or concrete materials that provide a sanitary discharge point and isolate the spring from contamination that could be introduced at the land surface. See Section 4.20.11 for spring construction standards.

4.4 Delineation of Area of Influence

For the purpose of assessing the potential impacts on sensitive receptors from a new pumping source, it is necessary to determine the Area of Influence for *new wells with planned yields of 100,000 gpd or greater*. MassDEP will determine, on a case-by-case basis, whether an Area of Influence delineation will be required for *new bedrock wells with planned yields of 100,000 gpd or greater*. The Area of Influence is the area that would experience a drawdown of 0.1-foot under steady-state pumping conditions at the approved pumping rate.

Unlike the Zone II wellhead protection area, which is delineated for the purpose of providing protection for the new source, an Area of Influence is delineated to provide information regarding the areas that may potentially be impacted by the new source under normal operating conditions. In most instances the Area of Influence will be smaller than the Zone II area. However, in some instances the Area of Influence may include areas that are outside of the Zone II area, that is, some areas may not be within the area that contributes water to the source under Zone II pumping conditions, but may still be influenced by the source (i.e. downgradient from the Zone II stagnation point).

The following requirements apply to a typical Area of Influence delineation:

1. Delineation of the Area of Influence

    a. The minimum information necessary for delineating the Area of Influence includes:

        (1) Water table contour map representing conditions typical of the predeveloped long-term average water table for an unconfined aquifer and potentiometric surface for a confined or bedrock aquifer;

        (2) Hydraulic conductivity, saturated thickness, transmissivity and storage coefficient of the aquifer obtained from the pumping test and boring logs; and,

        (3) Nature and characteristics of the aquifer's hydrogeologic boundaries.

b. Recommended procedure for delineating Area of Influence:

(1) Construct a water table contour (or potentiometric surface) map representative of pre-developed, long-term average conditions in the aquifer. The map area shall include, at a minimum, the preliminary estimate of the Area of Influence.

(2) Using an appropriate analytical or numerical model, predict the drawdowns by imposing steady-state pumping at the potentially approvable yield, with average recharge from precipitation. All modeling efforts must follow procedures set forth in Section 4.5.2.

(3) Determine the Area of Influence by delineating the area within which drawdown is equal to or exceeds 0.1-foot.

(4) The area delineated in this manner is the Area of Influence for the pumping well.

2. Area of Influence Reporting Requirements

The following minimum information relative to delineating the Area of Influence shall be included in the Source Final Report:

a. On 11"x 17" paper, outline the Area of Influence on a USGS topographic map of scale 1:25000.

b. Discussion of the methodology used to delineate the Area of Influence

c. MassDEP shall determine whether an Area of Influence shall be delineated for bedrock wells on a case-by-case basis. If required, the following items shall be considered when delineating an Area of Influence for a bedrock well:

(1) Interpretation of bedrock geologic maps, aerial aeromagnetic maps and infrared photography

(2) Geotechnical boring and road boring logs

(3) Geophysical data generated during the compilation of geologic and/or hydrogeologic reports

(4) Rose diagram plot of magnitude, density, and orientation of regional rock fractures

3. Model Documentation

It is the policy of MassDEP to require complete documentation of the application of a mathematical model to the solution of a hydrogeological problem. Complete documentation includes the requirements for Zone II delineations described in Section 4.5.2.

4.5 Delineation and Protection of Wellhead Protection Zones

1. Zone I must be determined for **all** public water supply wells and springs.

2. IWPA must be determined for **all** public water supply wells where a Zone II has not been approved.

3. Zones II and III will, in most cases, not be required for MassDEP approval of public water supply *wells with planned yields less than 100,000 gpd*. This decision shall be left to the discretion of the appropriate MassDEP. However, Zone II and Zone III will be required for all springs regardless of yield.

4. Zone II and Zone III shall be delineated for all public water supply *wells with planned yields 100,000 gpd and greater* **unless** the water supplier can demonstrate at the time of submittal of the Source Final Report that a groundwater monitoring well program and an aquifer protection bylaw or ordinance **have been implemented** that provide suitable water quality protection for the entire Zone III or watershed area. If the Zone III is adequately protected, then the water supplier shall only be required to complete the Zone III delineation. The issues that must be addressed by the groundwater monitoring well program and an aquifer protection bylaw are discussed in Section 4.6.2 and 4.8, respectively.

4.5.1 Zone I Delineation and Protection

For detailed guidance on complying with Zone I ownership, control, and protection requirements of 310 CMR 22.21, see Policy 94-03, *Implementation of Zone I Requirements* in *Guidelines and Policies for Public Water Systems, Volume II: Policies*. For information on Zone I land acquisition procedures, refer to Section 4.16.

MassDEP may require greater distances or permit lesser distances than the Zone I distances set forth at 310 CMR 22.02, if the Department deems such action necessary or sufficient to protect public health.

1. Zone I Radius for Vertical Wells, Wellfields, and Infiltration Galleries

   For most public water supply *wells with approved yields of 100,000 gpd or greater*, the protective radius is 400 feet and is measured from the wellhead.

   The only exceptions to the 400-foot Zone I radius for *wells with approved yields of 100,000 gpd or greater* are wellfields, infiltration galleries, and angle wells (discussed below in item 2.) Wellfields and infiltration galleries require a minimum 250-foot Zone I radius, regardless of the approved yield. The 250-foot Zone I radius for a wellfield is applied to each individual well in the wellfield. For an infiltration gallery, the 250-foot Zone I radius is applied to every point along the intake screen(s).

   Zone I protective radii for all other *wells with approved yields of less than 100,000 gpd* are determined by the following equation (see Appendix D for graphical depiction of Zone I calculations):

   Zone I radius in feet = (150 x $\log_{10}$ of pumping rate in gpd) – 350

   A minimum 100-foot Zone I radius shall be assigned for public water supply *wells with approved yields of 1,000 gpd or less*, unless otherwise determined by the Department.

   For wells going through the Source Approval process, if two or more wells are located within 50 feet of one another, then the Zone I radii will be based upon the combined approved yield of the wells and will be assigned to each well in the group. If one or more of the sources going through the Source Approval process are located at a distance greater than 50 feet from any of the other sources, then MassDEP will determine which wells, if any, are to be assigned combined yields. Wells that are not assigned a combined yield will be assigned a Zone I radius based upon the approved yield for each individual well.

2. Zone I Radius for Angle Wells

   For angle wells, the Zone I radius shall be centered on a point on the land surface located directly above the center of the screened interval. The Zone I radius for an angle well shall be 400 feet for a *well with an approved yield of 100,000 gpd or greater*, and shall be determined from the Zone I equation shown above in 4.5.1.1. for a *well with an approved yield of less than 100,000 gpd.*

   In addition, for all angle wells, a minimum 50-foot setback distance to the Zone I boundary is required around the wellhead and the land surface located directly above the well screen and well casing. This may result in Zone Is that are irregularly shaped.

3. Preferred Fuel Type

   Preferred fuels for standby power for pumps, related distribution equipment and treatment systems within the Zone I are:

   a. Natural gas, if available, is the preferred type of fuel.

   b. Propane gas is the second most preferred type of fuel. It shall be stored in an approved above-ground tank anchored to a concrete platform which is constructed to a depth just below local frost line.

   c. Liquid fossil fuels shall be stored on site only if natural gas or propane is not a viable option. Liquid fossil fuel tanks shall be double-walled and constructed above-ground inside the pump house and shall be surrounded by an impermeable containment wall, the capacity of which shall be 110% of the fuel storage tank. Leak detection devices shall be installed. If fossil fuel storage within Zone I is proposed, a written explanation why natural gas or propane is not an option shall be submitted to the appropriate MassDEP regional office.

4.5.2 Zone II Delineation and Protection

Only Zone II delineations approved by MassDEP will be used and recognized by MassDEP when implementing any MassDEP programs. The Interim Wellhead Protection Area (as per Appendix D) policy of April 4, 1988 shall be used by MassDEP for public water supply sources that do not have Zone IIs approved by MassDEP.

A copy of the approved Zone II map must be provided by the proponent to the local planning board at a scale specified by the board. If the approved Zone II extends into another community, the water supplier must send a copy of the approved Zone II map to the planning board and board of health in that community with a request for assistance in protection of that area. The proponent must demonstrate to MassDEP's satisfaction that a best effort has been made to have all cities and towns in which the Zone II is located establish appropriate Zone II zoning or non-zoning controls pursuant to 310 CMR 22.21.

The following requirements apply to a typical Zone II delineation. For those wells requiring a Conceptual Zone II, some of the following requirements may not apply.

1. Minimum information necessary for determining the Zone II area includes:

   a. Water table contour map representing conditions typical of the predeveloped long-term average water table for an unconfined aquifer and potentiometric surface for a confined or bedrock aquifer;

b. Hydraulic conductivity, saturated thickness, transmissivity and storage coefficient of the aquifer as obtained from the pumping test and boring logs;

c. Nature and characteristics of the aquifer's hydrogeologic boundaries.

2. Recommended procedure for determining Zone II:

a. Construct a water table contour (or potentiometric surface) map representative of predeveloped, long-term average conditions in the aquifer. The map area shall include, at a minimum, the preliminary estimate of the Zone II area.

b. Using an appropriate analytical or numerical model, predict the drawdowns by imposing Zone II criteria (180 days of pumping at the approved yield, with no recharge from precipitation). For calculating the 180-day drawdown of angle wells, use the midpoint of the screened interval as the withdrawal point, not the wellhead.

c. Determine the Zone II water table contours by subtracting the predicted drawdowns from the long-term average water table contours.

d. Construct a flow net based on the resulting Zone II water table contours.

e. Identify the groundwater divide induced by pumping, which separates the area contributing water to the well (Zone II) from the aquifer area outside the Zone II.

f. Extend the groundwater divide upgradient and upstream to its point of intersection with prevailing hydrogeologic boundaries. The area defined in this manner is the Zone II for the pumping well.

g. In certain cases where streams or lakes act as recharge boundaries, the extent of the Zone II shall terminate at the nearest edge of this recharge feature relative to the pumping well. The recharging stream or lake are part of the Zone III just as barrier boundaries (till and/or bedrock) are part of the Zone III.

h. If the downgradient and/or lateral Zone II extents are less than the protective distance required for Zone I, the Zone II shall be extended to include this area.

3. Zone II Reporting Requirements

The following minimum information relative to defining the Zone II and Zone III shall be included in the Source Final Report.

a. On 11"x 17" paper, outline Zone II and Zone III areas on a USGS topographic map of scale 1:25000, with the map title block (Appendix E). The map title block, signatures and dates must be completed prior to submission of the Source Final Report. An electronic file of the Zone II delineation shall also be submitted in ESRI compatible format (shapefile or personal geodatabase) in the Mass. State Plane (Mainland) coordinate system, using meters for horizontal units. The electronic files may be submitted to MassDEP via email or on CD media.

b. Provide a map of the Zone II area showing the surficial geology based upon USGS Geologic Quadrangle (GQ) series surficial geologic maps, topographic maps, USGS Hydrologic Investigations Atlas (HIA) series, field mapping, and provide a review of available subsurface data. In addition, for bedrock wells only, provide a description and discussion of the character of

the bedrock aquifer using USGS bedrock geologic maps, pertinent USGS open file reports, and existing well logs and borings from all available sources, including private wells.

c. A minimum of two geologic cross-sections through the pumping well, one in the direction of groundwater flow and the other perpendicular to it shall be provided.

d. Provide a discussion of the geologic conditions affecting the site, including hydrogeologic boundaries.

e. Provide a regional water table or potentiometric surface contour map showing groundwater flow directions under non-pumping conditions. The map shall be constructed based upon water levels obtained from production and observation wells, USGS observation well network, and hydraulically connected surface water features.

f. Provide a water table or potentiometric surface map showing groundwater flow directions that existed at the end of the constant-rate pumping test.

g. Provide an evaluation of data gathered during the prolonged pumping test.

h. Provide records of pumping rate and weather conditions.

i. Drawdown readings and recovery readings for all observation wells used shall be in table format.

j. Provide a discussion of hydraulic connections among overlying stratigraphic units (confined and bedrock aquifers wells only), including any overlying unconfined aquifer, the lateral extent of any confining layer and estimated leakage through any confining layer.

k. Provide a discussion of the hydrogeologic system and the likely sources of recharge to the production well.

l. Provide a discussion of other geologic/geophysical data.

m. Provide graphs showing time-drawdown plotted on a semi-logarithmic scale for all observation wells. At a minimum, distance-drawdown, residual-drawdown, and time-recovery plots shall also be submitted for those observations wells for which that data were used to calculate aquifer characteristics.

n. All calculations used to estimate aquifer characteristics shall be included.

o. Provided a discussion and comparison of aquifer characteristics based on the two or more methods used.

p. Provide a discussion of the methodology used to define Zone II including calibration and verification of the model, if applicable (Section 4.5.2.4.).

q. A complete land use/sanitary survey of the Zone II shall be included.

r. The following items shall be considered when delineating a Zone II for a bedrock well:

(1) Interpretation of bedrock geologic maps, aerial aeromagnetic maps and infrared photography;

(2) Geotechnical boring and road boring logs;

(3) Geophysical data generated during the compilation of geologic and/or hydrogeologic reports; and,

(4) Rose diagram plot of magnitude, density, and orientation of regional rock fractures.

4. Model Documentation

It is the policy of MassDEP to require complete documentation of the application of a mathematical model to the solution of a hydrogeological problem. Complete documentation includes the following, at a minimum:

a. Purpose
State the purpose, goals, and objectives of the model.

b. Conceptual Model
Develop and present a conceptual model of the aquifer system and any contamination problems of concern.

c. Data Collection
Explain how the data were collected, analyzed, and interpreted.

d. Model Description
Document the groundwater flow and contaminant transport model (code) used, including the version. Explain why the model was chosen. Describe where model assumptions and actual field conditions do not coincide and how this may affect model results. Any code modifications shall be described and justified.

e. Assignment of Model Parameters
All initial conditions, boundary conditions, hydraulic and transport parameter values shall be defined and the reasons for selecting these conditions justified.

f. Model Calibration
Model calibration goals and procedures shall be presented and discussed. The results of the final calibration run shall be presented and analyzed and departure from the calibration targets analyzed. Effects of these departures on the model results shall be discussed.

g. Sensitivity Analysis
Model sensitivity analysis shall be presented and interpreted. Discuss how well the model meets the purposes, goals and objectives stated above in 4.5.2.4.a. Determine what model parameters have the greatest influence on the results.

h. Model Validation
Model validation goals and procedures shall be presented and discussed. Model or field validation is the comparison of model results with numerical results, independently derived from laboratory experiments or observations in the field.

i. Model Results
The physical reality of the model shall be discussed. Note if the model results support the initial assumptions. The model results shall be presented in nontechnical terms.

j. Model Records
The modeler shall submit to MassDEP electronic files containing the following records:

(1) Information and data used for each model cell, including:

(a) Aquifer characteristics and the recharge and withdrawal rates assigned to each active model cell

(b) Constant-head values assigned to each constant-head node and drain elevations assigned to each drain cell

(c) Streambed conductance and head values assigned to each river cell

(d) Other model specific inputs

(2) The model outputs including inflow/outflow water budgets and final head values for each model cell for the final calibration run and all sensitivity and predictive runs addressed in the Source Final Report.

k. Particle Tracks
Provide particle track figures and outputs for verification of Zone II delineation boundaries.

4.5.3 Interim Wellhead Protection Areas

For all *wells with approved yields of less than 100,000 gpd* that were lacking a Zone II, MassDEP delineated an Interim Wellhead Protection Area (IWPA). The radius of the IWPA for a particular well can be determined by either using the equation provided below or referring to the chart provided in Appendix D of this document. The IWPA radius shall be measured from the wellhead; or from the center of the wellfield or infiltration gallery. For existing wells, infiltration galleries, or wellfields with approved pumping rates of 100,000 gpd or greater, the IWPA radius shall be one-half mile. For wells, infiltration galleries, or wellfields with approved pumping rates of less than 100,000 gpd, the IWPA radius is proportional to the approved pumping rate and may be calculated according to the following equation:

IWPA radius (feet) = [(32 X pumping rate (gallons per minute)) + 400]

The IWPA radius for an angle well is measured from the point on the land surface that is located directly above the center of the screened interval. In addition to the circular IWPA boundary that is defined above, the IWPA shall also include the Zone I. This may result in IWPAs that are irregularly shaped.

MassDEP may require greater distances or permit lesser distances than the IWPA distances set forth at 310 CMR 22.02, if the Department deems such action necessary or sufficient to protect public health.

4.5.4 Waiver of Zone II Delineation/Delineation of Zone III

Pursuant to 310 CMR 22.21(1)(f), MassDEP may waive the Zone II delineation requirement. Such approval requires that the Zone III be protected with municipal controls (bylaws, ordinances, health regulations) that meet all the Wellhead Protection Zoning and Non-Zoning Regulations, 310 CMR 22.21(2). This requirement applies to municipal and non-municipal water systems. If the Zone III extends into adjacent communities, the public water system will also be subject to complying with the Best Effort Requirement, 310 CMR 22.21(e).

The Zone III is defined in the Massachusetts Drinking Water Regulations 310 CMR 22.02. Simply stated, the Zone III can be defined as the surface watershed in which the well is located, excluding those downgradient portions of the watershed that do not contribute water to the well under extreme pumping conditions.

1. The upgradient watershed will be determined from USGS topographic maps. It is the land area from which surface water drains toward the well. The watershed boundary is established by drawing a line on a topographic map that represents a divide where surface water drains in opposite directions on opposing sides of the line. GIS and digital elevations may also be used to determine upgradient watershed boundaries. If the Zone III delineation using digital elevations is different from that derived from USGS topographic maps then an explanation of the discrepancy shall be provided in the report.

2. The downgradient portion of the Zone III will be delineated either by calculation of the downgradient stagnation point created by pumping the well or by use of geologic boundaries, whichever is smaller.

    a. The downgradient stagnation point will be calculated using the uniform flow equation (Todd[8]) or other MassDEP-approved analytical methods from the literature. Transmissivity (T) will be calculated using drawdown data from an observation well located approximately 20 to 100 feet downgradient of the pumping well. The pumping rate (Q) used in the calculation shall be the rate for which approval is sought or has already been approved, in the case of existing wells. Existing publications and pumping test information may be used in evaluating aquifer transmissivity and storativity. A line will then be drawn perpendicular to the direction of the regional watershed drainage at the downgradient stagnation point in order to determine the downgradient extent of the Zone III.

    b. If the downgradient stagnation point encompasses less permeable geologic boundaries, such as glacial till or bedrock, then the downgradient extent of Zone III will terminate at these boundaries.

    c. The downgradient extent of the delineated Zone III will include, at a minimum, all of the Zone I area. MassDEP discretion will be used when evaluating either method.

3. The required groundwater monitoring well program shall address the entire Zone III.

4. Communities should consider the costs and benefits prior to applying for waiver of the Zone II delineation. It shall be left to the discretion of MassDEP to determine whether a waiver is appropriate considering the local geology, the existing development of the watershed, adequacy of the proposed zoning and non-zoning land use controls, groundwater monitoring well program and the land uses allowed/proposed within the Zone III.

4.6 Source Final Report

Following the prolonged pumping test (and Zone II delineation for *wells with planned yields 100,000 gpd and greater*), a Source Final Report shall be prepared by the engineer or hydrogeologist and two copies of the report shall be submitted to the appropriate MassDEP regional office. For *TNC wells with planned yields of less than 10,000 gpd,* in addition to engineers and hydrogeologists, a Massachusetts Registered Well Driller may also prepare the Source Final Report. They will review the final report and either approve or disapprove

[8] Todd, op. cit.

said report in writing. The Water Management Act Permit Application for the well(s) must be submitted to MassDEP at the same time as the Source Final Report.

4.6.1 Report Contents

The Source Final Report shall include, but not necessarily be limited to, the following:

1. Hydrogeologic Background

    a. Description of the regional geology based upon all available geologic data (not required for *TNC wells with planned yields of less than 10,000 gpd*)

    b. Description of the subsurface materials based upon well logs and other information

    c. Provide copies of the boring logs for each observation/test hole

2. Pumping Test

    Provide a description and discussion of the pumping test, including:

    a. Ambient (pre-long-term pumping test) water level/potentiometric fluctuation trends (not required for *TNC wells with planned yields of less than 10,000 gpd*)

    b. Precipitation and/or recharge events

    c. Results of step-drawdown test, if applicable

    d. Discussion of how the pumping rate was selected for the long-term pumping test

    e. A surveyed site plan showing the location and elevation of all test wells, and the location of the production well

    f. Pumping rate data

    g. Drawdown and recovery readings for all monitored wells, tabulated and presented in a legible form and submitted on a CD that is attached to the report (CD format not required for *TNC wells with planned yields of less than 10,000 gpd*)

    h. Possible effects of changes in barometric pressure, for bedrock and confined aquifer wells (not required for *TNC wells with planned yields of less than 10,000 gpd*)

    i. Graphs showing time-drawdown, distance-drawdown, and time-recovery for all monitored wells

    j. Discussion of whether or not the stabilization criteria were met

    k. Evaluation of the hydrogeology (including aquifer characteristics) based upon data generated during the prolonged pumping test and recovery (not required for *TNC wells with planned yields of less than 10,000 gpd*)

    l. Evaluation of the Calculated Approvable Yield (in gpd)

m. Copies of the laboratory analytical reports of all water quality samples collected during the pumping test

3. Provide a generalized discussion of all the aforementioned elements of this section and a discussion of the geologic/hydrologic features that presumably contribute water to the production well

4. Provide copies of, or reference to, all relevant correspondence

5. Provide a discussion of the water quality as it relates to the flow system

6. If the water quality from the pumping test does not meet applicable standards, demonstrate that the proposed treatment or remedy, including waste disposal is technically and financially feasible, and protective of public health. If treatment is recommended, the unit process shall be discussed (e.g., corrosion control, iron and manganese removal and/or control, volatile organic removal, etc.).

7. Provide a surveyed site plan of the Zone I showing the necessary protective Zone I radius (as described in section 4.5.1), property boundaries, and all well locations and elevations.

8. Source Final Reports for public supply *wells with planned yields 100,000 gpd and greater* must also comply with the reporting requirements of Section 4.5.2.3. regarding the delineation of Zones II and III. The well location and Zone II delineation shall be submitted both in a hard copy map and in ESRI compatible electronic format (shapefile or personal geodatabase) in the Massachusetts State Plane (Mainland) coordinate system, using meters for horizontal units. The electronic files may be submitted to MassDEP via email or on CD media.

9. Provide Zone II model documentation in compliance with Section 4.5.2.4., if applicable.

10. Provide a listing and discussion of land uses within the Zone I and either the Zone II or the IWPA (whichever is applicable).

11. For *wells with planned yields 100,000 gpd and greater*, provide a discussion and quantification of any groundwater withdrawal impacts to surface water features or wetlands, including a discussion of drawdown due to pumping under Zone II conditions.

12. For *wells with planned yields 100,000 gpd and greater*, provide the status of efforts to complete the wellhead protection requirements of 310 CMR 22.21(2).

13. For *wells with planned yields less than 100,000 gpd*, provide the design plans and specifications for construction of permanent pumping facilities, including any water treatment. Also provide as-built well construction diagram, including sanitary seal, pump and pump setting information.

14. For wells that will result in a new community or non-transient non-community public water system, provide a copy of the *Water Supply Business Plan* filled out to the extent possible.

15. Provide a submittal of the final groundwater monitoring well plan (see the following Section 4.6.2).

16. For new community groundwater systems, document compliance with source redundancy requirements in accordance with 310 CMR 22.21(3).

4.6.2 Groundwater Monitoring Well Plan

310 CMR 22.21 requires that for *wells with planned yields of 100,000 gpd or greater*, and for wells of smaller yield where MassDEP deems it necessary, a Groundwater Monitoring Well Program shall be implemented for the newly delineated Zone II or Zone III (if applicable) prior to a source going on-line. MassDEP may also require the implementation of a Groundwater Monitoring Well Program for *new wells with planned yields of less than 100,000 gpd* that have an IWPA. The intent of the Groundwater Monitoring Well Program is to evaluate overall water quality within the Zone II, evaluate land use impacts on water quality and act as an early warning system for groundwater contamination that may impact the public supply well. The wells shall be installed and monitored by the proponent of the source **unless** local zoning, bylaws, regulations or site approval criteria require that impacts to groundwater quality from particular land uses be assessed by the landholder. In some instances it may be possible that MassDEP will not require the installation and monitoring of a monitoring well network; however, the water supplier is still required to submit a Groundwater Monitoring Well Plan that indicates the reason why monitoring wells should not be required and the water supplier's plan for re-examining the need for monitoring wells based upon future changes in land-uses within the Zone II. MassDEP may assess the need for, and require the implementation of, a Groundwater Monitoring Well Program for any well in active use regardless of MassDEP approved yield volume.

1. Land Uses That May Require the Placement of Monitoring Wells include:

   a. Industrial/commercial areas;

   b. Unsewered, densely populated residential areas;

   c. Agricultural areas;

   d. Landfilling of any type;

   e. Storage of liquid petroleum products, including USTs;

   f. Areas in which groundwater contamination has been detected.

   The groundwater monitoring well network is not meant to evaluate the impacts of all land uses within the Zone II, but to provide a more regional look at groundwater quality and address high risk land use areas such as those listed above. The number of wells necessary to receive MassDEP approval is dependent on the land uses within the Zone II and the development density.

2. Groundwater Monitoring Well Plan Approval

   a. A draft groundwater monitoring well plan shall be included with the Source Final Report. The groundwater monitoring plan shall include:

      (1) A large-scale map depicting:

         (a) Zones II and III boundaries;

         (b) The proposed production well;

         (c) All land uses within the Zone II and Zone III (if applicable);

         (d) Existing and proposed groundwater monitoring wells within Zone II and Zone III.

(2) Construction details for existing and proposed monitoring wells;

(3) A list of the proposed sampling parameters for each well and the proposed frequency of sampling.

b. At this time, if necessary, the proponent of the source shall begin discussions with abutting town(s) concerning locating groundwater monitoring wells in these town(s).

c. When siting wells to be used for pumping test analyses and the Zone II delineation, the source proponent should, whenever possible, use the same wells for the groundwater monitoring well program.

d. The source will not be approved to go on-line until all groundwater monitoring wells have been installed and sampling can commence.

e. MassDEP may require additional wells after review of the pumping test and Zone II delineation.

f. Since the primary purpose of the monitoring well program is the early detection of possible contaminants, in most instances, MassDEP recommends that monitoring wells be fully screened and designed to fully penetrate the aquifer if possible. However, MassDEP recognizes that for specific aquifer settings and given specific land-use concerns, in some instances it may be preferable to select screened intervals that target a particular depth interval as opposed to the entire aquifer thickness.

h. Towns should approach industrial land users within the Zone II to institute a monitoring well program at their expense.

i. Water quality results from the monitoring well program shall be kept with the water purveyor and should only be reported to MassDEP when any detections occur or if otherwise instructed in the approval letter. They may require additional information from these wells.

j. For wells located proximal to a surface water feature that induce a high percentage of recharge from that source, a discussion of the potential impacts from land uses located proximal to the surface water feature shall be provided. This discussion will include, but not be limited to, impacts from land uses located within the Zone III and adjacent to said surface water feature. Land uses located in areas underlain by till and/or bedrock, but in close proximity to the source shall also be discussed. Upon evaluation of the submittal, MassDEP will ensure that the recommended monitoring well program adequately addresses these land uses.

4.7 Source Approval Conditions

MassDEP approval of all new sources shall be at the discretion of the appropriate MassDEP . MassDEP will consider water quality, treatment feasibility, the presence of potential contamination sources, and demonstration of capacity.

The public water system shall comply with all source approval conditions. Approval conditions that may be placed on the water supplier include, but are not limited to:

1. Compliance with the Drinking Water Regulations, particularly 310 CMR 22.21, Groundwater Supplies and these guidelines.

2. Satisfactory completion of the Source Approval process and any required permit submittals.

3. Demonstration of ownership or control of Zone I and/or changes in land use to meet Zone I requirements (see Section 4.5.1 and 310 CMR 22.21).

4. New public water systems shall submit for MassDEP review and approval (when applicable): a satisfactory water supply business plan, certified operator staffing plan or contract notice, operation and maintenance (O&M) manual(s), total coliform sampling plan, lead and copper sampling plan, cross connection control plan, and deed recording of a water supply affidavit (refer to Appendix B).

5. Submittal with the Source Final Report of an approvable groundwater monitoring well program that addresses land uses that might impact public water supplies.

6. Submittal with the Source Final Report of an approvable wellhead protection bylaw or ordinance and district map, or evidence of most recent compliance with best efforts criteria. The submittal must address all the criteria listed for *wells with planned yields of 100,000 gpd or greater*.

7. Any further refinement of the Zone II required after the installation of the final production system, must comply with MassDEP's requirements.

8. MassDEP source approval will not be given until an ENF, and possibly an EIR, have been satisfactorily completed should withdrawal quantities or other threshold criteria trigger MEPA involvement with the project.

9. Establishing Approved Yields
   If MassDEP considers the technical data submitted insufficient to justify establishing a well's approved yield based on doubling of intermediate stage pumping test, another pumping test will be conducted on the final production well at the rate for which approved yield is sought. The pumping test shall go to stabilization and be monitored, as was the prior test. Changes in aquifer characteristics, sensitive resources impacted and the extent of the Zone II shall be evaluated thoroughly and discussed with MassDEP.

10. Provide as-built well construction diagram of final production well, including sanitary seal, pump and pump setting information.

4.8 Wellhead Protection Requirements

The Massachusetts Drinking Water Regulations, 310 CMR 22.00, were amended in 1990 to include wellhead protection requirements. These requirements are cited in the Groundwater Supply Protection Regulations and apply to all public water systems developing new wells or wellfields with planned yields of 100,000 gpd or greater, or requesting to increase yields of existing wells or wellfields to 100,000 gpd and greater. The wellhead protection requirements are intended to ensure that land uses and activities with the potential to contaminate drinking water quality are not allowed within the Zone II of public drinking water wells or wellfields.

Non-municipal water systems (such as water districts and water companies) and municipal water systems with Zone IIs located in another community must comply with the Best Efforts requirement, 310 CMR 22.21(1)(d) and 310 CMR 22.1(1)(e).

To achieve wellhead protection compliance the Zone II must be protected by municipal controls (bylaw, ordinances, and/or health regulations) that prohibit the land uses and activities cited in the Wellhead Protection Zoning and Non-Zoning Controls regulations, 310 CMR 22.21(2)(a) through 310 CMR 22.21(2)(b).

To initiate the wellhead protection process, the public water supplier must provide local officials with a copy of the approved Zone II delineation and 310 CMR 22.21(2). The public water system should expect they will need to meet with local officials and community groups to discuss the protection requirements and to generate support for municipal adoption. Local controls that meet 310 CMR 22.21(2) must be adopted prior to the operation of a new source.

For detailed information on achieving wellhead protection compliance, refer to MassDEP's *Making Wellhead Protection Work in Massachusetts,* available on MassDEP's website at http://www.mass.gov/dep/water/drinking/protect.htm.

Compliance with the Best Effort requirement, 310 CMR 22.21(1)(d) and 310 CMR 22.21(1)(e), applies to non-municipal public water suppliers, municipal public water suppliers with Zone IIs extending into adjacent communities, and all public water suppliers with wells are located in another community. Best Effort compliance is achieved when the public water supplier adequately demonstrates to MassDEP they have used their '*best efforts*' in encouraging the community (in which the Zone II is located) to adopt protection controls that cover the Zone II and meet 310 CMR 22.21(2).

For details and guidance on how to achieve compliance with the Best Effort requirement; refer to MassDEP's *The Best Effort Requirement* guidance document.

Public water suppliers should note that compliance with the Best Effort requirement is not an indication of permanent compliance status. The public water supplier should retain all documentation relating to on-going efforts to obtain wellhead protection zoning and non-zoning controls. The following activities will again trigger the Best Effort requirement:

1. new source approval
2. monitoring waiver application
3. MassDEP water withdrawal permit reviews or amendments
4. Zone II re-delineations
5. Sanitary Survey stipulations

It is the responsibility of the public water system to submit documentation to MassDEP of their compliance with the wellhead protection requirements and/or the Best Efforts requirement.

4.9 Establishing an Approved Yield for an Existing Well (Not Including Springs)

1. Existing Wells with Yields Less than 100,000 gpd:

   For existing wells that do not have a MassDEP established Approved Yield, pumping test information is often unavailable and Approved Yields must be derived from historical annual water supply statistics, Title 5 design flows, or other available information. The procedure below outlines, in preferred order, the various methods MassDEP uses for determining Approved Yield and Zone I and Interim Wellhead Protection Area (IWPA) radii for existing public water supply wells with yields less than 100,000 gpd.

   Method 1: Pumping Test

   If a pumping test is the selected method, a pumping test proposal shall be submitted to MassDEP for review and approval (except proponents of TNC wells with yields less than 10,000 gpd who shall schedule a meeting with MassDEP prior to conducting the pumping test). The pumping test shall be conducted at the rate for which approval is sought and shall continue until the well has stabilized. Drawdown and recovery readings shall be acquired as required in these guidelines. A pumping test report addressing aquifer parameters, drawdown, the well's Calculated Approvable Yield (per Section 4.3.1.5), and the pumping rate for which approval is sought shall be submitted to MassDEP for review and approval.

   Method 2: Monthly Averaged Volume

   In situations where a well does not have a MassDEP approved pumping rate but metered withdrawal records are available, MassDEP shall determine an Approved Yield by totaling the water withdrawn during the two historical months of greatest water use and dividing that total by the number of days in those months. However, professional judgment shall be used to exclude obvious outliers in monthly water use.

   Outliers include water loss through major leaks, use of water for backflushing treatment systems if such backflushing is conducted no more than twice per year, water obtained through emergency interconnections and obvious transcription errors. Water used for irrigation is considered to constitute normal usage and is not to be considered an outlier.

   Note that the two highest historical months of water use need not be consecutive months. When using this method it is important to note baseline conditions at the time of calculation, particularly the population served by the public water system. This information will enable MassDEP to evaluate requests for expansion or determine whether a public water system has expanded without MassDEP approval.

   Method 3: Title 5 Flow Design

   In situations where there is no Approved Yield and where there are no metered water withdrawals, the appropriate Title 5 design flow figures shall be used to determine the Approved Yield. Baseline conditions at the time of calculation should be noted as in Method 2.

   Method 4: Default Radii

   In cases where MassDEP has not yet taken action to establish an Approved Yield or to calculate Zone I or IWPA radii, default Zone I or IWPA radii may be temporarily assigned to a source by MassDEP.

2. Existing Wells with Yields 100,000 gpd and Greater:

   Frequently, for older wells, the pumping test information is unavailable and pumping rates must be derived from historical annual water supply statistics, another pumping test, or possibly statistics compiled for Water Management Act applications. These data shall be used in one of the following three methods to determine an Approved Yield:

   Method 1: Pumping Test

   If a pumping test is the selected method, a pumping test proposal must be submitted to MassDEP for review and approval. The pumping test shall be conducted at the rate for which approval is sought and shall continue until the well has stabilized. Drawdown and recovery readings shall be acquired as required in these guidelines. A pumping test report addressing aquifer parameters, drawdown, the well's Calculated Approvable Yield (per Section 4.3.1.5), and the pumping rate for which approval is sought shall be submitted to MassDEP for review and approval.

   Method 2: Monthly Averaged Volume

   Conceptual Zone IIs may be delineated for wells based on pumping averaged over the period of an entire month. The period selected may be the high month of record but devoid of any extenuating circumstances that may have caused excessively higher than normal pumping rates.

   The Approved Yield shall be calculated by determining the average daily volume for the selected month. Calculations shall be based on days of pumping, not hours. The volume of water pumped from a well during any 24-hour time interval shall constitute one day's volume.

4.10 Conceptual Zone II for an Existing Source

A Conceptual Zone II is a delineated zone of contribution in which a combination of analytical and surficial geologic mapping techniques are applied. Based on the findings, MassDEP will approve Conceptual Zone IIs for existing sources if they meet the technical criteria in this section. It will be left to MassDEP 's discretion to require monitoring wells where potential adverse impacts on the water supply exist. These wells will be used for water quality testing and for stratigraphic well log information.

MassDEP highly recommends that, prior to undertaking a Conceptual Zone II delineation for an existing source, MassDEP be contacted and the technical approach be discussed.

MassDEP staff has researched the similarities in size, shape, and extent of Conceptual Zone IIs and Zone IIs generated through the use of analytical or numerical techniques. There is no difference in credibility between Zone IIs that have been delineated using a conceptual approach (analytical model, geological/hydrogeological boundaries) versus those delineated using a more complex numerical modeling approach.

Completing a Conceptual Zone II delineation for an existing source requires that whatever modeling is undertaken be done at the Approved Yield rate.

1. A Conceptual Zone II delineation for *wells with planned yields 100,000 gpd and greater* shall, at a minimum, include the following:

a. Provide a description and discussion of the stratigraphy and hydrology of the aquifer using USGS geologic maps, any pertinent USGS or other reports, well logs (including private wells), and boring logs from all available sources.

b. Provide a discussion of the methodology used to establish an estimate of aquifer characteristics (such as transmissivity) and the data/information that was used (i.e. pumping test data, boring/well logs, etc.).

c. Provide a discussion of water quality as it relates to the groundwater flow system.

d. Provide a map of the surficial geology based on USGS GQ series surficial geologic maps, topographic maps, and hydrologic investigations atlas; field mapping; and review of the available subsurface data.

e. Provide a regional water table or potentiometric surface map showing groundwater flow directions in the region in which the Conceptual Zone II is located. The map shall be constructed based on water levels obtained from production and monitoring wells, USGS observation well network, and hydraulically connected surface water features.

f. For aquifers under confined conditions, provide a discussion of the hydraulic connection among overlying stratigraphic units, including any overlying unconfined aquifer, the lateral extent of the confining layer and estimates of leakage through the confining layer.

g. Provide the results of a complete land use/sanitary survey of the Conceptual Zone II.

h. Provide a discussion of the hydrogeologic system and the likely sources of recharge to the production well.

i. A minimum of two cross-sections through the pumping well, one in the direction of groundwater flow and the other perpendicular to it shall be provided.

j. Provide a discussion of other geological/geophysical data.

k. At a minimum, the conceptual Zone II shall be based upon the theoretical cross gradient and downgradient capture zone that would exist under steady-state pumping conditions, at the approved yield pumping rate. As with an analytically or numerically modeled Zone II (see Section 4.5.2.), in all cases, the Conceptual Zone II shall extend upgradient to its point of intersection with prevailing hydrogeologic boundaries (a groundwater flow divide, a contact with till or bedrock, or a recharge boundary).

2. Additional requirements for bedrock wells:

   a. Additional reporting requirements include the following:

      (1) Description and discussion of the character of the bedrock aquifer using USGS bedrock geologic maps, pertinent USGS open file reports, and existing well logs and borings from all available sources, including private wells;

      (2) Discussion of the chemical characteristic effects of the rock unit on water quality; and,

      (3) Discussion of hydraulic connections among the bedrock unit proposed to be developed, overburden deposits and surface water features, if applicable.

b. The following items shall be considered when compiling the Conceptual Zone II delineation:

(1) Interpretation of bedrock geologic maps, aerial aeromagnetic and infrared photographs

(2) Well logs, geotechnical borings and road borings

(3) Geophysical data generated during the compilation of geologic and/or hydrogeologic reports

(4) Estimates of hydraulic conductivities, total and saturated thicknesses of overlying surficial geologic units derived from well logs, borings, pumping tests and related subsurface explorations

(5) Rose diagram plot of magnitude, density, and orientation of regional rock fractures

4.11 Redelineation of Zone II

The following describes the process for the redelineation of MassDEP-approved Zone IIs. Redelineation will be considered based on the submittal to MassDEP of new or improved geologic and hydrogeologic information. The redelineation will include the entire Zone II.

The Zone II redelineation process consists of two phases:

1. Phase I

a. The proponent shall submit a detailed hydrogeologic pumping test proposal and payment (if applicable) of MassDEP permit fee (BRP WS-07).

The following, at a minimum, must be submitted with the proposal and fee (if applicable) for consideration by MassDEP to proceed with the redelineation:

(1) Discussion of technical rationale for redelineation including a conceptual model of the redelineated Zone II

(2) The number and location of boring or monitoring wells or other forms of subsurface investigative work that will be undertaken as part of the redelineation

b. The proponent must notify the applicable water supplier of the proposed Zone II redelineation.

c. MassDEP will review the proposal based on timelines.

d. MassDEP will coordinate a technical meeting with the project proponent to discuss the criteria required to redelineate a MassDEP approvable Zone II.

e. The proponent concurs with MassDEP requirements for data acquisition and resubmits the final proposal for redelineation.

2. Phase II

   a. The proponent conducts a field investigation to acquire the necessary information as per discussion in Phase I.

   b. The sophistication of the Zone II modeling effort shall be of an equal or greater level than the original modeling effort.

   c. The proponent shall complete an evaluation of the impacts of the proposed Zone II redelineation (i.e. impacts on Water Supply Protection Districts, etc.).

   d. The Zone II and all pertinent data and analyses shall be submitted by the proponent to MassDEP for evaluation along with payment (if applicable) of MassDEP permit fee (BRP WS 08). A copy of the Zone II submittal package shall also be submitted to the public water supplier.

   e. The public water supplier shall have the opportunity to review and comment on the Zone II prior to MassDEP approval.

   f. Based on criteria established in Phase I and in compliance with directives provided for the delineation of the Zone II in appropriate sections of this document, MassDEP will approve or disapprove the redelineation.

4.12 Redelineation of Watershed Boundary

If a person or entity disputes a watershed boundary delineation, as reported in MassGIS, they must submit a written justification for their disagreement to the MassDEP regional office(s) in which the disputed boundary is located. The submittal shall include a scaled map showing the disputed boundary, as it is depicted in MassGIS, and a written explanation as to why the existing boundary is incorrect. The person or entity that disputes a watershed boundary may also include on the scaled map their recommendation for the redelineated boundary. If MassDEP agrees to specific revisions to the boundary it will make these changes in the GIS watershed boundary data layers. Any other data that are used to justify the disputed boundary or the proposed redelineated boundary should also be submitted. In most instances water level data will not be accepted as justification for redelineation unless it is measured from a surveyed benchmark elevation.

4.13 Zone II Methodology for *Wells with Planned Yields < 100,000 Gallons per Day*

The Zone II methodology for *wells with planned yields less than 100,000 gpd* will be consistent with the Zone II approach currently in effect for *wells with planned yields 100,000 gpd and greater*. In most cases a numerical model will not be required unless extenuating circumstances dictate that this approach will provide the only acceptable level of wellhead protection. Generally the Zone II will be delineated using hydrogeological mapping and simple mathematical techniques (*e.g.*, uniform flow equation).

The minimum information required to employ this delineation method includes:

1. The well's pumping rate either determined from a pumping test or obtained from historical pumping records;

2. A hydraulic gradient from existing data or interpreted from USGS topographic maps;

3. Saturated thickness, as determined from maps or well logs;

4. Hydraulic conductivity (determined from pumping test information, or from USGS Hydrologic Atlas, geologic logs, etc.).

In some cases, the methodology that has been developed for delineating Zone IIs for *wells with planned yields 100,000 gpd and greater* will not be appropriate for low yield wells. Very low pumping rate wells located in or adjacent to glacial till and/or bedrock do not lend themselves to Zone IIs that adequately protect the wellhead. In these cases, methods to be considered to produce more realistic Zone IIs will include mass balance calculations to determine upgradient Zone II limits, utilization of topographic contours for flowpath analysis and equating hydraulic conductivity values to pumping rates for bedrock wells.

4.14 Rescinding an Approved Zone II

If a well does not go on-line within five years of Zone II approval and MassDEP receives a written request for a determination of the well site and/or Zone II validity, DWP will reevaluate the Zone II and the proposed well site using the criteria outlined below. The validity of the Zone II will only be reevaluated if no other groundwater sources in that Zone II have been active within the past five years. In cases where a public water supplier has elected to delineate the Zone III instead of the Zone II for a proposed well, in accordance with 310 CMR 22.21(1)(f), the Zone III shall be considered as a Zone II for the purpose of this guideline.

1. Determine whether the site(s) will be able to meet any new requirements that have been incorporated into the Source Approval process over the past five years since the Zone II approval **and** meets one of the following:

   a. The subject Zone II is protected through the adoption of local regulatory controls meeting 310 CMR 22.21(2); **or**

   b. The public water supplier has been making progress toward the adoption of the control measures in 310 CMR 22.21(2), has acquired Zone I, and has provided written documentation to MassDEP's satisfaction that extenuating circumstances have prevented completion of the process within the five year time period and necessitate an extension of time; **or**

   c. For non-municipal water systems and those with part or all of the Zone II located in another community: the public water supplier has acquired ownership or control of the Zone I and has demonstrated to MassDEP's satisfaction that the supplier has met the "best efforts" requirement in seeking the adoption of control measures that meet 310 CMR 22.21(2).

If the site doesn't meet any of the above criteria, MassDEP may consider the following to determine whether or not the Zone II should be rescinded:

2. Inspect the well(s) site itself and consider any site alteration or any relevant changes in land use within Zone I and II; and/or,

3. Determine current water quality at the proposed well(s), and at associated monitoring wells, if relevant.

A Zone II will also be rescinded if the approval of a well abandonment by MassDEP, as described in Section 4.21, results in all the wells included in a Zone II delineation being abandoned.

4.15 Replacement Wells (Includes Satellite Wells, Excludes Bedrock Wells)

MassDEP approvals of replacement wells will be considered on a case-by-case basis. Replacement Well means a new well(s)/wellfield installed to replace or supplement an approved well(s)/wellfield, where the proposed well(s)/wellfield will be situated within 50 feet of the original well(s)/wellfield for *wells with approved yields of less than 100,000 gpd*, and within 250 feet for *wells with approved yields of 100,000 gpd or greater*. A replacement well(s)/wellfield must be installed in the same unconsolidated geologic formation as the original approved well(s)/wellfield; therefore, this provision does not apply to bedrock wells. They can be used to replace a well(s)/wellfield that will be inactivated or abandoned, or to replace lost yield in the existing active well(s)/wellfield. In the latter case, individual replacement wells may be used in conjunction with the existing active well(s)/wellfield to better manage the system without increasing the yield.

The approved pumping rate of the replacement well(s)/wellfield shall not exceed the approved pumping rate of the original source. If the original source remains in use along with the replacement source(s), the total water produced by the original source and all its replacement sources cannot exceed the approved pumping rate of the original source.

The following are specific circumstances where a replacement well may be located up to 250 feet from the original well(s)/wellfield:

1. The Zone I for the original source contains non-conforming land uses such as buildings and roadways (not associated with the pumping works), septic systems, sewer lines, etc., that will be mitigated by siting the replacement well at the proposed location.

2. The Zone I for the original source is not completely owned or controlled by the water purveyor and the proposed location allows for greater or complete ownership or control of the Zone I.

3. Pumping impacts to wetlands and waterways can be mitigated by siting the replacement well at the proposed location. This proposed mitigation must be accompanied by scientific evaluation and must not further impact other sensitive receptors. Documentation such as constant low flow in waterways and lowering of water levels in ponds, lakes, wetlands, etc. must be submitted for review.

4. The proposed location will mitigate a determination based on MPA testing that the original source is Groundwater Under the Direct Influence of Surface Water.

5. The proposed location will provide water of better quality, as demonstrated by preliminary water quality analyses results provided to MassDEP.

Criteria used to determine the location of replacement wells shall include, but is not limited to, the following: extents to which negative environmental impacts caused by the existing well can be minimized; degree to which replacement wells alter the existing groundwater hydraulics or Zone II boundaries; and the degree to which significant potential contamination threats can be lessened. Replacement wells shall not significantly alter the existing groundwater hydraulics or Zone II boundaries. Replacement wells are subject to the Source Approval requirements as deemed applicable by MassDEP.

Efforts must be made to obtain the Zone I for all replacement wells, but if the existing well does not have the required Zone I area, then the Zone I will be considered on a case-by-case basis.

Satellite wells meeting the following description also fall under the definition of replacement well. A satellite well is a new well, which is directly manifolded to an existing active well. The satellite well pumps water into the existing well, from which it is then pumped into the distribution system or treatment facility. Satellite wells can be used to better manage the withdrawal at an active well(s) or wellfield but cannot be used to increase the approved volume. A satellite well will be subject to the requirements of the Source Approval process if any of the following criteria are met: the satellite well is located more than 50 feet from the existing well for *wells with approved yields of less than 100,000 gpd* or 250 feet from the existing well for *wells with approved yields of 100,000 gpd or greater*; the total yield of the satellite and existing well(s) exceeds the approved yield of the existing well(s); or, the satellite well is located in a different geological formation and/or in bedrock; or, is not of similar depth.

4.15.1 Proposal for Replacement Wells (including satellite wells)

A proposal for a replacement well(s) shall be submitted to MassDEP for approval. MassDEP s may also require applicable permit submittals. The submittal shall consist of a letter report that includes, but is not limited to the following:

1. A short justification of why the application is being made for the replacement well. This shall include a discussion of any decline in yield from the original well, the reason for the decline, well rehabilitation efforts and results, exploratory drilling for the replacement well, and the reason for selecting the proposed location for the replacement well(s). Additional justification may be required if the replacement well is located between 50 and 250 feet away.

2. If exploratory drilling has been conducted the following shall be submitted:

    a. Site plan of the replacement well, its Zone I, potential sources of contamination within the Zone I, location of the original well and any property boundaries relevant to evaluation of ownership of the Zone I

    b. Geologic logs of exploratory wells including depth, yield and lithology

3. A short discussion of the Zone I land ownership shall be included and any proposal to acquire the Zone I, if appropriate. Include compliance status with applicable wellhead protection zoning and non-zoning land use provisions.

4. Provide a pumping test proposal including:

    a. Length of pumping test (24-48 hour minimum – longer test may be required if a Zone II must be delineated or other conditions warrant);

    b. Pumping rate;

    c. Observation wells, if any are needed (location, construction details, frequency of measurements, ambient well, etc.);

    d. Discharge location;

    e. Water quality sampling – at a minimum, samples for coliform bacteria, volatile organics, secondary contaminants, nitrate, and nitrite must be collected at the end of the pumping test.

5. The proposed well design and proposed operation scheme, and plan for disposition of the original source shall be included. (i.e., the original well will be abandoned and decommissioned, used in conjunction with the replacement well(s), or maintained as an emergency well). A separate BRP WS 36 permit may be required for the abandonment of any public water supply source (refer to section 4.21 Well Abandonment and Decommissioning).

6. For *replacement wells with planned yields of 100,000 gpd and greater*, a characterization of land uses within the Zone I of the well, including a 1:6000 scale or larger map depicting the proposed well site and the area located within a ½ mile radius of the proposed well shall be included showing the following information:

    a. Existing and potential sources of contamination, including any landfills and hazardous waste sites located within the Zone II or IWPA for the well

    b. Current land uses

    c. Great ponds, streams, and wetlands within the Zone I of the original and replacement wells

4.15.2 Source Final Report

Following the completion of any required pumping tests, groundwater sampling events, and laboratory analytical work, the proponent shall submit a Source Final Report to MassDEP along with the applicable permit to construct. The BRP WS 20 permit shall be submitted for *wells with planned yields of 100,000 gpd and greater* and the BRP WS 15 permit shall be submitted for *wells with planned yields of less than 100,000 gpd*. The Source Final Report shall include the following information:

1. As-built well construction diagram

2. Discussion of findings

3. A plot plan of the Zone I for the replacement well

4. Discussion of changes, if any, to the Zone II

5. Water quality results

6. Status of source protection bylaw

7. Demonstration that the well has acceptable water quality and is capable of producing the desired yield with no additional impacts

8. Pumping test data and analyses (if required)

9. Geographic coordinates of the well

The design plans and specifications for construction of the finished well(s) and finished pumping facilities must be submitted to MassDEP for review and approval prior to construction. The replacement well(s) or wellfield may not be used for public water supply until MassDEP has granted final approval to do so. MassDEP shall issue applicable public water supply source identification numbers upon final approval.

4.16 Land Acquisition for Wellhead Protection

MassDEP will not approve construction of the permanent pumping facilities until the public water supplier has demonstrated that it owns or controls the Zone I of the well(s) or wellfield, as described in Section 4.5.1. In determining the protective distance to be acquired, the "Zone I Radius vs. Pumping Rate" graph (Appendix D) shall be used.

The land acquisition procedures for Zones I, II, and III are as follows (these requirements do not apply to privately owned water companies or corporations unless they have franchise rights that encompass an entire city, town, or district):

1. The land acquisition procedure should be initiated once a decision has been made to develop a permanent water supply at a given site.

2. Massachusetts general law requires water suppliers to obtain the consent and approval of MassDEP before acquiring lands for the construction, operation, or protection of a water supply. Acquisition includes land purchases and the development of conservation restrictions or other deed restrictions, subject to public notice and a public hearing. Permit Application BRP WS 26 and permit fees, if applicable, must be submitted to MassDEP.

3. MassDEP must receive, in writing, from the water supplier, a request for the acquisition of said land. The request shall incorporate a site plan in sufficient detail to draw a legal deed, the current names and addresses of the land owners and acreage involved. The names and addresses of abutters shall also be submitted. MassDEP shall make all necessary arrangements for the conduct of the public hearing and will notify all parties of the time and place of the hearing.

4. If the water supplier intends to acquire rights in land, the proposed wording of any restriction or easement shall be provided for MassDEP review and approval prior to acquisition. MassDEP has Model Conservation Restriction language available for use.

5. Subsequent to the public hearing, MassDEP shall either approve, modify, or disapprove the land acquisition and shall so notify the water supplier in writing. Upon receipt of MassDEP's approval, the water supplier may proceed with the land acquisition. The water supplier shall file with MassDEP and with the appropriate registry of deeds a copy of the approved plan. Following land acquisition, the water supplier shall submit a copy of the deed(s) to MassDEP.

4.17 Final Approval of the Completed Water Works

MassDEP must approve the completed construction of the permanent pumping facility in writing prior to the facility and the new source being placed on-line. When the permanent well and pumping facility are complete, MassDEP shall be notified by the water supplier and/or consulting engineer in order that a final inspection of the finished facility can be made. Bacteriological and secondary chemical analyses shall be completed on samples of water from the completed works, and the results shall be provided to MassDEP at the final inspection. MassDEP will issue a final approval letter for the completed water works, including the assignment of applicable public water system and public water source identification numbers, and water quality sampling schedule.

4.18 Surface Water Treatment Rule Requirements

The Surface Water Treatment Rule (SWTR), an amendment to the federal Safe Drinking Water Act, requires MassDEP to notify the U.S. Environmental Protection Agency (EPA) of groundwater sources determined to be under the direct influence of surface water and at risk for carrying waterborne contaminants such as *Giardia*. Water suppliers developing groundwater sources must demonstrate compliance with the SWTR by either receipt of a MassDEP SWTR exemption, institution of appropriate wellhead/watershed protection, or installation of adequate filtration and disinfection contact time. Exemptions are granted based upon well siting, well construction, or the results of microscopic particulate analysis (MPA). A public water system seeking SWTR exemption for a groundwater source shall submit the appropriate Exemption Application and supporting documentation for MassDEP review and approval.

Any new test well or production well that has total or fecal coliform in source water during the pumping test is ineligible for exemption consideration unless the bacteria is determined to be a result of sample acquisition or linked to well construction.

If a groundwater source cannot meet the exemption criteria, spring and fall rounds of MPA testing must be conducted the first year the source is on-line. The initial MPA testing round may occur either in the spring or fall, whichever time period occurs first after the well has been on-line for at least six months. The Spring MPA sample must be collected between April 1st and May 30th, and the Fall MPA sample must be collected between August 15th and October 15th. MassDEP may require non-community seasonal sources to test during alternative months. Sources that are periodically flooded shall also test during an annual flood event during which their system is inundated in addition to the initial fall and spring sampling periods unless the times are synonymous.

MPA results will be reviewed by MassDEP staff, who will determine whether the source warrants a MassDEP exemption, requires additional testing, or requires filtration and adequate disinfection contact time. MassDEP may re-evaluate any exemption granted based upon periodic site inspections, including a reported change in surface water or setback conditions, or water quality data.

1. Sand and Gravel Wells for community water systems shall be considered exempt if one of the following criteria is met:

    a. Groundwater sources located 150 feet or more horizontally from a surface water feature are exempt from MPA sampling. For angle wells, this 150-foot setback distance does not apply to the wellhead but rather to a line that is generated by mapping the vertical projection of the screened interval onto the land surface. If any portion of this line is located within 150 feet of a surface water feature, this particular exemption criterion is not met. "Surface water feature" is defined as an area **continuously inundated** with flowing or standing water. Wetlands or low lying areas that are only periodically flooded are not considered surface water features.

    b. Groundwater wells constructed with a **sanitary seal** and the screens of which are separated from surface water features by a confining layer are exempt from MPA sampling. "Confining layer" is defined as a continuous extensive geologic unit of low permeability.

    c. A groundwater source that cannot meet either of the exemption criteria listed above must meet all of the following to be exempt from MPA testing:

(1) The top of the well screen must be 50 feet or more below the ground surface. For angle wells, this 50-foot depth requirement is measured from the highest screen elevation to the lowest elevation of the bottom of the nearest surface water feature.

(2) The well must be approved by MassDEP to pump 720,000 gpd on average or less.

(3) The well must have a properly installed sanitary seal.

The well must not have any total or fecal coliform violations during the past three years of operation. A new public supply well that otherwise meets exemption criteria but does not have three years of bacteria testing results for source water, must test the source water twice annually for bacteria (spring and fall) for three years. If there are no total or fecal coliform present over the three year period, the source will be considered to have met the exemption criteria and will not be required to conduct MPA testing or install filtration.

2. Sand and Gravel Wells for non-community systems shall be considered exempt if one of the following criteria is met:

a. The well must be 100 feet or more horizontally from a surface water feature and not located within the 100- year floodplain; if the well is within the 100-year floodplain, the well should be evaluated at the next sanitary survey for flooding or construction issues; or

b. If well is 100 feet or less from a surface water feature, **all** the following conditions must be met:

(1) The well must be 50 feet or more in depth.

(2) The well has sanitary seal **or** the well has no sanitary seal but a MassDEP sanitary survey determines that well is not subject to flooding, and the height of the well casing is a minimum of 18 inches above the ground or as MassDEP directs.

(3) No bacteriological violations within the last 3 years for that well **or** if there were violations, they were corrected and/or not attributed to surface water infiltration. A new public supply well that otherwise meets exemption criteria but does not have three years of bacteria testing results for source water, must test the source water twice annually for bacteria (spring and fall) for three years. If there are no total or fecal coliform present over the three year period, the source will be considered to have met the exemption criteria and will not be required to conduct MPA testing or install filtration.

3. Bedrock Wells pumping less than 100,000 gpd for community systems shall be considered exempt if all of the following exemption criteria are met.

a. The well must be 50 feet or more in depth.

b. The well must have a surface seal.

c. The well must be 200 feet or more horizontally from a surface water feature.

d. For existing wells, the well must not have had any total or fecal coliform detections over the past 3 year period. A new public supply well that otherwise meets exemption criteria but does not have three years of bacteria testing results for source water, must test the source water twice annually for bacteria (spring and fall) for three years. If there are no total or fecal

coliform present over the three year period, the source will be considered to have met the exemption criteria and will not be required to conduct MPA testing or install filtration.

If **all** criteria are met, the water supplier will be required to test the source monthly for total coliform bacteria to remain in compliance with the SWTR. Bedrock sources that fail to meet the above criteria must conduct MPA testing in the spring and fall in accordance with the appropriate time periods listed above.

4. Bedrock Wells pumping 100,000 gpd and greater for community systems must conduct MPA testing.

5. Bedrock Wells for non-community systems shall be considered exempt if one of the following criteria is met:

   a. The well must be100 feet or more horizontally from a surface water feature.

   b. If the well is less than 100 feet from surface water feature, **all** of the following conditions must be met:

      (1) The well must be 50 feet or more in depth.

      (2) The well has sanitary seal, **or** well has no sanitary seal but a MassDEP sanitary survey determines that well is not subject to flooding, and the height of the well casing is a minimum of 18 inches above the ground or as the Department directs.

      (3) No bacteriological violations within the last 3 years for that well **or** if there were violations, they were corrected and/or not attributed to surface water infiltration. A new public supply well that otherwise meets exemption criteria but does not have three years of bacteria testing results for source water, must test the source water twice annually for bacteria (spring and fall) for three years. If there are no total or fecal coliform present over the three year period, the source will be considered to have met the exemption criteria and will not be required to conduct MPA testing or install filtration.

6. All springs must conduct MPA testing.

4.19 Other Permit Requirements in the Source Approval Process

This section addresses the other state and federal agencies that are involved in the Source Approval process, what each agency requires, and at what phase of the process specific information must be submitted regarding the proposed new source for public water supplies. In addition to MassDEP Drinking Water Program, the Source Approval process may involve state and federal agencies, including the U.S. Army Corps of Engineers (ACOE), MassDEP Water Management Act Program, MassDEP Wetlands and Waterways Program, Massachusetts Environmental Policy Act (MEPA) Office, and Department of Conservation and Recreation (DCR). All permits may not be required for every new source, but will depend upon a number of factors, including the alteration of wetlands, yield of the well, and ownership of the property.

Groundwater source development frequently involves state and federal agencies other than MassDEP when sites are located on state-owned parkland or when the development processes impact wetlands from activities such as construction of temporary and permanent access roads, construction of permanent pumping and/or treatment facilities, and long-term drawdown of groundwater levels. To avoid long and costly delays or

possible prohibition of well installation, MassDEP strongly recommends that information be submitted in a timely and complete fashion to the agency having jurisdiction. Permission to access state-owned parklands to conduct groundwater exploratory work shall be obtained from DCR early in the Source Approval process before any exploratory drilling is conducted.

MassDEP requires identification and assessment of wetlands impacts during the Source Approval process to ensure that the Army Corps of Engineers, MassDEP Wetlands and Waterways Program, and MassDEP Watershed Management Program receive the information necessary for prompt evaluation of permit applications. MassDEP recommends that water suppliers or their consultants identify all practicable means to avoid, minimize, and mitigate impacts early in the Source Approval process to prevent delays.

1. Exploratory Phase

   Prior to the submittal of a Request for Site Exam/Pumping Test Proposal to MassDEP, the following permits may be required if the exploratory work is to be conducted in or near wetlands or on state owned parkland.

   a. MassDEP Wetlands and Waterways Program

      (1) Order of Conditions
      This permit approves work pursuant to the Massachusetts Wetlands Protection Act. Public water suppliers shall file a Notice of Intent. Special provisions regarding the exploration for new public water supplies are contained in the Wetlands Protection Act Regulations 310 CMR 10.53 (3) (o).

      (2) Massachusetts 401 Water Quality Certification
      This permit certifies that the project complies with state water quality standards. The 401 permit shall be applied for and obtained prior to the Army Corps of Engineers Section 404 permit application. The Army Corps of Engineers generally requires the issuance of the 401 Water Quality Certification prior to issuance of the Section 404 permit.

      The allowable duration of temporary roads and structures will be regulated within the permitting process.

   b. Department of Conservation and Recreation: Special Use Permits

      The following describes the process for the exploration and development of public water supply wells on DCR property. Development of public water supplies on DCR property shall only be considered under exceptional circumstances, which is defined as the solution to a significant hardship for which there is no other feasible alternative. If a proponent is interested in conducting exploratory work on DCR property, they shall make a written request to the Director of Forests and Parks with a copy to DCR's Director of Water Resources. If approved, DCR will issue a Special Use Permit granting permission to access public parkland for a specified period of time to conduct an exploratory well investigation program. Exploratory work will not be conducted within 400 feet of all trails, paths, recreational land uses or any other DCR permitted land uses, such as agriculture. A special request must be submitted for the installation of temporary roads and all property must be restored to its original condition upon completion of the project.

      The issuance of a Special Use Permit for test wells for exploratory purposes does not imply approval by the DCR for construction of a permanent well (public water supply) on conservation/recreation land. Such permits are only to facilitate general planning and feasibility studies.

Any access gained to the property, or exploratory work done without a Special Use Permit, will preclude that well site from being considered by DCR for approval.

2. Request for Site Exam/Pumping Test Proposal

The following permits may be required at the Request for Site Exam/Pumping Test Proposal phase:

a. Publish an Early Notice (for sources with planned yields of 100,000 gpd or greater)

MassDEP Water Management Act Program requires that the proponent for a new source place a notification in the *Environmental Monitor* indicating the location where a site exam is being requested and the planned withdrawal volume for the proposed new source.

b. Army Corps of Engineers: Section 404 Permit

This permit is required when any filling of wetlands occurs in the process of well site exploration or well development. To meet the requirements for a Section 404 Permit, an Alternative Analysis must be conducted. This analysis will primarily be conducted in two phases. The first phase will be conducted at the time of the Request for Site Exam/Pumping Test Proposal, and the second phase will be submitted with the Source Final Report. As part of the first phase, a statement of the Basic Project Purpose shall be submitted concurrently with the Request for Site Exam/Pumping Test Proposal. This is the most important part of the Section 404 permit application process as it is the foundation of the Corps' evaluation in determining whether to issue the permit.

As part of the Request for Site Exam/Pumping Test Proposal, the following information shall be included:

(1) Basic Project Purpose
Since the first phase of the Alternatives Analysis, which includes the Basic Project Purpose, is the most important part of the process and may determine whether the Army Corps of Engineers will issue the Section 404 Permit, it should be as comprehensive as possible, developing a strong argument why the selected site is the preferred well location to the exclusion of all other sites or alternatives.

A statement of the basic project purpose as well as discussions of the expected short and long term impacts is required. The discussion should be based on information obtained during the groundwater exploration phase of the Source Approval process, specifically information relating to baseline seasonal water levels and estimates of drawdown due to pumping.

Items in the discussion to support the basic project purpose shall include the following:

(a) Volume that will be required

(b) Reasons project is being undertaken

(c) Needs or goals

(d) Constraints placed on applicant by other programs (DWP, WMA)

(e) Use and purpose of new source

(2) Alternatives Analysis
Items in the discussion to support the alternative analysis shall include the following:

(a) Discussion of all sources considered

(b) Justification for selected site

(3) Wetlands information shall include:

(a) Provide a definition and description of the type(s) of wetland potentially impacted including a characterization of functions and values.

(b) Data shall be gathered to support an estimate of the functional values of the waters and wetlands, which are likely to be affected by the project.

(c) For each affected wetland, an assessment shall be prepared addressing at least the following wetland functions:

(i) Groundwater recharge/discharge

(ii) Flood storage and desynchronization

(iii) Sediment and shoreline stabilization

(iv) Sediment, toxicant, pathogen retention/transformation

(v) Nutrient retention/transformation

(vi) Nutrient export

(vii) Aquatic diversity/abundance

(viii) Fish and shellfish habitat

(ix) Wildlife habitat

(x) Endangered species

(xi) Consumptive recreation (e.g., hunting, fishing)

(xii) Nonconsumptive recreation (e.g., boating, aesthetics)

(xiii) Uniqueness/heritage

(xiv) The proponent will conclude whether or not each of the listed functions is a principal valuable function of the wetland and briefly explain any available data

(xv) General discussion of potential impacts to downstream wetlands

(xvi) Discussion of options considered to minimize the impacts

(d) A map of the wetlands area shall include:

(i) Provide a surveyed site plan of property with both existing and proposed contours.

(ii) Stake out a field delineation of waters and wetlands. Delineation shall be made in accordance with the Massachusetts Wetlands Protection Act, as specified in the Wetlands Protection Act Regulations (310 CMR 10.00), and in accordance with the Federal Clean Water Act as specified in the Corps of Engineers Wetland Delineation Manual, Technical Report Y-87-1, January 1987. These two delineations may or may not coincide.

(iii) Provide a plot of the limits of the waters and wetlands, and the general limits of each wetland type on surveyed site plan.

(iv) The proposed footprint of the entire project, including buildings, roadways, parking areas, etc., and limits of all fill to be placed in waters and wetlands shall be shown on the surveyed site plan.

(e) Provide a discussion of potential wetland replication necessary and proposed methods of mitigation for the principal valuable function impacted.

Mitigation may be required in accordance with the following:

(i) Mitigation for the Army Corps of Engineers shall be in accordance with the Memorandum of Understanding Between EPA and the Department of the Army concerning the Determination of Mitigation Under the Clean Water Act Section 404 (b)(1) guidelines.

(ii) Mitigation for the Massachusetts Wetlands Protection Act shall be proposed in accordance with 310 CMR 10.00, and the Order of Conditions issued under the Wetlands Act.

One full year of quarterly wetland monitoring (water level) data is required for wells *with an approved yield of 100,000 gpd and greater*. This may be in the form of hand driven points in wetland deposits and underlying deposits. The location and number of monitoring wells will be reviewed and approved by MassDEP in consultation with its Division of Wetlands and Waterways (DWW) prior to installation. Wetland monitoring results shall be submitted with the Source Final Report.

Discussion should be limited to 2-3 pages. Periodic meetings between MassDEP and Army Corps of Engineers will be held to discuss permit applications.

c. Massachusetts Environmental Policy Act (MEPA**)**

All proposed new groundwater withdrawals or expansion of existing groundwater withdrawals of 100,000 gpd or greater require that an Environmental Notification Form (ENF) be filed with MEPA. The ENF may be filed at this stage of the Source Approval process or as late as the submittal of the Source Final Report. An ENF is **generally not required for *sources with planned yields of less than 100,000 gpd,*** unless there are other permits required for a project that will require MEPA involvement. The filing initiates a 30-day public review period, which commences with a notification in the Environmental Monitor of the availability of the ENF. During the ENF review, the environmental impacts associated with the proposed well are evaluated. For projects with significant environmental impacts, the ENF review can result in a

requirement for the preparation of an Environmental Impact Report (EIR). However, if an EIR is not required, the MEPA review is complete at the end of the public comment period. An EIR is always required for any proposed new groundwater withdrawal or expansion of existing groundwater withdrawal of 1.5 million gpd and greater. An EIR is also required for any new groundwater withdrawal of 1 million gpd and greater that also requires an interbasin transfer.

d. Department of Conservation and Recreation: Special Use Permit

Application must be made to DCR for a Special Use Permit to conduct the prolonged pumping test.

If a favorable site is located on DCR property, the proponent must formally request permission from DCR to conduct further water supply development work including installation and testing of production and observation wells. The request shall be submitted to the Director of Forests and Parks, with a copy to the Director of Water Resources. Only requests from municipal water departments, water districts, public water supply agencies or companies, or other public entities will be entertained by DCR.

The request must state the basic project purpose and alternative analysis as outlined in DCR's *Policies and Procedures For the Disposition of Land, Water or Interests Therein* including:

(1) A demonstration that the proposed water supply withdrawal shall be the only feasible source available to correct an immediate public health problem or a projected long-term water supply deficit;

(2) A demonstration that the withdrawal shall have no significant adverse environmental impact upon critical natural resource values on the property, or the volume/time of withdrawal is conditioned to adequately address the potential impact(s);

(3) The implementation of (a) a water conservation plan approved by the Water Resources Commission and (b) either watershed protection or aquifer protection measures;

(4) A demonstration that the water supply withdrawal shall not cause unacceptable impacts upon the operation, management, or delivery of the conservation, open space or recreational programs of DCR;

(5) A demonstration that the withdrawal shall comprise the only source available at comparable costs, quantity, or long range availability;

(6) The water supply withdrawal shall adhere to and meet the conditions and permitting requirements of all applicable local state and federal laws, regulations and policies;

(7) A surveyed site map of the area showing all recreational uses.

If further water supply development work is approved, DCR will issue a Special Use Permit to access the land and perform a prolonged pumping test.

e. Massachusetts Endangered Species Act (MESA)

The Massachusetts Endangered Species Act (MESA) and its implementing regulations (321 CMR 10.00) establish procedures for the listing and protection of rare plants and animals. As such, MESA plays an important role in maintaining biological diversity, preventing species extinctions, and contributing to rare species recovery in Massachusetts.

Project proponents must file with the Natural Heritage & Endangered Species Program (NHESP) for all nonexempt projects or activities where the proposed project is located within a *Priority Habitat*. A *Priority Habitat* is the mapped geographical extent of known habitat for all state-listed rare species, both plants and animals. Habitat alteration within *Priority Habitats* may result in a "take" or cause "known harm" of a state-listed species, and is subject to regulatory review by the NHESP. Habitat maps are used to determine whether or not a proposed project must be reviewed by the NHESP for MESA compliance. Maps are available in the current edition of the Massachusetts Natural Heritage Atlas or on the NHESP website. MassDEP strongly recommends that project proponents file an Information Request with NHESP. This submittal provides preliminary information for NHESP to determine if a site presents concerns under the MESA.

NHESP recommends that applications be as complete as possible. Within 30 days of receiving a filing (Information Request form), NHESP will provide a response letter indicating whether or not the submission is complete. If the submission is complete, the NHESP will provide a determination letter within 60 days of the date of posting the first letter. In this letter the NHESP will determine whether or not a project, as currently proposed, will result in a take. If a project is determined to result in a take then it may be possible to redesign the project to avoid the take. If such provisions are not possible, then projects resulting in a take may only be permitted if they qualify for a *Conservation & Management Permit*. It is recommended that for larger projects, proponents consider a pre-filing consultation with NHESP staff.

For those projects requiring a Notice of Intent (NOI) because their location is within an Estimated Habitat for Rare Wildlife under the MA Wetlands Protection Act Regulations, a copy of the NOI must be sent to the NHESP. For those projects located within an Estimated Habitat and a *Priority Habitat*, NHESP recommends that the MESA checklist (available on the NHESP website), fee, and required supporting information be submitted to the NHESP at the same time a copy of the project NOI is submitted.

3. Source Final Report

The following permits may be required:

a. MassDEP Water Management Act Program: Water Management Act Permit

The Water Management Act, which is administered by MassDEP, regulates water withdrawals, which exceed 100,000 gallons per day. Issuance of this permit ensures protection for the needs of competing water uses, natural resources, and the potentially approvable yield of each water source.

b. MassDEP Wetlands and Waterways Program Permits

(1) Order of Conditions
This permit approves work pursuant to the Massachusetts Wetlands Protection Act. Public water suppliers shall file a Notice of Intent. Special provisions regarding the construction and development of new public water supplies are contained in the Wetlands Protection Act Regulations 310 CMR 10.53 (3) (o).

(2) Massachusetts 401 Water Quality Certification
This permit certifies that the project complies with state water quality standards. The 401 permit shall be applied for and obtained prior to the Army Corps of Engineers Section 404 permit application. The Corps generally requires the issuance of the 401 Water Quality Certification prior to issuance of the Section 404 permit.

c. Army Corps of Engineers: Section 404 Permit

(1) Provide a detailed discussion of hydrologic impacts due to construction of and withdrawals from the final pumping well.

(2) Provide a discussion of options considered to minimize the impacts.

(3) Provide a discussion of withdrawal impacts on downstream wetlands.

(4) Discussion of impacts associated with the withdrawal based on a proposed pumping schedule. An additional pumping test or modeling effort approved by MassDEP at the proposed pumping schedule may be required to demonstrate long-term drawdown and recovery.

(5) Replication plans shall be submitted at this time. The Corps requires mitigation which replicates the "function and values" of the impacted wetlands.

(6) Survey sample plots shall be identified at this time for long term monitoring under the withdrawal permit for the Water Management Act.

(7) Public notices for MassDEP and the Army Corps of Engineers shall be executed at this time.

d. Department of Conservation and Recreation: Approval of Transfer

A copy of the pumping test report must be submitted to DCR. If the DCR Lands Committee has approved the site for well development and transfer to the proponent, DCR submits a transfer request (Form TR1) to the Division of Capital Asset Management and Maintenance (DCAM) for transfer of the property to the proponent. A surveyed map including any property easements, utility easements, accessways, the Zone I and neighboring land uses must be submitted to DCAM. It is recommended that the proponent contact DCAM for specific instructions on survey map requirements. DCAM will poll state and local agencies to determine if any interest exists in the property. DCAM will also conduct an appraisal of the property to determine its value.

Concurrent with the Lands Committee's approval for further water supply development work, DCR will file legislation to transfer the state owned property (Article 97 land) to the proponent.

4.20 General Well Construction

The proponent for a new source or replacement well shall notify MassDEP of construction schedules and changes to those schedules. Certain engineering or geologic circumstances may require site specific well construction adaptations. It shall be left to the discretion of MassDEP to allow deviation from the following well construction criteria:

4.20.1 Well Casing

1. Steel well casing wall thickness shall be dependent on casing length and shall be determined using American Petroleum Institute (API) or American Water Works Association (AWWA) standards.

2. All bedrock wells shall be cased and sealed a minimum of 15 feet into competent and unweathered bedrock.

3. Every well shall be tested for plumbness and alignment in accordance with AWWA standards. The test method and allowable tolerance shall be clearly stated in the specifications. If the well fails to meet the requirements, the engineer may accept it, if it does not interfere with the installation or operation of the pump or uniform placement of grout.

4.20.2 Well Screen

1. The screen must be constructed of material resistant to damage by chemical action of groundwater or cleaning operations.

2. The screen shall have size of openings based on sieve analysis of formation and/or gravel pack materials.

3. The screen shall have sufficient diameter to provide adequate specific capacity and aperture entrance velocity, which shall not exceed 0.1-foot per second.

4.20.3 Grouting Requirements

Recommendations for grouting techniques and materials shall be accompanied by an explanation of selection and shall be presented to MassDEP prior to well construction. All permanent well casings shall be grouted from the bottom of the casing, or the top of the well screen's filter pack (if present), to the bottom of the pitless adapter. Where no pitless adapter is present, the well casing shall be grouted to ground surface. These requirements also apply to bedrock wells.

Wells with Planned Yields Less than 100,000 gpd - Well casing and drilling techniques shall allow for a minimum of 3 inches annular space between the outer diameter of the well casing and the borehole. At MassDEP 's discretion a smaller annular space may be allowed.

Wells with Planned Yields 100,000 gpd and Greater - Well casing and drilling techniques shall allow for a minimum of 2 inches annular space between the outer diameter of the well casing and the borehole.

All temporary construction casing should be removed, but shall be withdrawn at least 5 feet to insure grout contact with the native formation.

1. Neat Cement Grout

   Type II cement conforming to ASTM standard C150 and water must be used for 1.5-inch openings, with not more than six gallons of water per 94 lbs of cement.

2. Concrete Grout

   a. Concrete grout shall contain equal parts of type II cement conforming to ASTM standard C150 and sand, with not more than six gallons of water per 94 lbs of cement. Concrete grout must be used for openings larger than 1.5-inches.

   b. Where an annular opening larger than four inches is available, gravel not larger than one-half (1/2) inch in size may be used in the concrete grout.

3. Clay Seal

   Pressure-grouted clay slurry may be used where an annular opening of greater than six inches is available, when approved by MassDEP's regional office.

Grouting shall take place by pressure or tremie pipe and shall be applied from the bottom of the section being grouted upward and should be completed in one continuous motion. Any deviation from this methodology requires approved from MassDEP. The casing must be provided with sufficient guides welded to the casing to permit unobstructed flow and uniform thickness of grout. After cement grouting is applied, work on the well shall be discontinued until the cement or concrete grout has properly set, in accordance with manufacturers recommendations.

4.20.4 Upper Terminal Well Construction

1. Permanent casing for all groundwater sources shall project at least 12 inches above the pump house floor or concrete apron surface and at least 18 inches above final ground surface.

2. Where a well house is constructed, the floor surface shall be at least 6 inches above the final ground elevation.

3. The top of the well casing, at sites subject to flooding, shall terminate at least 2 feet above the 100-year flood elevation, or as MassDEP directs.

4.20.5 Development and Disinfection

1. Every well shall be developed to remove the native silts and clays, drilling mud and/or finer fraction of the gravel pack. Wells shall be developed using either pumping or surging techniques.

2. Where chemical conditioning is required, the specifications shall include provisions for the method, equipment, chemicals, testing for residual chemicals, and disposal of waste and inhibitors. Prior to on-site disposal, acidified wastewater shall be neutralized to a pH between 6.5 and 8.0. Chlorinated wastewater shall be completely neutralized prior to on-site disposal.

3. Bedrock well source proponents considering well yield enhancement techniques such as hydrofracturing or other techniques shall notify the appropriate MassDEP regional office verbally or in writing. The results of the enhancement exercise shall be reported to the appropriate MassDEP regional office.

4.20.6 Capping Requirements

1. A welded metal plate or locking threaded cap is the preferred method for capping a well.

2. At all times during the progress of work, the contractor shall provide protection to prevent tampering with, or entrance of foreign materials into the well.

4.20.7 Aquifer Types and Construction Methods - Special Conditions

1. Sand and Gravel Wells

   a. If clay or hardpan is encountered above the water bearing formation, the permanent casing and grout shall extend through the clay or hardpan.

   b. If a sand or gravel aquifer is overlain by permeable soil, the permanent casing and grout shall extend to at least 20 feet below original or final ground elevation, whichever is lower.

   c. If temporary casing is used, it shall be completely withdrawn as grout is applied.

   d. Gravel pack shall be well rounded particles, 95% siliceous material, smooth and uniform, free of foreign material, properly sized, washed and then disinfected immediately prior or during placement.

   e. Each gravel pack shall be tremied in place in one continuous operation.

   f. Protection from grout leakage into the gravel pack or screen shall be provided through the use of a transition sand.

2. Bedrock Wells

   a. Recommendations for grouting techniques and materials shall be accompanied by an explanation of selection and shall be presented to MassDEP during the site visit or earlier in the Source Approval process.

   b. All pumps with a capacity greater than the approved yield shall be equipped with modulating discharge controllers coupled to drawdown sensors in the well. These discharge controllers gradually throttle discharge as dynamic pumping level drops from the theoretical drawdown (based on specific capacity) to shutoff at an elevation 5.0 feet above the top of the pump if a submersible pump, or 5 feet above the top of the pump intake if a turbine pump is used. As minimum protection, a low water cutoff shall be provided.

3. Dug Wells

   MassDEP will not approve new dug wells. For the rehabilitation of existing dug wells, the following shall apply:

   a. The protective casing of the well shall be watertight and shall extend at least 10 feet below original or final ground elevation, whichever is lower.

   b. A watertight cover for the well casing shall be installed.

   c. The upper terminus of the well casing shall extend at least 12 inches above the pre-existing ground surface or two feet above the highest recorded flood, whichever is greater.

   d. Pump discharge piping, placed through the well casing or wall, shall be sealed.

4. Naturally Flowing Wells

   a. Flow that exceeds system demand shall be controlled to prevent damage to the well or its associated piping, equipment, and building structures (i.e. damage caused by freezing). Any damage prevention controls that involve "bleeding" water from the wellhead shall be installed in such a manner as to prevent rainwater or potential floodwater from entering the well, and the outfall shall be covered with a 24-mesh, corrosion resistant screen.

   b. If erosion of the confining bed appears likely, special protective construction may be required by MassDEP.

4.20.8 Well Pump and Pumping Capacity

1. The well pump shall be capable of operation at the approved yield for extended periods.

2. For *wells with approved yields of 10,000 gpd and greater*, MassDEP may allow the installation of a pump with a capacity that is no greater than 1.5 times MassDEP approved daily yield (expressed in gpm). If MassDEP approves a pumping capacity that is greater than the approved yield (in gpm), the water supplier may pump the well at the higher pumping capacity (in gpm) but may not exceed the approved daily yield (in gpd). For instance, if MassDEP allows the installation of a pump with a capacity that is 1.5 times the approved daily yield, the water supplier may withdraw water from the well at the higher rate for a maximum of 16 hours per day.

3. For *wells with approved yields of less than 10,000 gpd*, MassDEP may allow the installation of a pump that is rated at up to 5 times the approved yield (in gpm). If MassDEP allows the installation of the oversized pump, the following restriction shall apply: the water level in the well must have stabilized during the pumping test and the *approved yield (in gpd)* cannot be exceeded on a daily basis.

4. Information on pump curves of the proposed well and a schematic cross-section of the proposed well showing well depth, pump setting, screen setting, and the low water cutoff shall also be submitted.

5. Instrumentation and control equipment shall be installed to ensure that the operating water level in the well is at least 5 feet above the top of the well screen, or 5 feet above the pump intake, whichever is higher.

6. Check valves shall be installed.

7. For bedrock wells, a minimum of 35 feet of borehole must be maintained below the top of the pump.

8. Line shaft pumps shall:

   a. Have the casing firmly connected to the pump structure or have the casing inserted into a recess extending at least 0.5 inch into the pump base;

   b. Have the pump foundation and base designed to prevent water from coming into contact with the joint.

9. Where a submersible pump is used:

    a. The top of the casing shall be effectively sealed against the entrance of water under all conditions of vibration or movement of conductors or cables;

    b. The electrical cable shall be firmly attached to the riser pipe at 20-foot intervals or less;

    c. The installation shall provide for the ability to measure drawdown.

4.20.9 Discharge Piping and Appurtenances

1. Discharge Piping
   The discharge pipe for each well shall:

    a. Be designed so that the friction loss will be minimized;

    b. Have control valves and appurtenances located above the pump house floor when an above-ground discharge is provided;

    c. Be protected against the entrance of contamination;

    d. Be equipped with a check valve, shutoff valve, pressure gauge, means of measuring flow, and smooth nosed sampling tap located at a point where positive pressure is maintained and at least 100 feet distance from pumping station;

    e. Where applicable, be equipped with an air release-vacuum relief valve located upstream from the check valve, with exhaust/relief piping terminating in the down-turned position at least 18 inches above the floor and covered with a 24-mesh corrosion resistant screen;

    f. Be valved to permit test pumping and control of each well;

    g. Have all exposed piping, valves, and appurtenances protected;

    h. Be properly anchored to prevent movement;

    i. Be protected against surge or water hammer;

    j. The discharge piping shall be provided with a means of pumping to waste, such as a hydrant, but shall not be directly connected to a sewer.

2. Pitless Well Units

    a. MassDEP must be contacted for approval of specific applications of pitless units.

    b. Pitless units shall:

        (1) Be threaded or welded to the well casing;

        (2) Be of watertight construction throughout;

        (3) Be of material and weight at least equivalent and compatible to the casing;

(4) Have field connection to the lateral discharge from the pitless unit of threaded, flanged or mechanical joint connection.

c. The design of the pitless unit shall provide:

(1) Access to disinfect the well;

(2) A properly constructed casing vent;

(3) Facilities to measure water levels in the well;

(4) A cover at the upper terminal of the well that will prevent the entrance of contaminants;

(5) A contamination-proof entrance connection for electrical cable;

(6) An inside diameter as great as that of the well casing, up to and including casing diameters of 12 inches, to facilitate work and repair on the well, pump, or well screen.

3. Casing Vent

Provisions shall be made for venting the well casing to the atmosphere. The vent shall terminate in a down-turned position, above the 100-year flood elevation, at or above the top of the casing or pitless adapter, with a minimum 1.5-inch diameter opening covered with a 24-mesh, corrosion resistant screen. The pipe connecting the casing to the vent shall be of adequate size to provide rapid venting of the casing. In order to avoid the installation of a high vent pipe for a well located in a floodplain, a directional vent pipe that vents at the pump house may be installed, provided that it is constructed in such a fashion as to avoid the creation of hydraulic locks.

4. Water Level Measurements

a. Provisions shall be made for periodic measurements of water levels in the completed well.

b. When recommended, installation of permanent water level measuring equipment shall be made using corrosion resistant materials attached firmly to the drop pipe or pump column and in such a manner as to prevent entrance of foreign materials.

c. All bedrock production wells shall be constructed to allow water level measurement at all times through the use of stilling wells or internal hose connections within the well casing and well bore.

4.20.10 Observation Wells

Observation wells shall be protected at the upper terminus to preclude entrance of foreign materials.

4.20.11 Spring Construction Standards

A new spring source shall be protected against contamination from surface and storm water run-off, direct infiltration of precipitation, flooding, and acts of vandalism/sabotage. Constructing a springhouse at the spring source shall provide part of that protection. A springhouse is an otherwise watertight collection vessel with either a permeable floor or a permeable subsurface section of a wall.

Based upon the nature of the flow, some of the fill material beneath or beside the springhouse will be of a permeable nature to promote spring yield and to reduce particulate matter from entering the springhouse. Any coarse material that extends beyond the footprint of the springhouse shall be covered with fill material which grades from coarser to finer material with increased elevation to minimize the quantity of fine soil particles that could percolate down into the spring water. An impervious apron composed of a minimum of a 6-inch thick layer of clay shall extend a minimum distance of 10 feet from the springhouse walls or to the full extent of the excavation for the springhouse, whichever is greater. The apron should slope away from the springhouse at a slope of approximately 2-inches per foot. This will prevent contaminated water from pooling against the springhouse at or beneath the ground surface. A minimum of 3 feet of sand and topsoil should be placed above the clay layer and shallow rooted grass or plants should be planted and maintained to prevent soil erosion and to minimize the potential for plant roots to penetrate through the clay layer.

Other than the permeable floor or wall section that allows spring water to enter the springhouse, the remaining wall sections and the roof shall be impermeable. The walls shall be constructed of steel and/or concrete. The roof or cover of the springhouse shall overhang the wall exteriors by a minimum of 3 inches and shall have drip edges to prevent roof drainage from running down the walls. The exterior roof surface should be sloped so that water is forced to drain off.

The inlet for the supply-line piping shall be no lower than the pre-development elevation of the ground surface where the spring water had previously surfaced. Alternatively, control mechanisms shall be installed to prevent the water level in the springhouse from dropping beneath that elevation. If the supply-line piping design allows the springhouse water level to drop below the pre-development water table elevation, the source shall be classified as groundwater and well construction standards will apply. The inlet shall be placed at least one foot above the floor of the spring to reduce the potential for drawing in fine sand or silt that may enter the springhouse. The supply-line piping outside of the springhouse shall be laid below frost line.

The springhouse shall not be used as a water storage vessel as this would hydraulically affect groundwater. The spring flow shall be directed to a separate storage tank, to prevent water table mounding from occurring at the springhouse. Significant mounding could result in a destabilization of the springhouse foundation, flooding of the area surrounding the springhouse, or cause a rupture or "blow-out" to occur in the impermeable clay layer that surrounds the springhouse.

An overflow pipe capable of draining the maximum spring flow volumes with the supply-line piping closed or blocked without having the water level in the springhouse reach the top of the walls or the bottom of the roof shall be installed with an inlet elevation no closer than 1-foot below the top of the walls or the base of the roof/cover, whichever is lower in elevation. The overflow pipe shall be resistant to vandalism and shall slope down away from the springhouse; and, the outfall shall be covered by a screen that would prevent animal or insect infestation. The screen shall be composed of a combination of mesh sizes for structural strength, durability, and effectiveness. The outfall shall be located at least 3 feet away from the springhouse walls and at an elevation not less than 1-foot above ground surface to avoid potential backflow and to minimize access to insects and small animals in the event that the integrity of the outfall screen become compromised. Unless discharging onto a solid surface such as bedrock, concrete, or asphalt; stone riprap shall be placed beneath the outfall to prevent soil erosion. The spring site shall be landscaped or drained such that if 100 percent of the spring's capacity were to exit the springhouse through the overflow pipe, it would not result in flooding or soil erosion.

Drainage piping and valves may be installed in the springhouse for the purpose of draining the spring for repairs or cleaning. The outfall shall be constructed in a similar fashion to the overflow pipe.

The interior of the springhouse shall be disinfected with a chlorine solution, and flushed, prior to being placed in service.

A drainage trench shall be installed at a distance of 25 to 50 feet uphill from the springhouse to prevent surface water runoff from reaching the springhouse. The drainage trench shall direct potential surface water runoff to points where it would naturally flow away from the springhouse and any portion of ground surface within a 25-foot radius of the walls of the springhouse. The drainage trench shall be lined with an impermeable material to prevent a significant amount of infiltration into the groundwater. If the trench is composed of silts or clays, an overlying layer of riprap shall be placed on top of the impermeable material to prevent its erosion.

A fence with a radius of at least 25 feet shall also be placed around the spring to minimize the potential for vandalism and contamination by animals.

Before placing the springhouse in service, disinfect the inside of the springhouse with a chlorine solution. The solution for washing the springhouse should be mixed in a ratio of 1 part chlorine (approved for use in water supplies) per 1,000 parts water. After washing the interior of the springhouse, chlorine should be added directly to the water in the springhouse in a ratio of 100 parts chlorine per million parts water, and allowed to sit for 24 hours. If it is not possible to allow the chlorine to sit for 24 hours, two consecutive applications twelve hours apart should provide for adequate disinfection.

MassDEP shall issue site-specific construction standard approvals for a spring source that is developed using horizontal well(s). MassDEP will only categorize such a source as a spring, if its operation does not hydraulically affect the groundwater table.

4.21 Well Abandonment and Decommissioning

MassDEP uses the term "abandonment" to refer to the elimination of a well's status as a public water supply source. "Decommissioning" refers to the physical closure of the well.

No supplier of water may abandon a source of water supply without the prior written approval of MassDEP. Submittal of the well abandonment application must be accompanied by the appropriate permit application (BRP WS 36) and fee, if applicable. MassDEP will not approve the abandonment of any public water supply unless the supplier of water demonstrates to MassDEP's satisfaction that such action will have no significant adverse impact upon the water supplier's present and future ability to provide continuous, adequate service to consumers under routine and emergency operating conditions. Emergency conditions include those concerning the contamination of sources of supply, failure of the distribution system, and shortage of supply.

Once MassDEP approves abandonment of a well, the well no longer has any status as a public water supply source. Any future attempt by the water supplier to reactivate or replace the well will be subject to all of the requirements of the Source Approval process. The Zone II of an abandoned well will be rescinded by MassDEP, unless there are additional wells included in the Zone II that are not abandoned. An abandoned well is not protected as a public water source under any MassDEP programs, and a rescinded Zone II is not protected as a public water supply area under MassDEP programs.

1. Purpose

   Any abandoned well that is no longer in use or that is unfit for its intended purpose should be decommissioned. Plugging the well and restoration of the surface are the central features of the decommissioning process. For small diameter wells, plugging consists of constructing a low permeability cylinder or plug within that portion of the subsurface occupied by the well. For most larger diameter wells, plugging consists of filling the majority of the well with a clean material and inserting a low permeability plug at the surface.

Surface restoration consists of the removal of the upper 3 or 4 feet of the well and backfilling the area with an effective seal.

Proper abandonment of wells will:

a. Eliminate physical hazards;

b. Prevent groundwater contamination;

c. Conserve the yield and hydrostatic head of confined aquifers;

d. Prevent the intermingling of potable and non-potable groundwater;

e. Prevent the migration of contamination through a confining layer separating aquifers.

It should be noted that the objective in Massachusetts differs markedly from the goals established by the American Water Works Association and the statutes, regulations, or guidelines of most other states. Many organizations advocate the concept of restoration, as far as possible, of the controlling hydrogeological conditions that existed before the well was drilled and constructed. To accomplish this goal some states have suggested the placement of sand and gravel opposite the more permeable subsurface zones and clay opposite less permeable zones. Ideally this represents the proper method of well abandonment, but in practice, this procedure may be very difficult to properly execute.

MassDEP therefore will require this method be used only for confined aquifer wells where the possibility of cross-contamination of aquifers can be significantly reduced by the placement of low permeability material opposite confining layers.

In order to meet the objectives of proper plugging as stated above, MassDEP has tried to develop a simple, workable approach that will solve the existing and potential problems from unsafe non-decommissioned wells.

A Massachusetts Registered Well Driller shall complete well decommissioning. There is no nationally recognized or state-approved examination or certification process for well decommissioning and plugging. However, it is obvious that a well contractor or person who is familiar with well construction and the geologic conditions of their region is preferable to a person who does not routinely perform such work.

2. Clearing the Well

Decommissioning a well starts with removal of any obstructions, such as drop pipes, check valves and pumps, and clearing any obstacles or debris that may have entered the well.

When the well is obstructed by pumps or other equipment that have been dropped down the well, the debris must be removed or "fished" out before the well can be sealed. A variety of fishing tools are used to remove obstructions. Threaded taps on the end of a drill rod may be run into the hole in an attempt to screw into the top of a pump or drop pipe. Another type of equipment used is an 'over shot' (a casing with inner teeth that is run over the obstacle to be removed). Corkscrews and spears also have been used to hook the obstacle for removal.

In some instances the driller may chop or grind up the obstacles in an attempt to clear the well. Debris or other materials such as rock, sand, clay, stones, and wood is usually drilled out or washed

out of the hole. This technique appears to be suitable for destroying multi-level wells installed within a single borehole.

3. Plugging Material and Procedures

There are a large number of plugging materials available that can be used to plug abandoned wells. Each grout has certain special characteristics and distinctive properties. Therefore, one plugging material may be especially suited for doing a particular job. The selection of the most appropriate material or combination of materials is dependent on the construction of the well, the nature of the formation penetrated, the material and equipment available, the location of the well with respect to sources of contamination, and the cost of doing the work.

Recognizing that several well types exist in Massachusetts, MassDEP recommends plugging procedures for four general categories of wells:

a. Sand and Gravel Wells with Diameters Greater than 2.5 Inches

Because some of these wells could potentially have large diameter casing it generally is considered prohibitively expensive to completely fill them with sealing material. Sealing materials are watertight substances that prevent water and contaminants from entering and seeping through abandoned wells. The proper procedure for the decommissioning of these wells will be the following: the casing will be cut off 4 feet below the surface. Fill material (clean sand, gravel or pea gravel or crushed stone) will be used to fill the casing to within 10 feet of the top of the cut off casing. The upper 10 feet will be filled with a mixture of neat cement and 6% bentonite by weight. The plugging material shall be allowed to flow out the top and along the sides of the casing to assure that a proper seal is established. The upper 4 feet of soil from the top of the casing to the surface shall be properly compacted.

b. Bedrock Wells with Diameters Greater than 2.5 Inches

Bedrock well casings will be cut off 4 feet below the surface. To prevent the transport of fill material into fractures, it is recommended that larger diameter fill material, such as gravel or pea gravel, be used. The well will be filled to the base of the well casing. The casing shall then be filled with a mixture of neat cement and 6% bentonite by weight. The plugging material shall be allowed to flow out and along the sides of the casing to assure that a proper seal is established. The upper 4 feet of soil from the top of the casing to the surface shall be properly compacted.

c. Confined Aquifer Wells

The low permeability layer that creates the confined aquifer must be sealed so that there is no chance of leakage between aquifers and the yield and hydrostatic head of the aquifer can be retained. A mixture of neat cement and 6% bentonite by weight will be used to seal the confining layer and will extend 10 feet below and 10 above the confining layer. Clean fill can be used to plug the remainder of the well in the confined and unconfined units. The well casing will be cut off 4 feet below ground surface and the top 10 feet of the casing will be filled with a mixture of neat cement and 6% bentonite by weight. The upper 4 feet of soil from the top of the cut off casing to the surface shall be properly compacted.

d. Small Diameter Wells (< 2.5 inch diameter)

For all small diameter wells (<2.5 inches), a mixture of neat cement and 6% bentonite by weight possesses most of the advantages that MassDEP looks for in a plug for wells where the grout will be inserted through the well riser. This neat cement mixture may be used as grout for wells

installed in all geologic formations. This neat cement mixture is superior for sealing small openings, for penetrating any annular space outside of casings, and for filling voids in the surrounding formation. When applied under pressure, it is strongly favored for sealing wells under artesian pressure or those encountering more than one aquifer. Decommissioning of a tubular wellfield can be accomplished by pulling the casings and allowing the formation to collapse in the hole. The surface shall then be properly compacted to prevent water collection.

Completion of the decommissioning process will be conducted in accordance with the procedure described in the Final Surface Completion section below.

4. Placement of Plugging Materials

Good planning is the first step in decommissioning any well. Professional well drillers start by carefully measuring the depth and diameter of the well to determine the amount of plugging material required. After clearing of the well bore, the well is ready for plugging. For wells requiring grout slurry, the mixture must be placed from the bottom to the top and not from the top to the bottom. In other words, slurries cannot be poured from the land surface into the borehole, annular space, or well to be sealed. When grout is placed at the bottom of the space to be grouted and finally appears at the surface or top, the integrity of the plug is assured. Methods involving pouring grout from the surface into the annular space are not reliable because bridging may occur and the depth of grout descent cannot be easily verified. However, pouring grout through a tremie pipe is sometimes a satisfactory alternative to pumping through a tremie pipe. An improperly sealed well may be as much a threat to groundwater quality as an unsealed well.

The well driller shall calculate the volume of slurry that will be needed to grout the well. He shall have enough mixed slurry ready for placement so that it will not be necessary to stop the grouting process in order to prepare more slurry. Due to borehole irregularities, it is advisable to have on hand 25 to 50% more slurry than the calculated volume.

The grout pipe (or tremie pipe) method, either with or without a grout pump, appears to be a method of grout placement that will achieve all the objectives of the well plugging program. A vigorous preventative maintenance program for mixing and pumping equipment, compressors, hoses and fittings, is essential. This includes adequate clean-up of equipment after each grout job. Failure of equipment in the field can result in: waste of grouting material, lost labor and equipment costs, property damage, contamination of the grout, and/or an unsuccessful or incomplete grout job.

To assure that a well is properly plugged and that there has been no bridging of the material, verification of calculations and measurements are made by the well contractor to determine whether the volume of material placed in the well equals or exceeds the volume of the casing or the hole that has been plugged and/or filled.

5. Final Surface Completion

A proper surface seal is the final step in decommissioning a well. The well casing shall be removed from the upper 4 feet below ground surface. Sealing material placed at the top of the well shall extend several inches above and around the outside of the cut-off casing to reduce seepage down the outside of the casing. In some cases it may be necessary to bring in fill to properly complete the surface. Finally, compacted soil shall be mounded over the well site. This is done to prevent water from collecting above the abandoned well.

6. Record of Decommissioning

   The well driller that completes the decommissioning of the well shall submit complete and accurate records of the entire decommissioning procedure to the DCR, Well Drillers Program. The standard Well Completion Report form shall be used, indicating the well is being decommissioned. A copy of the report shall also be submitted to the water supplier and the municipality's board of health. The water supplier shall submit a copy of the report to MassDEP Drinking Water Program.