RESPONSE TO OUTSTANDING SWMI QUESTIONS / COMMENTS
March 23, 2012

Note: Below are the answers to outstanding questions as of the SWMI Technical Question and Answer Meeting, held on February 17, 2012. Many questions were answered at the meeting. Additionally, individuals have had questions that have been answered in the interim.

1. **One-page summary of what Todd's presentation means** (Kaiser)
   A summary of the presentation can be found in the brief write-up on streamflow criteria that was provided in the SWMI Framework document (Page 8) and the Appendices document (Page 20) on February 03, 2012.

2. **Need an example (such as the Parker) to work through Linda's numbers (**Kaiser)
   All of the statistics and spreadsheets used to develop the Basin Yields for Safe Yield calculations are available (upon request). The values used for the Parker River basin are as follows:

Monthly Q90's and Annual Rollup of Monthly Flows for Parker River Basin, cfsm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0.50	0.63	1.19	1.45	0.84	0.32	0.14	0.09	0.10	0.14	0.27	0.46	0.51

   Multiply the Annual value by the entire Basin Area:

   Basin Yield = 0.51 cfs per Square Mile X 81.8 Square Miles = 41.7 cfs

   Basin Yield = 41.7 cfs X 0.646 MGD/cfs = 26.9 MGD

   Safe Yield = Basin Yield X 55% = 26.9 MGD X 0.55 = 14.8 MGD

3. **How were the new or old DEP baseline numbers actually calculated?** (Kaiser)
   The old Baseline is defined as: Registered Volume OR 2003-2005 actual average water use OR 2005 actual water use – whichever is higher;
   The new Baseline is defined as: Registered Volume OR 2003-2005 actual average water use + 5% (or 8% if it does not trip a BC or FL) OR 2005 actual water use + 5% (or 8% if it does not trip a BC or FL)-whichever is higher;

   In both the old and new baseline these qualifiers also exist:
   - Baseline cannot be lower than the registered volume;
   - DCR Water Needs Forecast will be the limit if the DCR forecast value is less than the other (2003-2005 average or 2005) options with the exception of the registered volume which baseline cannot be lower than.
   - Baseline cannot be higher than the allocated volume allowed in 2005.

RESPONSE TO OUTSTANDING SWMI QUESTIONS / COMMENTS
March 23, 2012

4. **If we understand correctly, the biological categories map is based on modeled percentage "reductions" in fluvial fish abundance without regard to actual fluvial fish counts. Therefore, the framework is incorrect in stating that "the relative abundance of fluvial fish, as measured by catch per unit effort (CPUE) was used as a surrogate for the current condition of fisheries resources." Results for abundance were modeled, not measured. If this is correct, we believe it would be informative to see at least two more maps on February 17th–one showing "actual" measured fluvial fish counts and another showing the theoretically "unaltered "counts that the model predicts "should" exist in the subbasins.** (MWWA)
   We will clarify that relative fluvial fish abundance is predicted and will delete the word "measured" from this sentence in the framework.

   A SWMI interactive GIS map is expected to be available by March 26. The map will include fish sample point locations with observed and modeled fluvial fish relative abundance data, along with biological categories and flow levels for 1400 Mass Water Indicators subbasins. The GIS map, instructions on use, and related material will be available from the DEP webpage.

5. **When comparing actual fluvial fish abundance in individual streams to the model predictions of reductions, what is the accuracy of the USGS model to predict actual measured conditions?** (MWWA)
   The model successfully determined a significant negative relationship between flow alteration and fluvial fish relative abundance. As stated on page 49 of the USGS report, "Factors Influencing Riverine Fish Assemblages in Massachusetts" (SIR 2011-5193), "the GLM model predictions represent the mean response at a site given the specified values for the variables in the equation. Consequently, these models are best employed to compare fish-assemblage response among a set of sites… The models are not meant to be used to predict responses at individual sites." Thus, the equations provide the basis of relationships between August flow alteration from ground water withdrawal and other variables on the robustness of fluvial fish communities (fluvial fish relative abundance).

   It is important to note that the model predicts the mean fluvial fish relative abundance response to alterations of an August median flow condition. A single fish sampling event would not be expected to replicate the results of the model, just as a single flow measurement made at a site on one August day would not be expected to replicate an August median flow condition.

   In technical terms, the accuracy of the model was also described in the USGS report. The predictive capability of the model (pseudo R-squared of 18%) is within the range expected for biological models. The association of percent alteration of August median streamflow from ground water withdrawals with a decline in fluvial fish relative abundance is significant according to the model and the model results are useful in the development of a statewide screening tool. There is only a 3% chance that the results could be ascribed to chance alone. This is statistically significant.

RESPONSE TO OUTSTANDING SWMI QUESTIONS / COMMENTS
March 23, 2012

The SWMI Technical Committee discussed the use of the fish and habitat study in great detail at its July 13, 2010 meeting. The use of the model was presented as a statewide screening tool that describes the current aquatic habitat condition, using the best available science (subject to future modification as the science develops) and as a useful tool in establishing streamflow criteria. Fluvial fish relative abundance was selected as an indicator of aquatic habitat. USGS noted at the meeting that the model represents a line through a data cloud, but the results were statistically significant and the model's use as a screening tool was appropriate. The use of the study was discussed in detail again at the August 24, 2010 SWMI Technical Committee meeting, and the attendees supported without opposition the recommendation that the SWMI Advisory Committee adopt the habitat categorization methodology as presented. After consideration of the model's strengths and limitations, the fish and habitat model was used as the basis for the SWMI Biological Categories and associated Flow Levels applied to all of the subbasins in the state to provide an assessment of expected fluvial fish relative abundance given the characteristics of the subbasin drainage area.

We recognize, however, that the model is just that, and have acknowledged that when applied to individual sites, the categories may not correspond to observed conditions. That is why the Framework allows for the submission of data to rebut the presumptive categories. The EEA agencies are committed to ensuring that there is a clear, predictable and streamlined process for the submission and consideration of site-specific data, and that this will be put in place through the pilots before the regulations are finalized.

6. **What are the documented examples of specific 'considerably reduced abundances' of individual sensitive species in Category 3 streams?** (MWWA)

The model is a representation of mean response across a variety of conditions in the state, not intended to directly assess a change in conditions at any specific site over time. The USGS report did not analyze data to assess nor describe reduction in abundances of any given species at specific sites over time.

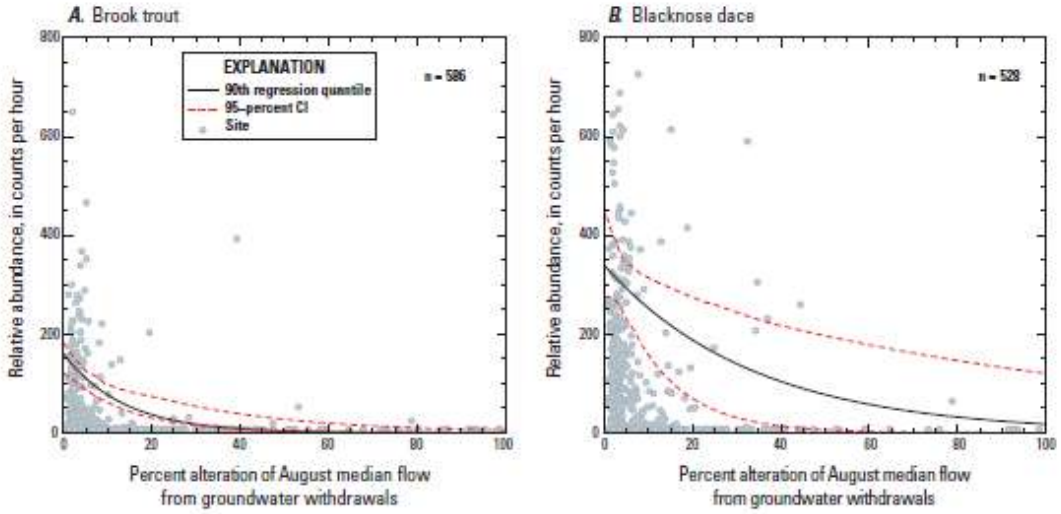


Figure 12. Quantile regression relations between relative abundance of A, brook trout and B, blacknose dace and percent alteration of August median flow from groundwater withdrawals for selected fish-sampling sites on Massachusetts streams. CI, confidence interval; n, number of sites. Fish samples were collected from 1998 to 2008.

Fluvial specialists brook trout and blacknose dace were illustrated as examples of sensitive species that are particularly vulnerable to low levels of August median streamflow depletion from ground water withdrawals. The results of the USGS quantile regressions along with data points from the statewide fish sampling sites are shown in Figures 12A and 12B of the USGS report referenced above.

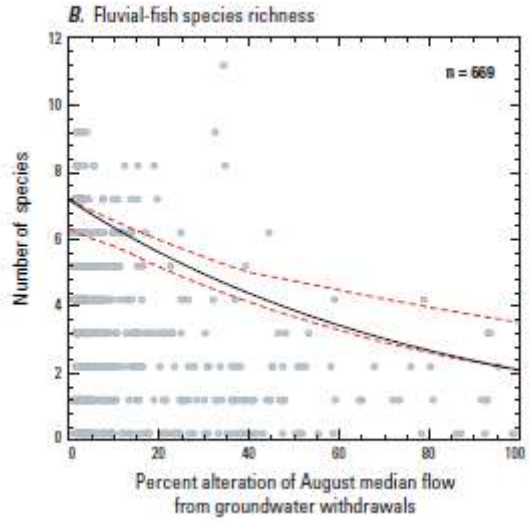
The two graphs show steep slopes for the black 90th quantile lines for relative abundance of brook trout and blacknose dace at low levels of August median streamflow alteration from ground water withdrawals. In other words, sites with the lowest amounts of August median streamflow alteration from ground water withdrawals had the highest numbers of these sensitive fluvial fish, while the sites with higher amounts of August median flow alteration from ground water withdrawals had much lower numbers of these fish. These two species are examples but do not represent the total of sensitive species and life stages on which the SWMI biological categorization framework was based. For example, juvenile fish of most species are more sensitive to alteration of their habitat than the adults of the same species.

In the SWMI framework, Biological Category 3 streams are those with modeled 15 to 35 percent lower fluvial fish relative abundance compared with the unimpacted condition. This corresponds with August median flow alterations from ground water withdrawals of 10 to 25 percent. As can be seen on the figures above, at sites with the range of 10 to 25 percent August median flow alteration from ground water withdrawals, the abundances of brook trout and blacknose dace are much lower than the unimpacted (zero percent alteration) sites.

7. **What are the documented examples of specific 'reductions in sensitive taxa' and "fluvial species diversity" and "substantive reductions of relative abundance" of individual sensitive species in Category 4 streams?** (MWWA)
The term "species diversity" or richness refers to the number of species present at a location; it does not address the presence or absence of any particular species. When it is stated that a "reduction in sensitive taxa" and "fluvial species diversity" is modeled, it means that a lower number of species would be present at a site with higher amounts of August median flow alteration from ground water withdrawals than at sites with lower amounts of August median flow alteration from ground water withdrawals. A lower value of species abundance generally implies a less robust ecological condition. The model does not imply that any particular individual species has been lost. The model is a representation of mean response across a variety of conditions in the state, not intended to directly address a change in conditions at any specific site over time. The USGS report did not analyze data to assess or describe the extirpation of any given species at specific sites over time.

While fewer species are expected at higher levels of flow alteration, the report is agnostic to the extirpation of any given species. Biological Category 3 streams (those with 10 to 25% alteration of August median flows due to groundwater withdrawal) almost always have eight species or fewer (figure 13B, reproduced below); those in Biological Category 4 (those with 25 to 55% alteration of August median flows due to groundwater withdrawal) almost always have four species or fewer.

RESPONSE TO OUTSTANDING SWMI QUESTIONS / COMMENTS
March 23, 2012



8. **Could you provide a more descriptive list of the fish sample sites that were included in the USGS model** (MWWA)
   A descriptive list of fish sample site locations and their model fish data will be posted as supportive documentation along with the SWMI interactive GIS map on the DEP webpage by March 26.

9. **What role, if any, will DCR play in amending its management policies for its recreational impoundments to assist in ensuring adequate downstream flow?** (MWWA)
   DCR manages a limited number of water bodies across the state that are primarily recreational, although some have municipal groundwater supplies nearby that are dependent on water levels. Where dam structures and recreational activities allow, DCR releases water downstream during low-flow periods. DCR can work with stakeholders at specific water bodies to determine if any changes are possible and could be helpful for low-flow downstream conditions.

10. **MWWA notes that the Streamflow Criteria has changed and is especially interested in learning why the seasonal criteria changed so dramatically. What is the biological rationale for the seasonal criteria? For example, how does it make sense that only 3% alteration could be considered significant in the early spring when flows are orders of magnitude higher than they are in August? Added in Comment Box: "Explanation is needed of what justifies switch from impact on biological resources (August) to "impact on hydrograph" (other months), especially what criteria are used, on what basis of documented significance?"** (MWWA)
    The seasonal criteria are an attempt to recognize that stream flow, and maintenance of the natural hydrograph depend on more than just August flows. Furthermore, stream flows should mimic the magnitude, frequency, timing, duration, and rate of change that are typical for natural systems. The

criteria changed because after the completion of the final Fish and Habitat study the percent alteration of median flow in August had changed within each biological category. Streamflow criteria for the other 3 months (October, January, April) were developed using these August values and were then compared with current maximum alterations for each season.

The February 17th Q&A presentation listed the rationale for the proposed streamflow criteria as follows: 1) seasonality protects aspects of the natural hydrograph; 2) that summer represents the time period of highest demand and lowest availability; 3) that August alteration percents are often highest of the four seasons illustrated; and 4) that even though small percents might be available in other seasons, they represent orders of magnitude higher volumes that are available in those months.

11. **How many subbasins will see violations in October but not in August?** (MWWA)
We consider the use of the term violations as premature. However, of the 389 subbasins that are in Flow Level 2 for August, 50 subbasins have more than 5% October flow alteration. Likewise, of the 225 subbasins in Flow Level 3 for August, 3 subbasins have more than 15% October flow alteration.

12. **How will streamflow criteria (i.e. all months) be applied in permitting?** (Colin Apse, Peter Newton) **How will SFC be required/permitted?** (Vicki Zoltay)
We recognize the importance of seasonality in streamflow criteria and the value those numbers in October, January and April bring to help protect streamflow and the natural hydrograph throughout the year. In those systems that are in the same flow level for the whole year, an increased withdrawal (above baseline) request will be checked against the streamflow criteria for August, October, January and April to see if the alteration crosses the thresholds for any of those months. If it does not cross the criteria for any month then, depending on the magnitude of the withdrawal, it can be subject to a Tier 2 or Tier 3 permit review. However, if the additional withdrawal crosses any of the seasonal streamflow criteria, then it could be considered as backsliding and the system can go through a Tier 4 permit review.

Agencies are currently working on details for the small subset of basins that start out at a different flow level in October versus the rest of the year (see answer to question #11 above) on how the seasonal criteria would apply in permitting.

13. **If a system contains subbasins in FLs 2 and 3, how will they be regulated?** (MWWA)
Agency staff are currently working through how a system with multiple subbasins will be permitted. Options vary from applying the worst flow level to the entire system (in this example, apply a FL3 to the system), to applying a sub-basin by sub-basin condition depending on where the withdrawal is occurring.

Also, it is important to note that there is very little difference in the SWMI Framework between requirements for a FL 2 and 3. Requirements increase if a subbasin has quality natural resources, or is a FL 4 or 5. One of the key differences between a FL 2 and 3 is that a basin (requesting an increased withdrawal above baseline) that is a FL 2 could trip its threshold sooner than a basin that is a FL3, and can therefore be subject to a Tier 4 permit review.

14. **How will SFC be calculated in areas that drain to the ocean where review will be provided on a case-by-case basis?** (MWWA)
    There are three types of areas that remain unassessed, and these are described in Appendix E of the SWMI Framework document (February 3, 2012), pages 22 and 23. These watersheds have different hydrological characteristics and fish community attributes compared to the rest of the state. In the Plymouth Carver, Cape Cod and Islands areas, the fish and flow relationships do not apply as a result of the thick sand and gravel geologic formations deposited in the wake of glacial retreat. The streamflow criteria developed for the remainder of the state cannot be directly used in these areas. There are also the coastal areas that are too close to the coast and do not drain to entirely freshwater rivers (such as in North Coastal, Buzzards Bay basins). Tidal flows from the ocean complicate streamflow estimation in these estuarine areas. The third area type is the Merrimack and Connecticut Rivers, where the fish and habitat study results do not apply due to the relatively higher flow rates of the rivers and their interstate watersheds which are each more than 1,000 square miles in size. The agencies are currently evaluating various approaches and have not yet determined how SWMI Principles would be applied to WMA permitting in these areas. However, existing policies within the Water Management Act include assessment of water withdrawal impacts on surrounding water resources. Minimization and Mitigation of these impacts can be developed based on site-specific conditions at withdrawals within these areas.

15. **Define 'Quality Habitat'.** (MWWA)
    For the purposes of the SWMI framework, quality natural resources are biological categories 1, 2, and 3, and coldwater fisheries resources.

16. **What will 'highest level of review' entail?** (MWWA)
    In the interest of protecting our best biologic categories, the Permitting Tiers Table holds those proposing to change a FL or BC in a Quality Natural Resource to a higher level of review (Tier 4). That highest level of review designation is intended to highlight the importance of this resource area to staff conducting reviews and proponents of projects in this category. The increased awareness will be reflected in additional scrutiny of the alternatives to ensure that the mitigation is commensurate with the additional withdrawal impact.

RESPONSE TO OUTSTANDING SWMI QUESTIONS / COMMENTS
March 23, 2012

17. **How can one prevent backsliding if the model automatically predicts backsliding and the framework provides no means for superseding measurements to prove absence of backsliding?** (MWWA)
"Backsliding" refers to a change into a worse Flow Level or Biological Category. The framework adopts a principle of avoiding backsliding while at the same time it acknowledges a user's legitimate need for more water in the future that could result in backsliding out of a flow level or biological category. Incremental change within and outside of a Flow Level or Biological Category is allowable with commensurate mitigation.

18. **What does the desktop pumping evaluation entail?** (MWWA)
The desktop pumping evaluation required of Tier 1 withdrawals will require the permit holder to evaluate whether they can meet their demand in a manner that minimizes the impacts on the CFR present. The evaluation will require the supplier to review the impacts of existing use and withdrawal patterns of its available sources if a CFR is present, discuss the financial, engineering, and/or operational reasons for the current operating practice, opportunities to alter the withdrawal among its current sources (including water purchased), and the implications of changes to that practice should withdrawals be impacting the CFR. Should opportunities exist to manage existing sources of supply (including water purchase) to lessen withdrawal impacts on the CFR, while not significantly altering the PWS ability to feasibly meet demand, the supplier shall takes steps to optimize in that manner.

19. **Explain justification for requiring mitigation before exceeding baseline. To require mitigation before exceeding baseline could provide an unnecessary financial burden on a system.** (MWWA)
Typically, for each community a Water Needs Forecast is done in 5-year increments. This gives the community an estimate of when an increase may be needed. The community can plan for mitigation needed along with the growth that is driving the demand increase. While mitigation planning commences at the time of permit renewals, mitigation implementation requirements and their timing will be the subject of regular agency reviews to ensure that water use is actually increasing and that mitigation is applied as appropriate.

20. **At what watershed scale would mitigation need to occur**? (MWWA)
Priority will be given to mitigation in the same sub-basin where the withdrawal takes place, preferably upstream of the withdrawal point. If such opportunities do not exist, the applicant can look for mitigation in other subbasins in the same town (with a preference to subbasins upstream of the withdrawal point), as long as they are a part of the same major basin. Further details are currently being developed and may be informed by the pilots.

RESPONSE TO OUTSTANDING SWMI QUESTIONS / COMMENTS
March 23, 2012

21. **Designation Cold Water Fisheries Resources: There is an opportunity for a water supplier to provide information if they do not believe that a designation is correct and it says the requestor must use a methodology developed by the Division. What will this methodology be and when will it be available? How long will the review of the information by DFW take? It should be clearly stated that the Division will get back to the requestor within a specified period of time.** (MWWA)
    The amount of information required to rebut the coldwater fishery status of a stream will be determined based on a review of existing data. Existing data and a determination of the status of the stream will be provided during the agency consultation process and the protocol, if needed, will be determined at that time.

    The timeline for the agency consultation process has yet to be determined, but it is not unreasonable that the information provided to MDFW, if complete and according to the protocol that will be developed in the agency consultation process, can be reviewed within a 30 day period.

22. **What if local water suppliers weren't relying on local sources during baseline period?** (Peter Newton)
    Permitted PWS relying on alternative sources during the baseline period may have their baseline calculated based on their total usage (not just withdrawals) provided that usage is no more than their 2005 allocation volumes. The volume credited towards the baseline will be calculated using the same methodology as everyone else (see #3 above). The PWS supplying the water will have their baseline adjusted downward by that amount so long as it does not lower their baseline below their registration volume.

23. **How will DEP track cumulative impacts?** (Q from technical meeting on 02-17-12)
    DEP is working on developing the tools necessary to track cumulative impacts. The existing WMA permitting structure allows for all permits within a major basin to come up for renewal at the same time. This provides the Department with a unique opportunity to look at the cumulative impacts of all withdrawals within a basin and evaluate the flow level changes within a basin at that time.

24. **How does 7-day LF statistic compare to median?** (Ian Cooke)
    The 7-Day Low flow value for a gage is determined on an annual basis; it is the lowest seven continuous days of each year. The value is calculated for each year of gage record, and the median value of all of the years' values is the one we are using. The values were calculated using the Indicators of Hydrologic Alteration (IHA) software. We assume the question is not how this value compares to an annual median flow, but rather to monthly median flows. Also, because the SWMI proposal is to use actual gage data instead of simulated unimpacted flows, this response represents actual monthly median flow data for gages. The low-flow statistics were analyzed on a set of active USGS gages. Values for the annual 7-day low flow statistic and the August median flow statistic for each are provided in the table below.

	Ipswich Middleton	Neponset Norwood	Sudbury Saxonville	Charles Medway	Charles Dover	E Br Housatonic Great Barrington	Quinsigamond Grafton
Gage 7-day LF, cfs	1.0	6.4	15	8.1	30	19	1.9
Aug median flow, cfs	6.1	14	47	21	61	29	11

Monthly median flow values were not considered for the low-flow trigger, as flows are expected to be below the median 50 percent of the time. The low flow statistic was intended to represent a more severe period, which would trigger sooner than the state drought declaration but be representative of minimal flow conditions in the river. The frequency of occurrence is expected to be once a year on average based on the nature of the statistic (the median of the annual 7-day low flow). During extreme dry periods, the statistic would be triggered more frequently, and during wetter than normal periods, the statistic would be triggered less frequently. In application, increased outdoor water conservation would be required once the low-flow value has been observed in the river for three consecutive days. The increased restrictions would continue until the low-flow value has been exceeded for three consecutive days, or for a minimum of 7 days, whichever occurs first. Analysis of the 7-day low-flow trigger using actual gage data indicated that the trigger would be met 6 to 9 percent of summer days (on average) for the gages tested. During dry summers, the trigger would be met up to 57% of the days between May and September. Application of the 7-day low flow trigger was responsive to subsequent drought declarations in the regions where the tested gages are located. Agency staff determined that the Sudbury River gage would not be appropriate as a trigger gage as a result of upstream influences.

25. **7-Day LF is woefully low in the Ipswich basin. Maybe something else should be used in FL-4/5 areas?** (Q from technical meeting on 02-17-12)
In general, a phased approach is being used to trigger outdoor watering restrictions. Once the flow in the stream goes below the aquatic baseflow (ABF) value, the first set of restrictions (2 days of watering per week outside 9 am – 5pm for those above 65RGPCD) is triggered. In addition, when the flow in the stream decreases to the 7-day LF value, then further restrictions (1 day per week outside 9 am -5 pm for those above and below 65 RGPCD) are triggered. In the case of the Ipswich, the current permits require that nonessential outside water use cease when stream flow falls below 0.42 cfsm, which is akin to the ABF. This is required of all permits holders regardless of their RGPCD value. Thus, Ipswich permit holders cease watering entirely at the ABF, which is far more stringent that what is required in other basins at the 7-day low flow. The Ipswich conditions will be reviewed at the permit renewal. However, in basins where conditions that are more stringent have already been required in permits to address streamflow issues and which are approaching Safe Yield volumes, MassDEP expects to maintain the more stringent conditions. We believe the phased in approach proposed for the other watersheds including the FL 4/5 is sufficiently protective and is a

significant improvement over the old approach, which relied upon the slower responding Drought Task Force declaration for more stringent restrictions and did not require those below 65 RGPCD to make similar reductions.

26. **Permit Condition 9—never reduce below the 40-year drought level like Russell Biomass.** (Kaiser)
Conditions that require operational changes are becoming more frequent in our permitting particularly on new sources. In the case of Russell Biomass the permit requires them to reduce pumping when stream flow begins to approach historic lows, with withdrawals being shut-off entirely when we reach those historic lows. Applying similar operating conditions to all other permits would put existing public water systems in great danger of failing to meet demands during such droughts. In addition, the withdrawal proposed could be so small as to be barely perceptible to stream flow even at drought conditions, so applying such a uniform condition may be inconsistent with the many things that Act requires us to consider. The Department would propose to continue to consider such operational limitations on withdrawals during low flow, particularly as they relate to water quality limits (7Q10 flows), on a case-by-case basis. We propose to develop guidance on how we could apply such low flow triggers.

27. **Consider if a redundant well in another subbasin could be more beneficial**
In general, installing redundant wells is a good water supply practice. Redundant wells provide needed capacity should other sources experience operational problems & they prevent the loss of future water supply sites from being developed. In addition, redundancy may provide an environmental benefit by allowing additional flexibility for suppliers to withdraw their water away from a stream during low flow conditions. This optimization may also allow suppliers to withdraw from multiple sources to lessen the impacts of existing withdrawals. The proposal in the SWMI framework applies to a small sub-set of registered-only systems seeking to develop a redundant well. A geographic limit (HUC-12) was included to address concerns about limiting the potential distance of new impacts to the general area of the existing well(s) being provided redundancy.

28. **DCR unwillingness to call their Safe Yield methodology a "model" and to calibrate or validate it. The biggest problems come from investigation of the two most highly stressed rivers in the state -- Parker and Ipswich.** (Kaiser)
The methodology for calculating Basin Yield is not considered a “model” in that it is not attempting to predict a condition; rather, it is using simulated historic unimpacted flow data to develop a consistent methodology of representing conservative drought condition unimpacted basin yields, in accordance with the Water Management Act Safe Yield definition. Actual unimpacted river gage data are not available for major basins of the state from historic drought periods, thus, there is no way to “calibrate” the methodology to actual data representing those conditions. Rather, the methodology relies on the best available science (SYE unimpacted flow simulations, based on relatively unimpacted actual index gage data) to represent historic flow conditions for the major basins in the state where SYE is functional. The monthly Q90 values, or daily flow that is exceeded

90 percent of the time during that month, were used to generate the Basin Yield values. In the Parker River example presented above, the following values were used to establish Basin Yield. These values can be compared to the 1965 (drought) simulated unimpacted median flow values for the Parker River, to see how the selection of monthly Q90 statistics represent the drought year, but that is not considered a "calibration" or "validation" of the model, as neither set of data are based on actual flow measurements.

Use of actual flow data from the drought of record to establish Safe Yield is not feasible, because the flows that were measured at gages were affected by withdrawals and wastewater return flows. Consistent records of withdrawal and return volumes that would be needed to estimate unimpacted flow or the degree of streamflow alteration affecting gages are not readily available from these time periods.

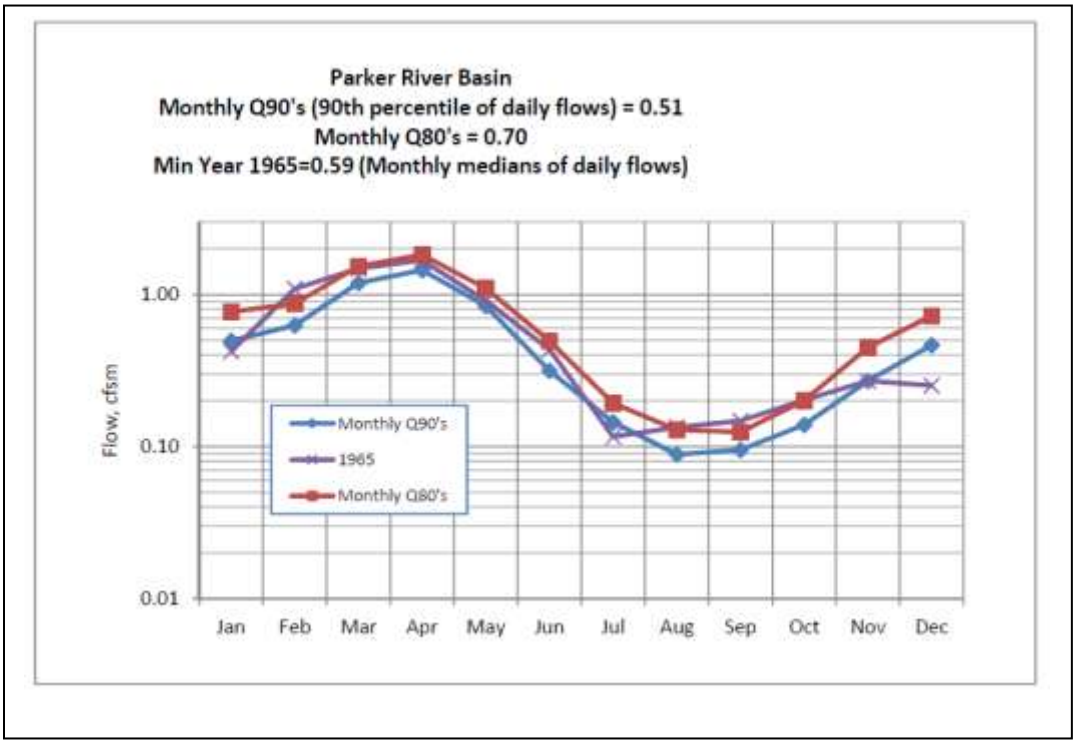
Monthly Q90's and Annual Rollup of Monthly Flows for Parker River Basin, cfsm
(using SYE simulated unimpacted daily flow values for the Parker River)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0.50	0.63	1.19	1.45	0.84	0.32	0.14	0.09	0.10	0.14	0.27	0.46	0.51

1965 Median Monthly Flows (Medians of Daily Flows for Each Month) and Annual Rollup of Monthly Flows for Parker River Basin, cfsm
(using SYE simulated unimpacted daily flow values for the Parker River)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0.42	1.09	1.48	1.68	0.91	0.43	0.12	0.13	0.15	0.20	0.27	0.25	0.59

Comparison of the 1965 simulated monthly median flows and the Monthly Q90's for the simulated unimpacted flows for the Parker River is shown graphically below. Similar graphs are available for all of the major basins that were analyzed using the Sustainable Yield Estimator.



Review of the two sets of data indicate that use of the monthly Q90's for Basin Yield is a reasonable representation of the historic 1965 drought, and is more conservative than even the simulated unimpacted flows for 1965 in the Parker River basin. For each month, the Q90 flow value is less than (11 months) or equal to (November) the simulated 1965 values. The approach of using monthly Q90's is considered conservative with respect to actual drought periods experienced in Massachusetts, and provides a consistent methodology to apply that condition across the state, regardless of how severe the actual 1965 drought was at different locations, and considering that actual unimpacted flow data are not available at the locations of concern. In development of the SYE model, USGS used least-impacted gage data for the water-year 1961 to 2004 period as the basis for simulating un-gaged river flows. The correlations between simulated and actual index gage flows were excellent, indicating the SYE flow simulation model is very robust, especially at the middle flow ranges. Simulations are less accurate at extreme low and extreme high flows. The model validation procedure is described in the USGS publication:

Archfield, S.A., Vogel, R.M., Steeves, P.A., Brandt, S.L., Weiskel, P.K., and Garabedian, S.P., 2010, The Massachusetts Sustainable-Yield Estimator: A decision-support tool to assess water availability at ungaged stream locations in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2009–5227, 41 p. plus CD-ROM.

RESPONSE TO OUTSTANDING SWMI QUESTIONS / COMMENTS
March 23, 2012

The analogous data and graph for the Ipswich River basin are presented below. Review of the two sets of data for the Ipswich River indicate that use of the monthly Q90's for Basin Yield is again more conservative than even the simulated unimpacted flows for 1965. Although the monthly Q90 values for some months (January, July, December) are higher than estimated for 1965, the overall annual rollup value of the monthly Q90 values (0.53 cfsm) is less than that estimated for 1965 (0.61 cfsm).

Monthly Q90's and Annual Rollup of Monthly Flows for Ipswich River Basin, cfsm
(using SYE simulated unimpacted daily flow values for the Ipswich River)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0.52	0.65	1.22	1.48	0.87	0.33	0.16	0.10	0.11	0.16	0.29	0.49	0.53

1965 Median Monthly Flows (Medians of Daily Flows for Each Month) and Annual Rollup of Monthly Flows for Ipswich River Basin, cfsm
(using SYE simulated unimpacted daily flow values for the Ipswich River)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0.45	1.12	1.52	1.71	1.94	1.46	0.13	0.15	0.17	0.22	0.29	0.27	0.61