Research Management for EWRE Students, Post-Docs and Interns

General

Your UMass laboratory research project may be one of the first long-term professional assignments in your career. Although you are a student (or post-doc), its important that you develop good professional practices while in EWRE. It's also a necessity to fulfill most sponsored research agreements. Whether you're on a formal research assistantship (RA), a fellowship, traineeship or internship, you should adhere to standard business practices.

First is the **work schedule**. Except for rare exceptions, we conform to a conventional 9AM-5 PM workday, Monday-Friday. Of course there are times when research constraints demand that you temporarily adopt alternative hours (e.g., evenings or weekends due to instrument availability or when timed samples must be taken and processed). However, working during off-hours should not be the norm, but on an "as needed" basis. We do not ask students to use timesheets (a practice quite common the non-academic world), however, we do ask that you notify your advisor when you do not plan to be at UMass during the normal business hours. This is both a courtesy and a necessity as the exigencies of research sometimes require that your advisor, our research staff, or fellow students be able to reach you during those hours.

As an RA you're expected to devote 50% of your working time during the semester to the sponsored research project, and 100% during summers and scholastic breaks. Vacations are arranged with your advisor and normally amount to 2-3 weeks for any given year, and rarely exceed 4 weeks over a 2-year period.

Next is the professional **workplace culture** (office & lab). Be considerate of your co-workers. Good communication is probably the single most important characteristic of a successful business relationship. Recognize that everyone around you is trying to do their best, and help out if someone is in need. It's also very important to be responsive to the faculty and research staff if they make specific requests regarding laboratory practices, cleanliness, office etiquette, etc. Try to anticipate and solve such problems before they become apparent to others.

Last is **documentation**. You will be asked to prepare reports of various sorts and with frequencies ranging from weekly to quarterly. There is also, of course, the thesis/dissertation and published journal articles. The foundation upon which all of these written works rest is your **research laboratory notebook**. It is essential that all raw data be recorded in a bound notebook at the time of data collection. If you anticipate conducting lab work for your research (as all of my students normally do), you should ask me to purchase a bound lab notebook for your use. These are available at the Campus Center, University Store and come in various sizes. Normally these are kept by you during your studies at UMass, but must be turned over to me upon your departure in accordance with the sponsor's contract.

It is important that the laboratory notebook remain in good physical condition and legible for a long period of time. For this reason use only ball-point pens, do not use felt-tip pens or pencils. Black ink is preferred, but blue is also acceptable. Do not try to erase mistakes. Instead, draw a line through the erroneous entry and record the correct entry nearby. Write legibly, but don't be overly concerned with neatness. Pages must be used consecutively. Leaving a page or pages blank for later use is not good practice. Entries must be presented in chronological sequence and dated. Time of day should be indicated at least every 3 hours. A good practice is to reserve the first page as a periodically-updated table of contents. Avoid excess detail, so that the table of contents can completely fit on one page.

As you plan your experiments you should also think about how you will record data in the lab notebook. This will not only help to produce an organized notebook, but it may lead you to recognize a deficiency in your experimental procedure while you still have a chance to correct it. Data are often best recorded and presented in tabular form. For some repetitive procedures, standardized report forms may be

most convenient. These forms should be numbered consecutively and kept in a separate notebook. Reference should be made in the laboratory notebook to the specific report form as appropriate. You should present a complete record of your experiments. All non-standard or new steps in a procedure should be recorded, even if they seem trivial. Very often it is the fine details which take on great importance in retrospect. Record all of your observations. Refer to standard or published procedures whenever possible. However, carefully describe any deviations you may have taken from these procedures. You should also describe any unusual aspects of the laboratory environment. For example, the smell of fresh paint, new asphalt, etc. may indicate possible sources of atmospheric contamination of laboratory solutions. (for more guidance, see Writing the Laboratory Notebook, by Kanare, ACS Publishers, 1985).

Research Meetings

There are at least three types of research meetings that you will likely participate in at UMass: (1) the regular 1-on-1 research meeting with your advisor; (2) the regular, but less frequent[1] internal group meeting, and (3) the occasional research meeting with external participants such as a sponsor or a collaborating group from another university.

First the regular 1-on-1 research meetings with your advisor. For my students these will usually take place at the same day and time each week as mutually agreed upon at the beginning of each semester. On occasion, I will need to re-schedule or skip a meeting due to travel or other commitments. Formal weekly meetings may be suspended during the summer, if I am available to meet on a more frequent basis. If so, it is still important that you submit a weekly report (see below).

These research meetings present are an opportunity to go over progress, discuss problems, plan new experiments, etc. Research meetings are critical to project management, and they help reduce misunderstandings and unnecessary experiments or wasted lab time. It's important to all concerned that these meetings be productive and efficient. The preparation of weekly research summaries and quarterly research reports (see below) are the vehicles we use to achieve these goals. We will also refer to the long-term plan (see below) from time to time, as a guide to keep the overall research program "on course".

The internal group meetings typically include from 3-10 people; graduate students, undergraduates, interns, research staff ,and faculty (the principal investigators, PIs, or co-investigators, co-PIs). Usually the participant list is crafted around a single funded project or several closely related projects. These may be regularly scheduled and are often held on a bi-weekly or monthly basis. Be prepared to present your work at these meetings even if you're not warned ahead of time. This means that you should always bring your laboratory notebook, weekly reports and any other documents that you might need to refer to.

The research meetings involving external participants are less frequent, but quite important. These offer an opportunity to show the work that UMass has been doing. Often they are used by research sponsors to evaluate progress, and ultimately make judgments on whether the research funding is being well used. It is common for the UMass participants to plan and practice their presentations ahead of time. This type of meeting is very similar to the meetings you will probably have with business clients in your post-UMass professional life. Needless to say, it is important to make a good impression.

Long-term Planning

Near the beginning of your research program, you should prepare a **long-term research plan** (1-2 page) that summarizes:

- Research objectives or questions
- General types of experiments conducted with some description

[1] Some projects lend themselves to regular group meetings with less frequent 1-on-1 meetings.

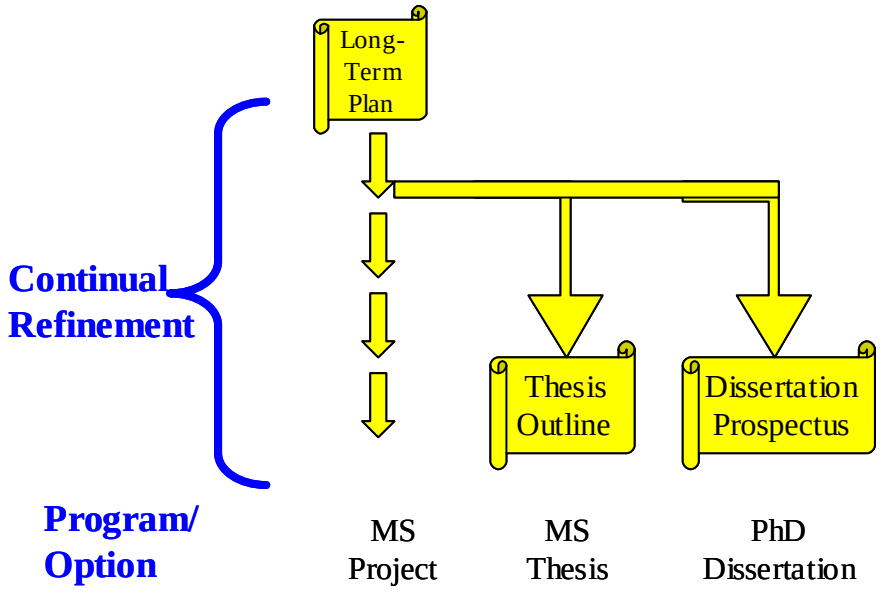
- Timeline

This program should be revised periodically. See attached plan as an example. With very focused and applied research, I will often prepare a short or preliminary version of this plan for the student. The student should then be prepared to elaborate on this and modify it as needed. Some of these long-term plans will closely parallel the sponsored research plans as delineated in the research contract between the sponsor and UMass. In other cases, they will represent subsets or tangents of this overarching research plan. Masters students pursuing a **thesis option** will further develop the long-term plan into a thesis outline, which must be completed 4 months prior to the thesis defense (see Figure 1). Students pursuing the **project and report options** do not have to submit a formal outline. Instead, this informal long-term plan fills the need for an outline. **Doctoral students** will develop the long-term plan into a full dissertation prospectus. This is normally done near the end of the second year of the Ph.D. program. **Post doctoral students** will normally prepare research plans near the time of the start of their period of residency.

Weekly Research Summary[2]

All students should prepare a brief (e.g., 1-2 pages) written summary in advance of the weekly meeting. It should be sent to me via email no later than noon on Saturday (many will choose to submit this on Friday afternoon). See appendix for an example. The weekly summary should be appended with graphs and tables if appropriate (these are not shown in the example). It should be structured as a succinct overview of your most recent work[3]. These reports reflect short-form progress reports that are common in professional practice. They need not have much written text, but they should cover progress in an easily understandable form. I recommend following the outline below:

- What you've done in the past week
- What you plan to do over the next week
- Very brief projection of activities planned for next 4 weeks
- Any expected changes in your long-term plan (above) in terms of scope or timing.



[2] This preparation of weekly reports is not always required of incoming students until they have been in residence for a few weeks. This is in recognition of the fact that many new students spend their first few weeks on research training activities.

[3] In this context, your "work' includes some or all of the following: literature read and summarized, research planning, lab work, field work, data analysis and writing.

Figure 1: Research Planning

Most "wet" research projects involve collection of field samples and chemical or biological analysis of those samples. The weekly research meeting is a good time to review the progress on these. As a result you will also want to present this progress in an appropriate form. A table is recommended.

You should also have ready to hand out, as needed:

- Attachments containing detailed experimental results
- Data analysis, standard curves, QC data, other data summaries
- Draft written material (e.g., for thesis, dissertation, project report, or publication)

Please think ahead in preparing for your meeting. Anticipate necessary data analysis, graphical presentation, etc. Very often, material prepared for these meetings can be used in your quarterly progress reports and eventually in your thesis. These weekly reports will also give you a valuable record of activity and experiments performed that you will use as you write the progress reports and thesis. Remember, the better prepared you are, the smoother and more efficient the meeting will be.

Doctoral students will frequently be assigned a relevant research paper to read at the weekly meeting. Please come prepared to discuss the previous week's paper if there was one (e.g., bring a marked-up copy or some handwritten notes on the paper). When reading the paper consider the following elements:

- What were the objectives of the work reported?
- Were the objectives of the work clear and reasonable given the state of knowledge at the time the work was done?
- How was the experimental design tailored to address these objectives?
- What was the essence of the work and its conclusions?
- Which conclusions were well supported by the work presented and why?
- Which conclusions were not well supported, and why?
- Are some of the conclusions simply irrelevant or trivial?
- Were there elements of the experimental design that were unnecessary, and were there some that were needed but not included?
- What did the authors show that is a new contribution to the field?
- Did the authors present data or conclusions that are contrary to prior work?

These papers are intended to help frame your knowledge of the literature, but they cannot complete it. As part of your research training, you will need to seek out literature on your own (see Table 1 below for a list of some journals that you will want to follow; you should also make use of on-line UMass resources such as the "Web of Science" to find new papers in your area. Students often read the literature most intensively while writing their literature reviews (whether for the prospectus, dissertation or thesis). However, a regular routine of reading current literature is important to the professional development of anyone entering the environmental engineering field.

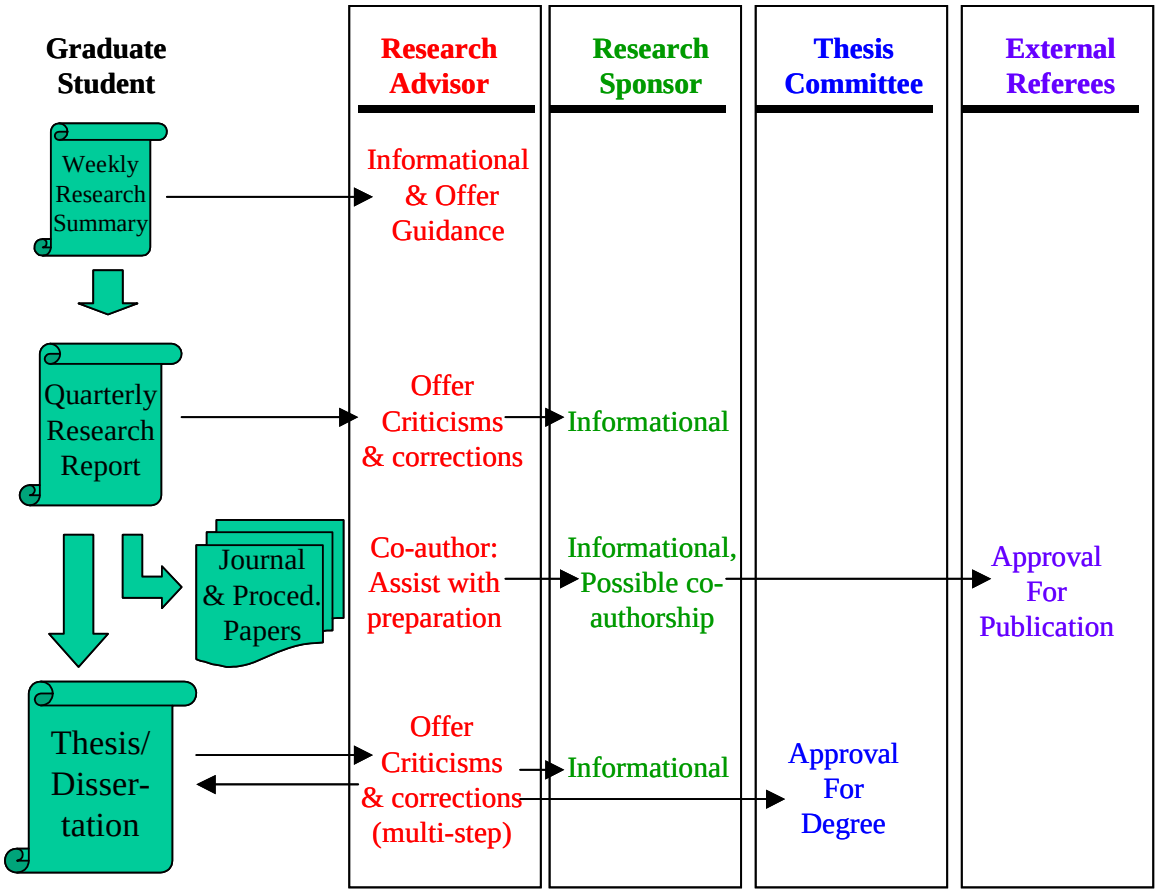


Figure 2. Documentation and Reporting of Research Results

Quarterly Research Reports

At the end of each third month, students conducting research need to prepare a quarterly progress report. The timing of these is often modified to coincide with the end of a major experiment or phase of research. In this way the quarterly report can double for a summary of a particular phase of work. Sometimes these are used as the basis of chapters or sub-chapters in a thesis. There are certain cases where two or more students will prepare a single report, if they regularly work as an integrated team. The structure of these reports may depend on the particular research project, but a good general outline is presented below. The best approach to starting these is to look over the preceding weekly summaries and do as much electronic (computer) cut-and-pasting as possible. You will then need to review these, and consolidate to the extent possible. Some material may need to be added. Discussion and summary statements will likely need to be expanded and modified. Please turn in one paper copy and one computer file (preferably, MS Word with imbedded figures and tables) copy to your advisor.

TITLE PAGE

This should include the project title, your name, your advisor's name, the sponsor's name, and the time period that the report covers.

BACKGROUND or INTRODUCTION

This should include some background information on the overall research project. It will probably change very little from one month to the next. As a result, you can prepare this section once, and then reproduce it with each successive bimonthly report, as "boiler plate" text. Generally speaking you should be able to condense the necessary material into less than 2 pages, double-spaced.

OBJECTIVES

What is the reason for making the types of measurements, or conducting the types of tests that you did? These objectives usually fall within the overall project objectives. Half a page is usually more than enough.

SPECIFIC PROCEDURES or MATERIALS & METHODS

Do not list the analytical procedures or steps followed in lab, instead you should refer the reader to appropriate written SOP, sections in Standard Methods or other widely-available references for details. Any significant modifications of the referenced procedures should be noted, however. When using instruments, record the type, manufacturer and model number. Any procedures that are not fully delineated in the referenced methods (e.g., concentrations of stock solutions, type of glassware used, glassware cleaning procedures) should be described here. This section will evolve into your thesis chapter on "Materials & Methods".

RESULTS and DATA ANALYSIS

Results should be presented in a summary form. Leave detailed tables of results for an appendix. Graphs and other figures are often the best way to present complex environmental data. Tables may also be appropriate, as long as they don't becomes excessive in number and length. These data should also be presented in an efficient and logical manner. Data tables are often the best choice. A small amount of text **must** accompany the presentation of all results to aid the reader. You should never have a table or figure that is not cited by number in the text. Calculations and data manipulations may be left for an appendix.

DISCUSSION

At this point, you should explain the significance of the results within the context of your research. You should use this section to compare your results with those reported earlier (e.g., by yourself in an earlier report, by others using the same type of samples, or others using different samples). This is also where you should comment on data quality. Were data quality objectives met (e.g., spike recoveries, calibration checks)? If not, what is being done to solve the problem, and what data are affected? Be careful not to over-emphasize analytical inaccuracies, failures, or unexpected results. Some of this is to be expected whenever performing complex environmental research.

CONCLUSIONS

Do your best to summarize the relevant findings and state the certainty with which you hold these findings. You should not present any new thoughts here, nor should you use this section to further your discussion. This should be just a distillation of the conclusion-type statements that you had already made in the discussion section (1/2 page max.). If conclusions are not yet warranted, you may say this too.

REFERENCES

List any cited literature in this section. Give the full citation in the references section. Use some type of abbreviated citation at the point in the text where you wish the reference to appear. The preferred in-text citation is the "author, date" format. In this case you place the authors last names before a comma and the year of publication (e.g., (Switzenbaum & Hickey, 1993)). When there are more than two authors, you list only the first author's name and "et al." For the others (e.g., (Switzenbaum et al., 1995)). If there is more than one reference with the same authors and date, you should use a lower

case letter after the year to distinguish them (e.g., (Tobiason & Edzwald, 1998a)). The full citations (Journal or Book titles, volume #, issue #, page numbers, etc.) then appear in alphabetical order by authors' last names in the References section.

APPENDIX

Include here all of your raw data in some clear and convenient form (often in tables). You should also prepare a regular bimonthly appendix with quality assurance data. This may include internal standard areas, standard curve slopes, calibration check standards, and spike recoveries.

Journal and Proceedings Papers

At some universities, accepted or published research papers (e.g., minimum: one for an MS, three for a PhD) are required prior to awarding a degree. This is not a formal institutional requirement at UMass, however, publication of thesis/dissertation results is considered a necessary part of the research process. In addition, many students have the opportunity to present their work at regional and national conferences (e.g., AWWA annual conference). Oral presentations and written papers are an excellent way of raising one's profile in the environmental engineering field. These are usually published in full-length or abstract-form as conference proceedings. Most of these papers are also submitted to an archival journal[4]. Opportunities for publication are summarized in Tables 1 and 2, below.

Journal and proceedings publications are prepared as collaborative efforts between the student and his/her research advisor. They are based on bimonthly research reports and other material that may be available. Publications should be initially written by the graduate student or post-doc after development of an outline with the research advisor. Successive drafts and re-drafts usually follow as the advisor and student work toward a clear and polished product. In this case the student is listed a first author and the advisor is the second author. Please plan on devoting a substantial amount of time to this effort prior to leaving the University. Careful structuring of the thesis/dissertation can facilitate the simultaneous preparation of research papers (see: Thesis Survival Guide). Under some circumstances, the research advisor will prepare an additional summary paper that comprises data from several students' work. In this case the advisor will take the lead in preparing the paper. When this occurs, he/she will take the role as first author.

Table 1. Important Archival Research Journals in Water (Clean & Drinking)

Journal Name	Comments
Aqua	Substantial European readership, becoming more important in the water field
ASCE Journal of the Environmental Engineering Division	Very high quality, many modeling papers
Environmental Science and Technology	Best journal for environmental chemistry
Environmental Technology Letters	
International Journal of Environmental Analytical Chemistry	Lower quality on average, but some good stuff
Journal of the American Water Works Association	Good, but small number of research articles; high visibility in the US drinking water field
Journal of the New England Water Works Association	Average quality, lower than J. AWWA, also smaller readership, but well known in Northeast US
Ozone Science & Engineering	Lower quality on average, focuses on ozone and related oxidation
Water Research	Good quality, wide readership in US & Europe

[4] This is important, because conference proceedings may not be widely available, but archival journal generally are.

Table 2. Important Research Proceedings in Water (Clean & Drinking)

Conference Proceedings	Comments
American Chemical Society Conference	Meetings held 2x per year (Spring & late summer), Environmental Chemistry Division is most appropriate, extended abstracts instead of full papers, some sessions are published as books
AWWA Annual Conference	Once per year in June, very good for meeting major figures in US water treatment, Universities forum for student presentations
International Ozone Association Conferences	World congress every 2 years, regional conference more often
New England Water Works Association	Annual conference in New England, student session
Water Quality Technology Conference	Once per year in early November, sponsored by AWWA water quality division, more focused on research than AWWA annual conference
Water Science & Technology	International Conferences

Thesis & Dissertation

See Thesis Survival Guide

Dave Reckhow
May 20, 2011

Appendices

Weekly Summary

John Q. Student
February 28 2008

Activities over the preceding 7 days

1. Data reduction and graphing of HAA data on untreated sampled collected from Northampton on Feb 13th
2. HAA and THM analysis of lab chlorinated samples derived from the Feb 13th sample collection day
3. Planning next sampling run
4. Read 2 journal articles (Speitel et al., 2001; Krasner et al., 2002) & took notes for lit review

Activities planned for the next 7 days

1. Arrange for next sampling run in Northampton
2. Collect samples (3 March target date)
3. Measure TOC and start analysis of THMs and HAAs
4. Read 2 more journal articles for lit review (Singer & Harrington, 1998; Richardson et al., 2002)

Activities planned over the next month

1. Two more sampling runs in Northampton
2. Kinetic analysis of pooled data from first 4 runs

Changes in the long-term research plan

1. Possibly drop plan for continuous UV monitoring
2. Look into possibility of doing a fluoride tracer study

Summary of Recent Sample Collection & Analysis

Field Sampling		Laboratory Treatment		Analysis			Data
General Location	Date	Type	Date	Type	# samples	Date	Sum-marized
Northampton raw & DS	2/13/08	None	NA	TOC	23	2/15/08	2/16/08
				THM	23	2/18/08	2/20/08
				HAA	23	2/20/08	2/22/08
		Chlorination	2/19/08	THM	15	2/22/08	2/23/08
				HAA	15	2/26/08	2/27/08

Proposed MS program for:

Michele Addison

Long Term Plan

Research Questions

1. Do aldehydes and keto-acids persist in the distribution system of an ozonation plant not practicing filtration?
2. If so, to what extent are they lost during distribution?
3. If their loss is variable and incomplete, what are the factors that determine the extent of degradation of these compounds?
4. Does filtration reduce the amount of aldehyde/keto-acid biodegradation in drinking water distribution systems?
5. Does the loss of aldehydes/keto-acids correlate with or indicate a similar loss of BDOC or other biodegradable ozonation byproducts?
6. How does overall BDOC loss compare kinetically with the loss of specific ozonation byproducts (e.g., acids, aldehydes, keto-acids)?
7. Will ozone byproducts be loss as a result of coagulation?

Some Proposed Research Tasks

Preliminary Work on Methodology

1. Demonstrate analytical proficiency for aldehydes and keto-acids with QA/QC criteria
2. Test analyte stability.
3. Verify ability to measure hydroxy byproducts using MSTBSTFA

Field Studies[5]

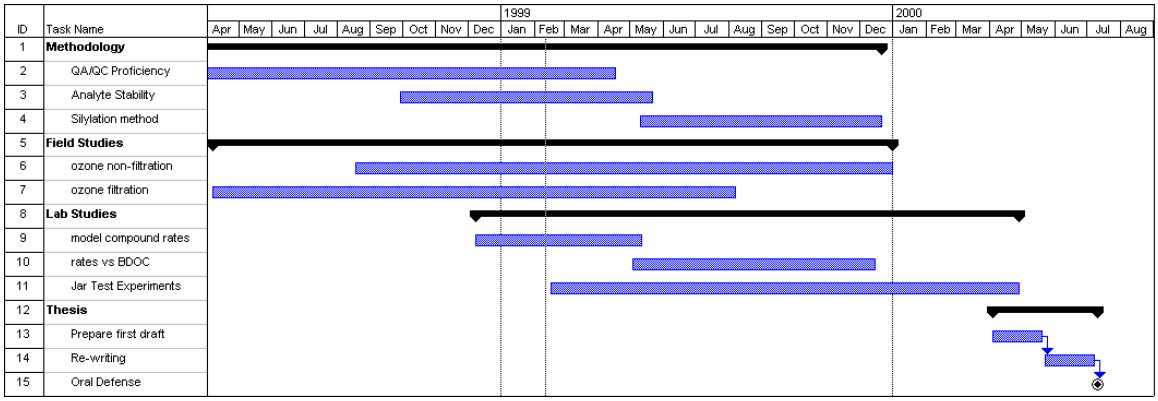
4. Analyze samples collected from ozone non-filtration plants (e.g., Bangor, Brewer, and possibly Portland). These should include raw, ozonated, and finished water, as well as samples collected at other significant intermediate points, and multiple points in the distribution system.
5. Analyze samples collected from ozone plants practicing filtration after ozonation (e.g., Andover, and possibly, Worcester, Amherst, and Hackensack). These should include raw, ozonated, filtered, and finished water, as well as samples collected at other significant intermediate points, and multiple points in the distribution system.

Laboratory Studies[5]

6. Assess rate of biodegradation of the aldehydes and keto-acids in a laboratory BDOC reactor. This should be done in collaboration with Anne Piekarski.
7. Evaluate the relative rates of degradation of the aldehydes and keto-acids versus BDOC, etc., in a laboratory BDOC reactor. This should be done in collaboration with Anne Piekarski.
8. Run jar test experiments to determine loss of ozone byproducts across coagulation and abiotic filtration. Look at metal and polymer coagulants.

[5] Samples from many of the field and laboratory studies proposed may be analyzed for other ozonation byproducts by Caroline von Stechow, pending full development of their analytical methods (e.g., organic acids, multifunctional compounds). Analysis may also be expanded to include hydroxy compound per method development of Jon Weiner.

Schedule



May 31, 2011