SCOPING EVALUATION OF ECONOMIC IMPACT ASSESSMENT METHODOLOGIES FOR WATER QUALITY STANDARDS

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June 30, 2006

1.0 Introduction

The Montana Department of Environmental Quality (MT DEQ) is currently developing preliminary, geographically-based nutrient standards for state waters. Some of the preliminary criteria, which were developed consistent with USEPA guidance, are low relative to commonly used municipal treatment technologies. Therefore, MT DEQ has initiated an evaluation of the potential economic impacts of the preliminary nutrient criteria on public and private wastewater treatment entities. This report presents a scoping evaluation of potential methods for assessing the economic impacts of the preliminary nutrient criteria. The objective of the scoping evaluation is to identify the applicability and the advantages and disadvantages of previously developed methodologies and to provide recommendations for a methodology most suitable to MT DEQ's current project.

In 1995, the U.S. Environmental Protection Agency (USEPA) published *Interim Economic Guidance for Water Quality Standards Workbook* (USEPA 1995), which is hereafter referred to as the *EGWQS Workbook*. USEPA recommended this guidance for use by states and USEPA Regions in implementing their water quality standards programs. USEPA clarified that the guidance is not intended to be applied as "absolute decision points," and that other economically defensible approaches may be used instead.

Because the *EGWQS Workbook* was developed specifically for water quality programs, the methodology it recommends is the primary focus of the evaluation. The *EGWQS Workbook* is evaluated to determine its applicability and relevance, practicality of application, data needs and availability, and analytic rigor. This report also describes and evaluates other directly relevant methodology sources, including USEPA's *Guidance for Preparing Economic Analyses* (USEPA 2000a), USEPA's *Information for States on Developing Affordability Criteria for Drinking Water* (USEPA 1998), and policies used by the Revolving Fund programs in Montana and other states. The evaluation also discusses accepted general economic and decision making approaches, including input-output models and multivariable decision analysis that may be relevant to MT DEQ's affordability analysis.

This report is a first step toward developing a detailed methodology for the MT DEQ economic analysis for preliminary nutrient standards. The information presented in this report is meant to help MT DEQ choose a general approach and then begin further exploration regarding specific aspects of the analysis. Examples of aspects of the analysis that will require further development include specific modifications to the chosen methodology, selection of pilot communities, and procedures for gathering data from communities.

Section 2 of this report provides a summary and evaluation of the *EGWQS Workbook* and the other guidance documents and methodologies identified above. Section 3 presents four case studies of the application of affordability assessment methodologies. The case studies highlight advantages and limitations of the methodologies used. Section 4 provides a summary of the evaluation and recommendations for next steps. Section 5 identifies the references cited in this report.

2.0 Summary and Evaluation of Relevant Economic Impact Assessment Methodologies

This section summarizes and evaluates previously developed methodologies and guidance that may be relevant to developing an economic affordability assessment of MT DEQ's preliminary nutrient criteria. Section 2.1 discusses the *EGWQS Workbook* methodology (USEPA 1995), which was specifically developed to assist states and USEPA regional offices in addressing economic impacts associated with new or revised water quality standards. Because the *EGWQS Workbook* provides is the most directly relevant potential methodology, it is discussed first and all other methodologies and guidance (discussed in Sections 2.2 through 2.5) are compared and related to it.

2.1 USEPA Interim Economic Guidance for Water Quality Standards (USEPA 1995)

USEPA's *EGWQS Workbook* (USEPA 1995) was developed for use by states, USEPA regional offices, and other applicants in considering economics at various points in the process of setting or revising water quality standards. This guidance provides a framework for making the following determinations: (1) if a designated use cannot be attained; (2) if a variance to an individual discharger can be granted; or (3) if degradation of high-quality water is warranted. In order to remove a designated use or obtain a variance, the state or discharger must demonstrate that attaining the designated use would result in substantial and widespread economic and social impacts. If a degradation in high-quality water is proposed, it must be shown that lower water quality is necessary to accommodate important social and economic development.

The *EGWQS Workbook* provides a series of worksheets and accompanying guidance for evaluating whether meeting water quality standards would result in substantial and widespread economic and social impacts. Assessments of "substantial" and "widespread" impacts are further discussed in Sections 2.1.1 and 2.1.2, respectively. The economic impacts to be considered are those that result from treatment beyond that required by technology-based regulations. All economic impact analyses of water quality standards should address only the cost of improving the water to meet water quality standards. USEPA recommends that its guidance, including the various screening levels and measures presented, be implemented as reference points and used as guides by the states and Regions. The measures outlined in the guidance are not intended to be applied as absolute decision points. States may use other economically-defensible approaches in lieu of those suggested in the guidance (USEPA 1995).

The *EGWQS Workbook* applies equally to point and non-point sources; the distinction regarding how to analyze different sources relates only to whether a source is public or private because this determines who will pay for the necessary pollution control as well as the types of funding mechanisms available. The *EGWQS Workbook* addresses the distinctions between these two entities in two separate chapters of the *EGWQS Workbook*. Distinctions between the two entities are also identified in the discussions of "substantial" versus "widespread" impact analyses below.

2.1.1 Assessment of "Substantial Impacts"

Substantial impacts are assessed based on whether the affected discharger is a public or private entity. For the *public sector*, the determination of substantial impact is a five-step process, as summarized below.

- Step 1: Estimate the cost of the pollution control project and calculate the annual cost of the proposed pollution control project.

- Step 2: Calculate the total annual pollution control cost per household, including the cost of the project and existing pollution control costs. This reflects the average cost per household and does not account for differential usage rates amongst households.

- Step 3: Use the Municipal Preliminary Screener (MPS) to identify entities that clearly will not experience substantial impacts due to the cost of the necessary pollution control. The MPS is the ratio of average total pollution control cost per household to median household income (MHI). This screening level is designed to trigger additional tests or screen out the possibility of substantial impacts. Communities with an MPS less than one percent are assumed to be able to bear the cost of compliance and do not require further analysis. Communities with an MPS between one and two percent are expected to incur mid-range impacts. Where the MPS is greater than two percent, an unreasonable financial burden would be expected for many households in the community.

- Step 4: Apply the Secondary Test to help characterize the community's current financial and socioeconomic well-being. The six Secondary Test indicators include bond rating, overall net debt as a percent of full market value of taxable property, unemployment rate, median household income, property tax revenue as a percent of full market value of taxable property, and property tax collection rate.

- Step 5: Assess where the community falls in the Substantial Impacts Matrix based on the MPS and Secondary Test results.

For the *private sector*, the primary measure of substantial impacts is how control costs affect the profitability of the entity that will pay for the pollution control, based on several years of operation for the entity. Then, the secondary measures include indicators of liquidity, solvency, and leverage, which are used to further characterize whether the entity will bear a substantial financial impact. Considerations include whether the private entity will absorb the costs (i.e., out of profits) or will be able to pass all or a portion of costs on to consumers, and whether the entity is an important part of a parent firm that could pay the pollution control costs.

If the public or private entity cannot demonstrate substantial impacts, then compliance with existing water quality standards will be required. Demonstration of substantial financial impacts is not sufficient reason to modify a use or grant a variance from water quality standards. An applicant must also demonstrate that compliance would create widespread socioeconomic impacts on the affected community, as discussed in the following section.

2.1.2 Assessment of "Widespread Impacts"

If public or private entities will bear substantial financial impacts, an additional analysis must be performed to demonstrate that there will be widespread adverse impacts on the community or surrounding area. One important factor in determining the magnitude of these impacts is defining the geographical area affected. Also important are the types of impacts that might occur. USEPA does not provide any explicit criteria by which to evaluate widespread impacts. Instead, the relative magnitude of a group of indicators should be taken into account. For public sector entities, changes in socioeconomic indicators such as median household income, community unemployment rate, percent of households below poverty line, and overall net debt as a percent of full market value of taxable property should be considered. For private-sector entities, the assessment of widespread impacts should consider many of the same socioeconomic conditions, and should also consider the effect of decreased tax revenues if the private-sector entity were to go out of business, income losses to the community if workers lose their jobs, and indirect effects on other businesses.

2.1.3 Evaluation of the *EGWQS Workbook*

The methodology provided by the *EGWQS Workbook* is applicable and relevant to the MT DEQ economic assessment of preliminary nutrient standards. The metrics and general approaches used by this methodology are logical and may be feasibly implemented. Although the *EGWQS Workbook* does not provide examples to demonstrate the utility of this methodology, Case Studies 1 and 4 in Section 3 show that the methodology has been applied with success in the real world.

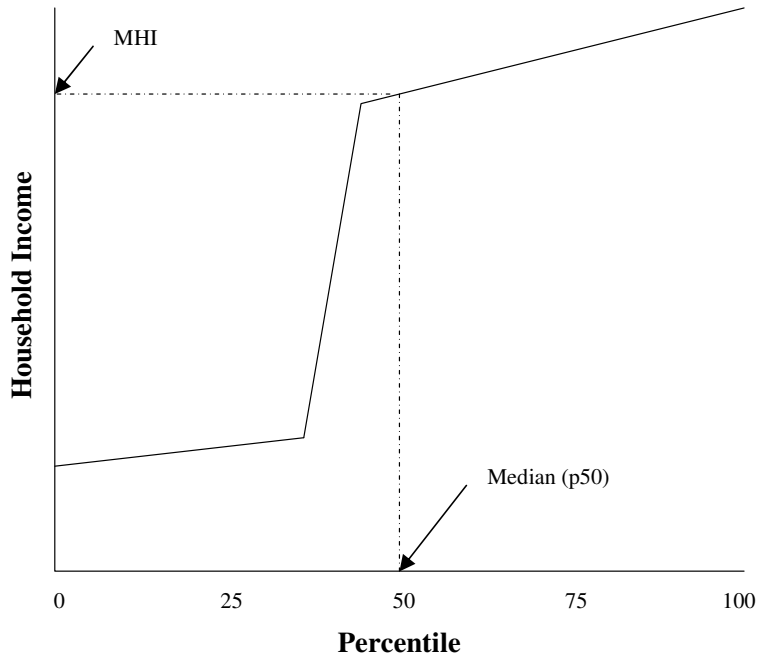
One key advantage of the *EGWQS Workbook* is its relative clarity and ease of use. Because it is organized as a workbook, it provides a clear step-by-step process for assessing substantial impacts, as well as useful worksheets and tables. Benchmark comparisons allow an assessment of the magnitude and relative importance of potential impacts. USEPA acknowledges, however, that these worksheets should not be used in isolation. Discussion of key sources of information, important entity and community attributes, and interpretation of results are found only in the associated text. In addition, in certain circumstances, the information presented in the guidance may not adequately address *all* potentially impacts. Applicants may need to consider other relevant measures not mentioned in the *EGWQS Workbook*. They may have to go beyond the information provided in the *EGWQS Workbook* in order to complete their impact analyses. For example, USEPA does not provide any explicit criteria by which to evaluate widespread impacts. USEPA presents the types of data the applicant will need to collect, but does not appear to suggest specific methodologies to estimate these impacts.

Conducting a complete analysis of substantial and widespread impacts has the potential to be data intensive, time consuming, and costly. For example, calculation of the MPS for a community would require median household income data available from the U.S. Census Bureau, community-specific water system information, and non-specific treatment cost information. This limitation is particularly relevant to the current application in which MT DEQ is considering an analysis of multiple communities. However, the *EGWQS Workbook* does provide some flexibility with regard to the depth of analysis, particularly for the assessment of

widespread impacts. To perform a full, in-depth analysis using the *EGWQS Workbook*, detailed socioeconomic data may be needed, including unemployment rates, poverty rates, household-level financial information, and much more. Current and reliable information may not be readily available, and the resources available for an in-depth analysis may be limited. Using generic information on pollution control costs could be another means of reducing data needs, but would affect the precision of the analysis.

The MPS used to screen communities potentially having substantial impacts is subject to the limitation that it may not be sufficiently sensitive to areas with a high incidence of poverty. A cost impact of two percent of the MHI may not be affordable to those on the bottom end of the income distribution. If there are many such households in a community – if the income distribution mathematically resembles a step function, as illustrated in Figure 1 – the MPS will not adequately represent the overall affordability for much of the community. It may be possible to refine the methodology using poverty statistics or other socioeconomic data, as discussed later in Section 2 (e.g., see Section 2.4.3).

Figure 1. Example of an Income Distribution for Which the MPS May be Misleading



A second potential limitation of the MPS is that it is insensitive to differences among locations in the overall cost of living. A two percent MHI is more affordable when cost of other essential goods is low rather than high. This issue, with regard to the MPS, is discussed in Case Study 1 in Section 3.1. One potential remedy to this limitation is to compare the community-level MPS to a county or regional MPS instead of a fixed benchmark. This approach is used by some states when assessing affordability in State Revolving Fund programs (see Section 2.4.2).

A concern about the *EGWQS Workbook* methodology as it was applied in Case Study 4 (Section 3.4) is that communities with low MHI may be less likely to pass the MPS test and therefore less

likely to get higher environmental standards. This is characterized as an environmental justice issue in which the methodology would tend to result in economically disadvantaged communities receiving lower levels of environmental protection than non-disadvantaged communities. This limitation has the potential to apply to any approach that may result in environmental variances or exceptions in disadvantaged communities.

The average cost per household method proposed in the *EGWQS Workbook* does not account for differential usage of water and/or wastewater facilities by households. In the event that the cost of pollution control technologies is to be recovered from increased user fees, and if user fees are related to the quantity of water and/or wastewater service consumed, and if there is a correlation between income and consumption of water and/or wastewater, the average cost per household may not reflect the actual burden on low-income families. The potential association between water consumption and cost burden may not affect the validity of the MPS measure, however. This observation is only intended to clarify the relationship between the "average cost" calculation and actual costs incurred by households at specific points on the income distribution.

The secondary test as described in the *EGWQS Workbook* currently contains four factors relating to the ability to raise and service debt and only two factors measuring socioeconomic impacts. All six factors are weighted equally. Thus, it may be argued that the secondary test is weighted more heavily towards measuring the financial solvency of a municipal area rather than the impact of pollution control costs on low income households. This potential shortcoming may be remedied by including additional factors relating to socioeconomic impacts to the secondary test and/or by weighting the factors differently. An alternative weighting system may be developed using the methods of multicriteria decision analysis, described in section 2.5.2.

The methodology for assessing widespread impacts is vague and subjective compared to the substantial impacts methodology. The *EGWQS Workbook* is intended to provide flexibility for assessing widespread impacts. Although flexibility can be an advantage (e.g., by promoting the selection of metrics and approaches best suited to local conditions), the use of subjective or qualitative criteria may be viewed as not sufficiently rigorous. For example, in Case Study 1, the widespread analysis methodology was criticized by a local stakeholder group (see Section 3.1.3).

2.2 USEPA Guidance for Preparing Economic Analyses (USEPA 2000a)

USEPA's *Guidelines for Preparing Economic Analyses* (*EA Guidelines*; USEPA 2000a) represents USEPA policy on preparing economic analyses as a component in designing sound environmental policy. The *EA Guidelines* provide guidance on analyzing the economic impacts of regulations and policies, and assessing the distribution of costs and benefits among various segments of the population, with a particular focus on disadvantaged and vulnerable groups.

2.2.1 Overview of the *EA Guidelines*

USEPA describes the *EA Guidelines* as a summary of analytical methodologies, empirical techniques, and data sources that can assist in performing economic analyses of environmental policies. The guidance document is consistent with published theoretical and empirical analysis on the use of discounting for private and public costs in an economic impact analysis, and for

social benefit and cost information. Guidance for assessing benefits of environmental policies provides various techniques of valuing risk-reduction and other benefits, and the guidance for analyzing social costs presents the theoretical approach for assessing social costs of environmental policies and describes how that approach can be applied in practice.

A comprehensive economic analysis as described in the *EA Guidelines* is comprised of three parts:

- **Analysis of benefits**. The *EA Guidelines* provide guidance for assessing the benefits of environmental policies including techniques of valuing risk-reduction and other benefits.

- **Analysis of costs**. The *EA Guidelines* present the basic theoretical approach for assessing the social costs of environmental policies and describes how this can be applied in practice.

- **Distribution analysis**. The *EA Guidelines* provide guidance for performing a variety of different assessments of economic impacts (examination of gainers and losers) and equity effects (examination of specific sub-populations, particularly those considered to be disadvantaged) of environmental policies.

Concepts and approaches for conducting each of these steps are presented in three separate chapters in the *EA Guidelines*.

Critical to a defensible economic analysis is specification of a baseline scenario (i.e., contrasting the state of the economy and environment absent the policy or regulation). The *EA Guidelines* address other major analytical issues on key topics, including:

- Treatment of uncertainty and non-monetary information;
- Estimating the value of reducing fatal risks;
- Discounting and comparing differences in the timing of benefits and costs;
- Examining environmental justice concerns in economic analyses;
- Assessing who pays the costs and receives the benefits of regulations; and
- Locating available data sources for conducting economic analyses.

2.2.2 Evaluation of the *EA Guidelines*

The *EA Guidelines* do not specifically address economic affordability associated with setting or revising water quality standards. The *EA Guidelines* are intended to be used by all parts of the USEPA for carrying out regulatory analyses. The *EA Guidelines* are guidelines for analysis, not a ready-to-use template for all policy assessments. It covers a number of principles and practices that virtually all economic analyses should follow.

A tiered methodology that specifically addresses both “substantial” and “widespread” impacts is not provided in the *EA Guidelines*. Approaches suitable to estimate impacts of environmental regulations on the private sector, public sector, and households are not presented. In the context of determining the economic affordability associated with compliance with numeric nutrient

standards, this type of tiered approach that considers household versus community impacts and also addresses the distinctions between public and private entities is critical.

USEPA describes the *EA Guidelines* as a *summary* of analytical methodologies, empirical techniques, and data sources that can assist in performing economic analyses of environmental policies. A major advantage of the *EA Guidelines* is its detailed presentation of methods that may be used to estimate net social benefits. This may be particularly useful for entities that have limited experience in conducting economic impact analyses. Although the *EA Guidelines* provide details on what these methods can do, it does not provide actual guidance on *how* to implement these methods. Although the *EA Guidelines* do not provide a methodology to compare with the *EQWQS Workbook* and other potential methodologies, it may serve as a useful reference in developing specific details for implementing a chosen methodology.

2.3 Information for States on Developing Affordability Criteria for Drinking Water (USEPA 1998)

The 1996 amendments to the Safe Drinking Water Act (SDWA) recognized that some water systems, particularly small systems, may have difficulty affording compliance with some requirements. To address this possibility, the SDWA amendments allowed affordability to be considered in various regulatory decisions, including variances, exemptions, and allocation of state revolving funds.

SDWA gives states discretion to develop their own affordability criteria. To aid the states in doing so, USEPA published *Information for States on Developing Affordability Criteria for Drinking Water* (USEPA 1998), hereafter referred to as *Affordability Criteria for Drinking Water*.

2.3.1 Summary of *Affordability Criteria for Drinking Water*

According to *Affordability Criteria for Drinking Water*, USEPA has adopted or considered approximately two dozen methodologies for assessing the financial burdens municipalities face under Federal environmental laws and regulations (USEPA 1998). Upon reviewing these methodologies, USEPA concluded that the most prevalent measure of affordability is the annual user charge expressed as a percentage of median household income (AUC/MHI). The *EGWQS Workbook*, for example, uses this metric as the Municipal Primary Screener (see Section 2.1.1).

Variations on this basic methodology include using average household income instead of median household income, weighting percentages to capture poverty effects, and comparing the percentages to various benchmarks (e.g., at the state or national level). In addition, the percentages may be used in conjunction with related socioeconomic indicators (e.g., unemployment). In some methodologies, user affordability percentages or ratios are used as screening criteria that may be followed by a more detailed analysis phase. For example, if the screening phase finds a potential for affordability concerns, the subsequent phase may involve collection and analysis of detailed financial (e.g., debt capacity) and socioeconomic data (USEPA 1998). The five-step approach for evaluating "substantial impacts" in the *EGWQS Workbook* (see Section 2.1.1) is an example of a tiered methodology of this type.

Affordability Criteria for Drinking Water summarizes the findings of an USEPA-sponsored expert panel on affordability. A key finding of the panel was that staged methodologies, like those described above, may not result in relief for communities that have high household-level costs but do not meet the community-level (i.e., second stage) criteria for assistance. To improve upon the staged methodologies previously developed, the expert panel recommended two potential two-stage methodologies for assessing affordability (USEPA 1998). These methodologies are summarized in Figure 2.

Based on review of previously developed methodologies as well as recommendations from USEPA's expert panel, *Affordability Criteria for Drinking Water* presents resource flow models and a general framework for assessing affordability for drinking water projects. Table 1 presents the recommended indicators of affordability from the guidance document (USEPA 1998).

2.3.2 Evaluation of *Affordability Criteria for Drinking Water*

Affordability Criteria for Drinking Water and the *EGWQS Workbook* present similar and compatible approaches and metrics for assessing affordability. Overall, the *EGWQS Workbook* provides a more specific methodological procedure than the *Affordability Criteria for Drinking Water*. Although *Affordability Criteria for Drinking Water* does not provide an overall approach that is superior to the *EGWQS Workbook* methodology, it does provide potential refinements. In particular, the *EGWQS Workbook* methodology could be refined using one of the two conceptual methods summarized in Figure 2. Such a refinement would address the limitation identified by USEPA's Expert Panel, which does apply to the *EGWQS Workbook* methodology, that relief may not be obtained by communities with high household-level costs (i.e., exceeding the MPS criterion) but that do not meet the community-level (i.e., Secondary Test) criteria for assistance.

2.4 State Revolving Fund Programs

With the 1987 amendments to the Clean Water Act, Congress created the Clean Water State Revolving Fund (CWSRF) to help communities afford infrastructure and other expenses of protecting and improving water quality (USEPA 2001). Following the model of the CWSRF, Congress amended the SDWA in 1996 to create the Drinking Water State Revolving Fund (DWSRF). With Federal funding allocated under these programs, as well as related state laws, many states provide low-interest loans and other assistance to local water and wastewater systems and other eligible parties.

Some state revolving fund programs, including Montana's Water Pollution Control State Revolving Fund, offer extra relief or assistance to economically "disadvantaged" communities. Methods of identifying "disadvantaged" communities are at the discretion of states (USEPA 1998) and they do vary from state-to-state (USEPA 2000b). All state programs reviewed for this report identify disadvantaged communities primarily based on economic affordability.

Figure 2. Affordability Assessment Methodologies Recommended by USEPA's Expert Panel

Methodology 1

Basic Burden Screen - First determine the incremental cost per household divided by the median household income (or a construct like per capita income times household size). Then evaluate this result to see if the cost incurred by low income households is potentially too high by examining whether the cost-to-income ratios in the lower quantiles of the income distribution are disproportionately high.

Secondary Screen - For the communities that fall on the margin or that display a high burden, a more extended analysis would examine various measures of ability-to-finance the improvement. This analysis is based, in most cases, on the need for capital improvements and access to sources of financing. Some sources of revenue and borrowing may be accessible to one community but not to others. Intergovernmental flows can also greatly alter apparent costs.

Methodology 2

Basic Burden Screen - First determine if the residents of the jurisdiction would be unfairly burdened (that is, whether the annual cost relative to household income is above a selected threshold which would qualify the community for relief).

Petition for Relief - If the primary criterion for relief is not met, the municipality could petition for relief under either of two secondary criteria: (1) the municipality is unable to finance the project at a reasonable cost, or (2) the compliance cost is excessively large relative to the level of resources in the municipality. The burden of proof then falls on the municipality or system.

Source: USEPA (1998)

As discussed in Section 2.3, USEPA published *Affordability Criteria for Drinking Water* to aid states in developing affordability criteria for various SDWA provisions, including drinking water state revolving fund programs. Although *Affordability Criteria for Drinking Water* was developed for drinking water programs and not water pollution control programs, states use similar affordability criteria in both drinking water and water pollution control revolving fund programs. For example, most states include a calculation similar to the MPS defined in the *EGWQS Workbook* (USEPA 1995). Therefore, affordability criteria for both types of revolving fund programs are discussed in this section.

Table 1. Indicators Relevant to Assessing Affordability for Drinking Water Systems

Category	Selected Indicators
Household Affordability	– Ratio of user charges to income – Ratio of user charges to income relative to income levels – Percentage rate increase (rate shock)
Financial Capacity	– Ratio of revenues to expenditures – Ratio of net income to revenues – Ratio of assets to liabilities – Debt-service coverage – Composite indicators of financial health – Market test for goods and services (non-community systems)
Access to Private Capital	– Credit and bond ratings – Debt and debt capacity – Market test
Eligibility for Public Capital	– Credit and bond ratings – Priority rankings – Eligibility test
Fiscal Conditions	– Debt as a percentage of market property value – Tax revenues as a percentage of market property values – Property tax collection or delinquency rate – Local expenditures per resident – Opportunity costs associated with water system expenditures
Socioeconomic Conditions	– Median household income – Percent below the poverty level – Percent unemployment – Composite indicators of distressed communities

Source: adapted from USEPA (1998)

2.4.1 Montana Water Pollution Control State Revolving Fund

Information about Montana's Water Pollution Control State Revolving Fund (WPCSRF) was obtained from personal communication with MT DEQ staff (LaVigne 2006), the 2006 Intended Use Plan (MT DEQ 2006), and the authorizing law and regulations.[1]

Disadvantaged Montana communities are eligible to receive an additional one percent interest rate reduction for eligible water pollution control projects. For the purposes of the WPCSRF, Montana identifies disadvantaged communities by comparing water and wastewater system rates to the median household income (MHI) of the community. Separate criteria are used for communities with water and wastewater systems and communities with wastewater systems only. A community with water and wastewater systems is considered economically disadvantaged if the combined monthly system rates are greater than or equal to 2.3 percent of

[1] The Water Pollution Control State Revolving Fund Act and implementing regulations are available at http://www.deq.state.mt.us/wqinfo/Laws.asp.

the MHI. For a community with only a wastewater system, the system rate must exceed 0.9 percent of the MHI (MT DEQ 2006).

The threshold percentages used by the Montana WPCSRF were selected to be consistent with affordability requirements of other state funding agencies in Montana. Cost components included in the affordability calculation are the water and sewer rates, new and existing debt service and required coverage, new and existing operation and maintenance charges, and depreciation and replacement of equipment (MT DEQ 2006).

This methodology offers both advantages and disadvantages for potential use in the nutrient standards economic impact analysis. One potential advantage of using this methodology would be consistency with other state water protection programs in which affordability is considered. In addition, the approach is simple and could be easily applied to many communities. However, this approach uses fixed numerical benchmarks (i.e., 2.3 and 0.9 percents) that do not change even though costs of treatment change relative to the economic conditions. In addition, this methodology addresses household affordability, but not financial capacity, socioeconomic conditions, or other indicators of economic impact listed in Table 1.

2.4.2 Other State Revolving Fund Programs

Summaries are presented below of eight states' drinking water revolving fund affordability assessment methodologies. These summaries are provided for comparison with the Montana methodology described above and to illustrate a range of variation among states. Information for these summaries was obtained from USEPA (2000b). The methodologies below are examples and do not include all states that have methodologies for assessing affordability for pollution control and/or drinking water revolving fund programs.

2.4.2.1 Florida

Disadvantaged communities are defined in Florida as having an MHI less than the statewide average. In addition to eligibility for reduced interest rates based on the MHI, a portion of the loan principal may be forgiven based on financial burden. If the MHI is at least 80 percent of the state average, the financial burden criterion is one percent. If the MHI is lower than 80 percent of the state average, the financial burden criterion is 0.5 percent. The financial burden value is calculated using one of two formulas for estimating debt service as a percentage of revenue.

2.4.2.2 Maine

In Maine, communities are considered disadvantaged if the MHI of year-round residential water consumers is below the statewide MHI for non-metropolitan areas.

2.4.2.3 Maryland

In Maryland, a community is considered disadvantaged if it meets at least one of three criteria:

1. A small community (i.e., less than 10,000 residents) where the annual average water system user rate exceeds the target user rate (TUR) for that community.

2. A community of any size where the MHI is less than 70 percent of the statewide MHI for non-metropolitan counties.

3. A community of any size where the average user rate would have to increase by at least 20 percent to repay the loan.

TURs for individual communities range between 1 and 1.25 percent and depend on each community's MHI.

2.4.2.4 New Hampshire

New Hampshire uses a two-part affordability definition. A community must have an MHI below the statewide MHI. In addition, at least half of the residential units must be occupied at least six months of the year by households whose MHI is less than the statewide MHI.

2.4.2.5 New York

New York uses several affordability factors when considering eligibility for financial hardship relief. Decision-making is tied to the ranking system used to prioritize all project applications, as well as a comparison of target and projected household service charges, total project cost, a comparison to the statewide MHI, and other factors.

2.4.2.6 Oregon

In Oregon, a disadvantaged community is defined as one whose average user charge exceeds 1.75 percent of the MHI.

2.4.2.7 South Carolina

South Carolina has a two-tiered definition of disadvantaged communities. Level 1 disadvantaged communities have a service area MHI less than the statewide MHI. Level 2 disadvantaged communities, which are eligible for additional relief, meet the Level 1 definition and also experience a user charge above the target user charge. The target user charge is defined as the annual residential user charge for water, based on 6,000 gallons per month, equal to at least 1.4 percent of the applicant's MHI.

2.4.2.8 Washington

Washington defines a disadvantaged community as one with an MHI below 80 percent of the MHI of the county in which it is located. Further relief is available for disadvantaged communities with an MHI below 50 percent of the county MHI. Washington also designates

"distressed" counties based on unemployment data. Specifically, a distressed county is one with a three-year unemployment rate at least 20 percent greater than the statewide average.

2.4.3 Potential Usefulness of State Revolving Fund Affordability Criteria

The affordability criteria described in this section could be used to refine the MPS step of the *EGWQS Workbook* methodology. Like the MPS step of the *EGWQS Workbook* methodology, some states, including Montana, assess affordability by comparing a user-cost ratio to a static user-charge benchmark percentage. For consistency among related state programs, Montana should consider using the WPCSRF benchmarks (i.e., 0.9 percent and 2.3 percent) in place of the benchmark recommended by the *EGWQS Workbook* (i.e., two percent).

Instead of a fixed benchmark, some states define affordability by comparing the community's MHI or user-cost ratio relative to countywide or statewide values. Relative benchmarks may be more appropriate than a fixed benchmark (e.g., two percent) if costs-of-living or compliance costs are not heterogeneous throughout the state. An analysis of Montana's economy (Swanson undated) suggests that Montana contains three economically distinct regions. Therefore, it may be appropriate to compare the user-cost ratios for individual communities to average ratios for the economic region in which the community is located. However, calculating regional user-cost ratios would involve significant data collection and analysis.

Florida, Maine, and Washington couple household affordability criteria with financial burden or socioeconomic criteria. One of these states, Maryland, uses a tiered system that accounts for the population of each community. These approaches serve the same function as the Secondary Test or the widespread impact analysis of the *EGWQS Workbook* methodology.

2.5 Other Potential Methodologies

This section discusses two general analysis methodologies that may useful to MT DEQ as it assesses the potential economic impacts of preliminary water quality standards for nutrients. The first of these, input-output modeling, uses a detailed model to simulate how an economy responds to a change, such as a new regulation. The second general methodology discussed in this section is multiple criteria decision analysis (MCDA). Variations of this general methodology are useful when decision-making is complicated by multiple objectives, tradeoffs, and varying priorities (e.g., among stakeholder groups). Because these methodologies are described generally, their utility for the preliminary nutrient standards analysis is not directly comparable to the utility of the *EGWQS Workbook* methodology. These methodologies are included in the report because they may be useful for augmenting the *EGWQS Workbook* or other methodology, or for developing a customized methodology.

2.5.1 Input-Output Models

Policymakers and others often require information on the impacts of impending or potential changes to a local or regional economy. For instance, the setting up of new businesses in an area can cause changes in employment levels and local income. Plant closures, regulatory changes, or the imposition of new taxes could also have similar implications for a local economy. As

some local jobs are lost (or gained) as a result of the change, purchasing power and consumption decreases (or increases) affecting the output of other businesses in the region. Thus, apart from the impact of the initial change (i.e., the "direct" effects), the economy could also be affected by "indirect" or "multiplier" effects. Input-output analysis is a type of general equilibrium economic modeling that facilitates the estimation of the overall impact of an economic or regulatory change on a regional economy. For example, input-output analysis may be used to estimate the number of jobs created or lost in an area and the impact on regional income as a result of some type of economic or regulatory change.

Input-output models quantify the interrelationships between the various sectors of a complex economic system. Input-output models are easiest to develop when the underlying data on the economic interrelationships in a specific region have been pre-compiled and are readily available for use. Shortcomings of the method include insensitivity to consumer and producer behavior, such as product substitution. These models are "static" in the sense that they provide an all-at-once view of economic effects, without a time component that is necessary for understanding when the effects will be realized. More sophisticated applications of regional economic models supplement input-output relationships with simulation techniques to forecast the year-to-year effects of projects on economic and demographic patterns.

The IMPLAN economic impact modeling system is a commonly used input-output model developed by the Minnesota IMPLAN Group, Inc (MIG, Inc). Other commonly used input-output models include the Regional Industrial Multiplier System (RIMS) II (developed by the Bureau of Economic Analysis) and the Regional Economic Models, Inc. (REMI) model. In terms of complexity, IMPLAN is moderately complex, with RIMS II being less complex and REMI being considerably more complex. Case Study 3 (Section 3.2) provides an example of how the National Resource Conservation Service of the US Department of Agriculture used IMPLAN to estimate the economic benefits of conservation programs, in addition to the environmental benefits, to communities in Beaverhead County, Montana.

In the context of determining the affordability of measures to improve water quality in Montana, input-output models may serve two purposes. First, in the event that compliance with higher water quality standards requires the construction of new plants (such as wastewater treatment systems) or some other type of major expenditure, the models may be used to determine the positive economic effects of new local construction or expenditure. Second, if compliance costs are to be met by the imposition of new local taxes or levies, input-output models will help predict the dampening effect of new taxes on local demand and the number of jobs lost and the aggregate income lost as a consequence. Thus, input-output analysis has the potential for providing robust quantitative estimates of the overall socioeconomic impacts of the cost of compliance with higher water quality standards in Montana. This approach is likely to be more accurate and rigorous than the qualitative estimation of socioeconomic effects using expert judgment. A disadvantage of this approach is that it may be analytically demanding and data intensive, although it has been used extensively in regulatory applications.

2.5.2 Multiple Criteria Decision Analysis

Decision making in environmental projects can be complex because of trade-offs between social, political, environmental, and economic factors. Selection of appropriate remedial and abatement strategies for contaminated sites often involves weighing multiple criteria such as potential human risks, potential ecological risks, the distribution of costs and benefits, environmental impacts for different sub-populations, among others, many of which cannot be easily condensed into a monetary value. Even if it were possible to aggregate multiple criteria rankings into a common unit, this approach would not always be desirable because the ability to track conflicting stakeholder preferences may be lost in the process. Consequently, selecting from among many different alternatives often involves making trade-offs that fail to satisfy one or more stakeholder groups. Research in the area of MCDA has made available practical methods for addressing complex multi-criteria problems.

Methods of multi-criteria decision analysis attempt to arrive at scientific rankings by weighting and aggregating the scores on multiple criteria in a manner that is consistent with the stakeholder's preferences. These methods seek to ensure that stakeholder rankings are consistent with stakeholder preferences by adopting a consistent and systematic mathematical approach. There are many different MCDA methods, such as multi-attribute utility theory, multi-attribute value theory, analytic hierarchy process, paired comparisons, etc. These methods are based on different theoretical foundations such as optimization, outranking, or a combination of these rationales. The common purpose of these diverse methods is to be able to evaluate and choose among alternatives based on multiple criteria using a systematic analysis. Different methods require different types of raw data and follow different optimization algorithms. Some techniques rank options, some identify a single optimal alternative, some provide an incomplete ranking, and others differentiate between acceptable and non-acceptable alternatives.

Multi-attribute utility theory or multi-attribute value theory (MAUT/MAVT) and the analytical hierarchy process (AHP) are optimization methods. They employ numerical scores to communicate the merit of one option in comparison to others on a single scale. Scores are developed from the performance of alternatives with respect to an individual criterion and aggregated into an overall score. Individual scores may be simply summed or averaged, or a weighting mechanism can be used to favor some criteria more heavily than others

AHP uses a quantitative comparison method that is based on pair-wise comparisons of decision criteria rather than utility and weighting functions. All individual criteria must be paired against all others and the results compiled in matrix form. The user uses a numerical scale to compare the choices, and the AHP method moves systematically through all pairwise comparisons of criteria and alternatives. The AHP technique thus relies on the supposition that humans are more capable of making relative judgments than absolute judgments.

Outranking is based on the principle that one alternative may have a degree of dominance over another rather than the supposition that a single best alternative can be identified. Outranking models compare the performance of two or more alternatives at a time to identify the extent to which a preference for one over the other can be asserted. Outranking models are most

appropriate when criteria metrics are not easily aggregated, measurement scales vary over wide ranges, and units are incommensurate or incomparable.

MCDA methods may have relevance to the context of Montana's water quality compliance strategy in two ways: (1) if there are two or more technological alternatives or management practices for achieving the same objective, MCDA may be of use in facilitating a scientific comparison, and (2) in determining the economic affordability of water quality compliance costs, some MCDA methods may be of use in developing a weighting system for competing socioeconomic criteria.

3.0 Case Studies

This section presents four case studies in which methodologies discussed in Section 2 have been applied. The case studies describe the project context, methods used, and outcomes.

3.1 Case Study 1: MWRA Combined Sewer Overflow Variance Order

3.1.1 Introduction

On March 5, 1999, the Massachusetts Department of Environmental Protection issued a variance to the Massachusetts Water Resources Authority (MWRA) and the cities of Boston, Cambridge and Chelsea for discharges of combined sewer overflows (CSO) to the Alewife Brook and the Upper Mystic River.

The approval was based on a finding that investments in additional CSO controls would cause "substantial and widespread economic and social impact" to cities in the MWRA service area. In the absence of the variance, the cities would have had to commence engineering projects to separate sewerage and stormwater systems in the MWRA service area to prevent CSO events.

The details of the variance order are contained in the MWRA's final variance report (MWRA 1999). The approach applied to assessing economic and socioeconomic impacts are summarized in this case study.

3.1.2 Assessment Methodology and Findings

The variance report assessed impacts in three cities in the MWRA service area: Boston, Cambridge, and Chelsea. For each city, the methodology of the assessment was fairly closely based upon USEPA's *Interim Economic Guidance for Water Quality Standards* (USEPA 1995). The prevalence of substantial economic impacts was assessed using the MPS and the Secondary Test prescribed in the *EGWQS Workbook*.

For the computation of the MPS current MHI figures were escalated at a rate of 2.5 percent per year to the year 2009, the year in which increased user charges would commence if the project was undertaken. User fees were computed for two estimates of average water usage, which were based on (1) the actual average water consumption for the whole MWRA service area (the same average was used for each city) and (2) the American Water Works Association standard.

The Secondary Test prescribed in the *EGWQS Workbook* for assessing substantial economic impacts was applied with a few modifications to suit the MWRA service area context. In the *EGWQS Workbook*, six financial indicators are recommended for applying the Secondary Test: bond rating, overall net debt as a percent of full market value of taxable property, unemployment, MHI, property tax revenues as a percent of full market value (FMV) of taxable property, and property tax collection rate. Of these six factors, two were modified because of Massachusetts laws which limit the amount of property tax revenue that a community can assess. For this reason, the factor evaluating overall net debt as a percent of FMV of taxable property was changed to overall net debt per capita, and the factor evaluating property tax revenues as a percent of FMV was eliminated. Thus, only five factors were used to assess the financial health of these cities. Per the *EGWQS Workbook*, each of the factors was assigned a score from 1-3 with 1 representing economic weakness and 3 representing economic strength. The scores were then averaged to provide an overall secondary score.

The MPS score and the Secondary Test score were together used to determine the position of each city in the USEPA's substantial economic impacts matrix. For Boston and Cambridge, the economic impacts were found to be unclear, but potentially substantial. For Chelsea, the economic impacts were determined to be substantial.

In the assessment of widespread socioeconomic impacts, the report uses a subjective "expert judgment" approach loosely based upon *EGWQS Workbook*. The *EGWQS Workbook* proposes the following approach to assess socioeconomic impacts:

- Define the affected community (geographic area where project costs pass through to the local economy).

- Estimate the change from pre-compliance conditions in socioeconomic indicators. The indicators proposed in the *EGWQS Workbook* are the MHI, unemployment rate, overall net debt/full market value of taxable property, percent households below poverty line, impact on community development, and potential impact on property values.

The *EGWQS Workbook* suggests that the impacts of compliance upon each of these indicators be estimated either qualitatively (for instance, as "high" or "low") or through economic modeling.

The MWRA report assesses the existing socioeconomic condition of the three cities using the following indicators: unemployment rate, prevalence of subsidized housing, education levels, MHI, health characteristics (specifically, the teen birth rate), and state aid received. The report compares the level of each indicator with overall Massachusetts levels. Based upon these comparisons with the state average, the report classifies each of the cities as experiencing "economic stress" and concludes that the implementation of CSO control projects would result in substantial and widespread social and economic impacts on residents. The report attempts no further quantification of the potential changes in the socioeconomic indicators as a result of the project. Nor does the report qualitatively assess the potential changes in any of the cited socioeconomic indicators, apart from the overall conclusion of widespread impacts. No details

are provided describing the reasons for the choice of socioeconomic indicators or for the comparison to state rather than national averages.

3.1.3 Comments from Local Groups

The Mystic River Watershed Association (MyRWA), which describes itself as a nonprofit grassroots organization representing communities in the affected area, disagreed with the bundling of water and wastewater charges in the MWRA analysis and also disputed many of the cost estimates and methodologies used in the report. The association recommended that actual average usage per household in each community be used to calculate costs per household, rather than a weighted average for all MWRA communities. It suggested that only the incremental change in user fees as a result of the project be used in computing economic impacts. The association disagreed with the methods used in the assessment of widespread socioeconomic impacts (such as comparison of socioeconomic indicators to overall state levels and the lack of assessment of potential changes in those indicators) and called for the use of a more rigorous method of assessing economic and social impacts (MyRWA 2003).

3.1.4 Additional Analyses using Non-Standard Methods

In 2004, MWRA added some extensions to their original analyses, prompted by the finding that the use of updated estimates of MHI and sewer charges suggested that the communities' MPS values may be below the 1999 projections. These and other developments in economic and social conditions since MWRA's 1999 finding raised the question of whether additional investments in CSO controls would still cause "substantial and widespread economic and social impact" in the MWRA service area (Stavins et al. 2004).

The extended analysis uses additional methods beyond those prescribed in the *EGWQS Workbook*. The methods are based on the idea that the economic impact of additional CSO controls is directly related to the existing level of economic burdens on households. The greater the existing burdens, the greater will be the impact of additional controls. For example, the economic impact of increased sewer charges would be far greater if households do not have adequate income to purchase basic necessities, such as food and shelter, than if the income of those households could support substantial discretionary spending. In the former case, additional sewer charges would cause households to forego basic necessities. In the latter case, the foregone consumption would be less essential.

The analysis performs two extensions of USEPA's analysis to compare economic conditions in the MWRA service area with those typically associated with USEPA's two percent screener value threshold for a "large" economic impact. The first extension compares the broader economic burdens arising from the cost of basic necessities in the MWRA service area with those typically associated with a two percent screener value using data from 80 metropolitan areas nationwide. The second extension explores the implications of evaluating the burdens of particular costs based on their relationship to incomes of lower income households, rather than to the income of the median household.

The analysis concluded that economic burdens in the MWRA service area associated with the cost of basic necessities and shelter costs are well above those typically associated with a two percent preliminary screener value that indicates a "large" economic impact. Further, it was concluded that in the Boston metropolitan area, the ratio of the income of lower income households to that of the median household is below that found in 86 percent of metropolitan areas nationwide. Consequently, it was concluded a given economic burden expressed as a share of MHI implies more severe burdens on lower income households in the MWRA service area than it does on lower income households in most metropolitan areas nationwide.

3.2 Case Study 2: Economic Impact Analysis of Advanced Stormwater Treatment Systems in Los Angeles

Cities in the United States are likely to be affected by proposed stormwater treatment standards set to be triggered by existing Federal policy-making requirements. In Los Angeles County, these standards require three levels of treatment of all stormwater before it is discharged into a public body of water. A paper by economists and engineers at the University of Southern California presents a methodology for conceptual cost budgeting for these new required treatments, and describes methodologies and cost modeling tools needed for assessment of city and regional economic impacts associated with construction and operation of these plants. The paper also performs an economic impact analysis using input-output models for the construction of the stormwater treatment facilities over a twenty year period, assuming that the facilities are financed locally (Moore et al. 2004). This case study therefore represents a higher-end analytic approach to the assessment of social and economic impacts associated with a project.

The paper first estimates engineering cost for a range of alternative rainfall scenarios and treatment technologies. It then examines the regional economic impacts on employment and income arising from construction of each of the alternatives assuming that the project construction costs are recovered from local taxes and levies.

Building and operating a system of treatment plants of the scales described in the paper involve large expenditures, which have the potential to stimulate the economy. However, paying for these expenditures requires levels of taxation that often have opposite, and usually greater, depressive economic effects. The paper assumed that capital costs were spread evenly over 15 years of construction activity. Households throughout Los Angeles County were assumed to be taxed for twenty years to repay 4 percent, 20-year bonds (including 10 percent underwriting costs). The depressive economic effects of this financing scheme were calculated by reducing households' expenditures by the amount of the annual tax assessed to service this debt.

Two economic models were used to study the full impacts of all of these activities. The first was IMPLAN, a 528-sector input-output model describing the economy of the five-county Southern California region. The other model used in this study was a proprietary model developed at the University of Southern California, the Southern California Planning Model (SCPM), which had the unique capability of allocating all of the IMPLAN outputs to the various cities and communities throughout the five-county Southern California metropolitan area. This technique captures the multiplier effects associated with a depression in local demand associated with an increase in local taxes.

The approach used in the paper does not represent a standard cost-benefit analysis. No attempt was made to quantify the benefits of storm water treatment. Rather, the paper presents an impact study that acknowledges and accounts for both the stimulative and depressive economic effects associated with constructing new storm water treatment plants.

The paper finds that if stormwater treatment facilities are financed locally, the net employment impacts associated with the construction and operation of the new treatment plants will be strongly negative, despite the stimulative secondary economic effects in some economic sectors. Any short-term positive employment stimulus would be more than offset by the long-term reductions in household income necessary to pay for the new facilities. The paper presents the estimated overall change (gain or loss) in employment by sector (such as agriculture, mining, construction, manufacture, services, etc) and year. Estimates of the overall change in total output effects (direct plus indirect plus induced impacts) are also presented by location and by year.

The paper converts impacts from sector-specific job losses to dollars and estimates the present value of this stream of impacts in total and by location and year. A four percent discount rate was used throughout for net present value calculations, which is consistent with the interest rate used in the bond cost calculations.

3.3 Case Study 3: National Resource Conservation Service Use of Input-Output Analysis

The National Resource Conservation Service (NRCS) of the US Department of Agriculture is required to determine national and regional economic impacts for each watershed project it implements. Similar impact analysis is needed for state conservation programs and projects. In these efforts, NRCS extensively uses IMPLAN, a software-based economic input-output model developed by the US Forest Service and the Minnesota Implan Group. While originally implemented to supplement National Economic Development (NED) accounting with regional impact analysis, IMPLAN is also being used to examine impacts of proposed regulations and benefits of conservation programs.

IMPLAN measures economic and social impacts of conservation program implementation in terms (dollars of sales, local taxes received, jobs created) that decision-makers can understand. NRCS has used IMPLAN to estimate the impacts of projects implemented in Montana. For instance, during 2005, NRCS spent more than $3.4 million on conservation programs in Beaverhead County, Montana. This investment in the county's economy and environment is projected to generate a total of $5.1 million in economic activity and create or maintain 28 jobs. These estimates were derived from an application of IMPLAN to Beaverhead County (USDA 2006). Several other case studies involving the application of input-output analysis are briefly described on the NRCS website.

3.4 Case Study 4: Economic Analyses of Nutrient and Sediment Reduction Actions to Restore Chesapeake Bay Water Quality

3.4.1 Introduction

In May 2003, USEPA Region III issued guidance entitled *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries* (hereafter referred to as Regional Criteria Guidance). USEPA developed the Regional Criteria Guidance to achieve and maintain the water quality conditions necessary to protect aquatic living resources of the Chesapeake Bay and its tidal tributaries from the effects of nutrient and sediment pollution (USEPA Region III 2003a). The *Economic Analyses of Nutrient and Sediment Reduction Actions to Restore Chesapeake Bay Water Quality* (hereafter referred to as Economic Analyses) was developed to provide Chesapeake Bay Program partners with the results of analyses conducted by the Chesapeake Bay Program related to controls to meet the revised water quality criteria and uses (USEPA Region III 2003b). The Chesapeake Bay Program partners include Maryland, Virginia, Pennsylvania, the District of Columbia, the Chesapeake Bay Commission, and the USEPA.

As part of the Economic Analyses conducted by the Chesapeake Bay Program, a screening-level analysis of the potential for economic and social impacts was performed to help determine whether controls more stringent than those required by sections 30l(b)(l)(A) and (B) and 306 of the Clean Water Act would result in substantial and widespread economic and social impacts. The Chesapeake Bay Program did *not* attempt to provide conclusions regarding the affordability of controls to meet Bay water quality standards. Discussions in the Economic Analyses indicate that a comprehensive analysis of substantial and widespread impacts for all of the affected point and nonpoint sources in the Chesapeake Bay watershed would have been very time consuming and costly. The primary purpose of the screening analysis was to try to *rule out* areas that would not require further consideration because one condition or the other (substantial impacts, or widespread adverse effects) would not likely occur (USEPA Region III 2003b). Although beyond the scope of the screening analysis, the document does provide direction to assist states in evaluating substantial and widespread impacts for public sector and private sector entities. As a resource for conducting its screening-level analysis and directing states in evaluating substantial and widespread impacts, the Chesapeake Bay Program used the *EGWQS Workbook* (USEPA 1995).

3.4.2 Screening Analysis Methodology and Results

The Chesapeake Bay Program constructed a number of screening-level variables or ratios at the county level that may provide some indication of whether or not both impact conditions could be met. These ratios were designed to indicate whether either substantial or widespread economic and social impacts would *not* be likely. Twelve sector-related screening variables were developed as follows (USEPA Region III 2003b):

1. Agriculture: Average best management practices (BMP) costs/net cash return;
2. Agriculture: Crop plus portion of hay BMP costs/crop plus hay sales;
3. Agriculture: Livestock plus portion of hay BMP costs/livestock sales;

4. Agriculture: Average BMP costs/median household income;
5. Agriculture: Percent of county earnings from agriculture, agriculture services, food and kindred products, and tobacco sectors/total county earnings;
6. Forestry: Percent of county earning from forestry and logging/total county earnings;
7. Urban Sources: Average BMP costs/median household income;
8. Onsite Treatment Systems: Average BMP costs/median household income;
9. Onsite Treatment Systems: Percent of households affected in county;
10. POTWs: Current household sewer rate plus average new household cost/median household income;
11. POTWs and Urban Sectors Combined: Total sewer costs (current plus new) plus average urban BMP cost/median household income; and
12. Industrial Point Sources: Percent of county earnings from industrial sectors containing affected facilities/total county earnings.

The constructed screening model variables for some sectors indicate when control costs are small relative to household incomes and, therefore, unlikely to meet USEPA (1995) guidance conditions for substantial impacts. Variables for other sectors indicate whether they are small relative to the local economy and, therefore, unlikely to meet USEPA conditions for widespread impacts.

Screening results were summarized by sector for three levels, or *tiers*, of pollution control based on the costs of best management practices to remove nitrogen and phosphorus loads to the Chesapeake Bay (USEPA Region III 2003b). Each tier represented a specific "level-of-effort" combination of BMPs and wastewater treatment upgrades. Tier 1 represented the current level of implementation throughout the watershed, plus regulatory requirements implemented through year 2010. Each subsequent tier represented increased levels of control. Each tier has associated with it a given nitrogen, phosphorus, and sediment load reduction resulting from model-simulated implementation of the different technologies assigned to the tier (USEPA Region III 2003b; Chesapeake Bay Program 2003).

The summaries of screening-level social and economic impacts by sector and tier were used to show where substantial and widespread impacts *may* occur. Results indicated what percent of jurisdictions (i.e., counties and independent cities) for particular sectors are unlikely to incur substantial and widespread impacts. Further in-depth analyses (as described in the *EGWQS Workbook*) would be needed to make final determinations of social and economic impacts.

4.0 Summary and Recommendations

This report evaluates potential methodologies for assessing the economic impacts of preliminary nutrient standards for Montana state waters. In particular, the objectives of the report are to identify the applicability, practicality, and advantages and disadvantages of previously developed methodologies, and to provide recommendations toward further development of a detailed methodology for MT DEQ's economic analysis for preliminary nutrient standards.

Although several potentially relevant methodologies and guidance documents are available, the primary focus of the evaluation is a methodology developed specifically for state water quality

standards programs, the USEPA's *Interim Economic Guidance for Water Quality Standards Workbook* (*EGWQS Workbook*; USEPA 1995). Because the *EGWQS Workbook* methodology is the most directly relevant available methodology, it is regarded as a default option, and other available methodologies are evaluated relative to it. The evaluation considers whether any of the other available methodologies are more appropriate or advantageous (e.g., more analytically rigorous) than the *EGWQS Workbook* methodology and whether a tailored methodology should be developed by blending components of various methodologies.

Based on the comparative advantages and disadvantages of the methodologies investigated, this evaluation recommends using the *EGWQS Workbook* as the basis for a blended economic analysis for Montana's preliminary nutrient standards. This recommendation is supported by the following observations:

- Application of the *EGWQS Workbook* methodology in other states appears to have been effective and largely uncontroversial (e.g., see Case Studies 1 and 4 in Section 3).

- *EGWQS Workbook* methodology is more comprehensive than most other methodologies. For example, it includes separate and explicit approaches for evaluating "substantial" and "widespread" impacts. In addition, the guidance addresses differences in assessing impacts involving public and private sector entities.

- Among the guidance documents and methodologies identified and evaluated, *EGWQS Workbook* methodology is the one most directly relevant to the MT DEQ's current project. Therefore, it may offer a degree of acceptability by stakeholders and peer reviewers.

- The *EGWQS Workbook* methodology offers flexibility with regard to level of effort and depth of analysis, particularly with respect to assessment of widespread economic impacts.

- As a tiered methodology, intensive analysis would be required only for the subset of communities that do not pass the municipal primary screening step.

- Although the *EGWQS Workbook* methodology has potential limitations (discussed further below), it is sufficiently defensible and some limitations can be addressed with modifications based on other methodologies.

As indicated by the last bullet above, the *EGWQS Workbook* methodology is subject to the following limitations. The key limitations are described below, along with potential options to address them.

- The MPS (i.e., user-cost divided by MHI) may not be sufficiently sensitive to areas with a high incidence of poverty. A cost impact of two percent of the MHI (i.e., the benchmark recommend by EPA) may not be affordable to those on the bottom end of the income distribution. If there are many such households in a community, the MPS

will not adequately represent the overall affordability for much of the community. Options to address this limitation are to (1) analyze household income distribution data, if available; (2) couple the MPS criterion with a criterion based on poverty statistics; or (3) use a relative benchmark developed for a homogenous economic region of the state. The third option is used by some states when assessing affordability in State Revolving Fund programs (see Section 2.4.2). Since affordability assessments for the Montana Water Pollution Control State Revolving Fund (WPCSRF) are made using a metric similar to the MPS, input from the WPCSRF administrators would be helpful in evaluating options for this aspect of the methodology.

- The MPS has the potential to be insensitive to differences among locations in the overall cost of living. A two percent MHI is more affordable when cost of other essential goods is low rather than high. A potential remedy to this limitation is to compare the community-level MPS to a county or regional MPS instead of a fixed benchmark (see previous bullet). However, developing regional benchmarks would require significant data collection and analysis.

- Because disadvantaged communities (e.g., those with low MHIs) are more likely than other communities to receive a variance from meeting standards, they are more likely to experience lower environmental quality. This could be viewed as an environmental justice issue. This limitation is not specific to the *EGWQS Workbook* methodology; it could apply to any approach that may result in environmental variances or exceptions in disadvantaged communities.

- The secondary test for substantial economic impacts appears weighted more heavily towards ensuring the financial solvency of a municipal area rather than assessing the impact of pollution control costs on low income households. This potential shortcoming may be remedied by including additional factors relating to socioeconomic impacts and/or by weighting the factors differently. An alternative weighting system may be developed using the methods of multicriteria decision analysis.

- The methodology for assessing widespread impacts is vague and subjective compared to the substantial impacts methodology. Thus, if MT DEQ chooses to assess widespread impacts, it will be necessary to develop a specific approach and criteria. MT DEQ should consider the use of an input-output model (e.g., IMPLAN, see Case Studies 2 and 3) to quantify effects on income and employment. A pilot test of this and other potential approaches is recommended to help select a method for the full-scale analysis.

Recommended next steps toward developing and implementing an economic analysis for MT DEQ's preliminary nutrient standards include the following:

- Assemble a workgroup of appropriate MT DEQ personnel and others to discuss the findings of this evaluation and to choose a general methodology for further

development. The workgroup should provide guidance and review throughout the steps below.

- Select a specific criterion for the MPS step, if different from the default criterion provided in the *EGWQS Workbook*.

- Develop specific options and criteria for assessing widespread social impacts. For example, an input-output model, such as IMPLAN, could be pilot tested for a limited number of communities for practicality and performance. In addition, the more qualitative approach suggested by the *EGWQS Workbook* could be tested as well.

- Select communities for a pilot test of the substantial and widespread assessment methodologies. For example, a small, medium, and large community could be selected from each of Montana's three economic regions, for a total of nine pilot test communities. The pilot test should include communities with public and private sector treatment systems.

- After performing the pilot test, "ground truth" the results by consulting with community representatives. Then, refine the methodology as needed.

- If the pilot test indicates that the level-of-effort to apply the assessment methodology is too high, consider revising the methodology to include additional screening indicators to focus the analysis on a smaller scope of communities.

5.0 References

This section identifies the sources of information used to prepare this report. Relevant sources of information were obtained in three ways: (1) publications and contacts identified by MT DEQ; (2) internet searches; and (3) a literature search performed by the ICF International library. The literature search used the DIALOG database which is comprised of more than 500 individual database files. Specific databases included in the literature search were: National Technical Information Service (NTIS), EconLit, Water Resources Abstracts, WATERNET™, Environmental Sciences, Environmental Engineering Abstracts, FLUIDEX, Aquatic Science & Fisheries Abstracts, CAB Abstracts, Enviroline®, Pollution Abstracts, Ei Compendex®, Biosis Previews®, BioEngineering Abstracts, WasteInfo, and ChemEng & Biotec Abstracts. These databases were chosen to represent government, environmental, engineering, biological, chemical, and science related sources.

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