Memorandum

TO: Lucia Ramirez
FROM: HDR and CH2M Hill
DATE: December 31, 2012
RE: Discounting Recommendations for Least Cost Planning in Oregon, Part 2

This memorandum reviews the question of discounting and discount rates in relation to the development of Oregon's least cost planning framework and tool (Mosaic: Value and Cost Informed Planning). It is a complement to the memorandum "Discounting Recommendations for Least Cost Planning in Oregon" dated March 15, 2011 and available on ODOT's website[1].

SUMMARY OF RECOMMENDATIONS

The March 2011 memorandum addresses three questions in relation to discounting, namely: i) whether Mosaic should employ discounting; ii) if so, at what rate; and iii) how to approach discounting over very long time horizons. This memorandum addresses two additional questions: iv) whether all benefits and costs should be discounted at the same rate; and v) whether the discount rate should vary across projects or bundles of actions. Our recommendations in relation to all five question areas follow:

i. **Whether to discount in Mosaic:** The monetized benefits and costs estimated in the Benefit Cost Analysis (BCA) should be discounted. On the other hand, for practical reasons, the non-monetized effects considered in the Multi Objective Decision Analysis (MODA) should not be discounted.

ii. **The size of the discount rate:** A "real" (that is, constant-dollar) discount rate of 3 percent should be used, and sensitivity analysis at a real rate of 7 percent should *always* be conducted. Additional sensitivity tests can be considered by the Mosaic user.

iii. **What to do about the distant future:** It is recommended that Mosaic hold the discount rate constant for the full period of analysis (which in most cases will be 30 years or less). When the planning horizon extends beyond 30 years, we recommend sensitivity tests where the discount rate is held constant for the first 30 years and then declines linearly from 3 percent to 2.5 percent between Year 31 and Year 50, and by 0.5 percentage points between Year 51 and Year 100, to a lowest value of 2.0 percent.

iv. **Whether all benefits and costs should be discounted at the same rate:** It is recommended that the same discount rate be used for all benefits and costs, unless there is a compelling reason to do otherwise *and* a well-established alternative. We advise that this is only the case for life cycle CO2 emissions. These should be discounted at the rate implicit in the social cost of carbon used in their monetization, regardless of the rate at which other effects are discounted.

v. **Whether the discount rate should vary across projects or bundles of actions:** We recommend that the same discount rate (or set of discount rates) be used for all projects or bundles of actions.

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[1] At http://cms.oregon.gov/ODOT/TD/TP/docs/lcp/discount.pdf

TECHNICAL BACKGROUND TO THE RECOMMENDATIONS [2]

i. Whether to Discount

A method used to convert future benefits and costs into a common year, discounting allows the level-playing field comparison of alternatives whose costs and benefits occur at different rates over time. The procedure involves the use of a discount rate (the annual percentage change in the present value of a future dollar, or other unit of account) to covert future outcomes to their present-day equivalent.

ii. Size of the Discount Rate

The size of the discount rate can have a significant impact on the results of the assessment and ranking of options. In general, with higher discount rates, less value is assigned to future benefits and costs. And because benefits tend to arise later than costs, higher discount rates typically reduce the net present value of options. Higher discount rates also penalize options for which benefits arise relatively late.

There are two main rationales for setting a discount rate in the public sector: (i) the Social Opportunity Cost of capital (SOC); and, (ii) the Social Rate of Time Preference (SRTP). The SOC is based on the idea that funds used in government projects – or as a result of government actions – have an "opportunity cost" in terms of foregone *investment* elsewhere in the economy. In this view, the discount rate should reflect the rate of return on the investments that may be foregone (or "crowded out"). The SRTP focuses on the idea that individuals, and society as a whole, value outcomes that occur in the present more highly than those occurring in the future. In this view, the discount rate should reflect the rate at which society is willing to trade current for future *consumption*.

These two approaches have been used by a number of public agencies around the world. Resulting estimates for developed economies range from 3 percent in Germany to 12 percent in Mexico. In the United States, the White House Office of Management and Budget (OMB) recommends the use of an SOC-based discount rate of 7 percent whenever the main effect of a project or action is to displace or alter the use of capital in the private sector[3]. When this is not the case, a discount rate of 3 percent may be used. This rate is based on the return on long-term government debt, which is generally considered a fair approximation of the SRTP.

The debate between the SOC and SRTP views is not fully settled, but an emerging consensus among economists involves using an estimate of the SRTP to discount future benefits and costs, and to adjust the costs of the project or action upward to account for the opportunity cost of capital displacement[4]. This approach however, while preferred by "purists", is difficult to implement in practice because the degree of "crowding out" is generally unknown[5]. **Best practice in this case involves producing estimates of net present value with both the SOC and SRTP-based discount rates**.

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[2] This section is based in part on the March 2011 memorandum.

[3] The rate of 7 percent is based on the pretax rate of return on an average investment in the private sector in the U.S. during the 1970s and 1980s. Use of this rate for discounting is equivalent to assuming that public financing of a project − or bundle of actions − results in a "dollar-for-dollar" crowding out of investment in the private sector.

[4] This is referred to as the "shadow price of capital" approach in the economic literature.

[5] The extent of capital displacement depends on a variety of factors, including the nature and size of the project or bundle, whether the economy is open or closed (i.e., whether private investors have access to foreign capital), and general economic conditions. Nonetheless, some estimates of the "shadow price of capital" are available in the literature. Moore et al. (2004), for example, recommend a factor ranging from 1.0 to 1.3 applicable to all investment costs when there is "some crowding out", with a preferred value of 1.1 (to be used in combination with a real discount rate of 3.5 percent).

iii. Discounting and the Distant Future

Discounting over very long periods of time, especially periods that span generations, is an ethically loaded issue. It is also complicated by a number of factors, including the need to consider long-term growth projections, or to determine whether the choices made by individuals over their own life time can reasonably be used as a basis for assessing trade-offs between current and future generations. Economists have not reached a consensus, but they generally agree that discounting at a constant rate does tend to over-discount effects that occur in the distant future. **It is thus considered reasonable to reduce the discount rate over time for project evaluations with time horizons greater than about 30 years**.

iv. Discounting Different Costs and Benefits at the Same Rate or Different Rates

It is generally recommended that all benefits and costs be discounted at the same rate. The economic literature, however, identifies a number of cases where departures from this general rule may be warranted. This is explained below.

First, a number of experimental studies have found that individuals discount different outcomes differently. Individuals may, for example, discount future health benefits at a lower rate than future reductions in travel costs. Experiments also suggest that people discount future losses at a lower rate than future gains. The U.S. Environmental Protection Agency (EPA) provides a brief summary of the literature on these alternative views on discounting:

> *Some studies of individual financial and other decision-making contexts suggest that even a single individual may appear to value and discount different actions, goods, and wealth components differently. This "mental accounts" or "self-control" view suggests that individuals may evaluate one type of future consequence differently from another type of future consequence (…). Some evidence from experimental economics indicates that discount rates appear to be lower the larger the magnitude of the underlying effect being valued. Experimental results have shown higher discount rates for gains than for losses (…). Further, individuals may have preferences about whether sequences of environmental outcomes are generally improving or declining (…).*
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> EPA (2010), Text Box 6.4, p. 6-11

Discounting different outcomes at different rates is conceptually appealing, and it is supported by experimental data. But it is difficult to implement in practice, in particular because there is no broadly accepted approach to assessing how intertemporal preferences vary across benefit and cost categories. Rather, as discussed in the March 2011 memorandum, social discount rates are typically set on the basis of aggregate, observable values (e.g., the rate of return on long-term government debt).

Second, the use of different discount rates may be justified by the specific methods or metrics used in the measurement of benefits and costs. This is the case, in particular, for GHG emissions and certain health effects.

It is generally agreed that changes in CO2 emissions should be discounted at the rate used in the estimation of the Social Cost of Carbon (SCC), *regardless* of the discount rate applied to other benefits and costs[6]. Thus, the Inter-agency Working Group on the Social Cost of Carbon (IWGSCC) explains:

> *While the SCC estimate grows over time, the future monetized value of emissions reductions in each year (the SCC in year t multiplied by the change in emissions in year t) must be discounted to the present to determine its total net*

[6] The real discount rate considered by the IWGSCC in developing guidance for the social cost of carbon ranges between 2.5 percent and 5 percent. Their "preferred" SCC value of $21.4 per metric ton (in dollars of 2007, for emissions occurring in 2010) was derived with a real discount rate of 3 percent.

present value (…). Damages from future emissions should be discounted at the same rate as that used to calculate the SCC estimates themselves to ensure internal consistency—i.e., future damages from climate change, whether they result from emissions today or emissions in a later year, should be discounted using the same rate. For example, climate damages in the year 2020 that are calculated using a SCC based on a 5 percent discount rate also should be discounted back to the analysis year using a 5 percent discount rate. However, it is possible that other benefits or costs (…) unrelated to CO2 emissions will be discounted at rates that differ from those used to develop the SCC estimates.

IWGSCC (2011), pp. 28-29

Some economists have argued that certain health effects – in particular those expressed in terms of Quality Adjusted Life Years (QALY) or utility – may also be discounted at different rates. Parsonage and Neuberger (1992), for example, argue that non-monetary health benefits should not be discounted at the same rate as variables expressed in monetary terms, and that the appropriate discount rate for those benefits should be at or close to zero. Keeler and Cretin (1983), on the other hand, stress that discounting benefits and costs at different rates may lead to "peculiar results". While recognizing the "ethical argument" against the discounting of life years, they reason that failure to discount health benefits implies a willingness to transfer resources away from present needs to "buy additional life years" for future generations.

OMB offers the following summary and recommendations:

When future benefits or costs are health-related, some have questioned whether discounting is appropriate, since the rationale for discounting money may not appear to apply to health. It is true that lives saved today cannot be invested in a bank to save more lives in the future. But the resources that would have been used to save those lives can be invested to earn a higher payoff in future lives saved. People have been observed to prefer health gains that occur immediately to identical health gains that occur in the future. Also, if future health gains are not discounted while future costs are, then the following perverse result occurs: an attractive investment today in future health improvement can always be made more attractive by delaying the investment. For such reasons, there is a professional consensus that future health effects, including both benefits and costs, should be discounted at the same rate.

OMB Circular A4 (2003)

We believe that, unless there is a compelling reason to do otherwise and a well-established alternative, the same discount rate should be applied to all benefit and cost categories. In the current version of Mosaic, the only specific indicator for which both conditions are met is Life Cycle CO2 Emissions, in the Environmental Stewardship category.

v. Discounting Different Types of Projects at the Same Rate or Different Rates

At least a couple of rationales have been put forward to justify the use of different discount rates for different projects or bundles of actions. They are described briefly below.

First, it is often argued that projects that deliver benefits later in their life cycle and/or over a longer planning horizon should be assessed with a lower discount rate. For example, investments in rail transit which promote long-term changes in travel behavior and land use should be discounted, it is argued, at a lower rate than highway projects delivering immediate – and often short-lived – congestion relief.

This is a misunderstanding of discounting. Discounting is precisely about leveling the playing field when comparing options whose costs and benefits occur through time at different rates. If anything, concerns

about penalizing options delivering benefits later in life should be addressed with a discount rate that is lower for *all* options, including those producing immediate effects.

The second justification for different discount rates relates to the distinction between the Social Opportunity Cost and the Social Rate of Time Preference. Young (2002) summarizes the view of several economists who argue that the social discount rate should be calculated as a weighted average of both metrics, as follows:

$$\textit{Social Discount Rate} = \alpha.SOC + (1-\alpha).SRTP$$

Where the weights α and (1-α) are *project-specific*, and depend on the resources used in a particular project or as a result of a particular action (α is the proportion of resources or costs crowding out private investment). This is somewhat in line with OMB's recommendation of using a lower, SRTP-based discount rate whenever projects or actions "primarily and directly" affect private consumption (e.g., through higher consumer prices) as opposed to the allocation of capital.

As noted earlier, and pointed-out by Young, however, determining whether the impact will be on private investment or private consumption – and estimating project-specific weights – is likely to be challenging. And the alternatives of either conducting sensitivity analysis using both rates (SOC and SRTP-based) or using a "shadow price of capital" approach are often preferred.

Overall we conclude that the same discount rate should be used in the assessment of all projects or bundles of actions.

Annotated Bibliography [7]

Interagency Working Group on Social Cost of Carbon, United States Government, *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*, February 2010, available at http://www.epa.gov/oms/climate/regulations/scc-tsd.pdf, last accessed 08/28/2012

> *This document summarizes the process used by a working group tasked with developing estimates of the Social Cost of Carbon (SCC). The group recommended four SCC values for use in regulatory analyses: three values were based on the average SCC derived from three integrated assessment models (the FUND, DICE, and PAGE models), at discount rates of 2.5, 3.0, and 5.0 percent; a fourth value was included to represent higher-than-expected impacts. The group was comprised of technical experts from twelve federal agencies, including the Environmental Protection Agency, the Office of Energy and Climate Change, the Office of Management and Budget, and the Council of Economic Advisers.*

Keeler E.B. and S. Cretin, *Discounting of Life-Saving and Other Nonmonetary Effects*, Management Science, Vol. 29, No. 3, March 1983, pp. 300-306

> *This paper examines the conditions under which, in a cost-effectiveness analysis, the streams of monetary and non-monetary effects can be reduced to one discounted sum of monetary costs and another of effects. It argues that if the non-monetary effects can be cashed out in a way that does not vary with time, then the rates of discount for monetary and non-monetary effects have to be equal. The paper presents an argument for the equality of those rates when hard to monetize benefits such as life-saving are involved. It shows that if the ability to produce the non-monetary effect does not diminish too quickly over time, failure to discount benefits implies that programs are always improved by delay. In general, it argues that discounting benefits and costs at different rates can lead to peculiar results.*

Moore, M.A., A.E. Boardman, A.R. Vining, D.L. Weimer, and D.H. Greenberg, *Just Give Me a Number! Practical Values for the Social Discount Rate*, Journal of Policy Analysis and Management 23(4), 2004, pp. 789-812.

> *This paper offers guidance about the choice of a social discount rate. It recommends the following procedures: If the project is intra-generational (does not have effects beyond 50 years) and there is no crowding out of private investment, then discount all flows at 3.5 percent; if the project is intra-generational and there is some crowding out of investment, then weight investment flows by the shadow price of capital of 1.1 and then discount at 3.5 percent; if the project is inter-generational and there is no crowding out of investment, then use a time-declining scale of discount rates; if the project is inter-generational and investment is crowded out, then convert investment flows during the first 50 years to consumption equivalents using a shadow price of 1.1, and then discount all of these flows at 3.5 percent, and discount all flows after the 50th year using time-declining rates. The paper also compares current discounting practices of U.S. federal agencies with the recommended estimates.*

National Center for Environmental Economics, U.S. Environmental Protection Agency, *Guidelines for Preparing Economic Analyses*, December 2010, available at http://yosemite.epa.gov/ee/epa/eed.nsf/pages/guidelines.html, last accessed 10/16/2012

> *This document establishes a framework for performing economic analyses of environmental regulations and policies. It provides guidance on analyzing the benefits, costs, and economic impacts of regulations and policies, including assessing the distribution of costs and benefits among various segments of the population. Chapter 6 provides recommendations for discounting. The chapter describes the mechanics of summarizing present and future benefits and costs; highlights the different approaches to selecting a discount rate (e.g., Social Rate of Time Preference, Social*

[7] The summaries included in this annotated bibliography borrow heavily from the papers' abstracts.

Opportunity Cost of Capital); addresses the issue of inter-generational discounting, and concludes with some guidance.

Parsonage, M. and H. Neuburger, *Discounting and Health Benefits*, Health Economics, Volume 1, 1992, pp. 71-79

This paper argues that non-monetary health benefits should not be discounted at the same rate as variables expressed in monetary terms. It explores the various influences of rising income, age and pure time preference on the relative value of current and future health states. It examines various arguments advanced to justify the current practice of discounting health benefits at the same rate as monetary costs. These include uncertainty and delay. The article concludes with an analysis of the likely impact of adopting a zero discount rate on the ranking of health interventions

The White House Office of Management and Budget, Circular No A-4, Regulatory Analysis, September 17, 2003, http://www.whitehouse.gov/omb/circulars_a004_a-4, last accessed 08/28/2012

This circular provides the OMB's guidance to Federal agencies on the development of regulatory impact analysis. It includes an excellent discussion on the rationale for discounting, and refers to OMB Circular A-94 for "basic guidance" on the discount rate. The document also addresses the issues of inter-generational discounting, and time preference for non-monetized benefits.

Young, Louise, *Determining the Discount Rate for Government Projects*, New Zealand Treasury Working Paper 02/21, September 2002, available at http://www.treasury.govt.nz/publications/research-policy/wp/2002/02-21/twp02-21.pdf, last accessed 08/28/2012

This working paper assesses the applicability of two key theoretical approaches to selecting discount rates in the public sector. The two approaches considered are the Social Rate of Time Preference (SRTP) and the Social Opportunity Cost (SOC). Estimation issues in determining the rate using these two approaches are reviewed. The SRTP is considered to be the appropriate approach. When estimates of the SRTP are unavailable or clearly unreliable and the Government is considering financing a project, the SOC should be used. The SOC can be used as a proxy for the SRTP. The paper also presents an example using the capital asset pricing model in a weighted average cost of capital formula to determine a SOC.