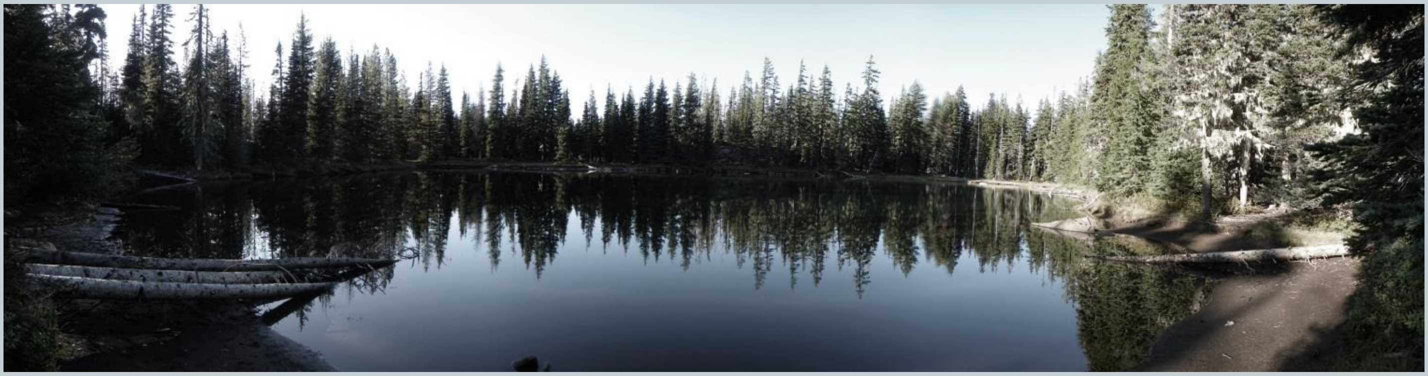
Proposed Methods for Analyzing Feasibility, Costs, and Benefits of Water Storage Projects in Oregon



Senate Bill 839 Economic Subgroup Report
February 1, 2014

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Executive Summary

Senate Bill 839 calls for the protection of Seasonally Varying Flows (SVF) to maintain the biological, ecological, and physical functions of the watershed during periods outside of the irrigation season when public funds from the Water Supply Development Account are used for certain water storage projects. In this document, the economic subgroup examines the associated economic realities of developing and operating water storage projects and makes recommendations to the Seasonally Varying Flows Task Force.

In this report, economic subgroup identifies several factors that demonstrate a need in Oregon for additional stored water. The report then describes the four primary techniques used to store water in Oregon for instream and out-of-stream use. The economic subgroup conducted a literature review of methods used to evaluate both the financial feasibility and the cost and benefits of such water storage projects. This report provides an outline of both approaches, as well as additional references for practitioners.

The report recommends that the State form a Technical Review Team to assist applicants with the design of these financial feasibility and cost-benefit analyses. The report also recommends using pre-application meetings to improve communication and coordination between the State and funding applicants.

The economic subgroup fully appreciates the benefits that water storage projects can provide to both instream and out-of-stream users. The subgroup has laid out methods in this report to help funding applicants and potential funders at the state level fully account for both the costs and benefits of these projects.

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Introduction. Framing the Discussion

The Department shall establish seasonally varying flows using a methodology established by Water Resources Commission rules. (Senate Bill 839, 2013)

In 1992, the Oregon Water Resources Commission adopted the State's water storage policy, identifying water storage options as an integral part of Oregon's strategy to enhance public and private benefits from use of the State's water resources. The policy acknowledges that both structural and nonstructural methods should be used in Oregon to store water, with preferences for storage that optimizes instream and out-of-stream public benefits and beneficial uses. In 1993, the Oregon Legislature codified the State's policy of water storage facilities, declaring it a high priority to develop environmentally acceptable and financially feasible multipurpose storage projects, and to enhance watershed storage capacity through natural processes using non-structural means.

The need for stored water among municipal, agricultural and other water users is documented and growing. One factor that will continue to increase the need for storage in future years is climate change. In recognition of these present and future challenges, Oregon's Integrated Water Resources Strategy, adopted in 2012, calls for, among other things, improved access to built storage (Recommended Action #10B).

Purpose, Outcomes, and Timelines of This Process

In 2013 the Oregon Legislature approved Senate Bill 839, establishing a Water Supply Development Account (Account) to provide loans and grants for water supply development projects that have economic, environmental and social-cultural benefits. Both above- and below-ground water storage projects are eligible for funding, provided that seasonally varying flows are protected.

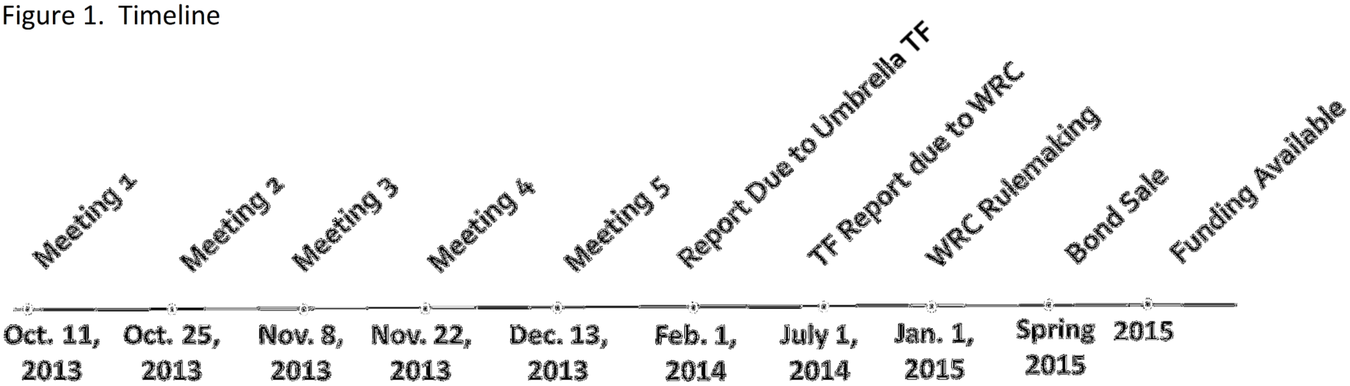
The design of reasonable and understandable requirements for storage projects will help ensure that both instream and out-of-stream needs are met, while also considering the economic feasibility of proposed storage projects.

To assist in developing these requirements, the bill calls for the creation of a Seasonally Varying Flows Task Force that shall, by consensus, develop a recommended methodology for determining seasonally varying flow requirements for water storage projects funded by the Water Supply Development Account. In developing the methodology, the Task Force, as directed by Senate Bill 839, must consider the financial feasibility of new water storage projects and that such projects might not be appropriate or feasible in many locations.

The bill also required the creation of an economic subgroup to examine the associated economic realities of developing and operating water storage projects and submit a report to the Task Force by February 1, 2014. The report must describe: 1) the practical engineering methods for new water storage projects; 2) the feasibility of water storage development, 3) the costs and benefits of water storage projects, and 4) the cost of complying with environmental benefit standards. The following chapters are organized to reflect this charge.

Senate Bill 839 further directed the following sequence of events: (1) the Task Force shall submit a report to the Governor, an interim committee of the Legislative Assembly, and to the Water Resources Commission no later than July 1, 2014; (2) the Water Resources Commission shall adopt rules to establish a methodology for use in determining the seasonally varying flows, giving consideration to adoption of the methodology described in the Task Force report; and (3) the Commission shall complete adoption of the rules in time for them to take effect on January 1, 2015.

Figure 1. Timeline



The economic subgroup has a very narrow mandate: to assess the economic realities of water storage projects that may seek state funding from the Water Supply Development Account, and that:

- require a new water storage or aquifer recharge permit or limited license;
- store water outside of the official irrigation season; and
- impound surface water on a perennial stream; divert water from a stream that supports state or federally listed sensitive, threatened or endangered fish species; or divert more than 500 acre-feet of surface water annually.

Factors Contributing to the Potential Benefits of Additional Stored Water

The subgroup began by looking at factors contributing to the potential benefits of additional stored water. These factors are unevenly distributed, and include: timing of streamflow, water uses, soil class, and water availability, as described below.

Factor #1—Timing of Streamflow

Although the volume of water seems enormous in some areas of the state, it does not always arrive when we need it most. The arrival of precipitation in Oregon, whether by rain or snow, typically occurs from October through May. This stands in stark contrast to the months in which water demands are at their highest, or peak, for most uses.

Figure 2 demonstrates this mismatch in timing. The highest water demand for irrigation (example shown on the green line) occurs during the months of June, July, and August, similar to the demands for municipal / domestic supplies (orange line). The blue line, representing typical streamflow distribution in Oregon, hits a seasonal low during those same summer months.

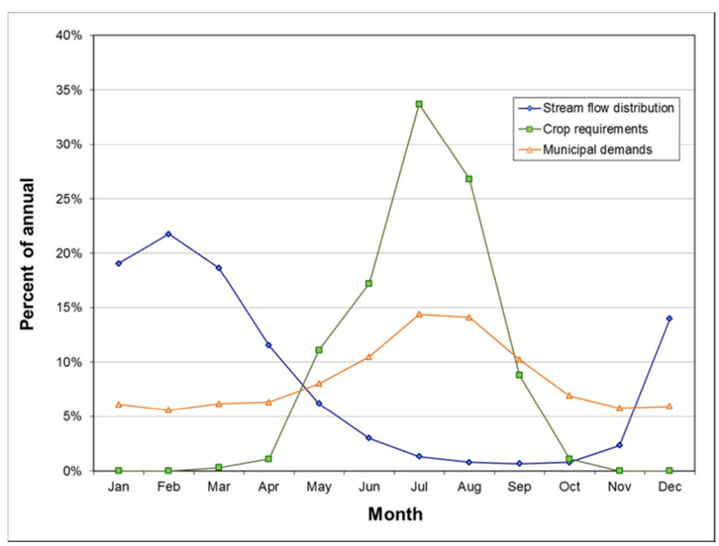


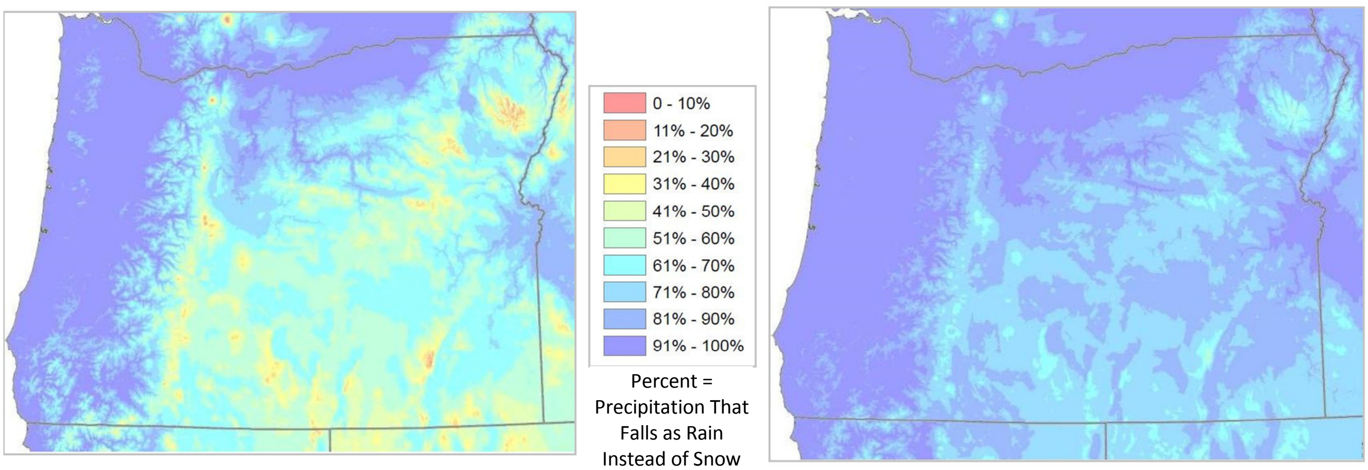
Figure 2. Typical Timing of Streamflow vs. Demand in Oregon

Climate models project an average rate of warming of approximately 0.1° – 0.6° Celsius per decade through the 2050s. In such a scenario, the percentage of precipitation that falls as snow will be significantly less.

Precipitation arriving as rain instead of snow could pose several challenges to water systems, such as altering the timing of runoff and water availability throughout the state, creating flood-prone systems, decreasing summertime run-off to surface water, and reducing recharge to groundwater aquifers. Water users who are dependent on snowpack for summertime water could see significant decreases in water when they need it most. Approximately 50 percent of Oregon water users are located in areas of the state that are dependent on snowpack to meet their water needs.

Figure 3 shows the percentage of precipitation that falls as rain in two scenarios: current precipitation conditions and conditions with a rise in temperature of 3.0° Celsius.

Figure 3. Current Precipitation Conditions Versus Future Scenario (3° C Temperature Increase)



Red, yellow, and orange hues represent areas where a large percent of precipitation falls as snow.

Blue represents areas where a large percent of precipitation falls as rain.

Factor #2—Out-of-Stream Uses

Historically, agricultural water users and municipal water providers have tried to meet summertime demands through storage—using a combination of above- or below-ground options and relying upon natural storage (e.g., snowpack or floodplains) to replenish and filter water supplies.

About eight percent of the total water in Oregon is diverted for out-of-stream uses, such as agricultural, municipal, industrial-commercial, and domestic uses. Oregon last conducted a statewide water demand forecast in 2008. The results were mapped by basin and county. The forecast estimated total statewide out-of-stream water demand in 2008 at approximately 9.1 million acre feet, and projected that in 2050, the total would increase to about 10.3 million acre-feet for the agricultural, municipal, industrial-commercial, and domestic sectors.

Factor #3—Soil Class

Water can increase agricultural yields 200 to 600 percent and enable the production of a wider variety of crops, which can make land more valuable and create economic hubs. Significant acres of agriculturally zoned lands exist that presently lack water for irrigation but would benefit if water were developed and became available during the growing season.

The Soil Survey conducted by USDA Natural Resources Conservation Services identifies soil classes 1-8 to indicate their potential for agricultural productivity. Soil classes 1-4 are considered to be the best quality soils for agricultural production, potentially increasing production when irrigation water is available. Although class 5-8 soils are of poorer quality, some class 5-8 soils can move to the class 1-4 range with irrigation.

The Oregon Department Agriculture analyzed three GIS data layers—land use information obtained from the USDA Cropland Database, soil survey data from the NRCS, and water rights information from the Oregon Water Resources Department's Water Rights database—to calculate acreage that could realize improved agricultural production if water became available.

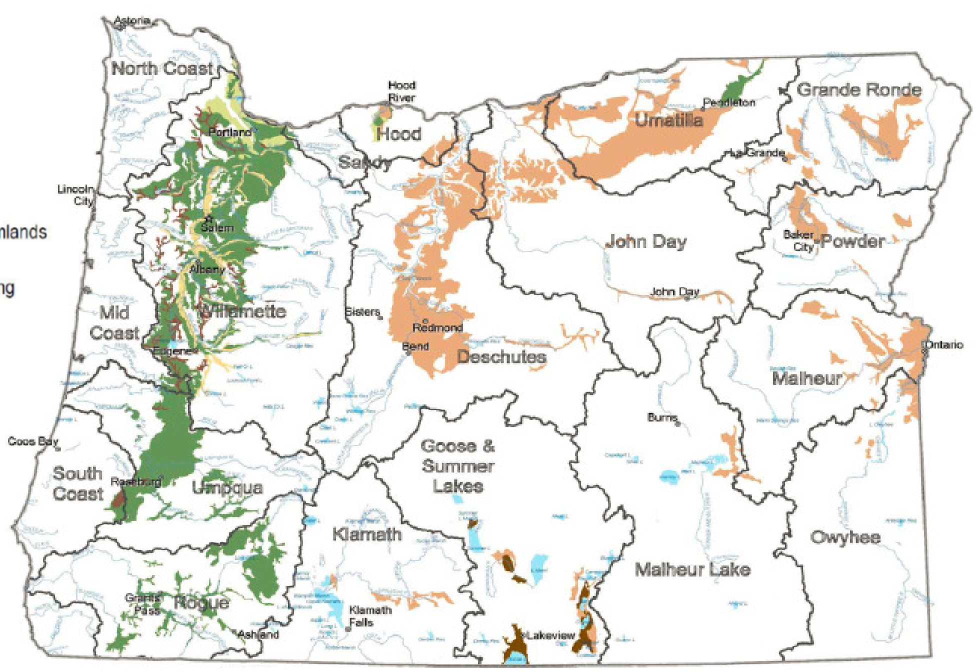
Figure 4 shows estimates of acres in several Oregon counties that could increase productivity if water were available to irrigate these lands. These counties are representative of various climatic and ecological conditions that can be found in Oregon.

Figure 4. Selected Counties with Acres That Could Improve Soil Class with Application of Water

County	Acres That Could Improve Soil Class with Application of Water	Total Acres in County
Baker	44,627	1,963,520
Harney	90,275	6,486,400
Jackson	247	1,139,840
Josephine	7,055	1,049,600
Malheur	135,941	6,328,320
Union	1,747	1,303,680
Yamhill	44	458,240

Similarly, the U.S. Department of Agriculture identifies "prime farmland" as land that has the best combination of soil properties, growing season, and water supply needed for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. Prime farmland, which is highlighted in Figure 5, can produce sustained, high yields of crops in an economic manner if it is treated and managed according to acceptable farming methods.

Figure 5. Prime Farmland
Source: NRCS STATSGO 1994



Factor #4—Instream Uses
Just as water is needed to support out-of-stream needs, water is needed to ensure overall ecosystem health. Water within the stream system and within groundwater aquifers is needed to sustain Oregon's diverse aquatic species and ecosystems. This has been a recognized beneficial use of water in Oregon since 1987.

As noted in Oregon's 2012 Integrated Water Resources Strategy, the timing of instream needs is difficult to identify and quantify because different species require sufficient water at different times of the year for different biological purposes. Low streamflows during the summer months generally represent the greatest concern for the survival of aquatic species.

Instream flows also support the needs of Oregon's industries, such as recreational and commercial fisheries and associated businesses, water-related tourism and destination spots, energy production, and navigational transportation.

The release of stored water during low-flow summer months can benefit instream needs, whether they be ecological, recreational, energy- or transportation-related.

As noted in Senate Bill 839, some of the instream functions the State is specifically striving to protect throughout the process of water supply development include: (a) stream channel development and maintenance; (b) connectivity to floodplains; (c) sediment transport and deposition; (d) migration triggers for upstream movement of adult fish and downstream movement of fry and juvenile fish; (e) fish spawning and incubation; (f) juvenile fish rearing; and (g) adult fish passage.

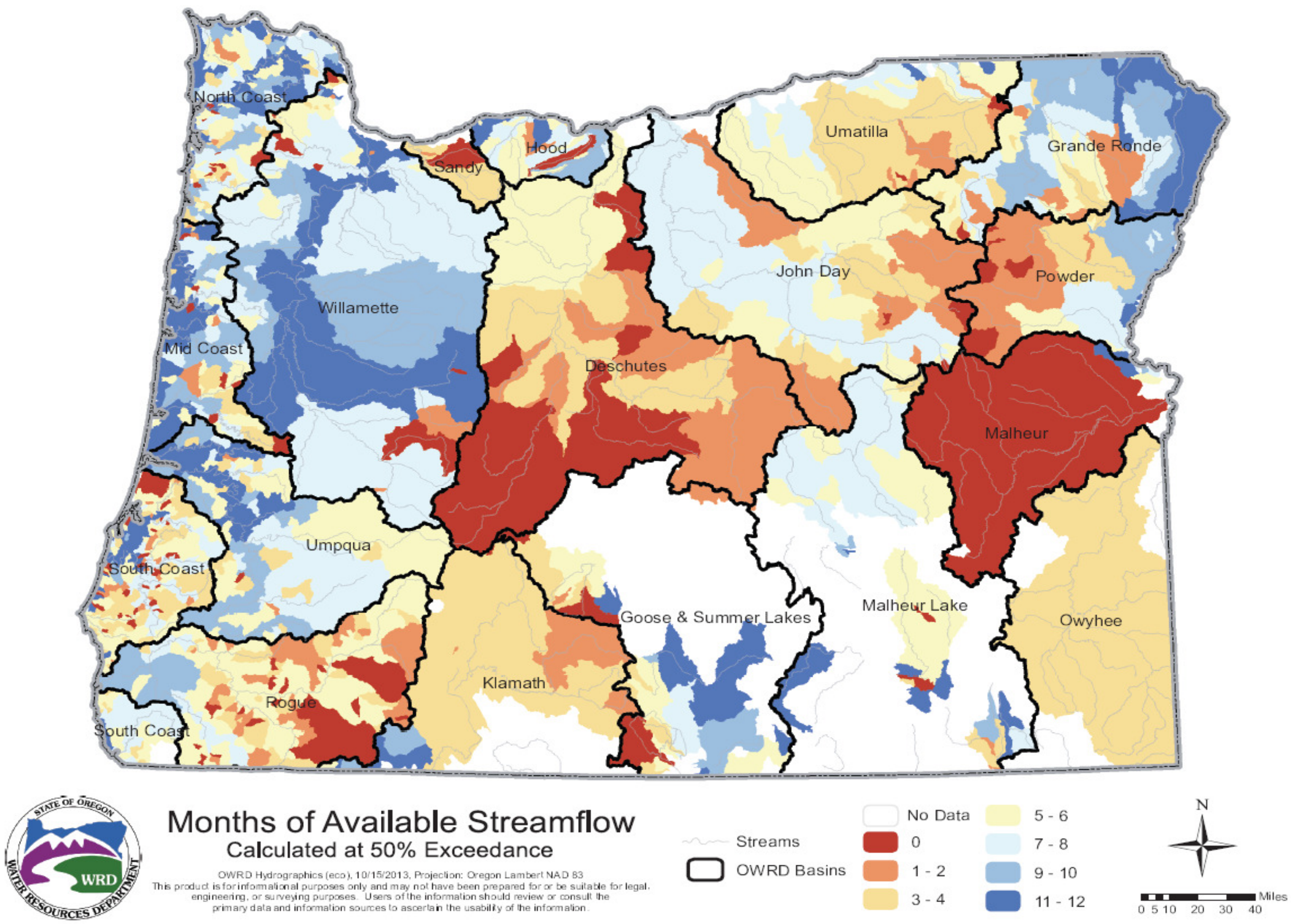
Recommendation #1. Update the State's water demands and needs forecast, to pinpoint locations and sectors with growing or changing demand for water.

The subgroup feels it would be instructive, as the State goes about developing its funding program, to update its water demands and needs forecast. To create a long-term context, track the trend in water demands, and weigh the value of various proposals, an up-to-date water demand analysis would prove useful.

Factor #5—Availability

The accompanying map indicates, generally, where water may be available for storage throughout Oregon, based the Water Resources Department's method to determine water availability. Areas in red have water available for storage "zero" months of the year. Areas in dark blue have water available for storage 11-12 months of the year.

Figure 6. Months When Streamflow Is Potentially Available for Storage



To provide consistency with Oregon Administrative Rules 690-410-0070 (2)(c), the Water Resources Department generally evaluates water availability for storage, using the median flow for any given month as a cap for allocation. All of the (natural) streamflow measurements for the month over a 30-year period are ranked in order of magnitude and the median flow for the month is identified. This is a statistical calculation, based on historic data. Then already-existing water rights, including instream rights, are subtracted from that median flow to determine whether there is still water available for storage during that month. The Water Resources Department repeats this process, called the "50 percent exceedance criteria," to evaluate the availability of water for each month.

The concept of "water availability" as used in this report is a term used by the Water Resources Department and does not take into account other limiting factors, such as federal biological opinions prohibiting the further allocation of water.

Chapter 1. Practical Engineering Methods for Water Storage Projects

Today, there is a mix of both publicly and privately owned water storage facilities throughout Oregon. The smallest of these are privately owned ponds with less than 9.2 acre feet of storage. The largest are federal systems, storing millions of acre feet of water behind a series of reservoirs.

Practical Engineering Approaches

Oregon's Integrated Water Resources Strategy, adopted in August 2012, calls for improved access to built storage, using both above- and below-ground storage sites. In particular, the Strategy identifies three kinds of built storage for future pursuit: above-ground off-channel storage, aquifer storage and recovery, and aquifer recharge. A fourth technique, on-channel storage, faces greater challenges, given overall environmental impacts and mitigation costs, as well as concerns related to the difficulty of providing fish passage. The following are brief descriptions of each.

Above-Ground Storage. Generally, reservoirs provide a source of water for both instream and out-of-stream uses during times of the year when streamflow is low and the needs are greatest. Depending on the design of the outlet structure, the released water may be colder than the water instream, which can be beneficial to fish and wildlife species. However, there are also many challenges related to reservoirs, many in the realm of water quality. For instance, reservoirs can act as temperature sinks, collecting and warming water at the surface. They may serve as a point for nutrient loading and concentration of dissolved oxygen, pH, and harmful algal blooms. They may also pose a barrier to fish passage, inundate land, trap sediment, and their operations may alter the natural hydrograph in the stream system.

On-Channel Storage. This technique stores surface water behind dams constructed on the stream, such as the Columbia River dams. On-channel reservoirs store the natural streamflow behind dams for flood protection, hydropower generation, and sometimes water supply. The streamflow is dammed along its natural course and water flows into the reservoir by gravity. These reservoirs can create a barrier to fish migration. Project designs often include measures to mitigate these barriers, but these measures can increase the overall cost of the water storage reservoir.

Off-Channel Storage. This method of storage involves conveyance of available streamflow to a nearby canyon or other drainage channel that does not have a perennial flow or flow that supports sensitive, threatened, or endangered species. Off-channel storage becomes a viable option when the nearby stream channel does not present a suitable storage location or when damming the stream is not permitted due to fish protection or other limiting factors. Considerations regarding reservoir siting and dam construction are similar to the on-channel storage option. However, piping and pumping water from the stream are additional cost factors to consider.

Figure 7. Dam Safety Requirements

All dams require a water right permit from the Water Resources Department. Statutory dams, defined as having a height of at least ten feet and with a capacity of at least 9.2 acre feet of water, require dam safety inspections by the Department as well.

For more information on water right permit requirements, visit: http://www.oregon.gov/OWRD/pages/index.aspx.

Below-Ground Storage. Methods of below-ground storage include infiltration into shallow aquifers through spreading basins or direct injection into deep aquifers using wells. Artificial Recharge (AR) and Aquifer Storage and Recovery (ASR) are increasingly used as water storage techniques, particularly in the northwest and north central regions of Oregon, where in many places geologic conditions are conducive to storage.

Aquifer Recharge. Aquifer recharge (AR) involves diversion of seasonally available surface water to recharge alluvial aquifers. Recharged groundwater can be used to restore the alluvial aquifer if depleted. The project may also be designed so that the recharged groundwater flows back to the stream to increase its flow when needed. The increased streamflow may be used to support additional out-of-stream uses and/or enhance instream habitat conditions. Recharge water may not impair or degrade groundwater quality.

Aquifer Storage and Recovery. Aquifer storage and recovery (ASR) involves storing seasonally available surface water in underground aquifers for later recovery and use. The diverted surface water must be treated to drinking water standards before storage. Treatment is typically achieved through the use of a water treatment facility. To store large volumes of water, such as typically involved for crop irrigation, treatment may involve the initial recharging of a shallow alluvial aquifer, if available. Treated water (whether from the treatment facility or an alluvial aquifer) is then injected into the storage aquifer via injection wells. Due to its cost of operation, ASR systems are used primarily to supply municipal potable water or irrigation water for relatively high value production agriculture.

Authorizations—permits and limited licenses—for both ASR and AR projects are issued by the Oregon Water Resources Department in collaboration with the Department of Environmental Quality (DEQ). WRD ensures that water is available and that no already-existing water rights are injured by the recovery and use of the groundwater. DEQ's role is to ensure that a project meets standards for underground injection control systems, as well as groundwater quality protection requirements. The Oregon Department of Fish and Wildlife (ODFW) is also involved when surface water is used as source water, consulting with the Water Resources Department on permit conditions to protect aquatic habitat. The Oregon Health Authority plays a role too, ensuring that drinking water quality requirements are met. Water that is treated to standards safe enough for drinking water is the only source water allowed for direct injection into groundwater aquifers. Direct injection of water must not degrade groundwater quality.

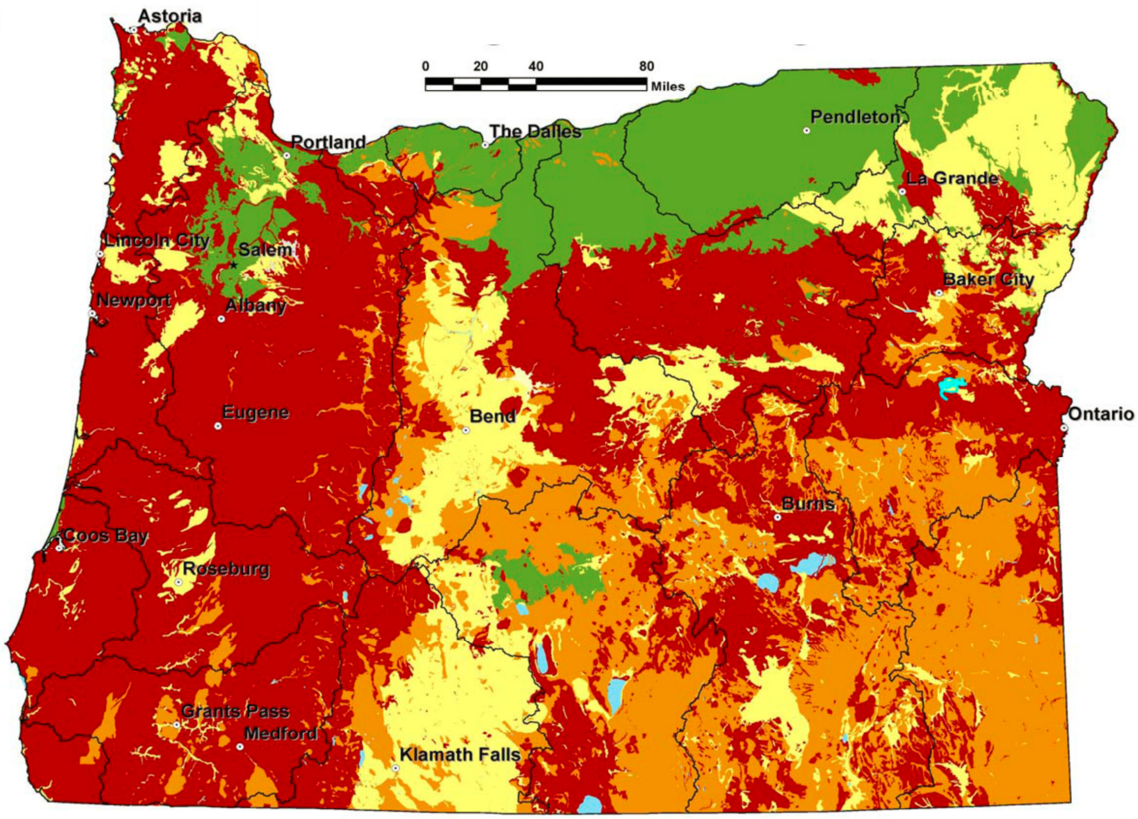
There are a number of water quality challenges identified with groundwater storage; addressing these challenges can increase project costs. These challenges can include concentrated contaminants, particularly nitrates. Underground storage may also create issues with already existing septic fields, as groundwater levels rise. Protection of human health and the environment require project permitting, regular monitoring, and sometimes water treatment. Figure 8 provides a side-by-side comparison of both techniques.

Figure 8. Current Uses of Groundwater Storage Technologies in Oregon

	Artificial Recharge (AR)	Aquifer Storage and Recovery (ASR)
Water Use	Irrigation, streamflow enhancement	Primarily drinking water, some irrigation
Recharge Method	Seepage systems, injection wells	Injection wells only
Water Quality Requirements	Recharge water cannot impair or degrade groundwater quality	Recharge water must meet drinking water standards
Water-Rights	Permits required to appropriate source water and also to pump recharged groundwater	Can use existing rights to store and recover the water
Governing Statutes	ORS 537.135	ORS 537.531 to 537.534
Rules	OAR 690-350-0120	OAR 690-350-0010 to 690-350-0030

The Water Resources Department staff has evaluated 54 aquifers within Oregon, creating a rating system of "geologic suitability for underground storage." This helps assess the suitability of potential locations for underground storage. The resulting summary map in Figure 9 demonstrates that areas with Columbia River Basalt aquifers (northern areas shown in green) score highest for their potential to store water. Other aquifer types with storage potential include volcaniclastic layers in the Fort Rock Basin, (Central Oregon also shown in green), as well as glacial and fluvial layers west of Pendleton (shown in green). Aquifers with little storage potential (marked in red) include Coast Range marine sediments, Western Cascades volcanics, and southwest Oregon metamorphics, although there may be local exceptions.

Figure 9. Geologic Suitability for Underground Storage



As noted throughout Chapter 1, there are both above-ground and below-ground engineering methods for water storage projects, each with its sets of strengths and weaknesses. A professional engineer, licensed in Oregon, must prepare and stamp a project design to accompany the funding application for any water storage project. This ensures the proposed project meets design criteria, public health and safety standards, and environmental benefits standards, as set forth in Oregon statute.

Recommendation #2. Include a project design prepared and stamped by a professional engineer, licensed in Oregon, with each funding application for water storage.

Chapter 2. The Feasibility of Water Storage Projects: Would This Project Be Successful?

A feasibility analysis is a measure of the overall viability of a proposed plan or project. (Economic Subgroup 2014).

A feasibility analysis is an essential tool that helps both project developers and project evaluators decide whether to pursue a project, helping to answer the question, "would this project, if approved, be successfully implemented?" For purposes of this report, feasibility analysis is a measure of the overall viability of a proposed plan or project, based on the evaluation of several factors, including overall project quality, operational issues, project construction risks, and funding commitments / market assessments.

There are many factors relevant to a project's success and implementation that cannot be easily quantified. To capture those qualitative aspects, evaluators should consider the following factors.

Recommendation #3. Demonstrate the feasibility of each proposed project, using the process and form developed by the State.

Operational Factors

- Is there a demonstrated need for the project?
- How clear are the planning objectives in the proposal?
- How well are the planning objectives met?
- Are permit requirements met?
- Have regulatory requirements been satisfied?

Project Construction Factors

- Can the applicant construct the project within the estimated costs and schedule?
- Is the proposed construction schedule reliable?

Project Risk Factors

- Are the project's scientific, technical, and design assumptions grounded in reality and well-documented?
- What is the extent to which climate change impacts are considered?
- Are the estimated costs and benefits reliable?
- What is the long-term reliability of the source water?

Recommendation #4. Use pre-application meetings that are available to applicants to design a high quality application with information that is meaningful to project reviewers.

Funding Commitment / Market Assessmens Factors

- What is the capability and willingness of the project partners to financially support the project?
- Do current and future customers/ratepayers have the ability to repay the debt?

The point of this exercise is to help the evaluator determine whether the outcomes of the project warrant public investment. The economic subgroup recommends that the State establish a technical review team to lead this evaluation and meet with funding applicants, as they design their projects, feasibility analyses (discussed here in Chapter 2), and cost-benefit analyses (discussed in Chapter 3).

Recommendation #5. Establish a Technical Review Team that can help with the review and design of feasibility and cost-benefit analyses.

Funding Commitments

The Federal Approach. A Federal funding analysis of water resources projects uses a formulaic approach, as spelled out in the *Principles and Guidelines* document (P&Gs) (U.S. Army Corps of Engineers 1983)[1]. It assumes "the distribution of all financial costs of a multi-purpose project among its authorized purposes. An allocation of project costs is necessary to determine whether project beneficiaries are capable of repaying the reimbursable costs assigned to them."

Recommendation #6. State and federal agencies, non-profits, and other partners may want to have a role in paying for public benefits of water storage projects. Use pre-application meetings to determine how significant this role might be.

Benefits such as improved flood control, fish and wildlife habitat, and recreational opportunities accrue to the public, so for projects with a federal nexus, those costs are typically borne by the federal government. Benefits that accrue to agricultural users result in costs borne by the agricultural sector through no or low interest loans. Benefits that accrue to municipal, industrial, or other water users result in costs borne by these users through loans repayable with interest.

Specific costs that can be associated with a single purpose are separated out and assigned to that purpose (e.g., agriculture, municipal, or self-supplied industrial). The remaining costs are joint costs and are allocated among the purposes, based upon the percent of benefits expected to accrue for each purpose.

Funding Options in Oregon. Water users in Oregon have a variety of funding options available to them, depending on the statutory authority by which the entity was established, the powers granted to their governing bodies, and the by-laws adopted by the governing bodies.

Municipal Water Providers. In Oregon, municipal water providers include:

- Incorporated cities and domestic water supply districts organized under Oregon Revised Statute (ORS) Chapter 264 and 198;
- Joint Water Authorities formed under ORS 450;
- People's Utility Districts formed under ORS 261;
- Joint ventures as intergovernmental agreements formed under ORS 190; and
- Water agencies that are separate from, but formed under, city charters.

Figure 10. Potential Sources of Funding for Municipal Water Storage Projects

- Tax-Exempt Bonds, secured by: full faith and credit; revenues generated by the water system; system development charges; and property assessments
- Special Public Works Fund from Oregon's Infrastructure Finance Authority
- Community Development Block Grants from Oregon's Infrastructure Finance Authority
- Cash generated from water sales, system development charges, and other miscellaneous sources.

[1] This is required of all Federal agencies constructing water resource projects. In March 2013, the administration released updated P&Gs called the Principles and Requirements. Final interagency guidelines are currently being drafted and the Principles and Requirements will take effect 180 days after the interagency guidelines are finalized.

Water departments in incorporated cities are generally established as enterprise funds, with separate accounting and financial reporting mechanisms. Enterprise funds pay for goods and services that are supported by user fees. These fees generally cannot be used for purposes other than the service for which they are collected. For example, in most cases water fees cannot be used to support General Fund obligations (e.g., police and fire) or other Enterprise Fund activities (e.g., sewer and wastewater).

The strategy of municipal water providers is to seek the lowest cost of capital. Bond financing is an important source of financing for such projects. Municipal water providers can generally issue tax-exempt debt, which does not require voter approval as long as revenue bonds are used (full faith and credit general obligation bonds do require voter approval).

Tax-exempt bonds can be secured by the full faith and credit of the issuer (using taxes, reserves, and other lawfully available funds), revenues generated by the water system, system development charges, assessment to properties that benefit from the project, and other predictable and reliable sources. The use of these other sources of funding ultimately depends on the particulars of the project in question.

Figure 11. Potential Sources of Funding for Agricultural Water Storage Projects

- Reserves / assessment revenue
- Hydropower and other projects that generate revenue
- Outside matching funds, such as:
  ~ Loans from the Clean Water State Revolving Fund (EPA, OR)
  ~ WaterSmart Grants (DOI, BOR)
  ~ Farm Bill 2012 (DOI, BOR)
  ~ Grants from the Oregon Watershed Enhancement Board (OR)
  ~ Water Conservation Funding (NRCS)

Agricultural Water Users. ORS Chapter 545 provides the statutory authority for irrigation districts and provides such districts with assessment authority, "for the purpose of defraying the expenses of the organization of the district, and of the care, operation and management, repair and improvement of the portions of the canals and works that are completed and in use, including salaries of officers and employees" (ORS 545.471). The assessment charge can be adjusted periodically and can account for the following (ORS 545.484):

- The care, operation and maintenance of district facilities;
- Reasonable reserve funds for major maintenance, improvement and replacement of capital improvements and facilities;
- The acquisition of land or water rights;
- Bond or interest payments, or payments due or to become due to the United States or the State of Oregon under any contract of the district with the United States or the State or Oregon; or
- Other expenses of the district.

Recommendation #7. Identify the parties who will bear the cost of various project components; describe in specific terms the funding mechanisms they will use to meet their funding commitments.

Irrigation districts face a number of constraints on capital financing. For example, irrigation districts must hold an authorization election prior to issuing bonds (ORS 545.511). And, although irrigation districts can also borrow from private banks, the ability of districts to declare bankruptcy means that banks may be reluctant to issue such loans. Credit markets may also be difficult for irrigators to access.

Industrial and Commercial Water Users. Self-supplied industrial and commercial users account for about six percent of water use in Oregon. A highly diversified sector, these users can range from timber to high tech products, and education to health care services. This sector typically uses water to process or manufacture a product or service, or to construct, operate, and maintain facilities. Industrial and commercial water users may also wish to access the Water Supply Development Account to develop water storage projects.

Chapter 3. The Costs and Benefits of Water Storage Projects: Should We Pursue This Project?

The goal of utilizing cost-benefit analysis is to identify projects whose overall benefits outweigh the overall costs, resulting in "net benefits" to the project developers and to Oregonians. (Economic Subgroup 2014)

A cost-benefit analysis (CBA) is another essential tool that helps both project developers and project evaluators decide whether to pursue a project, helping to answer the question, "Should we pursue this project?" In principle, a cost-benefit analysis attempts to quantify the value of all economic, social-cultural, and environmental changes resulting from the project. Identification of these changes is useful, even if valuing each of them is not ultimately possible. Quantification of each cost and benefit allows the evaluator to compare each project to the status quo, or to each other, in a consistent manner, using common metrics. Costs and benefits should be described in present value dollar amounts, reflecting the private and social values for changes in the quantity or quality of identifiable resources, e.g., acres irrigated, population served, etc..

Established methods of conducting cost-benefit analysis recognize opportunity cost, cost savings, and the need to subtract any additional costs from gross benefits. Cost-benefit analysis is distinct from "regional impact" or input-output analysis, which does not measure values in a manner compatible with cost-benefit analysis. The goal of utilizing cost-benefit analysis is to identify projects whose overall benefits outweigh the overall costs, resulting in "net benefits" to the project developers and to Oregonians[2].

As such, the cost-benefit analysis must identify the geographic scope over which costs and benefits will be measured, and provide a basis for choosing specified geographic boundaries.

Recommendation #8. Applicants must conduct a cost-benefit analysis of sufficient quality and detail so as to inform each project evaluation, stating the assumptions and the discount rates used.

Net benefits must accurately represent a "with" the project situation, as compared to a "without" situation, where the only changes are those due to the implementation of the project.

Projects must demonstrate a positive net benefit (net present value).

[2] For a general reference, see Boardman, Greenberg et al. 2010.

Applicants must thoroughly demonstrate to the state how they developed their cost-benefit analysis, including any discount rates used. Applicants also seeking federal cost-match dollars in addition to Oregon's Water Supply Development Account dollars will need to follow federal guidance on cost-benefit analysis, found in the *Principles and Guidelines* document, mentioned earlier as a good framework for water-related projects.

The major categories of potential costs include the upfront capital costs of a project, ongoing operations, maintenance, replacement costs, and sometimes interest during construction. Costs may also include the opportunity cost of resources that were previously being put to other beneficial uses (e.g., land).

Potential benefits include out-of-stream benefits to agricultural, municipal, industrial-commercial, power generation, and domestic water users, as well as instream benefits for fish and wildlife, recreation, water quality, scenic waterways, and flood control. Projects can also have negative impacts in these areas; these are counted as costs (or negative benefits).

It is worth noting that the costs and benefits of a project will vary depending on the location of the project, the design, the size and scale, the materials used, and other inputs.

Senate Bill 839, Section 11, requires project applicants to demonstrate environmental, social-cultural, and economic benefit. The Economic Subgroup makes recommendations on the following pages about a general framework and the methods available to the state and to project applicants to quantify the costs and benefits for potential projects.

Figure 12 provides more detailed examples in each category, and Appendix D lists potential benefits in the economic, social-cultural, and environmental categories, as suggested by Senate Bill 839.

Figure 12. Example Costs and Benefits

Example Costs	Example Benefits
Capital Construction Costs • Acquisition of lands and rights of way • Relocation of uses or improvements (e.g., houses, railroads, farms, parking lots, fences, etc.) • Environmental permitting • Environmental compliance and mitigation • Design/engineering • Feasibility studies • Data collection /scientific investigations (e.g., surveys, drilling geotechnical holes) • Contracting • Construction, including management/oversight Operations, Maintenance, Replacement Costs • Costs to operate facilities, such as labor, overhead, materials, supplies, utilities • Power costs for pumping • Replacement of equipment or infrastructure during the life of the project, such as gates, valves, pumps, etc.	Water for Irrigation • Value calculated from increased crop value and acreage, water right transactions, farmland rental rate Water for Municipal, Industrial, Domestic Use • Costs that would have been incurred to develop the next best source Power • Value based on price for kilowatt hours produced via hydropower or other mechanism Water for Instream Uses • Value based on benefits to fish and wildlife, recreation, water quality, or scenic waterways • Nonmarket valuation or benefit transfer methods (willingness to pay for environmental benefits by relevant population) Flood Control • Estimating the reduced flood risk seasonally when unfilled reservoir capacity would buffer against costly flood event (i.e. flood damages prevented)

The economic subgroup cautions project evaluators to avoid double counting benefits or costs.

Quantifying Benefits of Irrigation Water. Irrigated agriculture is a significant partner that can reap benefits from water storage projects. The net economic benefit of providing additional irrigation water in a particular location, however, is not straightforward to estimate. First, competitive markets for water, do not exist, for the most part, so we cannot observe a price that would indicate what farmers are "willing to pay." Second, the net economic value of water in irrigation varies greatly from location to location due to differences in soil class, crop choices, weather conditions, and market opportunities. Input requirements and costs for energy, labor, fertilizer, chemicals or machinery, can also vary significantly from region to region and farm to farm. Third, some commonly used approaches to calculate net revenue at the farm or field level will often omit important costs such as land, or the farm operator's labor or risk. Indeed, the kinds of average values reported in "crop enterprise budgets" produced by university agricultural economists are not intended to be used for this purpose, and cannot represent the variations across locations nor the importance of farm-level adjustments or scale economies. All of these factors can skew estimates of even the "average" net benefits of water for use in irrigated agriculture.

In addition, in order to estimate the net economic benefit of adding irrigation water in an area where irrigation is currently practiced, one cannot simply use an estimate for the observed highest value irrigation use, or even the average value of existing irrigation uses. This is because farmers in these areas have likely put existing water resources to their highest value uses, such as irrigating the best available soil or irrigating lands with the lowest conveyance costs. As a result, to estimate the value of additional irrigation water, funding applicants will need to estimate the marginal value of added water, based on an assessment of its value for irrigation of the next available (currently unirrigated) land, or the location with the next highest conveyance cost.

In some cases, farmers might use additional water to augment, or "intensify," irrigation on existing lands; this might produce higher yields or allow growing a higher value crop. Evidence suggests, however, that in most cases farmers have already optimized the relative shares or combinations of land and water to achieve the highest net return from both resources. As a result, the marginal value of water should have the same value whether it is used to augment acres or to augment yields per acre.

A highly reliable and low-cost approach to estimating the marginal value of irrigation water involves evaluating county assessors' estimates of the real market value of irrigated land (by soil class) as compared to the real market value of non-irrigated lands. The difference between the two metrics can be interpreted as reflecting the value of an irrigation water right (see Griffin 2006; Shaw 2005; Jaeger 2004). This is an example of the "hedonic method" widely used in economics, meaning the value of the good (e.g., the land) reflects the services it provides (e.g., when irrigated). To the extent that real market land values reflect farmers' expectations of farm profits with and without water rights, this approach will provide a more reliable method of evaluating the value of water in irrigation, short of constructing complex computer models. See Appendix E for evidence for this approach as compared to observed prices from water leases and purchases. By applying this approach for the additional lands and soil classes that would likely come under irrigation with the project, the net benefits to agriculture can be estimated. We recommend this approach, even if other methods are also undertaken.

Recommendation #9. Projects involving irrigation should use the "hedonic method" based on farmland values (described in Appendix E) to estimate the value of additional irrigation water.

Quantifying Non-Market Benefits for Instream Water. It may be challenging to quantify some of the non-market benefits or costs including "nonuse values" associated with environmental resources. For non-market costs and benefits, methods for valuation include "stated preference" methods. In these cases, a survey approach measuring "willingness to pay" of households in the relevant geographic area can be used to place a monetary value on that particular benefit, such as the non-use value of a fish population. For example, households could be asked about their willingness to pay for fish-related benefits from the proposed project. Household willingness to pay is then multiplied by the number of households that can reasonably be expected to value the resource in question at the estimated level (usually households within a specified geographical region similar to the region in which the willingness-to-pay value was estimated). This provides an estimate of the total non-market and/or non-use value of the resources.

Some guidance on these methods and the use of "benefit transfer" methods (borrowing results from preexisting studies to approximate values for a proposed project) can be found in various publications. See Chapters 5 and 6 of US Fish and Wildlife Service 1998; Koteen, Alexander and Loomis 2002; and the National Research Council 2004. An example of the values estimated with these kinds of studies is indicated in the U.S. Fish and Wildlife Service documents, as reproduced in Figure 13.

Figure 13. Studies of Willingness to Pay for Improvement or Preservation of River Flows

Study	Resource Valued	Survey Type	Population	Annual "Willingness to Pay" per Household (in 2013 dollars)
Clonts and Malone 1990[a]	Preservation of Flows in 15 Alabama Rivers	Telephone	River Users	$172
			Non-Users	$105
Sanders et al. 1990[a]	Designation as Wild & Scenic of up to 11 Colorado Rivers	Mail	Colorado Households	$48[b]
				$107
				$227
Berrens et al. 1996[a]	Minimum Instream Flows in all New Mexico Rivers (to protect fish species)	Telephone	New Mexico Households	$44[c]
				$140
White River Valuation Study 1998[a]	Preventing Hydro Development of White River in Vermont	Mail	White River Households	$75
			Other VT Households	$27
			Non-user White River	$34[d]
			Non-User Other	$22[d]
Welsh et al. 1995	Reducing Flow Fluctuations on the Colorado River, Glen Canyon Dam	Mail and Telephone	U.S. Households	$32[e]
			Salt Lake City Households	$46
Olsen et al. 1991	Columbia River			$102[f]
Loomis 1996	Elwha River			$102[f]
Bell et al. 2003	Coastal Oregon and Washington			$122[f]

a. Source: U.S. Fish and Wildlife 1998.
b. The estimates provided are for preservation of the most important, three most important, and the entire set of eleven rivers.
c. The first estimate coincides with a valuation scenario that would protect a single fish species in one river whereas the second estimate pertains to preservation of eleven fish species on all New Mexico Rivers.
d. Estimates are of the median willingness to pay.
e. The study provided three alternatives for reduced flow fluctuations. The estimate is associated with the greatest reduction.
f. For increased fish population by 250,000 (Olsen et al. 1991), 300,000 (Loomis 1996), and 165,000 (Bell et al. 2003).

Improved stream habitat associated with the proposed project may have the potential to improve ecosystem services and related use and non-use values, including increased fish populations that benefit sport and commercial fishing. The benefits associated with these changes can have a wide geographic distribution due to the migratory nature of some fish species, and also the wide geographic origins of those who are willing to travel to participate in sport and commercial fishing. Stated preference and benefit transfer methods are frequently used to estimate the net social benefits of fishing. For examples of estimated use and non-use values of numerous west coast fisheries see Huppert 1989, Johnson and Adams 1988, Anderson and Lee 2013.

Discounting. The cost-benefit analysis must identify the time period over which costs and benefits are likely to occur. Since some costs and benefits will occur in different time periods, the cost-benefit exercise requires "discounting" so that all costs and benefits can be compared. In this case, that means adjusting costs and benefits so that they are equivalent at a given point in time (e.g., the present). When the costs and benefits of a project are discounted, the results can be presented in a variety of different ways. The most common is to calculate the project's "net present value"; this approach converts both costs and benefits into a value that would be paid (cost) or received (benefit) every year over the life of the project, and examining the "net" result. Calculating "cost-benefit ratios" is another common approach, but these ratios can obscure the true net benefit when projects of different scales are being compared.

There is no consensus on what discount rate should be used for projects that have a public dimension to them (as Senate Bill 839 projects will, because they will be partly funded by the state and because they provide ecosystem services). It is widely recognized that the public or "social discount rate" should be lower than the private, or "market rate." It is also increasingly recognized among natural resource economists that a lower discount rate may be appropriate for more distant time periods: e.g., a six percent discount rate for the first 30 years into the future, with a four percent discount rate for the next 30 years and a two percent discount rate after that. See Appendix F for more details about discounting, and Appendix G for additional references.

Recommendation #10. Real social discount rates of 2%, 4%, and 6% are recommended to provide a range of results and to see how sensitive the net present value calculation is to the choice of discount rate.

Uncertainty and Risk. Uncertainty and risk directly affect society's ability to accurately measure future costs and benefits and, therefore, they occupy an important place in the decision-making process. Uncertainty generally refers to the lack of precise knowledge of future events. Risk refers to the consequences of experiencing those uncertain future events.

An example of an uncertainty is the future cost of power that may be required for pumping water. If future power costs are higher than expected, the cost-benefit analysis may predict more net benefits than will be realized.

There are a variety of techniques available to assess the risk for future projects. Some of these techniques are fairly simple (e.g., conducting a simple sensitivity analysis within the cost-benefit analysis.) Others techniques are more technical (e.g., Monte Carlo analysis) and include using statistical tools to assign probabilities of various future outcomes.

When preparing a cost-benefit analysis, the applicant should conduct an appropriate risk assessment. Depending on the proposed project's size and complexity, the appropriate level of risk assessment may vary.

Recommendation #11. Applicants should determine how sensitive their estimates of net benefits are to the uncertainty surrounding various assumptions they have made. This can be done by employing a risk analysis. The level of risk analysis will depend on the size and complexity of the project.

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Chapter 4. The Cost of Complying with Environmental Benefit Standards

There are two specific environmental benefit standards outlined in Senate Bill 839
that are required for certain water storage projects:
(1) protecting seasonally varying flows, and
(2) dedicating 25 percent of newly developed water for instream use.

Protecting Seasonally Varying Flows

As directed in Senate Bill 839, projects seeking funding from the Water Supply Development Account that require a new water storage or aquifer recharge permit or a limited license to store water outside the irrigation season will have their rights conditioned to protect seasonally varying flows (SVFs) if the project: (a) impounds surface water on a perennial stream; (b) diverts more than 500 acre feet of water annually; or (c) diverts water from a stream with state or federally listed sensitive, threatened, or endangered species.

Seasonally Varying Flows—as defined in Senate Bill 839—means the duration, timing, frequency and volume of flows that must remain instream outside of the official irrigation season in order to protect and maintain the biological, ecological and physical functions of the watershed downstream of the point of diversion, with due regard given to the need for balancing the functions against the need to store water for multiple purposes. SVFs are identified for the purpose of determining conditions for new or expanded storage project. This first standard, in effect, leaves water instream for beneficial use.

Potential costs relating to SVFs include: conducting studies to determine the amount and timing of flows needed, operating diversions in a manner that protects these flows, and any measurement or other equipment required to manage the system. The cost of flow conducting studies depends on the methods involved. These can range from multi-year, multi-site investigation of flow, water quality, and habitat conditions, to more simple and less costly desk studies.

Applicants completing a cost-benefit analysis described in Chapter 3 should include all of these costs, as appropriate.

Dedicating 25 Percent of Newly Developed Water for Instream Use

As directed in Senate Bill 839, new or expanded above-ground storage facilities meeting one or more of the three criteria listed above will also be required to dedicate 25 percent of the newly developed water to instream use. However, the bill provides for some flexibility in meeting this requirement, by allowing dedicated water to come from newly developed water or from other sources, and to be put instream at other locations in the tributary.

In order to put the water instream at a different location, the Water Resources Department must first determine that this will not injure existing water rights. In consultation with the Department of Fish and Wildlife, WRD must also determine the location that will provide greater or equal environmental benefit. The two agencies will determine the timing of the flows necessary to maximize instream benefits. This likely will entail the release of water during the summer and other critical times of the year when it is needed instream.

Recommendation #11. Applicants must demonstrate a project design and operational plan that ensures the project is complies with the environmental benefit standards outlined in Senate Bill 839.

Costs include: (a) studies to determine the amount, timing and manner of releases needed, (b) sizing and maintenance of the reservoir to hold water for instream benefits, (c) operation of the reservoir to release flows at a time and in a manner to create instream benefit, (d) downstream protections afforded to the released water, (e) measurement equipment or other equipment to manage the system, (f) foregone revenue of not using the water for out-of-stream purposes. These costs should be reflected in the cost-benefit analysis described earlier.

A financial feasibility analysis of a project may find that the cost of complying with environmental benefit standards makes the project infeasible without other sources of financing. The cost-benefit analysis can be used to evaluate the net benefits provided by the project, and can help the state and other potential funders determine and justify funding for the environmental benefits provided by the project.

As discussed previously, the federal government traditionally pays the costs of public benefits provided by federal storage projects, including benefits for the environment, recreation, and flood control. Financial feasibility and cost-benefit analysis are tools that can be used to understand the benefits and costs associated with projects and to engage project proponents, non-governmental entities, the state, and others in a discussion of how aspects of the project will be funded.

A project that is not financially feasible from a private investment standpoint may become feasible when public benefits and funds are factored in as funding sources. As a result, multipurpose water storage projects have the opportunity to be collaborative efforts. Applicants should engage the state early in pre-application meetings to assist with project and funding evaluation.

Conclusion. Observations and Recommendations

The goals of Senate Bill 839 are forward looking. Water resource development projects funded through the Water Supply Development Account have the potential to meet Oregon's instream and out-of-stream water needs into the future.

However, large-scale water storage projects are difficult to undertake successfully; they take many years to plan, design, engineer and construct. These projects also require significant dollars to fund. It is highly unlikely that any one entity will be able to fund a significant project on its own.

The decision about what projects to fund will ultimately be based on both quantitative and qualitative information. The quantitative information relies heavily upon a robust cost-benefit analysis and the qualitative elements will include other criteria that are more difficult to measure; the relative weight to give the two different kinds of information will ultimately involve some subjective evaluation. Projects will need to be evaluated based on private financial feasibility analyses and the social cost-benefit analysis presented in the proposal. Additional criteria may also come into play for choosing projects, such as notions of equity, geographic diversity, or alignment with other regional or state goals.

As noted below, the economic subgroup has developed a dozen recommendations to help the state and its funding applicants fully examine the economic realities of developing and operating water storage projects that request state funding assistance.

Summary of Recommendations

- Recommendation #1. Update the State's water demands and needs forecast, to pinpoint locations and sectors with growing or changing demand for water.
- Recommendation #2. Include a project design prepared and stamped by a professional engineer, licensed in Oregon, with each funding application for water storage.
- Recommendation #3. Demonstrate the feasibility of each proposed project, using the process and form developed by the State.
- Recommendation #4. Use pre-application meetings that are available to applicants to design a high quality application with information that is meaningful to project reviewers.
- Recommendation #5. Establish a Technical Review Team that can help with the review and design of feasibility and cost-benefit analyses.
- Recommendation #6. State and federal agencies, non-profits, and other partners may want to have a role in paying for public benefits of water storage projects. Use pre-application meetings to determine how significant this role might be.
- Recommendation #7. Identify the parties who will bear the cost of various project components; describe in specific terms the funding mechanisms they will use to meet their funding commitments.

- Recommendation #8. Applicants must conduct a cost-benefit analysis of sufficient quality and detail so as to inform each project evaluation, stating the assumptions and the discount rates used. Net benefits must accurately represent a “with” the project situation, as compared to a “without” situation, where the only changes are those due to the implementation of the project. Projects must demonstrate a positive net benefit (net present value).

- Recommendation #9. Projects involving irrigation should use the “hedonic method” based on farmland values (described in Appendix E) to estimate the value of additional irrigation water.

- Recommendation #10. Real social discount rates of 2%, 4%, and 6% are recommended to provide a range of results and to see how sensitive the net present value calculation is to the choice of discount rate.

- Recommendation #11. Applicants should determine how sensitive their estimates of net benefits are to the uncertainty surrounding various assumptions they have made. This can be done by employing a risk analysis. The level of risk analysis will depend on the size and complexity of the project.

- Recommendation #12. Applicants must demonstrate a project design and operational plan that ensures the project complies with the environmental benefit standards outlined in Senate Bill 839.

Appendix A. Acknowledgements

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Appendix B. Acronyms

AR	Artificial Recharge
ASR	Aquifer Storage and Recovery
CPI	Consumer Price Index
BOR	Bureau of Reclamation
DEQ	Department of Environmental Quality
DOI	U.S. Department of Interior
EPA	U.S. Environmental Protection Agency
FSA	Farm Service Agency (U.S. Department of Agriculture)
GIS	Geographic Information Service
IPCC	Intergovernmental Panel on Climate Change
IWRS	Integrated Water Resources Strategy
NASS	National Agricultural Statistics Service
NPV	Net Present Value
NRCS	Natural Resources Conservation Service
NWPCC	Northwest Power and Conservation Council
OAR	Oregon Administrative Rules
ODFW	Oregon Department of Fish and Wildlife
OMB	Office of Management and Budget
OR	Oregon
ORS	Oregon Revised Statutes
P&G	Principles & Guidelines
SB	Senate Bill
TF	Task Force
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
WA	Washington
WRC	Water Resources Commission
WRD	Water Resources Department
WTP	Willingness to Pay

Appendix C. Definitions

Applicant	The agency or group that is submitting an application to the Oregon Water Resources Commission and requesting funding for public benefits.
Application	The package of information submitted by applicants in support of their request for funding for public benefits.
Benefit	The change in a good or service provided by a project. It may be expressed as a physical benefit or a monetary benefit.
Benefit Transfer Method	Borrowing results from preexisting studies to approximate values for a proposed project.
Cost	The value of resources and materials required for a specified economic activity. Costs for water storage projects typically include capital, operations, maintenance, and replacement costs.
Cost-Benefit Analysis	Quantifying the value of all economic, social-cultural, and environmental changes resulting from a project.
Discount Rate	The rate at which projected future benefits and costs are adjusted relative to the present.
Discounting	The process of determining the present value of a payment or stream of payments that occur in the future.
Feasibility Analysis	A feasibility analysis is a measure of the overall viability of a proposed plan or project.
Hedonic Method	A method of valuing attributes of a good or resource, typically real property, using an analysis of observed market prices.
Irrigation Seasons	Irrigation Seasons are defined in Oregon's Basin Plans, adjudication decrees, and administrative rules, identifying the time period when water may be appropriated and applied to agricultural lands. For example, the irrigation season in some areas of the Willamette Valley is April 1 through September 30, while other areas are limited to May 1 through September 30. However, some basin plans define the irrigation season as any time water can be put to beneficial use, while other plans do not define the irrigation season at all. The "storage season" is generally considered to be any time outside of the irrigation season.
Joint Cost	The share of project costs that cannot be attributed to any single purpose; usually, the total cost minus the sum of identifiable costs for single purposes.
Monetize	To quantify a benefit using monetary units.

Monetized Benefit	The dollar value of the estimated level of public or non-public benefit provided by a proposed project. Monetized benefits include cost savings, revenues to sellers or producers, and willingness to pay above the price actually paid by users or consumers.
Non-Use Values	Monetary values that people claim for a good even though they have no intention of consuming, viewing, or otherwise using the good.
Opportunity Cost	The value of other goods and services that are forgone by using a resource for a particular purpose. The benefit that is foregone is the opportunity cost.
Present Value	The current worth of a future sum of money or stream of cashflow, given a specified rate of return. (Future cashflows are discounted at the discount rate.)
Proposed Project	The specific water storage project for which funding is being requested.
Revealed Preference Method	A data gathering approach whereby observations are made with regard to voluntary choices and behavior; these observations can be used to place a monetary value on a particular benefit.
Seasonally Varying Flows	Defined in Senate Bill 839. The duration, timing, frequency and volume of flows, identified for the purpose of determining conditions for a new or expanded storage project, that must remain in-stream outside of the official irrigation season in order to protect and maintain the biological, ecological and physical functions of the watershed downstream of the point of diversion, with due regard given to the need for balancing the functions against the need to store water for multiple purposes.
State Preference Method	A survey approach measuring the "willingness to pay" of households in the relevant geographic area; this can be used to place a monetary value on a particular benefit.
Willingness to Pay	The average estimated monetary value of other goods and services that people would be willing to forgo to obtain or enjoy more of a specified good or service.

Appendix D. Potential Public Benefits Identified in Senate Bill 839

Section 8 of the Bill. Subsection (2). The evaluation of economic benefits for a project shall be based on the changes in economic conditions expected to result from the project, including but not limited to conditions related to:

(a) Job creation or retention;
(b) Increases in economic activity;
(c) Increases in efficiency or innovation;
(d) Enhancement of infrastructure, farmland, public resource lands, industrial lands, commercial lands or lands having other key uses;
(e) Enhanced economic value associated with tourism or recreational or commercial fishing, with fisheries involving native fish of cultural significance to Indian tribes or with other economic values resulting from restoring or protecting water in-stream; and
(f) Increases in irrigated land for agriculture.

Subsection (3). The evaluation of environmental benefits for a project shall be based on the changes in environmental conditions expected to result from the project, including but not limited to conditions related to:

(a) A measurable improvement in protected streamflows that: (A) Supports the natural hydrograph; (B) Improves floodplain function; (C) Supports state or federally listed sensitive, threatened or endangered fish species; (D) Supports native fish species of cultural importance to Indian tribes; or (E) Supports riparian habitat important for wildlife;
(b) A measurable improvement in ground water levels that enhances environmental conditions in ground water restricted areas or other areas;
(c) A measurable improvement in the quality of surface water or ground water;
(d) Water conservation;
(e) Increased ecosystem resiliency to climate change impacts; and
(f) Improvements that address one or more limiting ecological factors in the project watershed.

Subsection (4). The evaluation of the social or cultural benefits for a project shall be based on the changes in social or cultural conditions expected to result from the project, including but not limited to conditions related to:

(a) The promotion of public health and safety and of local food systems;
(b) A measurable improvement in conditions for members of minority or low-income communities, economically distressed rural communities, tribal communities or other communities traditionally underrepresented in public processes;
(c) The promotion of recreation and scenic values;
(d) Contribution to the body of scientific data publicly available in this state;
(e) The promotion of state or local priorities, including but not limited to the restoration and protection of native fish species of cultural significance to Indian tribes; and
(f) The promotion of collaborative basin planning efforts, including but not limited to efforts under the state integrated water resources strategy.

(Taken from Senate Bill 839, 2013)

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Appendix E. Estimating the Value of Irrigation Water

There are a number of ways to estimate project benefits. Some of these are more accurate and trustworthy than others. Economists recognize that methods relying on "revealed preference" (observed choices and behavior) are usually a better guide than "stated preference" (statements about the value of something).

"Revealed preference" methods include observed transactions that are voluntary and where the buyer (seller) of a water right can be assumed to be trying to minimize (maximize) his or her cost (revenue). The best information of this kind comes from actual market transactions: water right transfers, investments in water conservation techniques (when saved water can be used for additional irrigated lands), and the sale or rental of farmland with (versus without) water rights. An excellent source of data of this kind is to rely on a "hedonic analysis," looking at differences in the price of farmland between irrigated and non-irrigated lands. As described in the text, we can infer, with sufficient data, what the value of water is by observing the differences in prices for these lands, or in the rental rates charged for lease agreements. There is a correspondence between the annual value of a water right reflected in lease or rental rates and the "capitalized" value of water reflected in farmland purchase prices. A water right that conveys an annual benefit of $100 per year might be purchased at a price of $2,000. The logic behind this reflects the idea that if an investor had $2,000 and could earn 5 percent interest on it ($100/year), he would view that as comparable to the cost of a water right that also generated $100/year.

Data from these multiple direct and indirect sources are shown in Figure 14 on the following page to illustrate the value of irrigation water for various parts of Oregon and neighboring states. All of the values are converted to 2012 dollars and annualized to reflect the annual benefit reflected in these various kinds of market information. For example, recent data from Umatilla County for land values Indicate that three-quarters of the land irrigated, based on the data, is in the $20 to $46 per acre-foot range.

Related to this information and evidence for a stored water project is the need to be sure the evaluator is assessing the value of the additional water when applied to the specific kinds of land that would be newly irrigated. This is a subtle but critical point: if more water were made available, where would it be used? What is the "with and without" comparison? Class I and II lands in the Umatilla region with water rights have market values suggesting water values of $78/acre-foot/year. But if there is Class I and II land available to irrigate, why would farmers currently be putting half their water on Class VI land? It is reasonable to expect that farmers are currently putting water on the best land available, and so additional water would likely result in additional lands being added at the lower end of the Land Capability Class scale.

Figure 14. Summary of Transaction-Based Estimates of Irrigation Water Values in the Pacific Northwest

Location	Number of Contracts	Average Lease Price ($2012) af/yr
Columbia Basin Water Transactions Program (2003-2010)[a]		
Yakima River, Washington	25	39
Upper Grande Ronde, Oregon	5	33
Walla Walla Basin, Oregon	10	27
Deschutes River, Oregon	18	25
Blackfoot River, Montana	7	15
Weighted Average:		32
Transactions by Oregon Water Trust (throughout Oregon, late 1990s)[b]		
One-year lease price	22	30
Inferred from farmland rentals, Upper Klamath Basin[c]		
Pasture (all areas)		41
Alfalfa (all areas)		103
Row crops (Klamath Project)		246
Transactions in the Deschutes Basin (2004-2009)[d]		
Water rights sales to irrigation districts	288	37
Water Bank payments by KWAPA (Klamath Reclamation Project)[e]		
Land idling payments		
Alfalfa, 2012		71
Pasture, 2012		64
Average from 2010		89
Average from 2007		75
Average from 2006		80
Groundwater substitution		
Average from 2007		74
Average from 2006		76
Inferred from farmland real market value estimates (Umatilla County Assessor's office)[f]		
Class V soils (about 20% of irrigated lands)		46
Class VI soils (about 50% of irrigated lands)		20
Class VII soils (about 10% of irrigated lands)		13

Notes: Values adjusted to 2012 dollars using the US Consumer Price Index (CPI). Deflating these values with Oregon's agricultural wage index (USDA/NASS 2012) would produce slightly higher values in some cases. The CPI is more representative generally of trends in purchasing power for income. The transactions data included here are from situations where prices can be expected to reflect irrigators' "reservation price" or minimum acceptable payment for voluntary transactions.

[a] Independent Economic Analysis Board, Northwest Power and Conservation Council 2011. Locations are in Washington and Oregon.

[b] Jaeger and Mikesell 2002.

[c] Jaeger 2004.

[d] from the Klamath Basin Rangeland Trust Report by WestWater LLC 2010.

[e] Klamath Water and Power Agency 2012a and 2012b.

[f] Soil classes I to IV account for less than 15 percent of these irrigated lands (Umatilla County Assessor).

Appendix F. Discounting

There is no consensus on appropriate discount rates for projects that have a public dimension to them, as Senate Bill 839 project will have. Below is some background on the concept of discounting and some evidence of the range of discount rates that have been used for a range of public-entity cost-benefit analyses.

It is widely recognized that the public or “social discount rate” should be lower than the private, or market rate of interest. It is also increasingly the case among natural resource economists that a lower discount rate is used for more distant time periods: e.g., a six percent discount rate for the first 30 years into the future, but a four percent discount rate for the next 30 years and a two percent discount rate after that.

Discounting amounts to adjusting the value of benefits or costs that occur in different time periods so that they are directly comparable. It is similar to converting from one currency to another, such as from Euros to dollars to be able to compare values in the same units. There are two main aspects relating to discounting.

First, resources that are “productive” have an opportunity cost over time if they can be invested and generate a greater value or “return” in the future. Receiving $100 today is more valuable than receiving $100 in 10 years because you could take the $100 today and invest it, so that in 10 years you would have more than $100. This relates to the “productivity” or production side of choices in economics.

Second, people value things differently in different time periods, tending to be impatient (i.e., wanting to consume now rather than later). But society also has a concern for future generations, which suggests a patience factor. This relates to the “preference” or utility side of choices in economics.

Together, these two aspects (and many more subtleties and complexities) have led scholars to distinguish between the private discount rate and the social discount rate. The private discount rate is what a private business would use when making investments where the interest is entirely financial and capital can be borrowed, saved, invested or spent. Very similar to this would be what a public entity might use if the benefits and costs, and tradeoffs over time, can all be tied directly to financial obligations now or in the future. An urban water utility may have both short- and long-term financial tradeoffs to consider. The private discount rate should reflect the borrowing cost or the opportunity cost (return on investment opportunities).

The social discount rate is more complicated. There is a general agreement that as the relevant time frame gets longer (from 30 to 50 to 100 years), there is a sense that the social discount rate should be lower. Indeed, one approach that has received a lot of attention, “hyperbolic discounting” refers to the idea that one should use a gradually declining discount rate instead of a constant discount rate as one considers values farther into the future. Below are some excerpts from analyses related to choosing a social discount rate.

Some of the rates used or recommended from a range of sources are:

Summary of rates used by government agencies (U.S. Office of Management and Budget, 1992)	3 to 7 %
Researchers taking a “prescriptive approach”	1 to 3%
Congressional Budget office (“since 1990”, as of 2002)	2%
General Accounting Office (for long-term projects with intergenerational effects):	0.5%
Roughly 40 percent of municipal governments use real rates	2.5 to 3.5%
IPCC (Intergovernmental Panel on Climate Change)	3%

US Department of Energy Documents

Year	Official Document (Technical Publication Number)	Real Discount Rate	Nominal Discount Rate	Projected 10-year Average Inflation Rate
1996 (1995 analysis)	NISTIR 85-3273-10	4.1%	7.6%	3.4%
1996 (1996 analysis)	NISTIR 85-3273-11	3.4%	6.6%	3.1%
1997	NISTIR 85-3273-12	3.8%	6.9%	2.9%
1998	NISTIR 85-3273-13	4.1%	6.6%	2.4%
1999	NISTIR 85-3273-14	3.1%	5.7%	2.5%
2000	NISTIR 85-3273-15	3.4%	6.3%	2.8%
2001	NISTIR 85-3273-16	3.3%	6.1%	2.7%
2002	NISTIR 85-3273-17	3.2%	5.6%	2.3%

(Source: Zerbe et al. 2002)

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