Working paper for WSIP common assumptions – economics

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This paper is a working draft of economic common assumptions for discussion and development by the Water Storage Investment Program (WSIP) technical team. Each common assumption is described, some options for the assumption are stated and explored, and an associated requirement or recommendation is provided. The requirements and recommendations will continue to be developed and refined as necessary and will inform the draft and final regulations packages, guidelines, and proposal solicitation packages. Where a common assumption is not provided, or flexibility is provided, reasonable assumptions reflecting most-likely future conditions should be used.

The common assumptions for economic evaluations are discussed in this document. The common assumptions for calculating physical changes are discussed in the companion document Working Paper for WSIP Common Assumptions – Physical Changes.

The common assumptions described in this document include:

- Period of analysis
- Analysis in real dollars
- Constant dollar year
- Price indices for updating past benefits and costs to 2015 dollars
- Real energy prices
- Projected condition years
- Relationship of projected conditions to hydrologic period
- Future population levels
- Future land use
- Municipal and Industrial (M&I water) demand levels
- Discount rate
- Construction cost and contingencies
- Conveyance costs
- Water unit values
- Economics reporting requirements

Definitions

Period of analysis: the future time period over which project costs will be paid and benefits received. It can be based on the expected useful life of the project, or in some cases can be set equal to or not to exceed a defined period of years.

Example: The selected period of analysis is 2020 to 2120.

Real dollars: monetary values from different years adjusted for inflation so that their purchasing power can be compared (see also constant dollar year).

Example: All future benefits and costs are compared in real, 2015 dollars

Constant dollar year. For an analysis in real dollars, the year to which all dollar values are adjusted for inflation so they can be compared.

Example: The constant dollar year is 2015, so all benefits and costs are shown in 2015 dollars

Existing condition: The level of development, infrastructure, population, land use, water use, climate and all other relevant factors including operations plans, laws and regulations that are in place in the current or a very recent year.

Example: The existing condition data used in the analysis is 2015.

Projected condition: The level of development, infrastructure, population, land use, water use and all other factors including operating plans, laws and regulations that are projected to change in the future, normally stated as a particular year in the future.

Example: The projected condition used in the analysis is 2030.

Projected condition with climate change: Same as projected condition but with specific climate change

Hydrologic Period: A period of historic years that has continuous hydrologic information such as precipitation, inflows, storage, flows, water diversions, and/or water consumption available.

Example: The hydrologic period used in the analysis is 1922 to 2013.

Common assumption: A requirement or recommendation for project analysis regarding approach, assumptions, methods, data, models, metrics, or related analysis inputs, procedures or outputs, provided to WSIP funding applicants, for the purpose of improving comparability of different project analyses.

Period of Analysis

A project investment analysis is inherently a forecast or projection of future development and natural resource conditions, comparing physical and economic benefits with and without the project over a future period of years.

Requirement: The period of analysis must not exceed the expected life of the project facilities, or 100 years, whichever is less, plus the construction period. All project costs, including operations, repair, maintenance and replacement costs within the period of analysis must be included.

Analysis in Real Dollars

Requirement: The analysis must be conducted in real dollars, that is, free of inflation, using constant dollars and the real discount rate as defined below. All future costs and benefits must be displayed in real dollars for each year of the period of analysis.

Constant Dollar Year

Expressing costs or benefits in constant dollars means displaying money or value paid or received over a number of years according to its purchasing power in a stated year. All monetized values from other years must be adjusted to the stated constant dollar year so that all costs and benefits are consistently displayed in real terms at the same general price level. The necessary selection is the stated year.

It is expected that inflation levels through 2015 will be known by the time applications are being prepared (see Price Indices for Updating below). A constant dollar year beyond 2015 cannot be selected because future inflation is unknown.

Requirement: All applicants must provide benefits and costs in 2015 dollars.

Price Indices for Updating Past Benefits and Costs to 2015 Dollars

Some feasibility studies were conducted in the past in constant dollar terms at that time. With 2015 as the recommended constant dollars year, all costs should be updated to 2015 levels. Rather than require costs and benefits to be recalculated, price indices can be used to update recent benefits and costs. The price indices used for benefit and cost updating can significantly influence benefit and cost comparisons. Construction cost indices are available from several sources including the Engineering News Record (ENR), Producer Price Indexes [PPI] produced by the U.S. Department of Labor, Bureau of Labor Statistics, and the Bureau of Reclamation (Reclamation). Reclamation's data include the ENR and PPI data in their calculations. Other indices will be used for other cost or benefit categories.

Requirement: Construction costs more than 5 years old must be re-estimated. For benefits estimates and construction cost estimates less than 5 years old, updated estimates are preferred, but escalation using price indices will be allowed. Indices will be provided for escalation of different categories of costs or benefits. (*Precise indices under development*) For example, if project construction costs are escalated (rather than re-estimated), escalation must use the provided construction cost index. Flood damage reduction benefits for residential structures will use a housing construction cost index. Energy and conveyance costs will be escalated using an energy cost index. Other benefits and other costs will use a more general price level index (such as the Consumer Price Index or GDP Implicit Price Deflator). Table 1 is an example of the format of the table that will provide the escalation factors based on price and cost indices.

Table 1. Price and Cost Escalation Factors to Use for Estimates Made in Previous Years

	For Most Benefits	Housing Construction Costs	Project Construction Costs	Energy Costs	Other Cost Categories
2015					
2014					
2013					
2012					
2011					
2010					

Real Energy Prices for Future Cost Projections

Energy costs have a strong influence on groundwater pumping and conveyance costs, and some projects may produce electricity. Real energy costs are expected to increase in real terms in the future. The California Energy Commission (2013) mid-demand scenario predicts that real electricity rates will increase 1.7 percent annually over the 2014 to 2024 period. The electricity prices that provide this result are reproduced in Table 2 below.

Table 2. Energy Prices, CEC 2013 Revised Forecast
Electricity Year/Period

Average Price (2012 cents/kWh)

	High Demand Scenario	Mid Demand Scenario	Low Demand Scenario
2012	13.4	13.4	13.4
2015	14	14.6	15.2
2020	14.2	15.7	17.2
2024	14.9	16.4	18

The annual rate of increase from 2012 ($0.134 per kWh) to 2024 is 1.7 percent

Requirement: Future real energy costs or energy cost savings, including groundwater pumping and pumping for surface water conveyance, should be escalated 1.7 percent annually.

Projected Condition Years

The economic analysis requires dollar benefits and costs for each year of the period of analysis. From "Analysis in Real Dollars", any trend in dollar values based on economy-wide inflation should not be included (i.e., the future inflation rate is unknown so all the future benefits and costs will be monetized based on base year (real) dollars). However, "real" benefits might increase or decrease over time. For example, if the proposed project has a water supply component, the unit value of water for future years will be constant unless the applicant can justify a change in the unit value value of future water supply which is faster (or slower) than the real (base year) value of water. Trends based on quantity of physical benefits increasing or decreasing over time, or based on unit values (prices) increasing faster or slower than inflation should be included, but must be justified.

All five types of public benefits could increase in quantity or value over time as population grows. Where physical benefits trends or economic benefits increase in real terms, it would not be realistic to ask applicants to develop projections using modeling for every year in the period of analysis. Rather, this recommendation allows the use of two or more years to establish trends during the period of analysis.

Requirement: If any public benefit is expected to trend downward in the future, or if future costs are expected to trend upward, these trends must be reflected in the real economic benefits and costs

displayed and discounted. If any public benefit physical or monetary amount is expected to trend upward over the period of analysis, the reasons for trending benefits must be documented.

Recommendations:

1. If any public benefit physical amount or monetary benefit is not expected to trend from existing conditions over the period of analysis, then results for an existing condition should be used.
2. An applicant can provide a conservative quantification of benefits documented to be increasing over the period of analysis using existing condition or near-future projected condition benefits for the entire period of analysis. The near-future year should not be later than 2030.
3. If applicants want to claim benefits that trend upward over the period of analysis, they should develop monetary benefits estimates for at least two years, one early and one later in the period of analysis. Interpolation and extrapolation can be used to complete the remaining years of the period of analysis.
4. Trending benefits can be based on an existing condition year and one projected condition year if the resulting trend is expected to continue steadily over the period of analysis.
5. If there are important without-project condition structural changes during the period of analysis, for example, completion of other water supply, conveyance, habitat, or other projects, that result in a change to the level of physical or monetary benefits provided by the applicant's project, then two additional projected conditions should be provided so that the year and direction of the change is clearly shown. For example, if a major conveyance project will phase in substantial changes in water delivery between 2035 and 2040, then analysis could be based on the following projected conditions

    1. 2020 without new conveyance
    2. 2035 without new conveyance
    3. 2040 with new conveyance
    4. 2060 with new conveyance

    So, benefits over the 2020 to 2035 period would be based on interpolation using 1 and 2, benefits over the period 2036-2040 would be based on interpolation using 2 and 3, and benefits for the years 2041 to 2060 and beyond would be based on 3 and 4.

Relationship of Projected Conditions to Hydrologic Period

Requirement: For the existing conditions and each projected condition used as a basis of benefits quantification, a hydrologic and water delivery analysis should be conducted that includes a representative time series of years from a hydrologic period long enough to capture the known historical variability in precipitation and inflows. (For a climate change analysis, any change to this hydrology will be defined separately.) For each projected condition year, the representative time series must be adjusted to reflect the level of development, infrastructure, population, land use, water use, operations plans, laws and regulations consistent with that projected condition. The physical and economic benefits information for each projected condition year in the period of analysis must be based on the average annual amounts from the entire representative time series of years.

The inter-relationship of period of analysis, projected condition and hydrologic period is shown in Tables 3 and 4 below.

Table 3. Example Calculation of Benefits for Representative Hydrology at Two Development Conditions

Year of hydrologic period	2030 Projected Condition			2050 Projected Condition		
	2030 Condition Water Supply Change 1.	2030 unit value ($/AF) for year type	2030 benefit of water supply	2050 Condition Water Supplies 1.	2050 unit value ($/AF) for year type	2050 benefit of water supply
1922	AF	$/AF	AF x $/AF	AF	$/AF	AF x $/AF
1923	AF	$/AF	AF x $/AF	AF	$/AF	AF x $/AF
1924	AF	$/AF	AF x $/AF	AF	$/AF	AF x $/AF
1925	AF	$/AF	AF x $/AF	AF	$/AF	AF x $/AF
…	AF	$/AF	AF x $/AF	AF	$/AF	AF x $/AF
2011	AF	$/AF	AF x $/AF	AF	$/AF	AF x $/AF
2012	AF	$/AF	AF x $/AF	AF	$/AF	AF x $/AF
2013	AF	$/AF	AF x $/AF	AF	$/AF	AF x $/AF
			Avg2030			***Avg2050***

1. With-project supply minus without-project supply, for each year.
All benefits are adjusted to 2015 dollars
Avg2030 and ***Avg2050*** are the expected annual benefits for each development condition.

Table 4. Example Calculation of Projected Benefits over the Project Life

Year of Project Construction or Operation	Project Costs and Benefits by Year of Analysis		
	Project Costs	Monetized Project Benefits	Benefits minus Costs
2020	Construction, IDC		2015 $
2021	Construction, IDC		2015 $
2022	Construction, IDC		2015 $
2023	Construction, IDC		2015 $
2024-2029	OM&R	Extrapolate from 2050 and 2030	2015 $
2030	OM&R	***Avg2030*** from Table 3	2015 $
2031-2049	OM&R	Interpolate between 2030 and 2050	2015 $
2050	OM&R	***Avg2050*** from Table 3	2015 $
2051-end	OM&R	Extrapolate from 2030 and 2050	2015 $

OM&R is operations (including power), maintenance, and replacement cost as needed during the operational life of the project.

Future Population Levels

Future population levels could be relevant for estimating future M&I water demand levels, water quality conditions, emergency response needs, recreation demands, flood risk, and potentially, the value of ecosystem services.

The Department of Finance (California DOF, 2015) provides population forecasts for California counties, cities, and designated census places. These forecasts are generally accepted for California planning purposes.

Requirement: Where future population levels are relevant to benefits calculations, population forecasts must be consistent with Department of Finance (DOF) population projections. DOF forecasts will be available through 2060. For years beyond 2060, either zero growth, or the average annual growth rate between 2050 and 2060 should be assumed. Other published, well-documented population forecasts can be used, including from Urban Water Management Plans as long as they are not inconsistent with DOF projections.

Future Land Use

Requirement: Any future land use projections must be based on an existing published document whenever possible, including local general plans, agricultural and urban water management plans, or the California Water Plan Update.

M&I Water Demand Levels

Existing demand forecasts are provided for a large fraction of California urban water use through the urban water management plans (UWMPs). These plans are developed by individual water providers at five-year intervals, the most recent being 2010. The plans also provide information about local water supplies, generally not included in system-wide assessments, which suggest the future need for additional water supplies.

Recommendation: Where M&I water demands are relevant to water supplies provided for public benefits, or other public benefits claimed, M&I water demand levels should be consistent with future population levels. Urban water demands should meet required 20% by 2020 targets. Economic benefits that stem from municipal water use should be generally consistent with water demand forecasts for the affected agencies from their UWMPs. Water demand projections beyond years in UWMPs should be based on the product of the last average gallons per capita per day (gpcd) (including all sectors) forecast in the UWMP and the population forecast.

Discount Rate

The discount rate is a real (inflation-free) interest rate that allows all benefits and costs occurring in future years to be compared and combined. If two projects use different discount rates, their benefits and costs are weighed differently and therefore they cannot be compared fairly.

Some options are displayed in Table 5. Economists have developed three fundamental approaches regarding how to implement discounting, 1) the social rate of time preference (SRTP), 2) the social opportunity cost of capital (SOC), and 3) the shadow price of capital (SPC). In general, SRTP tends to

provide the lowest discount rate (1 to 4 percent) although some economists propose long-term, inter-generational rates that are near zero. SOC tends to provide the highest rates; perhaps 5 to 8 percent.

Table 5. Options for Real Discount Rate

Option Name	Description	Current value	Advantages	Disadvantages
DWR Rate	Has been used by DWR for State project evaluations for years	6%[1]	Precedent in DWR grant programs; may approximate opportunity cost of capital	No recent, formal documentation or update.
FEMA Rate	Rate for Pre-Disaster Mitigation (PDM) grant program	7%	Compliance with OMB BCA guidelines, intended to be based on the marginal opportunity cost of private investment per OMB Circular A-94	OMB Circular A-94 BCA rate not changed since 1992.
Water Resources Development Act rate	Rate for federal water projects	3.375%[2]	Consistency with federal feasibility studies; related to federal cost of capital	Changes very slowly over time, so lags changes in federal cost of capital[4]
California cost of borrowing, LAO Prop 1.	LAO assumed a nominal rate of just over 5%	About 3%[3]	Reflects state costs of capital	Not known how LAO developed[4]
California cost of borrowing, independent	Develop a rate based on CA bond interest costs	3.5% (tentative)	Reflects state costs of capital	Must be calculated – no publication to use as standard reference[4]

[1] The DWR rate of 6 percent was based generally on an estimate of the opportunity cost of capital.

[2] Discounting methods for the federal Water Resource Development Projects are specified by the Water Resources Development Act (WRDA) of 1974. The rate is based on a mix of federal Treasury Bond yields, but the annual change in the rate is capped. During periods of rapid change in interest rates, the WRDA rate can diverge from the federal cost of capital by a substantial amount.

[3] The California Legislative Analyst's Office (2014) prepared an analysis of borrowing costs for Proposition 1. After adjusting for an estimated expected long-term inflation rate of 2%, the real rate is 3%.

[4] These rates can be heavily influenced by short and medium term federal monetary policy (e.g., Quantitative Easing).

California's appropriate discount rate for evaluating public benefits of water projects should not be based on the private opportunity cost of capital. First, repayment of bonds is not drawing money out of the private sector because no new tax revenue is available. Rather, bond repayment diverts existing tax revenue from other state-funded programs. Second, most bond buyers are likely to be out of state, so the opportunity cost of their investments do not matter from a State perspective.

The real interest rate at which California General Obligation bonds are sold is arguably the most realistic basis for the State's cost of capital and therefore the appropriate discount rate. The WSIP technical team

conducted a review of recent bond costs to estimate the likely nominal rate for State bonds. Since 2008, the state has paid an average of 3.22 percent for revenue bonds. The current general obligation bond rate is about 3.25%. Several adjustments to this rate are appropriate.

- First, the bonds will not be sold immediately and then might be sold over a period of ten years. Current bond rates reflect expansionary monetary policy (low Federal Reserve interest rates). Recent expectations by the Federal Reserve Board of Governors (FRB, 2015) indicate that longer-term federal funds rates could rise by 2 to 3 percentage points by 2017. In response, bond rates are expected to increase over the next several years.
- Second, the State's borrowing rate reflects investors' (bond buyers') assessment of the risk that they will be repaid by the State. However, the risk that taxpayers take in investing in public benefits of water storage projects is likely to be greater than that, considering the significant uncertainties about future hydrologic, economic, climate, and ecosystem conditions. Therefore, the WSIP team believes that an appropriate discount rate, though based on the State's real borrowing rate, should be higher to reflect the larger risk of achieving the future public benefits.
- The nominal rate must be adjusted for expected inflation. The Federal Reserve Bank of Cleveland reports that its latest estimate of 10-year expected inflation is 1.88 percent, and its estimate of 30-year expected inflation is 2.2 percent (FRBC, July 2015). The Federal Reserve Board of Governors (FRB, 2015) expects inflation to be about 2.0 percent in the long run.

The WSIP team has considered these factors of expected inflation, changes in monetary policy that the Federal Reserve Board has signaled, and the inherent risk in future levels of public benefits, and recommends that all projects be evaluated using a real discount rate of 3.5%.

Requirement: 3.5% real (inflation-free) discount rate must be used for all calculations involving discounting, compounding, present value, or annual equivalent (amortized) values.

Construction Costs and Contingencies

Construction cost is a major portion of the total project cost. The level of accuracy of construction cost estimates varies at different stages of project development, ranging from preliminary estimates in the early stages to fairly accurate figures for budget control prior to construction (United States Society on Dams, 2012). The contingencies discussed below generally pertain to feasibility-level estimates. Construction cost estimates consist of the costs of the construction of the physical features of the project, relocation of existing real property, clearing and restoring lands, service facilities, investigations, engineering (preparation of design and specifications, construction management, and contract administration), and other general expenses.

This section outlines some conventions for cost estimating for purposes of economic analysis. Construction cost consists of the following components:

Contract Cost

The contract cost is intended to represent the estimated cost of the contract at time of bid or award. This estimate will include detailed quantity and unit price estimates, and if not covered under a bid item may include an allowance for mobilization/demobilization that shall not exceed 5% of the contract cost.

Construction Contingencies

Feasibility-level design cost estimates will include a percentage allowance for construction contingencies as a separate cost item to compensate for unforeseen or changed site conditions, owner-directed orders for change, quantity overruns, etc. The percentage allowance used should be based on engineering judgment of the major pay items in the cost estimate, reliability of the data, adequacy of the projected quantities, and general knowledge of site conditions. The allowance will vary inversely with the certainty of the engineering and geological information and data. Construction contingency allowance shall not exceed 20 percent of the contract cost.

Field Cost

The field cost is an estimate of the capital costs of a project from award to construction closeout. The field cost equals the contract cost plus construction contingencies (Contract Cost + Construction Contingencies).

Non-Contract Costs

Non-contract costs include engineering and design, construction management, project close-out, administration, legal services, permitting, etc. The non-contract costs shall not exceed 25 percent of the field cost.

Total Construction Costs

Total Construction Cost consists of the field cost and non-contract costs (Field Cost + Non-Contract Cost).

Total Project Cost

The total project cost will include the construction cost and other allowances including land acquisition, right of way, and environmental mitigation costs.

Requirements:

1. Allowance for mobilization/demobilization shall not exceed 5% of the contract cost.
2. Construction contingency allowance shall not exceed 20 percent of the total construction cost.

Conveyance Costs

Benefits that are compared to project costs should be benefits net of any non-project costs including conveyance costs from the project to its destination. All water delivered through conveyance systems should be assigned a water delivery cost per AF based on variable costs. For the State Water Project (SWP) system, Bulletin 132 provides costs. For the Central Valley Project (CVP) system, Reclamation charges Operations and Maintenance (O&M) rates. The variable cost of SWP is the variable Operation, Maintenance, Power, and Replacement (OMP&R) component plus the Off-Aqueduct charge, which is also charges based on amount of deliveries.

Requirement: Reclamation's CVP O&M rate and SWP's OMP&R and Off-Aqueduct charge must be used for conveyance costs through the CVP and SWP systems, respectively. Conveyance losses in the Delta or conveyance channels must be estimated and incorporated into the cost calculation, if appropriate.

Water Unit Values

The technical team is working to develop unit values for water that would be recommended, with other methods, wherever public benefits are provided by water supply. The unit values (in dollars per acre-foot) will be based on water market transactions data through 2015 and on the Statewide Agricultural Production Model (SWAP). SWAP is an optimization model that can estimate the value per AF of changes in water supply to agricultural production for locations in the Central Valley. The recommended unit values are expected to be provided for different year types, for different projected conditions (such as 2030 and 2060), and for different general locations, for example the Sacramento Valley and San Joaquin Valley just south of the Delta. In addition, conveyance costs will be provided to allow the unit values to be adjusted to other locations such as the southern San Joaquin Valley and South Coast. Draft results and documentation are expected August 2015.

Economics Reporting Requirements

The following metrics and documentation for monetary benefits and cost shares must be provided.

1. For each public benefit category, the net present value (NPV) of monetary benefits based on the annual expected real monetary benefits for each year of the period of analysis, and the approved discount rate. Complete documentation must be provided, including methods, models, assumptions, data sources, and annual physical and monetary benefits for each year of the period of analysis. Qualitative description of public benefits that could not be quantified in physical or monetary terms must be provided.
   Rationale for requirement: Applicants will be required to document that 50% of the public benefits requested to be funded by bond funds are ecosystem improvements, and that the cost share for each benefit category is justified by its level of quantified benefit.
2. Project costs, including construction, interest during construction, contingencies, land acquisition, mitigation, operations and maintenance, repair and replacement (OMR&R) costs, for each year of the period of analysis, with documentation.
   Rationale for requirement: Applicants will be required to document that their funding request is at or below the 50% public cost share maximum, and to obtain assurances that future costs can be paid.
3. The proposed public cost share proposed for each public benefit category, in net present value terms, and documentation regarding how each public cost share was calculated. The proposed public cost share in terms of the total 2015 dollar value of funding request should also be provided.
   Rationale for requirement: The applicant will be required to support the amount of each cost share and indicate that the public cost share is fair (i.e., public benefits are greater than the public costs).
4. The expected return for public investment as measured by 1) the internal rate of return to the State investment, and 2) the ratio of the NPV of public benefits to the NPV of the public cost share.
   Rationale for requirement: The applicant will be required to document the expected return for public investment.

5. The 2015 NPV of alternative cost of providing the same quantities of public benefits as provided by the project by the least-cost alternative means. This alternative means should be feasible, and might include single-purpose alternatives for each public benefit.
   Rationale for requirement: The applicant will be required to illustrate that the project is cost-effective.

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