FINAL REPORT

Integrated Water Resource Planning Project

JEA

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Executive Summary

JEA has completed the Integrated Water Resource Planning (IWRP) Project incorporating the potable water, sewer and reclaimed water systems in a long-term planning tool to analyze the current system, identify water resource challenges and opportunities, and develop a method for assessing future water resources investments and policies. At the start of the IWRP Project, the following mission statement was developed to guide the study:

> *"The project team will develop an integrated water resource planning process that is designed to provide a road map for assessing future investments and developing policies to sustainably meet water needs through year 2035. The project will develop processes and tools for ongoing assessment and adaptive management."*

A systems model was developed as part of this study in order to answer the following types of questions:

- When will water demand outpace existing water supply?
- What supply alternatives will offer the most cost-effective and reliable solutions?
- How can supply-side and demand-side management be used together cost-effectively?
- How should new infrastructure and facilities be phased?

In addition to the systems model, an evaluation framework and decision tool was also developed. The decision tool incorporates performance metrics from the systems model along with other qualitative metrics, in order to rank alternatives against multiple criteria. To demonstrate the systems model and decision tool, several illustrative alternatives were created. While these illustrative alternatives utilize reasonable information, they assume certain conditions which will likely change. Therefore, these alternatives should in no way be construed as alternatives that JEA is pursuing at this time. Rather, they were developed to demonstrate how the systems model, evaluation framework and decision tool can be used by JEA to evaluate future water resources and develop an appropriate long-term strategy.

The IWRP process starts by defining planning objectives and performance measures that are important to the utility, customers, regulators and other stakeholders. These guiding objectives were outlined at the first workshop with JEA's Planning Team, then reviewed and modified by the broader group of JEA staff and leadership. Each objective and its related performance measures are listed in **Table ES-1** along with the weights assigned to each used in scoring and analyzing the illustrative alternatives. The performance measures are either quantitative, and calculated within the integrated model, or qualitative, and determined outside the model based on experience and professional judgment.

Table ES-1 Objectives, Performance Measures and Weights

Objective	Weight	Performance Measure	Sub-Weight	Units	Better Scores Are:
Maximize Cost-Effectiveness	0.167	Total customer lifecycle costs	0.4	2012 dollars (billions)	lower
		JEA levelized costs	0.4	2012 dollars per million gallon	lower
		Ratio of JEA fixed costs to JEA total costs	0.2	Fixed costs/total costs	lower
Reliably Meet Water Demands	0.167	Magnitude of water shortage	0.6	Million gallons	lower
		Time of water shortage	0.4	% of months showing deficit > 5%	lower
Maximize Flexibility	0.167	Operational flexibility	0.5	% of months showing South Grid deficit >5%	lower
		Diversity of supply	0.5	% supply remaining after removing top source	higher
Promote Environmental Sustainability	0.167	Aquifer sustainability	0.5	% supplies not from Floridan Aquifer	higher
		Water use efficiency	0.4	% demand reduced by conservation/reuse	higher
		River impacts	0.1	% supply from surface water	lower
Maximize Implementation	0.167	Reliance on proven technology	0.4	Qualitative score of 1 to 5, 1 - unproven technology, 5 - common technology	higher
		Ability to permit	0.4	Qualitative score of 1 to 5, 1 - difficult to permit, 5 - no permitting hurdles	higher
		Public acceptance	0.2	Qualitative score of 1 to 5, 1 - unlikely public acceptance, 5 - no new public acceptance needed	higher
Meet Customer Water Quality	0.167	Water quality blending/secondary water quality	1	Qualitative score of 1 to 5, 1 - difficult to blend sources, 5 - no blending challenges	higher

The next step in the IWRP process is the identification and characterization of various supply and demand-side options. A full list of options modeled is listed in **Table ES-2**. Each of these options has been previously studied and information concerning the configuration, potential yield, constraints and costs were taken from previous reports for incorporation into the model.

Table ES-2 Modeled Options within the System Planning Tool

Water Supply Options	Water Reuse Options	Demand Management Options
▪ CUP Allocations ▪ Regional Surface Water Reservoirs on either Ortega River, Big Davis Creek, or Durbin Creek ▪ Non-Floridan Private Irrigation Promotion for either current self supply customers or for wider adoptions ▪ Desalination of either brackish groundwater, brackish St. Johns River water, lower St. Johns River water or the ocean. ▪ Intermediate Aquifer Wells	▪ Indirect Potable Reuse ▪ Keystone Lake Regional Reuse ▪ Regional Reuse throughout the whole St. Johns River Water Management District ▪ Targeted Reuse focusing on either the Stone Container Corporation, creation of a South Grid Salinity barrier, or providing reclaimed water to identified 'Water Hogs'.	▪ Conservation ▪ Reduction of unaccounted for water

Because no single option is likely able to meet all of the specified planning objectives, options are combined into complete alternatives. During a JEA workshop, several themed-alternatives were initially developed and then expanded into the five listed below. These alternatives are NOT intended to represent actual plans or recommendations – rather, they were formulated solely to demonstrate the comparison process with the IWRP tools.

1. No Options – Water is supplied solely from the Floridan Aquifer by way of the CUP.

2. Low Cost – In addition to the planned North to South Grid transfer capacity, up to an additional 5 mgd of supply is provided from intermediate aquifer supply wells (IAS wells). Targeted reuse expansion options are included to offset potable demand. This alternative results in future deficits.

3. High Reliability with Groundwater Desalination – All options in the Low Cost alternative (IAS wells and targeted reuse) are included, along with a 30 mgd brackish groundwater desalination plant.

4. High Reliability with Surface Water Desalination - All options in the Low Cost alternative (IAS wells and targeted reuse) are included, along with a 30 mgd brackish St. Johns River water desalination plant.

5. High Reliability with Indirect Potable Reuse (IPR) – All options in the Low Cost alternative (IAS wells and targeted reuse) are included, along with up to 30 mgd of indirect potable reuse capacity in the South Grid.

The alternatives are then evaluated using an integrated systems model that simulates system constraints, supply reliability, lifecycle costs, water quality and other metrics.

To facilitate the programming of the systems model, a conceptual schematic of JEA's water system was developed (see **Figure ES-1**). In this figure, the size of the circles represents the relative size of water demand and CUP allocation in the year 2036. As shown in the figure, the North and South Grids represent the majority of the system water demands. A range of low, medium and high demand projections are included for each grid. These demands are met by the CUP allocation allowed per grid and then by any of the selected additional supply options or demand management options.

The systems model is run for a 25-year planning period from 2012 to 2035 allowing factors such as demand or the availability of supply sources to change over time. The model was created using the software STELLA and can be operated through a set of user-friendly interface management panels. From these panels all options can be turned on or off to build the alternatives for investigation. Navigation buttons easily allow changes and updates to any of the project data or assumptions included within the model structure. Additionally, the user can adjust the priority order in which the water supply options are utilized. The model utilizes the water from one source to meet demand until it is exhausted and then moves on to the next source on the priority list until the demand is satisfied or no additional water supply options remain.

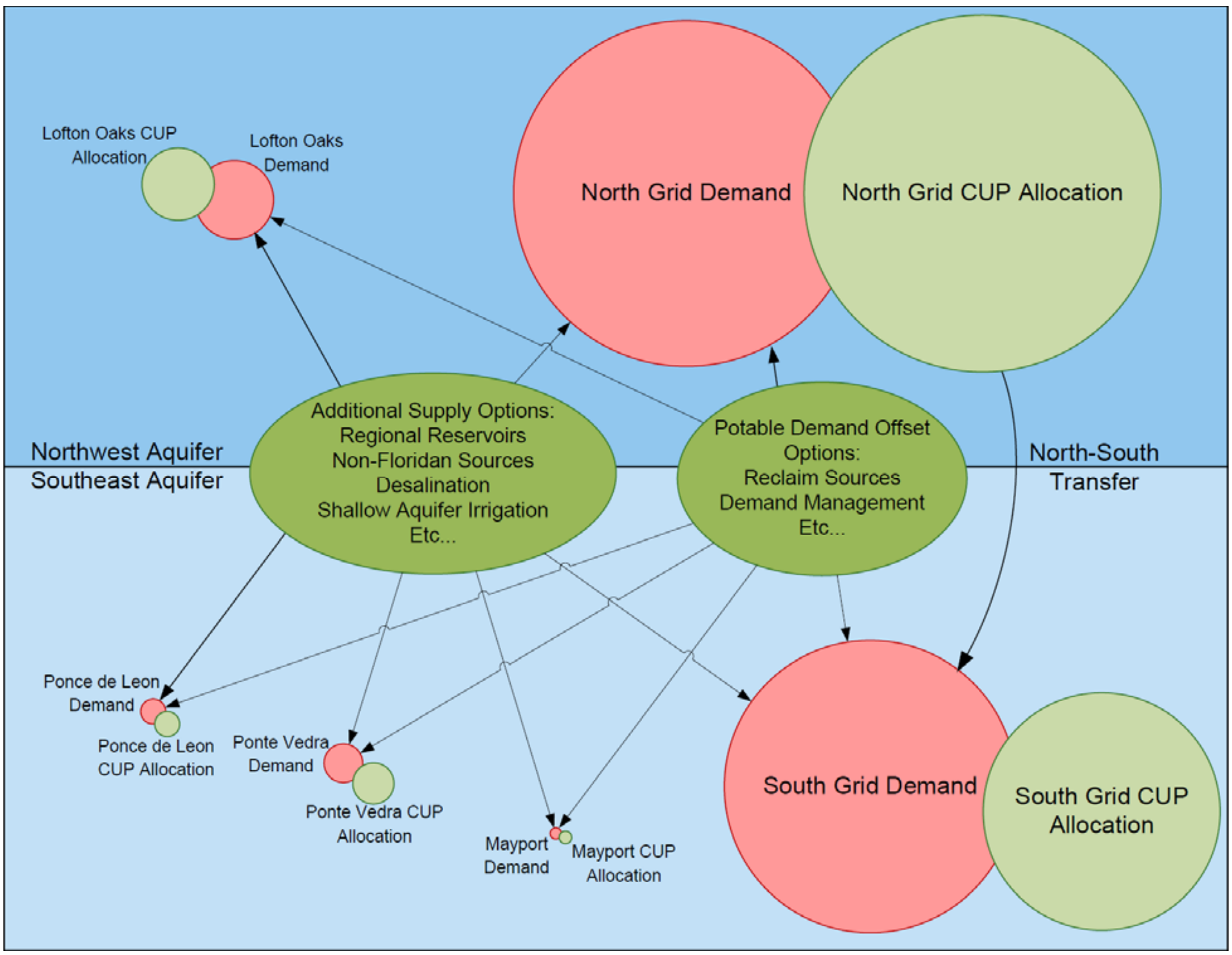

Figure ES-1
Modeled System Schematic, Based on 2036 Demands and CUP Allocation

The systems model will produce raw output for the various quantitative metrics. To facilitate the ranking of alternatives, a decision software tool called Criterium Decision Plus (CDP), was utilized. CDP uses a method called multi-attribute rating to convert raw performance metrics (both quantitative and qualitative) into standardized scores (removing units such as dollars for cost or mgd for water supply), and then applies the relative weights in order to compare and rank alternatives.

The scoring of the illustrative alternatives produces the following scores and ranking (Table ES-3 and Figure ES-2). The score is a composite of the sum of the normalized scores for each objective category; theoretically, an alternative that scores perfectly in all objective categories would have a composite score of 1.0.

Table ES-3 Results of Illustrative Alternative Ranking

Alternative	Composite Score	Rank
High Reliability with Groundwater Desalination	0.67	1
High Reliability with Surface Water Desalination	0.63	2
High Reliability with Indirect Potable Reuse	0.59	3
Low Cost	0.57	4
No Options	0.55	5

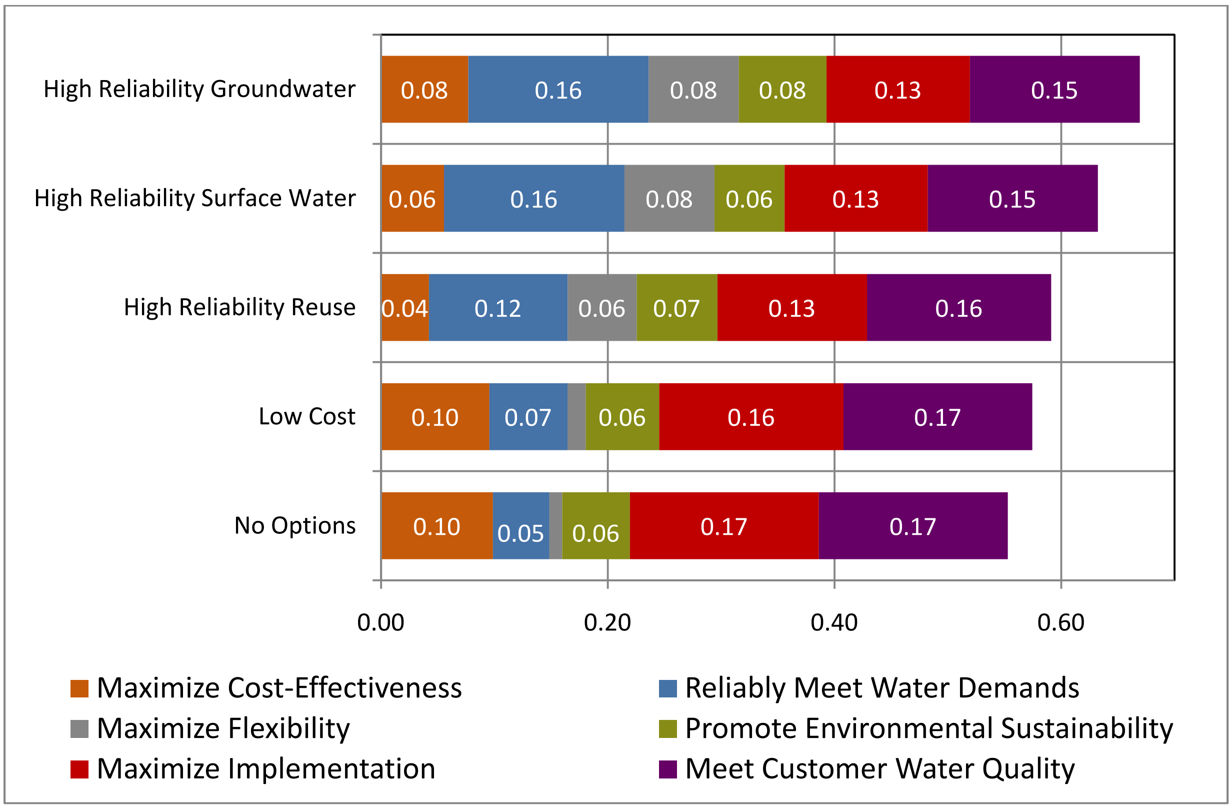

Figure ES-2
Illustrative Alternative Scores

The groundwater desalination alternative scored the best because, despite having a higher cost, the supply options chosen resulted in higher supply reliability when compared to lower cost alternatives. A sensitivity analysis on the weights of the objectives—which were weighted equally at 17 percent each in the baseline scenario—showed that as the weight of the cost objective is increased beyond 75 percent, the less expensive and less reliable alternatives rank higher.

This report demonstrated how the current systems model can be used to compare alternatives with respect to supply reliability, economic viability, and other criteria. The report and the planning process were not intended to yield a recommended plan for future water supply. However, there are some important observations that can be made from this study, these being:

- While an overall future water supply deficit is predicted for the JEA system if no new options are selected, this deficit is largely present only in the South Grid and Lofton Oaks Grid. The CUP allocation is sufficient to meet the currently projected North Grid demands and those of many of the smaller grids through 2035. Thus the focus on alternative supplies should remain on those with a potential impact for the South Grid system.
- Significant water supply deficits (i.e., greater than 5 mgd) do not occur until after 2025 under a low population forecast scenario, and not until after 2015 under current or high population forecast scenarios.
- There is not always the need to move the full flow capacity through the interconnect between the North and South Grids. The optimal timing for the use of the interconnect depends on the time of year and options selected. Future optimization of the best way to utilize this infrastructure should be considered and could be performed using the system model with some modest refinement.
- The final rankings of the illustrative example were found to be fairly sensitive to cost. Thus, as JEA continues to use the model, specific attention should be paid to continuing to refine the cost of selected alternatives.

Moving forward, JEA can use the model in two ways:

- **Planning Mode:** The model can be used exactly as demonstrated in this report to formulate alternative combinations of supply and demand management options, simulate their performance over the planning period, and compare cost, reliability, and other factors. It can also be used to form hybrid alternatives with options that seem to address or satisfy many of the specified planning objectives. In this way, a preferred plan can be formulated by studying tradeoffs, combining the options that satisfy the objectives broadly, and tuning them to appropriate yield levels.
- **Operations Mode:** The model can also be used (with its accompanying output spreadsheet) to formulate an annual operating plan at any point in time, given the infrastructure that would be currently available. For example, JEA could use the model to formulate an operating plan for 2013 by enabling the current supply options and experimenting with demand management alternatives to see how they might offset potable demand, and what the economic implications would be. In future years, when additional supply sources are brought online, JEA can experiment with alternative prioritization strategies for the suite of installed supplies to help optimize for cost.

As recently discussed with JEA at the project completion workshop, JEA may want to consider the following suggestions for ways to expand and improve the system model:

- **Create more refined alternatives.** The options included in the systems model were all summarized from previous reports and studies. As certain options and combinations of options become favored, the costs and yields should be revisited and refined. More attention to the scaling or phasing of infrastructure can also be considered and modeled.
- **Enhance the financial output.** The current systems model has a significant economic component set up to compute levelized cost and total lifecycle costs. However, an additional export spreadsheet could be created to calculate additional financial output that can feed into a more comprehensive JEA financial analysis for rate making and bonding analysis.
- **Continue model maintenance.** The systems model relies on multiple future projections out to the year 2035. These will need to be updated regularly to remain relevant with current conditions and changing planning activities.
- **Invest in staff training.** JEA may want to consider additional staff to fully utilize both the systems model and CDP decision software.

Section 1

Introduction

JEA operates as an integrated utility providing water, sewer and power to customers in the Jacksonville, Florida area in addition to operating a reclaimed water system. Operating these systems together, JEA inherently understands their connectivity and the need for considering the full system holistically when planning their long-term water resources strategy. To accomplish this goal, JEA's planning group commissioned an Integrated Water Resource Planning (IWRP) Project to analyze the current system, identify water resource challenges and opportunities, and develop a tool for assessing future water resources investments and policies.

1.1 JEA Service Area

In order to assess JEA's water resources challenges and opportunities, it is important to understand JEA's three water resource systems: water, wastewater and reclaimed water.

1.1.1 Water

The water distribution system serves approximately 305,000 customers, and is divided into two major interconnected grids (North Grid and South Grid) as well as four smaller discrete grids. The North Grid and South Grid are interconnected through a pipeline river crossing that allows for the transfer of water from the North Grid to the South Grid. The four smaller grids include the Ponte Vedra and Ponce de Leon systems in St. Johns County, Lofton Oaks in Nassau County, and Mayport in Duval County (see **Figure 1-1**).

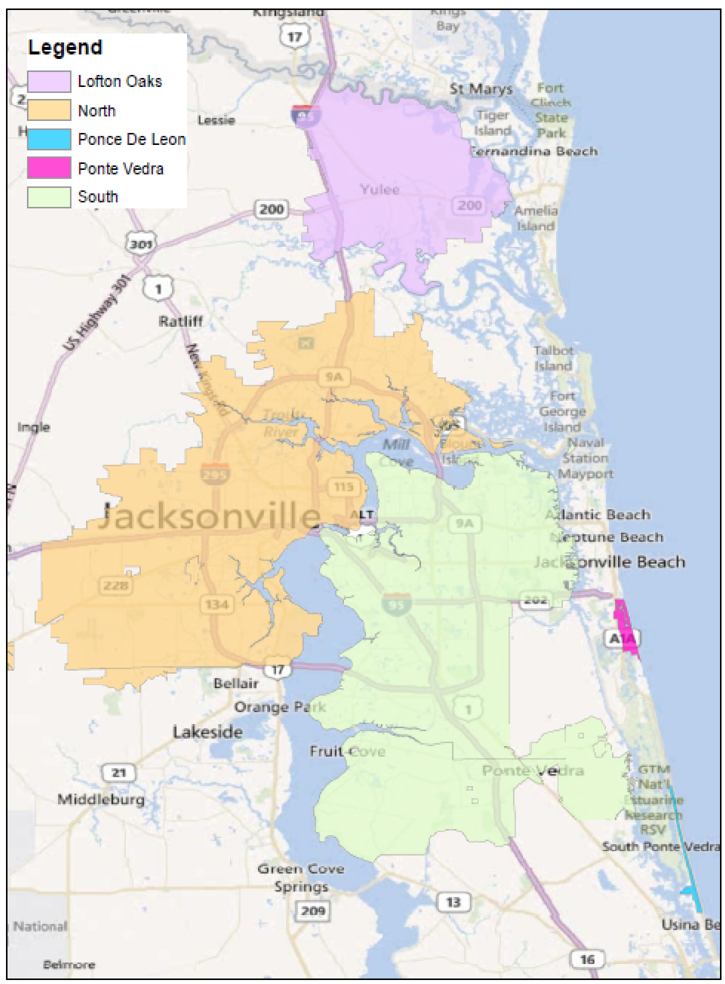

Figure 1-1
JEA Water Grid Geographical Extents

All grids use deep wells to draw water from the Floridan Aquifer. Raw water is pumped to small scale water treatment plants for disinfection and ultimately into the water distribution systems.

Population within the JEA service area is projected to grow 43 percent by 2035, with especially high growth in the Lofton Oaks area. This is projected to increase water demands in the region by the same proportion. As of September 2011 the average daily flow of the water system was 124 million gallons per day (mgd) with maximum daily flow reaching 172 mgd.[1]

1.1.2 Wastewater

The wastewater system is broken into service areas that do not align directly with the water distribution grids. JEA's wastewater system serves approximately 230,000 customers. The majority of the wastewater treatment plants discharge into the St. Johns River. JEA is already meeting 2013 TMDL nutrient requirements through the phase-out of smaller facilities and the increased distribution of reclaimed water. Following the completion of all phase-outs, three wastewater treatment plants will remain in the north grid area (Buckman, District II/Cedar Bay, and Southwest), four treatment plants within the South Grid (Arlington East, Blacks Ford, Monterey, and Mandarin), and one plant each within the Ponte Vedra, Ponce De Leon and Lofton Oaks grids. These plants are not simulated explicitly in the IWRP model, but the reclaimed water derived from wastewater plants throughout the system is included.

The peak capacity for the sewer system as of September 2011 was 246 mgd with an average daily flow of 64 mgd and maximum daily flow of 101 mgd. By 2035, the end of the project planning period, average daily wastewater flow is projected to be 103 mgd.

1.1.3 Reclaimed Water

JEA currently has 11 reclaimed water production facilities with a total capacity of 30.8 mgd to serve an average daily flow of 13 mgd. Demand for reclaimed water is projected to more than triple by 2035.

Current reclaimed capacity is split between the North Grid, South Grid and satellite grids. The South Grid currently has the capacity to deliver 14.7 mgd to a customer distribution system where the water is used predominately for irrigation. However, in the North Grid the available capacity of 13.5 mgd is currently non-public access reclaimed water for reuse within the treatment facilities and one transmission pipeline to three industrial customers. The smaller satellite grids currently have combined reclaimed water capacity of 2.6 mgd, which includes transmission pipelines from the treatment facilities mainly to specifically identified customers.

1.2 Water Resources Challenges

JEA's 20-year Consumptive Use Permit (CUP) was approved in May 2011 and revised in August 2012 to include 142.26 mgd of groundwater from the Floridan aquifer, which can be increased to 162.6 mgd provided JEA can replace/offset other permitted Floridan aquifer uses with expanded utilization of reclaimed water.

While the current CUP allocation is able to provide for customer water demands, as population in the region rises, JEA may need to turn to alternative water supply options and expanded demand management. **Figure 1-2** shows the potential gap between the CUP allocation and water demand based on varying population projections. More detail about this analysis and assumptions made in determining population increases and water demand are found in **Appendix A**.

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[1] JEA (2011) *2012 Annual Water Resource Master Plan: Water – Wastewater – Reclaimed*. Corporate Planning Department, Water/Sewer System Planning. September 2011.

Withdrawals from some South Grid wellfields have been leading to increasing saline water intrusion. Because of this, CUP allocations in the South Grid are scheduled to decrease over time instead of rise as in other areas. This strengthens the need to investigate alternative water supplies within the South Grid geographical area. JEA carefully monitors the salinity at the wells as well as the potentiometric surface of the aquifer. While there is a confining layer between the Floridan aquifer and the upper surficial aquifers, there continues to be concern over the effect of groundwater pumping on local lakes and wetlands in the area that could put further restrictions on groundwater pumping in the future.

Another water resource challenge is improving the water quality of the St. Johns River. A revised Total Maximum Daily Load (TMDL) effective October 2013 sets the total nitrogen limit at 720 tons/yr or 7 parts per million (ppm) for all wastewater treatment facilities in aggregate, which is a drop from the previous limit of 1,536 tons/yr or 15 ppm. Besides improving the wastewater treatment facilities, expanding the reclaimed water system not only provides a reduction to the potable water demand but reduces nitrogen released to the river.

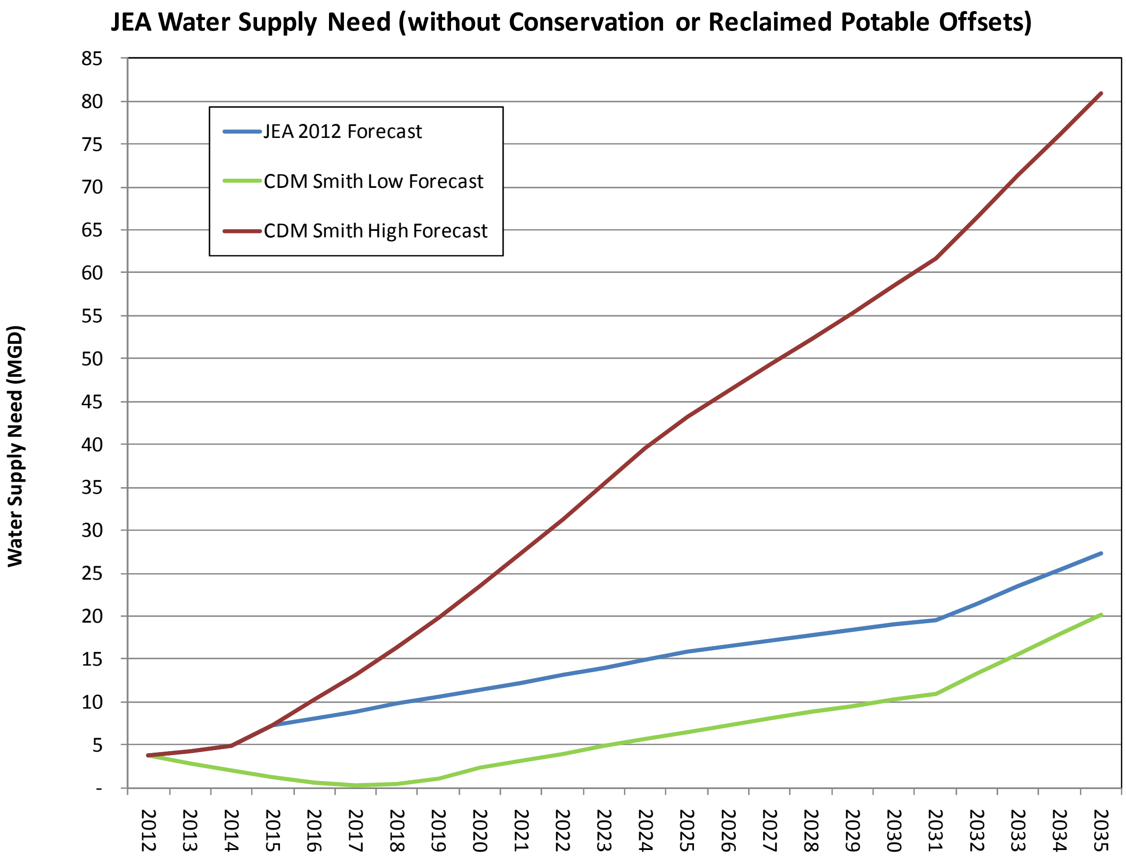


Figure 1-2
Range of Water Supply Need

1.3 Purpose of the Study

At the start of the IWRP Project, the following mission statement was developed to guide the study:

> *"The project team will develop an integrated water resource planning process that is designed to provide a road map for assessing future investments and developing policies to sustainably meet water needs through year 2035. The project will develop processes and tools for ongoing assessment and adaptive management."*

A systems model was developed as part of this study in order to answer the following types of questions:

- When will water demand outpace existing water supply?
- What supply alternatives will offer the most cost-effective and reliable solutions?
- How can supply-side and demand-side management be used together cost-effectively?
- How should new infrastructure and facilities be phased?

In addition to the systems model, an evaluation framework and decision tool was also developed. The decision tool incorporates performance metrics from the systems model along with other qualitative metrics, in order to rank alternatives against multiple criteria. To demonstrate the systems model and decision tool, several illustrative alternatives were created. While these illustrative alternatives utilize reasonable information, they assume certain conditions which will likely change. Therefore, these alternatives should in no way be construed as alternatives that JEA is pursuing at this time. Rather, they were developed to demonstrate how the systems model, evaluation framework and decision tool can be used by JEA to evaluate future water resources and develop an appropriate long-term strategy.

Section 2

IWRP Evaluation Framework

2.1 IWRP Process and Terms

The main purpose of the IWRP Project is to develop a framework and set of tools for JEA in order to evaluate alternatives and develop a long-term, sustainable water resources strategy. The outcome is a high-level, strategic planning tool that can illustrate key interrelationships and trade-offs between water resources alternatives. This will allow JEA to make informed decisions and adaptively manage their resources and infrastructure in the face of future uncertainty.

Terms commonly used within this IWRP process include:

- **Objectives:** Represent major goals of plan, defined in broad, understandable terms (e.g., ensure water reliability).
- **Metrics/Performance Measures:** Indicate how well an objective is being achieved (e.g., frequency and magnitude of water shortages). Objectives combined with their corresponding metrics represent the criteria by which alternatives are compared against.
- **Options:** Represent individual projects or demand management measures.
- **Alternatives:** Represent combinations of options designed to best meet the stated objectives, and will be evaluated against the criteria (objectives and metrics).

The IWRP process starts by defining planning objectives and performance measures that are important to the utility, customers, regulators and other stakeholders. Then the process continues with the identification and characterization of various supply and demand-side options. Because no single option is likely able to meet all of the specified planning objectives, options are combined in various ways into complete alternatives. The alternatives are then evaluated using an integrated systems model that simulates system constraints, supply reliability, lifecycle costs, water quality and other metrics. The output from the systems model, along with some qualitative metrics, is summarized in a decision tool to facilitate ranking of alternatives. **Figure 2-1** presents the overall IWRP process for JEA.

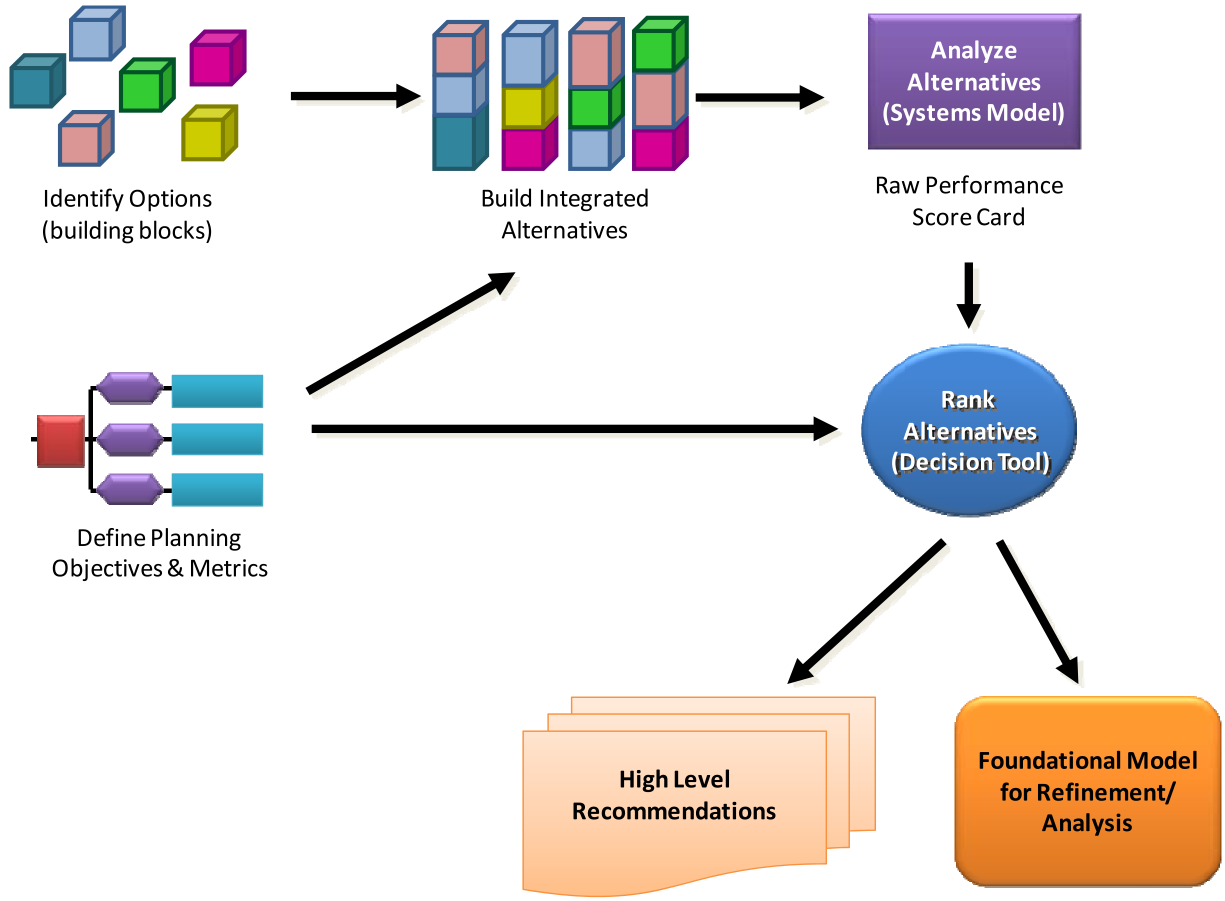


Figure 2-1
IWRP Process

2.2 Objectives and Performance Measures

The first workshop with JEA's Planning Team identified the guiding objectives for the IWRP. Associated with each objective are performance measures, which were reviewed and modified by the broader group of JEA staff and leadership at the kickoff meeting. One of the expectations of the integrated model is that it will provide numerical output in the form of the performance measures that are deemed to be quantitative, as opposed to qualitative. These will then be used in a scorecard along with any qualitative scores to provide balanced, broad-based comparisons of alternatives. The objectives and performance measures are listed in **Table 2-1** with more detail on their use provided in Section 4.

Table 2-1 Objectives and Performance Measures

Objective	Performance Measure
Maximize Cost-Effectiveness	Total customer lifecycle costs JEA levelized costs Ratio of JEA fixed costs to JEA total costs
Reliably Meet Water Demands	Magnitude of water shortage Time of water shortage
Maximize Flexibility	Operational flexibility Diversity of supply
Promote Environmental Sustainability	Aquifer sustainability Water use efficiency River impacts
Maximize Implementation	Reliance on proven technology Ability to permit Public acceptance
Meet Customer Water Quality	Water quality blending/secondary water quality

2.3 Integrated Systems Model

An important aspect of any IWRP study is the ability to analyze alternatives in an integrated, interconnected manner. This is especially important when water, wastewater, and reclaimed water intersect in decision making. While there are numerous models and tools that can be used to evaluate IWRP alternatives, "systems models" have several advantages, including the following:

- Extremely customizable and integrated, allowing for all of the most pertinent systems or parts of systems to be accounted for
- Ability to simulate demands, supplies, major system constraints, costs and other metrics in a comprehensive manner
- Highly visual, with built-in graphics, and performance indicators for on-the-fly simulations
- Quick run time, facilitating systems learning and exploration of "what-if" analyses

2.3.1 Systems Model Software Selection

At the beginning of the IWRP Project, a thorough evaluation of various systems models and customized spreadsheet tools were evaluated for JEA. Based on the needs of the project, software cost, and flexibility, the systems model STELLA (Systems Thinking Experimental Learning Laboratory with Animation) was selected for this project. STELLA is a dynamic and graphical systems model that uses object-oriented programming to develop virtually any type of system (e.g., physical, biological, financial, facilities) or multiple systems. It is frequently used in environmental engineering studies to better understand the implications of decisions across a broad array of physical, social and environmental sectors that are essential for integrated water resource planning.

STELLA allows users to model physical flow systems with operations or planning level resolution. An on-screen control interface is then developed that facilitates rapid adjustments of system variables for alternatives and sensitivity analysis. STELLA does not make decisions, but is used to generate information and promote more informed and balanced decisions via rapid comparison of the performance of alternatives using physical, environmental, and economic metrics. Its ability to include multi-sectoral interests in an analytical framework is what distinguishes it from more traditional hydraulic or numeric groundwater models, which evaluate systems in a purely one-dimensional physical setting. While systems models are not typically used to model detailed hydraulics or complex water allocations and surface hydrology, they excel at quickly simulating multiple systems in a very comprehensive manner. The model selection process is outlined in **Appendix B** and the economic modeling methodology is documented in **Appendix C**.

2.3.2 System Attributes

To facilitate the programming of the systems model, a conceptual schematic of JEA's water system was developed (see **Figure 2-2**). In this figure, the size of the circles represents the relative size of water demand and CUP allocation in 2036. As shown in the figure, the North and South Grids represent the majority of the system water demands. A range of low, medium and high demand projections are included for each grid. These demands are met first by the CUP allocation allowed per grid and then by any of the selected additional supply options or demand management options.

The systems model is run for a 25-year planning period from 2012 to 2035, allowing factors such as demand or the availability of supply sources to change over time. Generally, data are input into the model as annual numbers, with seasonal factors applied to generate monthly values (the seasonal peaking factors are described in **Appendix D)**.

The planned capacity and projected use of the reclaimed water system is also tracked within the model and constrained by the total wastewater available. **Table 2-2** shows the current and future projections for this system.

Table 2-2 Wastewater and Reclaimed Water System Projections

	Year	North Grid	South Grid	Ponce de Leon	Ponte Vedra	Nassau
Wastewater Projections (mgd)	2012	42.29	30.21	0.62	0.09	0.87
	2035	60.41	39.85	0.63	0.14	1.47
Reclaimed Plant Capacity (mgd)	2012	13.5	14.7	0.24	0.8	1.55
	2035	17.5	38.7	0.24	0.8	1.55
Reclaimed Demand Projections (mgd)	2012	5.44	6.5	0.08	0.53	0.89
	2035	12.69	30.06	0.08	0.53	0.89

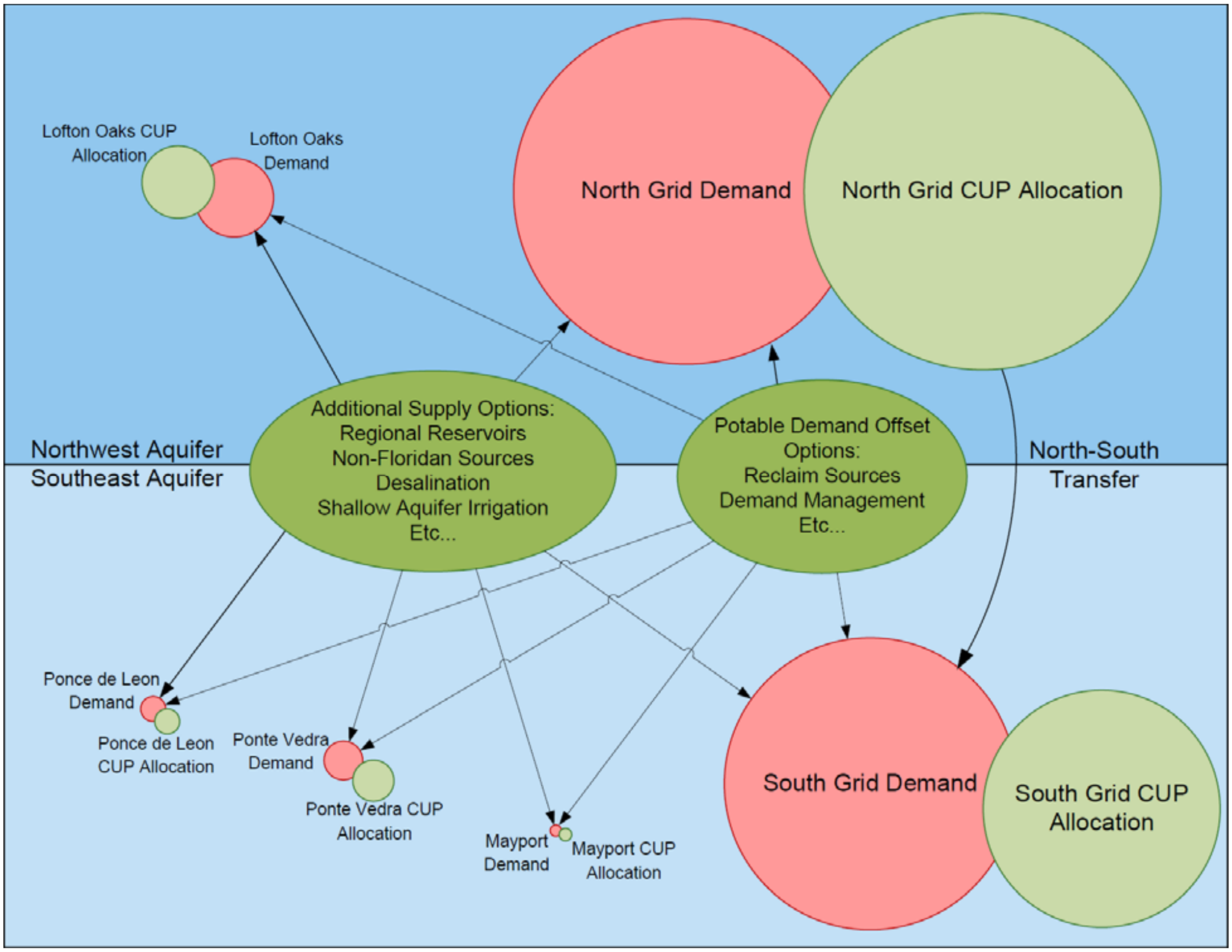


Figure 2-2
Modeled System Schematic, Based on Demands and CUP Allocations in 2036

The systems model is set-up to be operated through a set of user-friendly interface management panels (see **Figure 2-3** for an example). From these panels all options can be turned on or off to build the alternatives for investigation. The navigation buttons also easily allow changes and updates to any of the project data or assumptions included within the model structure. Additionally, the user can adjust the priority order in which the water supply options are utilized. The model utilizes the water from one source to meet demand until it is exhausted and then moves on to the next source on the priority list until the demand is satisfied or no additional water supply options remain.

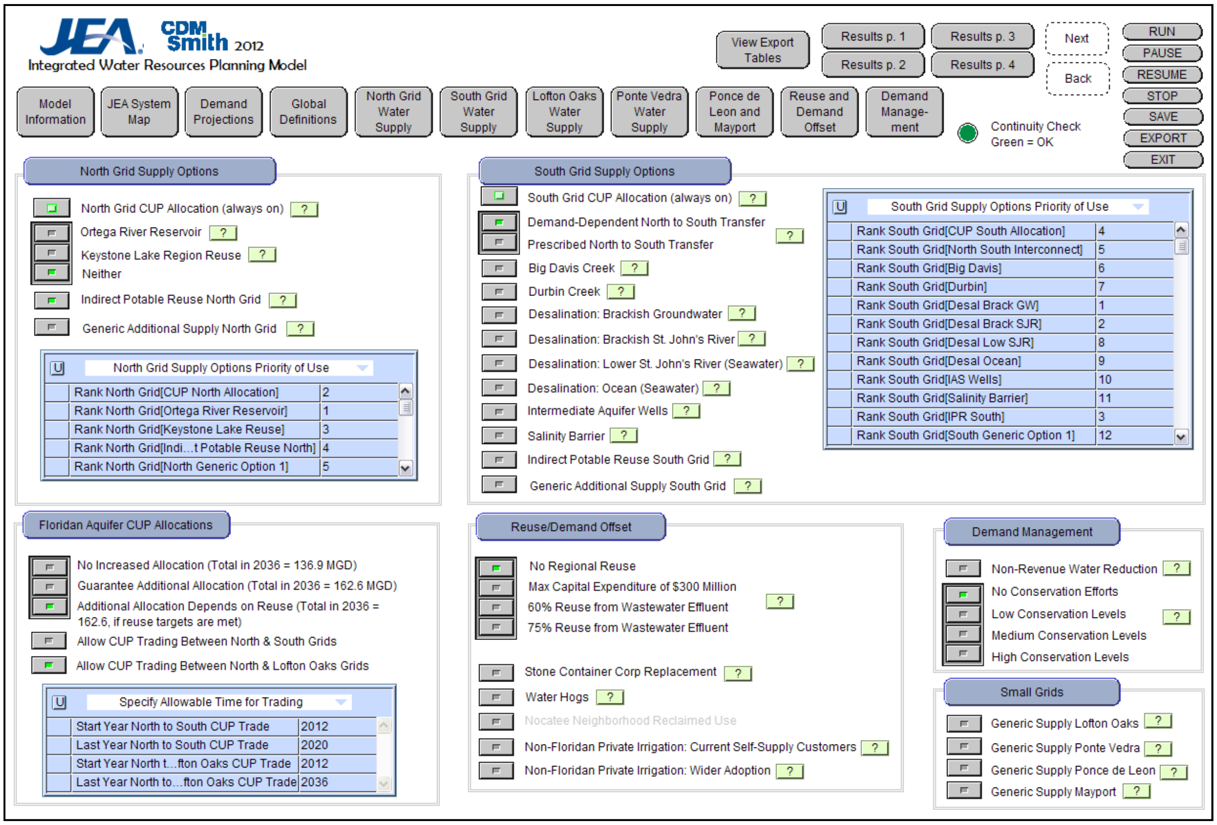


Figure 2-3
Systems Model Interface Panel

2.4 Cost Analysis Methodology

To help evaluate the projects and alternatives, an economic modeling approach was programmed into the STELLA model allowing for the tracking of all costs and reporting out in standard economic terms. Within the model, each potential option is assigned a capital costs, fixed O&M cost per year, and variable O&M cost in dollars per million gallons of water delivered. These costs came from the many planning studies JEA has conducted over the past several years on the various modeled options with all costs brought forward to 2012 dollars. Additional general economic factors used within the model are listed in **Table 2-3**. These are the starting default values based on the last 10 years of historical trends but can be easily updated within the model as desired.

Table 2-3 Default Economic Constants

Economic Factor	Value
Interest Rate	5%
Discount Rate	5%
Escalation Rate	3%
Percent of Capital Financed	50%

Within the model, the main economic tool used to compare options and alternatives is levelized cost along with the total lifecycle cost. Total lifecycle cost represents the sum of future capital costs (plus financing) and O&M costs brought back to present value terms using a discount rate. Levelized cost takes into account both the time value of money and the beneficial water supply that is provided by JEA, and is expressed as a unit cost (dollars per million gallons). Beneficial water supply is the amount of water that is needed as opposed to just the capacity of supply that can be produced. Levelized costs are a proxy for potential rate impacts to JEA's customers. Additional details regarding the cost analysis methodology can be found in Appendix C.

2.5 Ranking Methodology

The systems model will produce raw output of various quantitative metrics. In addition, there are qualitative metrics that are important to consider in the overall ranking of alternatives. Both of these types of metrics are rolled up to the primary objectives shown in Table 2-1. Tying these metrics and objectives together are weightings of relative importance. To facilitate the ranking of alternatives, a decision software tool called Criterium Decision Plus (CDP), developed by InfoHarvest, was utilized. CDP uses a method called multi-attribute rating to convert raw performance metrics (both quantitative and qualitative) into standardized scores (removing units such as dollars for cost or mgd for water supply), and then applies relative weights in order to compare and rank alternatives. **Figure 2-4** summarizes the multi-attribute rating approach used by CDP, which is summarized below.

- Step 1 compares the raw performance metric of a given objective for all the alternatives being evaluated. In this example, Alternative 6 has a raw cost (or performance) of $10 million.
- Step 2 standardizes the raw performance metric for each objective into comparable numeric scores (the higher the score the better the performance). In this example, Alternative 6 has relatively high costs when compared to the other alternatives, so the standardized score for this objective (between 0 and 10) is 3.4, a fairly low performance.
- Steps 3 and 4 calculate the partial score for the alternative, based on the standardized score and the relative weight for the objective being calculated. In this example, the cost objective was given a weight of 9 percent (out of a possible 100 percent). The partial score for this objective represents the standardized score (3.4) multiplied by the objective weight (0.09), which equals 0.306.
- Step 5 plots the partial score of 0.306 for Alternative 6, and this procedure repeats for all of the other objectives for Alternative 6 until a total score for the project is calculated [see Step 6]. The process is repeated for all alternatives so they can be compared and ranked.

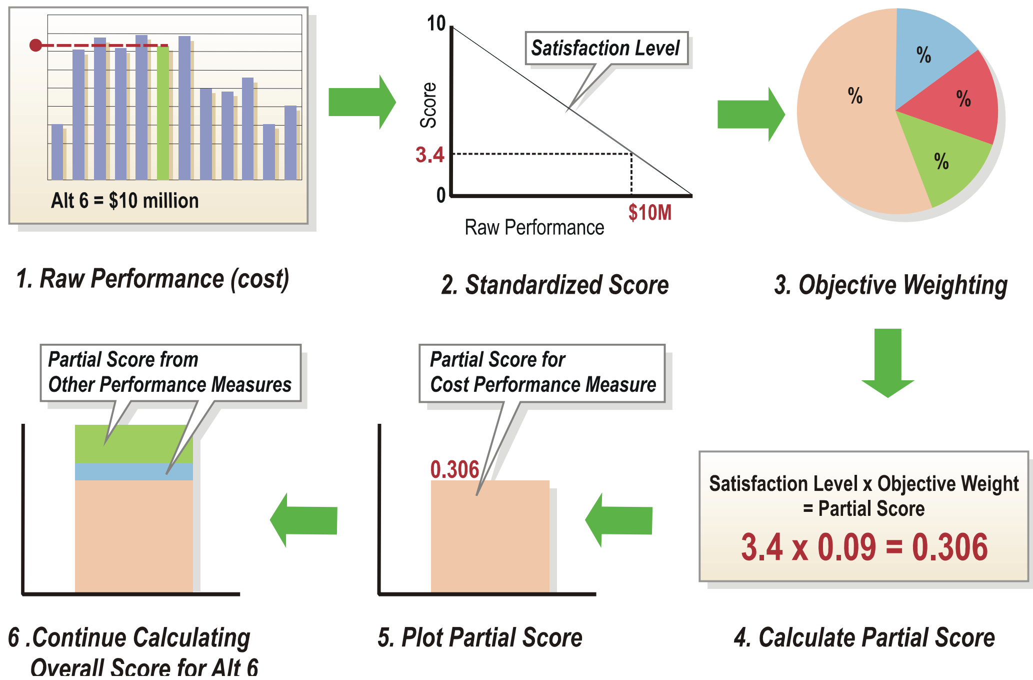


Figure 2-4
Multi-Attribute Rating Method

Section 3

Potential Options and Projects

Potential options to meet future water demands were split into the three broad categories: (1) water supply options, (2) water reuse options, and (3) demand management options. The options modeled within each of these categories are listed in **Table 3-1** and are described in the following sections, along with assumptions made about the current system operations. Each of these options has been previously studied and information concerning the configuration, potential yield, constraints and costs were taken from previous reports for incorporation into the model. Additional detail on all the options and references to the source reports can be found in Appendix D.

Table 3-1 Summary of Options for JEA IWRP Project

Water Supply Options	Water Reuse Options	Demand Management Options
▪ CUP Allocations ▪ Regional Surface Water Reservoirs on either Ortega River, Big Davis Creek, or Durbin Creek ▪ Non-Floridan Private Irrigation Promotion for either current self supply customers or for wider adoptions ▪ Desalination of either brackish groundwater, brackish St. Johns River water, lower St. Johns River water or the ocean. ▪ Intermediate Aquifer Wells	▪ Indirect Potable Reuse ▪ Keystone Lake Regional Reuse ▪ Regional Reuse throughout the whole St. Johns River Water Management District ▪ Targeted Reuse focusing on either the Stone Container Corporation, creation of a South Grid Salinity barrier, or providing reclaimed water to identified 'Water Hogs'.	▪ Conservation ▪ Reduction of unaccounted for water

As an additional way to assess future supply options, generic projects were programmed into the systems model. Each generic option is treated as a new supply options. The user can specify the amount of supply yield, capital cost, fixed O&M cost, variable O&M cost, start year, project life, and finance terms.

The generic supply options, however, are stand alone and do not currently interact with other model features (such as reliance on other facilities or system constraints). For example, the supply will not be checked against reclaimed capacity nor will the supply go toward meeting the reclaimed requirements to increase the CUP allocation. This can be updated later as additional options become better defined.

3.1 JEA Current System Assumptions

Within the model, options selected build upon JEA's current water supply system. It was important to accurately represent the constraints of this system as well as the operating costs to understand the best way alternatives compare to the baseline condition of no action. Assumptions used in modeling the current JEA system are described below.

- The CUP outlines the total volume which can be withdrawn from the Floridan aquifer each year. However, within the permit are a series of conditions affecting the CUP allocation. Values within the CUP provide the total volume allowable per year per wellfield. The values provided for 2011 through 2021 are used as the baseline allocation for each grid. After 2021 the allocation is held constant pursuant to condition 12 of the permit which does not allow for an increase in the allocation unless additional requirements are met. One of these requirements is the amount of reclaimed water provided for reuse. An exemption to meeting these reclaimed water targets is provided in condition 38: “except to the extent the permittee demonstrates that some portion of the amount of reuse required below is not economically, environmentally, or technologically feasible.” To account for these conditions and exceptions, the model has a series of choices for how the CUP allocations can be handled:
  - **No increased allocation**: This option can be selected to maintain the allocation at the baseline conditions.
  - **Guarantee additional allocation**: This option automatically provides the increase in allocation independent of reclaimed water availability and usage.
  - **Additional allocation depends on reuse**: Within this option the amount of reclaimed water made available by JEA is compared to the targets and the CUP allocation is not increased until the targets are met.
- Another condition of the CUP allows for individual wellfields to surpass their allocation by 20 percent as long as the total system allocation is not exceeded. Within the model, there is an option to allow this internal system trading between the North and South Grids or between the North and Lofton Oaks Grids between specified years to help meet grid specific deficits. There is no cost assigned to this option.
- The amount of groundwater supplied to each grid is constrained by the CUP allocation but also by the physical limits of the system either at the wellfields or the water treatment plants. Constraints used within the model can be found in the CUP Allocation Factsheet within Appendix D. Under the currently modeled conditions, the CUP allocations remain more restrictive than any of the physical system constraints.
- It is assumed that 30 percent of JEA’s total reported operating costs for water and sewer are spent on water withdrawal, treatment and distribution. A higher percentage of the costs were attributed to sewer over water due to an assumed higher cost for wastewater treatment compared to treatment of a relatively clean groundwater source to drinking water quality. Based on an average of 2010 and 2011 data this equates to $74,355,000 in O&M per year for the water system. Within the model $0.43 per 1000 gallons (or $430 per million gallons) is assumed to be variable O&M based on the total water produced. This leaves $55,484,000 per year as a fixed O&M cost for running the existing water system.
- It was assumed that 50 percent of JEA’s current debt financing could be attributed to the water system. Taking the average of annual debt service for 2010 and 2011 this was $62,000,000 per year.
- Another component of the current system is the ability to move water from the North Grid to the South Grid through a pipeline river crossing. The flow through this interconnect can be handled in the model in two different ways. It can either be assigned volume per year or the

model can determine the amount needed based on the remaining demand in the South Grid but with the constraint of not exceeding the hydraulic capacity of the pipeline. Based on JEA provided data, the cost for utilizing the interconnect is $132 per million gallons for average annual transfers less than or equal to 15 mgd and $148 per million gallons for average annual transfers above 15 mgd.

3.2 Water Supply Options

An overview of the water supply options is provided in **Table 3-2** with a short summary of the options in the following subsections and additional detail available in Appendix D.

Table 3-2 Water Supply Options

Option	Sub-Options	Included Items	Yield (mgd)	Capital (total)	Fixed O&M per Year	Variable O&M ($/MG)
Regional Surface Water Reservoirs	Ortega	River diversion, dam, reservoir, treatment plant, land, connection to distribution system	6.7	$56,000,000	$2,100,000	$572
	Big Davis		1.3	$23,000,000	$660,000	$927
	Durbin		3.4	$38,700,000	$1,260,000	$677
Non-Floridan Private Irrigation	Current Self Supply	Subsidized shallow wells	4.4	$2,130,000	$0	$0
	Wider Adoption	Partially subsidized shallow wells	15	$18,500,000	$0	$0
Desalination	Brackish Groundwater	Intake, Treatment, Concentrate Disposal, Connection to the Distribution System	5	$43,100,000	$520,000	$1,140
			15	$88,800,000	$1,160,000	$847
			30	$136,000,000	$1,940,000	$709
			50	$207,000,000	$2,840,000	$622
	Brackish St. John's River Water		5	$85,500,000	$640,000	$1,403
			15	$160,000,000	$1,540,000	$1,125
			30	$238,000,000	$2,700,000	$986
			50	$335,000,000	$4,060,000	$890
	Lower St. John's River (Seawater)		5	$173,000,000	$1,120,000	$2,455
			15	$352,000,000	$2,800,000	$2,046
			30	$562,000,000	$5,320,000	$1,943
			50	$795,000,000	$8,680,000	$1,902
	Ocean (Seawater)		5	$185,000,000	$1,120,000	$2,455
			15	$376,000,000	$2,800,000	$2,046
			30	$590,000,000	$5,320,000	$1,943
			50	$825,000,000	$8,680,000	$1,902
Intermediate Aquifer Wells		New wells co-located at existing wellfields	5	$1,950,000	$28,000	$61

Note: Costs from 2010 AWS Study were escalated to 2012 dollars

3.2.1 Regional Surface Water Reservoirs

This option consists of construction of an off-line storage reservoir on a tributary to the St. Johns River to store wet weather flow to be treated and used as potable supply. Three locations have been carried forward for consideration including Ortega River, Big Davis Creek, and Durbin Creek. Using the Ortega

River location has the potential to provide 6.7 mgd to the North Grid, the Big Davis Creek location can provide 1.3 mgd to the South Grid, and the Durbin Creek location can provide 3.4 mgd also to the South Grid.

3.2.2 Non-Floridan Private Irrigation

This option consists of construction of groundwater wells either in the surficial aquifer or the intermediate aquifer in order to supply irrigation water to private residences. This use would replace the Floridan aquifer supply currently being used to meet those demands. Two options are proposed: (1) converting those already on self-supply from the Floridan aquifer to a different aquifer, and (2) wider scale adoption by moving current JEA customers to private irrigation wells. This supply source is available within the model to all grids.

3.2.3 Desalination

This option consists of desalination to produce a new source of potable water supply. Four different desalination options are considered: (1) extraction of brackish groundwater from the Lower Floridan aquifer, (2) withdrawing brackish river water from the upper St. Johns River, (3) withdrawing seawater-quality influent from the lower St. Johns River, or (4) withdrawing seawater from the ocean. All options could be sized to accommodate various treatment capacities. Options of 5, 15, 30 and 50 mgd are provided with costing within the model. All options are modeled to meet demand in the South Grid only.

3.2.4 Intermediate Aquifer Wells

This option consists of construction of wells or a wellfield targeting the intermediate aquifer as the source of supply for potable or irrigation use. The intermediate aquifer is a hydrogeologic unit that separates the higher surficial aquifer system from the Floridan aquifer system where currently the majority of water is withdrawn. The middle of the South Grid area was determined to be the best target for exploration of this source and new wells could hopefully be co-located at existing wellfields to diminish additional piping needs. A total yield of 5 mgd ramping up over time as the new source is investigated is included as a supply option within the model for the South Grid.

3.3 Water Reuse Options

An overview of the water reuse options is provided in **Table 3-3** with a short summary of the options in the following subsections and additional detail available in Appendix D.

Table 3-3 Water Reuse Options

Option	Sub-Options	Included Items	Yield (mgd)	Capital (total)	Fixed O&M per Year	Variable O&M ($/MG)
Indirect Potable Reuse	North Grid	Direct injection wells and process upgrades to wastewater treatment plants	5	$98,000,000	$1,280,000	$1,052
			15	$175,700,000	$3,080,000	$844
			30	$295,800,000	$5,400,000	$740
			50	$587,800,000	$8,120,000	$667
	South Grid		5	$101,600,000	$1,280,000	$1,052
			15	$182,700,000	$3,080,000	$844
			30	$309,800,000	$5,400,000	$740
			50	$498,300,000	$8,120,000	$667
Keystone Lake Region Reuse		Direct injection wells, process upgrades to wastewater treatment plant, Ortega Reservoir Construction with surface water treatment plant	15	$177,500,000	$2,000,000	$365
Regional Reuse	$300 Mil Max	Treatment plant expansions, pump stations, pipeline, storage, rapid infiltration basins	23	$157,400,000	$2,200,000	$262
	60% Reuse		41	$302,200,000	$3,700,000	$247
	75% Reuse		56	$479,000,000	$4,950,000	$242
Targeted Reuse	Stone Container Corp	new reclaimed water line	3.3	$27,600,000	$250,000	$232
	Salinity Barrier	new reclaimed water line and injection wells	5	$94,000,000	$276,000	$227
	Water Hogs	Install new reclaimed water infrastructure	1.05	$20,000,000	$300,000	$78

3.3.1 Indirect Potable Reuse

This option consists of treating wastewater effluent from one or more of JEA's large wastewater treatment facilities to meet the requirements for indirect potable reuse or groundwater recharge. The reclaimed water produced from this type of facility would be used to directly recharge the Floridan aquifer. Treatment capacities of 5, 15, 30, and 50 mgd are included within the model for both the north and South Grids.

3.3.2 Keystone Lake Regional Reuse

This option consists of using reclaimed water from the Southwest WWTP to directly recharge the Floridan aquifer through direct injection. It is likely that there may not be sufficient reclaimed water available for recharge exclusively from the Southwest WWTP since average wastewater flows at this facility (as of December 2010) were approximately 8.8 mgd. Therefore, it may be possible to augment the reclaimed water supply with surface water from the Ortega River, which is located in close proximity to this facility to increase the total available reuse to 15 mgd. Within the model, this option is only available to the North Grid and cannot be combined with the regional surface water reservoir on the Ortega River.

3.3.3 Regional Reuse

This option increases the supply of available reclaimed water throughout the entire St. Johns River Water Management District. Three different scales of options are considered: (1) increasing reclaimed water availability with a max capital expenditure of $300 million; (2) achieving 60 percent reuse from wastewater effluent; and (3) achieving 75 percent reuse from wastewater effluent.

3.3.4 Targeted Reuse

This option consists of using available reclaimed water for the specific targeted uses such as:

- Replacing the Stone Container Corporation use of potable water for reclaimed water in their commercial processes. The nearest reclaimed water pipeline is served from the Cedar Bay facility, which currently has 3.3 mgd potentially available for use. This option is modeled to provide a potable offset of 3.3 mgd in the North Grid.
- Use of reclaimed water from the Arlington East Water Reclamation Facility for groundwater salinity management in the South Grid. This option is modeled to provide a potable offset of 5 mgd.
- Providing reclaimed water to large residential users or 'water hogs' in the South Grid for irrigation. Bringing reclaimed water to the four high use areas of Queen's Harbor, Deerwood, Hidden Hills and Glen Kernan would provide a potable offset of 1.05 mgd in the South Grid.

3.4 Demand Management Options

An overview of the demand management options is provided in **Table 3-4** with a short summary of the options in the following subsections and additional detail available in Appendix D.

Table 3-4 Demand Management Options

Option	Sub-Options	Included Items	Yield (mgd)	Capital (total)	Fixed O&M per Year	Variable O&M ($/MG)
Conservation	Low	Lost revenue	6.74	$0	$500,000	$0
	Medium		10.22	$0	$750,000	$0
	High		13.47	$0	$1,000,000	$0
Reduce Unaccounted for Water		Leak detection Program, repairs	8.9	$5,000,000	$1,000,000	$0

3.4.1 Conservation

This option involves reducing demand through conservation efforts. Within the model the proposed conservation targets in the CUP were taken as the medium conservation scenario, with lower and higher conservation options created as sub-options. Conservation is split proportionately across all grids based on demand. It should be noted, while conservation reduces demand, and therefore total lifecycle costs, it also reduces revenues for JEA. Thus, when growth is high and the marginal cost of new water supplies is also high, conservation will have a net positive on levelized costs (dollars per million gallons of water sold by JEA). But when growth is not high or the marginal cost of new water is lower, conservation will have a net negative impact on levelized cost.

3.4.2 Reduce Unaccounted for Water

This option reduces unaccounted for water within the current system through a leak reduction program. Data from 2011 show 17.9 mgd of system losses. Assuming that half of the losses can be addressed through leak reduction programs, there would be 8.9 mgd in water savings. However, 5 mgd was considered a more reasonable goal and is the initial default value within the model. Currently this value is split with 80 percent of the savings in the North Grid and 20 percent of the savings in the South Grid.

Section 4

Evaluation of Illustrative Alternatives

In order to demonstrate the IWRP process, illustrative alternatives were developed. These illustrative alternatives should not be interpreted as recommendations being made or accepted by CDM Smith Inc. or JEA. Rather, they were developed for the sole purpose of testing the systems model, analysis approach and ranking method. While they may offer JEA insights as to which options may have merits, they are for illustrative purposes only.

4.1 Developing Illustrative Alternatives

To develop these illustrative alternatives, several options were chosen from the list of projects described in Section 3. During a JEA workshop, several themed-alternatives were initially developed and then expanded to include the following:

1. No New Options – This is the status quo or baseline alternative. Water is supplied solely from the Floridan Aquifer by way of the CUP. The planned North to South Grid transfer capacity and costs are included in this alternative.

2. Low Cost – In addition to the planned North to South Grid transfer capacity, up to an additional 5 mgd of supply is provided from intermediate aquifer supply wells (IAS wells). Targeted reuse expansion options and additional water conservation are included to offset potable water demand.

3. High Reliability with Groundwater Desalination – This alternative includes all options included in the Low Cost alternative, and adds the construction of a 30 mgd desalination plant to treat brackish groundwater.

4. High Reliability with Surface Water Desalination - This alternative is similar to No. 3 above, but uses Brackish St. Johns River as the source for desalination to test the scoring mechanism's sensitivity to surface water versus groundwater sources.

5. High Reliability with Indirect Potable Reuse (IPR) – This alternative is similar to No. 3 and No. 4 above, but relies on IPR in the South Grid instead of a desalination source.

Table 4-1 lists the options that are included in each of the illustrative alternatives.

Table 4-1 Illustrative Alternatives

Alternative Name	Options Included
No Options	CUP Allocations
	Planned North to South Grid Transfer Capacity
	Baseline Conservation
Low Cost	CUP Allocations
	Planned North to South Grid Transfer Capacity
	Baseline Conservation
	Intermediate Aquifer Supply Wells
	Targeted Reuse (Stone Container Corp. and Water Hogs Program)
High Reliability with Groundwater Desalination	CUP Allocations
	Planned North to South Grid Transfer Capacity
	Baseline Conservation
	Intermediate Aquifer Supply Wells
	Targeted Reuse (Stone Container Corp. and Water Hogs Program)
	Brackish Groundwater Desalination
High Reliability with Surface Water Desalination	CUP Allocations
	Planned North to South Grid Transfer Capacity
	Baseline Conservation
	Intermediate Aquifer Supply Wells
	Targeted Reuse (Stone Container Corp. and Water Hogs Program)
	Brackish St. Johns River Desalination
High Reliability with Indirect Potable Reuse	CUP Allocations
	Planned North to South Grid Transfer Capacity
	Baseline Conservation
	Intermediate Aquifer Supply Wells
	Targeted Reuse (Stone Container Corp. and Water Hogs Program)
	Indirect Potable Reuse in South Grid

Any of the options described in Section 3 can be combined into an alternative and modeled. Within the model interface, the user can see traces of surpluses and deficits, volumes of supplies provided from each source, and statistics describing the reliability and cost of the alternative model run. The model results can also be exported to a spreadsheet that is set up to display the annual supply volume by source, the 12-month running average supply volume by source, and the scoring results described in the next section. The export spreadsheet displays a plot of the annual supply used from each source through the planning period. **Figure 4-1** shows an example of these plots for the High Reliability with Indirect Potable Reuse alternative, for the North and South Grids. The projected demand is shown with a dashed gray line. The adjusted demand, after conservation, potable offsets, or additional demands added, is shown as a solid black line. Each supply source is shown in a different color and the supply volumes are stacked to show how the total of all supplies meets or falls short of demand. The North to South Grid transfer volume is shown as a demand on the North Grid, causing the adjusted demand to be significantly greater than the projected demand. The transfer volume—which is effectively North Grid CUP supply moved to the South Grid—is shown in green on the South Grid plot.

These plots show that, for the illustrative alternative with indirect potable reuse in the South Grid, demands are met until 2024, when competing uses for reuse water result in a decrease of available indirect potable reuse.

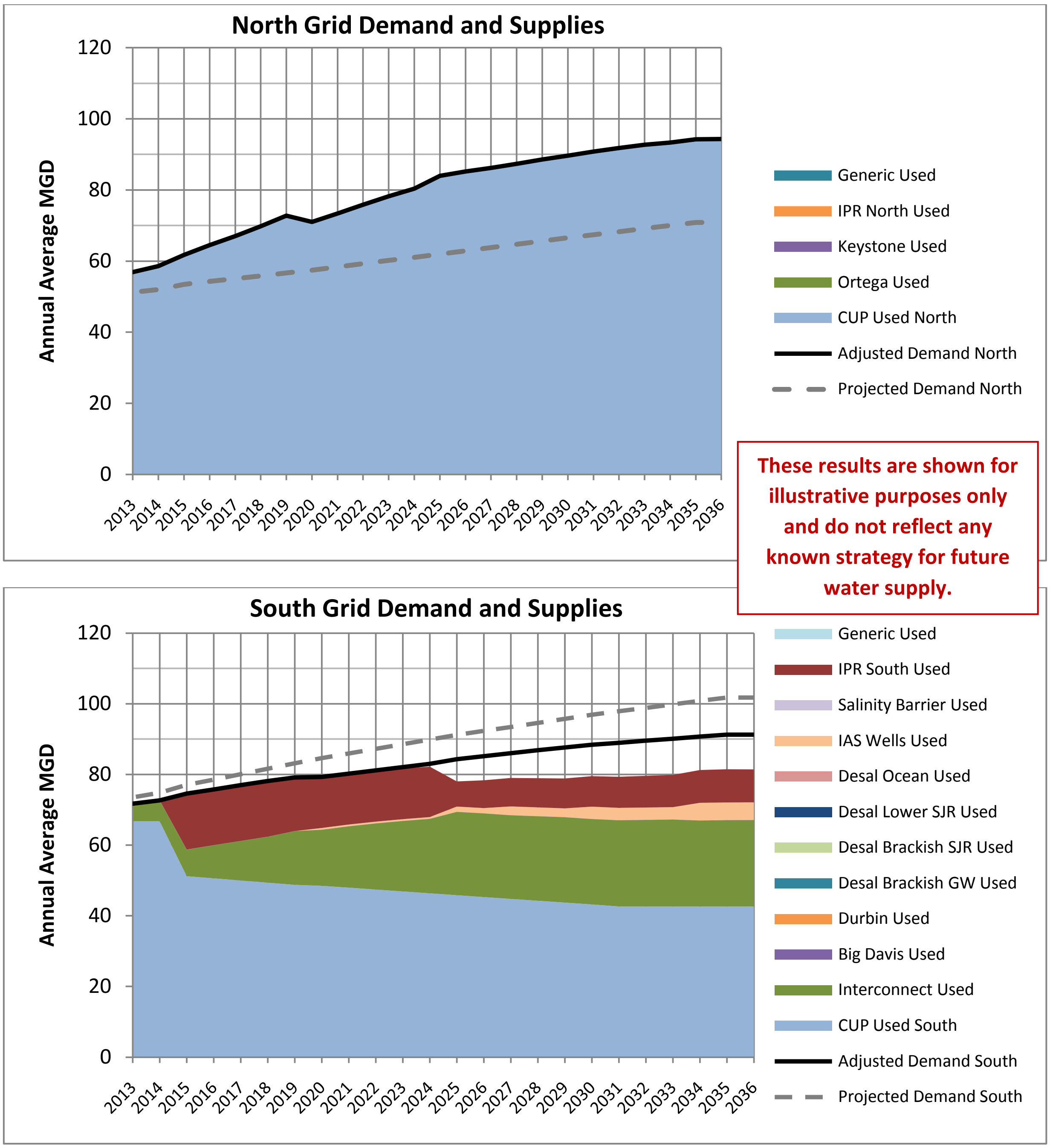


Figure 4-1
Example Model Export for Illustrative Alternative

4.2 Summary of Performance Measures

Performance measures were assigned to each IWRP Project objective to evaluate numerically how each illustrative alternative met the objective. The performance measures were either scored quantitatively using the integrated system model, or qualitatively by comparatively ranking project options. Each performance measure receives two weights: one reflecting the relative importance of its associated objective, and a second reflecting the relative importance of the performance measure compared with others associated with the same objective. The baseline scenario for scoring the illustrative alternatives used equal weights for all of the objectives (although subweights for the performance measures varied). Below is a description of each performance measure.

4.2.1 Quantitative Performance Measures

Table 4-2 lists the performance measures that were evaluated quantitatively using the integrated system model. The table lists the associated objective, the weight of the performance measure within its objective, the units by which to measure the objective, if a better score is higher or lower, and the range of expected scores.

Table 4-2 Quantitative Performance Measures

Objective	Weight	Performance Measure	Sub-Weight	Units	Better Scores Are	Range
Maximize Cost-Effectiveness	0.167	Total customer lifecycle costs	0.4	2012 dollars (billions)	lower	3.5 – 4.5
		JEA levelized costs	0.4	2012 dollars per million gallon	lower	3,000-4,000
		Ratio of JEA fixed costs to JEA total costs	0.2	Fixed costs/total costs	lower	0.0-1.0
Reliably Meet Water Demands	0.167	Magnitude of water shortage	0.6	Million gallons	lower	0-140,000
		Time of water shortage	0.4	% of months showing deficit > 5%	lower	0-100
Maximize Flexibility	0.167	Operational flexibility	0.5	% of months showing South Grid deficit >5%	lower	0-100
		Diversity of supply	0.5	% supply remaining after removing top source	higher	0-100
Promote Environmental Sustainability	0.167	Aquifer sustainability	0.5	% supplies not from Floridan Aquifer	higher	0-50
		Water use efficiency	0.4	% demand reduced by conservation/reuse	higher	0-50
		River impacts	0.1	% supply from surface water	lower	0-50

4.2.2 Qualitative Performance Measures

The qualitative performance measures could not be scored using the integrated system model. In order to dynamically score any alternative (beyond the five illustrative examples presented herein) each option was given a qualitative score, and a composite score was calculated based on the volume of supply for the option. The qualitative scores all range from one to five, with five being the best score. An example of the qualitative scoring procedure is shown on **Figure 4-2**.

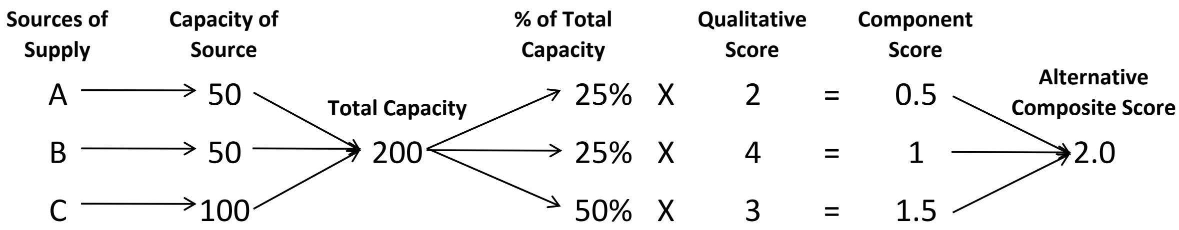


Figure 4-2
Example Qualitative Scoring Procedure for a Single Performance Measure

Table 4-3 lists the performance measures that were evaluated qualitatively. The table lists the associated objective, the weight of the performance measure within its objective, the units by which to measure the objective, if a better score is higher or lower, and the range of expected scores.

Table 4-3 Qualitative Performance Measures

Objective	Weight	Performance Measure	Sub-Weight	Units	Better Scores Are	Range
Maximize Implementation	0.167	Reliance on proven technology[1]	0.4	Qualitative score of 1 to 5, 1 - unproven technology, 5 - common technology	higher	1-5
		Ability to permit[1]	0.4	Qualitative score of 1 to 5, 1 - difficult to permit, 5 - no permitting hurdles	higher	1-5
		Public acceptance[1]	0.2	Qualitative score of 1 to 5, 1 - unlikely public acceptance, 5 - no new public acceptance needed	higher	1-5
Meet Customer Water Quality	0.167	Water quality blending/secondary water quality[2]	1.0	Qualitative score of 1 to 5, 1 - difficult to blend sources 5 - no blending challenges	higher	1-5

1 – Uses total available supply capacity for calculation of composite performance measure
2 – Uses only volume that is used for supply for calculation of composite performance measure

Table 4-4 lists all of the assigned qualitative scores for the water supply options.

Table 4-4 Qualitative Scores for Supply Options

Option	Reliance on Proven Technology	Ability to Permit	Public Acceptance	Water Quality Blending/Secondary Water Quality
North Grid Supplies				
CUP North Grid	5	5	5	5
Ortega River Reservoir	4	3	3	4
Keystone Lake Reuse	2	1	1	4
Indirect Potable Reuse North Grid	2	1	1	3
South Grid Supplies				
CUP South Grid	5	5	5	5
Big Davis Creek Reservoir	4	3	3	4
Durbin Creek Reservoir	4	3	3	4
Desalination Brackish Groundwater	2	1	5	2
Desalination Brackish St. Johns River	2	1	5	2
Desalination Lower St. Johns River	2	1	5	1
Desalination Ocean Supply	2	1	5	1
Intermediate Aquifer Supply Wells	3	3	3	5
Salinity Barrier	4	3	1	5
Indirect Potable Reuse South Grid	2	1	1	5
Lofton Oaks Supplies				
CUP Lofton Oaks Grid	5	5	5	5
Ponte Vedra Grid Supplies				
CUP Ponte Vedra Grid	5	5	5	5
Ponce de Leon Grid Supplies				
CUP Ponce de Leon Grid	5	5	5	5
Mayport Grid Supplies				
CUP Mayport Grid	5	5	5	5

Table 4-5 summarizes all of the performance metrics for each alternative.

Table 4-5 Performance Measure Scores for Illustrative Alternatives

Objective	Performance Measure	Units	Better Scores Are:	Range	No Options	Low Cost	High Reliability + Ground-water Desal	High Reliability + Surface Water Desal	High Reliability + Reuse
Maximize Cost-Effectiveness	Total customer lifecycle costs	2012 dollars (billions)	lower	3.5-4.5	$3.56	$3.61	$3.83	$4.00	$4.07
	JEA levelized costs	2012 dollars per million gallon	lower	3,000-4,000	$3,572	$3,568	$3,628	$3,784	$3,900
	Ratio of JEA fixed costs to JEA total costs	Fixed costs/total costs	lower	0.0-1.0	0.774	0.779	0.774	0.768	0.793
Reliably Meet Water Demands	Magnitude of water shortage	Million gallons	lower	0-140,000	111,283	91,578	10,186	10,186	39,048
	Time of water shortage	% of months showing deficit > 5%	lower	0-100	56.1	48.5	0.3	0.3	24.6
Maximize Flexibility	Operational flexibility	% of months showing South Grid deficit >5%	lower	0-100	86.4	81.7	19.6	19.6	34.9
	Diversity of supply	% supply remaining after removing top source	higher	0-100	0	1	15	15	8
Promote Environmental Sustainability	Aquifer sustainability	% supplies not from Floridan Aquifer	higher	0-50	0.0	3.0	14.2	14.2	8.7
	Water use efficiency	% demand reduced by conservation/reuse	higher	0-50	3.7	5.4	5.4	5.4	5.4
	River impacts	% supply from surface water	lower	0-50	0	0	0	14	0
Maximize Implementation	*Reliance on proven technology*	Qualitative score of 1 to 5	higher	1-5	5.0	4.9	3.8	3.8	4.3
	Ability to permit	Qualitative score of 1 to 5	higher	1-5	5.0	4.9	3.4	3.4	4.1
	Public acceptance	Qualitative score of 1 to 5	higher	1-5	5.0	4.9	4.9	4.9	4.1
Meet Customer Water Quality	*Water quality blending/secondary water quality*	Qualitative score of 1 to 5	higher	1-5	5.0	5.0	4.6	4.6	4.9

4.3 Ranking of Illustrative Alternatives

4.3.1 Ranking Procedure

The performance measures listed in **Tables 4-2** and **4-3** were scored for each illustrative alternative. The decision software program CDP was used to perform the scorecard analysis, which involves standardizing the raw performance measure scores, applying the objective weights and performance measure sub-weights, and ranking the alternatives based on the aggregate scores across all objectives. CDP is a visual tool with multiple ways of displaying results.

Goals, objectives, performance measures, and weights are input into CDP. To rank alternatives raw portfolio scores for each performance measure are also input to CDP. Each score is standardized on a linear scale from 0 to 1, with the best possible score translating to 1 and the worst possible score translating to 0. In this way, the various units in which the performance measures are quantified are eliminated, and it is possible to compare all scores. **Figure 4-3** shows an example of how the cost of an alternative is translated into a unit-less score.

A composite score for each objective was determined based on the sum of scores of its performance measures, and this score was multiplied by the weight of that objective. These values were then summed for comparison across all alternatives.

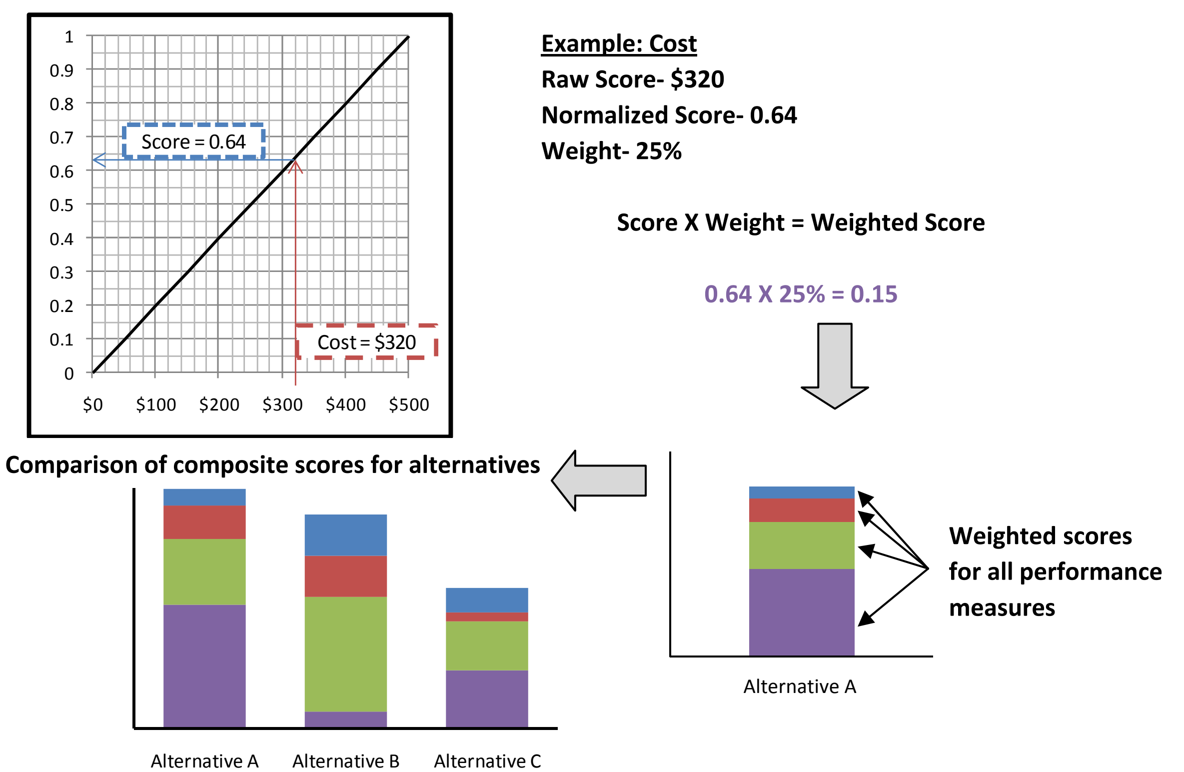


Figure 4-3
Alternative Scoring Procedure

4.3.2 Ranking Results

The five illustrative alternatives were scored using the performance measures and procedures described above. In addition to scoring the alternatives with equal weights for all objectives, various weighting scenarios were also scored to test the sensitivity of the results to objective weighting. **Figure 4-4** shows the composite scores of the illustrative alternatives. Each stacked bar represents the total score for the alternative, with the colored components representing how each alternative scores in each objective category. Theoretically, an alternative that scored perfectly in all objective categories would have a composite score of 1.0.

Based on the weights, performance measures, and model assumptions developed as part of the IWRP process, the "High Reliability with Groundwater Desalination" alternative scores the highest. The groundwater desalination scores better than surface water desalination in the cost and environmental sustainability objectives. The indirect potable reuse alternative does not score well because it is more expensive than desalination and does not achieve the same level of reliability. The "No Options" and "Low Cost" alternatives fall short in reliability and score poorly in the flexibility category. Those illustrative alternatives are less flexible because they assume JEA relies almost exclusively on the CUP allocation. Flexibility in sources is generally considered desirable in case of an unforeseen event that eliminates a major source of water.

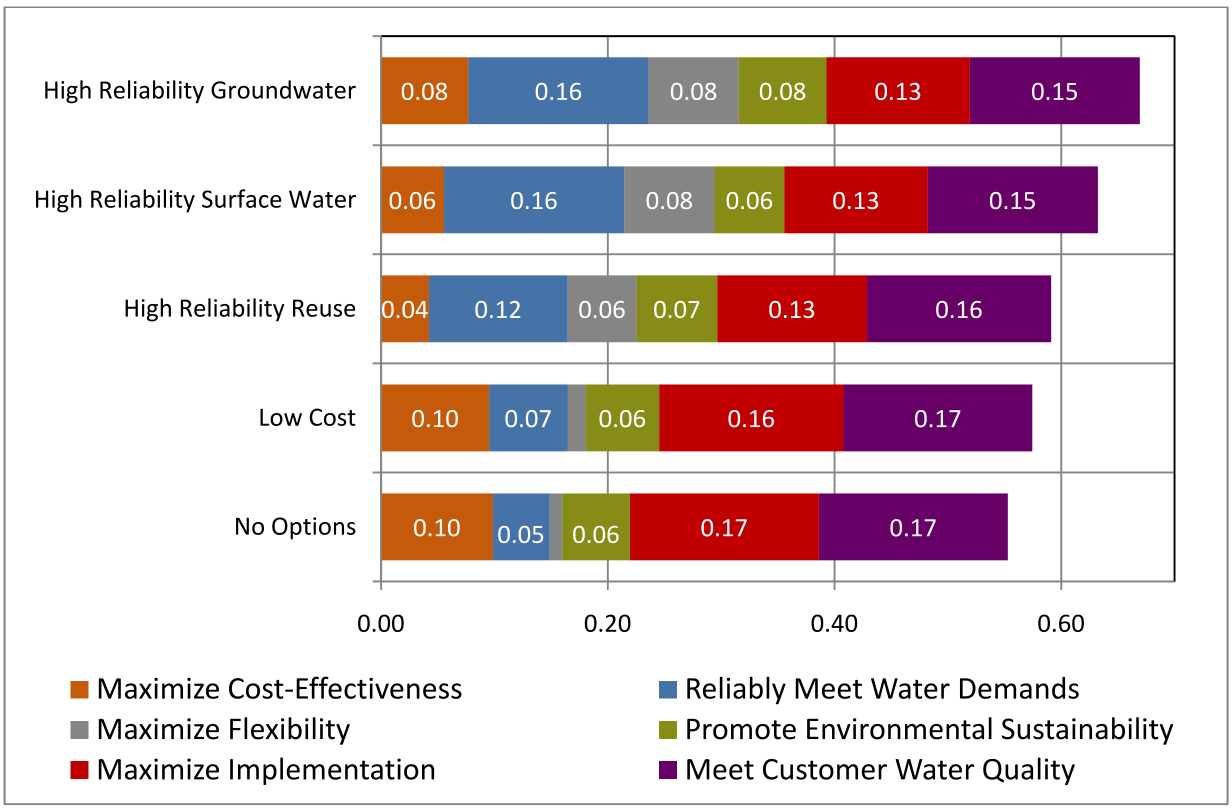


Figure 4-4
Illustrative Alternatives Scores

The objective weights were varied to study the sensitivity of the analysis to the importance placed on the top objectives: cost and reliability. **Table 4-6** shows the ranking of the illustrative alternatives using the original, equal weights, and various other weighting scenarios.

Table 4-6 Ranking of Alternatives with Different Objective Weightings (Rank of 1 is best, while Rank of 5 is worst)

Scenario	High Reliability Groundwater	High Reliability Surface Water	High Reliability Reuse	Low Cost	No Options
Baseline (equal weights, 17% each)	1	2	3	4	5
Cost = 75%, others equal	3	4	5	2	1
Reliability = 75%, others equal	1	2	3	4	5
75/25% between Cost/Reliability	1	4	5	2	3

The sensitivity analysis shows that the ranking is most sensitive to the weight of the cost effectiveness objective. The rankings change considerably when the weight of cost is increased to 75 percent of the total weight. The rank of the alternatives using this weighting scheme follows the cost of the alternative, with the No Options ranking first, following by Low Cost, then the High Reliability alternatives in order of least expensive to most. The same sensitivity test on the reliability objective, however, leaves the rankings unchanged from the baseline condition. If only cost and reliability are considered, with 75 percent of the weight going to cost and 25 percent going to reliability, the top ranking alternative remains High Reliability with Groundwater, but the Low Cost alternative jumps to second place and No Options to third (versus fourth and fifth in the baseline equal weights scenario).

The sensitivity analysis shows that the scoring algorithm—which consists of the weights, the performance measures, and the model assumptions—is most sensitive to cost. Therefore, additional efforts should be taken to establish robust cost estimates as JEA moves forward using this tool to determine a long-term water resources strategy.

Section 5

Summary and Next Steps

5.1 Summary

As the main purpose of the study was the creation of an IWRP planning process and set of tools to be used by JEA going forward, only limited conclusions could be made about the evaluation of the current system and potential future options. However, there are some important observations that can be made from this study, these being:

- While an overall future water supply deficit is predicted for the JEA system if no new options are selected, this deficit is largely present only in the South Grid and Lofton Oaks Grid. The CUP allocation is sufficient to meet the currently projected North Grid demands and those of many of the smaller grids through 2035. Thus the focus on alternative supplies should remain on those with a potential impact for the South Grid system.

- Significant water supply deficits (i.e., greater than 5 mgd) do not occur until after 2025 under a low population forecast scenario, and not until after 2015 under current or high population forecast scenarios.

- There is not always the need to move the full flow capacity through the interconnect between the North and South Grids. The optimal timing for the use of the interconnect depends on the time of year and options selected. Future optimization of the best way to utilize this infrastructure should be considered and could be performed using the system model with some modest refinement.

- The final rankings of the illustrative example were found to be fairly sensitive to cost. Thus, as JEA continues to use the model, specific attention should be paid to continuing to refine the cost of selected alternatives.

- The benefits and trade-offs between demand-side management and new supply sources greatly depend on population growth scenarios and the marginal cost of new supplies.

- The current systems model and the CDP ranking tool are an effective combination of tools to compare future water supply sources and system configurations.

5.2 Using the Model

This report demonstrated how the current systems model can be used to compare alternatives with respect to supply reliability, economic viability, and other criteria. However, the report and the planning process were not intended to yield a recommended plan for future water supply. Moving forward, JEA can use the model in two ways:

- **Planning Mode:** The model can be used exactly as demonstrated in this report to formulate alternative combinations of supply and demand management options, simulate their performance over the planning period, and compare cost, reliability, and other factors. It can also be used to form hybrid alternatives with options that seem to address or satisfy many of the specified planning objectives. In this way, a preferred plan can be formulated by studying tradeoffs, combining the options that satisfy the objectives broadly, and tuning them to appropriate yield levels.

- **Operations Mode:** The model can also be used (with its accompanying output spreadsheet) to formulate an annual operating plan at any point in time, given the infrastructure that would be currently available. For example, JEA could use the model to formulate an operating plan for 2013 by enabling the current supply options and experimenting with demand management alternatives to see how they might offset potable demand, and what the economic implications would be. In future years, when additional supply sources are brought online, JEA can experiment with alternative prioritization strategies for the suite of installed supplies to help optimize for cost.

5.3 Next Steps

As recently discussed with JEA at the project completion workshop, JEA may want to consider the following suggestions:

- **Create more refined alternatives.** The options included in the systems model were all summarized from previous reports and studies. As certain options and combinations of options become favored, the costs and yields should be revisited and refined. More attention to the scaling or phasing of infrastructure can also be considered and modeled.
- **Enhance the financial output.** The current systems model has a significant economic component set up to compute levelized cost and total lifecycle costs. However, an additional export spreadsheet could be created to calculate additional financial output that can feed into a more comprehensive JEA financial analysis for rate making and bonding analysis.
- **Continue model maintenance.** The systems model relies on multiple future projections out to the year 2035. These will need to be updated regularly to remain relevant with current conditions and changing planning activities.
- **Invest in staff training.** JEA may want to consider additional staff to fully utilize both the systems model and CDP decision software.

Appendix A

Water Demand Forecast & Gap Analysis

WATER DEMAND FORECAST & GAP ANALYSIS

Task 1 Water Demand Forecast and Gap Analysis for the JEA Integrated Water Resource Planning (IWRP) Project

This document summarizes the following CDM Smith Inc. (CDM Smith) activities:

- ***Review of JEA's water, wastewater and reclaimed water demand forecasts as well as the Consumptive Use Permit (CUP) Tracking and Prediction Tool.***
- ***Development of water demand forecast scenarios and determining the range of water supply need (gap between forecasted water demands and JEA's Consumptive Use Permit).***
- ***Assessment of JEA's unbilled water using a top-down approach.***

1.0 REVIEW OF JEA'S DEMAND FORECASTS

The purpose of the Integrated Water Resource Planning (IWRP) project is to holistically evaluate the long-term water management options available to JEA. Central to this effort is the development of a modeling tool to compare future alternative facilities, configurations, and management of JEA's water, wastewater and reclaimed water systems as an integrated resource. A critical input to this model is the future demand projections, particularly the water demand forecast, as comparing how combinations of supply options meet the projected demand will be a central focus of the model.

CDM Smith reviewed JEA's water demand, wastewater flow and reclaimed water forecasts for their appropriateness of use for the IWRP project as well as the CUP Tracking and Prediction Tool. The source documents used for this review included the ***Water/Sewer System Planning (WSSP) System Service Demand Forecasting Procedure*** (version 1.03, dated June 21, 2011), and the detailed spreadsheets for water, wastewater and reclaimed water provided to CDM Smith by JEA staff.

1.1 Water Demand Forecast

CDM Smith's understanding of JEA's water demand forecasting method is as follows:

1. Obtain median population projections at a county level from University of Florida's Bureau of Economic and Business Research (BEBR).

2. Using GIS and historical information, county population projections are disaggregated into JEA's water service areas.

3. Historical per capita water use is examined for each JEA service area and averaged to determine a projected water use factor

(gallons per capita per day or gpcd). For some water service areas, this factor is reduced very slightly over the planning period.

4. For each JEA water service area, the projected population is multiplied by the projected water use factor (gpcd) to obtain the forecast of water demands. For two water service areas, North Grid and South Grid, adjustments are made to account for transfers and bulk water sales to SJCUD.

5. Some adjustments are made for large commercial/industrial customers, as it is assumed that their water demands are not affected by future population growth.

Figure 1 summarizes JEA's water demand forecasts made over the last few years, based on different population projections and water use factors. It can be seen that all demand projections are greater than the current CUP allocation, which supports the need to further evaluate future water supply alternatives.

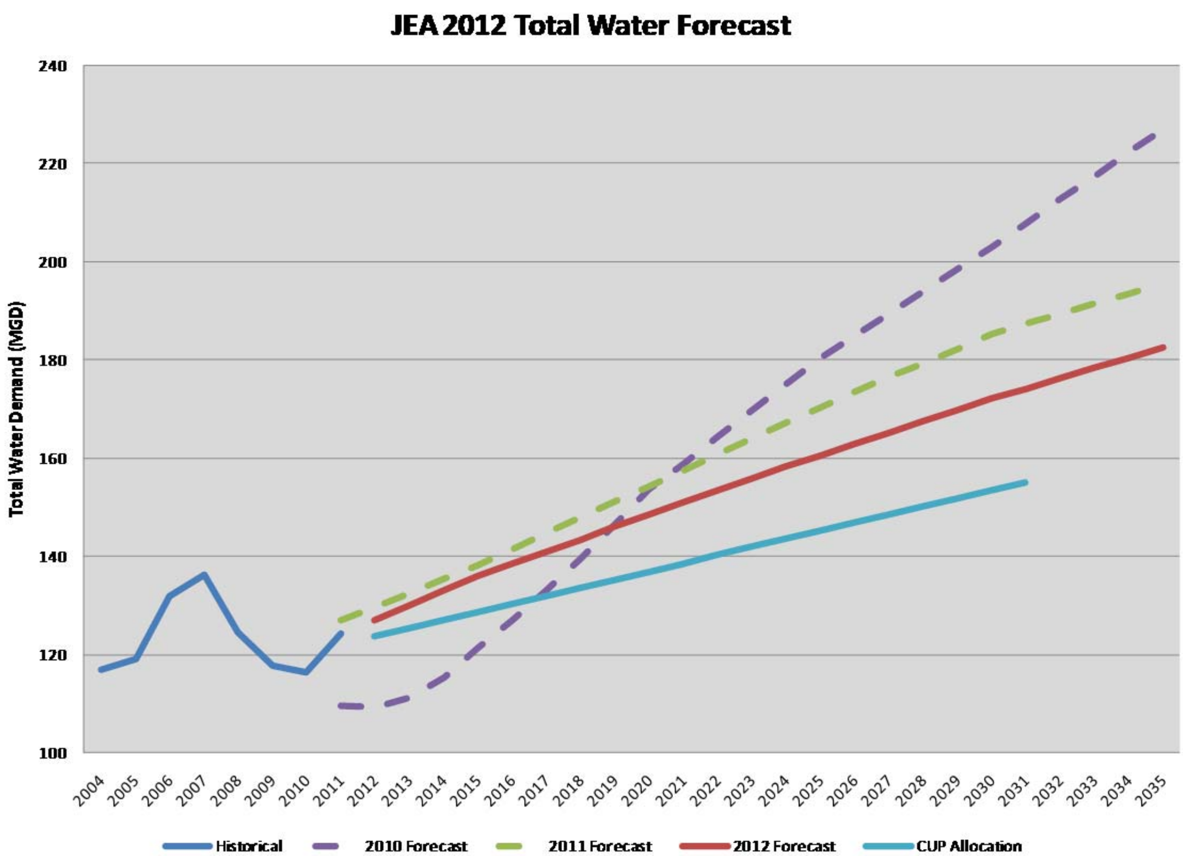


Figure 1. JEA's Water Demand Forecasts

The per capita water use method is one of the more common approaches for projecting urban water demands. While it has some drawbacks in being able to explain all of the factors that impact water use (socioeconomic, demographic, weather, and climate), it also has advantages and is often used when detailed historical data are not available.

One of the strengths of JEA's per capita water use method is the fact that the historical data and projection data are disaggregated into JEA's water service areas. This allows for much of the demographic and socioeconomic variability to be captured. For example, the North Grid service area has a historical average per capita water use of 161 gpcd, while the Ponce De Leon service area has a historical average per capita water use of 296 gpcd (approximately 84 percent greater). This is due to the fact that Ponce De Leon has larger, more affluent homes than North Grid. By examining historical per capita water use and by forecasting population at these service area levels results in a more refined per capita method.

Because of this disaggregated use of the per capita water use forecast method, and the fact that JEA maintains its different iterations of its water demand forecasts, CDM Smith concluded that this water demand forecast is appropriate for use in the JEA IRWP project.

Suggested Improvements

As time goes forward, JEA will have more historical water use and population data. Given this, JEA may wish to consider conducting a statistical analysis of historical monthly water production, population, weather, and unemployment rate. CDM Smith has successfully used this technique to improve per capita water use forecasts, as this approach allows utilities to understand the year to year variations in per capita water use, and therefore, provide more accurate projections of future values. For example, if per capita water use in the last few years was significantly lower than previous years and it could be statistically verified that the economy drove this condition, JEA may see per capita water use increase when the economy improves. Similarly, if weather in one year caused per capita water use to increase over the prior year, JEA could normalize the historical years taking out the impacts of weather. This statistical approach is not costly to perform, but does require at least 10 or more years of good monthly water use data. While these improvements could help refine the demand projections in the future, they are not critical for the current IWRP analysis.

1.2 Wastewater Flow Forecast

The wastewater flow forecasts are highly related to the water demand forecasts within each service area, as the majority of sewer flow originates as JEA provided water. Thus the two forecasts should follow similar trends. To project wastewater demands, JEA used a similar approach to the water demand forecast, whereby projected population (this time by wastewater service areas) is multiplied by a per capita wastewater flow generation factor. The contribution for infiltration and inflow (I&I) is implicit into the average wastewater demand factors as the demand factors are based on the flow received at each wastewater facility and this flow includes base sewer flow along with any I&I added during transport.

JEA's method to forecast wastewater demands is a standard approach used by most wastewater utilities, although many utilities incorporate an explicit factor for I&I. One difference between the water and wastewater demand forecasts is that the service areas do not overlap exactly and JEA has more total water customers than sewer customers. In the future, through phaseout of septic tank systems and expansion of sewer services, wastewater is projected to grow at a slightly faster rate than the water demand. **Figure 2** shows the wastewater demand forecasts as currently included in the model for the North and South grid. The North Grid values are a combination of the projected flows from the Buckman, District II, and Southwest facilities. The South Grid values are a combination of the projected flows from the Arlington East, Blacks Ford, and Mandarin facilities. Projections are also included within the model for the smaller grids of Ponce de Leon, Ponte Vedra, and Lofton Oaks/Nassau.

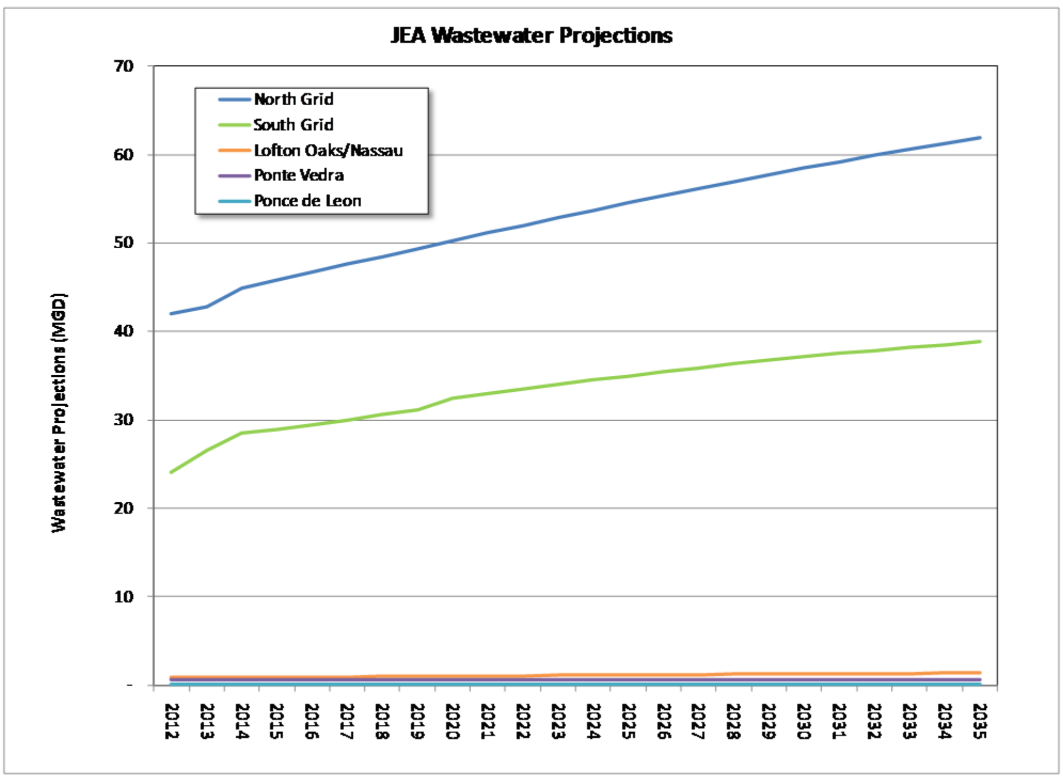


Figure 2. Wastewater Projections for IWRP Project

Many supply options within the model involve reclaimed water usage, which is dependent on wastewater flows. The model checks to ensure that the combination of options selected utilizing reclaimed water is constrained by the total wastewater projections per grid.

1.3 Reclaimed Water Demand Forecast

To project reclaimed water demands, JEA examines current and potential future users of reclaimed water that are adjacent to current and proposed reclaimed water facilities. JEA also analyzes monthly water patterns for these customers in order to analyze system needs such as diurnal storage.

This method is appropriate for IWRP use. The base projections are built upon within the model for reclaimed water options that expand the system for additional uses. For some options, additional reclaimed water is only utilized if there is available additional capacity at the reclaimed water plants. For other options, additional reclaimed water production capacity will be added to ensure available water within the constraints of wastewater projections. **Figure 3** shows the baseline reclaimed water demand projections per grid.

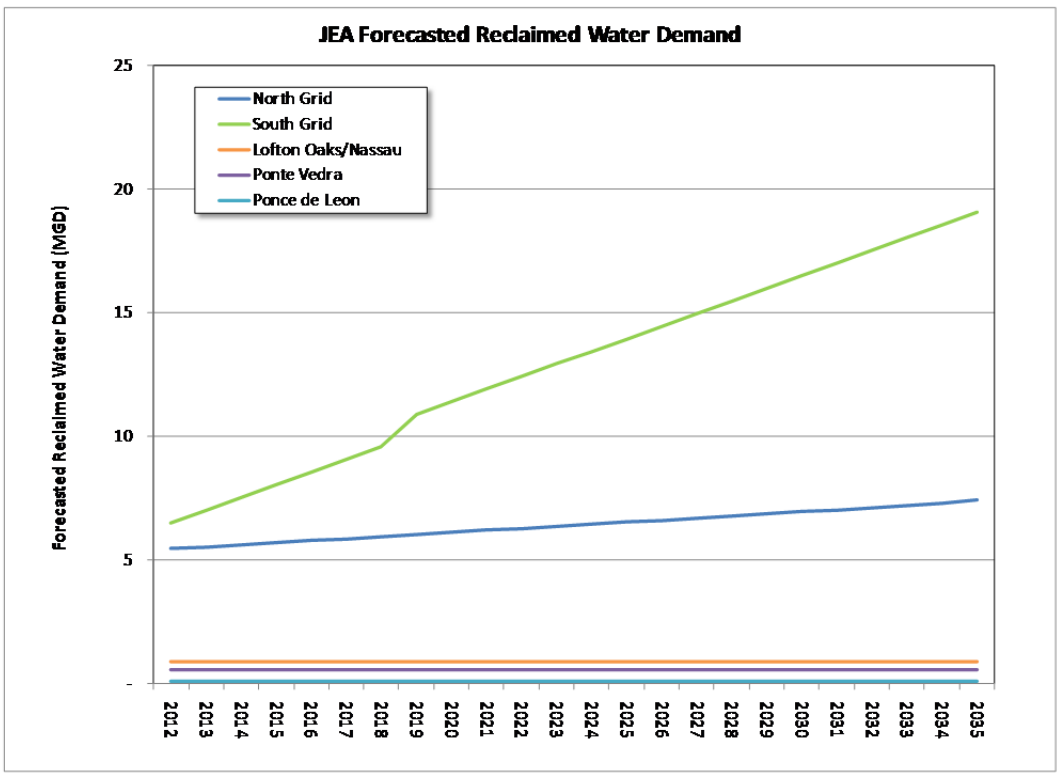


Figure 3. Forecasted Reclaimed Water Demand for IWRP Project

1.4 CUP Tracking and Prediction Tool

The CUP Tracking and Prediction Tool was developed to predict the probability of compliance with JEA's consumptive use permit in the short term. The tool evaluates factors such as forecasted population, conservation, potable offsets from reclaimed water, unbilled water, and weather conditions. A statistical approach is then used to determine a range and most likely distribution for future aquifer demands.

This approach is well suited for its specific use in short-term forecasting. However, because the IWRP model is being developed to evaluate and assist with long term planning, using inputs from the CUP Tracking and Prediction Tool for the model development will not be required.

2.0 DEVELOPMENT OF WATER DEMAND FORECAST SCENARIOS AND DETERMINING THE RANGE OF WATER SUPPLY NEED

Based on JEA's water demand forecast and historical data, CDM Smith developed three forecast scenarios for use in the IWRP project:

1. Baseline Scenario
2. High Scenario
3. Low Scenario

All three water demand forecast scenarios are presented without additional water conservation or reclaimed water potable offsets since these will be options that will be explored in the IWRP.

The baseline scenario will be the JEA 2012 water demand forecast. The baseline forecast (population, per capita water use, and water demand) was already disaggregated to each service area, so no additional calculations/modifications were necessary.

A high water demand forecast scenario was generated using the 2010 BEBR population projections for the total JEA service boundary. CDM Smith allocated the total 2010 population projections to each water service area based on the proportional split between each service area's population and total population from the baseline scenario. The higher population projections for each of the service areas were multiplied by the same per capita water use factors as in the baseline scenario, and the same transfer adjustments for North Grid and South Grid service areas were made.

To develop a low water demand scenario, CDM Smith calculated an annual population growth rate for each service area from 2007 to 2011, to account for slower growth due to the economic recession. This slower growth rate was applied to the 2012 population estimate made by JEA for the service areas through 2015. Then between 2015 and 2020, the growth rate was increased in order to parallel the actual baseline population projection. In other words, population growth would be minimal for the next 3 years then rebound after that to match the baseline's growth rate by 2020. The lower population projections for each of the service areas were multiplied by the same per capita water use factors as in the baseline scenario, and the same transfer adjustments for North Grid and South Grid service areas were made.

Figure 4 and Figure 5 present the aggregate population projections and water demand forecasts for the three demand scenarios. The average annual growth rate for demand over the scenarios from low to high is 1.4 percent, 1.6 percent and 2.7 percent.

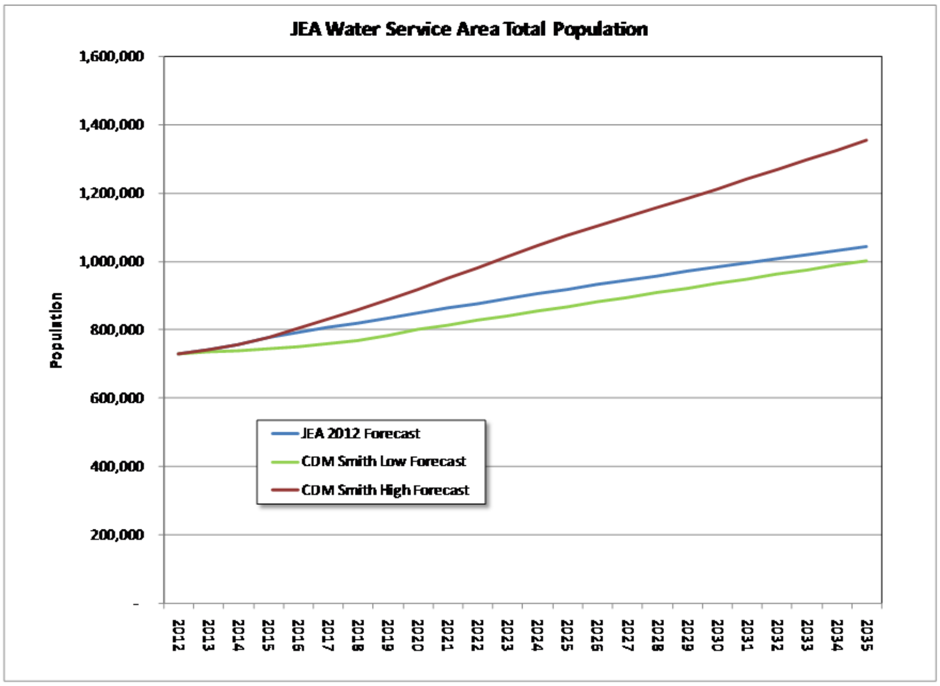


Figure 4. Population Scenarios for IWRP Project

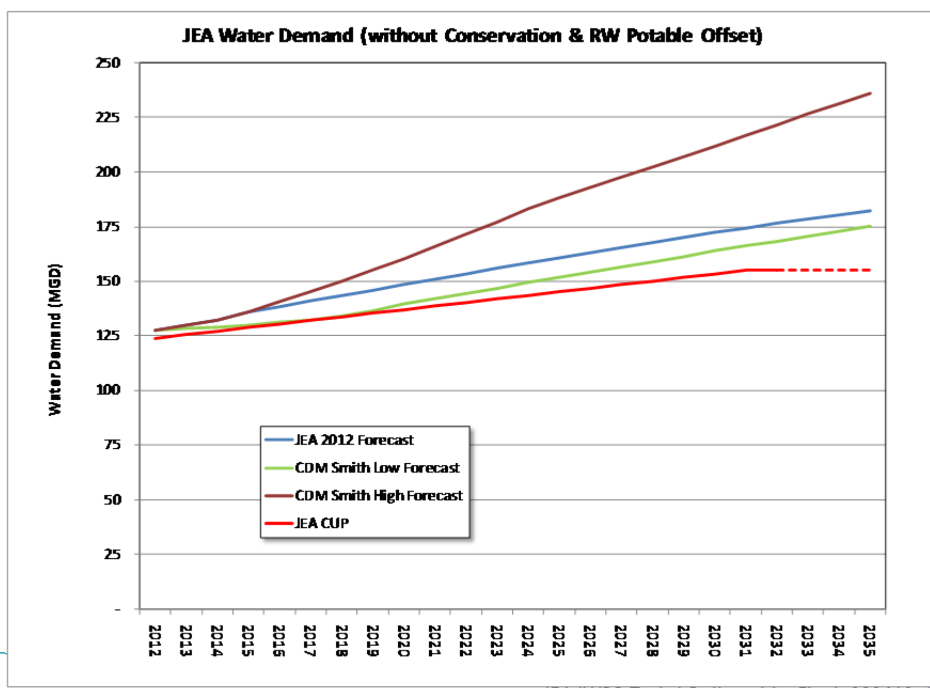


Figure 5. Water Demand Scenarios for IWRP Project

Subtracting JEA's CUP from the three scenarios of forecasted water demand results in a range of water supply need that the IWRP will need to address (**Figure 6**). The CUP allocation used for the calculation assumes the conditional increase in later years based on the reclaimed water conditions. It can be seen that under each growth scenario a need would exist to expand JEA's water supply beyond the CUP in order to meet the projected demand scenarios. This potential need is anywhere between 20 to 80 mgd by the end of the planning period depending on the demand projection scenario.

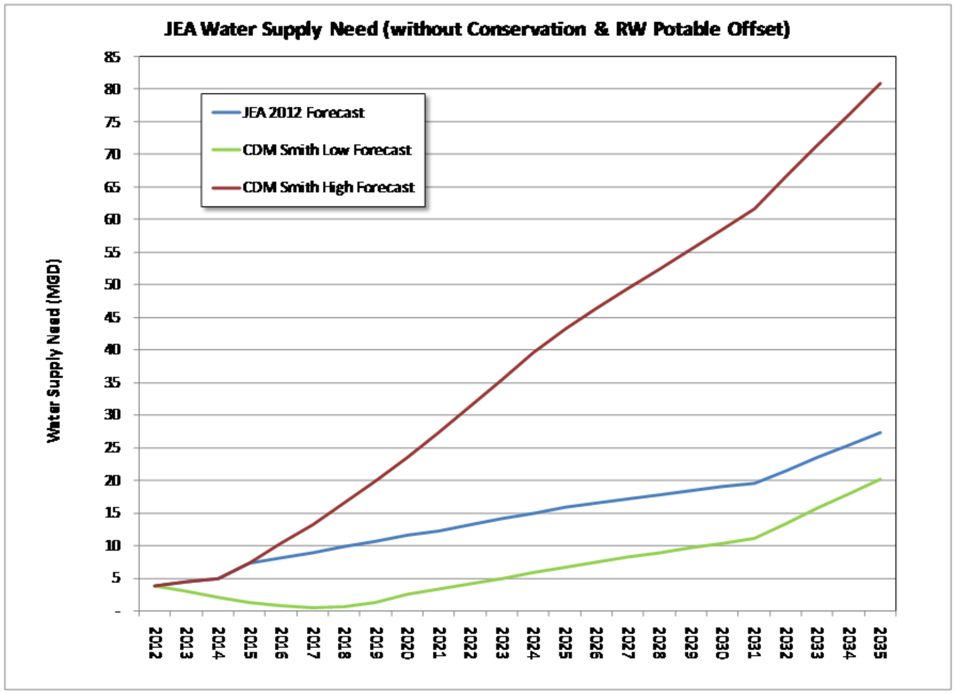


Figure 6. Range of Water Supply Need for IWRP Project

Upon review by JEA, the finalized water demand scenarios will be incorporated into the STELLA model so that various alternatives can be evaluated.

3.0 ASSESSMENT OF JEA'S UNBILLED WATER

CDM Smith assessed JEA's unbilled water from a top-down perspective to determine whether or not JEA should focus on this area as part of its overall water management strategy in the context of the IWRP Project.

CDM Smith reviewed JEA's historical accounting of unbilled water, as well as JEA's Water Audit (Final Report, 2011). To help assess JEA's unbilled water, information from the Water Audit and data provided by JEA were used by CDM Smith to calculate an industry standard (AWWA) benchmark.

3.1 Assessment of JEA Unbilled Data

CDM Smith reviewed JEA's historical unbilled data (MS Excel file provided by JEA) and has made the following observations:

a. The 2011 data show total production of 121.8 mgd, sales of 104.4 mgd, and the difference labeled as 'unbilled' of 17.4 mgd or 14.3 percent of production.

b. Note that 'Production' in this spreadsheet matches the value of finished water in the JEA report, rather than well production, and does not include purchased finished water as noted in the report.

c. The 'Sales' data by month is not adjusted for the lag in billing relative to the month of actual usage. However, on an annual basis these adjustments will average out and not affect the data.

d. This calculation of 'unbilled' water as a percent of production (14.3 percent) includes authorized unmetered uses, customer meter error and real system losses; and this conforms to the industry standard definition of non-revenue water (NRW).

e. The estimate of 'unbilled' or NRW in the spreadsheet is biased downward by the omission of purchased finished water. However, this bias is minimal as the total amount of potable water purchased by JEA for 2011 was only 0.105 mgd.

3.2 Assessment of JEA Water Audit

CDM Smith reviewed JEA's Water Audit (Final Report, 2011), and has made the following observations:

a. This report follows the estimation of water loss as prescribed by the SJRWMD water audit form. The calculations are performed for different grid networks.

b. The value calculated and reported as Unaccounted for Water (UFW) incorporates a number of parameters including: (1) differences between well meters and WTP master meters, (2) finished water purchased after the WTP master meter, (3) estimated adjustments for customer meter inaccuracies, (4) adjustments for meter reading lag, (5) estimated unmetered uses, and (6) estimated unavoidable annual real losses (UARL).

c. Because the difference between well meters and WTP master meters is negative, the resultant UFW percentage for the Major Grid appears to be biased downward.

d. Because the unavoidable real loss (UARL) is deducted from the calculated UFW, the resultant UFW value represents the portion of system losses that should be avoided, or could be controlled through a water loss control program. The calculated UFW is not comparable with standard metrics of system loss.

e. Before adjusting the UFW for the difference between well meters and WTP master meters, the interim UFW value is 14 percent of finished production. This value is a more commonly used definition of UFW.

3.3 Standard AWWA Benchmark

The JEA estimation of unavoidable annual real loss (UARL) uses a formula from the AWWA M36 manual of practice regarding water system loss. This manual provides a standardized format for classifying, calculating, and benchmarking water loss metrics.

CDM Smith used the 2011 data reported in the JEA 2011 Water Audit report to calculate the standardized water loss metrics in accordance with the AWWA format. These metrics are shown in **Table 1**, followed by notes on how data were used and converted.

The AWWA benchmarks use a ratio of the Real Loss to the UARL as a metric of a water system's Infrastructure Leakage Index (ILI). It is generally not economically or operationally feasible to reduce the ILI below a value of 2.0 or 3.0. This acknowledges that there are limits to the extent to which real losses can be eliminated within a system. The AWWA guidelines suggest that systems with an ILI in the range of 3.0 to 5.0 should evaluate the costs of water resources relative to the cost of a water loss control program that would reduce system losses. That is, if the unit value of water saved from leak detection and line replacement is less than the unit value of additional water supply, the utility could benefit from such a water loss control program. Generally speaking, for systems with an ILI between 5.0 and 8.0, the high level of real losses is only acceptable if water supply is inexpensive and relatively immune to supply shortages (i.e., the utility can afford to lose water). According to AWWA, an ILI greater than 8.0 is not an effective utilization of water resources.

Table 1. JEA Unbilled Water Benchmark Using AWWA/IWA Format

Water Supplied	Finished	44,456.39	MG
	Purchased	38.16	MG
		44,494.55	MG
Authorized Use	Metered	37,964.70	MG adjusted for billing lag
	unmetered	33.51	MG Fire flow
		14.81	MG Flushing
		11.65	MG Sewer cleaning
		38,024.67	MG
Losses (supply minus use)		6,469.88	MG
		14.54%	as Percent of Supplied
Apparent Loss	unauthorized use (theft)	0	MG
	billing error	0	MG
	customer meter inaccuracies	704.72	MG
		1.58%	as Percent of Supplied
Real Loss (RL)		5,765.16	MG
		12.96%	as Percent of Supplied
Non-Revenue Water		6,529.85	MG
(total loss + unmetered use)		14.68%	as Percent of Supplied
Unavoidable Real Loss (UARL)		1,414.3	MG
		3.18%	as Percent of Supplied
Infrastructure Leakage Index (RL/UARL)		4.07	

Notes on metric calculations:

a. Including purchased finished water in the water supplied into the distribution system increases the supply without changing the recorded use. Thus, the unbilled volume, or non-revenue water (NRW) volume increases to about 14.7% of supply.

b. The non-revenue water (NRW) volume is separated between unmetered authorized uses, apparent losses (i.e., customer meter slippage, theft and billing errors), and real losses (i.e., line breaks, major leaks, and unavoidable leakage). The unmetered authorized uses estimated by JEA amount to only 0.13% of total finished water supply. Customer meter inaccuracies estimated by JEA amount to 1.58% of supply. This leaves 13.0% of supply as real system loss.

c. Any pressurized system will lose water. The AWWA water audit format offers a methodology for estimating a water distribution system's unavoidable real loss (UARL) based on average operating pressure, number of service connections, lines of pipe and other parameters. However, many of the assumptions in this calculation are very generalized. Thus a conservative (i.e., safe) estimate is twice the calculated value. The JEA adjusted estimate of UARL is 1,414 MG, or 3.18% of total finished water supply.

Based on the analysis of JEA data reported in the JEA 2011 Water Audit report, it appears that JEA has an ILI of 4.07 and should evaluate the potential benefits from a program to reduce real loss in their system. JEA has recently formed a team to investigate such a program. The team has been tasked to develop and implement a leakage reduction program that will establish methodologies for assessment, prioritization and cost benefit analysis of the leak detection/reduction alternatives. Within the IWRP Project reducing unaccounted for water will continue to be an evaluated demand reduction alternative.

4.0 SUMMARY

The main conclusion of this technical memorandum is that the JEA demand projections are applicable to be used within the IWRP Project. The JEA provided baseline water demand forecast will be a key component within the developed model. An option will also be included to choose either a lower or higher demand projection for analysis utilizing the additional scenarios developed by CDM Smith as described in Section 2. These demand projections will form the base of the current analysis, but can always be updated within the model in the future if demand projections change.

The reclaimed water demand forecast will also be incorporated into the model, while the wastewater demand forecast will act as a constraint for the maximum level of reclaimed water capacity that can be developed.

While the CUP Tracking and Prediction Tool was reviewed and thought to be valid for its given usage, its ability to be incorporated into the IWRP model is limited due to the short time scale of its input data.

Unaccounted for water, and non-revenue water, within the JEA system were also analyzed and a loss reduction plan will be incorporated into the IWRP model.

Appendix B

Integrated Model Development Plan

INTEGRATED MODEL DEVELOPMENT PLAN

Task 3-1 Modeling Plan for the
JEA Integrated Water Resource Planning (IWRP) Project

This document is designed to be a guide for the formulation and development of a modeling tool for JEA that will accomplish two purposes:

- ***It will compare the performance, operating costs, and other characteristics of future alternative facilities, configurations, and management of JEA's water, wastewater, and reclaimed water systems, integrated as a single water resource and economic system. This will serve as the basis of IWRP evaluations.***
- ***It will be used going forward by JEA staff to develop and tune operating plans on a routine basis by simulated expected demand and testing alternative operating rules to help reduce costs.***

1.0 INTRODUCTION

The integrated systems model that will be developed as part of this project will compile information from other models/reports/studies, simplify relationships (such as groundwater drawdown as a function of pumping and recharge, saltwater upconing potential as a function of withdrawal rates, or conservation effectiveness as a function of investment and policy enforcement), and link the different subsystems together (water, wastewater, and reclaimed water) for comprehensive supply-demand, economic, and operational analysis of planned infrastructure and integrated operations.

As a guide, this document is malleable, and is not intended to serve as the basis for documenting final decisions at this early stage of the program. Rather, it is intended to function as a centralized collection of necessary inputs, outputs, formulation ideas, and functional requirements for the model, so that it can effectively address the questions that are driving its development. Workshops with CDM and JEA will help finalize the specific needs of the model. A separate document on the Economic Modeling Approach has been developed as a companion to this document.

2.0 FUNDAMENTAL QUESTIONS

The first workshop with the Core Planning Team identified the guiding objectives for the IWRP. Associated with each objective are performance measures, which were reviewed and modified by the broader group of JEA staff and leadership at the JEA kickoff meeting on March 6, 2012. One of the expectations of the integrated model is that it will provide numerical output in the form of the performance measures that are deemed to be quantitative, as opposed to qualitative. These will then be used in a scorecard along with qualitative scores developed with JEA to provide balanced, broad-based comparisons of alternatives. The objectives and performance measures are listed in **Table 1** below, and the numeric performance measures (to be generated with the model, or supported by model outputs) are highlighted in red.

Table 1: Objectives and Performance Measures

Objective	Performance Measures
Maximize Cost-Effectiveness	-Total customer lifecycle costs -JEA levelized costs -Ratio of JEA fixed costs to JEA total costs
Reliably Meet Water Demands	-Risk for water shortage
Maximize Flexibility	-Operational flexibility -Diversity of supply
Protect Environmental Resources	-Aquifer sustainability -Water use efficiency - River Impacts (quality and quantity)
Maximize Implementation	-Reliance on proven technology -Ability to permit -Public acceptance
Meet Customer Water Quality	-Water quality blending/secondary water quality metric

As part of the process of evaluating tradeoffs between alternatives, the model will also be useful in answering broad questions about alternatives and their implementation. Some examples include:

- When will water demand outpace various levels of supply?

- What supply alternatives will offer the most cost-effective and reliable solutions?
- How can supply-side and demand-side management be used together cost-effectively?
- How can the system with future infrastructure improvements be operated in an integrated way for cost and energy efficiency?
- How should new infrastructure and facilities be phased?

Lastly, once alternatives are operational (or even for the existing system), the model may be employed regularly by JEA to assist in planning operations for an upcoming year. Given a current system configuration (at any point in the future), expected demand for the year, current energy prices, maintenance schedules for specific facilities, etc., JEA can use the model to identify preferred sources based on cost, impacts, reliability, diversity, or other metrics defined above. Examples of the types of near-term operational questions that can be answered for any future system configuration include: How can the system, in any existing state, be operated in an integrated way for cost and energy efficiency? What sources should be used when? What plants should take the highest load? How much reclaimed water should be distributed?

3.0 MODELING APPROACH: SIMULATION VS. OPTIMIZATION

Some of the fundamental questions of water planning are best addressed with dynamic system simulation models – high level tools that assimilate data and simplified relationships from other tools into a single platform in which multiple subsystems can be evaluated together. This is essentially an experimental platform, in which "What-If" questions can be asked and answered. Such analysis provides insight into the effectiveness of various water management options with the benefit of illuminating WHY they work or do not work as an effective part of a larger system. Because integrated system models incorporate so much information from other models, it doesn't need to be recreated or recomputed, and consequently, analysis is fast. This allows for rapid assessment of performance, trade-off studies, and tuning of a system toward peak performance for cost, reliability, or other metrics. It can been used effectively to "optimize" integrated systems by progressively building comprehensive plans that address a broad variety of goals.

Another approach to addressing integrated plans is explicit mathematical optimization – employing advance search algorithms to sort through all possible combinations of options and scales and conditions and identify those that best meet one or two specific objectives (cost, or reliability for example). However, these approaches usually are effective only in defining an upper bound of opportunity, and do not necessarily explain HOW to achieve the resultant benefits, or WHY the benefits are the way they are. In other words, optimization models can prescribe what to do, but they can also leave planners and operators "flying somewhat blind."

The choice of a modeling approach naturally depends on the fundamental questions driving a study, and the way the questions are articulated. Purely prescriptive questions ("What's the best way to do this?") can be effectively addressed with explicit optimization, but may not be terribly informative to decision makers. Descriptive questions ("What options most effectively address multiple needs, and why") are better analyzed using simulation models.

Because the framework of objectives and performance measures is broad, a **simulation model will be most effective for JEA's IWRP**. It can be used to provide information on cost, reliability, environmental impacts, and water quality so that alternatives can be evaluated in the context of their tradeoffs, and informed decisions can be made. More information on the selected tool is included in Section 5 of this memorandum.

4.0 MODES AND SCENARIOS

As listed above, there are two types of fundamental questions formulating the need for integrated planning:

- What long-term capital improvements and management strategies are needed, and when?
- How can annual operating plans be tuned for cost-effectiveness?

Because of the different focuses and scales of these questions, two modes will be developed. *They will be based on the same network configuration, input data, and calculations, but the time scales and specificity of demand and energy price structures will vary between the two modes.*

Both modes will run on a monthly timestep, which is appropriate for capturing the dynamics of seasonal variations in water availability and demand for planning purposes, but does not become too data-intensive by simulating finer time-scales in which the supply/demand/cost variations have little impact on planning. It may be necessary to incorporate daily peaking factors for within-month dynamics so that infrastructure may be tested and sized appropriately.

Planning Mode: This mode will compare alternatives for the long-term integrated planning framework (Present – 2035) based on supply/demand analysis, operating cost, and other performance measures discussed above. CDM Smith will use this mode as part of the IWRP study to provide JEA with quantifiable tradeoffs between alternatives.

There are two options for how the planning mode could be arranged:

1. **One Year / Full Hydrology:** The model will look ahead to any single year between 2012 and 2035 based on demand projections developed in Task 1 of the study. It will superimpose historical periods of hydrologic record over a given demand year to obtain probabilistic results of water availability, operating costs, etc. for that year.

2. **25 Years / Representative Hydrology:** The model will run the full planning period of increasing demand with representative hydrology (wet, normal, or dry, for example) superimposed throughout.

Option 2 was selected for the JEA IWRP because the dependency of supply options on hydrology is not perceived to be as critical as understanding the long-term viability of supplies through periods of increasing demand. Options that depend on hydrology (river withdrawals, reuse demand as a function of rainfall, etc.) can still be tested by varying the hydrologic assumptions superimposed over the future 25-year planning period.

The information obtained from the model will be used to compare and prioritize options, group them into effective combinations ("alternatives"), and phase them appropriately. This planning mode will also allow experimentation with variations in demand projections, water availability, changes in regulations, etc.

The complete list of options defined by JEA in the initial workshops is listed in **Table 2** below. These are the options that can be selected and grouped into alternatives within the model.

Operations Mode: This mode will be used to formulate and/or tune annual operating plans by JEA. It will utilize the same modeling interface and network. However, unlike the Planning Mode, which looks up to 25 years into the future based on demand projections and hypothetical facilities and infrastructure, this mode will be used recurrently by JEA based on actual configurations (in the ground at the time of model use) and projected needs for any immediately upcoming 3 year period, corresponding with current in-house near-term demand forecasting procedures.

It is envisioned that the tool will be used to input the current 3-year demands, CUPs, energy prices, available operating options (today's existing sources plus the implemented in-the-ground options from Table 2), and other constraints on availability (permits, facility maintenance, etc.). This mode will also allow the selection of hydrologic conditions (dry, wet, average, or possibly key percentiles) that can be run for the three-year planning period.

The primary goal of this mode will be to formulate three-year cost-effective operating plans for the entire water/wastewater system. Output will be provided in the form of the same metrics outlined above for long-term planning (cost, reliability, impacts, etc.).

Table 2: Options for Inclusion in the Integrated Model

Water Supply	Reuse Water	Demand Management
Desalination: St. Johns River near NSGS "seawater quality"	Indirect Potable Reuse via Groundwater Recharge	Increased conservation
Desalination: St. Johns River upstream "brackish quality"	Keystone Lake Region Reuse (RIBs, Injection, or Lake Recharge)	Reduce unaccounted for water
Desalination: Intracoastal Waterway/Ocean	Multi-County Regional Reuse	Drought rate structures
Desalination: Brackish Groundwater	Targeted Reuse/Source Replacement (Project by Project Basis)	O&M System Operations/Performance (Pressures)
Regional Surface Water Reservoir for Potable		
WTP Intermediate Aquifer Wells		
Local Surface Water Reservoir for Potable		
Non Floridan Source Private Irrigation		
Other Floridan Sources		

5.0 CANDIDATE MODELING TOOLS AND RECOMMENDATION

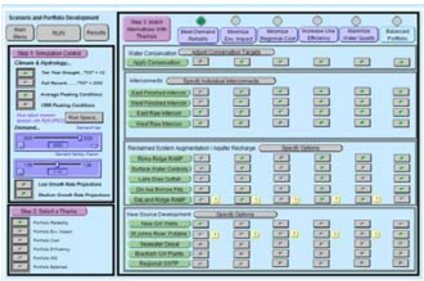
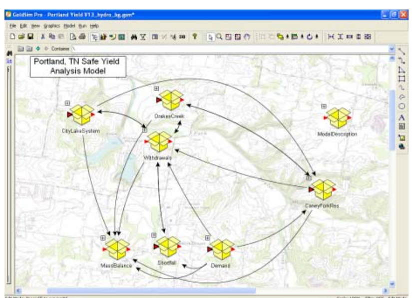
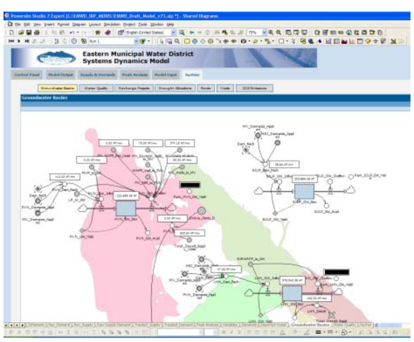
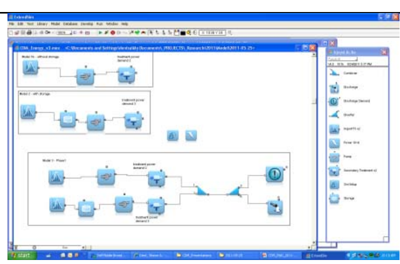
Integrated Model: Table 3 lists the candidate models that CDM Smith has identified for the JEA IWRP. All of the tools can represent complex flow networks, and are mathematically capable of producing the necessary results for both proposed modes (Long-Term Planning, and Annual Operations). Likewise, all of these tools have been used for integrated and operational modeling. Their relative strengths and weaknesses are outlined in the table for comparative purposes.

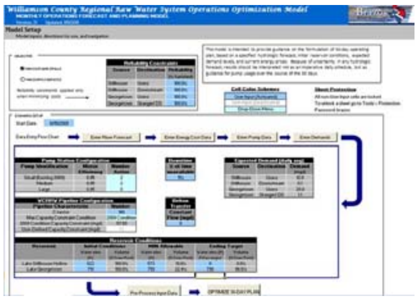
The most important aspect of selecting a model is to match it with the questions that are being asked, and with the intended usage of the model (in this case, both by CDM Smith for planning, and by JEA for annual operations). Based on the list of performance measures, the ease of programming and use, and its long and successful history at CDM Smith, **STELLA was selected as the most suitable option for JEA**.

Scorecard Tool: CDM Smith will utilize Criterion Decision Plus (CDP) to help rank alternatives in a comparative platform. CDP is a scorecard tool that compiles numeric scores (from the STELLA model) and qualitative assessments (poor – good – better – best) into composite scores for each alternative. The performance measures are assigned weights based on relative importance to overall planning objectives. Outputs help demonstrate the tradeoffs between alternatives, and illustrate which ones perform most effectively across the whole range of objectives. The tool is not used to make decisions, but rather to help support informed and defensible decisions.

Supplemental Templates: CDM Smith will develop supplemental templates in Microsoft Excel for the transferring of data to and from the model and scorecard tool, and possibly to help enhance graphical presentation of results.

TABLE 3: Candidate Models Evaluated for JEA IWRP

Software	Example	Description	Benefits for IRP	Shortcomings for IRP/Ops	Cost
STELLA		Graphical dynamic simulation model with interface that allows rapid adjustment of key variables. CDM and our clients have used STELLA extensively for IWRPs and Ops modeling.	-Intuitive interfaces for options and operating rules -Easy programming -Graphical depiction of the system -Long and successful history at CDM -Easy to modify	-Linking to external data is difficult -Output graphics are not great	$2,000
GOLDSIM		Statistically-based simulation model that facilitates uncertainty and Monte Carlo analysis	-Powerful algorithms for uncertainty analysis, Monte Carlo analysis, etc. -Subsystems contained in tiered modules for visual clarity	-Visual linkages are not clear or intuitive -Programming is more difficult than others -Can be difficult to modify	$4,000
POWERSIM		Graphical dynamic model with good interface and output graphics. Programming is higher level than most others in this comparison.	-Easy links to external databases -Intuitive interface and good output graphics -Graphical flexibility within the model -More powerful/ flexible math	-System links can be hard to follow -Data links can be difficult to change -Programming is less intuitive than others (more like a language)	$13,532
EXTENDSIM		Off-the-shelf software for which CDM Smith has develop customized modules	-More modular than others: allows rapid replication of similar facilities/elements -Easy to create tiered submodels	-Some of the modular functionality is proprietary to CDM Smith	$2,500

MICROSOFT EXCEL WITH PREMIUM SOLVER AND VISUAL BASIC (VBA)		Spreadsheet-based platform for explicit mathematical optimization (SOLVER) and dynamic/statistical programming (VBA)	-Completely customizable -Can do simulation and explicit optimization -Algorithms can be easily added with Visual Basic	-Changes are difficult with VBA and SOLVER -Programming can be lengthy -No functional system graphics -Limited planning insight with optimization	$2,000

6.0 MODEL INPUTS

Aside from a database of hydrologic data, economic information, demand projections, and other data sets that will be embedded within the model as needed, the user (CDM Smith and JEA) will enter key inputs to define scenarios. The inputs will be very similar for the PLANNING MODE and the OPERATIONS MODE. Table 4 lists the key inputs required for model scenarios:

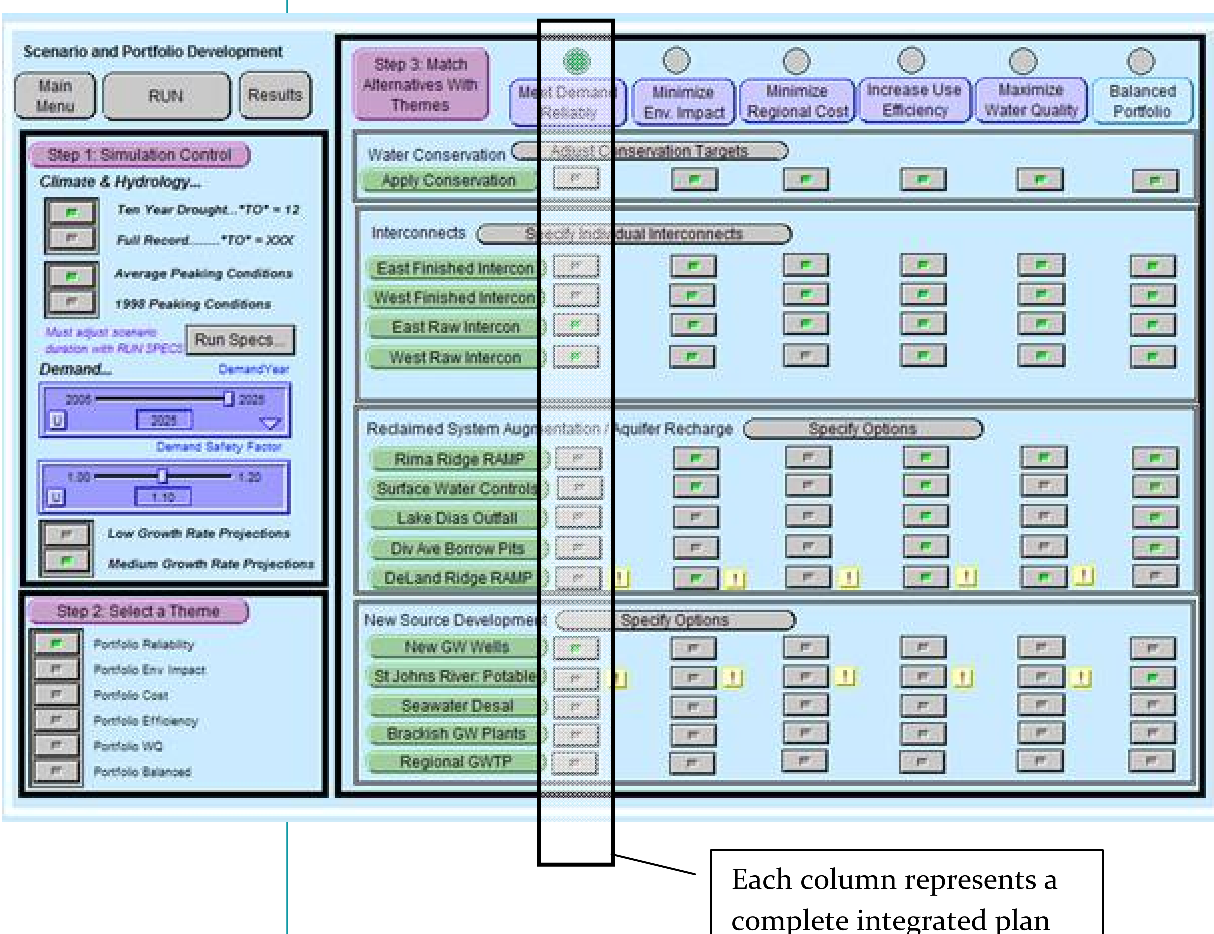
Table 4: Key Model Inputs

Input	Planning Mode	Operations Mode
Future options from Table 2 for supply, reuse, and demand management (ON/OFF and amounts available)	●	
Options from table 2 implemented and available at the time of model use		●
25-year demand projections for water and reuse (high/medium/low)	●	
1 or 3 year demand projection		●
Hydrologic conditions (dry, normal, wet)	●	●
Long-term energy price assumptions	●	

Input	Planning Mode	Operations Mode
Current energy prices		●
Operating Cost Assumptions / Energy Needs	●	●
Regulatory constraints for 25-year planning period (CUPs, MFLs)	●	
Current regulatory constraints (CUPs, MFLs)		●

Figure 1 illustrates an example input screen for a similar Integrated Water Resource Model using STELLA software. The user identifies key scenario parameters (hydrologic conditions, demand, etc.) and then selects from available supply and management options to formulate a comprehensive plan. Alternative plans can then be tested against each other and refined.

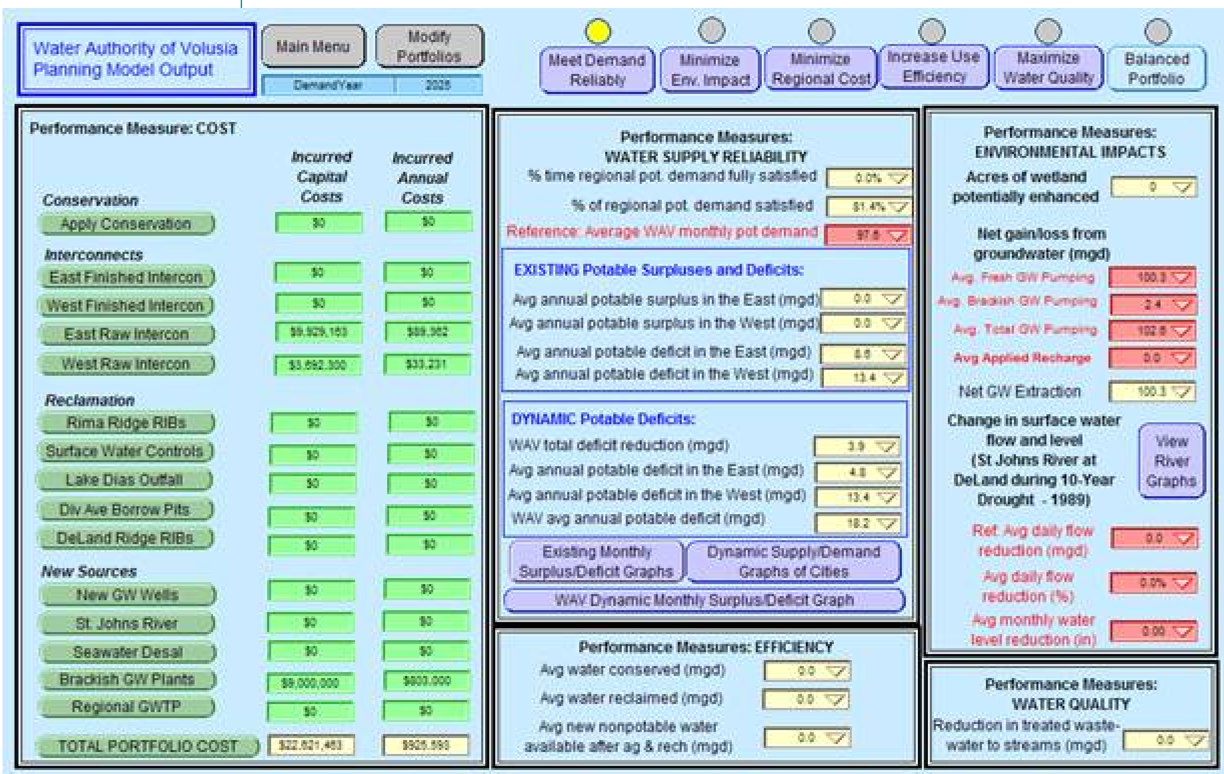
Figure 1: Example Input Screen for STELLA Model*



7.0 MODEL OUTPUTS

The outputs will be based around the performance measures outlined in Table 1, and will naturally evolve during the course of collaborative development with JEA. An example output screen in STELLA from another Integrated Water Resources Plan is included as **Figure 2.**

Figure 2: Example Output Screen in STELLA*



**Used for the Water Authority of Volusia Integrated Facilities Plan. Numbers are examples only, and do not reflect any actual decisions, costs, relationships, or specific scenarios.*

The example above is useful for defining specific performance measures in simple, numeric formats. Other key outputs, such as timeseries plots, will be presented in graphs, tables, and/or summary statistics to meet the needs of JEA.

8.0 MODELING WORK PLAN

The following task outline will be followed for the development of the model:

1. Develop Economic Modeling Plan: Define techniques and assumptions for cost calculations, energy price estimates, present

worth basis (inflation and discount rates, planning horizon, etc.), cost levelization.

2. Draw schematic diagram of model network and conceptual relationships

3. Develop simplified relationships based on previous modeling:

    a. Groundwater withdrawals vs. levels
    b. Groundwater withdrawals vs. salinity
    c. Energy needs and affiliated cost
    d. Conservation effectiveness
    e. Availability from other sources
    f. Etc.

4. Program model network with existing water, wastewater, and reclaimed facilities and infrastructure (represented either explicitly or conceptually, as needed), as well as future options identified for modeling in **Table 2.**

5. Develop input and output interface screens for selecting and grouping alternatives, specifying demand levels, viewing results, etc.

6. Test model against recent withdrawal, treatment, and distribution patterns to verify costs, supply usage, well response, etc.

7. Memorandum on model development and testing. At this point, the model will be ready for use in formulating and comparing alternatives for JEA's IWRP.

Appendix C

Economic Modeling Approach

ECONOMIC MODELING APPROACH

Task 3-2 Economic Modeling Approach for the JEA Integrated Water Resource Planning (IWRP) Project

To help evaluate projects and alternatives for JEA's IWRP project, an economic modeling approach (EMA) is required. This EMA will be programmed into JEA's STELLA system model in order to track all costs and present information in standard economic terms. The EMA can be applied for comparing individual projects or combinations of projects (e.g., alternatives).

The EMA will incorporate and address the following:

- ***All projects will have similar cost contingencies (planning, engineering, construction) that are typical for high-level planning estimates.***
- ***Although JEA might use different levels of cash vs. debt to fund capital projects during actual project implementation, the EMA assumes all project capital costs will be 50 percent financed.***
- ***The EMA will assume the same escalation factor for both capital and annual O&M costs to account for escalation.***
- ***The EMA will produce standard economic metrics, such as:***
    - ***Total lifecycle present value cost (sum of nominal annual costs discounted by a discount rate for life of project/alternative)***
    - ***Simple average unit cost (sum of total nominal annual costs divided by sum of total water supply capacity for life of project/alternative)***
    - ***Levelized unit cost (present value cost divided by present value of beneficial water supply produced for life of project/alternative)***

1.0 PROJECT COST ESTIMATION

JEA has conducted many planning studies during the past several years, and included in these studies are cost estimates for many of the projects that will be explored in the IWRP project. CDM Smith Inc. (CDM Smith) will first bring all prior cost estimates to current year (2012) dollars using the appropriate ENR index. For those projects without cost estimates, CDM Smith will utilize unit cost estimates for similar project from other studies conducted throughout the United States in order to develop high-level planning cost estimates. All cost estimates will include similar (comparable) contingencies for planning, permitting, engineering and construction.

2.0 ECONOMIC FACTORS AND ASSUMPTIONS

The following economic factors or terms will be used as default values for the IWRP project, based on the last 10 years of historical trends. However, these values can be changed or varied as inputs to the STELLA model in order to test the sensitivity they may have on decisions.

Economic Factor	Value
Escalation Rate	3%
Finance (Borrowing) Rate	5%
Life of project for pipelines, pump stations, stormwater BMPs	20 years
Life of project for treatment plants, wells, storage, conveyance	30 years
Discount Rate	5%

Assumptions were made to determine a baseline cost for running the current JEA system.

- Based on the 2011 data from the annual report, it was determined that assets were split evenly with about 50% for water and 50% for sewer. Thus, similarly it was assumed that 50% of the current debt financing could be attributed to the water system. Taking the average of annual debt service for 2010 and 2011 this was $62,000,000 per year.
- It is assumed that 50% of JEA's reported operating costs are spent on water withdrawal, treatment and distribution. Based on an average of 2010 and 2011 data this equates to $124,000,000 in O&M per year. Within the model $1.50 per 1000 gallons (or $1500 per million gallons) is assumed to be variable O&M based on the total water produced. This leaves $58,000,000 per year as a fixed O&M cost.
- The cost of moving water from the north to south grid through the interconnect is handled separately in the model. Based on JEA provided data, the costs used are $132 per million gallons for average annual transfers less than or equal to 15 mgd and $148 per million gallons for average annual transfers above 15 mgd.

3.0 ECONOMIC COMPARISONS

Comparing projects and alternatives (combinations of projects) from an economic standpoint can be challenging for several reasons. First, not all projects have the same economic life. Second, because JEA's current groundwater source is the cheapest water supply (up to JEA's CUP), any project that displaces this lowest cost water is not providing an economic benefit. And third, because new water supply projects come in all sizes of capacity, it is important to present economic terms in unit cost (dollars per volume of water produced).

Standard economic theory states that the best cost comparisons take into account the time value of money, meaning that a dollar today is worth more than a dollar 10 years from now. This is because a dollar today can be invested. To account for the time value of money, all future year costs are brought back to present value terms using the following formula:

$$\text{PVc} = \frac{\text{CF}_t}{(1+r)^t}$$

Where:

PVc = present value cost
CF = future cash flows in *t* years from now
t = number of years
r = discount rate

Project/alternative comparisons using a present value approach are only valid if the supply produced is the same for all projects/alternatives. If projects or alternatives produce different quantities of water, then a unit cost comparison is needed. For example, if Project A cost $100 and produces 20 units and Project B cost $10 and produces 1 unit, which is more cost effective? Without converting to unit cost, Project A is the most expensive. But when comparing unit cost, Project B is the most expensive ($10/unit for Project B vs. $5/unit for Project A). This is important because projects can be scalable, meaning many smaller projects can be done in order to equal the supply yield of one big project.

However, the method commonly used to develop average unit cost (sometimes called a simple unit cost), does not take into account the time value of money and the beneficial water supply. Beneficial water supply is defined as the amount of water that is needed (as opposed to the capacity of supply that can be produced). To account for both of these issues, levelized cost is used. Levelized cost for a particular project is defined as that value of a unit cost constant over time that, if charged for the annual volume of water supplied, would yield the present value of the cost of the project. The formula for levelized cost is:

$$\text{LC} = \frac{\text{PVc}}{\text{PVw}}$$

Where:

LC = Levelized cost
PVc = present value cost
PVw = present value of water that is beneficially needed (as opposed to supply capacity)

The use of levelized costs is also helpful in identifying options/alternatives that return the lowest user costs. To illustrate this, **Table 1** compares two projects against a projected need for water. The need for water represents the difference between projected water demands and existing water supplies. Project A has an annual supply capacity of 5,475 million gallons (15 mgd), a capital cost of $3.1 million and O&M cost of $0.25 million, with a life cycle of 20 years, and comes online in 2013. Project B has an annual supply capacity of 1,000 million gallons (2.7 mgd), a capital cost of $0.5 million and O&M cost of $0.05 million, with a life cycle of 15 years, and comes online in 2015.

Assuming capital costs are completely financed at 5 percent and O&M costs are escalated at 3 percent per year, the total lifecycle costs in nominal dollars over the life of both projects (no discounting) is $12 million for Project A and $1.8 million for Project B. Dividing both of these lifecycle costs by capacity of water that can be produced by the two projects yields a simple average unit cost of $110/million gallons for Project A vs. $120/million gallons for Project B—indicating that Project A is more cost-effective. But because the full supply capacity of Project A is not needed until 2025, the full capacity should not be counted when calculating a true levelized cost. Only the portion of supply yield that is equal or less than the total water need should be counted. Because Project B's supply capacity is always less than the total water need, all of its supply is beneficial. When this factor is taken into account, plus discounting both cost and water, then Project B becomes more cost-effective with a levelized cost of $119/million gallons vs. $146/million gallons for Project A. It should be noted that in this example, both projects cannot be phased. This method would allow phasing of projects to be tested from an economic perspective.

4.0 ECONOMIC MODELING PROTOCOL

To calculate both simple and levelized unit cost, capital costs estimated in 2012 dollars will be escalated at 3 percent to the start year of water production, and then 50% financed using an interest rate of 5 percent. O&M costs estimated in 2012 dollars will be escalated by 3 percent per year. For levelized cost, all future costs will be discounted at 5 percent in order to develop a present value cost. Future values of beneficial water supply (equal to or less then water need) will be discounted at 5 percent in order to develop a present value of water. Levelized cost will be calculated as PV cost divided by PV water. This economic modeling protocol will be incorporated into the STELLA model for evaluation of projects and alternatives.

Table 1. Economic Comparison Example

Escalation (inflation) Rate	3%
Financing Rate	5%
Discount Rate	5%

	Value	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Need for New Water (mil gal)		1,362	1,575	1,788	2,634	2,937	3,248	3,558	3,867	4,185	4,462	4,788	5,112	5,437	5,760	6,034	6,266	6,498	6,730	6,960	7,107	7,827	8,546	9,265	9,957
Project A																									
Annual Supply Capacity (mil gal)			5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475			
Beneficial Supply (mil gal)[1]			1,575	1,788	2,634	2,937	3,248	3,558	3,867	4,185	4,462	4,788	5,112	5,437	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475			
Project Life (years)	20																								
Total Capital Cost ($M)	$3.10																								
Annualized Capital + Debt ($M)			$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26			
Annual O&M Cost ($M)	$0.25		$0.26	$0.27	$0.27	$0.28	$0.29	$0.30	$0.31	$0.32	$0.33	$0.34	$0.35	$0.36	$0.37	$0.38	$0.39	$0.40	$0.41	$0.43	$0.44	$0.45			
Total Annualized Cost ($M)			$0.51	$0.52	$0.53	$0.54	$0.55	$0.55	$0.56	$0.57	$0.58	$0.59	$0.60	$0.61	$0.62	$0.63	$0.65	$0.66	$0.67	$0.68	$0.69	$0.71			
Simple Unit Cost ($/mil gal)[2]	$110																								
Levelized Unit Cost ($/mil gal)[3]	$146																								
Project B																									
Annual Supply Capacity (mil gal)					1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000						
Beneficial Supply (mil gal)[1]					1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000						
Project Life (years)	15																								
Total Capital Cost ($M)	$0.50																								
Annualized Capital + Debt ($M)					$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05						
Annual O&M Cost ($M)	$0.05				$0.05	$0.06	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.08						
Total Annualized Cost ($M)					$0.11	$0.11	$0.11	$0.11	$0.11	$0.12	$0.12	$0.12	$0.12	$0.12	$0.13	$0.13	$0.13	$0.13	$0.14						
Simple Unit Cost ($/mil gal)[2]	$120																								
Levelized Unit Cost ($/mil gal)[3]	$119																								

[1] Represents that water supply that offsets the need for new water, but nothing more since JEA's current groundwater source is already the cheapest water

[2] Represents the sum of total annualized cost divided by the sum of the annual supply capacity.

[3] Represents the present value of total annualized cost divided by the present value of beneficial supply.

Appendix D

Option Factsheets

JEA IWRP Option Factsheets

Model Set-Up

- Seasonal Peaking Factors
- CUP Allocations
- Reclaimed Water Capacity and Demand
- Generic Additional Supplies

Water Supply Options

- Desalination
- Intermediate Aquifer Wells
- Non-Floridan Private Irrigation
- Regional Surface Water Reservoirs

Reuse Water Options

- Indirect Potable Reuse
- Keystone Lake Region Reuse
- Regional Reuse
- Targeted Reuse

Demand Management

- Conservation
- Reduce Unaccounted for Water

Seasonal Peaking Factors

Category: Model Set-Up

Brief Description:

This factsheet describes how seasonal peaking factors were incorporated into the model

Water Demand:

The annual water demand values within the model are those described within the Task 1 Water Demand and Gap Analysis technical memo. To these annual demands, a monthly peaking factor is used to determine the demand for a given month. The seasonal peaking factors were developed based on JEA's historical sales data from 2004-2011. For each year, the ratio of the monthly sales to the yearly average was calculated providing a seasonal pattern for that year. All eight historical years were then averaged together to determine the overall peaking factor for the model. The developed pattern compared to the historical data can be seen in **Figure 1.**

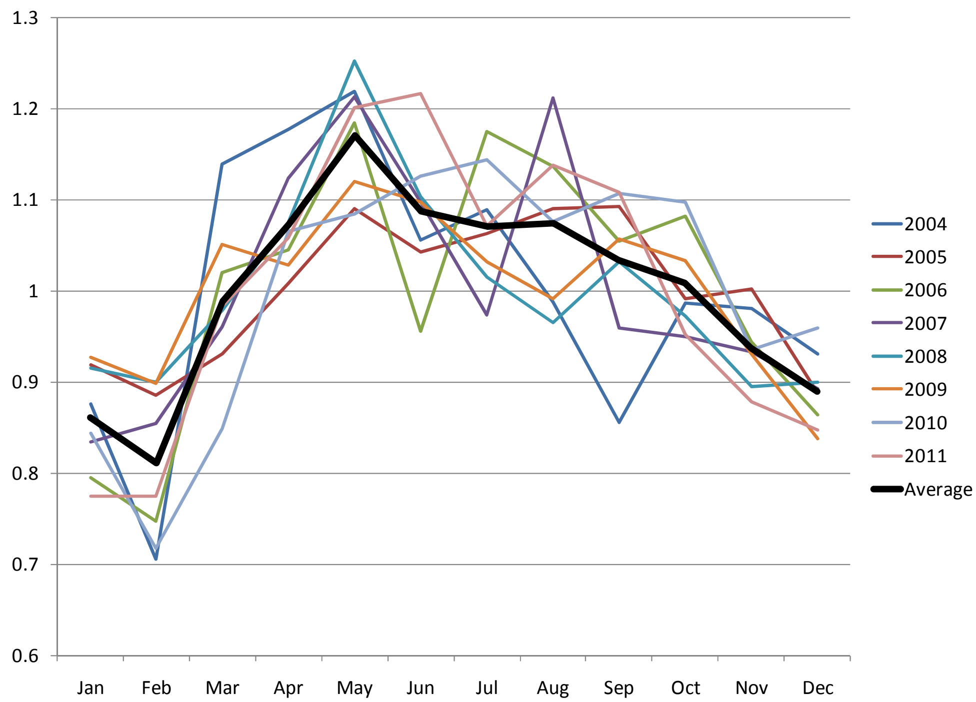


Figure 1: Seasonal Water Demand Pattern

Reclaimed Water Demand:

The same method was used to develop the reclaimed water demand pattern except only the years 2008-2011 were utilized. This was because earlier years showed different patterns as reclaimed water usage in the area was still being developed. The most recent years are assumed to be the most representative of the current usage patterns. **Figure 2** shows the historical data and the average seasonal pattern used within the model.

Seasonal Peaking Factors

Category: Model Set-Up

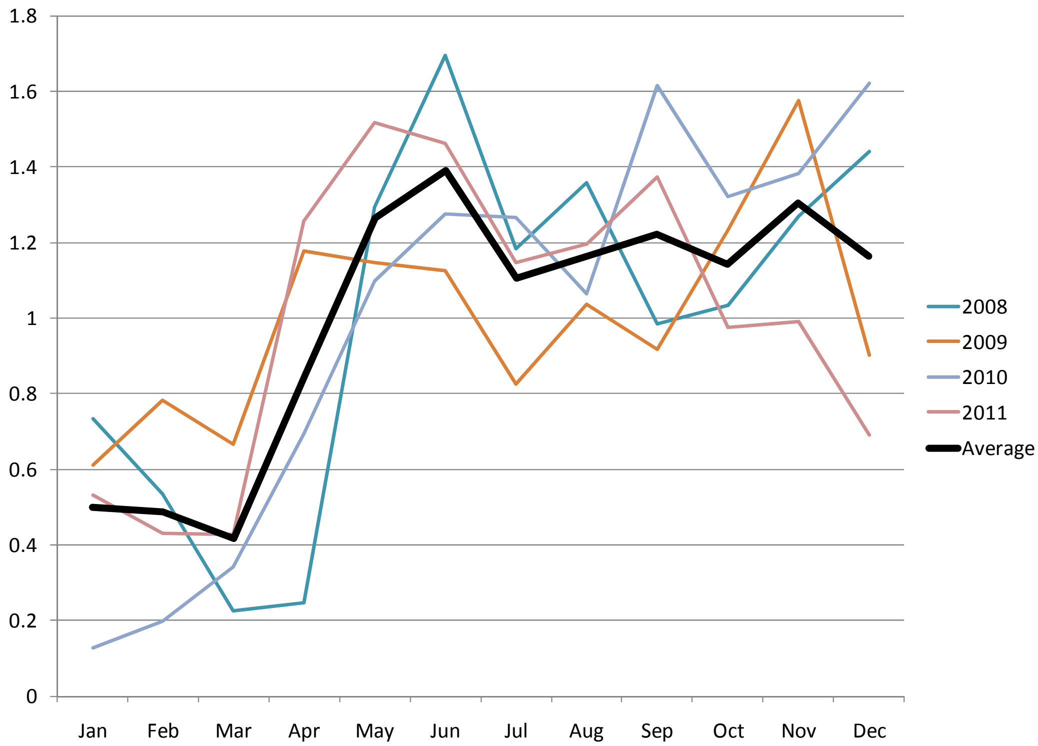


Figure 2: Seasonal Reclaimed Water Demand Pattern

Wastewater Demand:

The same method was used to develop the wastewater demand pattern which was based on the total wastewater treated for 2010 and 2011. The wastewater data seems to be strongly influenced by large storms which cause a large peak in wastewater flow. The years 2010 and 2011 were chosen since there appeared to be minimal influence from these storms. **Figure 3** shows the historical data and the developed seasonal pattern.

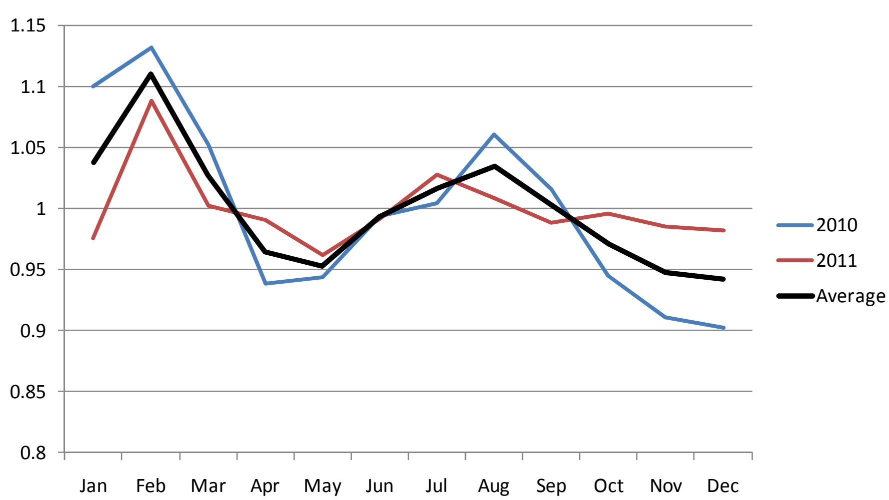


Figure 3: Seasonal Wastewater Peaking Factors

Seasonal Peaking Factors

Category: Model Set-Up

Citations:

CDM Smith (2012) “Water Demand Forecast & Gap Analysis” Task 1 of the JEA Integrated Water Resource Planning Project.

JEA (2012) “Sales Data.xlsx” Spreadsheet of historical sales data provided to CDM Smith on June 22, 2012.

JEA (2012) “Metrics.xlsm” Spreadsheet provided to CDM Smith on June 22, 2012

CUP Allocations

Category: Model Set-Up

Brief Description:

This factsheet describes how the main wellfields and CUP allocations are set-up within the Stella model.

Grid Set-Up:

Each individual wellfield is not modeled, but instead wellfields are combined based on grids. Six grids have been included within the model: the North Grid, South Grid, Ponte Vedra Grid, Ponce De Leon Grid, Lofton Oaks/Nassau Grid, and Mayport Grid.

Capacity Constraints:

The available flow to be supplied within each grid from the Floridan aquifer CUP allocations is limited by capacity constraints at either the wells or the water treatment plants. The limiting capacity for each grid came from JEA's 2012 Annual Water Resource Master Plan as listed in **Table 1.** The increases between current conditions and 2020 are based upon the planned improvements listed within the plan.

Table 1: Max Capacity per Grid

Grid	Limiting Capacity 2012 (MGD)	Limiting Capacity 2020 (MGD)
North	143.5	155.5
South	158.3	175.6
Mayport	0.19	0.19
Lofton Oaks	5.33	9.09
Ponce De Leon	1.29	1.29
Ponte Vedra	3.0	3.0

CUP Constraints:

JEA's consumptive use permit (CUP) outlines the total volume which can be withdrawn from the Floridan aquifer each year. However, within the permit are a series of conditions affecting the allocation. Figures 1a and 1b within the CUP provide the total volume allowable per year per wellfield. The values provided for 2011 through 2021 are used as the baseline allocation for each grid. After 2021 the allocation is held constant pursuant to condition 12 of the permit which does not allow for an increase in the allocation unless additional requirements are met. One of these requirements is the amount of reclaimed water provided for reuse. **Figure 1** shows the allocations for the North and South Grids. The allocation in the South Grid has a decreasing pattern to help combat salinity intrusion and there is thus not the opportunity for increased allocation. **Figure 2** shows the allocations for the smaller grids assuming an increase in allocation is available.

Another condition of the permit allows for individual wellfields to surpass their allocation by 20% as long as the total system allocation is not exceeded. Within the model, there is an option to allow this internal system trading between the North and South Grids or between the North and Lofton Oaks Grids between specified years to help meet grid specific deficits.

CUP Allocations

Category: Model Set-Up

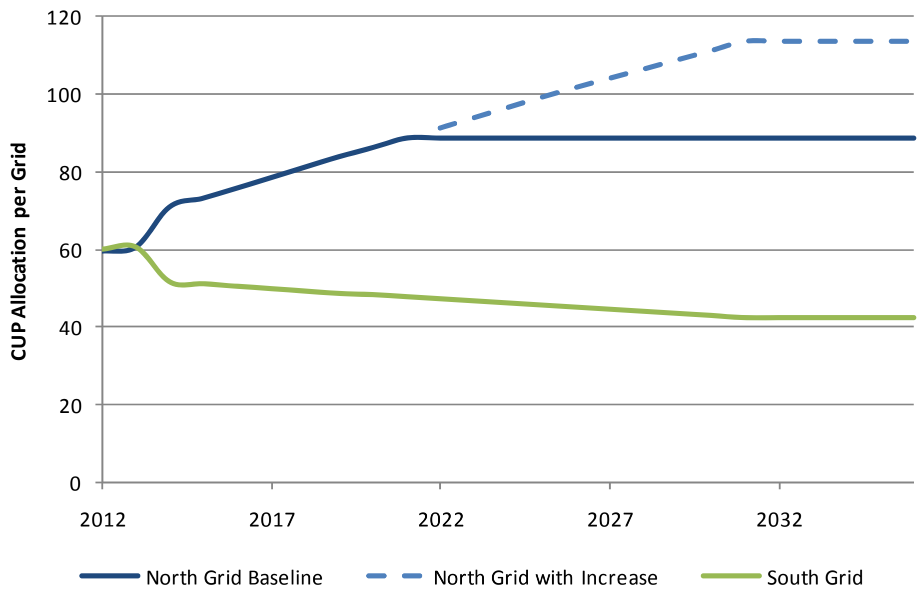


Figure 1: CUP Allocation per Grid for North and South Grids (mgd)

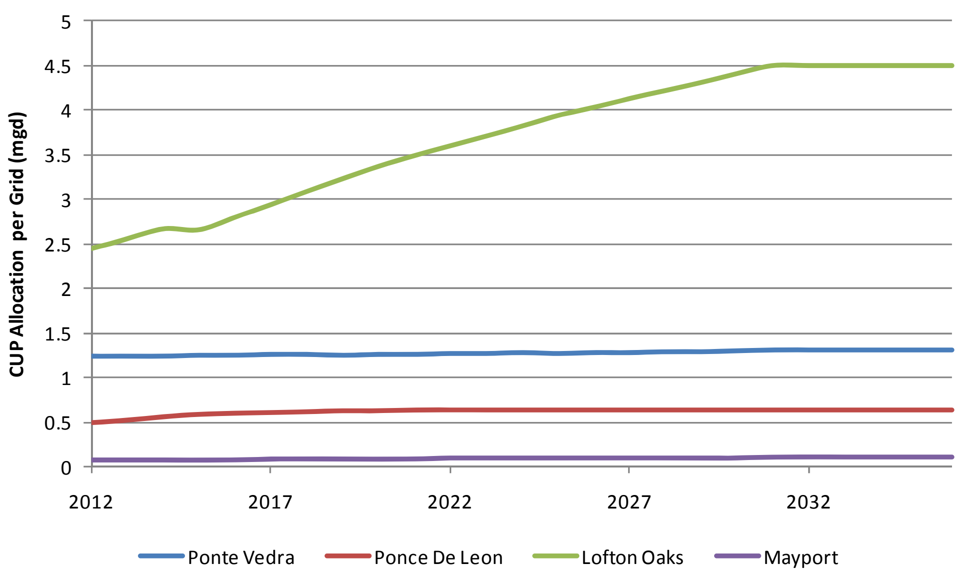


Figure 2: CUP Allocation per Grid for the Small Grids (mgd)

CUP Allocations

Category: Model Set-Up

Reclaimed Water and the CUP Allocations:

The targeted reclaimed water values required to increase the CUP allocation are provided in **Table 2**.

Table 2: Reclaimed Water Requirements for Increased CUP Allocation

Year	Required Reuse (mgd)
2020	31.55
2025	37.36
2030	43.76

An exemption to meeting these reclaimed water targets is provided in condition 38: "except to the extent the permittee demonstrates that some portion of the amount of reuse required below is not economically, environmentally, or technologically feasible". The model has a series of choices for how the CUP allocations are handled:

- **No increased allocation**: This option can be selected to maintain the allocation at the baseline conditions.
- **Guarantee additional allocation:** This option automatically provides the increase in allocation independent of reclaimed water availability and usage.
- **Additional allocation depends on reuse:** Within this option the amount of reclaimed water made available by JEA is compared to the targets and the CUP allocation is not increased until the targets are met.

Citations:

JEA (2011) "Consumptive Use Technical Staff Report; Application #: 2-031-88271-11" April 15, 2011

Reclaimed Water Capacity and Demand

Category: Model Set-Up

Brief Description:

This factsheet describes how the reclaimed water capacity and general demand was set-up within the model.

Reclaimed Capacity:

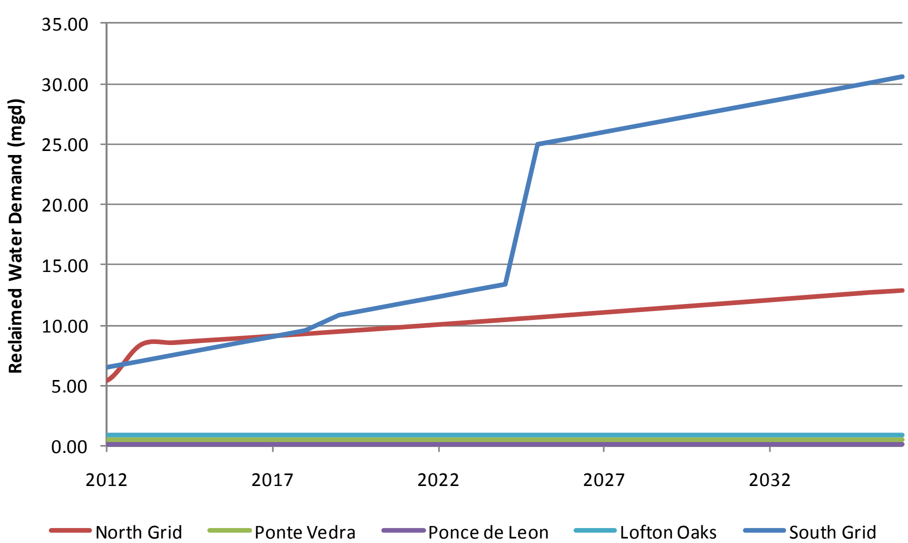
Initial capacities for the each of the reclaimed facilities were taken from the table on page 225 of the 2012 Annual Water Resource Master Plan and then confirmed and updated by JEA staff. Capacities of the plants are increased in future years as laid out in the Master Plan. **Table 1** provides the initial capacity and eventual planned capacity of each plant without any other options considered.

Table 1: Reclaimed Water Facilities Capacity

Facility	Grid	Initial Capacity 2012 (MGD)	Eventual Capacity (MGD)
Buckman	North	7.7	7.7
District II/Cedar Bay	North	5.0	9.0
Dinsmore	North	0	0
Southwest	North	0.8	0.8
Arlington East	South	6.0	18.0
Blacks Ford	South	3.0	6.0
Mandarin	South	5.7	5.7
GEC	South	0	9.0
Ponte Vedra	Ponte Vedra	0.8	0.8
Ponce de Leon	Ponce de Leon	0.24	0.24
Nassau	Lofton Oaks	1.55	1.55
Total		**30.8**	**58.8**

Reclaimed Demand:

The reclaimed water demand per grid also comes from the 2012 Water, Wastewater, and Reclaimed Water Forecast with refinements by JEA staff. The shape of these demand curves is shown in **Figure 1.** Any additional demand from the selected options is added to this baseline demand.



Citations:

JEA (2011) "2012 Annual Water Resource Master Plan: Water – Wastewater – Reclaimed" Corporate Planning Department, Water/Sewer System Planning. September 2011.

JEA (2011) "JEA 2012: Water, Wastewater, Reclaimed Water Forecast" Prepared by M. Dvoroznak and B. Russell, JEA Water/Sewer Systems Planning. December 2011.

Generic Additional Supplies

Category: Model Set-Up

Brief Description:

As a way to capture future supply alternatives, generic additional supplies were added into the model. All grids have a generic additional supply available with basic elements pre-programmed as described below.

Set-Up:

The generic supplies are treated as simple supply options. The standard option variables have been set-up within the model and interface. The user can adjust the variables of yield, capital cost, fixed O&M cost, variable O&M cost, start year, project life, and finance life similarly to any other option.

The generic supply options however stand alone and do not interact with other model features other than helping to meet the overall demand for the grid and influencing cost. For example, the supply will not be checked against reclaimed capacity nor will the supply go toward meeting the reclaimed requirements to increase the CUP allocation.

Desalination

Category: Water Supply Option

Brief Description:

This option consists of desalination to produce a new source of potable supply. Four different desalination options are considered: (1) extraction of brackish groundwater from the Lower Floridan aquifer, (2) withdrawing brackish river water from the upper St. Johns River, (3) withdrawing seawater-quality influent from the lower St. Johns River, or (4) withdrawing seawater from the ocean.

Facilities Required:

A desalination plant would be required for all options as well as connection to the distribution system and concentrate disposal. For brackish groundwater extraction, a well field would be needed, and for the surface water options an intake structure would be required.

Key Assumptions:

For brackish groundwater, a total dissolved solids (TDS) concentration of 1500 mg/l was assumed, this increased to 5000 mg/l for the brackish St. Johns River water, and 35,000 mg/l for ocean water.

Flexibility:

This option will add a previously unused source water to the JEA supply. It also makes use of either a source with an unlimited supply in the case of ocean water or a source with limited potential for other use in the case of the brackish supplies.

Environmental Impacts (Promote Environmental Sustainability):

For all options, concentrate disposal will be an environmental issue. Potentially more so for the sources with higher TDS values. For groundwater withdrawal there could be possible drawdown effects. For the river withdrawals there would be a decrease in river flows.

Ease of Implementation:

Concentrate disposal options will need more study and could complicate implementation. Within the qualitative scoring, desalination was given a score of 2 for reliance on proven technology signifying that there is a precedent for use in the Southeaster US but known challenges. Desalination was given a 1 for the ability to permit, signifying JEA has no precedent and it is assumed to be difficult to permit. A score of 5 was given to public acceptance signifying that no new public acceptance is needed.

Water Quality:

The required desalination and treatment facilities would produce water of potable quality. In is unknown how this new supply source would blend with current supplies. Within the qualitative scoring, the brackish desalination sources were given a score of 2 for water quality signifying that the blending is unknown or difficult. The lower St. Johns River and ocean desalination option were given a score of 1 since the more difficultly with blending over to the brackish sources is assumed for these locations.

Yield:

All options could be sized to accommodate various treatment capacities. Options of 5, 15, 30 and 50 mgd had costing provided and these four potential yields can be selected within the model set-up. Flow from all the desalination options is assumed to go towards meeting demand in the south grid.

Desalination

Category: Water Supply Option

Cost:

Table 1 provides estimated capital and O&M costs of each alternative for a range of treatment capacities. Capital costs include the treatment facilities, intake, link to the distribution system, and line for concentrate disposal.

Table 1: Desalination Option Costs

	Treatment Capacity (mgd)			
	5	15	30	50
Brackish Groundwater				
Capital	$43,100,000	$88,800,000	$136,000,000	$207,000,000
O&M Fixed Costs per Year	$520,000	$1,160,000	$1,940,000	$2,840,000
O&M Variable Costs per MG	$1139.73	$847.49	$708.68	$622.47
Brackish St. Johns River Water				
Capital	$85,500,000	$160,000,000	$238,000,000	$335,000,000
O&M Fixed Costs per Year	$640,000	$1,540,000	$2,700,000	$4,060,000
O&M Variable Costs per MG	$1402.74	$1125.11	$986.30	$889.86
Seawater Quality Water from St. Johns River				
Capital	$173,000,000	$352,000,000	$562,000,000	$795,000,000
O&M Fixed Costs per Year	$1,120,000	$2,800,000	$5,320,000	$8,680,000
O&M Variable Costs per MG	$2454.79	$2045.66	$1943.38	$1902.47
Ocean Water				
Capital	$185,000,000	$376,000,000	$590,000,000	$825,000,000
O&M Fixed Costs per Year	$1,120,000	$2,800,000	$5,320,000	$8,680,000
O&M Variable Costs per MG	$2454.79	$2045.66	$1943.38	$1902.47

Citations:

CDM (2011) “2011 Alternative Water Supply Evaluation and Implementation Plan” JEA. August 2011.

CH2MHill (2008) “JEA Total Water Management Plan”. September 2008.

WTP Intermediate Aquifer Wells

Category: Water Supply Option

Brief Description:

This option consists of construction of wells or a wellfield targeting the intermediate aquifer as the source of supply for potable or irrigation use.

Facilities Required:

New wells targeting the intermediate aquifer would be required. These could hopefully be co-located at existing wellfields to diminish additional piping needs.

Key Assumptions:

The middle of the South Grid area was determined to be the best target for exploration.

Flexibility:

This option will improve flexibility through the introduction of groundwater from a different aquifer system.

Environmental Impacts (Promote Environmental Sustainability):

The connectivity between aquifers is not well understood so withdrawing from the intermediate aquifer could have effects on the surficial aquifer above it or the Floridan aquifer below.

Ease of Implementation:

With many unknowns, developing this resource would be a long-term project. Additional test holes will be needed and aquifer testing required to determine the capacity of each well and potential impacts to surrounding users and environmental resources. Permitting will require this test data and new groundwater flow models will need to be developed that accurately include the intermediate aquifer. Within the qualitative scoring, intermediate aquifer wells was given a score of 3 for reliance on proven technology signifying that there is the precedent for use in Florida but the source is new to JEA and there are unknown hurdles. A score of 3 was given for the ability to permit signifying that it may be challenging but precedents do exist. A score of 3 was given to public acceptance signifying that it may be difficult to convince the public to participate or accept the water source.

Water Quality:

The water within the intermediate aquifer is generally of high-quality. Blending with water from the Floridan aquifer should be easier than with other surface water sources. Within the qualitative scoring, intermediate aquifer wells was given a score of 5 for water quality signifying that there should be no blending issues.

Yield:

Based on other regions currently utilizing the intermediate aquifer, it is reasonable to expect a yield of approximated 0.5 mgd per well. Dispersal of about 10 wells in strategic locations may be able to produce up to 5 mgd total yield for the South Grid. It is assumed that these wells will come on line in phases throughout the planning period. An initial phased approach is provided in **Figure 1** but can be updated within the model.

WTP Intermediate Aquifer Wells

Category: Water Supply Option

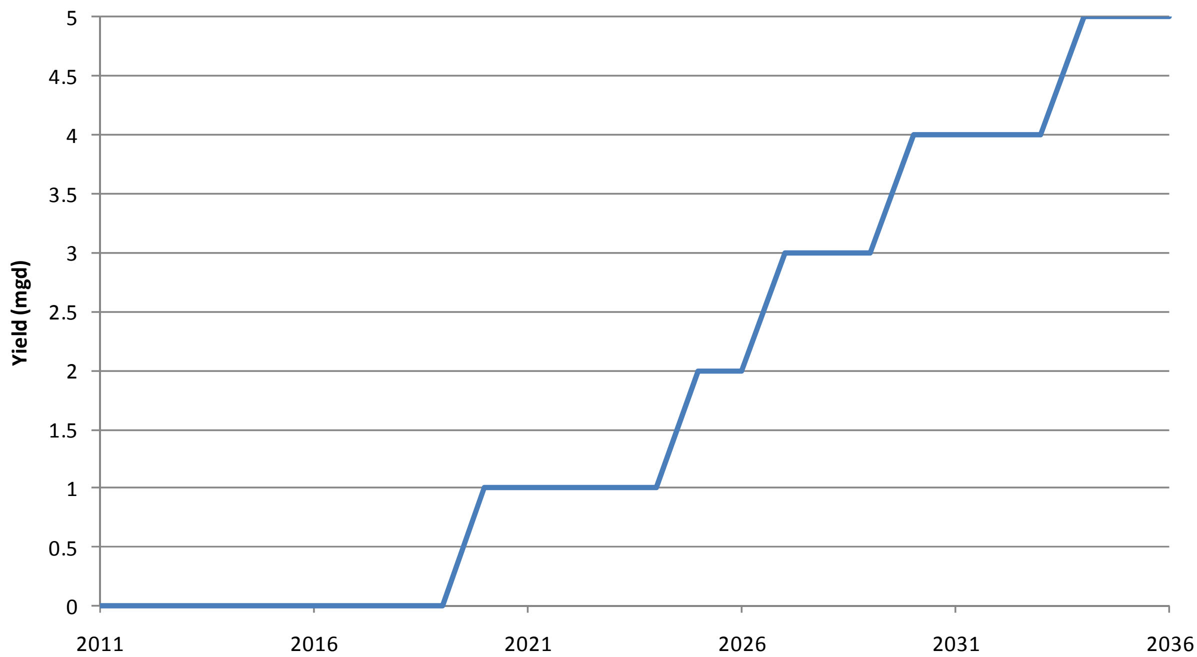


Figure 1: Phasing of the available yield provided by the intermediate aquifer to the South Grid

Cost:

Because the intermediate aquifer is shallower, the installation of new wells should be less expensive than those reaching the Floridan aquifer. Based on the JEA project definition for the intermediate aquifer pilot study/implementation, development of the new wells and integration into the wellfield would be approximately $1,950,000. O&M fixed costs were estimated as $28,000 per year while variable O&M was estimated as $61.37 per million gallons of water.

Citations:

CDM (2011) "2011 Alternative Water Supply Evaluation and Implementation Plan" JEA. August 2011.

JEA Water Sewer Systems Planning (2012) "Intermediate Aquifer Pilot Study/Implementation – Project Definition". Prepared for JEA Capital Budget Planning. February 2012.

SDII Global Corporation (2010) "Preliminary Feasibility Investigation: Viability of the Intermediate Aquifer as a Water Source". Prepared for JEA. November 2010.

Non-Floridan Private Irrigation

Category: Water Supply Option

Brief Description:

This option involves construction of groundwater wells either in the surficial aquifer or the intermediate aquifer in order to supply irrigation water to private residences. This use would replace the Upper Floridan aquifer (UFA) supply currently being used to meet those demands. Two options are proposed: (1) converting those already on self-supply from the UFA to a different aquifer, and (2) wider scale adoption by moving current JEA customers to private irrigation wells.

Facilities Required:

The only facilities required will be the private wells.

Key Assumptions:

In determining the potential yield, 50% of residential demand was attributed to landscape irrigation for the customers currently on self-supply. For wider adoption, an estimate of 12,500 gallons/month/household was used.

Flexibility:

This option will improve the operational flexibility of JEA as the demand needs on the Floridan aquifer will be reduced, freeing the allocation to be used in other areas.

Environmental Impacts (Promote Environmental Sustainability):

The connectivity between aquifers is not well understood so withdrawing from the surficial aquifer could still have effects on the Floridan aquifer. Additionally, environmental impacts to wetlands in the vicinity of new surficial aquifer wells are possible.

Ease of Implementation:

There is minimal technical difficulty with this option; however, gaining participation from the public could be a challenge. Permitting could also potentially be a concern near wetlands or other wellfields.

Water Quality:

The water quality of the surficial aquifer should be adequate for irrigation needs. Testing will be recommended at individual well locations.

Yield:

Self Supply

Currently there are 665 domestic supply wells in Duval County with an estimated withdrawal of 3.3 mgd. By 2030 it is estimated that there will be an increase of 755 additional private domestic supply wells bringing the total withdrawal to 8.9 mgd. It is assumed that through incentives up to half of these private owners would switch to a non-Floridan supply. This switch is assumed to happen slowly over time as estimated in **Figure 1**. As currently modeled, the self-supply customers are assumed to be split with 50% in the North Grid and 50% in the South Grid.

Wider Adoption

For wider adoption of this supply, households not currently using a self-supply for irrigation needs would need to switch to self-supply from the surficial aquifer. It is estimated that up to 37,000 households could be converted accounting for 15 mgd of supply. This adoption was spread linearly over the 25-year period as shown in **Figure 1**. As currently modeled, the yield from wider adoption is assumed to be split with 50% in the North Grid and 50% in the South Grid.

Non-Floridan Private Irrigation

Category: Water Supply Option

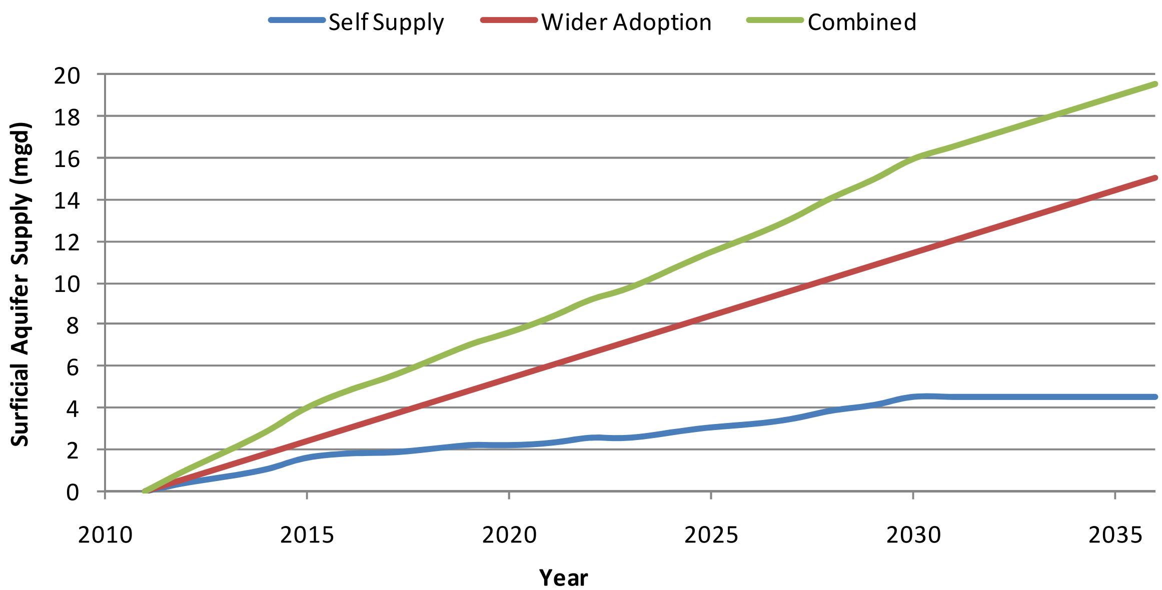


Figure 1: Projected yield per year

Cost:

Self Supply

Irrigation well replacement is estimated as $1,500 - $4,500 per well which includes the well, pump and electrical service. Assuming $3000 per well fully subsidized by JEA and 710 wells replaced (half of the total), capital costs would be $2.13 million. There would be no O&M costs as this would fall to the private homeowners.

Wider Adoption

For wider adoption the full cost of the wells would not need to be subsidized as the homeowners will have an additional financial incentive due to decreased water bills after switching to a self-supply. A subsidy of $500 would be provided. For 37,000 households this equates to a capital cost of $18.5 million. There would be no O&M costs as this would fall to the private homeowners.

Citations:

CDM (2011) "2011 Alternative Water Supply Evaluation and Implementation Plan" JEA. August 2011.

JEA "Reclaimed Water Feasibility Study: Retrofit of Multiple High Water Use Neighborhoods along Existing Reclaimed Water Lines" Powerpoint Presentation.

Regional Surface Water Reservoir for Potable

Category: Water Supply Option

Brief Description:

This option consists of construction of an off-line storage reservoir on a tributary to the St. Johns River to store wet weather flow to be treated and used as potable supply. Three locations have been carried forward for consideration: Ortega River, Big Davis Creek, and Durbin Creek.

Facilities Required:

Facilities required include a river diversion, dam, reservoir, treatment plant, and connection to the distribution system.

Key Assumptions:

In determining the estimated reliable yield the maximum diversion rate was assumed to be 25% of the mean daily flow and a ratio of 1.5 was used from the diversion rate to the reliable yield.

Flexibility:

This option will add surface water as a previously unused source into the system.

Environmental Impacts (Promote Environmental Sustainability):

This option will remove water from the tributaries. There is no affect assumed on the aquifers.

Ease of Implementation:

It is unknown if contiguous parcels of adequate size are available near the withdrawal points to site the dams and reservoirs. Ortega would need approximately 20 acres of land, Big Davis would need 7 acres, and Durbin Creek would need 13 acres. Additionally, there could be push back from neighbors not wanting a reservoir near them or because the project would affect tributaries in their areas. Permitting of dams and reservoirs will likely be more difficult then permitting of other options.

Within the qualitative scoring, the surface water reservoirs were given a score of 4 for reliance on proven technology signifying that further investigation is needed to implement. A score of 3 was given for the ability to permit, signifying that it may be challenging to permit but precedents exist. A score of 3 was given to public acceptance signifying that it may be difficult to convince the public to accept the new water source

Water Quality:

All locations in the lower St. Johns River basin are listed as impaired water according to the 2008 LSJRB SWIM study. Thus there will be a definite need for treatment before use. Blending issues with the groundwater sources are unknown and pilot studies would need to be conducted. Customers receiving the surface water or blended water could notice a change in taste and perceived quality. Within the qualitative scoring, the surface water reservoirs were given a score of 4 for water quality signifying minimal blending issues.

Regional Surface Water Reservoir for Potable

Category: Water Supply Option

Yield:

The yield was estimated as a maximum reliable yield. Potentially more flow could be available during wet years but the maximum reliable yield is assumed as a constant in the model. The estimations were made based on USGS gages stations. The yield from each reservoir is assumed to come online in the specific start year all at once without any phasing. **Table 1** shows the yield from each reservoir as well as the grid to which it is assumed to contribute flow.

Table 1: Regional Reservoir Yields

Tributary	Max Reliable Yield (mgd)	Grid
Ortega River	6.7	North
Big Davis Creek	1.3	South
Durbin Creek	3.4	South

Cost:

Table 2 provides the estimated capital and O&M costs for each tributary as well as a separate cost for the land. Land costs were estimated at $320,000 per acre plus an additional 18% for land acquisition. The cost of land was added to the capital costs for input into the model.

Table 2: Estimate Costs in 2012 Dollars

Tributary	Capital Costs	Land	O&M Fixed Costs per Year	O&M Variable Costs per MG
Ortega River	$48,500,000	$7,500,000	$2,100,000	$572.48
Big Davis Creek	$20,400,000	$2,600,000	$660,000	$927.29
Durbin Creek	$33,800,000	$4,900,000	$1,260,000	$676.87

Citations:

CH2MHILL (2010) "2010 Alternative Water Supply Study" JEA. July 2010.

Indirect Potable Reuse

Category: Reuse Water Option

Brief Description:

This option consists of treating wastewater effluent from one or more of JEA's large wastewater treatment facilities to meet the requirements for indirect potable reuse or groundwater recharge. The reclaimed water produced from this type of facility would be used to directly recharge the drinking water source of the Floridan aquifer.

Facilities Required:

Direct injection wells for the reclaimed water would be required as would process upgrades to the wastewater treatment plants.

Key Assumptions:

A one-to-one ratio of injection to allowable withdrawal is assumed but can be changed in the model.

Flexibility:

This option provides more flexibility in the amount of water to be withdrawn from the Floridan aquifer.

Environmental Impacts (Promote Environmental Sustainability):

This option has the potential to improve aquifer sustainability. River quality may also be improved as less wastewater effluent will reach the river.

Ease of Implementation:

Public acceptance could be an issue for injecting reclaimed wastewater into a potable water source. Permitting a one-to-one offset may also be difficult. Within the qualitative scoring, indirect potable reuse was given a score of 2 for reliance on proven technology signifying that there is a precedent for use in the Southeaster US but known challenges. A score of 1 was given for the ability to permit, signifying JEA has no precedent and it is assumed to be difficult to permit. A score of 1 was given to public acceptance signifying that public acceptance is unlikely.

Water Quality:

Upgraded treatment at the WWTP will be needed to bring wastewater to indirect potable reuse standards. Within the qualitative scoring, indirect potable reuse was given a score of 3 for water quality signifying that some blending issues are to be expected.

Yield:

Various treatment capacities can be implemented within both the north and south grids ranging between 5 and 50 mgd. The amount of potential yield JEA can then utilize would be dependent on the permitted injection to withdrawal ratio which can be changed within the model.

Indirect Potable Reuse

Category: Reuse Water Option

Cost:

Table 1 provides estimated capital and O&M costs for a range of treatment capacities within both the north and south grids

Table 1: Indirect Potable Reuse Option Costs

	Treatment Capacity (mgd)			
	5	15	30	50
North Grid				
Capital	$98,000,000	$175,700,000	$295,800,000	$587,800,000
O&M Fixed Costs per Year	$1,280,000	$3,080,000	$5,400,000	$8,120,000
O&M Variable Costs per MG	$1052.05	$843.84	$739.73	$667.4
South Grid				
Capital	$101,600,000	$182,700,000	$309,800,000	$498,300,000
O&M Fixed Costs per Year	$1,280,000	$3,080,000	$5,400,000	$8,120,000
O&M Variable Costs per MG	$1052.05	$843.84	$739.73	$667.4

Citations:

CDM (2011) "2011 Alternative Water Supply Evaluation and Implementation Plan" JEA. August 2011.

CH2MHill (2008) "JEA Total Water Management Plan". September 2008.

Keystone Lake Region Reuse

Category: Reuse Water Option

Brief Description:

This option consists of using reclaimed water from the Southwest WWTP to directly recharge the Floridan aquifer through direct injection. It is likely that there may not be sufficient reclaimed water available for recharge exclusively from the Southwest WWTP since average wastewater flows at this facility (as of December 2010) were approximately 8.8 mgd. Therefore, it may be possible to augment the reclaimed water supply with surface water from the Ortega River, which is located in close proximity to this facility.

Facilities Required:

Either rapid infiltration basins or direct injection wells will be required along with process upgrades to the Southwest WWTP as well as treatment of the surface water at Ortega. New pipelines will also be required to distribute the flow between the injection wells.

Key Assumptions:

A one-to-one injection to withdrawal ratio is assumed but can be changed in the model.

Flexibility:

This option provides more flexibility in the amount of water to be withdrawn from the Floridan aquifer.

Environmental Impacts (Promote Environmental Sustainability):

This option has the potential to improve aquifer sustainability. There will be impacts to the Ortega River if used to augment the wastewater effluent.

Ease of Implementation:

Public acceptance is a likely issue for injecting reclaimed wastewater into a potable water source. Additionally, there will be similar public issues as for the regional surface water reservoirs with use of the Ortega River. Permitting a one-to-one offset may also be difficult. Within the qualitative scoring, Keystone Lake regional reuse was given a score of 2 for reliance on proven technology signifying that there is a precedent for use in the Southeaster US but known challenges. A score of 1 was given for the ability to permit, signifying JEA has no precedent and it is assumed to be difficult to permit. A score of 1 was given to public acceptance signifying that public acceptance is unlikely.

Water Quality:

Upgraded treatment at the WWTP will be needed to bring wastewater to indirect potable reuse standards. The effects of blending reclaimed water, surface water, and groundwater sources together is unknown. Within the qualitative scoring, Keystone Lake regional reuse was given a score of 4 for water quality signifying minimal blending issues expected.

Yield:

A total yield of 15 mgd can be achieved if 8.8 mgd from the Southwest WWTP is utilized along with 6.7 mgd from the Ortega River. This option is thus not able to be combined with a regional surface water reservoir on the Ortega River since that would double count use of the Ortega River water.

Keystone Lake Region Reuse

Category: Reuse Water Option

Cost:

Capital costs for this option were estimated at $177,500,000 along with fixed O&M costs of $2,000,000 per year and variable O&M costs of $365.3 per million gallons of water.

Citations:

CDM (2011) "2011 Alternative Water Supply Evaluation and Implementation Plan" JEA. August 2011.

Regional Reuse

Category: Reuse Water Option

Brief Description:

This option increases the supply of available reclaimed water throughout the whole St. Johns River Water Management District. Three different scales of options were considered: (1) increasing reclaimed water availability with a max capital expenditure of $300 million; (2) achieving 60 percent reuse from wastewater effluent; and (3) achieving 75 percent reuse from wastewater effluent. A fourth scenario of 100 percent reuse was also considered in the base report, but this has not been included in the model since the yields as described were not available based on the most recent wastewater projections.

Facilities Required:

Treatment plant expansions would be required to bring the wastewater effluent to reclaimed quality. Additionally pump stations, pipeline, storage facilities, and rapid infiltration basins would be required to make use of the new resources feasible.

Key Assumptions:

The yields and costs for this option are set up based on the 2008 “Lower St. Johns River Reuse and Treatment Project” report. The exact percentage targets of 60 and 75 may no longer be accurate percentages based on the latest wastewater projections but the terminology has been maintained.

Flexibility:

Increased availability of reclaimed water will allow JEA to meet the reuse requirements for increases in the CUP allocations.

Environmental Impacts (Promote Environmental Sustainability):

There would be a beneficial impact to the quality of the St. Johns River with less wastewater effluent disposal. The estimated percentage reduction in total nitrogen to the river from the different scenarios is 24%, 43%, and 68% respectively.

Ease of Implementation:

Projects of this size and requiring coordination with both Clay County Utility Authority (CCUA) and the St. Johns County Utility District (SJCUD) will make implementation more difficult.

Water Quality:

Upgraded treatment at the WWTP will be needed to bring wastewater to indirect potable reuse standards.

Yield:

Within the Lower St. Johns River Reuse and Treatment Project, a series of scenarios were studied based on the percentage of wastewater effluent moved to reclaimed quality. **Table 1** provides the increased reclaimed water flows available under the four scenarios for the north and south grids. As well as the potable offset calculated for each scenario. In is assumed that this potable offset is for the whole region including the CCUA and SJCUD service areas. Within the model the percentage of the total offset available to JEA is set at 50% but can be adjusted. The percentage split of JEA’s portion of the offset is split between the North and South Grids based on the ratio of increased reclaimed water availability per grid for the given scenario.

Regional Reuse

Category: Reuse Water Option

Table 1: Reclaimed Water Increased Availability (mgd)

Scenario	North Grid	South Grid	Total Potable Offset for Region (MGD)
$300 Million Max	19	4	42
60% Reuse	27	14	61
75% Reuse	43	13	64

Cost:

Within the Lower St. Johns River Reuse and Treatment final report, costs for each scenario were provided for treatment facilities, pipeline, pump stations, storage reservoirs, and rapid infiltration basins. Within **Table 2** the estimated total costs of each scenario is provided along with JEA's estimated portion. Assumptions used in determining JEA's portion include the following:

- Costs of treatment facilities upgrades were broken down by facilities and those facilities within JEA's service area were included as part of the costs. Facilities within SJCUD or CCUA were not included.
- Only a total cost for pipeline improvements was provided. However, a listing of the linear-feet of pipe within each service area was given. The percentage of the pipeline cost attributed to JEA was proportional to the percentage of the linear-feet of new pipe within its service area.
- New storage reservoirs were listed based on the service area within which they were planned for construction. Only costs for the reservoirs within the JEA service area were included.
- The cost of the rapid infiltration basins was provided as a single cost with the facilities to be utilized by all three utilities. JEA's percentage of the costs was based on the percentage of the total projected wastewater flow for the region in 2030. JEA is projected to produce 75% of the flow so 75% of the cost for the infiltration basins was assigned to them. CCUA is projected to produce 18% and SJCUD 7% of the flow.

Table 2: Scenario Costs

	Capital	O&M Fixed per Year	O&M per MG	O&M Total
$300 Million Total Expenditure				
Total for Region	**$304,000,000**			**$8,000,000**
JEA Total	**$157,400,000**	**$2,200,000**	**$262.06**	**$4,400,000**
60% Reuse Target				
Total for Region	**$515,000,000**			**$14,000,000**
JEA Total	**$302,200,000**	**$3,700,000**	**$247.24**	**$7,400,000**
75% Reuse Target				
Total for Region	**$780,000,000**			**$18,000,000**
JEA Total	**$479,000,000**	**$4,950,000**	**$242.17**	**$9,900,000**

Citations:

CDM (2011) "2011 Alternative Water Supply Evaluation and Implementation Plan" JEA. August 2011.

CH2MHill (2008) "Lower St. Johns River Reuse and Treatment Project; Phase II: Combined East and West River Reuse Initiative Solutions". Prepared for St. Johns River Water Management District, JEA, St. Johns County Utility Department, and Clay County Utility Authority. September 2008.

Targeted Reuse

Category: Reuse Water Option

Brief Description:

This option consists of using available reclaimed water for the specific targeted uses of: (1) replacing the Stone Container Corporation's use of potable water with reclaimed water in their commercial processes; (2) use of reclaimed water from the Arlington East facility for groundwater salinity management; (3) providing reclaimed water to 'water hogs' (large residential users) in the south grid.

Facilities Required:

New reclaimed water lines would be required as well as injection wells for the salinity management option.

Key Assumptions:

The cost of increased treatment capacity to produce the reclaimed water is not included under this option. The sub-options are instead potential methods to use reclaimed water already available.

Flexibility:

Use of reclaimed water allows for a potable water offset and will potentially trigger increases in the CUP allocations if total reclaimed water use targets are achieved.

Environmental Impacts (Promote Environmental Sustainability):

This option will improve river quality through increasing the use of wastewater effluent. Aquifer sustainability will also be positively affected due to less reliance on groundwater.

Ease of Implementation:

Public acceptance could be an issue for injecting reclaimed wastewater into a potable water source. Also there is no guarantee that residential clients will use the reclaimed water once it is made available.

Water Quality:

There are no blending issues within the distribution system since the reclaimed water will be kept separate from potable sources under all options.

Yield:

The yields for the various sub-options are described below.

1. The Stone Container Corporation currently uses 8.8 mgd from the local aquifer. The nearest reclaimed water line is served from the Cedar Bay facility. Currently this facility produces 5 mgd of flow; however, accounting for other users only 3.3 mgd would currently be available for use by the Stone Container Corporation. This could be increased if other options are enacted increasing the available reclaimed supply.
2. The salinity barrier option was planned to provide 5 mgd of potable offset. A conservative injection to withdrawal ratio of 1.5 was used, meaning 7.5 mgd of treated and injected water would be required.
3. As part of a Reclaimed Water Feasibility Study, bringing reclaimed water to the four high use areas of Queen's Harbor, Deerwood, Hidden Hills, and Glen Kernan was studied. Based on the population of each community, the percentage of customers currently with irrigation meters and the average water use per irrigation meter a total value of 1.05 mgd was calculated for potential reclaimed use.

Targeted Reuse

Category: Reuse Water Option

Cost:

The costs assumptions for each option are described below and capital and O&M costs summarized in **Table 1**.

1. The costs for source replacement at the Stone Container Corporation includes filters and high level UV disinfection for the 3.3 mgd of flow as well as additional pumping and piping to transport the water.
2. The costs for the salinity barrier included low pressure RO, high level UV disinfection, pumping, piping, and 18 injection wells.
3. An estimate of $20 million is currently being used as the capital cost to expand the reuse system into high use residential areas. This is loosely based on the piping costs developed for the salinity barrier option and was verified by the Reclaimed Water Feasibility presentation.

Table 2: Estimate Costs in 2012 Dollars

Sub-Option	Capital Costs	O&M Fixed Costs per Year	O&M Variable Costs per MG
Stone Container Corp	$27,600,000	$250,000	$232.46
Salinity Barrier	$94,000,000	$276,000	$226.85
Water Hogs	$20,000,000	$300,000	$78.28

Citations:

CDM (2011) "2011 Alternative Water Supply Evaluation and Implementation Plan" JEA. August 2011.

CH2MHill (2008) "JEA Total Water Management Plan". September 2008.

JEA "Reclaimed Water Feasibility Study: Retrofit of Multiple High Water Use Neighborhoods along Existing Reclaimed Water Lines" Powerpoint Presentation.

Conservation

Category: Demand Management

Brief Description:

This option involves reducing demand through conservation efforts.

Facilities Required:

No significant new facilities would be required.

Key Assumptions:

It is assumed that conservation will follow the same seasonal pattern as demand with more potential for conservation in the summer than the winter months.

Flexibility:

Operational flexibility can be improved if conservation can reduce peak demand needs as well as delay the need for additional sources.

Environmental Impacts (Promote Environmental Sustainability):

This option will improve the efficiency of water use within the JEA system. There are no assumed impacts on the river and positive benefits to the aquifer through reducing demand.

Ease of Implementation:

This option depends on public participation.

Water Quality:

There are no water quality considerations.

Yield:

The proposed conservation targets in the CUP were taken as the medium conservation scenario. The pattern proposed included a sharp increase in conservation between 2012 and 2016 followed by a milder rate of increase in the following years. This same pattern was adjusted to form the low and high conservation scenarios. For the low conservation scenario, the original sharper increase was kept to half the original value followed by the same milder rate of increase as the medium scenario. For the high conservation scenario, the same initial jump in conservation as the medium scenario was used followed by a rate of conservation double that of the medium scenario in the following years. All these patterns can be seen in **Figure 1** and are able to be adjusted within the model. There is also the option for no conservation programs to be implemented.

The total conservation targets are split between grids proportionately based on the 2036 demand. The default percentage of the total conservation assigned to each grid is provided in **Table 1.** This can be adjusted within the model interface.

Table 1: Percentage of Conservation per Grid

Grid	Percentage
North	39%
South	57%
Ponte Vedra	1%
Ponce de Leon	0.3%
Lofton Oaks	3%
Mayport	0.1%

Conservation

Category: Demand Management

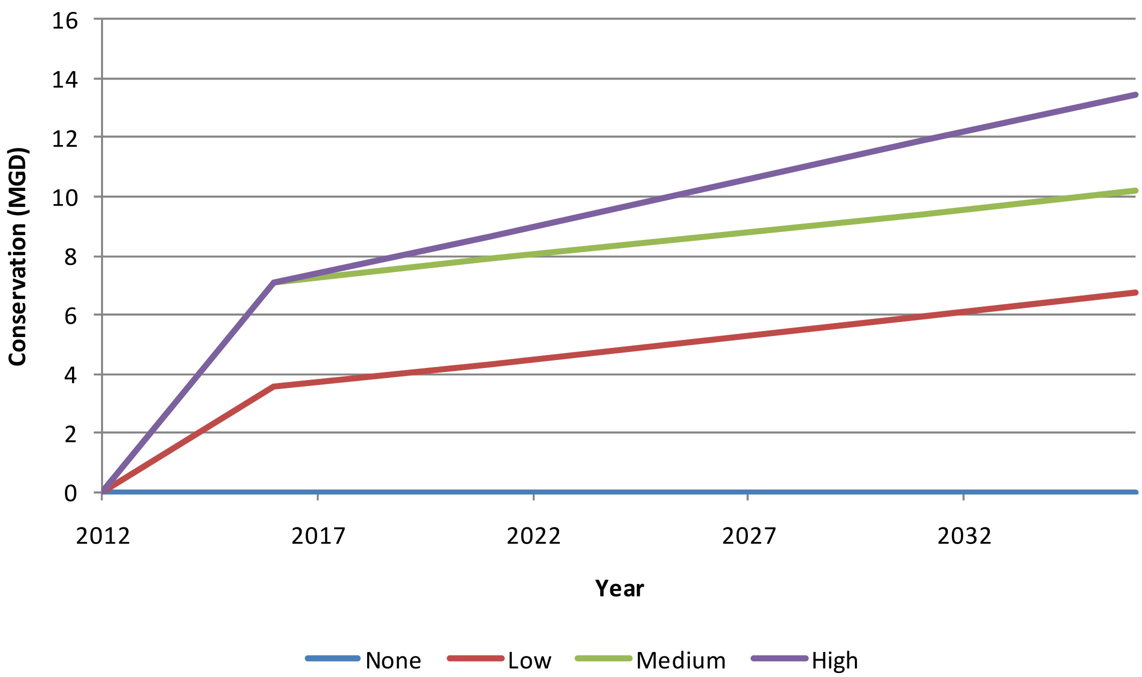


Figure 1: Levels of Conservation

Cost:

Since no infrastructure is required, the cost of the program is through education and outreach on the importance of conservation and methods to reduce water use within the home. For the low level, costs are assumed to be $500,000 a year, for the medium level $750,000, and for the high level $1,000,000 per year.

Citations:

CDM (2012) "Water Demand Forecast & Gap Analysis for the JEA Integrated Water Resource Planning Project" Prepared for JEA. April 2012.

Reduce Non-Revenue for Water

Category: Demand Management

Brief Description:

This option reduces non-revenue for water within the current system through leak reduction and other measures.

Facilities Required:

No significant new facilities would be required.

Key Assumptions:

JEA has an Infrastructure Leakage Index of 4.1 which puts it in the category which should evaluate the costs of water resources relative to the cost of a loss control program. However, the South and Ponce De Leon Grids have higher rates of unaccounted for water and a leak detection program is a requirement of the CUP allocation.

Flexibility:

This option will improve operational flexibility through reduction of wasted water.

Environmental Impacts (Promote Environmental Sustainability):

This option will improve the efficiency of water use within the JEA system. There are no assumed river or aquifer impacts.

Ease of Implementation:

A leak detection program should be easy to implement.

Water Quality:

There are no water quality concerns.

Yield:

Data from 2011 shows 17.89 mgd of non-revenue water. Assuming that at the maximum 50% of the losses can be addressed through leak reduction programs, there would be 8.9 mgd in water savings. However, 5 mgd was considered a more reasonable goal and is the initial default value within the model. Currently this value is split with 80% of the savings in the North Grid and 20% of the savings in the South Grid.

Reduce Non-Revenue for Water

Category: Demand Management

Cost:

Placeholder values of $5 million in initial capital costs and $1 million in fixed yearly O&M are included in the model for reducing non-revenue water. There is assumed to be no variable O&M. These values should be refined as more information becomes available.

Citations:

CDM (2012) "Water Demand Forecast & Gap Analysis for the JEA Integrated Water Resource Planning Project" Prepared for JEA. April 2012.

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