CV-SALTS Technical Memorandum

Date: April 15, 2010

To: CV-SALTS Technical Advisory Committee

From: Salt and Nitrate Sources Pilot Studies Review Knowledge Gained Subcommittee

Early in 2011, the CV-SALTS Executive Committee directed the Knowledge Gained Subcommittee to develop a framework for salt/nitrate identification studies by April 2011. This memorandum responds to this direction. An additional and more detailed report will be submitted in May to expand upon this memorandum.

PROCESS: Following review of the Salt and Nitrate Pilot Implementation Study (SNPS) report, the TAC established a voluntary review subcommittee, (Knowledge Gained Subcommittee) to evaluate and document what CV-SALTS learned through the experience and to examine the role of the SNPS in the development of Salt/Nutrient Management Plans and the larger CV-SALTS program. In the fall of 2010 the Executive Committee suspended all subcommittees in order to refocus the mission of the CV-SALTS. This memorandum responds to specific direction from the CV-SALTS Executive Committee.

RECOMMENDATION: The Knowledge Gained subcommittee submits this salt/nitrate identification study framework for adoption by the Executive Committee. This submittal is intended to meet the Progress Goal due in April:

> Framework developed for salt/nitrate identification studies (Assess the validity of the salt source survey pilot studies. If the approaches need modification, identify the adjustments that will be made to make the approach useful in the rest of the region.) [from Knowledge Gained Subcommittee]

FRAMEWORK FOR SALT/NITRATE IDENTIFICATION STUDIES: The Knowledge Gained Subcommittee is producing a framework report that includes:

1. Description of the purpose and components of Salt/Nitrate Identification Studies
2. A list of the technical design questions for Salt/Nitrate Identification Studies
3. A technical outline of the contents of Salt/Nitrate Identification Studies
4. Examples of visualizations of results of Salt/Nitrate Identification Studies

This memorandum presents the final version of the first section of this framework report.

The Knowledge Gained Subcommittee is also producing a companion document for the Executive Committee that describes how Salt/Nitrate Identification Studies support the overall objectives of the CV-SALTS effort.

DESCRIPTION OF PURPOSE AND COMPONENTS OF SALT/NITRATE IDENTIFICATION STUDIES:
Salt/Nitrate Identification Studies serve several purposes: Studies can develop information at appropriate regional scales for region-specific salinity problems, Studies enable prioritization of management efforts throughout the Basin, and Studies are a starting point for regulated regions' implementation activities. Studies can vary in the level of detail, dependent on the scope and scale of salinity issues, the availability of data, as well as the urgency of salt and nitrate issues in the region. Studies should be conducted in a stepwise fashion, as each step is dependent on the results of the previous step. All areas should complete Steps 1 through 4 and areas with more data and with a higher priority for management should complete Step 5 and will have greater detail developed in Steps 2 through 4.

Step 1: The first step in a Salt/Nitrate Identification Study is the **delineation of the study region**. Delineation considerations should include: natural hydrological pathways (watersheds), water supply and wastewater infrastructure, existing salinity/nitrate regulation endpoints, and land use. The regulatory endpoints are used to inform temporal scales of the budgets. Use of GIS is recommended.

Step 2: The second step in a Salt/Nitrate Identification Study is **the development of a water budget.** A water budget is the characterization and accounting of water sources, water uses, uncontrolled water pathways, controlled pathways of irrigated return water and treated municipal and storm waters, and other water loss pathways (evapotranspiration, biomass). Water budgets identify constraints to the water budget (permit terms, environmental regulations, risk management, etc.). More than one water budget may need to be developed to capture shifts in water or wastewater management due to factors like hydrology (dry versus wet year water management). Data sources should be described and quality assessed and assumptions documented (see principles). The development of an accurate water budget is the foundation of salt and nitrate characterizations.

Step 3: The third step in a Salt/Nitrate Identification Study is **the development of salt and nitrate sources and budgets**. All salt and nitrate sources are identified with appropriate quantitative, location, and land use data. Salt and nitrate information is attached to elements of the water budget and simple mass balances are developed. For more complicated and data-rich areas, more complicated mass balances are developed. Significant salt/nitrate sources and sinks are highlighted. Data sources should be described and quality assessed and assumptions documented (see principles).

Step 4: The fourth step in a Salt/Nitrate Identification Study is to **synthesize and create visualizations of the budget information**. The transformation of data into information should be done in consideration of salinity issue(s) and regulatory endpoints. Minimum uniform requirements shall be developed so that different Studies can be integrated into a conceptual model and directly compared, while recognizing variability in data availability and temporal scales.

Step 5: The fifth step (for higher priority/more complex areas) in a Salt/Nitrate Identification Study is to **develop additional information needed to support effective management practices and alternatives**. High priority areas will likely view Salt/Nitrate Identification Studies as a tool to inform solutions. Additional information can include the collection of information to refine budgets or default values, to develop additional ways of characterizing salt/nitrate loading, trends, or accumulation, or other data to inform strategic priorities related to regulatory endpoints.

Additional Principles

Data availability: The accuracy of water and salt/nitrate budgets is largely dependent on the availability of accurate data. The availability of data varies broadly throughout the Central Valley. Available data should be supplemented by documented assumptions (preferably supported by references) where needed to develop budgets.

Data quality: The highest priority is to use data that is supported by quality assurance/quality control processes. Other data should be used after they are reviewed for obvious quality issues, and such data should be clearly documented as of lower quality. The quality of data varies broadly throughout the Central Valley. Uncertainty analyses should be conducted to determine whether improved data would improve budgets.

Default assumptions: CV-SALTS should develop a set of default assumptions for use in areas where data is not available. Sensitivity tests can be used to determine where areas should consider replacing default assumptions through data collection to improve budgets.

Participants: Over the past year, the Knowledge Gained Subcommittee has included:

- Lisa Holm
- Mona Shulman
- Michael Nordstrom
- Nigel Quinn
- David Cory
- Joe DiGiorgio
- Linda Dorn
- Debbie Webster
- Bob Braun
- Melissa Turner
- Michael Johnson
- Robert Smith
- John Dickey
- Michel Steiger
- Andrew Safford
- Rudy Schnagl
- Jim Martin
- Jeanne Chilcott
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A Framework for Salt/Nitrate Identification Studies

1 Purpose of Studies

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2 Study Process

Studies should be conducted in a stepwise fashion, as each step is dependent on the results of the previous step. All areas should complete Steps 1 through 4 and areas with more data and with a higher priority for management should complete Step 5 and will have greater detail developed in Steps 2 through 4.

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Step 2: The second step in a Salt/Nitrate Identification Study is **the development of a water budget.** A water budget is the characterization and accounting of water sources, water uses, uncontrolled water pathways, controlled pathways of irrigated return water and treated municipal and storm waters, and other water loss pathways (evapotranspiration, biomass). Water budgets identify constraints to the water budget (permit terms, environmental regulations, risk management, etc.). More than one water budget may need to be developed to capture shifts in water or wastewater management due to factors like hydrology (dry versus wet year water management). Data sources should be described and quality assessed and assumptions documented (see principles). The development of an accurate water budget is the foundation of salt and nitrate characterizations.

Step 3: The third step in a Salt/Nitrate Identification Study is **the development of salt and nitrate sources and budgets**. All salt and nitrate sources are identified with appropriate quantitative, location, and land use data. Salt and nitrate information is attached to elements of the water budget and simple mass balances are developed. For more complicated and data-rich areas, more complicated mass balances are developed. Significant salt/nitrate sources and sinks are highlighted. Data sources should be described and quality assessed and assumptions documented (see principles).

Step 4: The fourth step in a Salt/Nitrate Identification Study is to **synthesize and create visualizations of the budget information**. The transformation of data into information should be done in consideration of salinity issue(s) and regulatory endpoints. Minimum uniform requirements should be developed so that different Studies can be integrated into a conceptual model and directly compared, while recognizing variability in data availability and temporal scales.

Step 5: The fifth step (for higher priority/more complex areas) in a Salt/Nitrate Identification Study is to **develop additional information needed to support management practices and**

alternatives. High priority areas will likely view Salt/Nitrate Identification Studies as a tool to inform solutions. Additional information can include the collection of information to refine budgets or default values, to develop additional ways of characterizing salt/nitrate loading, trends, or accumulation, or other data to inform strategic priorities related to regulatory endpoints.

3 Study Technical Objectives

Technical objectives are presented so that parties developing Salt/Nitrate Identification Studies have flexibility in following the described Study Process (2) and Detailed Study Outline (5) by focusing on the key technical objectives of the Studies.

Primary Objectives:

A basic conceptual model is developed that describes

- salt/nitrate sources and sinks,
- salt/nitrate paths of movement from source to sink,
- areas of salt/nitrate accumulation, and
- employs a clearly defined control volume to accomplish the regional water budget and salt/nitrate load balances

Conceptual model includes a regional water budget that

- Describes source quantity, quality and timing, and supply demand patterns (by timing and use);
- characterizes fate and transport of water; and
- lists critical influences on regional water management.

Additional Technical Objectives:

1. Study determines if the regional water budget and total salt/nitrate mass loads individually balance and clearly communicate the results. The regional water budget is used to examine salt and nitrate concentrations through the water supply chain.
2. Study identifies regulatory requirements, beneficial uses, and local planning objectives pertaining to salinity and nitrate within the region and considers their impact within the study components.
3. Study determines the salt/nitrate mass loading rates of each source and clearly presents a written and graphical comparison of source loads.
4. If possible to quantify sufficiently, study conducts trend analyses of historical and projected salt/nitrate loads for each source.
5. If salt/nitrate is accumulating within the region, study determines the locations and rates of accumulation.
6. Study translates the salt/nitrate mass loading rates into corresponding water flow volumes and salinity/nitrate concentrations so the loading rates can be put into a regional context to allow prioritization of management options.
7. Salt/nitrate assimilative capacities of groundwater and surface water bodies within the region are determined or estimated.
8. Salt/nitrate loadings are characterized in sufficient detail to inform control strategies.
9. Methodology used to conduct the study is clearly described.
10. Data gaps are identified.
11. Data is validated and validation methodology clearly described.
12. Data relied upon in the study sufficient and of high enough quality to answer the above questions with an acceptable degree of confidence.

4 Technical Principles

Data availability: The accuracy of water and salt/nitrate budgets is largely dependent on the availability of accurate data. The availability of data varies broadly throughout the Central Valley. Available data should be supplemented by documented assumptions (preferably supported by references) where needed to develop budgets.

Data quality: The highest priority is to use data that is supported by quality assurance/quality control processes. Other data should be used after they are reviewed for obvious quality issues, and such data should be clearly documented as of lower quality. The quality of data varies broadly throughout the Central Valley. Uncertainty analyses should be conducted to determine whether improved data would improve budgets.

Default assumptions: CV-SALTS should develop a set of default assumptions for use in areas where data is not available. Sensitivity tests can be used to determine where areas should consider replacing default assumptions through data collection to improve budgets.

5 Detailed Study Outline

For detailed review of regions expected information from a region would include the following areas. The required levels of information: Black text all regions, red text more impacted regions.

1. Physical Description of Region. *Region should identify itself by physical boundaries and participating stakeholders. (GIS shapefile format)*
    - 1.1 Existing Institutional and legal frameworks for addressing salt/nitrates (planning, funding, implementing)
2. Water Budget. R*egion should develop one or more water budget examples that characterize the water use of that region, at a scale that is appropriate to salinity and nitrate management. For more complex regions, numerical models should be used to develop water, salt, and nitrate budgets.*
    - 2.1 Define appropriate physical scale: *These may be traditional watershed boundaries, or they may need to adapt to human manipulation of watershed. Either way, they must maintain integrity between unit boundaries and throughout the region. (Or for a minimum level can it be the entire region?)*
    - 2.2 Define appropriate temporal scale: *Region should determine on which temporal scale salinity/nitrate issues are most appropriately addressed, and the water budget should be developed to support this scale. If there are no existing issues (existing water quality objectives or local water quality operational guidelines), then region's should consider as a default a monthly temporal scale for surface water and an annual/decadal? Scale for groundwater.*
        - 2.2.1 Residence time consideration – since some water quality solutions come through changing the timing of discharge or of water supply management.
        - 2.2.2 Exceptions to the steady state assumption and other factors needed to understand the water balance
    - 2.3 Define representative budget scenario(s). *Region should account for sources, qualities and uses of source waters and should identify waters leaving region. The water budget should consider all sources of water, as well as the current priorities and constraints of*

their use and properties. For example, if a region's water supply is entirely surface water in wet years, but entirely ground water in dry years, a region should develop water budgets for both of those hydrologic conditions. If water use decisions are dependent on other constraints that can vary significantly, those should be considered when defining representative scenarios.

- 2.3.1 Surface water (source and receiving) – *If there are major surface waters flowing through, but not entirely used as a supply, should there be some way to just pass through that water/salt and focus on incremental effect on the water body?*
  - 2.3.1.1 Identify drivers of surface water supply management
  - 2.3.1.2 Identify existing surface water models
  - 2.3.1.3 Identify evapo-transpiration rates throughout region
- 2.3.2 Groundwater (source and receiving)
  - 2.3.2.1 Identify drivers and constraints of ground water supply management
  - 2.3.2.2 Identify existing groundwater models
- 2.3.3 Recycled water
- 2.3.4 Constraints (i.e. hydrology, regulatory demands, habitat considerations, flood control, water supply variability, drought planning, future development, water rights)
- 2.3.5 Current state of development and future state of development

3. Land Cover. *Region should provide descriptions of land cover in region.*
   - *3.1 At current development level and at estimated build out (or through end of existing general plan coverage)*
   - 3.2 Identify associated water sources
   - 3.3 CUs where different from standard CVSALTS assumptions
   - 3.4 Salt and nitrate Loading rates where different from standard CVSALTS assumptions, including documentation of replacement values
   - 3.5 Identify any salinity/nitrate best management practices currently supported by region
   - 3.6 Identify the largest drivers of land cover decisions in region
4. Salt Budget. *Region should develop salt budgets that correspond to each representative water budget developed*
   - 4.1 Identify Salt Sources. *Region should identify all salt sources. Default values by land cover are provided by CVSALTS. Salt source categories are water supply, land cover, and atmospheric deposition. Salt sources should be described in terms of concentration, loading rate (per acre, per region), and acres of associated land cover.*
     - 4.1.1 Prioritize Salt sources: *Salt sources should be ranked by largest to smallest sources, with a focus on the largest sources relative to each major receiving water body. Differentiate between anthropogenic (controllable) and non-anthropogenic sources.*
   - 4.2 Identify Salt Sinks. *Region should identify all salt sinks: surface water, groundwater, land disposal, off-site shipping.*
   - 4.3 Inventory in soils, both as a source of nitrate to groundwater and interim storage
   - 4.4 Concentration processes and locations. *Region should identify activities that are currently concentrating salts a) within the region generally and b) in localized hot spots.*
   - 4.5 Identify where residence time and/or proximity is a factor in surface water balances of salt.
   - 4.6 Identify all site-specific salinity water quality objectives in the region.
     - 4.6.1 Identify all existing control programs adopted in region and status of implementation.

4.6.2 Are existing control programs in place to regulate throughout the watershed (including all of the region's neighboring regions)?

4.7 Identify any existing problem areas, hotspots and compliance issues for surface and groundwaters within the region (at any scale).

4.8 Identify any current salinity management plans, projects or activities being implemented in the region.

4.8.1 Identify current implementation of appropriate best management practices.

4.8.2 Scale, technology, economics, other drivers/benefits for each project.

4.9 Identify current plans, regulations, or projects designed to maintain or reduce salt that is transported to neighboring regions.

4.10 Identify current salinity monitoring locations.

4.11 Identify current salinity monitoring gaps and funding/schedule to fill.

4.12 Identify performance measures and triggers. *Based on nitrate budget, region must identify performance monitoring locations (can include water quality, land cover, planning or other activities) as well as "triggers" that would require reassessment of the region's status within the long term Central Valley salinity and nitrate management plan.*

5. Nitrate Budget- *region should develop nitrate budgets that correspond to each representative water budget developed.*

5.1 Identify Nitrate sources. *Region should identify all nitrate sources, including nitrate pre-cursors. Default values by land cover are provided by CVSALTS. Nitrate source categories are water supply, land cover (fertilizer application), and atmospheric deposition(?). Nitrate and nitrate pre-cursor sources should be described in terms of concentration, loading rate (per acre, per region), and acres of associated land cover. Transformation of pre-cursors into nitrates should be identified by facilitating activity. Nitrate and nitrate pre-cursor sources should be ranked by largest to smallest sources, with a focus on the largest sources relative to each major receiving water body.*

5.1.1 Prioritize Nitrate sources: *Nitrate and nitrate pre-cursor sources should be ranked by largest to smallest sources, with a focus on the largest sources relative to each major receiving water body. Differentiate between anthropogenic (controllable) and non-anthropogenic sources.*

5.2 Identify Nitrate Sinks. *Region should identify all nitrate sinks: surface water, groundwater, land disposal, off-site shipping.*

5.3 Nitrogen losses

5.4 Inventory of nitrate in soils that can enter groundwater

5.5 Identify all site-specific nitrate and dissolved oxygen water quality objectives in the region.

5.5.1 Identify all existing control programs adopted in region and status of implementation.

5.5.2 Are existing control programs in place to regulate throughout the watershed (including all of the region's neighboring regions)?

5.6 Identify any existing problem areas, hotspots and compliance issues for surface and groundwaters within the region (at any scale).

5.7 Identify any current nitrate or nutrient management plans, projects or activities being implemented in the region.

5.7.1 Identify current implementation of appropriate best management practices.

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5.8 Identify current plans, regulations, or projects designed to maintain or reduce nitrate that is transported to neighboring regions.

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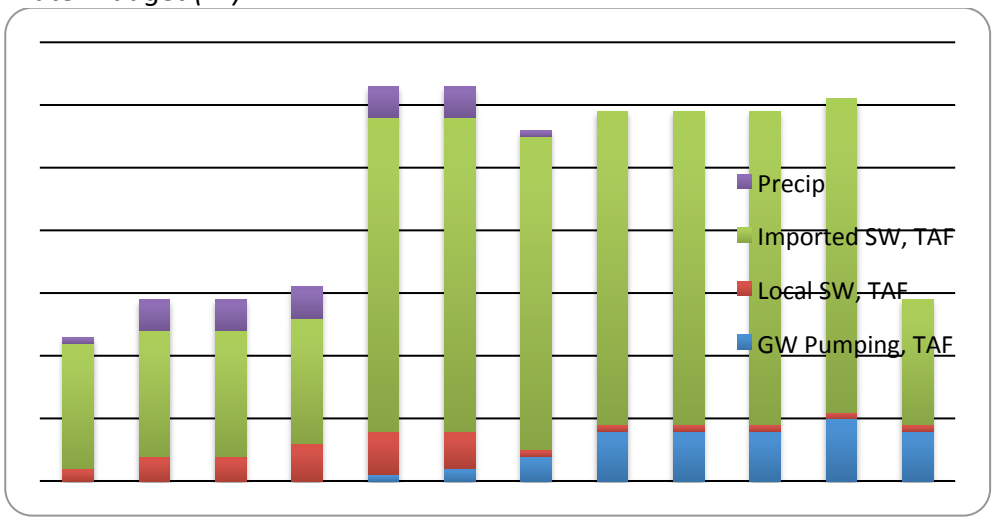
6 Suggested Visualizations of Study Results

Salt/Nitrate Identification Studies are meant to be a collection of regional studies that combine to represent the Central Valley. In order to ensure that the results of individual studies can be compared, CV-SALTS recommends that studies include at least the types of visualizations featured in this section.

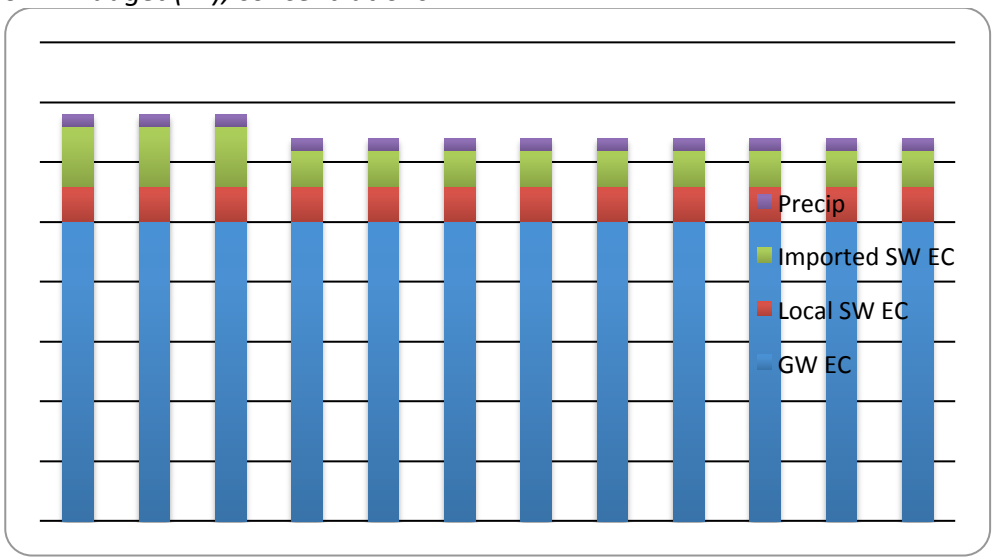
For areas with limited surface water data and therefore averaged over a significant period of time, or as appropriate for groundwater basins, studies should include the following types of pie charts. (examples to be added, see SNPS figures)

For areas with sufficient surface water data and responding to regulatory endpoints with monthly time steps, studies should include sufficient histograms to fully represent their water, salinity and nitrate budgets. Examples of these are:

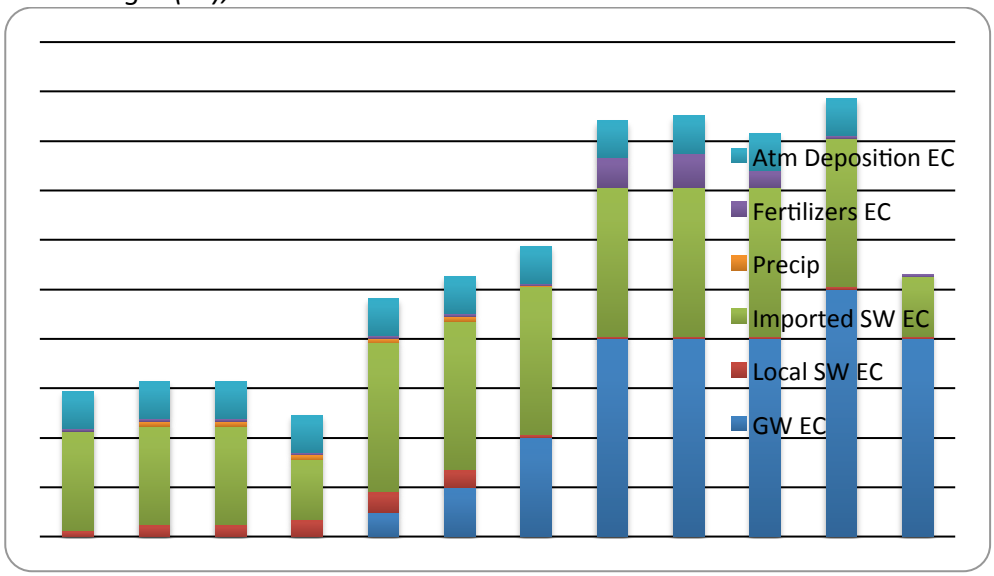
Water Budget (IN):



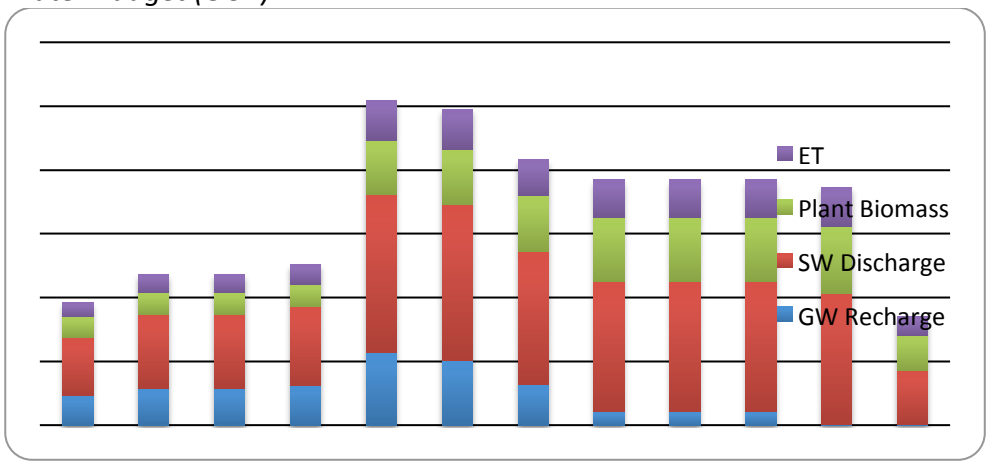
SALT Budget (IN), concentrations:



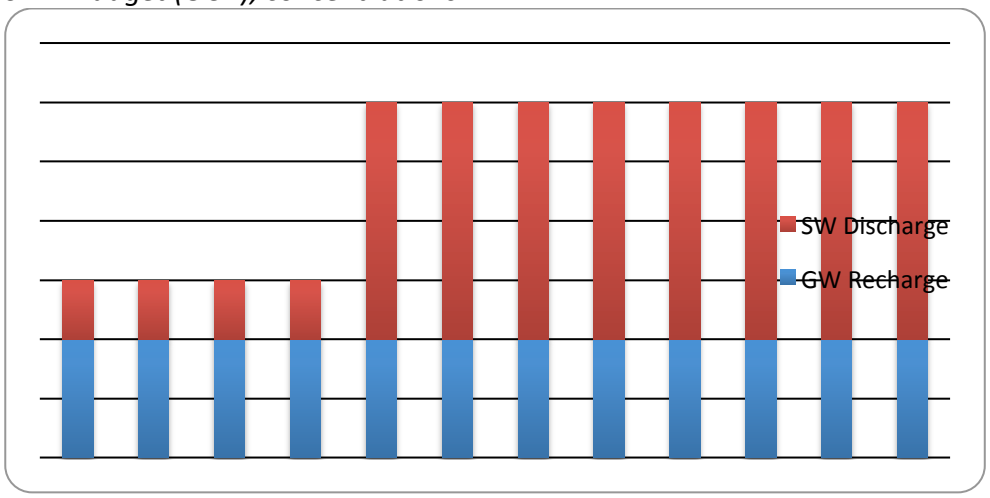
SALT Budget (IN), Loads:



Water Budget (OUT):



SALT Budget (OUT), concentrations:



SALT Budget (OUT), Loads: