Is It Possible to Predict the Future?
Projections are not forecasts

**Forecast**
- Educated guess.
- Based on expected conditions and actions.
- Timeframe limited by predictability of future conditions.
- Aim to be accurate.

**Projection**
- Extrapolation of trend.
- Based on hypothetical scenarios.
- Timeframe can extend beyond the limits of effective forecasting.
- Aim to be informative.
Stakeholder Input Throughout the Process

- Study Proposal
- Review of Literature
- Stakeholder Group Meetings
- Technical Advisory Conference Calls
- Draft Method Report
- Comment Period
- Methods Report

- Draft Water-Use Maps
- Registered & Permitted User Comments
- Draft Water-Use Projection Reports

- Baseline Calibration & Default Projections
- RBC Scenario Development
- Planning Scenario Projections
2016 -2017 - meetings with stakeholder interest groups for input on water-demand projection methods and data sources.

• SCAWWA Water Utility Council
• SC Water Quality Association
• SC Farm Bureau Water Committee
• Chamber of Commerce Environmental Technical Committee
• SC Water Planning Process Advisory Committee (PPAC)
• Water Works Association, Utility Council
  • Use weather and demographic variables for long term forecasts.
  • Consider impacts of outdoor use restrictions.

• Chamber of Commerce, Environmental Committee
  • Provide information on a reach scale for real-world application.
  • Guarantee privacy of survey responses.

• Farm Bureau, Water Committee
  • Agricultural return flows can be significant.
  • Not all cropland can be profitably irrigated.
  • Vegetables and hemp production could increase.

• Water Quality Association
  • Some systems are highly interconnected.
  • Inflow and Infiltration can be significant.
2018 - technical advisory conference calls with representation from a variety of fields of experience.

- Public water supply (17)
- Thermo-electric power (5)
- Manufacturing (5)
- Government (22)
- Consultants (4)
- Legal (2)
- Golf (2)
- Agriculture (5)
- Environment (4)
- Research & education (11)

Acknowledgements to Chrissa Waite and Stuart Norvell of USACE and Dr. Jeff Allen and Dr. Tom Walker of the SCWRC for their collaboration on developing the water demand projection methods.
Technical Advisory Committee Feedback

• General recommendations:
  • provide draft projections to local stakeholders.
  • provide an opportunity for feedback.
  • do not rely on overly complex methods.

• Sector specific recommendations:
  • **Thermo-electric**: Contact the utilities directly
  • **Public supply**: Do not rely on complex statistical methods which may underestimate demand.
  • **Industry**: Use economic output, not employment as the driver variable.
  • **Agricultural Irrigation**: A more technical method may be appropriate for projecting irrigated acreage.
  • **Golf**: A simpler projection method was recommended due to the relatively low volume of water use.
2018 – Publication of “Water Users’ Perspectives: Summary of Withdrawal Survey Responses and Commentary” in *Journal of South Carolina Water Resources*.

2019 – Projection Methods for Off-stream Water Demand in South Carolina published online by SCDNR following reviews by an editorial board, the PPAC, and technical advisory conference call participants.

Pellett, C. Alex (2020) "Mapping Center Pivot Irrigation Fields in South Carolina with Google Earth Engine and the National Agricultural Imagery Program," *Journal of South Carolina Water Resources*: Vol. 7 : Iss. 1 , Article 4. Available at: [https://tigerprints.clemson.edu/jscwr/vol7/iss1/4](https://tigerprints.clemson.edu/jscwr/vol7/iss1/4)
**Equation 1: Water Demand Mass Balance**

\[ \text{Demand} = \text{Withdrawal} + \text{Purchase} + \text{Reuse} - \text{Sales} - \text{Loss} - \Delta \text{Storage} + \text{Shortage} \]

Where:
- **Demand**: Off-stream water demand
- **Withdrawal**: Total water withdrawal from source water bodies
- **Purchase**: Total purchases of water from distributors
- **Reuse**: Total reuse of water previously used for another purpose
- **Sales**: Total wholesale transfers of water to another user or distributor
- **Loss**: Total losses of water preventing it from being put to use
- **ΔStorage**: Net change in off-stream storage
- **Shortage**: Water not available to meet the objectives of water users

**Equation 2: Return Flow Mass Balance**

\[ \text{Return Flow} = \text{Discharge} - \text{Inflow & Infiltration} \]

Where:
- **Return Flow**: Water returned to the environment after non-consumptive uses
- **Discharge**: Concentrated discharges to surface water bodies (NPDES data)
- **Inflow & Infiltration**: Waste-water resulting from inflow and infiltration (I/I)
Permitted and registered water withdrawals over 3 million gallons / month should be reported to SCDHEC.

Water that is used and evaporates or transpires to the atmosphere is *consumed* from the water use system.

Water Withdrawal System

Consumption

Return Flow

Inflow & Infiltration

Discharge

Withdrawal

Storage

Loss

Discharge volumes can be affected by inflow and infiltration from the environment.

Return flows result from non-consumptive water use.

The monthly volumes of water lost to the environment before use and changes in off-stream storage are generally assumed to be zero.

Consumption, return flow, and inflow & infiltration are estimated over the baseline period to project future non-consumptive use.

Wastewater discharges are reported under the national NPDES regulations.
A More Detailed Model

Water Use

*Volume in a specific month, applied to a specific kind of use, associated with a specific driver value, under specific weather conditions.*
Equation 3 – General Model of Water Demand

$$Demand_{u,t} = \frac{Driver_{u,t} \ast Rate_{k} \ast Seasonality_{k,m} \ast Weather_{u,t}}{Efficiency_u}$$

Where:
- **Demand**<sub>u,t</sub>: Modeled water demand for use <i>u</i>, expressed in terms of volume per month.
- **Driver**<sub>u</sub>: Primary driver value for use <i>u</i>, units vary by category.
- **Rate**<sub>k</sub>: Median rate for kind <i>k</i> of water demand, expressed per unit of primary driver.
- **Seasonality**<sub>k,m</sub>: Median seasonality coefficient for kind <i>k</i> and calendar month <i>m</i>, unitless.
- **Efficiency**<sub>_u</sub>: Average efficiency coefficient for use <i>u</i>, unitless.
- **Weather**<sub>_u t</sub>: Weather coefficient for use <i>u</i> at time <i>t</i>, unitless.

Equation 4 – Simplified Model of Water Demand

$$Demand_{u,t} = Driver_{u,t} \ast Rate_{u} \ast Seasonality_{u,m} + Deviation_{u,t}$$

Where:
- **Demand**<sub>u</sub>: Modeled water demand for use <i>u</i>, expressed in terms of volume per month.
- **Driver**<sub>u</sub>: Primary driver value for use <i>u</i>, units vary by category.
- **Rate**<sub>_u</sub>: Median rate for kind <i>k</i> of water demand, expressed per unit of primary driver.
- **Seasonality**<sub>_u,m</sub>: Median seasonality coefficient for kind <i>k</i> and calendar month <i>m</i>, unitless.
- **Deviation**<sub>_u t</sub>: Deviation for use <i>u</i> at time <i>t</i>, volume per month.
Business-as-usual Projections

- Water demand models derived from 2012-2017 input data will be applied to projected datasets including population, employment, and irrigated acres.
- ‘Business as Usual’ projections assume stable trends in dynamic factors, and no change in underlying relationships.
- **High-demand scenario assumes high growth and high withdrawals.**

Business-as-usual & High-demand projections will be presented to basin specific stakeholder groups.
Drivers of Water Demand

<table>
<thead>
<tr>
<th>Category</th>
<th>Primary driver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermo-electric power</td>
<td>Electricity production</td>
</tr>
<tr>
<td>Public and domestic supply</td>
<td>Population</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Economic production</td>
</tr>
<tr>
<td>Agriculture and Golf Courses</td>
<td>Irrigated acres</td>
</tr>
</tbody>
</table>
• Preliminary draft results, not yet vetted.
• For demonstration purposes only.
• Only includes users of surface water in the Broad basin.
• There will be modifications to these draft projections based on continued stakeholder feedback.
• All values are plotted as Million Gallons per Month
• Only one mine uses surface water in the Broad basin, a granite quarry.
• Mining water demand is not projected to change over time.
• 9 golf courses use surface water in the Broad basin.
• Golf course irrigation is not projected to change over time.
Golf Detail

- Carolina Country Club
- Country Club of Spartanburg
- Fox Run Country Club
- Holly Tree Country Club
- Links O'Tryn, Regent Properties, LLC
- Mid Carolina Club
- Musgrove Mill Golf Club
- Pebble Creek Country Club
- Willow Creek GC
I propose projecting no growth in agricultural irrigation in the Broad basin.
No planned expansions have been reported for VC Summer. Filed for extension of license to 2062. No change is water demand is projected.

Prior to 2014, water demand (and consumption) was greater than in recent years.

Apparently, maintenance/refueling is carried out in alternative spring and fall seasons.

Will there be a new nuclear plant in the future? Cherokee or William States Lee...
Manufacturing

Textiles. Moderate AGR: 0.3%, High AGR: 2.1%. ~70% Consumed

Inorganic Chemicals. Moderate AGR: 0.7%, High AGR: 2.1%. ~95% Consumed

Organic Chemicals. Moderate AGR: 1.3%, High AGR: 2.1%. ~5% Consumed
Public Supply

- Many Drinking Water Distributors are interconnected by wholesale purchases and sales.
- Public Supply Systems are represented as the total of all interconnected withdrawal and distribution permits.
- Population served by each distributor is projected based on the county listed on the distribution permit.
• Calibration of selected water supply systems.
• The populations are calculated as the sum of the populations of each associated drinking water distribution permit.
• The rate of use is expressed in terms of Gallons per Capita per Day (GPCPD), which generally ranges from 100-200.
Population Drives Water Demand for Public Supply

Population projections 2020 to 2070

- Cherokee
- Fairfield
- Greenville
- Laurens
- Lexington
- Newberry
- Richland
- Saluda
- Spartanburg
- Union
- York

Year

'20 '30 '40 '50 '60 '70

Population

- SC ORFA Projection
- Extended Moderate Growth
- High Growth
Total water demand of public suppliers that withdraw surface water in the Broad Basin.
• Clinton consumes ~50% and returns to Saluda basin.
• Columbia gets about half of its water from Lake Murray. All returns go to Saluda basin.
• Gaffney consumes ~45%
• Spartanburg consumes ~75%
Public Supply in North Carolina

- Bostic
- Concord Community
- Ellenboro
- Cleveland County Water
- Torrence County
- Bessemer City (not Broad basin)
- Kings Mountain
- Grover
- Fallston
- Buffalo Creek
- Shelby
- Boiling Springs
- Inman-Campobello, SC
- Grassy Pond, SC
- Town of Blacksburg, SC (Purchases from Gaffney)

- Knob Creek
- 1st Broad River
- 2nd Broad River
- Broad River Water Authority
- Polk County
- N. Pacolet (under construction)
Public Supply in North Carolina

- City of Asheville (not Broad basin)
- Laurel Park (not Broad basin)
- Hendersonville (Sources and discharges in French Broad)
- Saluda (Discharges from 0.05 to 0.1 MGD to Joels Creek, Broad Basin)
- Columbus (not Broad basin)
- Tryon (4 Surface intakes in Broad)
Questions?