WATER FOOTPRINTING
SUGAR BEET PROCESSING

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Water Footprinting
Sugar Beet Processing

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Overview

- Water Footprint Concepts
- Sugar Beet Processing – Water Balance & Reuse
- Crop Freshwater Requirements
- Overall Balance
Water Footprint Concepts

- **Freshwater usage** by individuals, businesses or communities.

- **Industry** - The total amount of freshwater (surface water or groundwater) that is consumed to produce a good or service.

- From: www.waterfootprint.org
Why Water Footprints?

- Facing the Freshwater Crisis (Scientific American Article – August 2008)

- Freshwater supplies are declining due to growing populations.

- Increased water usage for: drinking, hygiene, sanitation, food production and industry.
Lake Mead

- Key source of water for millions of people in southwest US (Las Vegas & Los Angeles)
- Largest human made lake located on the Colorado River, formed by the Hoover Dam.
- 118 feet below max levels (46% of capacity)
- Currently holds 28.5 million ac-ft
- Net deficit of 1 million ac-ft/yr
Water Footprint Concepts

- Relative new concept.
- Introduced in 2002 by UNESCO-IHE (United Nations Educational, Scientific and Cultural Organization)
- IHE – International Institute for Hydraulic and Environmental Engineering.
- Located in Delft, the Netherlands
The Amalgamated Sugar Co. LLC
Processing Facilities
Processing Facilities
The Amalgamated Sugar Co. LLC

- Three (3) processing facilities located in the cities of Paul, Twin Falls and Nampa.
- Beet Processing Campaign – October thru March.
- Juice Runs – March thru September
- Facilities utilize both surface water and freshwater for beet processing.
Sugar Beet Growing Areas
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➢ Most sugar beets grown in the Snake River Plain in Southern Idaho.
➢ Classified as a northern desert with annual rainfall amounts of ~10 in/yr.
➢ Crop Water – Supplied primarily by irrigation canals and well water.
General Water Balance
Sugar Beet Growing & Processing
Water Footprint – General Diagram
Growing & Processing of Sugar Beets

- Growers
  - Irrigation, Groundwater, Rainwater
  - Water – In

- Sugar Beets
  - Degraded Water
  - Water – Out

- Sugar Beet Processing Facility
  - Surface Water, Groundwater
  - Water – In
  - Degraded Water
  - Water – Out
Simplified Water Flow Diagram
Sugar Beet Processing Facility

Water In:
- Sugar Beets
- Freshwater (Groundwater or Surface Water)

Facility

Water Out:
- Evaporation
- Products
- Storage Ponds & Excess Water

Recycle
Water In - Sugar Beets

- Water contained in sugar beets.
- Processing facilities are net importers of water.
- Water reuse is critical to overall balance.
Sugar Beets

- Water: 76.0%
- Sugar: 17.0%
- Marc: 4.5%
- Impurities: 2.5%
Water In - Freshwater
The Amalgamated Sugar Co. LLC

- Needs vary based on water system design and waste water treatment.
- Groundwater Wells
- Surface Water – Rivers, creeks and irrigation water
Water Out - Excess Condensate

- Water evaporated from sugar beets.
- High Quality (low hardness, low COD, contains a small amount of nitrogen)
- Excellent source of water for process needs and crops.
Water Out – Process Waste Water

- Excess water from recycled systems (beet flume, scrubbers and ash), floor washings, tank overflows, etc.
- Lower Quality (high hardness, high COD, contains a small amount of nitrogen)
- Aerated and either reused and/or land applied.
Water Balance
Paul, ID Facility
## Water Inputs (MG’s)\(^a\)
Beet Campaign - Paul, Idaho Facility

<table>
<thead>
<tr>
<th>Source</th>
<th>Daily</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water – Sugar Beets (97%)</td>
<td>3.0</td>
<td>540</td>
</tr>
<tr>
<td>Freshwater (3%)</td>
<td>0.1</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>3.1</td>
<td>558</td>
</tr>
</tbody>
</table>

\(^a\) millions of gallons
## Water Outputs (MG’s)\textsuperscript{a}

Beet Campaign - Paul, ID Facility

<table>
<thead>
<tr>
<th>Source</th>
<th>Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess Water</td>
<td>1.3</td>
</tr>
<tr>
<td>Facility Vents (water vapor)</td>
<td>0.9</td>
</tr>
<tr>
<td>Cooling Towers (water vapor)</td>
<td>0.4</td>
</tr>
<tr>
<td>Products</td>
<td>0.4</td>
</tr>
<tr>
<td>Other</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3.1</strong></td>
</tr>
</tbody>
</table>

\textsuperscript{a} millions of gallons
Beet Campaign - Outputs

Water Balance

- Excess Water: 42%
- Stacks/Vents (Water Vapor): 42%
- Other: 3%
- Products: 13%
# Excess Condensate

**Total Quantities – Paul, ID Facility**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Quantities a</td>
<td>1.1 MG/day</td>
</tr>
<tr>
<td>Campaign Days</td>
<td>180 days</td>
</tr>
<tr>
<td>Total Excess Condensate</td>
<td>199 MG’s</td>
</tr>
</tbody>
</table>

\(^a\) Assume 85% of total wastewater
Facility Water Reuse
Water Reuse
Sugar Beet Processing Facilities

- Facility Operations - Optimizing the use of excess condensate minimizes the need for freshwater.
- Wastewater Treatment System – Influences the amount freshwater utilized.
Water Reuse
Sugar Beet Processing Facilities

- Process Uses
- Evaporator feedwater – Juice Run
- Land apply to crops
- Pond refilling
Facility Water Systems
Sugar Beet Processing Facility

- Inside Facilities – Complex piping systems for recirculating and reusing water.

- Outside Facilities – Storage Ponds & Aeration Systems
Storage Ponds
Paul, ID Facility

- Store water for reuse during juice run and crop irrigation.
- Solids settling & aeration.
## Pond Volumes
TASCO Facility Paul, ID

<table>
<thead>
<tr>
<th>Ponds</th>
<th>Million Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess Condensate</td>
<td>171</td>
</tr>
<tr>
<td>Process Water (Aerated)</td>
<td>42</td>
</tr>
<tr>
<td>Scrubber &amp; Ash Ponds</td>
<td>3</td>
</tr>
<tr>
<td>Flumewater (Mud)</td>
<td>2</td>
</tr>
<tr>
<td>Sanitary Lagoon</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>221</strong></td>
</tr>
</tbody>
</table>
Due to Idaho’s arid climate, storage pond evaporation accounts for a significant reduction in water inventories.

Assume 36 inches of evaporation per year.

Evaporation per year

- Excess Condensate = 30 MG’s
- Process Water = 17 MG’s
Juice Run
Excess Condensate Reuse
Juice Run

- Stored thick juice is processed into granulated sugar following the beet campaign.
- Typically 100 days for thick juice processing.
- Evaporator feed water needed to supply vapors to sugar end equipment.
Evaporator Feed Water Sources

- Initial juice run operations in the late 1980’s required the use of well water for juice runs.
- Well water requires softening (TDS concentration ~ 600ppm).
- Softening water increases process waste water TDS concentrations.
Evaporator Feed Water
Excess Condensate

- Beginning in 1992, excess condensate tested as a replacement for well water.
- Since then three excess condensate storage ponds have been installed covering 40 acres with a capacity of 170 MG.
### Excess Condensate

#### Juice Run Evaporator Feed Water

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Feed Water</td>
<td>540,000 gpd</td>
</tr>
<tr>
<td>Juice Run Days</td>
<td>100</td>
</tr>
<tr>
<td>Total Feed Water</td>
<td>54 MG</td>
</tr>
</tbody>
</table>
Benefits of Juice Run Excess Condensate Reuse

- Eliminates the need for 54 MG’s of groundwater.

- Reduces an equivalent quantity of waste water.
Land Application of Excess Water
Wastewater Land Application System
Paul, Idaho Facility

Paul, Idaho Processing Facility

Groundwater
Wastewater

Farms

Irrigation Water
Minimizing groundwater for facility operations is critical for reducing waste water volumes.

Excess water applied to ~700 acres of farm ground adjacent to the facility.

Crops grown – Alfalfa, winter wheat and beans

Excess condensate reduces the need for irrigation water (freshwater) and fertilizer.
Waste Water Land Application
Overview – Paul, ID Facility

- WW land application closely monitored by State of Idaho (IDEQ).
- Land application permit requires extensive monitoring & reporting of WW volumes & constituents, groundwater quality, soils, and crop production.
Types of Water Land Applied
Overview – Paul, ID Facility

- Process Water (15% of total) – Lower Quality
- Excess Condensate (85% of total) – Higher Quality
- Supplemental Irrigation Water needed to maintain the crops
## Factory WW Quality (mg/l)

### Juice Run Evaporator Feed Water

<table>
<thead>
<tr>
<th>Type</th>
<th>COD</th>
<th>TKN</th>
<th>Ammonia</th>
<th>TDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess Condensate</td>
<td>30</td>
<td>80</td>
<td>71</td>
<td>150</td>
</tr>
<tr>
<td>Process</td>
<td>270</td>
<td>30</td>
<td>4</td>
<td>1790</td>
</tr>
<tr>
<td>Type</td>
<td>Amount (MG)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excess condensate from factory</td>
<td>109</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process water from factory</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>124</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Crop Freshwater Requirements
Supplemental Irrigation Water
Factory Farms – Paul, ID Facility

- Total Water for Crop = Irrigation water + wastewater.
- Irrigation water - Largest freshwater requirement and varies based on crop type.
- For example, up to 50 in/ac/yr required for alfalfa.
## Waste Water Land Applied
2007-2008 Paul, ID Facility

<table>
<thead>
<tr>
<th>Type</th>
<th>Amount (MG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess condensate from factory</td>
<td>109 (11%)</td>
</tr>
<tr>
<td>Process water from factory</td>
<td>15 (2%)</td>
</tr>
<tr>
<td>Supplemental Irrigation Water</td>
<td>880 (87%)</td>
</tr>
</tbody>
</table>
Where is most freshwater used?

- To grow the sugar beet crop.
- The estimated quantity of irrigation water for to produce 3,000,000 tons for the Paul, ID facility is 83,000 MG’s.
Freshwater Balance (MG’s)
3,000,000 Tons Beets – Paul, Idaho

83,000 = Irrigation water – To grow sugar beet crop
880 = Irrigation water – To maintain wastewater treatment farms
18 = Well water - Facility
Facility Water Management & Conservation Goals
The Amalgamated Sugar Co. LLC

- Continue to maximize the use of water generated from processed sugar beets
- Minimize the need for surface or groundwater
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The Amalgamated Sugar Co. LLC

- Continue to maximize the use of water generated from processed sugar beets
- Minimize the need for surface or groundwater
Reducing Water Footprints
Sugar Beet Growing

- Based on the overall water balance, the potential for the greatest water footprint reductions are associated with crop water requirements.