Perspectives on Water Quantity
Issues in Ethanol Production

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US Senate legislation: Ethanol production from 7 BGY to 22 BGY by 2022

Cites existing ethanol-related conflicts over water use
U.S. Ethanol Biorefinery Locations

Source: Renewable Fuels Association
4.3.07
Growth in Other States

### Iowa:
- Existing: 27 facilities
- In Planning: 30 facilities

Source: IowaCorn.org
Growth in Other States

- Nebraska:  
  - 19 existing facilities  
  - 8 under construction  
  - 30 in planning/evaluation

Source: ne-ethanol.org
Minnesota Ethanol Water Use

Number of Facilities

Pumping (MMGY)

Data from MnDNR, Div of Waters
# Minnesota Ethanol Production

<table>
<thead>
<tr>
<th></th>
<th>Existing</th>
<th>Under Construction</th>
<th>Proposed</th>
<th>Tentative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Facilities</td>
<td>16</td>
<td>6</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Production Capacity (MMGY)</td>
<td>647</td>
<td>513</td>
<td>339</td>
<td>390</td>
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<tr>
<td>Average Production (MMGY)</td>
<td>40</td>
<td>86</td>
<td>85</td>
<td>65</td>
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Data from MPCA, current as of August 2007

- Plants currently proposed or under construction will increase production capacity by 130%
- New plants will be twice the size of existing, on average
Factors in Siting

- **Primary Factors**
  - Transportation
    - Rail Proximity and Capacity
    - Highway Access
  - Corn Availability
  - Accessible Market for DDGS

- **Availability of Water**

- **Considerations**
  - Natural Gas
  - Electricity
  - Wastewater Discharge
Water Demand

- 100 MMGY Ethanol Plant requires about 1000 gpm continuously

- ~5 gallons water : 1 gallon ethanol

- Developing a well that supplies 1000 gpm is not the same as developing a sustainable 500 MMGY water supply!!!
Ethanol production is a natural resource allocation issue.

- Expect increases in conflicts between users.
Typical Water Process Flow Diagram

100 MMGY Corn-base Ethanol Plant

1000 gpm

Prefilter

Storage

Cooling Towers

Treatment (RO)

Softening

Process

Boiler

Wastewater

Evaporation

Product

Supply

1000 gpm

1000 gpm

225 gpm

350 gpm

650 gpm

125 gpm

475 gpm

200 gpm

100 gpm

100 gpm

100 gpm

100 gpm
Water Conservation Opportunities

- **Substitute Wastewater**
  - Limited to non-contact uses (DDGSs)

- **Air Cooling Systems**
  - Adds cost

- **Zero-Discharge**
  - Evaporate wastewater to convert to solid waste
  - Adds Cost
Case Summaries

- Personal involvement in 7 sites
  - Owner’s Engineer role
  - Siting and/or Construction

- Every site is different

- Only 3 of 7 built to-date
On-Site Groundwater (1 Site)

- **Nebraska site**
  - Natural Resource Districts (NRDs) manage Water Rights
  - Each NRD is designated either “over-”, “fully-” or “not fully” appropriated
  - “Over” or “Fully” designation results in regulatory limits
  - Groundwater regulation:
    - Water rights attached to wells, with limits on pumping rate (not volumetric)
    - Permits required to drill new wells

- 2007 Nebraska moratorium on new irrigation wells

- Protected surface water flows for “natural resources”
On-Site Groundwater

- Two 1000 gpm irrigation wells acquired with property
  - Shallow, laterally extensive aquifer
  - Moderate irrigation development
  - Testing shows well yield ≥1500 gpm

- Actions taken:
  - Well use reclassification (Irrigation -> Industrial)
  - Replaced rather than upgrade-to-code and pipeline
  - NRD is “not fully appropriated”, so expanded allocation was possible
  - Permitted & built new PWS well
Off-Site Groundwater (3 Sites)

- All sites:
  - On-site exploration not fruitful
  - Off-site exploration done by client
  - All sites in Eastern states (reasonable use doctrine) with minimal or no regulation of appropriation

- Public-Private Partnership
  - Local community PWS develops well field, then provides raw and potable water

- Advantages to PWS Involvement
  - Financing provided by PWS, repaid through surcharge
  - Transfers responsibility for well and pipeline O&M
  - Plant is not a PWS
  - Land and Right-of-Way acquisition
Surface Water (2 Sites)

- **Indiana - Site adjacent to Ohio River**
  - On- and Off-site groundwater rejected
  - Not amenable to collector well
  - High unit cost due to treatment costs for both solids and organics (either self or PWS supplied)
  - Site rejected for non-technical reasons

- **Downstate Illinois**
  - Groundwater and other surface water alternatives evaluated and rejected
  - On-site reservoir proposed
  - Site rejected for non-technical reasons
Conjunctive Source

- North Dakota
  - Development with multiple industrial partners
  - ND Regulatory Environment
    - “Water Rights” state
    - Rights set limits for extraction rate and volume
    - No mining of groundwater
  - Water rights to preferred groundwater source unavailable
    - Modeling required
    - Existing water rights may be mining groundwater
  - Multiple water sources under consideration
    - Off-site groundwater
    - Industrial wastewater
    - Municipal “gray” water
    - Rural water districts and other PWSs
A Glimpse of the Future...

- **Sustainability**
  - Regulatory emphasis
  - Modeling to demonstrate

- **Multi-source, conjunctive solutions**
  - Groundwater
  - Surface Water
  - Water Reuse

- **Partnerships**
  - Industry-to-Industry
  - Public-Private