Medicine Lake
Excess Nutrients
TMDL project:
Modeling Overview

Steering Committee Meeting #2
January 8, 2009
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Photo by: Terrie Christian—President, AMLAC
TMDL Modeling Overview

- Modeling Basics
- Medicine Lake TMDL Modeling Approach
- Modeling Results and Making Use of Them
Why model?

- *Inform management decisions*
  - Answer questions, such as...
    - What conditions lead to impairment?
    - How extensive is the impairment?
    - What is contributing to the impairment?
    - What are appropriate goals to attain?
    - What changes are needed to attain goals?
      - *Where, when and how much???
Converting Data to a Decision

Data → Information → Knowledge and Understanding → Decision

Increasing Utility

Medicine Lake TMDL

Increasing Resource and Knowledge Requirements

Analysis and Visualization

Synthesis and Forecasting

Modeling
What is a model?

- Models attempt to simulate cause-and-effect relationships
  - If… then…

$ BUDGET MODEL $ $ BUDGET MODEL $

If I have given income, expenses, and interest rates, then what will my balance be?
What is a model?

- Models attempt to simulate cause-and-effect relationships
  - If… then…

$ BUDGET MODEL $ $ BUDGET MODEL $

Income? Expenses?

Balance

Interest

How do I need to adjust income or expenses to meet a goal for my balance?
Models in Management

- Medicine Lake TMDL
- Models in Management
- Watershed Model
- Lake Model
- Water Quality
- Flow and Pollutant Loads
- Climate Land Use
- Best Management Practices (BMPs)
Models in Management

- Medicine Lake TMDL
- Models in Management
- Watershed Model
- Flow and Pollutant Loads
- Climate Land Use
- Best Management Practices (BMPs)
- Adjust BMPs or Lake Management
- No
- Acceptable Water Quality???
- Lake Model
- Water Quality

Acceptable Water Quality???

No

Adjust BMPs or Lake Management

Best Management Practices (BMPs)

Watershed Model

Climate Land Use

Flow and Pollutant Loads
Models in Management

- Best Management Practices (BMPs)
  - Adjust BMPs or Lake Management
    - Yes: Establish TMDL
    - No: Acceptable Water Quality???

- Climate Land Use
- Flow and Pollutant Loads
- Watershed Model
- Lake Model
- Water Quality
P8 Watershed Model

Sweeping

Impervious Areas

Washoff

Pervious Areas

Runoff

BMPs

Percolation

Settling of Pollutants

Total Phosphorus To Medicine Lake
P8 Models a Network of Pervious and Impervious Areas and BMPs
Bathtub Lake Model

Mass Balance:
Lake TP = TP_{in} - TP_{out} - TP_{loss} + TP_{internal}

Inflow

Total Phosphorus (TP) Load

Loss

Internal Load

Outflow
Phosphorus Mass Balance:
Lake \( TP = TP_{in} - TP_{out} - TP_{loss} + TP_{internal} \)

Chlorophyll-\( a \) predicted based on an empirical relationship to Lake TP
Models to be Calibrated to Available Data
## Models to be Calibrated to Available Data

<table>
<thead>
<tr>
<th>Site</th>
<th>Total Phosphorus Loading (lbs/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2001</td>
</tr>
<tr>
<td>Plymouth Creek</td>
<td>1484</td>
</tr>
<tr>
<td>Fernbrook</td>
<td>1125</td>
</tr>
<tr>
<td>Industrial Park 1</td>
<td></td>
</tr>
<tr>
<td>Industrial Park 2</td>
<td></td>
</tr>
<tr>
<td>18th Avenue</td>
<td></td>
</tr>
<tr>
<td>Ridgedale Creek</td>
<td>276</td>
</tr>
<tr>
<td>Medicine Lake 1</td>
<td>239</td>
</tr>
<tr>
<td>Medicine Lake 2</td>
<td>138</td>
</tr>
<tr>
<td>Medicine Lake 3</td>
<td>258</td>
</tr>
<tr>
<td>Medicine Lake 4</td>
<td>398</td>
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<tr>
<td>Medicine Lake 5</td>
<td>23</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3934</strong></td>
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Models to be Calibrated to Available Data

Total Phosphorus (μg/L)


Water Quality Goal
Models to be Calibrated to Available Data
Making Use of Model Results

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Water Quality Goals</th>
</tr>
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<tbody>
<tr>
<td>Total Phosphorus</td>
<td>40 μg/L</td>
</tr>
<tr>
<td>Chlorophyll-a</td>
<td>14 μg/L</td>
</tr>
<tr>
<td>Secchi Depth</td>
<td>1.4 m</td>
</tr>
</tbody>
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Climate Land Use

Best Management Practices (BMPs)

P8

Flow and Pollutant Loads

Bathtub

???

Water Quality
Select BMPs to meet needed load reductions

Medicine Lake

Estimated Change in TP with Loading Reductions in 2003

<table>
<thead>
<tr>
<th>Loading Conditions</th>
<th>Total Loading (Pounds)</th>
<th>Loading Difference (Pounds)</th>
<th>TP Change (μg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed</td>
<td>5495</td>
<td>-</td>
<td>45</td>
</tr>
<tr>
<td>20% Reduction</td>
<td>4646</td>
<td>849</td>
<td>36</td>
</tr>
<tr>
<td>30% Reduction</td>
<td>4225</td>
<td>1270</td>
<td>32</td>
</tr>
<tr>
<td>40% Reduction</td>
<td>3802</td>
<td>1693</td>
<td>28</td>
</tr>
<tr>
<td>50% Reduction</td>
<td>3379</td>
<td>2116</td>
<td>24</td>
</tr>
</tbody>
</table>

2003 preliminary estimates are representative of average conditions
Next Steps

- Finalize watershed characterization in P8
  - Sub-watershed delineations
  - BMPs
- Calibrate P8 model
- Calibrate Bathtub model
- Apply models to inform TMDL
  - What load reduction is needed to meet goals?
  - How best to achieve load reduction?
Thoughts on Models…

- “All models are wrong, but some are useful.”
  - George Box, Professor, U. Wisconsin

- "Make your theory as simple as possible, but no simpler."
  - Albert Einstein

- "All other things being equal, the simplest solution is the best."
  - Occam’s Razor