Critical Aquifer Recharge Areas Review

Draft Final Report

CARA Review Committee Meeting 4
May 14, 2013

Mike Murray HDR
Michael Kasch HDR
Michael Hermanson Spokane County Utilities
Presentation Outline

- Draft Final CARA Review Report Overview
  - Report Structure
  - Technical Overview and Recommendations
  - CARA Spreadsheet
- Gather Comments
- Roundtable Discussion
Report Structure

- Executive Summary
  - Overview of project and recommendations
- Attachment A
  - Guidance for analysis
- Attachment B
  - Summary of project technical review
- Attachment C
  - Summary of stakeholder involvement
Review of Existing Code

- Non-residential uses in moderate and high susceptibility areas shall have a disposal system that protects the aquifer, <90 gallons of wastewater per acre per day
- County required to regularly review protection measures as effective, enforceable, and equitable
- Review concluded
  - Code protects aquifers for most situations
  - However a site specific approach is recommended to meet the goals of effective, enforceable, and equitable
Evaluate Standard Revisions

- Examined the characteristics of non-residential wastewater
- Reviewed potential fate and transport of wastewater
  - Nitrate – high mobile and primary contaminant
  - Phosphorus – connectivity to surface water and Spokane River TMDL
Recommended Approach

- Adopt a three level approach
  - Level 1 CARA spreadsheet (soil mixing) with a few project inputs
  - Level 2 CARA spreadsheet with a few project inputs and additional supporting information
  - Level 3 If Level 1 and 2 do not work, use WDOH Groundwater Mixing analysis or propose and have County approved alternative analytical approach
Analysis Methods

- **Level 1 and 2**
  - CARA spreadsheet
    - Soil nitrogen leachate mixing analysis
      - Checks hydraulic loading requirement
      - Checks nitrate concentration

- **Level 3**
  - WDOH LOSS spreadsheet
    - Groundwater nitrogen mixing analysis
      - Checks groundwater nitrate values

- **All Levels**
  - Distance to surface water
    - Shoreline Master Program protects surface water
Spreadsheet Inputs

- CARA Spreadsheet
  - Level 1
    - Parcel lot size
    - Recharge
    - Wastewater volume
    - Drainfield area
    - Soil type
    - Surface water information
  - Level 2
    - Effluent nitrate concentration
    - Soil denitrification
    - Precipitation nitrate concentration
- LOSS Spreadsheet
  - Level 3
    - Level 1 and 2 information
    - Groundwater hydraulic conductivity
    - Groundwater gradient
    - Upgradient groundwater nitrate concentration
Nitrogen Assessment

- Levels 1 and 2
  - Soil groundwater interface nitrogen concentration <10 mg/L

- Level 3
  - Groundwater nitrogen concentration <5 mg/L
Phosphorus Assessment

- Distance of drain field to surface water, soil-groundwater-surface water pathway
  - Shoreline Master Plan provides general protection
  - Restricts commercial/industrial uses
  - 200-foot buffer
    - Checked using Montana breakthrough analysis, >20 years

- Spreadsheet requires information on surface water and a map
  - Spokane County can require further evaluation
### ON-SITE SEPTIC SYSTEM ANALYSIS

**Project name:** ABC Church  
**Completed by and Date:** John Doe, May 4, 2013  
**Facility type, size and description:** Church, 5 acre parcel, 10,000 square foot building.  
**Address:** ###, Spokane County  
**Name of nearest waterbody:** Spokane River  
**Distance to shoreline:** 2 miles  
**Depth to groundwater:** 75 feet, based on driller well logs within 1/4 mile  
**Include a map of the parcel:** Attached

<table>
<thead>
<tr>
<th>Input Values</th>
<th>Sign</th>
<th>Values</th>
<th>Units</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parcel lot size</td>
<td>A_P</td>
<td>5</td>
<td>acre</td>
<td>Site specific 1 acre = 43,560 ft²</td>
</tr>
<tr>
<td>Recharge</td>
<td>R</td>
<td>4</td>
<td>in/yr</td>
<td>Use recharge Map</td>
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<tr>
<td>Wastewater volume</td>
<td>V_W</td>
<td>300</td>
<td>gpd</td>
<td>Use table or provide basis</td>
</tr>
<tr>
<td>Drainfield area</td>
<td>A_D</td>
<td>900</td>
<td>ft²</td>
<td>Primary drainfield area</td>
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<table>
<thead>
<tr>
<th>County Values</th>
<th>Sign</th>
<th>Values</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total nitrogen concentration in wastewater</td>
<td>N_W</td>
<td>45.0</td>
<td>mg/l</td>
<td>Default</td>
</tr>
<tr>
<td>Soil denitrification</td>
<td>d</td>
<td>0.1</td>
<td>unitless</td>
<td>Default</td>
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<tr>
<td>Nitrate concentration in precipitation</td>
<td>N_R</td>
<td>0.24</td>
<td>mg/l as N</td>
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<tr>
<th>Hydraulic Output Values</th>
<th>Sign</th>
<th>Values</th>
<th>Units</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>Hydraulic loading</td>
<td>D_H</td>
<td>0.6</td>
<td>gal/ft²/day</td>
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<tr>
<td>Minimum drainfield area</td>
<td>A_D</td>
<td>500</td>
<td>ft²</td>
<td></td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Nitrate Output Values</th>
<th>Sign</th>
<th>Values</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of recharge over parcel</td>
<td>V_P</td>
<td>1,488</td>
<td>gpd</td>
<td>A_P * R * conversion</td>
</tr>
<tr>
<td>Total infiltration (drainfield &amp; parcel)</td>
<td>V_P + V_W</td>
<td>1,788</td>
<td>gpd</td>
<td></td>
</tr>
<tr>
<td>Total Nitrogen concentration from drainfield &amp; parcel</td>
<td>N_{ip}</td>
<td>7.0</td>
<td>mg/l as N</td>
<td>((V_P * N_R + V_W * N_W) * (1 - d)) / (V_P + V_W)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Values</th>
<th>Units</th>
<th>Instructions</th>
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</thead>
<tbody>
<tr>
<td>Hydraulic loading</td>
<td>Okay</td>
<td>unitless</td>
<td>If Revise, review input values</td>
</tr>
<tr>
<td>Nitrate</td>
<td>Okay</td>
<td>unitless</td>
<td>If Revise, review input values</td>
</tr>
</tbody>
</table>
# WDOH LOSS Spreadsheet

## Washington Department of Health

### Level 1 Nitrate Balance for Large On-Site Sewage System

**Project name:**

**Address, city and county:**

**Completed by (name and title):**

**Date:**

### Input Values

<table>
<thead>
<tr>
<th>Factor</th>
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<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrate concentration in precipitation</td>
<td>$N_R$ mg/l as N</td>
<td>0.24</td>
<td>Default</td>
</tr>
<tr>
<td>Total nitrogen concentration in wastewater</td>
<td>$N_W$ mg/l</td>
<td>60</td>
<td>Default - residential strength</td>
</tr>
<tr>
<td>Soil denitrification</td>
<td>$d$ unitless</td>
<td>0.1</td>
<td>Default</td>
</tr>
<tr>
<td>Aquifer thickness</td>
<td>$b$ ft</td>
<td>20</td>
<td>Default or aquifer thickness if known</td>
</tr>
<tr>
<td>Drainfield area</td>
<td>$A_D$ ft$^2$</td>
<td></td>
<td>Primary drainfield area</td>
</tr>
<tr>
<td>Distance from drainfield to property boundary</td>
<td>$D_{pb}$ ft</td>
<td>0</td>
<td>Measure in direction of GW flow</td>
</tr>
<tr>
<td>Aquifer width</td>
<td>$W_A$ ft</td>
<td></td>
<td>Perpendicular to GW flow</td>
</tr>
<tr>
<td>Aquifer hydraulic conductivity</td>
<td>$K$ ft/day</td>
<td></td>
<td>Measured or literature value</td>
</tr>
<tr>
<td>Hydraulic gradient</td>
<td>$i$ ft/ft</td>
<td></td>
<td>If unknown, use 0.010</td>
</tr>
<tr>
<td>Recharge</td>
<td>$R$ in/yr</td>
<td></td>
<td>Recharge will be a % of ppt</td>
</tr>
<tr>
<td>Nitrate concentration of upgradient ground water</td>
<td>$N_B$ mg/l</td>
<td></td>
<td>Prefer sampling data</td>
</tr>
<tr>
<td>Wastewater volume</td>
<td>$V_W$ gpd</td>
<td></td>
<td>Design flows or measured volume</td>
</tr>
</tbody>
</table>

### Output Values

- **Groundwater nitrate value** $N_{GW}$ mg/l as N
  - Point of Compliance (POC)
- **Groundwater nitrate value** $N_{GW, ALT}$ mg/l as N
  - Alternative POC

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DOH 337-070  
Revised: July 2012
Groundwater Recharge & CARA

- Groundwater Recharge is an important variable in the proposed CARA Level 1 & 2 analysis

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<td>in/yr</td>
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<td>$V_w$</td>
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<td>gpd</td>
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<td>Primary drainfield area</td>
</tr>
<tr>
<td>Soil Type</td>
<td></td>
<td></td>
<td></td>
<td>Use Drop Menu and WAC 246-272A-0220</td>
</tr>
</tbody>
</table>

- At a concentration of 45 mg/l:
  - 2 inches of recharge – 47 gallons per day per acre
  - 6 inches of recharge – 144 gallons per day per acre
- No Existing countywide groundwater recharge data set
Groundwater Recharge

- Groundwater recharge is a dynamic process that is temporally and spatially variable.

- Dependent on many factors:
  - Climate
  - Soil
  - Land use
  - Landscape (slope)

We are interested in the amount that percolates to groundwater.
New Groundwater Recharge Analysis

- Spokane County conducted a recharge analysis using a USGS Groundwater Recharge Model.
- This model was chosen because:
  - Developed by USGS
  - Uses well established data sets that are available for the entire county.
  - Uses well established soil water balance calculation methods
  - Can account for wide variation of climate and land use found in Spokane County
Spokane County Recharge Model

- 114,000 model cells
- 660 ft by 660 ft
- 10 acres each
Data Inputs

- Soil Hydrologic Group
  - NRCS USDA Soil Survey Geographic Database (SSURGO)
  - Measure of runoff potential
Data Inputs

• Available Water Capacity
  ▫ NRCS USDA Soil Survey Geographic Database (SSURGO)
  ▫ Maximum amount of plant available water a soil can provide. Indicator of soil’s ability to retain water.
Data Inputs

- **Land Use**
  - USGS National Land Cover Database
  - Impacts variables such as:
    - Interception of precip from canopy
    - Root zone depth
    - Growing season
  - Open water
  - Low density residential
  - High density residential
  - Commercial/industrial
  - Bare exposed rock
  - Deciduous forest
  - Evergreen forest
  - Mixed forest
  - Shrubland
  - Grassland/herbaceous
  - Pasture
  - Row crops
  - Forested wetland
  - Wetland
  - Shrubland
Data Inputs

- Surface Flow Direction
  - Derived from USGS DEM
  - Which way water would flow on the surface.
Data Inputs

- Climate Data
  - Precipitation
  - Maximum Temperature
  - Minimum Temperature
  - Oregon State University PRISM Climate Group
  - 1981-2010
Recharge Estimate Map

- Average Recharge is 4.9 inches
- Median model cell value is 3.57
- Recharge varies from 0 – 27 inches per year.
• If a recharge value of 4 (median cell value of 3.57 rounded to nearest inch) is used in the CARA Level 1 spreadsheet with a nitrate concentration of 45 mg/l the allowable gallons per day per acres is 95.
Summary

• Application package with CARA spreadsheet*,
  ◦ Based on scientific data and analyses
  ◦ Protective of sensitive groundwater and surface water
  ◦ Provides a consistent review method for Spokane County
  ◦ Provides a straightforward submittal for the applicant
  ◦ Includes an adaptable approach for site specific conditions and/or specific project proposals

* For Level 3, LOSS spreadsheet, or alternatively approved analysis
Questions?