CIEG 440-010 Water Resources Engineering
Groundwater Engineering

1. Aquifer and Well Hydraulics

$$s1 - s2 = \frac{Q^* \ln(r2/r1)}{2(pi)T}$$

where: s1 = drawdown measured from bottom of aquifer (ft)
s2 = drawdown measured from bottom of aquifer (ft)
r1 = radius to drawdown (ft)
r2 = radius to drawdown (ft)
Q = well capacity (gpm)
T = transmissivity of aquifer (ft*ft/day) = K*b
Where: K = conductivity of aquifer (ft/day)
b = thickness of aquifer

Example:
Calculate well capacity (Q), given:
s1 = 40 ft
s2 = 30 ft
r1 = 100 ft
r2 = 1000 ft
K = 30 ft/ day (clean sand)
,b = 50 ft

Then $Q = \frac{(40 \text{ ft} - 30 \text{ ft})(2)(3.1416)(30 \text{ ft/day})(50 \text{ ft})}{\ln(1000 \text{ ft}/100 \text{ ft})}$

= 94248/2.3 = 40,977 cf/day(1 day/24 hr)(1 hr/60 min)(7.48 gal/cf)
Q = 213 gpm

2. Wellhead Protection

r = (Q*t/pi(b)(n))**0.5
Where:
,r = radius of wellhead area (ft)
Q = well capcity (cfs)
,t = time of travel of well, usually 5 years = 157,680,000 sec.
, b = aquifer thickness (ft)
n = porosity (0.2 - 0.5 depending on soil)
Example:
Calculate wellhead radius, r given:
Q = 1 mgd = 1.5 cfs
,t = 5 years = 157,689,000 sec
b = 100 ft
n = 0.4 (sand)

r =((1.5 cfs)(157,689,000 sec)/(3.1416)(100 ft)(0.4))**0.5
r = 1372 ft = 0.26 mi.

3. Infiltration Trench Design

$$L = \frac{Q}{K(2)(W+H)}$$

Where:

L = Length of infiltration trench (ft)
Q = 2 year flow from rooftop using Rational or TR55 method (cfs)
K = conductivity (ft/day)
W = width of infiltration trench (ft)
H = height of infiltration trench (ft)

Example:
Compute Length of Infiltration Trench needed given:

Q = 2 cfs (2 yr flow)
K = 30 ft/day (clean sand)
W = 5 ft
H = 5 ft

$$L = \frac{2 \text{ cfs}}{30 \text{ ft/day}(1 \text{ day}/24 \text{ hr})(1 \text{ hr}/60\text{min})(1 \text{ min}/60 \text{ sec})(2)(5 \text{ ft} + 5 \text{ ft})}$$

L = 2/0.0069 = 290 ft.

4. Infiltration Basin Design

Calculate the dimensions of an infiltration basin for a 2 year storm

Given:

P = 2 yr storm precip = 3.2 in.
Roof top area (Ar) = 50 * 500 ft = 25,000 sf
Rooftop runoff volume (V) = 3.2 in(25,000 sf)(1 ft/12 in) = 6,666 cf
Conductivity (K) = 3 ft/day
Max. Infiltration Time (Tmax) = 48 to 72 hours
Max. Depth of Pool (D) = 4 ft.

So: Area of Infiltration Basin $A = \frac{V}{D}$

$$= \frac{6{,}666 \text{ cf}}{4 \text{ ft}}$$

$A = 1{,}666$ sf = 41 ft x 41 ft

Check infiltration pool depth based on infiltration time.

Time = D/K = 4 ft/(3ft/day) = 1.33 days, less than 2 to 3 days

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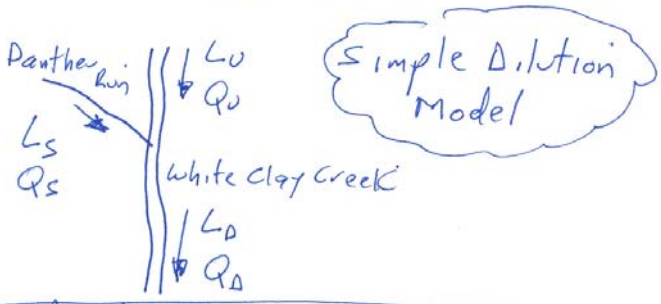
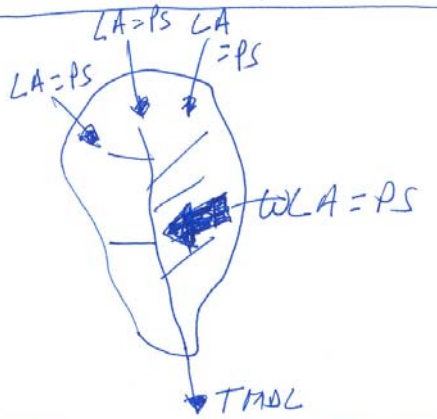


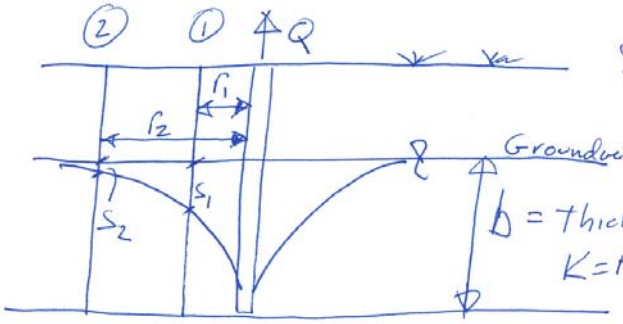
Simple Dilution Model



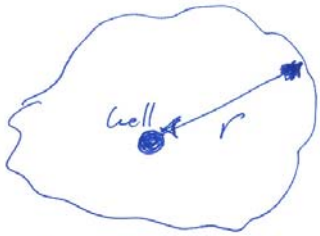
TMDL = WLA + LA + FS

or

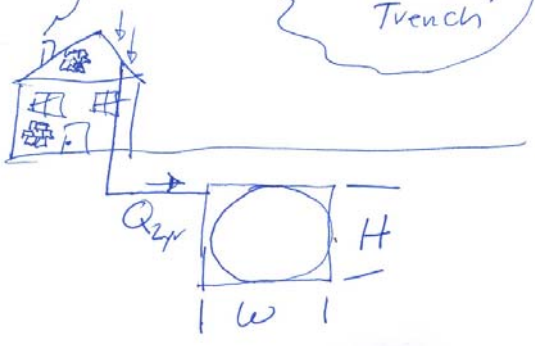
TMDL = PS + NPS + FS



Well Hydraulics



Wellhead Radius
Plan View



Infiltration Trench