CASE STUDIES

1) Whitehorse WTP, NC - Rn, Ra, U, Po
2) Enchanted Mesa WTP, NM - U
3) Glen Ridge WTP, NH - U
4) Waldoboro, ME - Rn, CO_2 , & U
4) Cherry Valley, MA - As, Rn, CO_2 , & U
5) Summer Village, ME - Ra & U Removal

Radon and Progeny

Isotope	half-life, days	mean life of atom, days	atoms/pCi	yrs to pump 1 mg at 500 gpm & 1000 pCi/L
Rn-222	3.82E+00	5.52E+00	1.7634E+04	1.55E+02
Po-218	2.16E-03	3.12E-03	9.9607E+00	2.79E+05
Pb-214	1.86E-02	2.69E-02	8.5835E+01	3.30E+04
Bi-214	1.38E-02	1.98E-02	6.3415E+01	4.47E+04
Po-214	1.89E-09	2.73E-09	8.7383E-06	3.24E+11
Pb-210	8.14E+03	1.17E+04	3.7539E+07	7.69E-02
Bi-210	5.01E+00	7.23E+00	2.3106E+04	1.25E+02
Po-210	1.38E+02	2.00E+02	6.3821E+05	4.52E+00
Pb-206	stable			

SMALL UTILITY IN NC

- 100 gpm well/35 gpm treated
- 90,155 pCi/L Rn
- 547 pCi/L U
- 65.7 pCi/L Ra
- Treated U & Ra <2 pCi/L
- Treated Rn <60 pCi/L
- Cation and Anion Exch.
- Air Stripping
- Waste to sewer

AWWARF-2695

- examined existing regs and guidelines
- sampled & monitored radiation levels at 18 WTP's
- modeled Rn emissions
- assessed worker & public exposure to radiation

FIELD MEASUREMENTS

- Well and Treated Water: Ra, U, Rn
- Media: Ra, U, gamma, Pb-210
- Sludges: U, Ra, gross alpha, Rn emissions
- Vicinity of treatment units: gamma, Rn
- Vicinity of building, inside and out: Rn
- Regeneration events: Ra, U, TDS
- Dosimetry: personal TLD's and gamma survey meter

RADON MONITORING

- Vent exit: 12.77 pCi/L
- Blower intake: 1.27 pCi/L
- 6’ D/3.5’ H: 1.28 pCi/L
- 28’ D/4’ H: 0.81 pCi/L
- 10’ D/6’ H: 1.38 pCi/L
- In IX Room: 0.47 pCi/L
- 34’ D/8’ H: 1.57 pCi/L
- 66’ D/4’ H: 0.97 pCi/L
- 115’ D/10’ H: 1.41 pCi/L

GAMMA MONITORING

- IX vessel surface: 0.246 mR/hr
- Same after regen.: 0.240 mR/hr
- 30” D/18” H: 0.054 mR/hr
- Surface brine storage: 0.200 mR/hr
- Outdoor background: 0.018 mR/hr
- 35 days in IX room at 36” D/48” H: 30 mR

CONCLUSIONS

- Sewer discharge, if available, is the most feasible option for Ra and U residuals
- IX is feasible for U in a throw-away operation using a LLRW facility
- RSC for radium removal may be a feasible once-use option using a LLRW facility
- Solids disposal on land is done on a case-by-case basis
- Results indicate that exposure to Rn levels at treatment plants is not a problem, with prudent location of air vent
- No problems with worker exposure at any of the monitored WTP's

CONCLUSIONS

- Gamma exposure was not a problem with all measurements well below occupational dose stds and most near background exposure rate
- Human exposure was not a problem
- Radon emanation from sludge with Ra indicates that existing limits in some states may be too restrictive
- Need some practical perspective w/respect to sewer discharge of small quantities of radionuclides

A PERSPECTIVE

≈1.0 Ci of Ra-226/sq mi in the top 6” of soil world-wide & more than 10 Ci/sq mi in some areas

>99% of all U and Ra WTP’s are/will be very small systems …for these systems:

all of the WTP’s in NC removing U & Ra would total <1.0 Ci/yr

all of the WTP’s in the entire U.S. removing U & Ra would total <5-10.0 Ci/yr

Enchanted Mesa, NM - U Removal

Engineer's Report

for

Modifications

to the

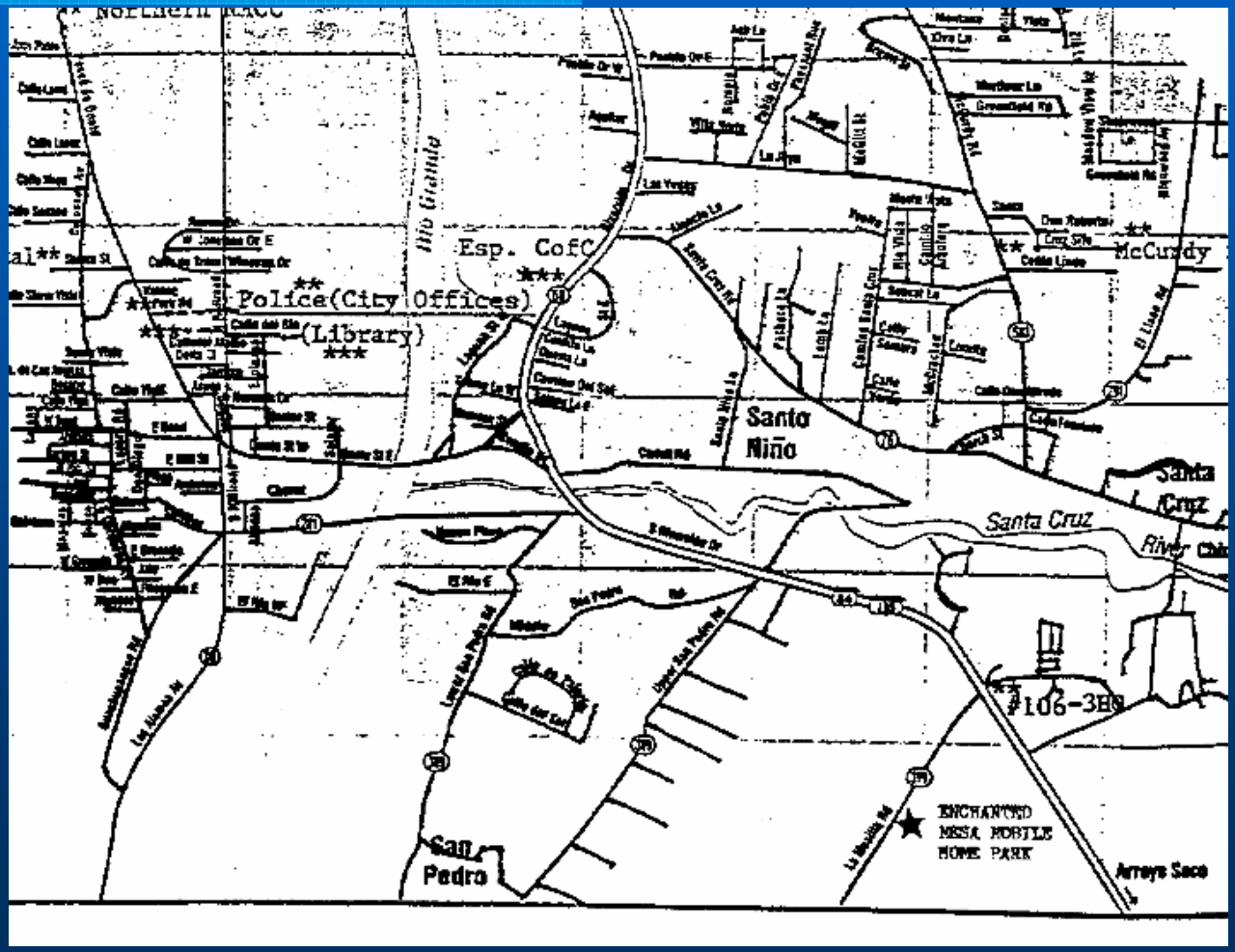
Enchanted Mesa Mobile Home Park

Water System

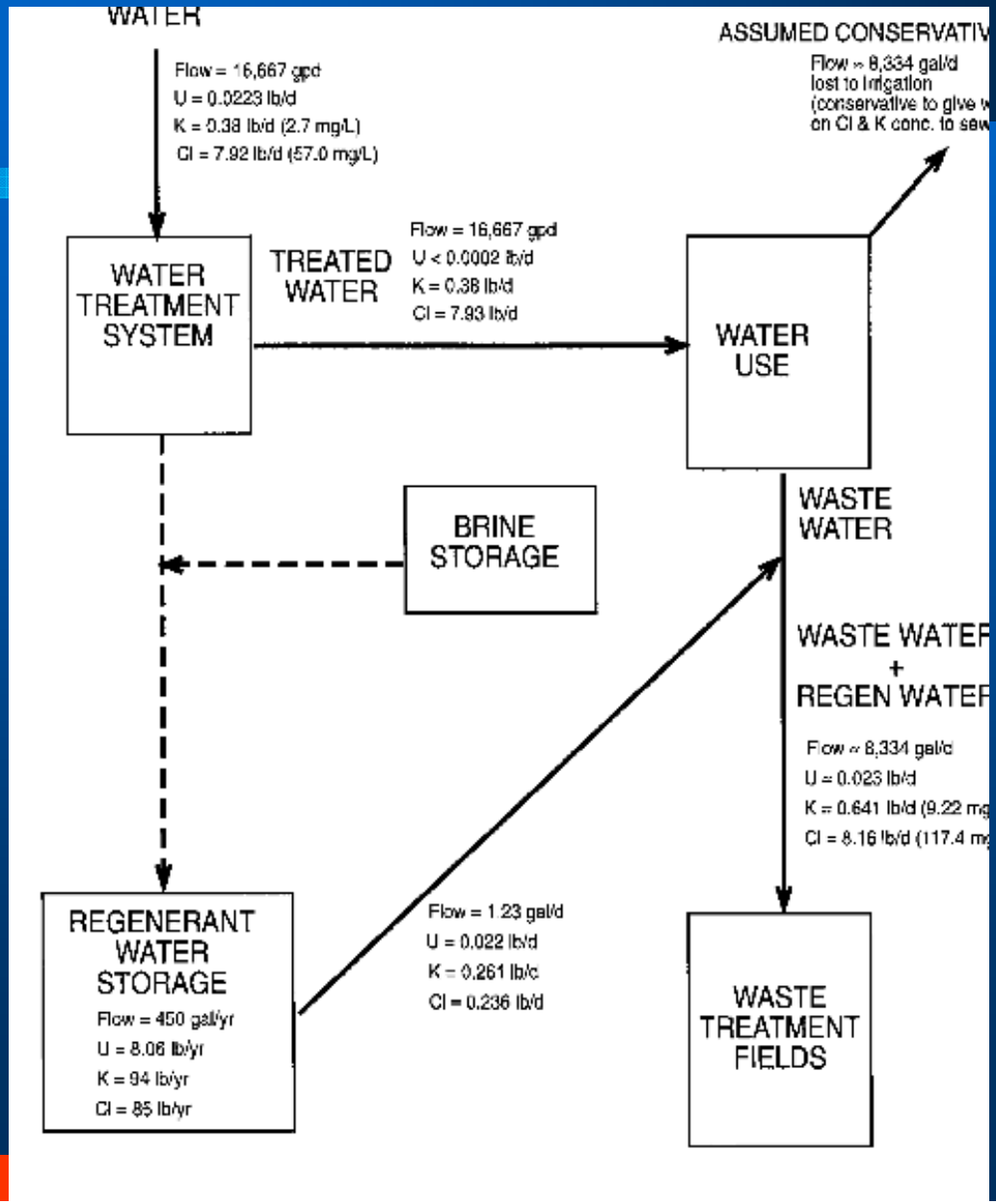
17 Jan 96

Lowry Environmental Engineering
P.O. Box 14209
Research Triangle Park, NC 27709

Enchanted Mesa, NM - U Removal



Enchanted Mesa, NM - U Removal



Enchanted Mesa, NM - U Removal

U Removal:

Inlet U at startup (1996): 73.4 pCi/L (35.7 & 36.0)

Treated U at startup (1996): 0.56 pCi/L (0.27 & 0.28)

Treated GA in 2000: 2.7 & 6.5 pCi/L (at each well)

“Working Well” in 2007

Glen Ridge, NH - U Removal

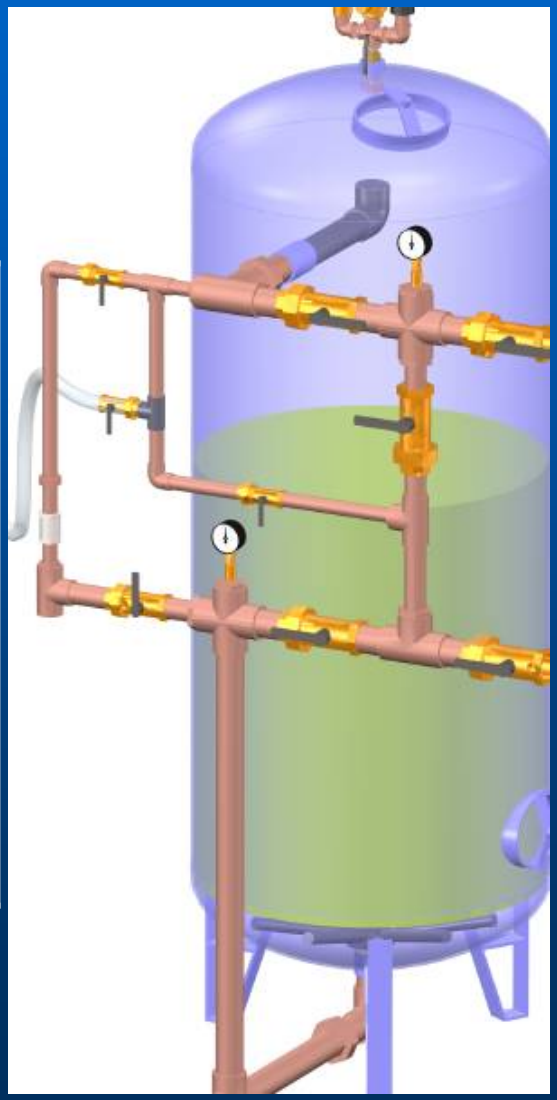
50 gpm
39,520 gpd
U = 34.3 µg/L
U = 22.9 pCi/L
Service = 100,000 BV
= 273 days
Resin, cu ft = 15
pH = 7.25
Sulfate, mg/L = 23

Glen Ridge, NH - U Removal

OPERATION/DISPOSAL (treat 100% of flow)

PARAMETER	VALUE
U exchanged per cycle, lb	4.48
U on resin, pCi/gram	5,900
Time to 0.05% by weight, days	20
Time to 15 lb on resin, yr *	2.5 (not possible)*
U in brine/rinse, mg/L in 590 gal	912
U in brine/rinse waste, Ci/yr	0.00181
Approx. cost of regen, $/yr	25
Approx. cost of once-use operation, $/yr	2,500 - 10,000 **

* - virgin resin may not go >300,000 BV; ** - variable with % by-passed (25-100%)



Waldoboro, ME - Rn & U Removal

Waldoboro - Flow Chart

Wells - 250 gpm,
120,000 gpd
U = 30 pCi/L
U = 0.00497 Ci/yr

Anion Exchange:
EBCT = 1.28 min; 2 beds in parallel;
36" diam. vessels; 6 month service cycle at 68,000 BV run length;
Water treated per cycle = 21.7 MG

Treated Water U
= 1-2 pCi/L;

Wastewater from Regeneration:
2,240 gal/cycle or 12.4 gal/day;
6.76 lbs U removed per cycle.
Annual averages - 4,480 gal and 13.52 lb U; 12.4 gal/day.
Total U Discharged < 0.005 Ci/yr

U, pCi/3000 < 1? NO;

275,421 pCi/L/3000 = 92 > 1

Discharged over 4 days

Mixed Wastewater:

Must have >92X dilution to meet:

U, pCi/L/3000 < 1

Wastewater in Sewer:
0.115 mgd

To WWTP & Land (60 acres)
= 0.000078 Ci/acre/yr

Cherry Valley, MA

Rn, U, & As Removal

80-100 gpm
57,600 gpd
28,000 pCi/L Radon
Uranium = 90 µg/L
As = 19 µg/L
Sulfate = 12.6 mg/L
pH = 7.1

EBCT = 1.87 min
Service Cycle = 130 days

Waste to WWTP:
Approx. 1350 gal into
55 mgd every 4 months

Summer Village, MA

Radon, Ra, & U Removal

100 gpm
68,000 gpd
81,000 pCi/L Radon
Radium = 7.55 pCi/L
Uranium = 43 µg/L

Stratified Bed IX
EBCT = 3.0 min
Service Cycle = 5 days
Waste Hauled to WWTP

Under Construction