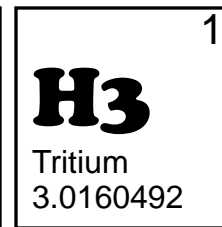
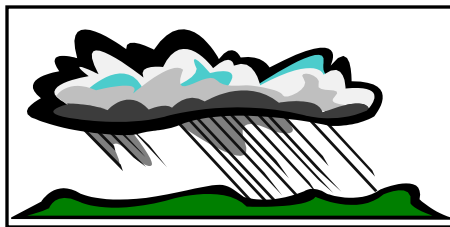
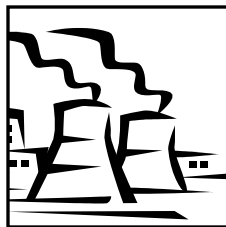
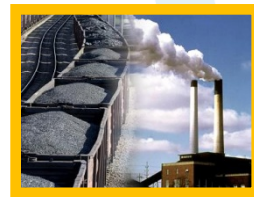


Radioactivity in Precipitation: Methods & Observations from Savannah River Site

Dennis Jackson P.E. & Timothy Jannik – Savannah River National Laboratory
Teresa Eddy – Savannah River Nuclear Solutions



Significant Sources of Radionuclides to Atmosphere:

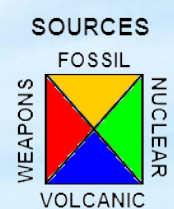


hydrogen 1 H 1.0079																	helium 2 He 4.0026						
lithium 3 Li 6.941	beryllium 4 Be 9.0122	Anthropogenic																boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305																	aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80						
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29						
caesium 55 Cs 132.91	barium 56 Ba 137.33	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]						
francium 87 Fr [223]	radium 88 Ra [226]	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	ununilium 110 Uun [271]	unununium 111 Uuu [272]	ununbium 112 Uub [277]												

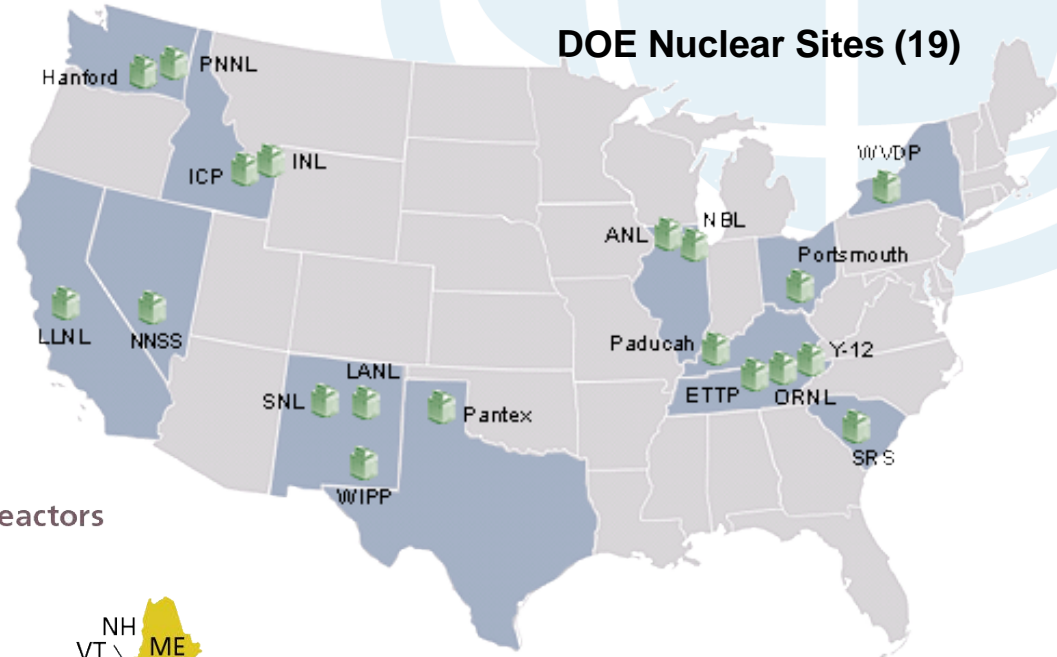
* Lanthanide series

** Actinide series

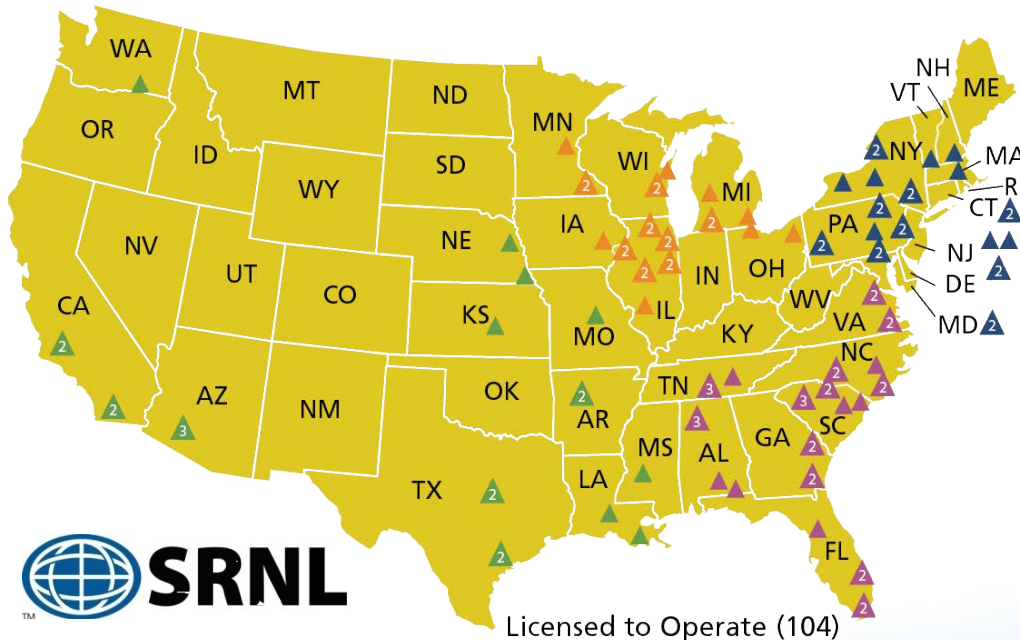
lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
actinium 89 Ac [227]	thorium 90 Th [232]	protactinium 91 Pa [231.04]	uranium 92 U [238.03]	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]



Major Atmospheric Sources in the United States:



U.S. Operating Commercial Nuclear Power Reactors



Licensed to Operate (104)

Annual Reporting

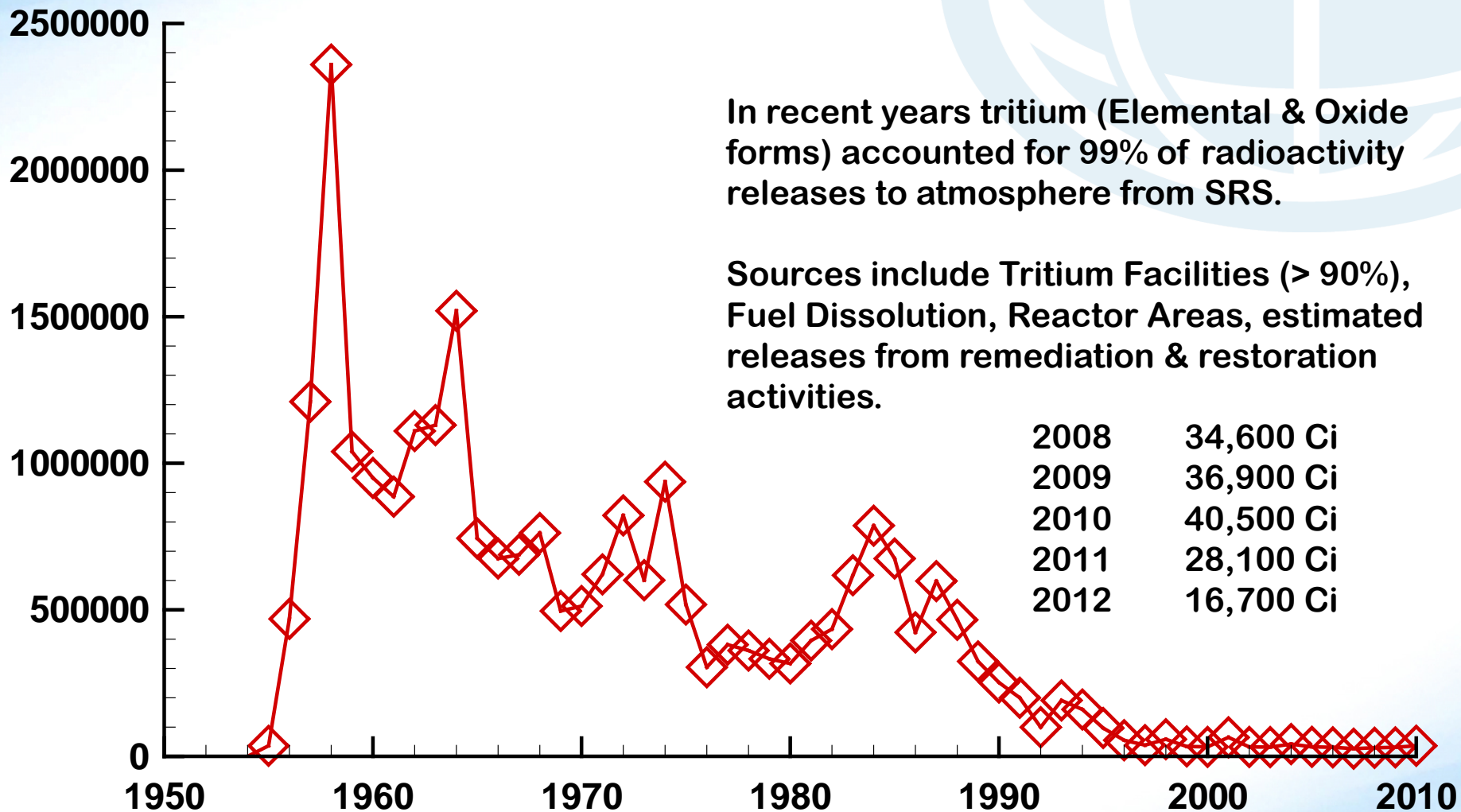


2007 Point Source Emissions:

- DOE: 39,542 Ci (25,088 Ci as H³)
- Nuclear: 10,746 Ci (6,419 Ci as H³)

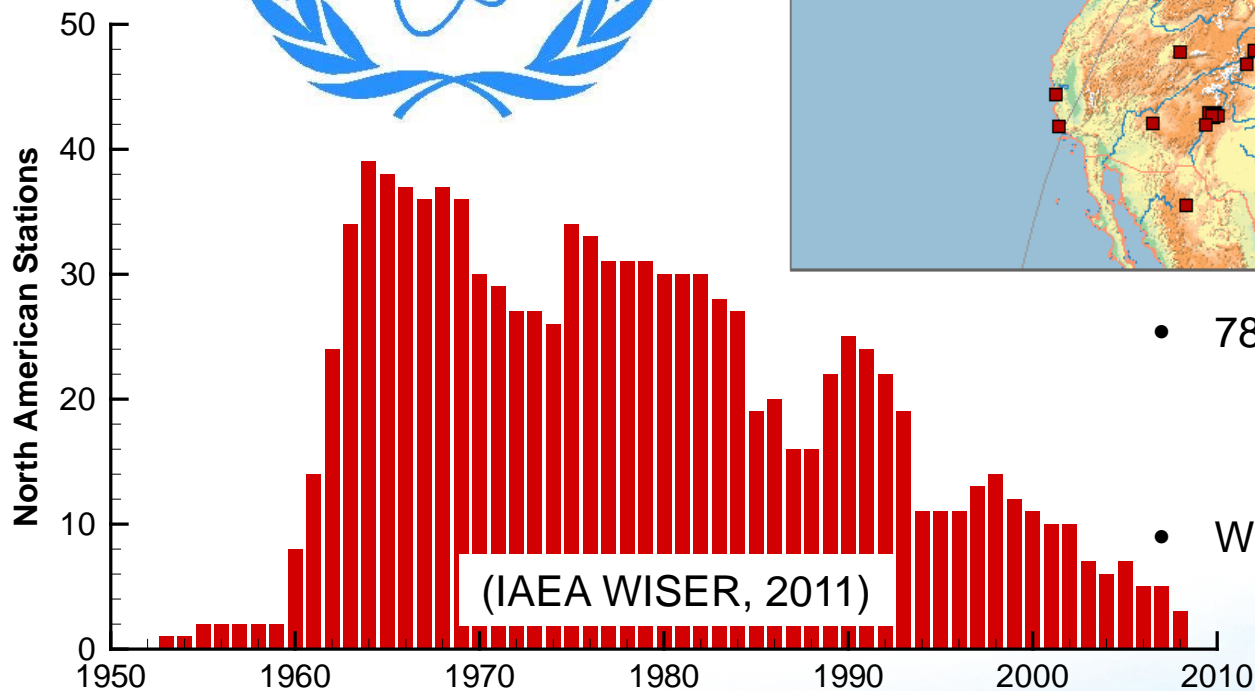
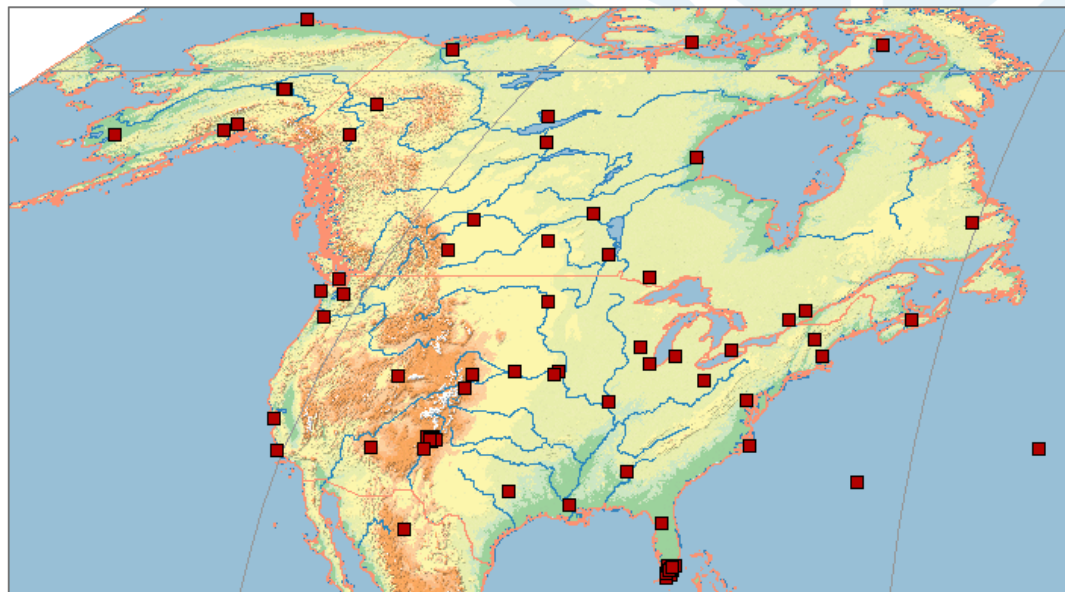
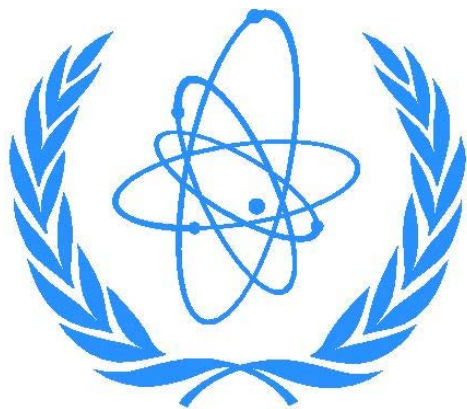
(Sources: Vazquez, 2009 & NRC, 2007)

Atmospheric Releases of Tritium from SRS (Curies):



Monitoring Radionuclides: IAEA-GNIP

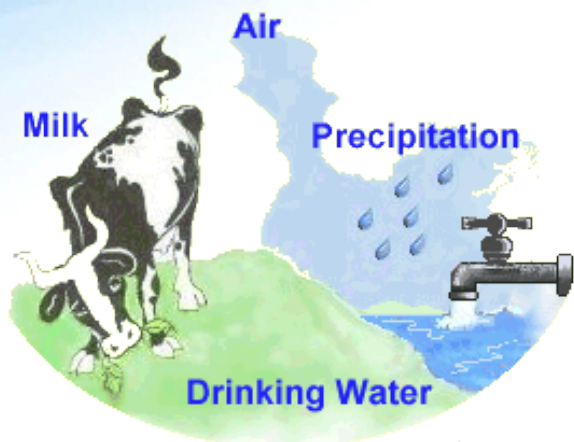
International Atomic Energy Agency (IAEA) Global Network for Isotopes in Precipitation (GNIP)



- 78 Stations in North America
 $\delta^{18}\text{O}$, H_2 , H_3

- Welker (2000) & Vachon (2007)
NTN 1989, 1991-1995

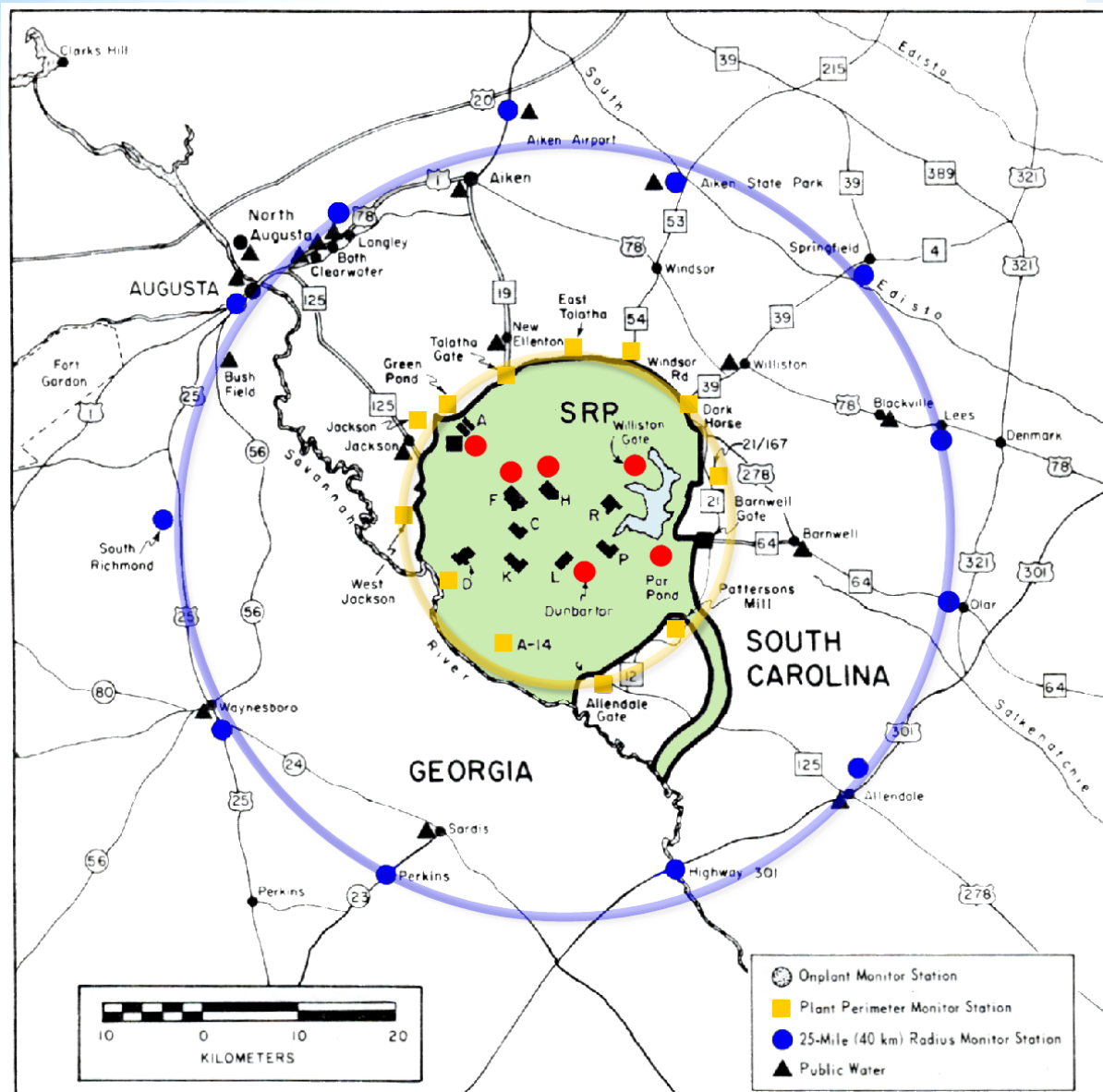
Monitoring Radionuclides: EPA RADNET



<table border="1"> <tr><td>Hydrogen</td><td>1</td><td>H</td><td>1.00794</td></tr> <tr><td>Lithium</td><td>3</td><td>Li</td><td>6.941</td></tr> <tr><td>Sodium</td><td>11</td><td>Na</td><td>22.98976928</td></tr> <tr><td>Potassium</td><td>19</td><td>K</td><td>39.0983</td></tr> <tr><td>Rubidium</td><td>37</td><td>Rb</td><td>85.4678</td></tr> <tr><td>Cesium</td><td>55</td><td>Cs</td><td>132.90545196</td></tr> <tr><td>Francium</td><td>87</td><td>Fr</td><td>[223]</td></tr> </table>																Hydrogen	1	H	1.00794	Lithium	3	Li	6.941	Sodium	11	Na	22.98976928	Potassium	19	K	39.0983	Rubidium	37	Rb	85.4678	Cesium	55	Cs	132.90545196	Francium	87	Fr	[223]	<table border="1"> <tr><td>Boron</td><td>5</td><td>B</td><td>10.811</td></tr> <tr><td>Carbon</td><td>6</td><td>C</td><td>12.011</td></tr> <tr><td>Nitrogen</td><td>7</td><td>N</td><td>14.007</td></tr> <tr><td>Oxygen</td><td>8</td><td>O</td><td>15.999</td></tr> <tr><td>Fluorine</td><td>9</td><td>F</td><td>18.998</td></tr> <tr><td>Neon</td><td>10</td><td>Ne</td><td>20.180</td></tr> <tr><td>Aluminum</td><td>13</td><td>Al</td><td>26.9815386</td></tr> <tr><td>Silicon</td><td>14</td><td>Si</td><td>28.0855</td></tr> <tr><td>Phosphorus</td><td>15</td><td>P</td><td>30.973762</td></tr> <tr><td>Sulfur</td><td>16</td><td>S</td><td>32.06</td></tr> <tr><td>Chlorine</td><td>17</td><td>Cl</td><td>35.453</td></tr> <tr><td>Argon</td><td>18</td><td>Ar</td><td>39.948</td></tr> <tr><td>Calcium</td><td>20</td><td>Ca</td><td>40.078</td></tr> <tr><td>Scandium</td><td>21</td><td>Sc</td><td>44.955912</td></tr> <tr><td>Titanium</td><td>22</td><td>Ti</td><td>47.88</td></tr> <tr><td>Vanadium</td><td>23</td><td>V</td><td>50.9415</td></tr> <tr><td>Chromium</td><td>24</td><td>Cr</td><td>51.9961</td></tr> <tr><td>Manganese</td><td>25</td><td>Mn</td><td>54.938045</td></tr> <tr><td>Iron</td><td>26</td><td>Fe</td><td>55.845</td></tr> <tr><td>Cobalt</td><td>27</td><td>Co</td><td>58.933195</td></tr> <tr><td>Nickel</td><td>28</td><td>Ni</td><td>58.6934</td></tr> <tr><td>Copper</td><td>29</td><td>Cu</td><td>63.546</td></tr> <tr><td>Zinc</td><td>30</td><td>Zn</td><td>65.38</td></tr> <tr><td>Gallium</td><td>31</td><td>Ga</td><td>69.723</td></tr> <tr><td>Germanium</td><td>32</td><td>Ge</td><td>72.61</td></tr> <tr><td>Arsenic</td><td>33</td><td>As</td><td>74.9216</td></tr> <tr><td>Selenium</td><td>34</td><td>Se</td><td>78.96</td></tr> <tr><td>Bromine</td><td>35</td><td>Br</td><td>79.904</td></tr> <tr><td>Krypton</td><td>36</td><td>Kr</td><td>83.80</td></tr> <tr><td>Rbrium</td><td>37</td><td>Rb</td><td>85.4678</td></tr> <tr><td>Srrium</td><td>38</td><td>Sr</td><td>87.62</td></tr> <tr><td>Yttrium</td><td>39</td><td>Y</td><td>88.906</td></tr> <tr><td>Zirconium</td><td>40</td><td>Zr</td><td>91.224</td></tr> <tr><td>Niobium</td><td>41</td><td>Nb</td><td>92.90638</td></tr> <tr><td>Molybdenum</td><td>42</td><td>Mo</td><td>95.94</td></tr> <tr><td>Technetium</td><td>43</td><td>Tc</td><td>[98]</td></tr> <tr><td>Ruthenium</td><td>44</td><td>Ru</td><td>101.07</td></tr> <tr><td>Rhodium</td><td>45</td><td>Rh</td><td>101.07</td></tr> <tr><td>Palladium</td><td>46</td><td>Pd</td><td>106.3676</td></tr> <tr><td>Silver</td><td>47</td><td>Ag</td><td>107.8682</td></tr> <tr><td>Cadmium</td><td>48</td><td>Cd</td><td>112.411</td></tr> <tr><td>Indium</td><td>49</td><td>In</td><td>114.818</td></tr> <tr><td>Tin</td><td>50</td><td>Sn</td><td>118.710</td></tr> <tr><td>Antimony</td><td>51</td><td>Sb</td><td>121.757</td></tr> <tr><td>Tellurium</td><td>52</td><td>Te</td><td>127.603</td></tr> <tr><td>Iodine</td><td>53</td><td>I</td><td>126.90547</td></tr> <tr><td>Xenon</td><td>54</td><td>Xe</td><td>131.29</td></tr> <tr><td>Cesium</td><td>55</td><td>Cs</td><td>132.90545196</td></tr> <tr><td>Barium</td><td>56</td><td>Ba</td><td>137.327</td></tr> <tr><td>Lanthanum</td><td>57</td><td>La</td><td>138.90547</td></tr> <tr><td>Cerium</td><td>58</td><td>Ce</td><td>140.12</td></tr> <tr><td>Praseodymium</td><td>59</td><td>Pr</td><td>140.90765</td></tr> <tr><td>Neodymium</td><td>60</td><td>Nd</td><td>144.242</td></tr> <tr><td>Europium</td><td>61</td><td>Pm</td><td>[145]</td></tr> <tr><td>Samarium</td><td>62</td><td>Sm</td><td>150.36</td></tr> <tr><td>Europium</td><td>63</td><td>Eu</td><td>151.964</td></tr> <tr><td>Gadolinium</td><td>64</td><td>Gd</td><td>157.25</td></tr> <tr><td>Terbium</td><td>65</td><td>Tb</td><td>158.92534</td></tr> <tr><td>Dysprosium</td><td>66</td><td>Dy</td><td>162.50014</td></tr> <tr><td>Holmium</td><td>67</td><td>Ho</td><td>164.93032</td></tr> <tr><td>Erbium</td><td>68</td><td>Er</td><td>167.259</td></tr> <tr><td>Thulium</td><td>69</td><td>Tm</td><td>168.93047</td></tr> <tr><td>Ytterbium</td><td>70</td><td>Yb</td><td>173.045</td></tr> <tr><td>Actinium</td><td>89</td><td>Ac</td><td>[227]</td></tr> <tr><td>Thorium</td><td>90</td><td>Th</td><td>232.0377</td></tr> <tr><td>Protactinium</td><td>91</td><td>Pa</td><td>231.036889</td></tr> <tr><td>Uranium</td><td>92</td><td>U</td><td>238.02891</td></tr> <tr><td>Neptunium</td><td>93</td><td>Np</td><td>[237]</td></tr> <tr><td>Plutonium</td><td>94</td><td>Pu</td><td>[244]</td></tr> <tr><td>Americium</td><td>95</td><td>Am</td><td>[243]</td></tr> <tr><td>Curium</td><td>96</td><td>Cm</td><td>[247]</td></tr> <tr><td>Berkelium</td><td>97</td><td>Bk</td><td>[247]</td></tr> <tr><td>Californium</td><td>98</td><td>Cf</td><td>[251]</td></tr> <tr><td>Einsteinium</td><td>99</td><td>Es</td><td>[252]</td></tr> <tr><td>Fermium</td><td>100</td><td>Fm</td><td>[257]</td></tr> <tr><td>Mendelevium</td><td>101</td><td>Md</td><td>[258]</td></tr> <tr><td>Nobelium</td><td>102</td><td>No</td><td>[259]</td></tr> </table>																Boron	5	B	10.811	Carbon	6	C	12.011	Nitrogen	7	N	14.007	Oxygen	8	O	15.999	Fluorine	9	F	18.998	Neon	10	Ne	20.180	Aluminum	13	Al	26.9815386	Silicon	14	Si	28.0855	Phosphorus	15	P	30.973762	Sulfur	16	S	32.06	Chlorine	17	Cl	35.453	Argon	18	Ar	39.948	Calcium	20	Ca	40.078	Scandium	21	Sc	44.955912	Titanium	22	Ti	47.88	Vanadium	23	V	50.9415	Chromium	24	Cr	51.9961	Manganese	25	Mn	54.938045	Iron	26	Fe	55.845	Cobalt	27	Co	58.933195	Nickel	28	Ni	58.6934	Copper	29	Cu	63.546	Zinc	30	Zn	65.38	Gallium	31	Ga	69.723	Germanium	32	Ge	72.61	Arsenic	33	As	74.9216	Selenium	34	Se	78.96	Bromine	35	Br	79.904	Krypton	36	Kr	83.80	Rbrium	37	Rb	85.4678	Srrium	38	Sr	87.62	Yttrium	39	Y	88.906	Zirconium	40	Zr	91.224	Niobium	41	Nb	92.90638	Molybdenum	42	Mo	95.94	Technetium	43	Tc	[98]	Ruthenium	44	Ru	101.07	Rhodium	45	Rh	101.07	Palladium	46	Pd	106.3676	Silver	47	Ag	107.8682	Cadmium	48	Cd	112.411	Indium	49	In	114.818	Tin	50	Sn	118.710	Antimony	51	Sb	121.757	Tellurium	52	Te	127.603	Iodine	53	I	126.90547	Xenon	54	Xe	131.29	Cesium	55	Cs	132.90545196	Barium	56	Ba	137.327	Lanthanum	57	La	138.90547	Cerium	58	Ce	140.12	Praseodymium	59	Pr	140.90765	Neodymium	60	Nd	144.242	Europium	61	Pm	[145]	Samarium	62	Sm	150.36	Europium	63	Eu	151.964	Gadolinium	64	Gd	157.25	Terbium	65	Tb	158.92534	Dysprosium	66	Dy	162.50014	Holmium	67	Ho	164.93032	Erbium	68	Er	167.259	Thulium	69	Tm	168.93047	Ytterbium	70	Yb	173.045	Actinium	89	Ac	[227]	Thorium	90	Th	232.0377	Protactinium	91	Pa	231.036889	Uranium	92	U	238.02891	Neptunium	93	Np	[237]	Plutonium	94	Pu	[244]	Americium	95	Am	[243]	Curium	96	Cm	[247]	Berkelium	97	Bk	[247]	Californium	98	Cf	[251]	Einsteinium	99	Es	[252]	Fermium	100	Fm	[257]	Mendelevium	101	Md	[258]	Nobelium	102	No	[259]	<table border="1"> <tr><td>Helium</td><td>2</td><td>He</td><td>4.002602</td></tr> </table>		Helium	2	He	4.002602
Hydrogen	1	H	1.00794																																																																																																																																																																																																																																																																																																																																																																																		
Lithium	3	Li	6.941																																																																																																																																																																																																																																																																																																																																																																																		
Sodium	11	Na	22.98976928																																																																																																																																																																																																																																																																																																																																																																																		
Potassium	19	K	39.0983																																																																																																																																																																																																																																																																																																																																																																																		
Rubidium	37	Rb	85.4678																																																																																																																																																																																																																																																																																																																																																																																		
Cesium	55	Cs	132.90545196																																																																																																																																																																																																																																																																																																																																																																																		
Francium	87	Fr	[223]																																																																																																																																																																																																																																																																																																																																																																																		
Boron	5	B	10.811																																																																																																																																																																																																																																																																																																																																																																																		
Carbon	6	C	12.011																																																																																																																																																																																																																																																																																																																																																																																		
Nitrogen	7	N	14.007																																																																																																																																																																																																																																																																																																																																																																																		
Oxygen	8	O	15.999																																																																																																																																																																																																																																																																																																																																																																																		
Fluorine	9	F	18.998																																																																																																																																																																																																																																																																																																																																																																																		
Neon	10	Ne	20.180																																																																																																																																																																																																																																																																																																																																																																																		
Aluminum	13	Al	26.9815386																																																																																																																																																																																																																																																																																																																																																																																		
Silicon	14	Si	28.0855																																																																																																																																																																																																																																																																																																																																																																																		
Phosphorus	15	P	30.973762																																																																																																																																																																																																																																																																																																																																																																																		
Sulfur	16	S	32.06																																																																																																																																																																																																																																																																																																																																																																																		
Chlorine	17	Cl	35.453																																																																																																																																																																																																																																																																																																																																																																																		
Argon	18	Ar	39.948																																																																																																																																																																																																																																																																																																																																																																																		
Calcium	20	Ca	40.078																																																																																																																																																																																																																																																																																																																																																																																		
Scandium	21	Sc	44.955912																																																																																																																																																																																																																																																																																																																																																																																		
Titanium	22	Ti	47.88																																																																																																																																																																																																																																																																																																																																																																																		
Vanadium	23	V	50.9415																																																																																																																																																																																																																																																																																																																																																																																		
Chromium	24	Cr	51.9961																																																																																																																																																																																																																																																																																																																																																																																		
Manganese	25	Mn	54.938045																																																																																																																																																																																																																																																																																																																																																																																		
Iron	26	Fe	55.845																																																																																																																																																																																																																																																																																																																																																																																		
Cobalt	27	Co	58.933195																																																																																																																																																																																																																																																																																																																																																																																		
Nickel	28	Ni	58.6934																																																																																																																																																																																																																																																																																																																																																																																		
Copper	29	Cu	63.546																																																																																																																																																																																																																																																																																																																																																																																		
Zinc	30	Zn	65.38																																																																																																																																																																																																																																																																																																																																																																																		
Gallium	31	Ga	69.723																																																																																																																																																																																																																																																																																																																																																																																		
Germanium	32	Ge	72.61																																																																																																																																																																																																																																																																																																																																																																																		
Arsenic	33	As	74.9216																																																																																																																																																																																																																																																																																																																																																																																		
Selenium	34	Se	78.96																																																																																																																																																																																																																																																																																																																																																																																		
Bromine	35	Br	79.904																																																																																																																																																																																																																																																																																																																																																																																		
Krypton	36	Kr	83.80																																																																																																																																																																																																																																																																																																																																																																																		
Rbrium	37	Rb	85.4678																																																																																																																																																																																																																																																																																																																																																																																		
Srrium	38	Sr	87.62																																																																																																																																																																																																																																																																																																																																																																																		
Yttrium	39	Y	88.906																																																																																																																																																																																																																																																																																																																																																																																		
Zirconium	40	Zr	91.224																																																																																																																																																																																																																																																																																																																																																																																		
Niobium	41	Nb	92.90638																																																																																																																																																																																																																																																																																																																																																																																		
Molybdenum	42	Mo	95.94																																																																																																																																																																																																																																																																																																																																																																																		
Technetium	43	Tc	[98]																																																																																																																																																																																																																																																																																																																																																																																		
Ruthenium	44	Ru	101.07																																																																																																																																																																																																																																																																																																																																																																																		
Rhodium	45	Rh	101.07																																																																																																																																																																																																																																																																																																																																																																																		
Palladium	46	Pd	106.3676																																																																																																																																																																																																																																																																																																																																																																																		
Silver	47	Ag	107.8682																																																																																																																																																																																																																																																																																																																																																																																		
Cadmium	48	Cd	112.411																																																																																																																																																																																																																																																																																																																																																																																		
Indium	49	In	114.818																																																																																																																																																																																																																																																																																																																																																																																		
Tin	50	Sn	118.710																																																																																																																																																																																																																																																																																																																																																																																		
Antimony	51	Sb	121.757																																																																																																																																																																																																																																																																																																																																																																																		
Tellurium	52	Te	127.603																																																																																																																																																																																																																																																																																																																																																																																		
Iodine	53	I	126.90547																																																																																																																																																																																																																																																																																																																																																																																		
Xenon	54	Xe	131.29																																																																																																																																																																																																																																																																																																																																																																																		
Cesium	55	Cs	132.90545196																																																																																																																																																																																																																																																																																																																																																																																		
Barium	56	Ba	137.327																																																																																																																																																																																																																																																																																																																																																																																		
Lanthanum	57	La	138.90547																																																																																																																																																																																																																																																																																																																																																																																		
Cerium	58	Ce	140.12																																																																																																																																																																																																																																																																																																																																																																																		
Praseodymium	59	Pr	140.90765																																																																																																																																																																																																																																																																																																																																																																																		
Neodymium	60	Nd	144.242																																																																																																																																																																																																																																																																																																																																																																																		
Europium	61	Pm	[145]																																																																																																																																																																																																																																																																																																																																																																																		
Samarium	62	Sm	150.36																																																																																																																																																																																																																																																																																																																																																																																		
Europium	63	Eu	151.964																																																																																																																																																																																																																																																																																																																																																																																		
Gadolinium	64	Gd	157.25																																																																																																																																																																																																																																																																																																																																																																																		
Terbium	65	Tb	158.92534																																																																																																																																																																																																																																																																																																																																																																																		
Dysprosium	66	Dy	162.50014																																																																																																																																																																																																																																																																																																																																																																																		
Holmium	67	Ho	164.93032																																																																																																																																																																																																																																																																																																																																																																																		
Erbium	68	Er	167.259																																																																																																																																																																																																																																																																																																																																																																																		
Thulium	69	Tm	168.93047																																																																																																																																																																																																																																																																																																																																																																																		
Ytterbium	70	Yb	173.045																																																																																																																																																																																																																																																																																																																																																																																		
Actinium	89	Ac	[227]																																																																																																																																																																																																																																																																																																																																																																																		
Thorium	90	Th	232.0377																																																																																																																																																																																																																																																																																																																																																																																		
Protactinium	91	Pa	231.036889																																																																																																																																																																																																																																																																																																																																																																																		
Uranium	92	U	238.02891																																																																																																																																																																																																																																																																																																																																																																																		
Neptunium	93	Np	[237]																																																																																																																																																																																																																																																																																																																																																																																		
Plutonium	94	Pu	[244]																																																																																																																																																																																																																																																																																																																																																																																		
Americium	95	Am	[243]																																																																																																																																																																																																																																																																																																																																																																																		
Curium	96	Cm	[247]																																																																																																																																																																																																																																																																																																																																																																																		
Berkelium	97	Bk	[247]																																																																																																																																																																																																																																																																																																																																																																																		
Californium	98	Cf	[251]																																																																																																																																																																																																																																																																																																																																																																																		
Einsteinium	99	Es	[252]																																																																																																																																																																																																																																																																																																																																																																																		
Fermium	100	Fm	[257]																																																																																																																																																																																																																																																																																																																																																																																		
Mendelevium	101	Md	[258]																																																																																																																																																																																																																																																																																																																																																																																		
Nobelium	102	No	[259]																																																																																																																																																																																																																																																																																																																																																																																		
Helium	2	He	4.002602																																																																																																																																																																																																																																																																																																																																																																																		
<table border="1"> <tr><td>Lanthanum</td><td>57</td><td>La</td><td>138.90547</td></tr> <tr><td>Cerium</td><td>58</td><td>Ce</td><td>140.12</td></tr> <tr><td>Praseodymium</td><td>59</td><td>Pr</td><td>140.90765</td></tr> <tr><td>Neodymium</td><td>60</td><td>Nd</td><td>144.242</td></tr> <tr><td>Europium</td><td>61</td><td>Pm</td><td>[145]</td></tr> <tr><td>Samarium</td><td>62</td><td>Sm</td><td>150.36</td></tr> <tr><td>Europium</td><td>63</td><td>Eu</td><td>151.964</td></tr> <tr><td>Gadolinium</td><td>64</td><td>Gd</td><td>157.25</td></tr> <tr><td>Terbium</td><td>65</td><td>Tb</td><td>158.92534</td></tr> <tr><td>Dysprosium</td><td>66</td><td>Dy</td><td>162.50014</td></tr> <tr><td>Holmium</td><td>67</td><td>Ho</td><td>164.93032</td></tr> <tr><td>Erbium</td><td>68</td><td>Er</td><td>167.259</td></tr> <tr><td>Thulium</td><td>69</td><td>Tm</td><td>168.93047</td></tr> <tr><td>Ytterbium</td><td>70</td><td>Yb</td><td>173.045</td></tr> </table>																Lanthanum	57	La	138.90547	Cerium	58	Ce	140.12	Praseodymium	59	Pr	140.90765	Neodymium	60	Nd	144.242	Europium	61	Pm	[145]	Samarium	62	Sm	150.36	Europium	63	Eu	151.964	Gadolinium	64	Gd	157.25	Terbium	65	Tb	158.92534	Dysprosium	66	Dy	162.50014	Holmium	67	Ho	164.93032	Erbium	68	Er	167.259	Thulium	69	Tm	168.93047	Ytterbium	70	Yb	173.045	<table border="1"> <tr><td>Uranium</td><td>92</td><td>U</td><td>238.02891</td></tr> <tr><td>Neptunium</td><td>93</td><td>Np</td><td>[237]</td></tr> <tr><td>Plutonium</td><td>94</td><td>Pu</td><td>[244]</td></tr> <tr><td>Americium</td><td>95</td><td>Am</td><td>[243]</td></tr> <tr><td>Curium</td><td>96</td><td>Cm</td><td>[247]</td></tr> <tr><td>Berkelium</td><td>97</td><td>Bk</td><td>[247]</td></tr> <tr><td>Californium</td><td>98</td><td>Cf</td><td>[251]</td></tr> <tr><td>Einsteinium</td><td>99</td><td>Es</td><td>[252]</td></tr> <tr><td>Fermium</td><td>100</td><td>Fm</td><td>[257]</td></tr> <tr><td>Mendelevium</td><td>101</td><td>Md</td><td>[258]</td></tr> <tr><td>Nobelium</td><td>102</td><td>No</td><td>[259]</td></tr> </table>		Uranium	92	U	238.02891	Neptunium	93	Np	[237]	Plutonium	94	Pu	[244]	Americium	95	Am	[243]	Curium	96	Cm	[247]	Berkelium	97	Bk	[247]	Californium	98	Cf	[251]	Einsteinium	99	Es	[252]	Fermium	100	Fm	[257]	Mendelevium	101	Md	[258]	Nobelium	102	No	[259]																																																																																																																																																																																																																																																																
Lanthanum	57	La	138.90547																																																																																																																																																																																																																																																																																																																																																																																		
Cerium	58	Ce	140.12																																																																																																																																																																																																																																																																																																																																																																																		
Praseodymium	59	Pr	140.90765																																																																																																																																																																																																																																																																																																																																																																																		
Neodymium	60	Nd	144.242																																																																																																																																																																																																																																																																																																																																																																																		
Europium	61	Pm	[145]																																																																																																																																																																																																																																																																																																																																																																																		
Samarium	62	Sm	150.36																																																																																																																																																																																																																																																																																																																																																																																		
Europium	63	Eu	151.964																																																																																																																																																																																																																																																																																																																																																																																		
Gadolinium	64	Gd	157.25																																																																																																																																																																																																																																																																																																																																																																																		
Terbium	65	Tb	158.92534																																																																																																																																																																																																																																																																																																																																																																																		
Dysprosium	66	Dy	162.50014																																																																																																																																																																																																																																																																																																																																																																																		
Holmium	67	Ho	164.93032																																																																																																																																																																																																																																																																																																																																																																																		
Erbium	68	Er	167.259																																																																																																																																																																																																																																																																																																																																																																																		
Thulium	69	Tm	168.93047																																																																																																																																																																																																																																																																																																																																																																																		
Ytterbium	70	Yb	173.045																																																																																																																																																																																																																																																																																																																																																																																		
Uranium	92	U	238.02891																																																																																																																																																																																																																																																																																																																																																																																		
Neptunium	93	Np	[237]																																																																																																																																																																																																																																																																																																																																																																																		
Plutonium	94	Pu	[244]																																																																																																																																																																																																																																																																																																																																																																																		
Americium	95	Am	[243]																																																																																																																																																																																																																																																																																																																																																																																		
Curium	96	Cm	[247]																																																																																																																																																																																																																																																																																																																																																																																		
Berkelium	97	Bk	[247]																																																																																																																																																																																																																																																																																																																																																																																		
Californium	98	Cf	[251]																																																																																																																																																																																																																																																																																																																																																																																		
Einsteinium	99	Es	[252]																																																																																																																																																																																																																																																																																																																																																																																		
Fermium	100	Fm	[257]																																																																																																																																																																																																																																																																																																																																																																																		
Mendelevium	101	Md	[258]																																																																																																																																																																																																																																																																																																																																																																																		
Nobelium	102	No	[259]																																																																																																																																																																																																																																																																																																																																																																																		



Savannah River Site Precipitation Monitoring Network:

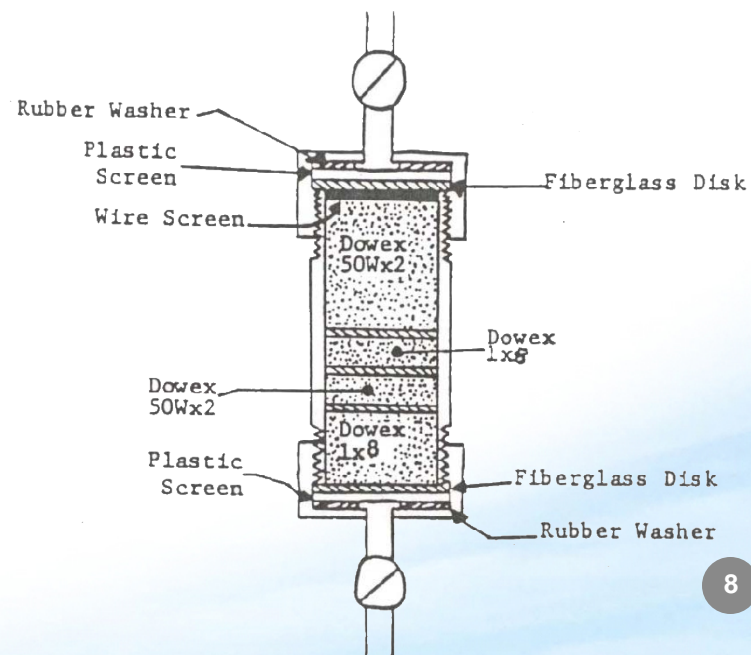


- Monitoring Sites**
- On-Site 1 - 6
 - 10 Mile 5 - 12
 - 25 Mile 5 - 12
 - 100 Mile 1 - 4

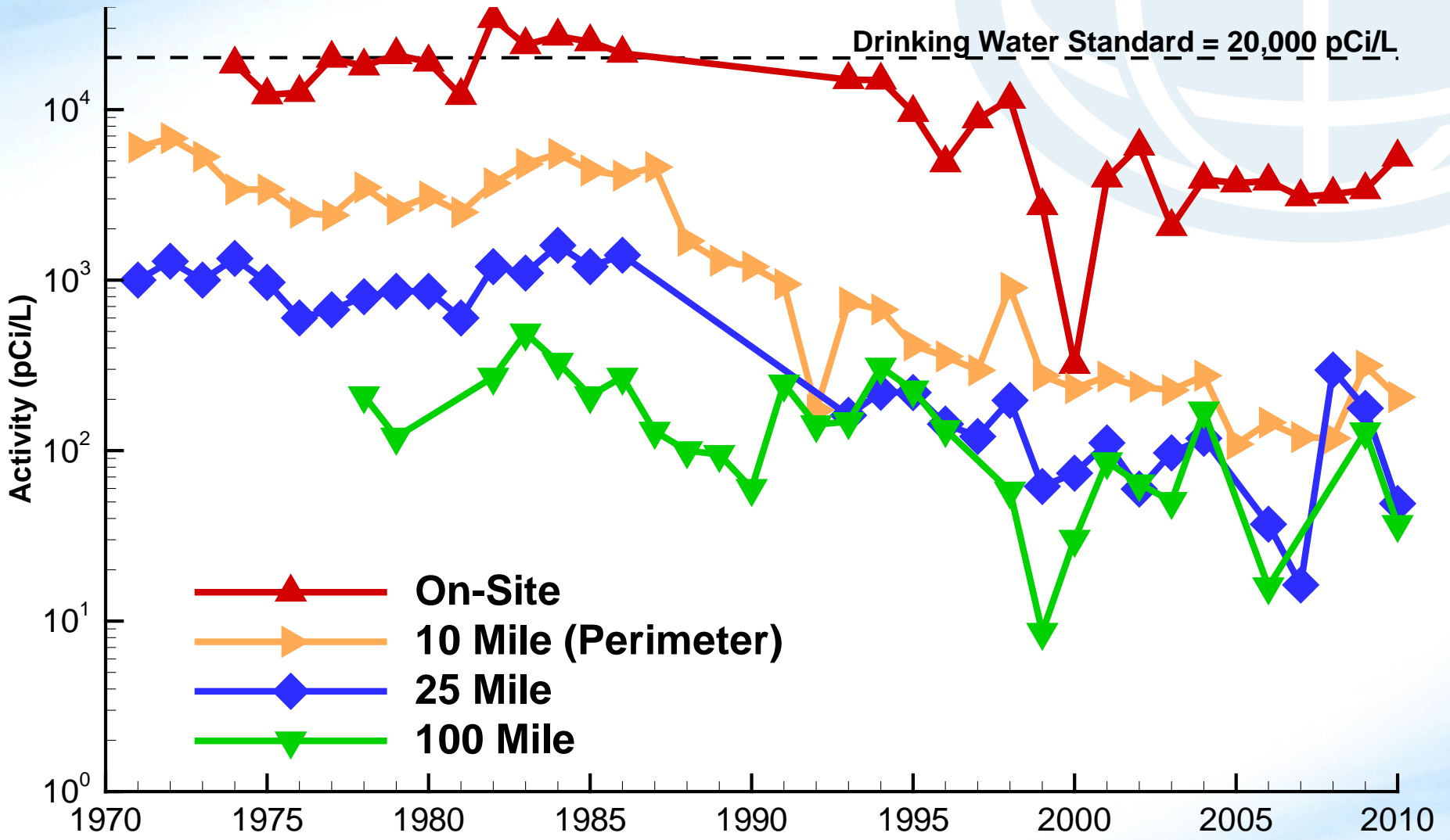
SRS Precipitation Sampling Equipment & Analysis:



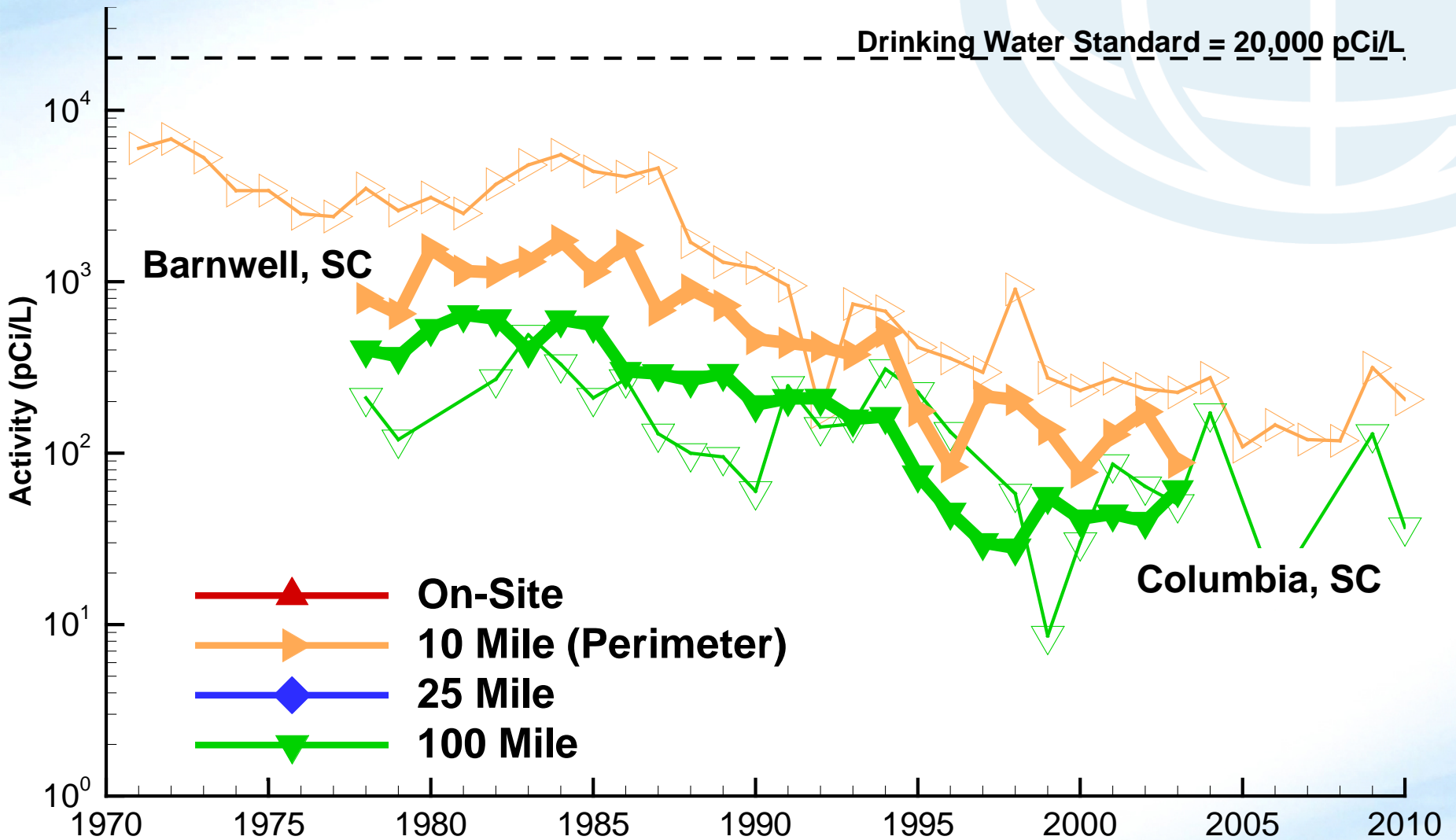
Detail of Ion Exchange Column



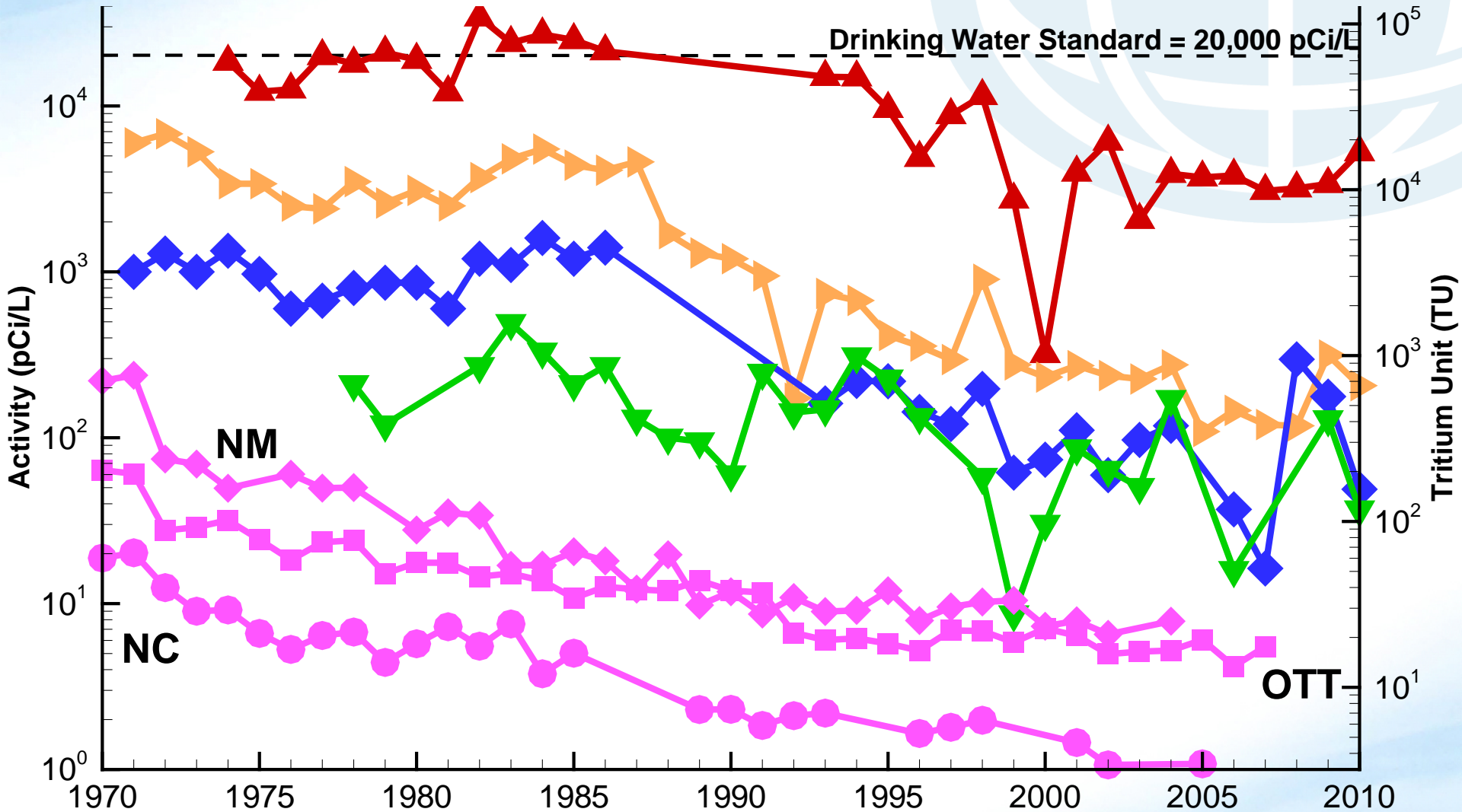
Average Tritium Activity in Rainwater - SRS



Average Tritium Activity in Rainwater – SRS & RADNET



Average Tritium Activity in Rainwater – SRS & IAEA



Conclusions & Observations:

- **Tritium Activity in Precipitation:**
 - Activity Decreases as Distance from SRS Increases,
 - Observations (10 & 100 miles) Consistent with EPA RADNET,
 - Observations in Vicinity of SRS are Greater Than IAEA Observations,
 - SRS, EPA & IAEA Indicate Overall Decrease in Tritium.
- **Need for improvements in low-level measurements at 25 & 100-mile locations!**
- **Is there a need for a large-scale monitoring network?**

Additional Information & Resources:

SRS Environmental Reports:

<http://www.srs.gov/general/pubs/ERsum/index.html>

IAEA Water Isotope System for Data Analysis, Visualization, and Electronic Retrieval (WISER):

http://www-naweb.iaea.org/napc/ih/IHS_resources_isohis.html

US EPA RADMAP:

<http://www.epa.gov/narel/radnet/>

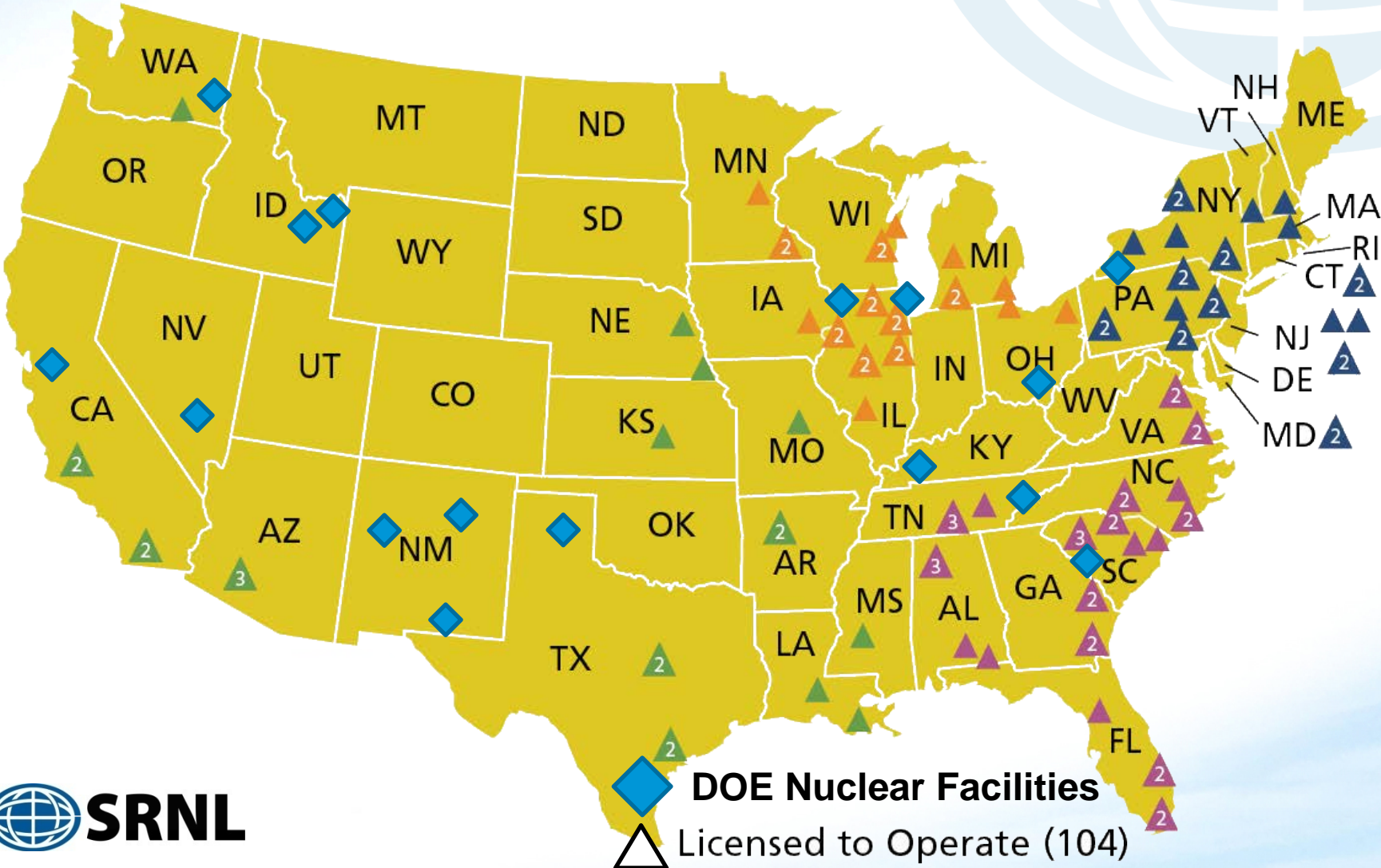
Nuclear Power Effluent and Environmental Reports:

<http://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-info.html>



DOE Nuclear & NRC Licensed Reactors in United States:

U.S. Operating Commercial Nuclear Power Reactors



Would NTN be a Suitable Network for Radionuclides?

