# An exercise: applying GAMP for the BOTUXIM site

Dejanira da Costa Lauria

# IDENTIFYING THE PROBLEM

# Where does the contamination come from?

Monazite ore was processed, from 1945 up to July 1992, to obtain rare earth oxides.

A residue containing Th and U oxide was produced (Cake II).

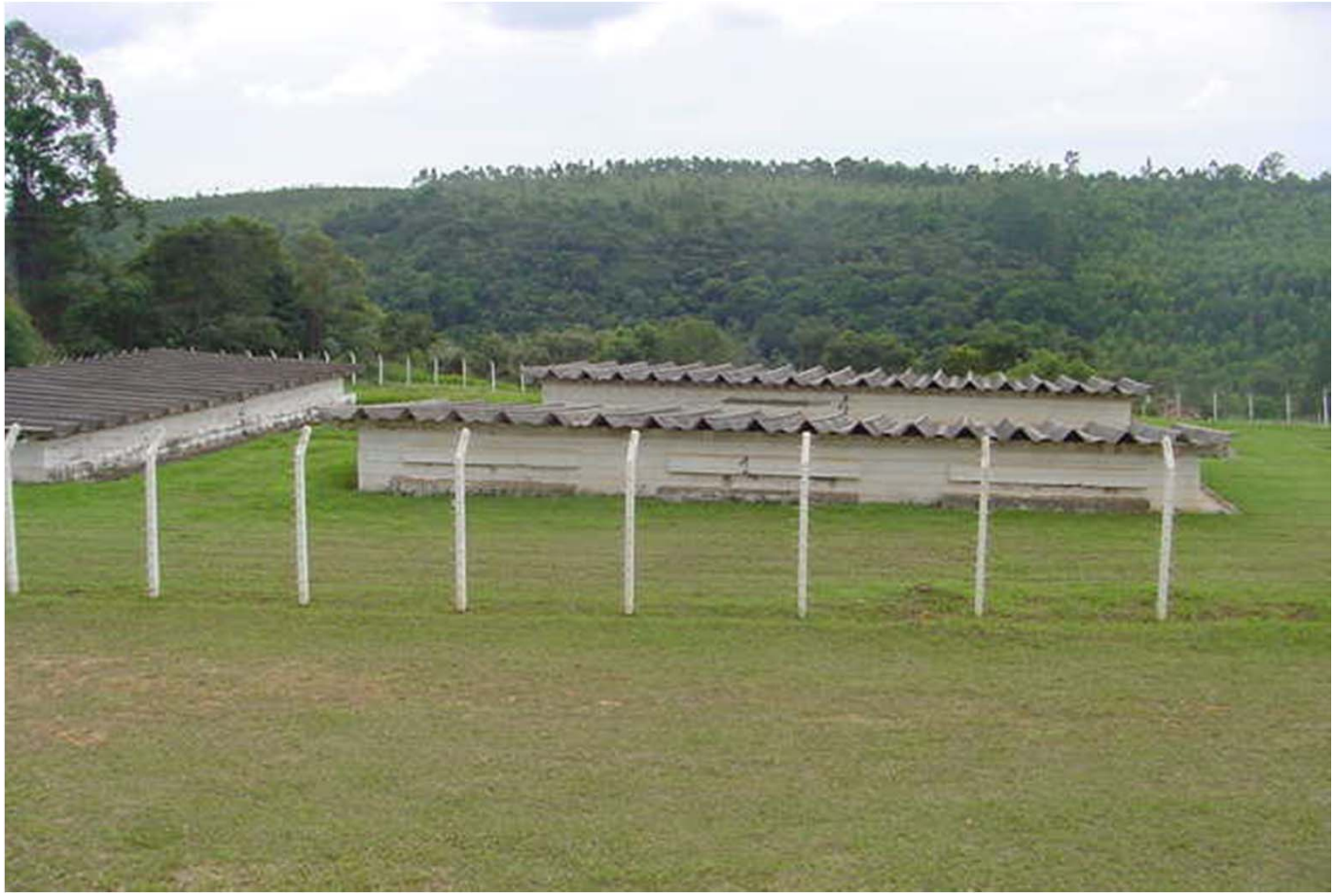
# And…. where are the residues stored?

# The Botuxim site

3,500 METRIC TONS of Cake II are STORED IN 7 POOLS (SILOS)

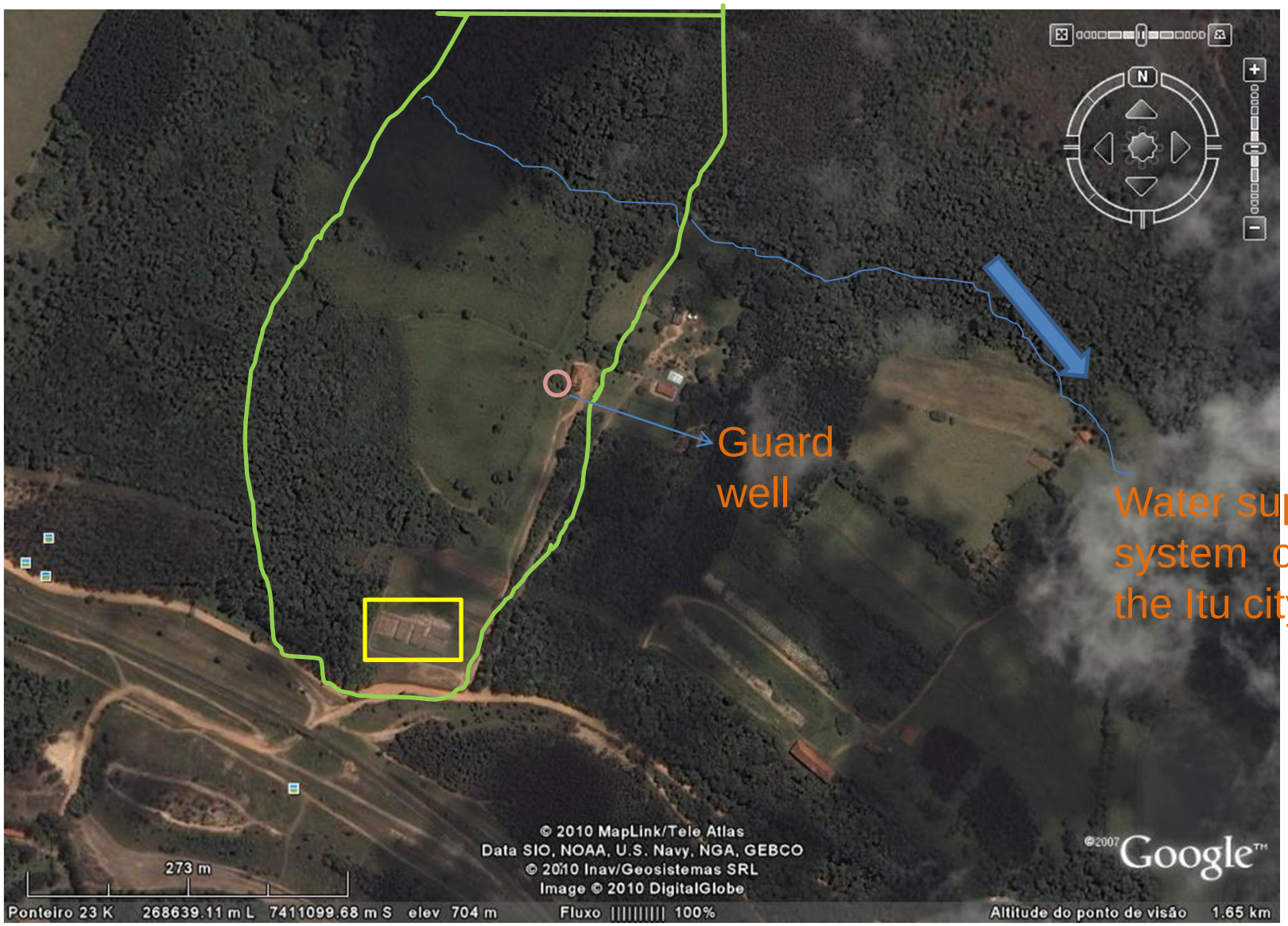

Seven pools, 3 m deep, surrounded by 30 cm thick concrete walls and floors. Each pool is 0.5 m above the soil surface and 2.5 m underground. They are capped with concrete .

# Cake II: residue or waste?



A mixture of 0.9 % of $U_3O_8$ and 22% of $ThO_2$: specific activity around 1820 Bq/g.

# Botuxim site



# The water of the Guard well presented high concentrations of radionuclides !!!

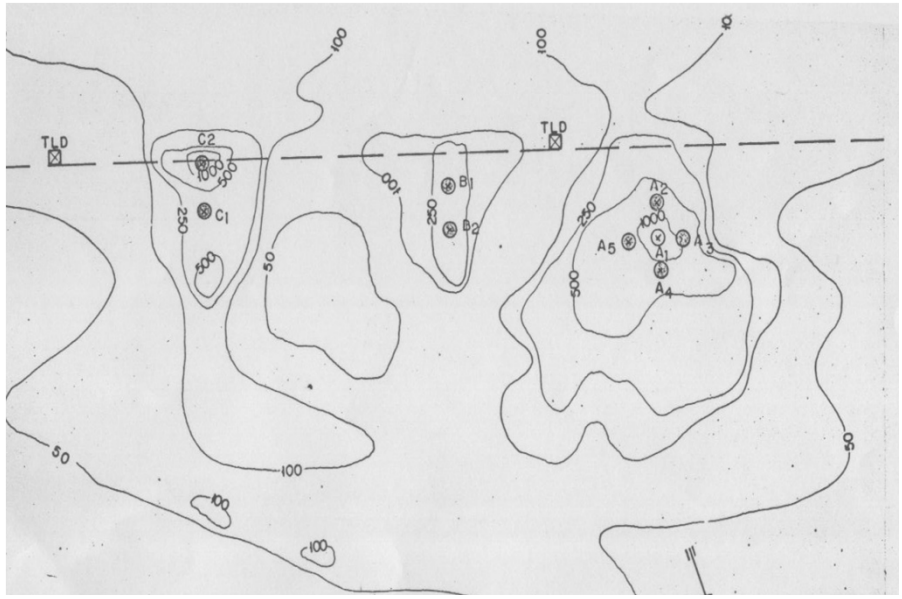
Beta concentration in some waters of the region (Bq/L)*

| Local | N | Minimum | Maximum | Geometric mean |
|---|---|---|---|---|
| Guard well | 77 | 0.01 | 4.00 | 0.30 |
| Monjolinho Creek | 8 | 0.04 | 0.40 | 0.15 |
| Itu town | 6 | 0.05 | 0.20 | 0.11 |

* Data supplied by CETESB

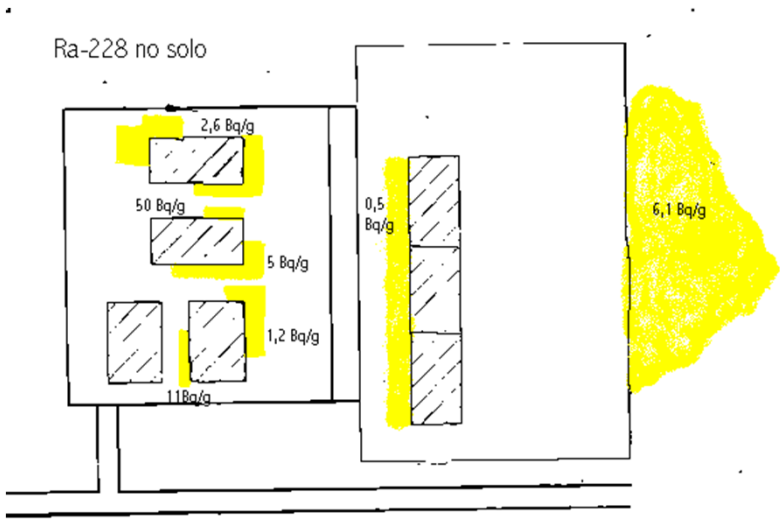
Heavy rain in the *rainy season* seems to play a important role for the observed high concentrations of radionuclides in the Guard well water.

# Previous radiological survey




Area out side the silos fence

- Gamma radiation survey: values ranged from 50 to 1000 cps




Distribution of radionuclides in soil (1993)

Ra-228: from 0.03 to 70 Bq/g
Ra-226: from 0.02 to 0.9 Bq/g
U-238: from 0.02 to 13 Bq/g

# PRELIMINARY SITE INVESTIGATION AND CHARACTERISATION

# Important features for the site

| Topic | Situation |
|---|---|
| Historical survey of the site | Yes |
| Radionuclides in soil, surface water, sediments and groundwater | Yes (in the air it was not considered necessary) |
| Physical and Chemical characteristics of contaminant; | Not completed |
| Integrity of the containing of the wastes (the silos); | inconclusive |

Radiological criteria: 1 mSv/y
Screening = clean up criteria

# Exposure scenario

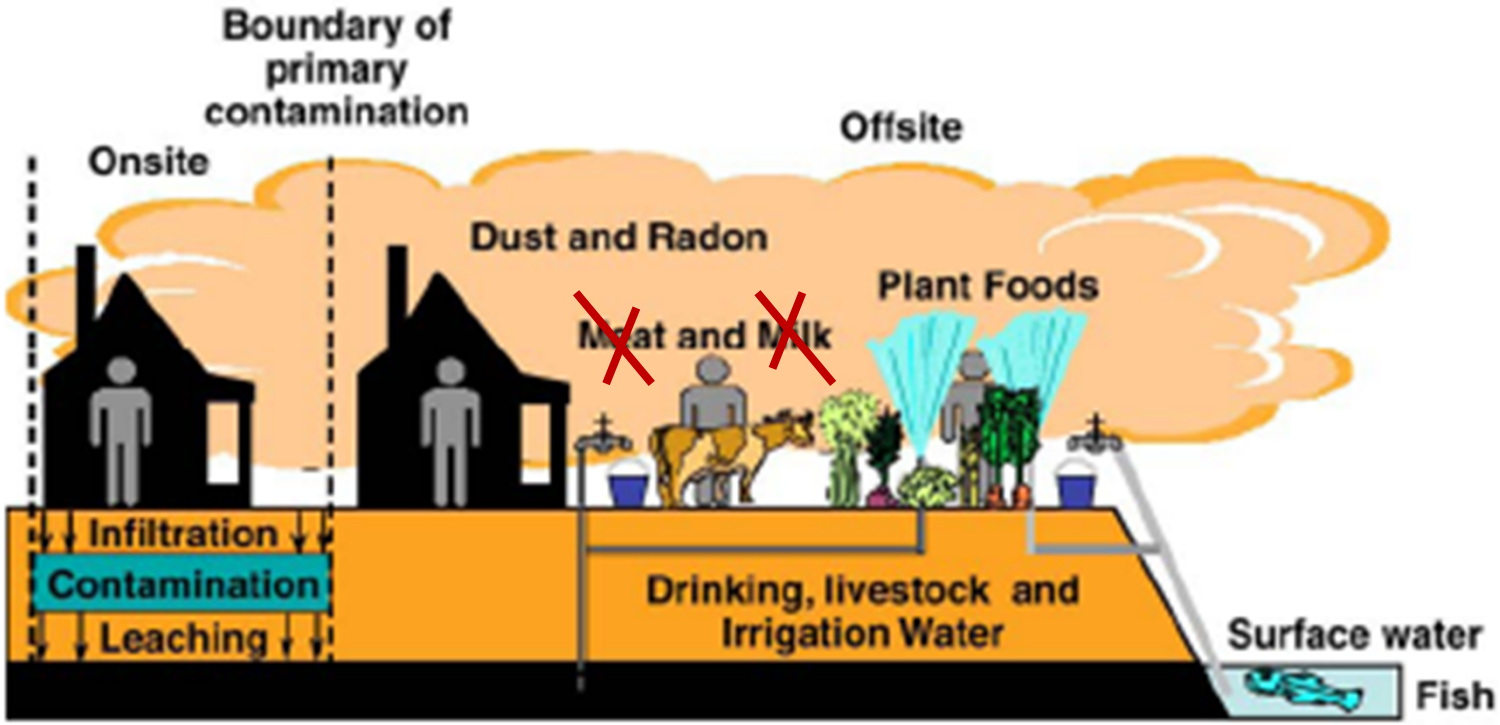
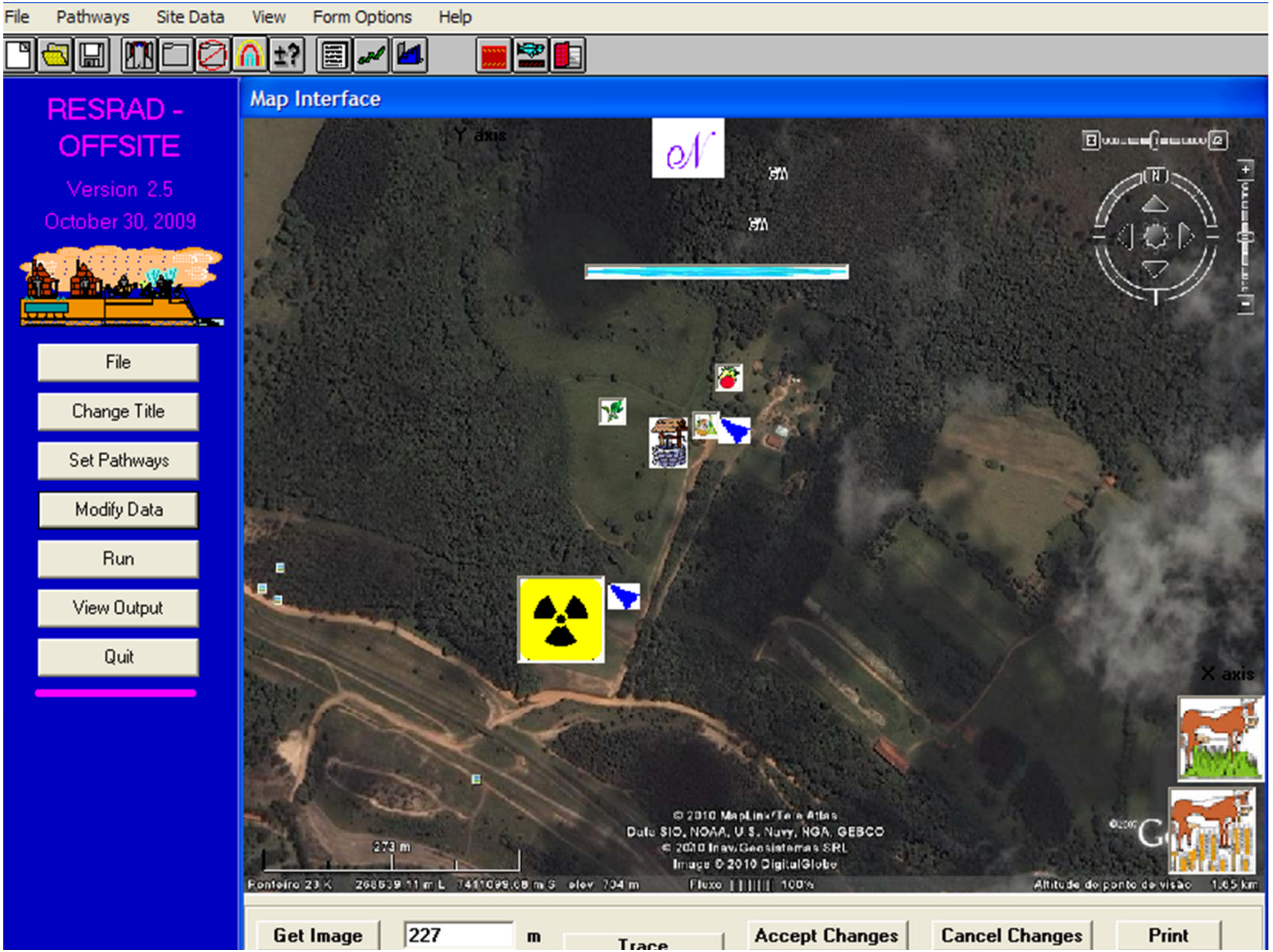
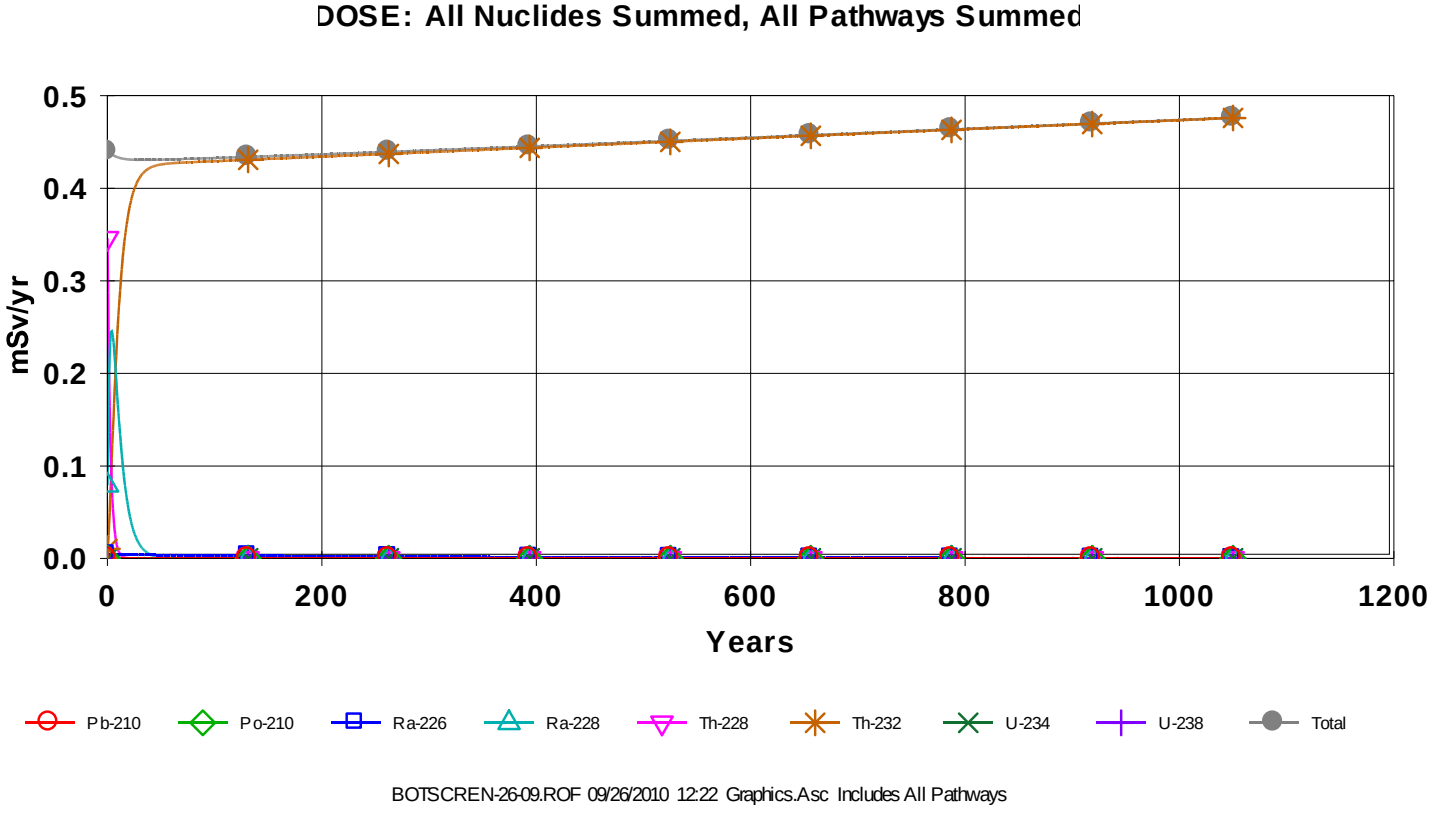



FIGURE 1.1 Locations of Primary and Secondary Contamination in RESRAD-OFFSITE


File
Pathways
Site Data
View
Form Options
Help
RESRAD - OFFSITE
Version 2.5
October 30, 2009
File
Change Title
Set Pathways
Modify Data
Run
View Output
Quit
Map Interface
Y axis
X axis
Get Image
227
m
Trace
Accept Changes
Cancel Changes
Print

# SCREENING ASSESSMENT

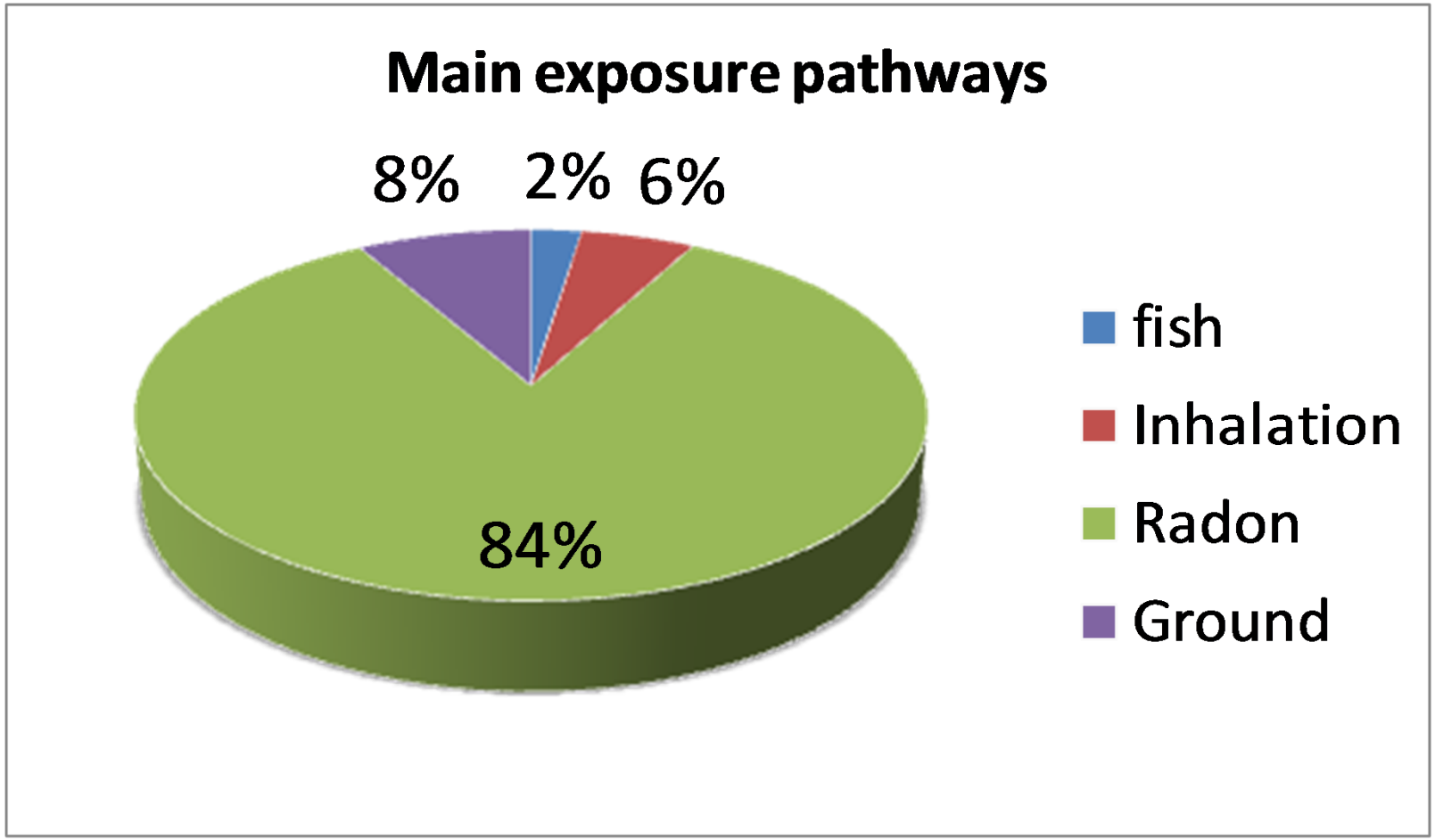
# Total dose due to the highest values of radionuclide concentrations in soil




Maximum value of dose: 0.44 mSv/y

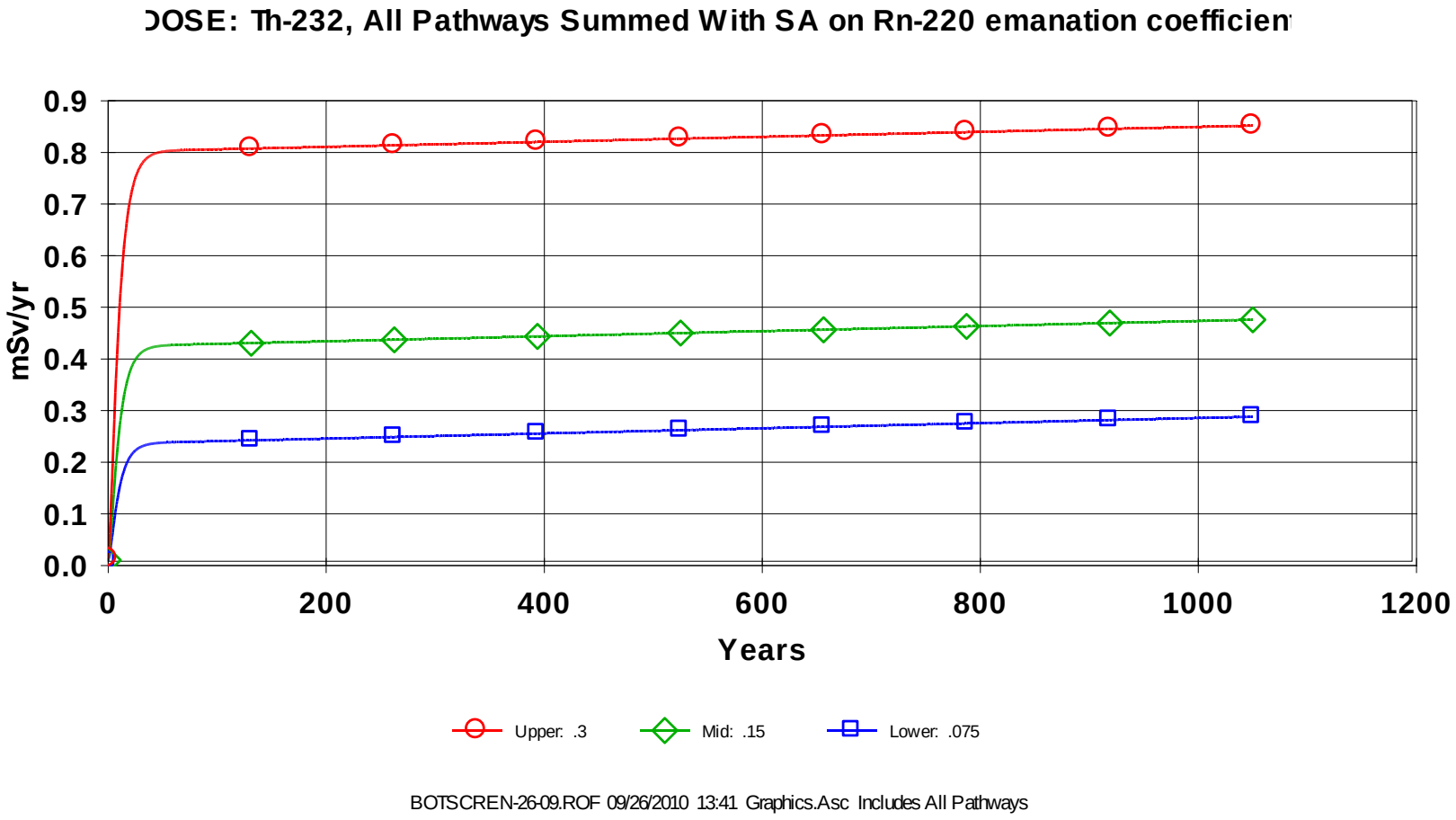
Parameters changed in RESRAD offsite:
Volume of surface water: 300$m^3$
Mean residence time of water: 0.003 y

# Main exposure pathways




Rn-220 is the highest contributor for the dose.

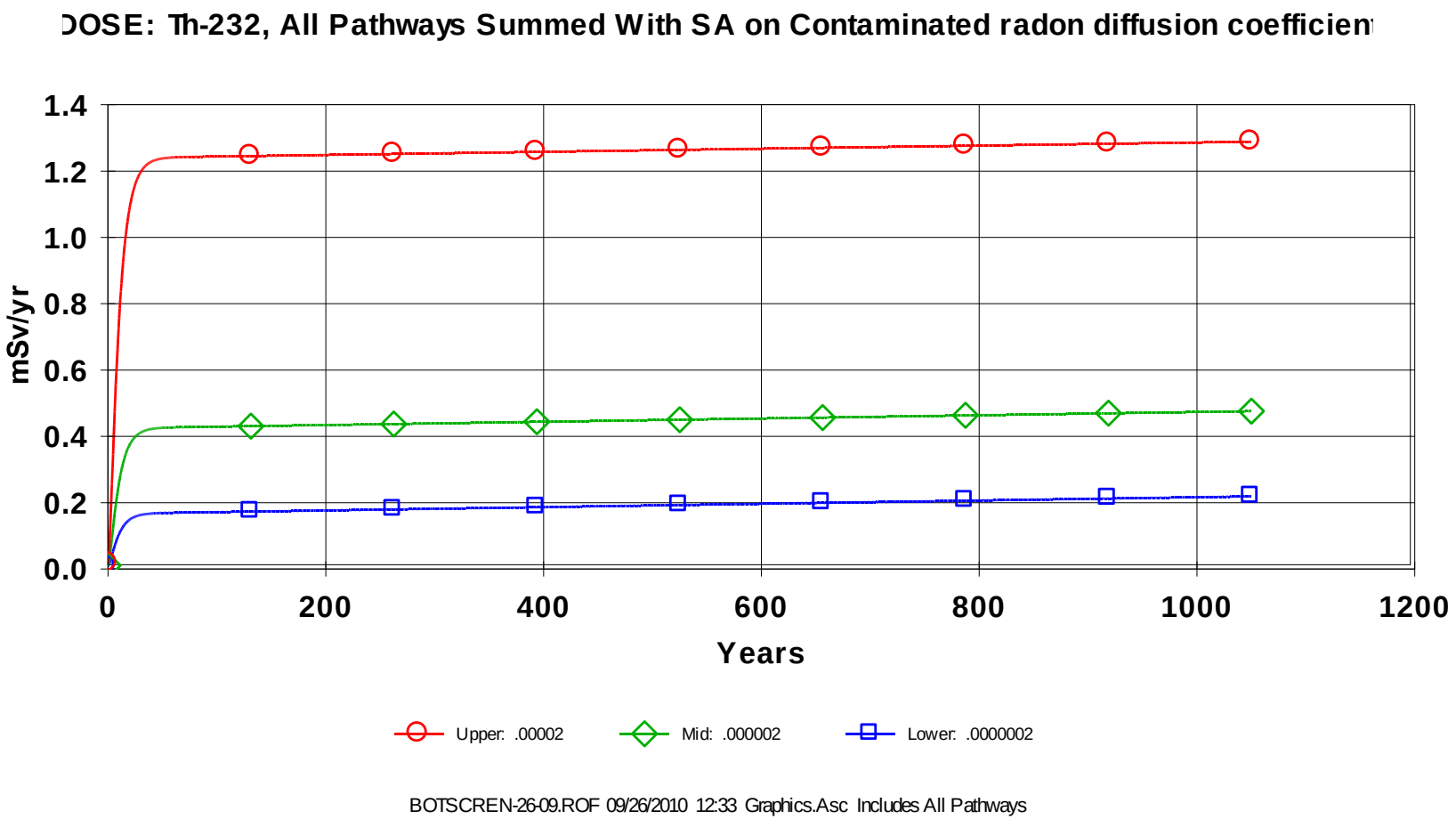
# Sensitivity Analysis




Emanation of Rn-220

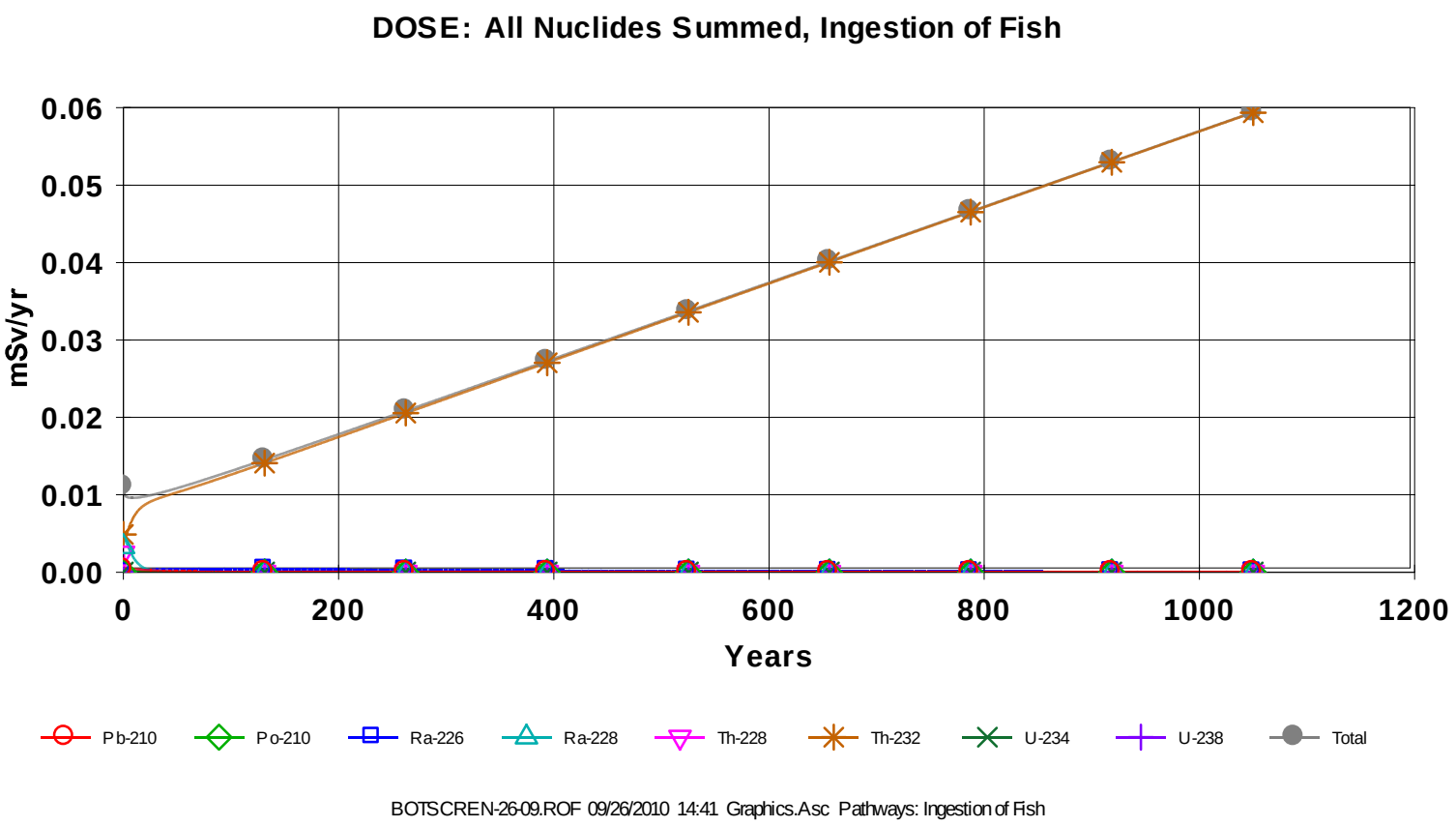
Varying by a factor of two, the dose also varied by a factor of 2

# Effective radon diffusion coefficient of contaminated zone



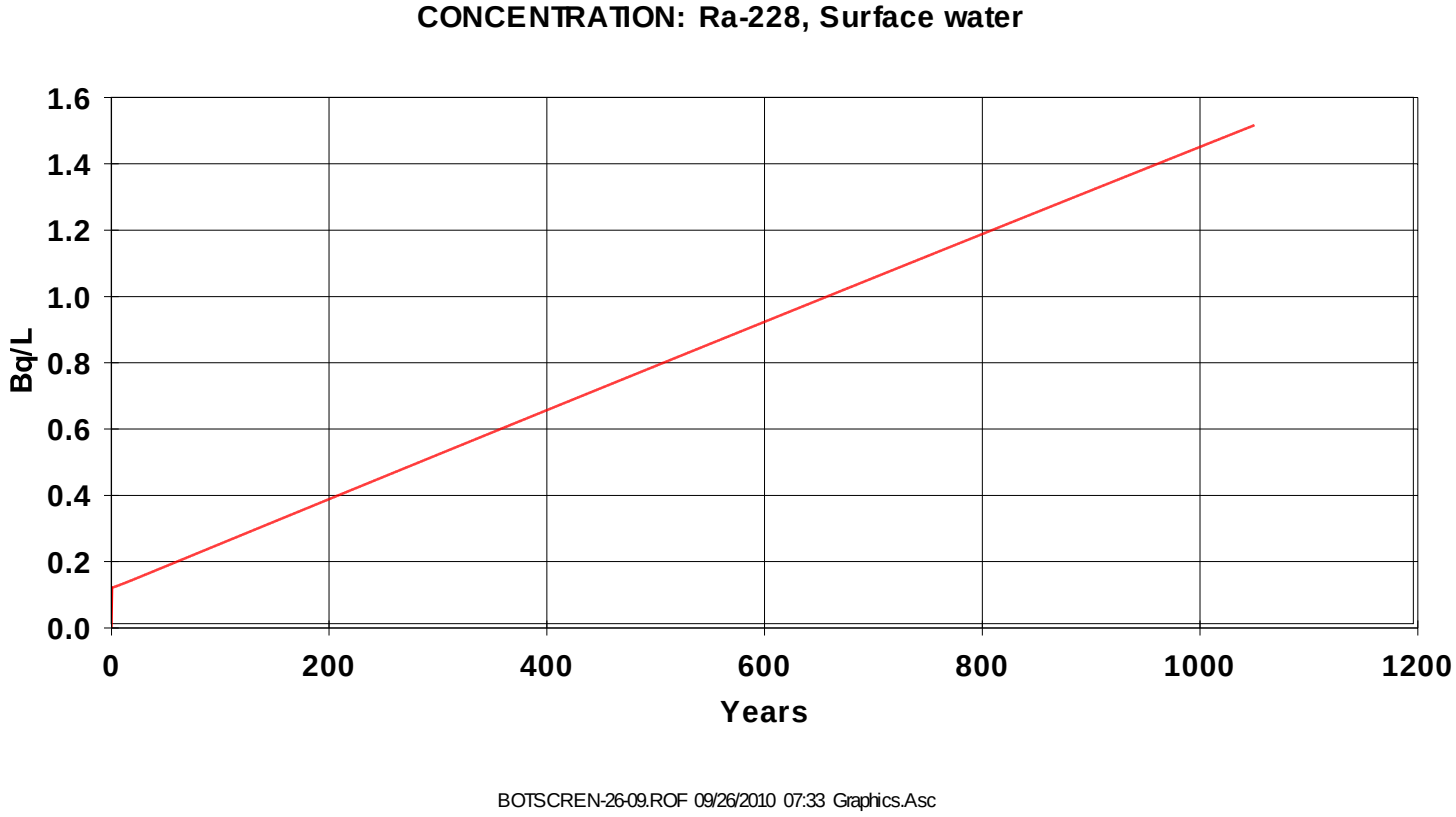

So, if possible these parameters should be assessed for the site!

# An exercise with biota…



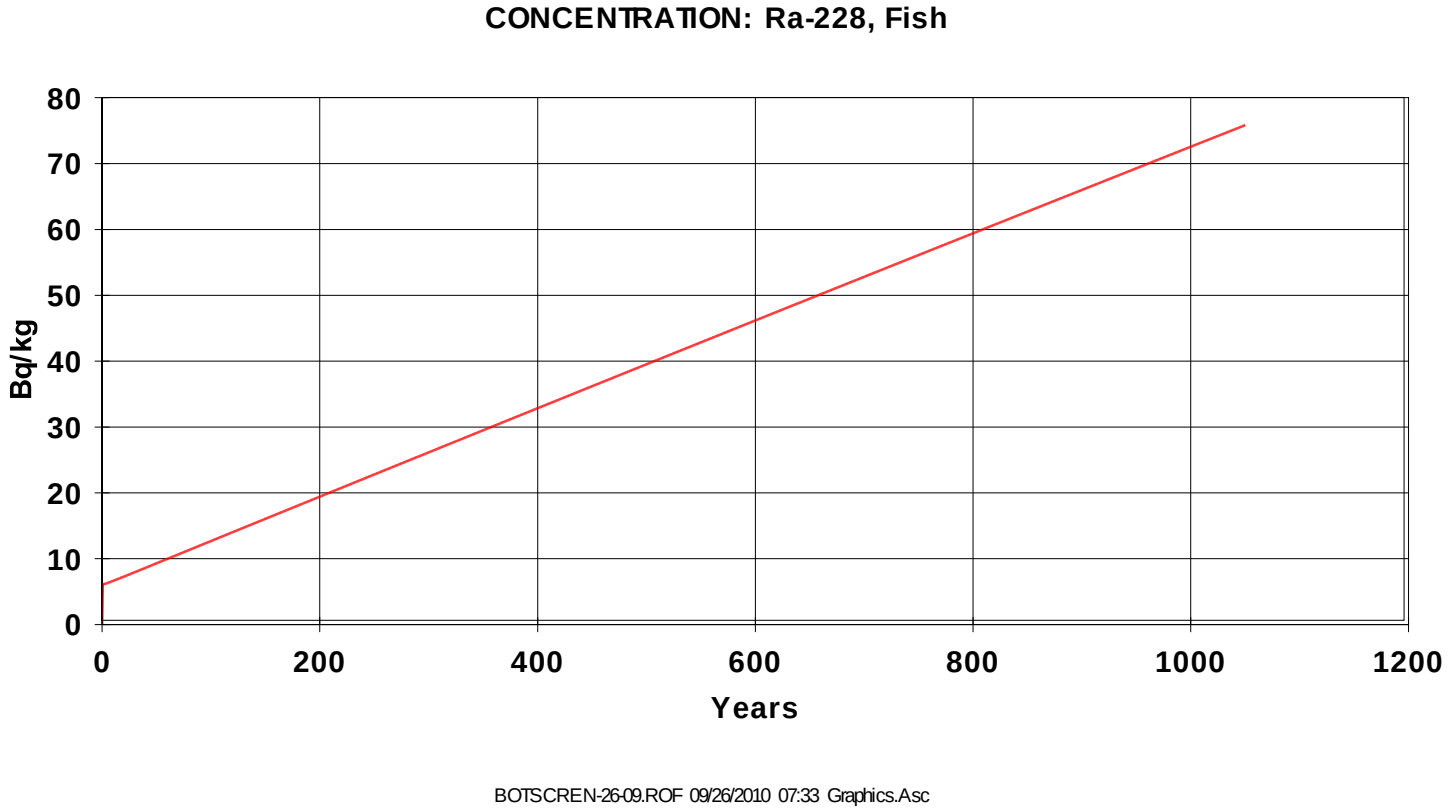

Very low value of human dose by fish ingestion

# However, high level of Ra-228 in surface water




The estimated concentration of radionuclides in water for 0.5 year is: Ra-228=0.1 Bq/L; Th-228=Th-232=0.1 Bq/L; U-238=U-234=0.02 Bq/L.

# And…..a very high radionuclides concentration in fish




The estimated concentration of radionuclides in fish for 0.5 year is: Ra-228=6.1 Bq/kg; Th-228=Th-232=30 Bq/kg; U-238=U-234=0.22 Bq/kg

# Dose for Biota-Erica Tool

- For at least one organism the screening dose rate is exceeded.

| Organism | Total Dose Rate per organism [µGy h-1] |
|---|---|
| Benthic fish | 763 |
| Pelagic fish | 2.3 |

Dose limit: Erica 10 µGy/h ; UNSCEAR, ICRP, DOE 400 µGy/h

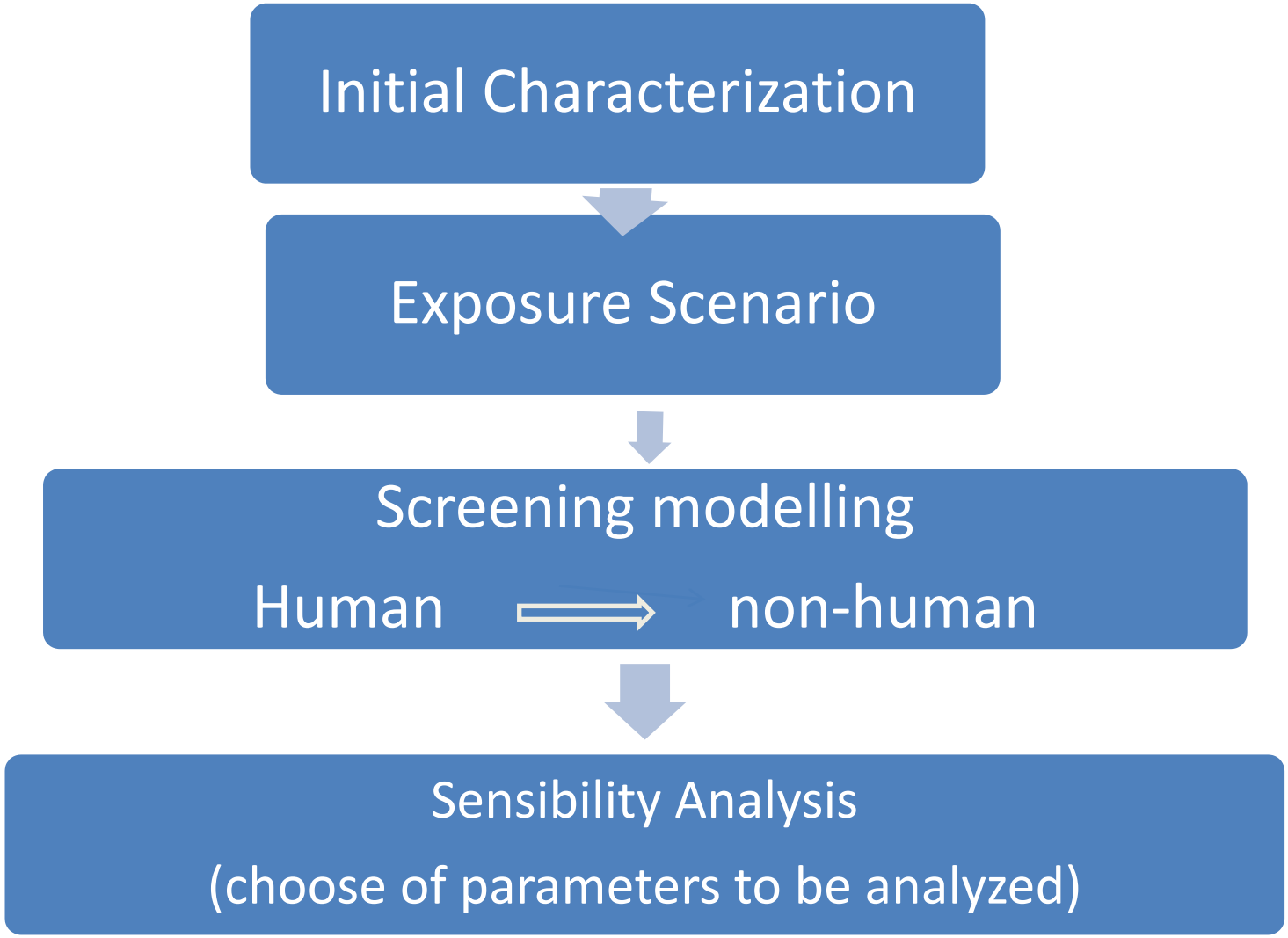
# Sediment concentration by ERICA!!

| Isotope | Activity Concentration in sediment [Bq g-1 d.w.] |
|---|---|
| Ra-228 | 7.6 |
| Th-228 | 1840 |
| Th-232 | 1840 |
| U-234 | 0.0004 |
| U-238 | 0.0004 |

# Some highlights

- Realistic, what does it mean realistic?
  - The establishment of exposure scenario is of primordial importance, specially for long-lived radionuclides. The exposure pathway can change with time. In the future someone can use the sediment for building. Why not?
- The use of default parameters (for screening analysis) should be followed by a sensitivity analysis, in order to avoid misunderstanding.
- The sensitivity analysis (SA) points out the specific parameters that should be determined for the step of detailed assessment.
- The exposure pathway for human can be very different of exposure pathway for biota. Consider to model both: human and biota;
- What about to include in the final report a list with some physical parameters as e.g. hydraulic conductivity (minimum and maximum) to help user with the SA ?

# GAMP…..


Initial Characterization
Exposure Scenario
Screening modelling
Human
non-human
Sensibility Analysis
(choose of parameters to be analyzed)

# DETAILED ASSESSMENT

# Should consider

- A detailed survey of the surface and subsurface contamination;
- Determination of some specific parameters: e.g. radon emanation and diffusion coefficient, residence time of the water in the creek
- Validation:
  - Monitoring sediment
  - Monitoring Rn-220

# THANKS FOR ATTENTION