

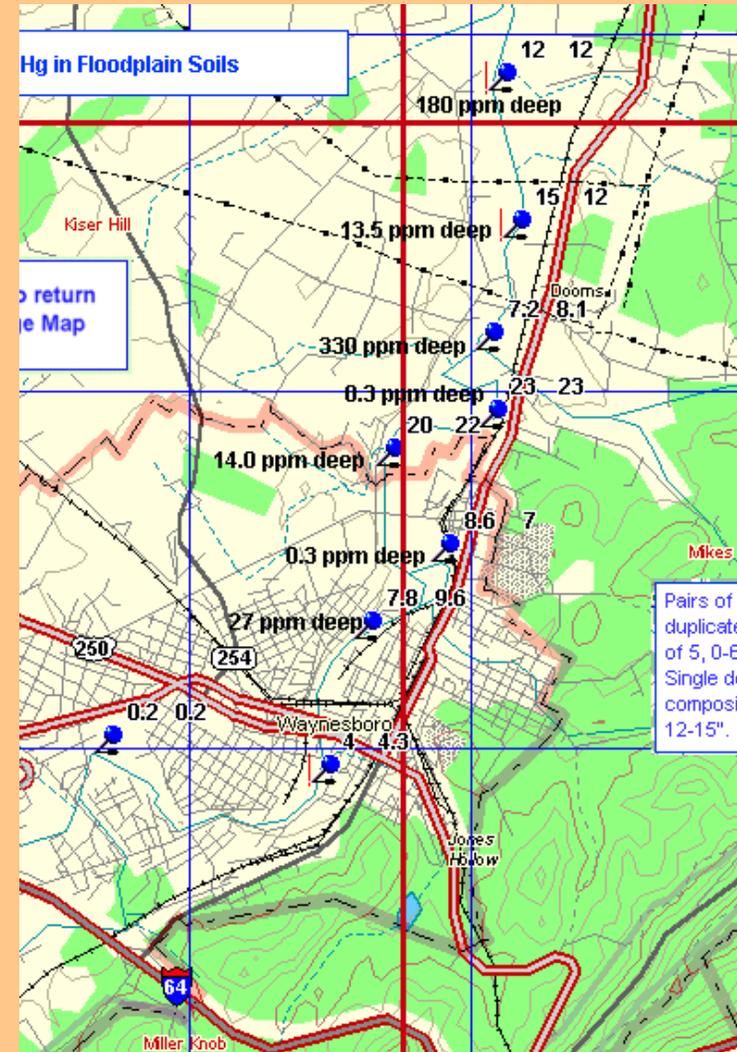
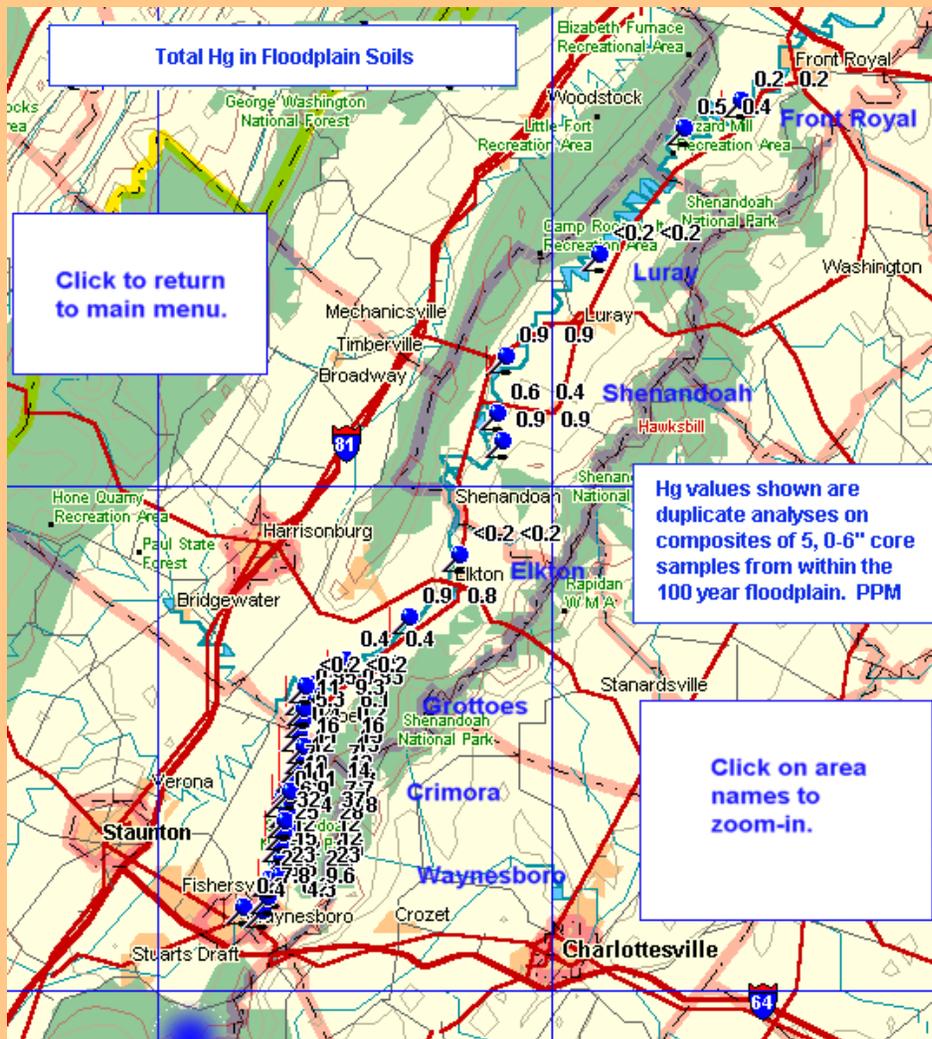
Earthworms as bioindicators of terrestrial floodplain Hg content

This is an invertebrate companion to *Corbicula*. They have an extended habitat from sediment banks to the floodplain

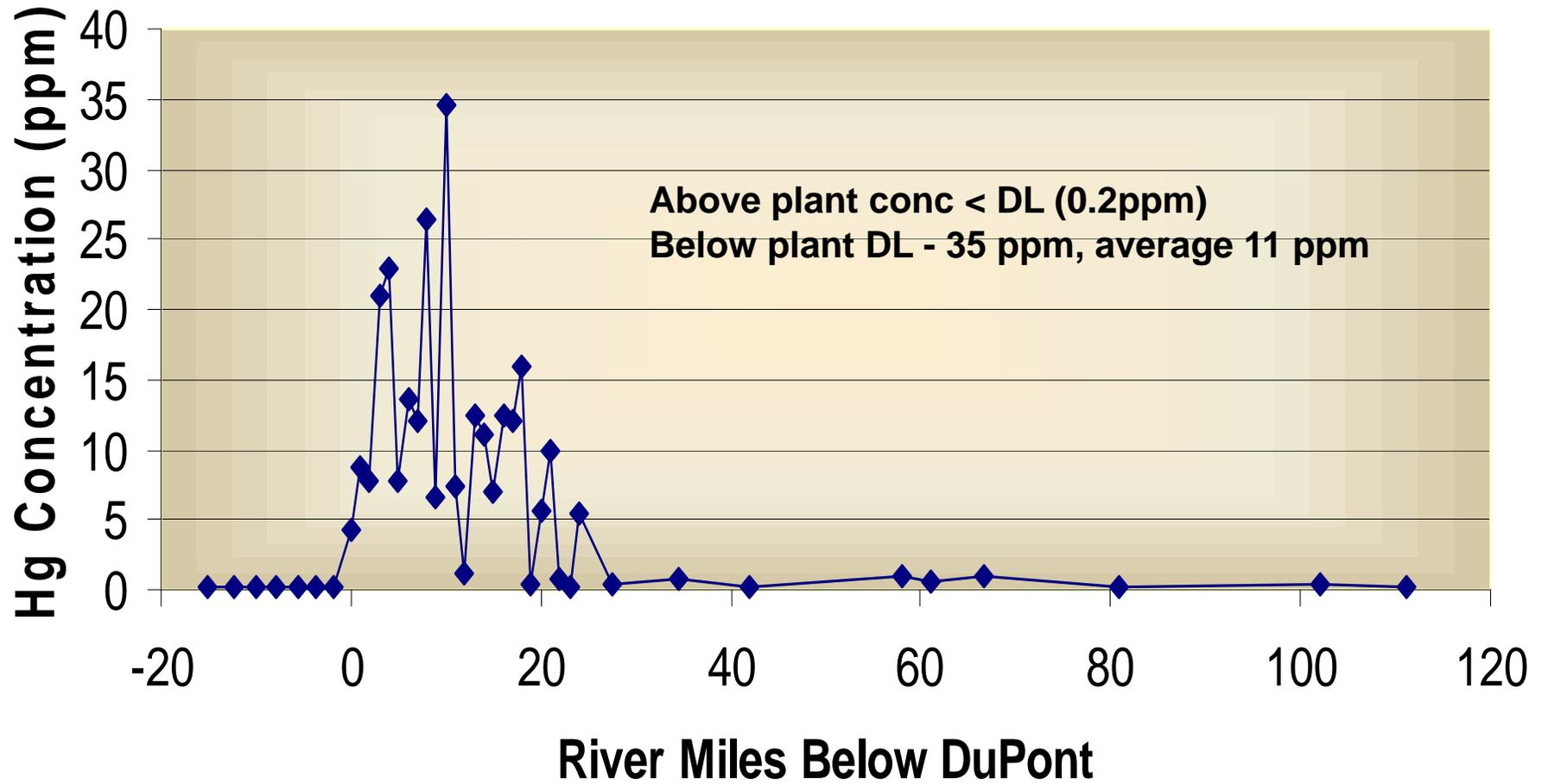


Hendricks Survey - 1980

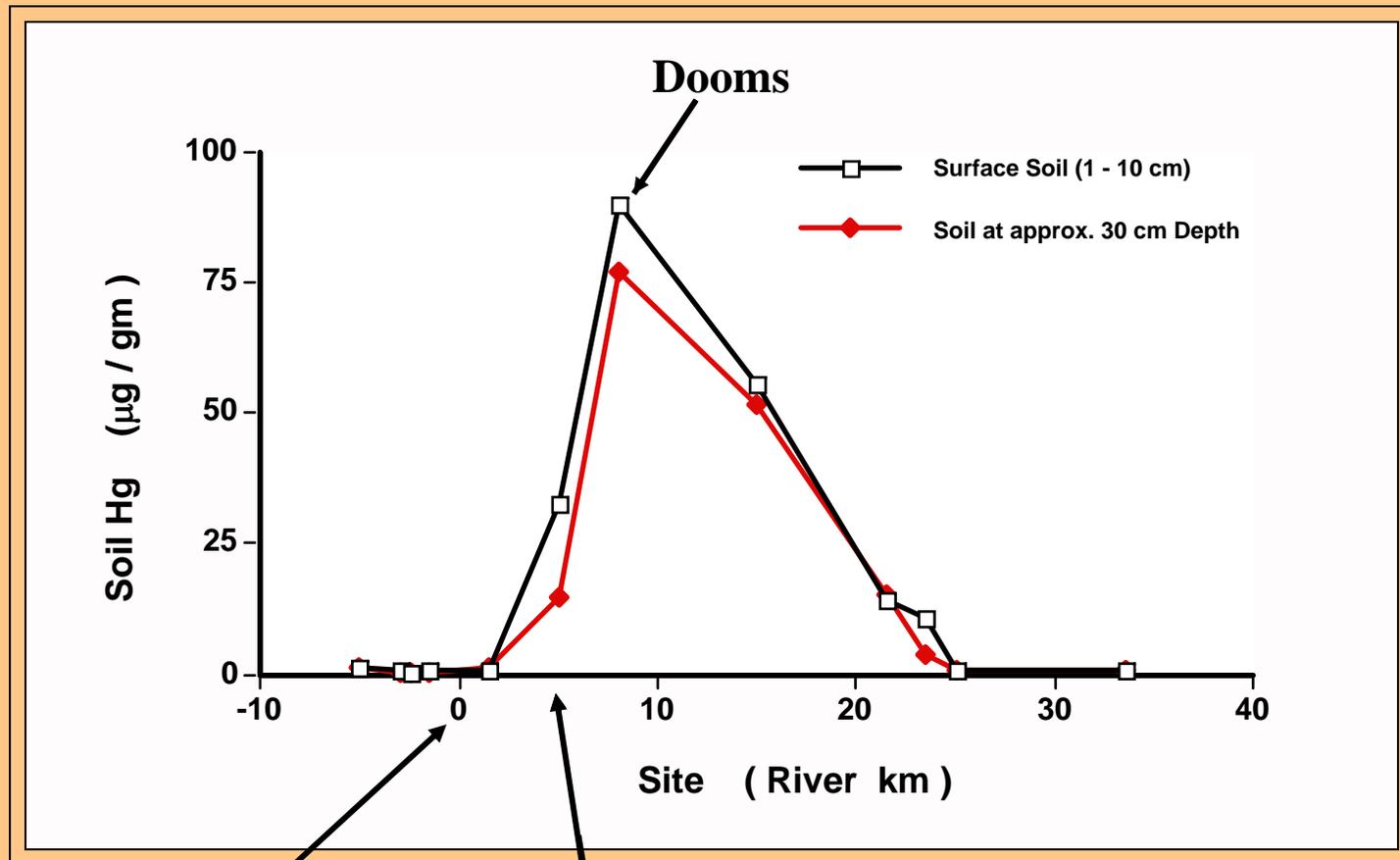
Extracted from Floodplain CD-ROM (Jensen and Guiseppi-Elie 2004)



Hg Concentration in Floodplain Soils Summer 1980



Floodplain Soil Hg Concentration South River ($\mu\text{g Hg gdw}^{-1}$)



Dupont facility

Hopeman Parkway site

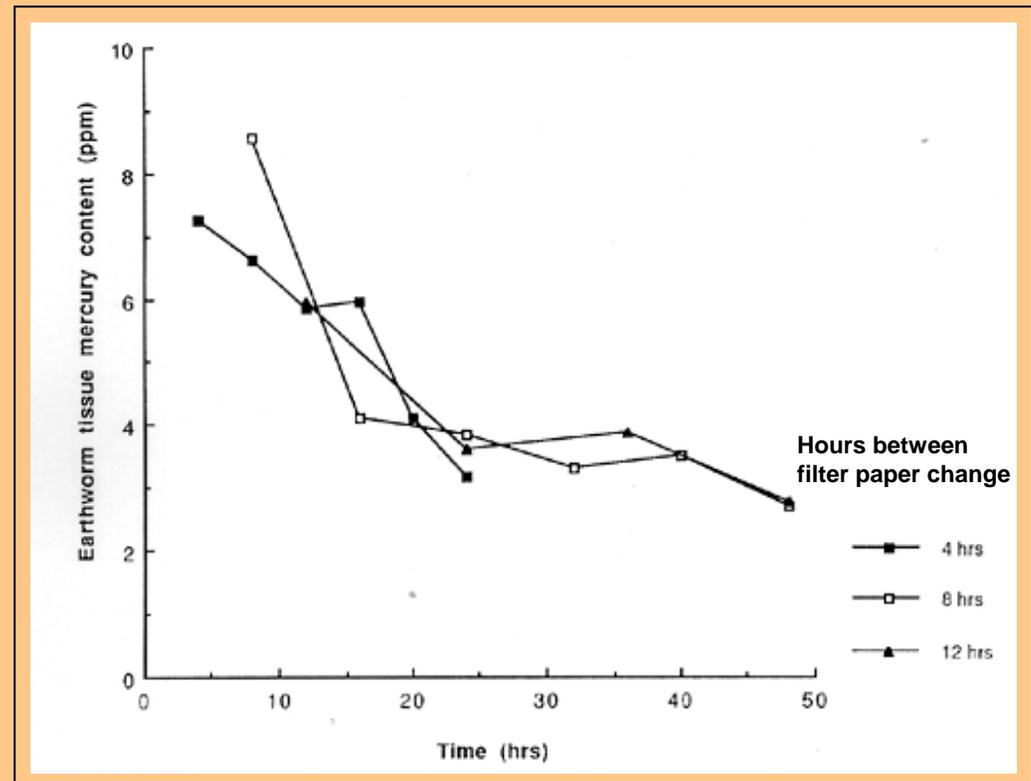
Jakes, 1998 unpublished study

Value of invertebrate models

- The ongoing *Corbicula* study is demonstrating that it is an excellent indicator for bioaccumulation of Hg in aquatic habitats.
 - abundant, widespread, correlates with fish uptake. easy to collect, provides reliable information, etc.
- Earthworms share these same virtues and have habitat requirements that allow them to live in terrestrial as well as aquatic environments.
- These species have previously been extensively studied as organisms which bio-accumulate Hg and other heavy metals.

Earthworms were chosen as a primary indicator of biological Hg accumulation in soils in our previous work. They ingest, process and digest detritus (organic debris)

- Earthworms collected from the field were placed on moist filter paper to allow them to void gut contents.
- Individuals grown in the lab in $21 \mu\text{g Hg gdw}^{-1}$ soil reach equilibrium tissue [Hg] after 1-2 weeks.
- Voiding of equilibrated earthworms indicated that the residual soil Hg in gut contents was cleared in 24 hr.
- More frequent changing of filter paper than every 12 hr had little effect.
- Voided earthworms were freeze dried, acid washed, hot acid digested and analyzed.

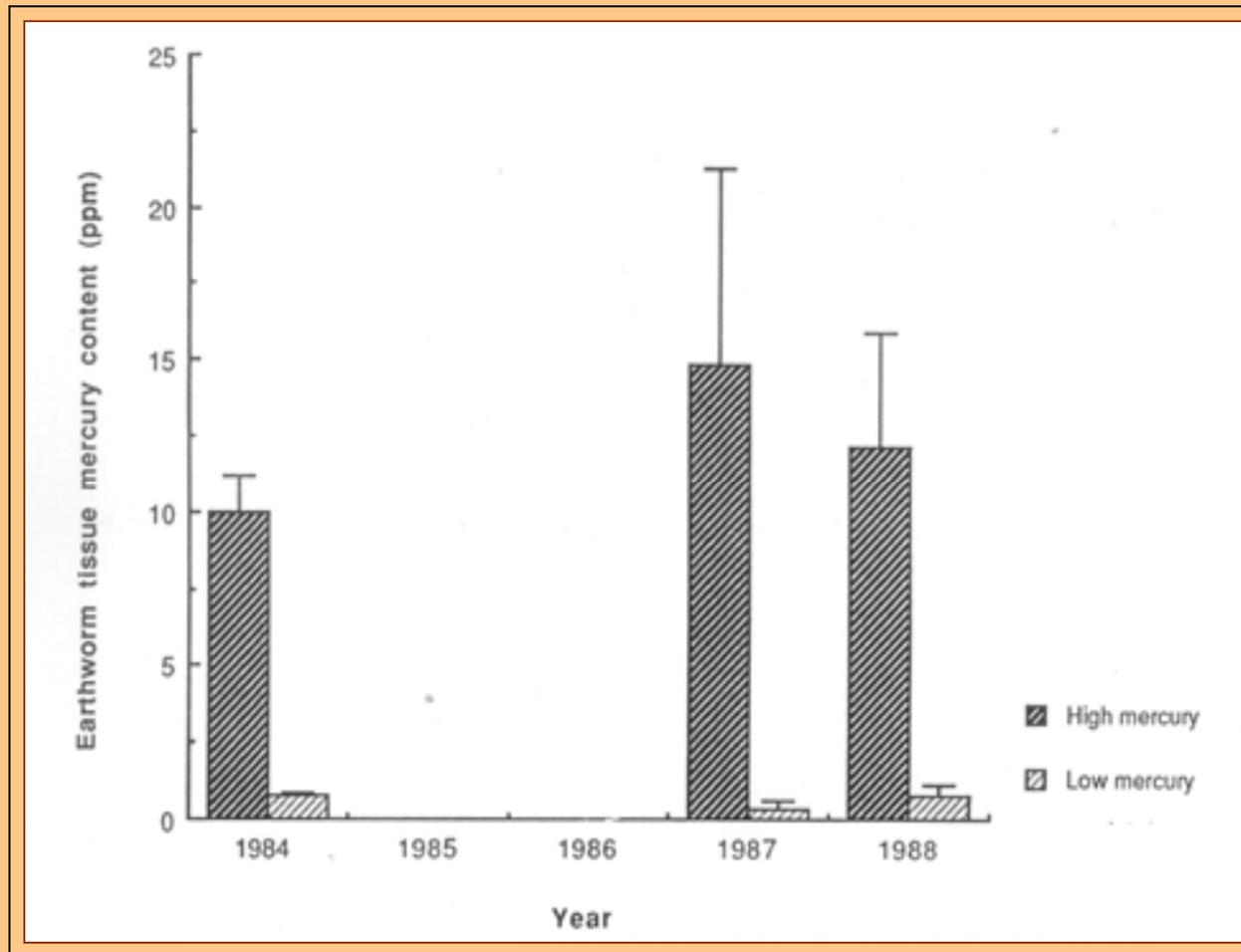


King, 1989 unpublished data

Voided earthworms are relatively transparent, frequently even more so than this individual.



Hg Concentration in soil and earthworms within Old field site at Hopeman Parkway. ($\mu\text{g Hg gdw}^{-1}$)

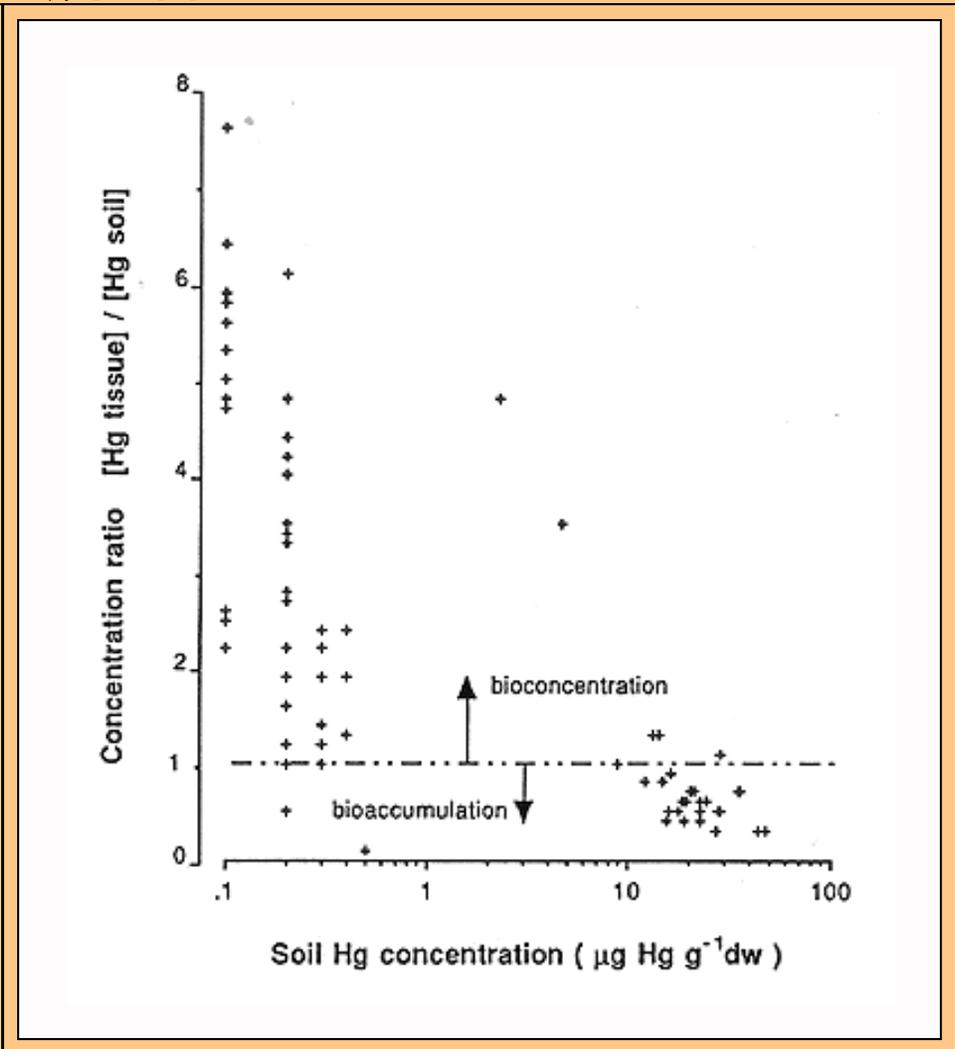
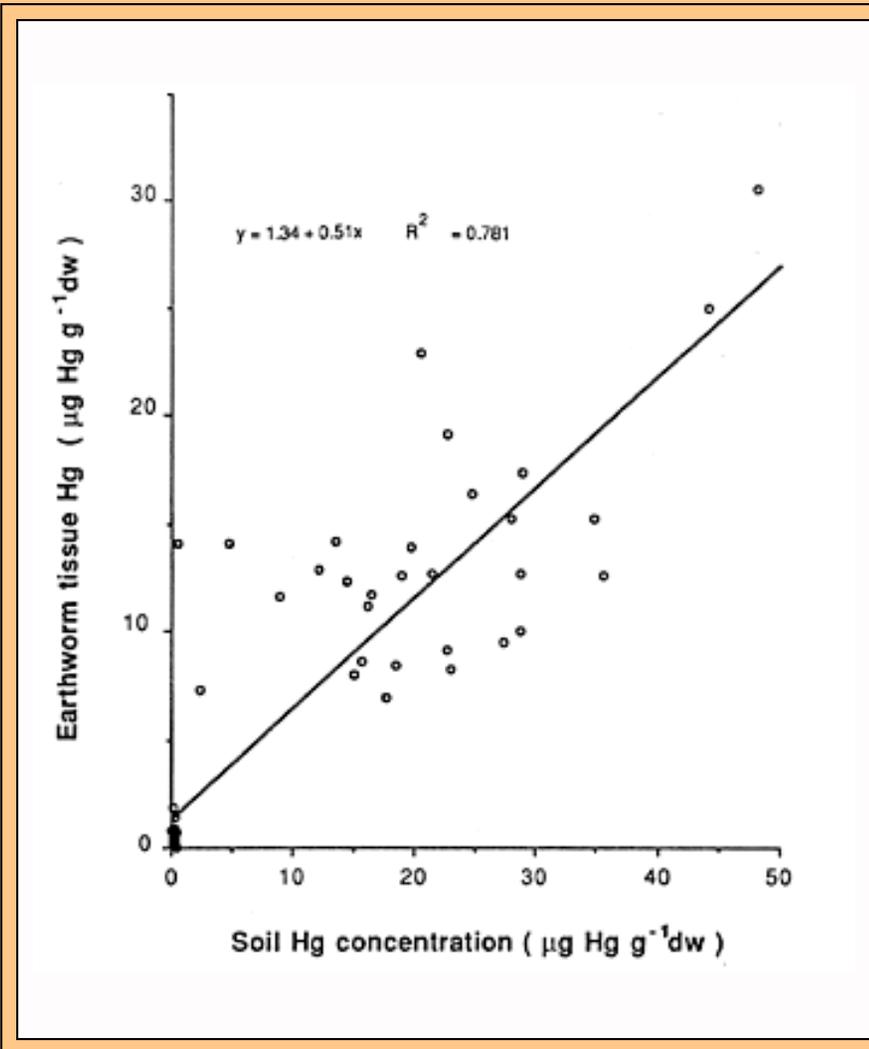


Note the tissues were freeze dried. Therefore, assuming 90% H_2O , in animal tissues, earthworms living in contaminated soil contained from 1 - 1.5 $\mu\text{g Hg / g}$ fresh weight

King, 1989

Floodplain Earthworm [Hg] is directly correlated with soil [Hg] Biological concentration occurs only at low [Hg]

($\mu\text{g Hg gdw}^{-1}$)

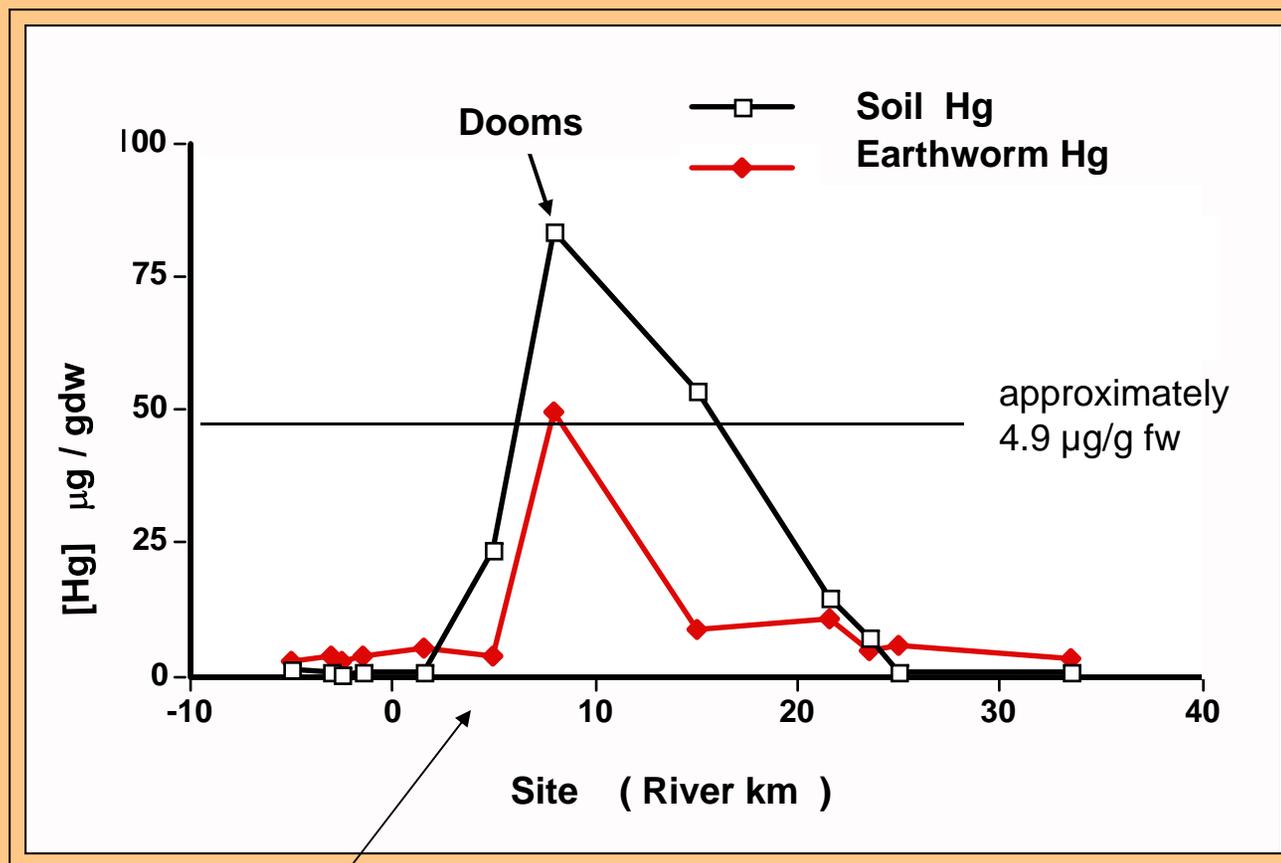


King, 1989; Cocking, et. al. 1994

Objective of Proposed Study

- To determine if tissue concentrations in earthworms living on the South River floodplain have a pattern similar to the terrestrial soil Hg concentration and *Corbicula* concentrations at comparable river locations.
- Total Hg concentrations will give an indication of bioaccumulation by terrestrial animals. MeHg concentrations if obtained, would be indicators of biological activity.
- The NULL hypothesis which will be tested is that there are no differences in the Hg tissue concentrations of earthworms collected from different locations along the river. It is expected that this hypothesis will be rejected and that the presence of a distribution pattern similar to that of soil Hg concentration and *Corbicula* will be supported.

Floodplain Earthworm [Hg] South River ($\mu\text{g Hg gdw}^{-1}$)



Hopeman Parkway
1.5 $\mu\text{g/g fw}$

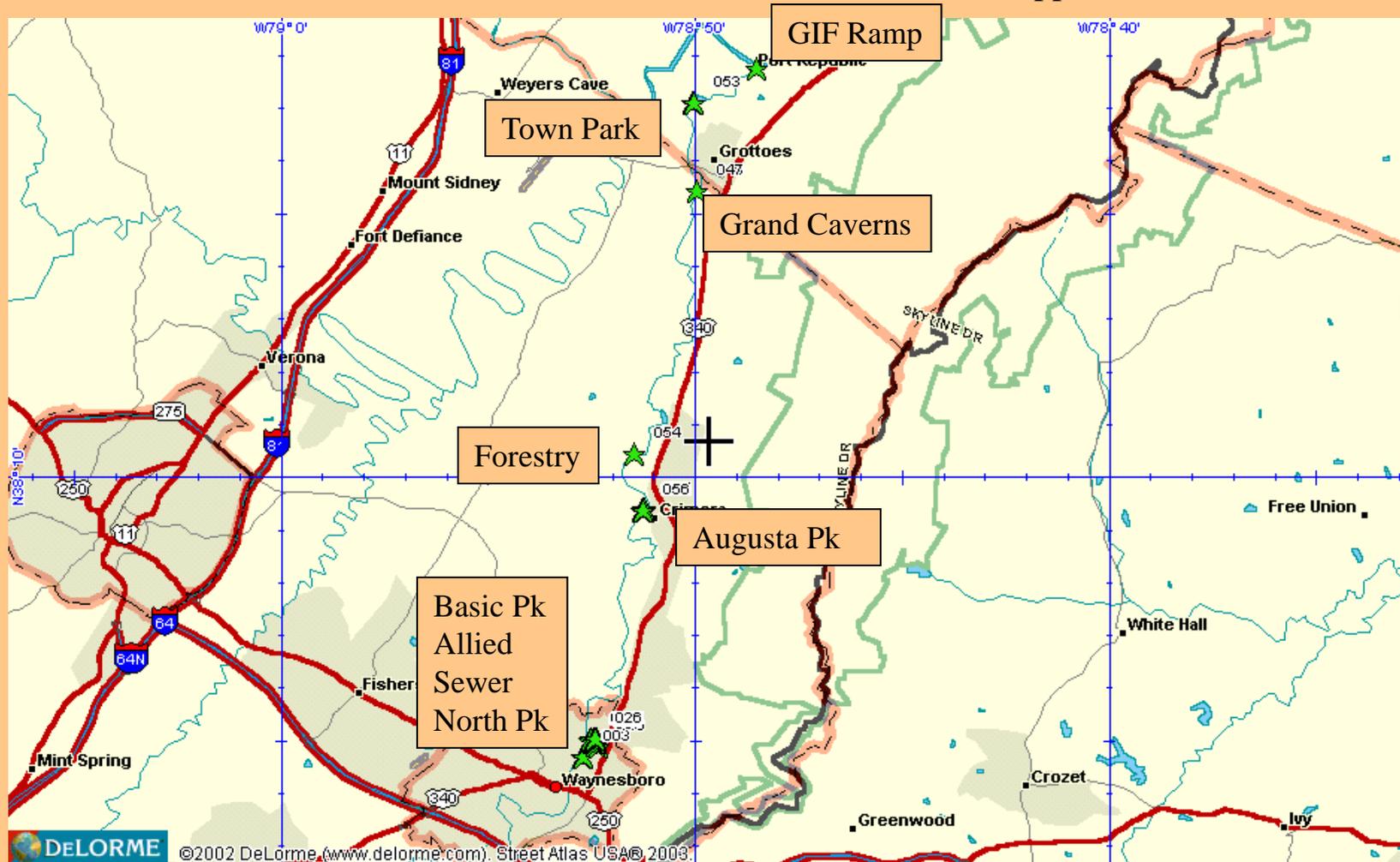
Jakes and Cocking, 1998 unpublished study

Field sample locations

- Multiple samples will be obtained from the Hopeman Parkway and Augusta Forestry Center floodplain and control garden locations. (18 samples)
- In consultation with Dick Jensen and Annette Guiseppi-Elie, twelve additional flood plain sites located from upstream of the former Dupont facility to Front Royal will also be selected for sampling.

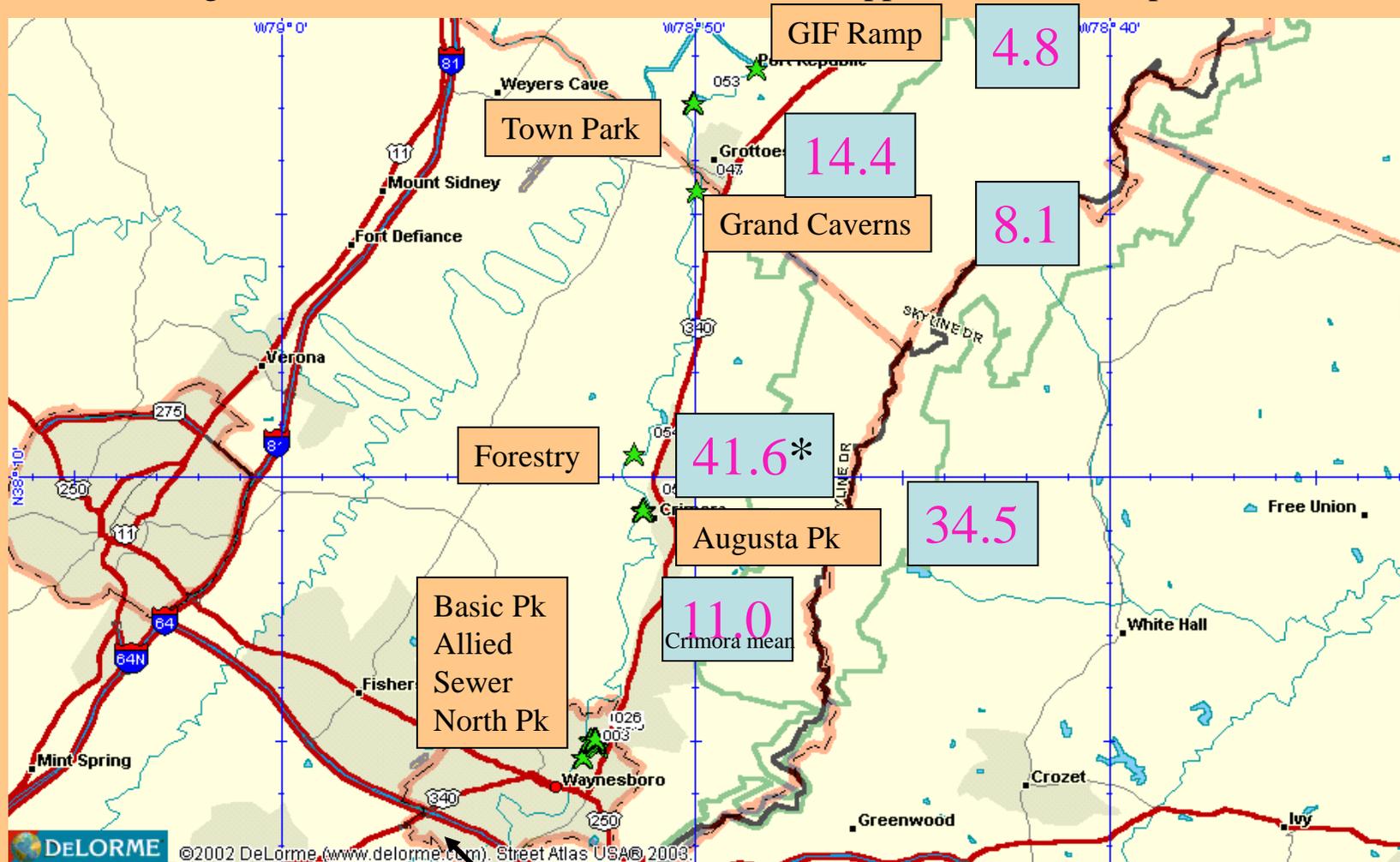
Floodplain Soil Sample Locations

from Jensen and Guiseppi-Elie 2004



Floodplain Soil Sample Locations

Unweighted location means from Jensen and Guiseppi-Elie 2004 except for * and **



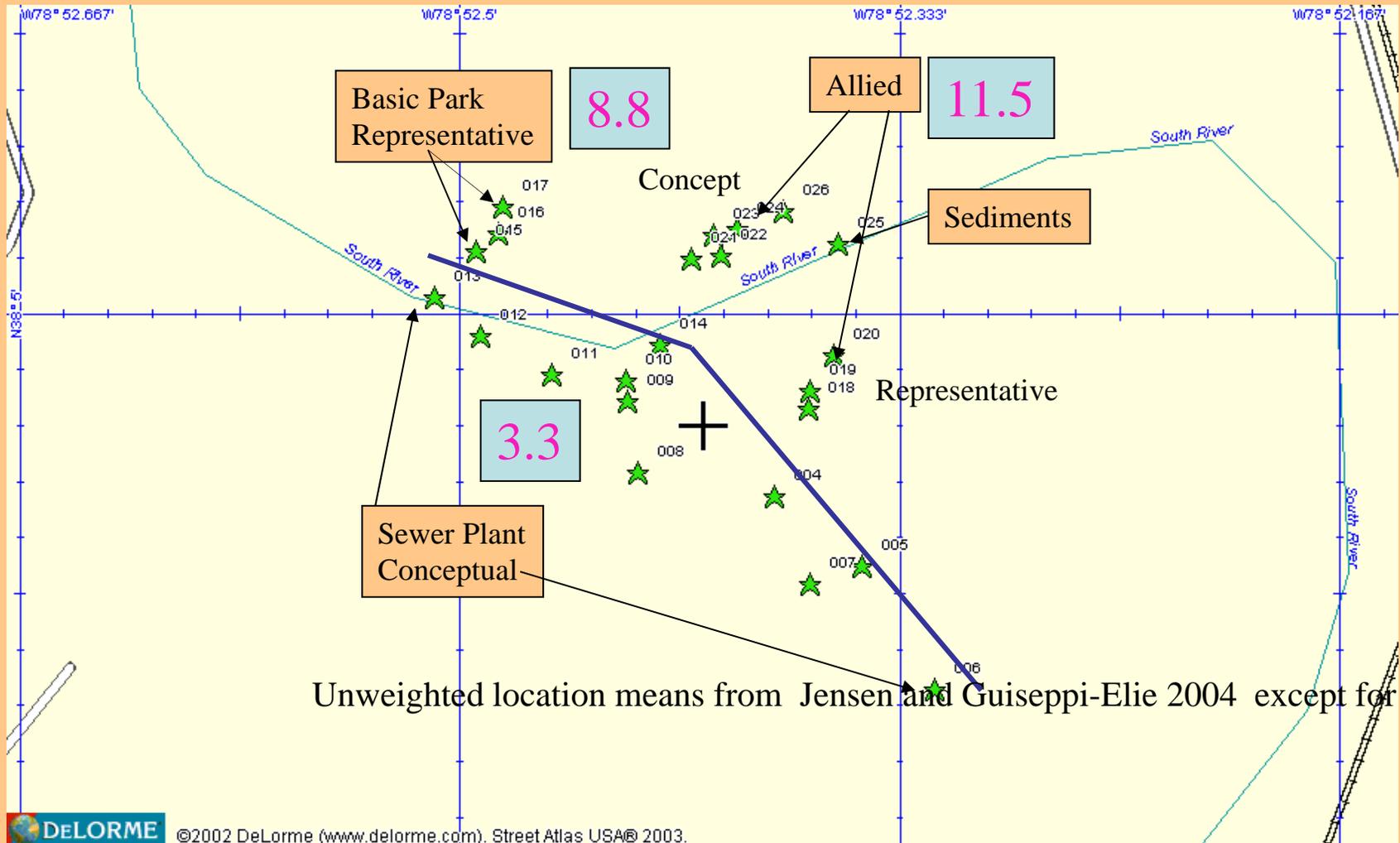
**Oak Lane. (least squares mean)
Pendleton & Cocking 1999

* Berti and Cocking 2004

Sewer Plant, Basic Park, and Allied Readymix

7.7*

* Hopeman Parkway field . Pendleton & Cocking 1999 (least squares mean)



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- In consultation with Dick Jensen and Annette Guiseppi-Elie, twelve additional flood plain sites located from upstream of the former Dupont facility to Front Royal will also be selected for sampling.
- Three replicate composite samples of earthworms will be obtained from the additional sites (36 samples }
- This amounts to 54 samples total for analysis. (Because earthworms migrate vertically, samples stratified by depth are not needed.)
- Preliminary examination will be necessary because it is desirable to identify and use the same earthworm species throughout if possible.
- This project will be completed during 2005. The actual sample times will depend on the weather. When it is too wet, it is difficult to excavate mud and if a drought occurs, the earthworms will burrow to depths that are impractical to sample.



Earthworms are collected live from the site, stored in soil (paper container), kept cool, and returned to laboratory. Worms are washed in DI water and randomly organized into composite samples.



Earthworms are placed into glass culture dishes which contain moist filter paper. They are kept at approximately 10 °C for 24 hr in order to void gut contents. The paper is changed after 12 hr.



Fresh weights of the voided earthworms are obtained and then they are placed in plastic sample vials and frozen. Vials with frozen tissue samples are sent packed in dry ice to Studio Geochemica for total Hg analysis. (Some MeHg values possible)

Proposed Budget

- \$ 2, 000 Salaries
 - Student summer employment approximately \$1500 (12 - 14 survey sites 1 day each plus more extensive sampling at Hopeman Parkway and Forestry Center 4 days includes lab processing time -- P.I. Stipend \$500
- 150 Supplies
- 800 travel/mileage
- 1,013 JMU overhead and benefits for salaries & wages*
 - Paying through JMU will make lab and growth chamber facilities available.

- \$3,963 TOTAL

- Hg sample analysis and expenses paid directly by DuPont (cost will depend on extent of sampling and replication \$2,000 to \$ 5,000 and choice of (total) or (total + MeHg)

