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Comments re the Proposed Plan for the West Lake Landfill radioactive wastes.

Submitted to the U.S. Environmental Protection Agency and the Missouri Dept. of Natural Resources
by Kay Drey, 515 West Point Ave., University City, MO 63130. December 19, 2006.

Portions of the following comments were presented at a public meeting hosted by the Bridgeton City Council in St. Louis County, Missouri, on September 14, 2006. Representatives of the EPA -- Region 7, and the Missouri DNR spoke in support of the Proposed Plan. I am now resubmitting my Sept. 14 comments, with additions.

The public is encouraged to send comments by December 29, 2006 —

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No one knows exactly how much radioactive waste and radioactively contaminated soil were dumped at West Lake Landfill in 1973, or exactly at what locations there. But we do know that of all the land types where perpetually radioactive contaminants could be placed, probably none is less appropriate or less secure than a floodplain in an urban area, along one of the longest rivers in the world.

So then the question becomes: what do we do to undo this illegal dump-and-run non-solution, made back in 1973? Do we do what is cheapest --- leave the wastes there and hide them under some rocks and construction rubble and an unspecified amount and type of clay? Or do we dig them up and transport them away from water, and away from people?

It seems likely that the vast majority of St. Louisans who get their drinking water from the Missouri River do not know about West Lake Landfill, next to Earth City --- or that about 20 percent of St. Louis County gets its drinking water only about eight miles downstream from the landfill, or that St. Louis City's water intake is also downstream from West Lake. They do not know that a decision is about to be made about these wastes that could affect not only people living today, but also people over the next 300 generations.

It was a great surprise to me to learn --- starting about 30 years ago --- that massive quantities of uranium had been imported into the St. Louis region in the 1940s, 50s, and 60s, from distant American and foreign mines and mills. I learned, in fact, that Mallinckrodt Chemical Works, a mile from Downtown, had purified all the uranium that went into the world's first self-sustaining nuclear chain reaction, in Chicago, in December 1942. Some of the wastes at West Lake Landfill could well have been generated in those earliest months and years. That is, we have in Metropolitan St. Louis some of the oldest radioactive waste of the Atomic Age.

The estimated volumes of radioactively contaminated materials at West Lake Landfill are:

Area One: Surface -- 940 cubic yards (Remedial Investigation Report, 4/2000, p. 90)
Subsurface – 24,000 cu.yds. (p. 93)

Area Two: Surface – 8,700 cu.yds. (p. 95)
Subsurface – 109,000 cu.yds. (p. 98)

The above West Lake volumes are only approximate. For example, regarding the comparison of "downhole gamma" readings from three subsurface soil borings: "These data suggest that the depth and elevation at which the radiologically impacted materials occur varies highly over even small distances indicating that the horizon(s) in which the radiologically impacted materials occur are **highly variable and highly irregular**." (RIR, p. 92; emphases added.)

To put the estimated West Lake volumes in perspective, a much greater volume of similar, radioactively contaminated nuclear weapons materials from the Mallinckrodt Chemical Works (MCW) has already been

excavated and transported away from Metropolitan St. Louis by the federal government --- specifically, some **750,000 cubic yards**. Plus an estimated **1.48 million cubic yards** of wet and dry radioactive MCW wastes were collected in the Weldon Spring bunker in St. Charles County, at a cost of about one billion dollars. A liner and leachate collection and removal system were engineered at the bottom, and a cap at the top, complete with a "mixture of cobbles," and climbing steps to encourage the public to come visit and view it all !!

This large volume of MCW nuclear-weapons-production wastes has been remediated because the wastes are dangerous. Unless and until the West Lake MCW wastes are removed, they will continue to migrate into groundwater used for farming and into the river used for drinking, irrigation, and fishing; and will continue to release radioactive radon gas and fugitive dusts into the air we breathe.

A. ***Some of the radioactive wastes at West Lake are extremely rare and are particularly dangerous:***

Almost all natural uranium found on the planet is uranium-238 (that is, more than 99 percent of the Earth's uranium); only seven-tenths of one percent is uranium-235. The 235 isotope and its daughter products are not detected in American soils and water. Starting after the end of World War II, the U.S. Atomic Energy Commission announced its willingness to buy any ore that had at least one-tenth of one percent uranium. Most American ore contains only one to two percent uranium,. The Belgian Congo ore ("pitchblende") that was processed downtown at the Mallinckrodt Chemical Works averaged **60 to 65% uranium**. Therefore, the rare uranium-235 and its daughter products are detectable at our Metropolitan St. Louis sites. That is, these isotopes are not found elsewhere in the United States except where Belgian Congo uranium residues were processed or discarded. The St. Louis sites include the Airport Site, Latty Avenue in Hazelwood, Downtown Mallinckrodt, Weldon Spring, vicinity properties, and West Lake Landfill.

Mallinckrodt Chemical Works processed uranium and thorium, and accumulated and dispersed the resulting radioactive waste, for twenty-five years --- 15 years near Downtown, and then ten years at Weldon Spring. Some of the materials present in the MCW wastes include some of **the most radioactively toxic** of all radioactive materials identified to date. People who seek to assure the public that radioactive materials are not particularly dangerous often say that mankind has evolved in a radioactive world; that radioactivity exists in nature. (For example, they like to point out that bananas may contain small amounts of naturally radioactive potassium.)

However, some radioactive materials are far more dangerous than others, **and some of the most dangerous --- most radiotoxic --- are present at West Lake Landfill**. Here are some quotes from the CRC Handbook of Chemistry and Physics, 82nd Edition, from 2001-2002, about radioactive elements at West Lake:

Protactinium "is a dangerous toxic material and requires precautions similar to those used when handling plutonium." (page 4-24). The United Nation's International Atomic Energy Agency had ranked protactinium-231, which we have at West Lake, as the most radiotoxic of the 236 radionuclides it included in a 1963 report. ("A Basic Toxicity Classification of Radionuclides," p. 32) **Eleven** of the 31 nuclides classified in the 1963 IAEA report as the **most highly toxic** are present at West Lake !! --- namely, protactinium-231; actinium-227; thorium-230, -228, and -227; radium-228, -226, and -223; lead-210; uranium-234; and polonium-210. **(Please see recent information below about the IAEA and polonium-210.)**

Radium: "Inhalation, ingestion, or body exposure to radium [another West Lake material] can cause cancer and other body disorders." (CRC, p.4-25) **Actinium-227** "is about 150 times as [radio-] active as radium." (p. 4-3)

Polonium: One gram (or a thirtieth of an ounce) is the weight in a packet of artificial sugar. In addition to gamma rays, one gram of radium-226 gives off **37 billion** radioactive particles every second. (The radium-226 emission rate is the basis of the word "curie" – that is, a curie is that amount of a material that gives off

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37 billion radioactive emissions every second.) By comparison, **one gram of polonium-210 (which is present at West Lake) gives off 185 trillion alpha particles every second**. That is, one gram of Po-210 contains 5,000 curies. And as pointed out to me by Dr. John Gofman, one of the world's preeminent physicians and nuclear-physical chemists, polonium-214 (also at West Lake) is even more radioactive and, therefore, even more hazardous, than polonium-210.

Polonium-210 has recently achieved international notoriety as the radioactive isotope believed to have poisoned Alexander Litvinenko, a former Russian intelligence officer, who died 11/23/06.

→ → Extremely relevant to the evaluation of the EPA's proposal to leave the K-65 residues, including polonium-210, in the Missouri River floodplain is the following recent information: The UN's **Internatl. Atomic Energy Agency** has decided to undertake **a review** of the biological hazards of polonium-210, in order to include for the first time the risks of ingesting polonium. (FT.com – Financial Times / UK. Dec. 13)

Analyses for polonium-210 concentrations were apparently not specifically performed at West Lake. For example, Po-210 data were not included in the "Remedial Investigation Report" of April 2000 --- that is, as one of the isotopes in the uranium-238 decay series. It is not included in the analytical results in Table B-2 or B-10 (soil); Table C-2 (groundwater); Table D-1 (rainwater runoff, leachate, and surface water); Table E-1 (sediment); or Table 6-2 (subsurface soil in Area One) or Table 6-4 (Area Two).

However, highly elevated levels of the progenitors of polonium-210 were indeed reported at West Lake, such as uranium-238, thorium-230, radium-226, and **lead-210**. Daughter products of lead-210 include bismuth-210, **polonium-210**, and ultimately the stable, non-radioactive lead-206. **If lead-210 is present at West Lake --- and it is* --- then polonium-210 is there, too**. As, without doubt, are other polonium daughters of uranium-238, uranium-235 and thorium-232.

* Some evidence of **lead-210**, a grandparent of polonium-210, at West Lake: (1) a filtered sample of groundwater from deep-depth Monitoring Well D-6 contained 204 picocuries* per liter of lead-210 in May 1997. (RIR, Table C-3, Uranium-238 Decay Series); (2) Soil Boring WL-234 contained 1040 pCi per gram (RIR, Table B-10); and (3) rain-water runoff collected at Weir 8 in Area Two registered **9200 picocuries per liter** in April 1996 (RIR, Table D-1).

> *A **picocurie** (pCi) or one trillionth of a curie, is that amount of a radioactive material that gives off about 2.2 radiation particles and rays per minute.

Specific evidence of the presence of polonium-210 in the K-65 residues: Some of the K-65 residues had been shipped from the Downtown MCW facility to the Fernald uranium processing plant in Cincinnati in 1953, and were stored there in Silos 1 and 2. The Silo One contents included **281,000 picocuries per gram of polonium-210 (!!)**, according to the "Fernald K-65 (Silos 1 and 2) Residues Fact Sheet," published by the Fernald Closure Project in 2006 (p. 2).

The silo residues were trucked from Cincinnati, starting in June 2005, through March 2006 — back through St. Louis — to Texas for interim storage. No one knows where they'll go for permanent disposal.

Quoting from the CRC Handbook: "Polonium-210 is very dangerous to handle in even milligram or microgram amounts, and special equipment and strict control is necessary. Damage arises from the complete absorption of the energy of the alpha particle into tissue. The maximum permissible body burden [for a nuclear worker] for ingested polonium is only 0.03 microcuries, which represents a particle weighing only

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6.8×10^{-12} grams." (p.4-23) [The nuclear industry is allowed to expose a nuclear worker to fifty times more radiation per year than a member of the public – that is, 5000 millirem, as compared to 100 mR.]
Radon gas: The West Lake wastes also generate and release radioactive **radon** gas. "The main hazard is from inhalation of the [radon] element and its solid daughters, which are collected on dust in the air." (CRC, p.4-25) Radioactive **lead-210**, with a half-life* of 22 years, and **polonium-210** are among the radon daughter-products. The West Lake residues generate three different isotopes of radon --- radon-222 (from U-238), Rn-219 (from U-235), and Rn-220 (from Th-232) --- all of which emit alpha particles. Even the U.S. Nuclear Regulatory Commission admits that if alpha-emitters are swallowed or inhaled, the alpha radiation is twenty times more biologically harmful than beta or gamma. (Code of Federal Regulations, Title 10, Part 20, Table 1004(B).1.)

> * A **half-life** is the time required for half the atoms of a radioactive substance to change into another substance by emitting subatomic particles and rays. Another half of the original atoms – that is, one fourth – will release radioactive particles during the next half-life; half of the remaining fourth during the next half-life, etc. **A radioactive substance is generally considered hazardous through at least ten half-lives.**

West Lake's thorium-230 and actinium-227 were ranked along with plutonium, americium and neptunium as among the most radioactively dangerous materials known, in a 1965 paper written by Dr. Allen Brodsky, and contracted by the U.S. Atomic Energy Commission and the U.S. Public Health Service (reprinted in Health Physics, Vol. 38 [June 1980], pp. 1155-1171).

B. ***Floodplains are for flood waters --- NOT for radioactive wastes.***

During an extremely informative visit that I had at Washington University with Robert E. Criss, Ph.D., a professor in the Department of Earth and Planetary Sciences, on October 20, Dr. Criss dictated the following comments regarding the EPA's proposal to keep radioactive wastes at the West Lake Landfill. I had asked him, for example, if he agrees with the type of statement I have heard and read as a part of the defense of the EPA's "Proposed Plan" --- that "the Earth City Levee District [of the U.S. Army Corps of Engineers] does not consider this area to be a floodplain. It's behind a levee."

Dr. Criss gave me permission to submit the following along with my comments:

> "The West Lake Landfill is located in a geomorphic* floodplain. A floodplain is a place where a river floods commonly. Levees fail. Several levees in St. Louis County have failed in the last fifteen years. It's preposterous to claim that levees don't fail. These risks are chronically underestimated.
>
> "Levees can fail either by overtopping or by piping through or underneath the structure. That is, the river water can form blow-holes [known as "blew holes" or scour holes]. Water can pipe through or underneath the levee. The water bubbles up under the levee.
>
> "In the event of failure, you have high-energy, high-velocity water that catastrophically scours the ground, especially unconsolidated material which it scatters for miles. This is the wrong place to store hazardous material. It does not belong in a floodplain."
>
> [*Geomorphic refers to the description and interpretation of land forms.]

Dr. Criss said that he thinks the flow rate of the Missouri River near West Lake Landfill is about 70,000 cubic feet per second. I asked about how long he thought it could take for the landfill's contaminants to reach the Missouri American Water Company's North County water intake plant --- in Florissant, about 8.5

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river-miles downstream from the landfill, in the event of the levee's failure. Dr. Criss estimated "about a day. The wastes would be everywhere."

Dr. Criss also mentioned concerns about liquefaction --- that when wet dirt is shaken enough, during an earthquake, the ground liquefies; "turns to goo."

The West Lake radioactive wastes leach into the groundwater. And the groundwater flows into the Missouri River.

Quoting from the West Lake "Feasibility Study on Operable Unit One" (the radioactively contaminated area of the landfill), prepared by Engineering Management Support Inc, for the Respondents, May 2006:

> The regional direction of groundwater flow is in a generally northerly direction within the Missouri River alluvial* valley, parallel, or sub-parallel to the river alignment. ... Regional groundwater flow in the vicinity of the landfill is to the northwest, towards the Missouri River. (page 10)
>
> *Alluvium is "Detrital material which is transported by a river and deposited – usually temporarily – at points along the flood plain of a river." From the Penguin Dictionary of Geology, 1988, p.22

C. Longevity: *West Lake's radioactive wastes will continue releasing dangerous particles and rays into the Metropolitan St. Louis environment* virtually forever *– unless they are removed.*

The predominant isotope of concern at West Lake is **thorium-230**. It has a half-life of 75,000 years. Two other extremely long-lived isotopes present at West Lake are **uranium-238**, with a half-life of four-and-a-half billion years, and **thorium-232**, with a half-life of 14 billion years

Not only do concerns exist about the potential for the migration offsite of ground water and of Missouri River flood waters contaminated with radioactive Belgian Congo (K-65) residues, but the interrelationship of West Lake Landfill's radioactive wastes with the chemical toxins (present in the demolition and sanitary wastes of the landfill's contiguous, non-radioactive "Operable Unit 2") is also of concern. The National Research Council's Niagara Falls Storage Site (NFSS) report of 1995 describes similar potential impacts between the radioactive and non-radioactive components in adjoining acreage:

> The NFSS is bounded on two sides by major waste disposal facilities, the Chemical Waste Management (CWM) Chemical Services, Inc., to the north and Modern Landfill, Inc., to the east. Current site plans and ongoing monitoring do not address the present or long-term potential impacts of these sites on the waste storage at NFSS. This is particularly important given the time frame (perpetual care), hydrological uncertainty, and the potential public health impacts of the wastes at these sites. (p. 45; emphasis added)

D. *"Hot spots" are found at and below the surface at West Lake.*

The EPA's "Proposed Plan" claims that: "Because the radiologically contaminated soils are distributed widely in the landfill waste material, there are no areas that qualify as 'hot spots'." (page 12) Whether or not hot spots at West Lake qualify as "hot spots" under some arcane EPA guidance, the "West Lake Feasibility Study" data do indeed indicate that hot spots – highly radioactive areas -- exist throughout and beyond Areas One and Two of Operable Unit One. Furthermore, those hot wastes will without doubt continue to migrate up, down, and sideways, within and beyond the floodplain --- even if a "cap" were to be

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placed on top --- until they are exhumed. I believe the highly radioactive waste at West Lake should be carefully excavated, containerized, and transported to a licensed U.S. Department of Defense or Energy nuclear-weapons-waste site or to a licensed commercial disposal site --- away from water and away from people. For example, to the site(s) where other MCW wastes are currently being transported.

After studying some of the West Lake soil data in the Remedial Investigation Report (RIR) and The Feasibility Study, a noted Washington University professor of radiochemistry told me that the proper interpretation of the data is that there are indeed hot spots at West Lake.

He noted, for example, that Soil Boring WL-234 has clear multi-positive results for uranium-235 and its daughters at 10 feet deep. No data exist regarding the soil at 20 feet, except for a combination sample of uranium-235/236. (RIR, Tables B-4 and B-11) The chemist questioned whether this lack of data would justify a reevaluation of the local area around the boring hole to determine the depth profile of the radioactive contamination. He wonders what soil samples would indicate if taken at the surface and at 5 feet. (And I wonder about samples from depths even deeper than 20 feet.)

The chemist also noted that additional examples, at Boring Wells WL-209 and WL-210 (RIR, Table B-4), also show coincident positives for U-235 and its daughters at the surface and at 5 feet. For example, he said that protactinium-231, actinium-227, and radium-223 "are found at logically consistent levels ten to a hundred times background. The contaminant levels peaked at the surface, with the next highest values reported at five feet and again at 25 feet. **There is a huge gap in the data**."

I would like to add that no "Site Specific Background" level is given for **uranium-235 and its daughters** in the RIR tables, because they just are not normally detected in soils in the U.S. --- including in U.S. uranium mill tailings piles. That is why the RIR Table B-4 and others identify the background level as "N.E." or "Not Established." The "Site Characterization Summary Report" of August 1997 defines NE as "Not established; all background samples below minimum detectable activity." (Table 4-1 fn. The report was prepared by Engineering Management Support, Inc., for the West Lake OU-1 Respondents Group.)

The Site Specific Background levels for uranium-238 and its daughters are given as between 1.30 picocuries per gram for radium-226 --- and 3.77 for lead-210, in some RIR tables (Mean+2 Std Dev). The natural background level of U-238 and Ra-226 in soil is typically given as one pCi/g; thorium-230 typically ranges from 0.2 to one pCi/g. Most of the uranium on the planet --- 99.27% --- is U-238. Only 0.72 % in nature is U-235. [CRC Handbook of Chemistry and Physics, 82nd Ed.; p. 11-184]. That explains why the rare U-235 and its daughters are not normally detected --- except in tailings or residues from the milling and processing of extremely rich ores, such as the K-65 Belgian Congo residues at West Lake.

1. **Some relevant federal regulations and standards:**

a. Nuclear Regulatory Commission "reference levels": A "reference level" is that level of background radioactivity found in nature --- ***plus five*** picocuries per gram for surface soil samples (the top 15 centimeters, or about six inches); or ***plus fifteen*** picocuries per gram for subsurface soil (any 15-centimeter layer below the surface). Although the NRC's reference level for exposure to **gamma** is **20 microrads per hour**, the agency "aims at exposure rates less than 10 microrads per hour above background levels; background radiation was taken to be 10 microrads per hour also." (NRC's 1982 West Lake report, page 8.) Radioactive wastes within the public domain that exceed those reference levels should be cleaned up, according to standards dictated by the NRC's Branch Technical Position. (46 FR 52061. Oct. 23, 1981)

A downhole gamma reading of "**nearly 2,300,000 counts per minute** was measured at the 3-foot depth of PVC-11," a boring in West Lake's Area 2. (RIR: p. 96, Table 6-9, Figure 6-2) Radiation in nature in the Midwest typically registers at about 10 gamma counts per minute.

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b. Uranium Mill Tailings Radiation Control Act standards: Although West Lake was never a uranium processing facility, it contains wastes and residues generated at a uranium processing plant. **(This situation is the same as the Latty Avenue site in Hazelwood at which nuclear weapons materials were never processed, but were prepared for transport. Latty wastes were trucked to West Lake in 1973 and were illegally dumped there. Latty is currently being remediated by the Corps of Engineers.)** The types and levels of radioactive materials at West Lake pose the same risks as if they were still located at a uranium processing plant --- that is, at the site of their origin, the MCW plant near Downtown. (The same weapons wastes are also currently being remediated at Mallinckrodt Downtown by the Corps.). Relevant UMTRCA standards would limit uranium in groundwater to 230 picocuries per liter; radium in water to 5 pCi/liter; and the radon emission rate to 20 pCi per square meter, per second.

2. Spurious claims of "no problem": Various efforts are made throughout the RIR to try to explain-away elevated readings --- that is, evidence of radiologically impacted materials. For example, one hot area identified by hand-auger borings (instead of drilled borings) was discounted by saying it "appears to be associated with deposition of runoff sediments rather than surface exposure of in-place material." (95, 99)

E. ***Many unanswered questions remain about the monitoring of the West Lake radioactive wastes.***

1. Alleged "false positives": Why are the high levels of radioactivity found in West Lake monitoring samples so often discounted in the reports?

The West Lake reports were prepared by consultants hired by the entities (defendants) that ultimately might be held liable for the cleanup of the West Lake Superfund National Priorities List site --- that is, the corporations that have been designated as the "potentially responsible parties," or PRPs. The U.S. Department of Energy is also one of the PRPs.

The consultants have reported that many of the high levels of radioactive isotopes found at West Lake (such as thorium-230 and radium-226), are merely "false positives," caused by mistakes in sampling or analysis. For example, see the "Groundwater Conditions Report -- West Lake Landfill Areas 1 & 2," prepared by the McLaren/Hart Environmental Engineering Corp., for the West Lake Superfund Site Respondent Group; November 26, 1996. And the "Split Soil and Groundwater Sampling Data Summary Report – West Lake Landfill Areas 1 & 2," also prepared by McLaren/Hart for the PRPs; November 22, 1996.

a. Conflicting groundwater results:

(1) It was explained that detection-limit problems had existed with the groundwater monitoring equipment regarding the thorium-230 data collected by Quanterra Environmental Services of St. Louis, the initial analyzing laboratory, during the November 1995 and February 1996 sampling rounds. ("Groundwater Conditions Report," p. 2-5)

An additional round of groundwater samples was therefore collected in May 1996 to resolve such concerns. But it is curious that when the third round of samples was collected, Deep-Depth Well **D-14** was not included in the retesting. D-14 is a remedial-investigation monitoring well that is located in the eastern part of Radiological Area One, "at the edge of the alluvial valley." ("Groundwater Conditions Report," Figure 2-1) It had been reported to have extremely high levels of radioactive lead-214, bismuth-214, and radium-226 in both filtered and unfiltered samples in November 1995 and February 1996. (Ibid., Table 2-9) To repeat: why was Well D-14 not one of the wells that were retested in the May 1996 sampling round that was specifically designed to resolve Quanterra's quality control issues?

(2) Groundwater samples from three monitoring wells had been found to have levels of gross alpha radioactivity that exceeded the Metropolitan Sewer District's maximum permissible concentration for releasing waste water into the environment. (Ibid., pp. 2-2 and -3; Figure 2-1; and Tables

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2-1 through 2-5). However, samples from those unusually hot wells (S-80, S-88, and 1206) were not collected and analyzed in May 1996, during the Third Sampling Round. S-80 was one of two "background wells" that were designed to indicate "natural groundwater conditions for the geographical area." (Ibid., p. 3-3) Although considered a background well, S-80 was very near the landfill and the alluvial valley. It has since been abandoned.

b. Conflicting soil results:

(1) It was explained that the thorium-230 levels in soil samples Quanterra had collected during the first sampling round (November 1995) appeared to have contained "false positives or to have been reported at levels higher than actually present" due to a laboratory procedural issue. (RIR, p.47) Accu-Labs Research of Golden, Colorado, was contracted by McLaren/Hart to provide analyses of archived split soil samples. When Accu-Labs reported thorium-230 in soil at concentrations even higher than the high Quanterra Lab samples, McLaren/Hart blamed the disparity between the two labs' data on the fact that Quanterra had changed its "sample preparation procedures in late 1995," and that Accu-Labs had not. ("Split Sampling Report," page 6.)

(2) Many of the thorium-230 results from both labs, by the way, are extraordinarily high. It is important to remember that in nature, thorium in soil averages from two-tenths to one picocurie per gram. To repeat: a picocurie (pCi) or one trillionth of a curie, is that amount of a radioactive material that gives off about 2.2 radiation particles and rays per minute.

(a) In Radiological Area One at West Lake, split soil samples of thorium-230 collected at the surface, from Soil Boring **WL-106**, were reported at **9700** picocuries per gram (pCi/g) by Quanterra, and at **57,000** pCi/g by Accu-Labs. (RIR, April 2000, Table B-10)

(b) At ten feet below the surface, field-split samples of thorium-230 collected from boring location **WL-234** were also high --- **57,300** pCi/g, as reported by Quanterra, and **83,000** by Accu-Labs. (McLaren/Hart: "Split Sampling Report," Nov. 1996, Table 2-1; RIR, Table B-10). Both labs also reported high levels of other isotopes from the uranium-238 decay series in WL-234 samples from 10 feet below: radium-226 (3060 and 1800 pCi/gram) and of three other U-238 daughters: lead-214, bismuth-214 and lead-210. (loc.cit.) Quanterra also reported extremely high levels of the rare uranium-235 and its notoriously toxic daughters (protactinium-231, actinium-227, and radium-223) in WL-234 samples, also at 10 feet. (RIR, Table B-11) How did McLaren/Hart decide which high readings were or were not to be discounted as "false positives" or "biased high"?

(c) It is interesting to note that in the earliest radiological survey of West Lake's radioactive wastes, prepared for the NRC by Radiation Management Corp. of Northbrook, Illinois, thorium-230 was also reported high: 178,000 pCi/gram !! (NUREG/CR-2722, published in 1982. Table 4)

2. Why is there never any reported suspicion of false *negative* or "biased low" values?

3. Why were different sampling methods and analyses allowed to be used? Which experts determined which results of which methods were to be discounted as "false positives"?

The two laboratories contracted to study split samples of soil and groundwater at times used different monitoring equipment, sample preparation, and methods of analysis. When high radium-226, lead-214, and bismuth-214 were reported in groundwater monitoring wells and soil borings, McLaren/Hart often discounted the results, claiming one of the groundwater methodologies and a soil-sample preparation procedure had led to "false positives" or "biased high" results. ("Groundwater Conditions," page 3-6; and "Split Sampling," page 6.)

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4. Why were monitoring samples often filtered? If groundwater is being tested, for example, why filter the water sample and thus potentially remove the isotopes for which the technician is testing?

5. Why were the cited Minimum Detectable Activity (MDA) levels of the monitoring equipment so extremely varied, even when using the same instrument to test the same sample for the same isotope?

I believe the following information calls into question the claims of "false positives."

1. **Uranium-238** is the predominant uranium isotope found on the planet --- specifically, the natural abundance of uranium-238 is 99.2745%. It decays into a series of daughter and granddaughter (etc.) products, including radium-226. Radium-226 in turn decays into radon-222 which ultimately decays into lead-214, bismuth-214, polonium-210, and other daughters.

(a) **Groundwater Deep Well D-14:** High levels of lead-214 and bismuth-214 were found in D-14. Lead-214 registered at 71 pCi/L in November 1995, and at 91.8 in February 1996. Bismuth-214 registered at 69.4 in November 1995. ("Groundwater Conditions," Table 2-9)

Faced with those high readings of radium daughters, McLaren/Hart claimed that not enough radium-226 was present to have been able to generate such high levels of lead-214 and bismuth-214. Therefore, they claimed the bismuth data could be ignored because the bismuth was not in "secular equilibrium" with its progenitors [radium and lead]. (Ibid., page 3-6)

However, radium-226 had indeed actually been found at high concentration levels. For example, an unfiltered sample in Deep Well D-14 registered at 69.8 picocuries per liter in November 1995, and a filtered sample registered at 96.7 in February 1996. (Ibid., Table 2-9)

Therefore, when faced with high levels of radium and its daughters, McLaren/Hart rejected the accuracy of the well data **by discounting the entire EPA gamma spectrometry methodology** (EPA Method 901.1) that had detected the high levels.

> **Quoting from "Groundwater Conditions": "The gamma spec results are susceptible to interferences and are not considered reliable by McLaren/Hart. Additionally, the minimum detectable activity for this method are [is] not acceptable for comparing results to MCLs" [maximum contaminant levels].**
>
> **If McLaren/Hart was willing to accept only results using the EPA's isotopic methodology (EPA 903.0), why had the corporation not specified that only EPA 903.0 – and not 901.1 – was to have been used for the split-sample analyses?** ("Groundwater Conditions," page 3-6)

(b) **Soil Boring WL-234:** According to the "Split Sampling" report, both Quanterra and Accu-Labs reported extremely high levels of radium-226 at 10 feet (3,060 and 1,800 pCi/L), and also of three radium daughters: lead-214, bismuth-214 and lead-210. (Table 2-1) Thorium-230, the progenitor of radium-226, was detected at 57,300 by Quanterra and 83,000 by Accu-Labs. **Please remember that thorium-230 in nature is found at about from 0.2 to one pCi/gram in soil.**

Further information about the thorium-230 issues in soil: McLaren/Hart discounted the high thorium-230 levels detected by Accu-Labs because the laboratory had not made the same changes in its sample preparation procedures that Quanterra had. ("Split Sampling," page 6) The new procedures were supposedly designed to keep possible interferences – such as the potential presence of plutonium and neptunium --- from distorting the analysis of the soil samples. (loc.cit.) How Quanterra could possibly have been worried about the presence of plutonium and neptunium is mystifying. Significant quantities of those two synthetic

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transuranic elements would only have been present at West Lake **if the wastes there had come from a reactor, which they clearly had not !!**

2. **Uranium-235** and its daughters are rarely detected in the United States, in soil or water, because the uranium-235 isotope is present in the planet's uranium at only 0.72%. But because the Belgian Congo pitchblende (ore) that was processed at the Mallinckrodt Chemical Works in the late 1940s contained such high levels of uranium (60 to 65% pure, as compared to one percent found in American ore), the rare isotopes of the uranium-235 decay chain that are **not detected in United States' uranium residues** *are* detected in the Belgian Congo residues – such as in those residues that were dumped at the West Lake Landfill in 1973.

Quanterra reported extremely high levels of uranium-235 and its dangerous daughters in West Lake soil samples. For example, from the **WL-234 boring**, at 10 feet: Uranium-235: 774 picocuries per gram; protactinium-231: 1050; actinium-227: 952; and radium-223: 5270. For some unexplained reason, a combination of uranium-235 and -236 yielded only 10.9 pCi/g. ("Split Sampling Report," Table 2-2. The same data are reported in the "Remedial Investigation Report," Table B-11.)

Because uranium-235 and its daughters are not normally detected in the United States, instead of listing "Site Specific Background" levels for uranium-235 and its daughters in many of the West Lake reports, **the tables merely say "NE – Not Established" for those isotopes** (e.g., in the RIR, Table B-11 fn.).

3. The Washington University radiochemist cited above (p. 6), reading through some of the tables in the "Feasibility Study," explained to me that if two isotopes are detected positive by gamma spectrometry, those coincident positives should **not** be discarded (even if a different monitoring methodology has subsequently been deemed preferable). The coincident positives would indicate an absolute positive.

The West Lake reports contain significant monitoring incongruities regarding the quantities and locations of these dangerous materials. Would this fact not justify additional testing of soil and water samples by a team of scientists with no financial stake in the test results?

F. ***Other monitoring issues at West Lake:***

1. Who would keep track of the West Lake radioactive wastes in the future --- and over how many generations? How would compliance monitoring be designed --- and for how many decades or centuries?

2. How many monitoring wells would be installed for ground and surface water sampling, and how many soil borings? In what locations at West Lake and its environs? How often would sampling be required? What public agency would be mandated to oversee the monitoring program and to inspect and maintain the monitoring wells? If the Missouri Department of Natural Resources were so designated, what would happen if the Missouri Legislature were to abolish the Department as has at times been threatened?

3, Which federal agency would dictate the effluent or concentration limits for the water and soil?

4. What if contaminants in the soil or water were to exceed the permissible limits? Who would design and carry out a **contingency plan** --- for example, who would provide alternative drinking water? How many cities downstream on the Mississippi River would be included?

5. Which laboratories would be used to analyze the soil and water samples? Who would pay for the sampling and analysis costs --- the State, the EPA, the Potentially Responsible Parties? What if some or all of the PRPs no longer exist, including the U.S. Department of Energy?

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6. Who would pay for the ongoing inspection, maintenance and repair of the two radioactive piles? Who would pay to remediate the rock/rubble/clay caps, if necessary, or --- alternatively --- to exhume and remove the wastes? For example, what actions would be taken when the vegetation that would have established itself on the surface of the cap dies? As the root system disintegrates, the resulting spaces could potentially serve as funnels for the expedited release of radon gas to the atmosphere. Also, would the cap be routinely refurbished as the contents of the piles settle and collapse over time?

7. If the Proposed Plan is approved, no liner would be installed beneath the two radiological areas and no leachate collection and disposal system. How, then, would the surface and subsurface discharges be monitored? At what location or facility would the radioactive leachate be discarded? (The leachate from the Weldon Spring bunker in St. Charles County is trucked all the way across St. Louis County and the City to the Metropolitan Sewer District's Bissell Point sewage treatment plant on East Grand. It is then dumped into the Mississippi River. I have never understood why the Department of Energy did not decide to have the Weldon Spring leachate dumped into the Missouri or Mississippi River near the Weldon Spring site --- upstream from St. Louis --- though I am glad it didn't.)

G. Safe removal of the wastes is possible: ***The excavation, containerization, and transport of the West Lake wastes away from the floodplain can and must be done safely, using state-of-the-art technologies that are safe for the workers, neighboring communities, and the environment.***

Legitimate concerns exist regarding the ability to excavate West Lake's radioactive contaminants safely, without dispersing radioactive dust and gases to nearby residential, industrial, commercial, and agricultural areas. Leaving the wastes in the floodplain to be dispersed over time should not be an option. The best available remediation technologies must be and can be pursued. Decisions about removing radioactive materials as permanently hazardous as those at West Lake must be made on the basis of safety, not cost. Safety for the remediation workers, neighboring residences, and workplaces, and for the environment.

As one example, a temporary pressurized structure could be installed above Operable Unit One that will keep the contaminants isolated during the excavation and containerization of the radioactive wastes. Major federal funding was provided to install and operate several water treatment plants and a Chemical Stabilization and Solidification Plant at Weldon Spring for processing radioactive sludge. Appropriate technologies should also be required to process the West Lake radioactive wastes in order to minimize water contamination and soil runoff and to filter dust and gaseous releases during remediation.

Companies that sell or lease waste remediation enclosures include the following: Environmental Structures Incorporated (www.esidome.com); Universal Fabric Structures (www.ufsinc.com); American Spaceframe Fabricators Intl. (www.asfi.net); Sprung Instant Structures (www.sprung.com); and Signature Structures (www.signaturestructureshome.com). The latter company, for example, advertises that it has "worked with private contractors, generators and on DOE sites. Airborne contaminants, dust control, noise reduction, and odor control are some of the reasons the contractors have chosen to enclose their project's excavation area. Signature's enclosure system can be completed with ventilation and air cleaning units . . . . "

The wastes should be transported to a federally licensed radioactive waste disposal facility.

H. ***Radioactivity cannot be destroyed. It decays only with the passage of time.***

The EPA Proposed Plan's "Alternative Six" is not a perfect solution for West Lake's radioactive wastes -- but it would clearly be better than leaving all the high-level wastes in the floodplain. Alternative Six would call for the "excavation of some accessible portion(s) of the landfill material containing relatively higher concentrations of radiologically contaminated material." (Proposed Plan, p.12)

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The EPA's preferred duck-and-cover "Alternative Four" would be to regrade the waste piles to a 2% slope and then cover them with rock, construction rubble, and clay. This would not provide protection for current or future generations.

The wastes would migrate at the time of flooding and are, in fact, already accessible now to ground- and surface-water and to the air. Adequate funding is essential to provide for the permanent, safe remediation of the site.

The wastes need to be taken away from water. The U.S. Nuclear Regulatory Commission requires that a near-surface radioactive waste disposal site "must minimize to the extent practicable the contact of water with waste." (Code of Federal Regulations, Title 10, Part 61.51.)

The reduction of the volume of water entering West Lake Landfill would of course be key to controlling runoff. However, the total diversion of surface- and ground-water and rain and snow is not possible, of course, nor is the diversion of surface and subsurface floodwaters, Even if the Earth City levee were to be inspected and maintained at an optimal level over the requisite millennia, floodwater could still have access to the waste piles. While the river water would perhaps not go over the levee, it could go under or through it.

Global warming could also have unpredictable impacts on the Missouri River and therefore on West Lake Landfill. Increased drought could result in less water for the dilution of contaminants. Or the river level could rise dramatically. As the ice caps melt and the global temperature increases, there could be a great increase in precipitation, river flow and flooding. And added pressure on the proposed rock and clay caps of the waste piles would help lead to a major dispersal of the wastes into the groundwater and into the river.

The mistakes of the past should not be allowed to contaminate the future.

I believe the Environmental Protection Agency should mandate, instead of its "Proposed Plan," that the West Lake radioactive wastes be dug up, containerized, and removed, using the most sophisticated equipment, technologies and worker protections possible; that the wastes be transported as safely as possible to a licensed nuclear-weapons-waste or other disposal facility; and that this commitment be made now.

P.S. In response to my husband's inquiry about what I was working on at the computer (and all over the house), I said I am concerned that the EPA wants to keep highly radioactive waste in the Missouri River floodplain. Leo's reassuring response: "Don't worry. It won't stay in the floodplain. It will move out !! "

Comments on West Lake Landfill — an addendum.

Additional history about the West Lake wastes follows— evidence that the wastes are high-level, not low-level:

1. The National Research Council's Committee on Remediation of Buried and Tank Wastes issued a report in 1995, entitled "Safety of the High-Level Uranium Ore Residues at the **Niagara Falls Storage Site**, (NFSS) Lewiston, New York." Most of the highest-level uranium residues addressed by the Committee have the same origin as those at West Lake Landfill --- that is, they are residues from the Belgian Congo pitchblende processed at the Mallinckrodt Chemical Works in St. Louis.

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Unlike the K-65 residues at West Lake Landfill, however, the K-65 residues at the Niagara Falls Storage Site, in Lewiston, New York, were not deposited in the floodplain of a gigantic, flood-prone river. The concerns about the possible infiltration of water into the buried residues at Niagara Falls were based on the potential contamination and transport of groundwater as the principal exposure pathway. It seems to me that the threat of cyclic flooding of the Missouri River makes the dispersal of West Lake's K-65 residues highly probable, not just possible.

Some significant and relevant quotes from the Niagara Falls Storage Site report follow:

a. "In about 1942, the Mallinckrodt Chemical Works in St. Louis, MO, began extracting uranium from very rich Belgian Congo ores received form the African Metals Corporation of Belgium (AMCB) for use in the Manhattan Engineering District Project. The residues remaining after uranium extraction (classified as K-65 residues; see Table 1) contain many of the uranium decay products that had been in secular equilibrium with the ^{238}U and ^{235}U [uranium] isotopes." (page 7) [Table 1 on page 8 defines K-65 residues as coming "from processing ore containing **35-60%** U_3O_8 [an oxide form of uranium]." Other non-K-65 uranium ore residues listed in Table 1 range from 3.5 to 10%.]

b. "All of the K-65 residues at the Niagara Falls Storage Site and in Silo 1 [and some in Silo 2] at the Fernald [Cincinnati] Environmental Management Project site were produced at the Mallinckrodt Chemical Works in St. Louis." (page 32)

[Recent information about the St. Louis connection: Some 1,888 truckloads, hauling 3,776 half-inch thick carbon-steel canisters of K-65 residues, "solidified" with flyash and cement, were shipped back through St. Louis from Fernald (from June 2005 – March 2006; ten to fifteen trucks per day) to an interim parking lot in Texas for ultimate disposal in an unknown location. It seems apparent that the only solution we have for radioactive waste is to ship it from place to place, and then back again.]

c. "The continuing high levels of radioactivity of the K-65 residues, the cumulative uncertainties in understanding and predicting local geological and hydrological behavior, the indeterminate nature of future land and water use and future demographics, the unpredictable physicochemical behavior of the residues such as possible complexation with reactants in the soil and colloid or pseudocolloid formation, and the large potential risk to the public, **all argue decisively against leaving the residues at the NFSS permanently** ... . The extraordinarily high concentrations of radium and its daughters, especially of radon, and the presence of substantial concentrations of ^{230}**Th** with a half life of **75,400 years** dictate that a potential for unacceptable radiation exposure will remain for a time far in excess of the 1,600-year half life of ^{226}**Ra**." (p. 39; emphases added.)

d. Regarding barium sulfate — presumed to comprise the predominant contents of the Latty Avenue/Mallinckrodt residues that were dumped at West Lake:

"During processing of the high grade pitchblende ores [from the Belgian Congo] at the Mallinckrodt Chemical Works, the radium was precipitated as radium sulfate, along with lead sulfate (the ores contained about 6 percent lead) from a nitric acid dissolution of the ore. Barium was added to the solution from which the radium had been precipitated, causing precipitation of **barium sulfate**, which scavenged residual **radium** sulfate from the uranium solution. Uranium was then extracted using diethyl ether. The aqueous raffinate (waste stream) after uranium extraction contained the bulk of the thorium that precipitated. Thus, most of the ^{226}**Radium** and ^{230}**Thorium** in the residues is contained in insoluble sulfate salts. This does not mean, however, that all of the residues are sulfates, nor that the behavior of the radium and thorium in the residues would be those of the pure sulfate salts. [Letter from John Russell of Booz-Allen to J.E.Patterson, U.S. DOE, EM-421, re 'Briefing for the National Academy of Science[s] Panel -- Alternatives for Management of K-65 Residues at the NFSS,' June 28-30, 1994.] The K-65 residues are present with two distinct types of materials. Approximately 73 percent is characterized as 'slimes' (particle size less than 37 micrometers), and the remainder is sand. Most of the ^{226}Ra is in the slimes fraction." [U.S. DOE/EIS-0109F,

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re NFSS. 1986. Table 3.6, p. 3-15.]. (This paragraph is from the Natl. Research Council's NFSS report, p.40; emphases added.)

2. The U.S. Nuclear Regulatory Commission Office of Nuclear Material Safety and Safeguards (ONMSS) published a report in May **1982** entitled "Radiological Survey of the West Lake Landfill, St. Louis County, Missouri" (NUREG/CR-2722), prepared by the Radiation Management Corporation.)

a. "Analyses of soil samples from both areas [at West Lake – that is, Radiological Areas 1 and 2], as well as in situ measurements, show that the contaminants present at West Lake consist of uranium and uranium daughters. Chemical analyses reveal high concentrations of barium and sulfates in the radioactive deposits. These results tend to confirm the reports that this contaminated material is uranium and uranium ore, contained in leached barium sulfate residues, and presumably transferred from the Latty Avenue Site in Hazelwood, Missouri.

"Analysis of soils also shows a high Th-230 to Ra-226 ratio. Since the target criteria for Ra-226 is the most restrictive of those contaminants present, it has been assumed that Ra-226 would be the controlling radionuclide for remedial action determinations. However, since Th-230 levels may be from 5 to 50 times higher than Ra-226 concentrations, this assumption may be erroneous. It is likely that high concentrations of thorium resulted from separation of both uranium and radium from the ores, thus 'depleting' the ores of uranium and radium, or, 'enriching' the residues in thorium. This 'enrichment' would also be evident in the U-235 chain, despite the short half-lives of Th-227 [18.7 days] and Th-231 [1.1 days], since the long-lived Pa-231 [protactinium-231: 32,760 years] would remain in the residues. The concentrations of Pa-231, inferred from Ra-223 determinations [11.4 days], are also shown to be high." (pp. 20-21; emphasis added)

b. "An NRC investigation conducted by Region III in 1976 [IE Inspection Report No. 76-01, June and August] concluded that about 7 tons of U3O8, contained in 8700 tons of leached barium sulfate residues, had been mixed with about 39,000 tons of soil at Latty Avenue and the entire volume disposed of at the West Lake Landfill." (p. 4, emphasis added). [Please note that the soil used to "dilute" the wastes before disposing of them at the landfill came from Latty Avenue and was therefore also most probably contaminated.]

McLaren/Hart's "Overland Gamma Survey Report" of April 1996 also noted that the West Lake radiological areas contained "about 8,700 tons of uranium ore processing residue and 39,000 tons of clean soil." (pg.1-1)

3. The U.S. Nuclear Regulatory Commission's ONMSS then published a summary report in June **1988**, entitled "Radioactive Material in the West Lake Landfill." (NUREG-1308, Rev. 1) It concluded that "remedial action is called for" (p.15) and that if onsite disposal were to be possible at West Lake, the radiological conditions "will likely require moving the material to a carefully designed and constructed 'disposal cell'." (p. 13; emphasis added)

That is, it was suggested that **if** onsite disposal at West Lake were possible, the radioactive wastes would have to be excavated, and an engineered disposal cell would have to be built. Such a cell would have to provide protection from erosion, infiltration, biointrusion, etc., at the top, bottom, and sides, with a leachate collection and removal system. That is, the mobile, highly radioactive K-65 wastes should not just be left at West Lake in ***unlined*** piles with a "cap" of construction rubble, clay, and rocks on top. **They should be excavated, containerized, and transported — away from water, and away from people.**

##

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Rec'd, 12/20/06
via e-mail

Comments re the Proposed Plan for the West Lake Landfill radioactive wastes.

Submitted to the U.S. Environmental Protection Agency and the Missouri Dept. of Natural Resources
by Kay Drey, 515 West Point Ave., University City, MO 63130. December 19, 2006.

Portions of the following comments were presented at a public meeting hosted by the Bridgeton City Council in St. Louis County, Missouri, on September 14, 2006. Representatives of the EPA -- Region 7, and the Missouri DNR spoke in support of the Proposed Plan. I am now resubmitting my Sept. 14 comments, with additions.

The public is encouraged to send comments by December 29, 2006 —

Via mail: Debbie Kring, Community Involvement Coordinator
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Or via email: **kring.debbie@epa.gov**

No one knows exactly how much radioactive waste and radioactively contaminated soil were dumped at West Lake Landfill in 1973, or exactly at what locations there. But we do know that of all the land types where perpetually radioactive contaminants could be placed, probably none is less appropriate or less secure than a floodplain in an urban area, along one of the longest rivers in the world.

So then the question becomes: what do we do to undo this illegal dump-and-run non-solution, made back in 1973? Do we do what is cheapest --- leave the wastes there and hide them under some rocks and construction rubble and an unspecified amount and type of clay? Or do we dig them up and transport them away from water, and away from people?

It seems likely that the vast majority of St. Louisans who get their drinking water from the Missouri River do not know about West Lake Landfill, next to Earth City --- or that about 20 percent of St. Louis County gets its drinking water only about eight miles downstream from the landfill, or that St. Louis City's water intake is also downstream from West Lake. They do not know that a decision is about to be made about these wastes that could affect not only people living today, but also people over the next 300 generations.

It was a great surprise to me to learn --- starting about 30 years ago --- that massive quantities of uranium had been imported into the St. Louis region in the 1940s, 50s, and 60s, from distant American and foreign mines and mills. I learned, in fact, that Mallinckrodt Chemical Works, a mile from Downtown, had purified all the uranium that went into the world's first self-sustaining nuclear chain reaction, in Chicago, in December 1942. Some of the wastes at West Lake Landfill could well have been generated in those earliest months and years. That is, we have in Metropolitan St. Louis some of the oldest radioactive waste of the Atomic Age.

The estimated volumes of radioactively contaminated materials at West Lake Landfill are:

Area One: Surface -- 940 cubic yards (Remedial Investigation Report, 4/2000, p. 90)
Subsurface – 24,000 cu.yds. (p. 93)

Area Two: Surface – 8,700 cu.yds. (p. 95)
Subsurface – 109,000 cu.yds. (p. 98)

The above West Lake volumes are only approximate. For example, regarding the comparison of "downhole gamma" readings from three subsurface soil borings: "These data suggest that the depth and elevation at which the radiologically impacted materials occur varies highly over even small distances indicating that the horizon(s) in which the radiologically impacted materials occur are **highly variable and highly irregular**." (RIR, p. 92; emphases added.)

To put the estimated West Lake volumes in perspective, a much greater volume of similar, radioactively contaminated nuclear weapons materials from the Mallinckrodt Chemical Works (MCW) has already been

excavated and transported away from Metropolitan St. Louis by the federal government --- specifically, some **750,000 cubic yards**. Plus an estimated **1.48 million cubic yards** of wet and dry radioactive MCW wastes were collected in the Weldon Spring bunker in St. Charles County, at a cost of about one billion dollars. A liner and leachate collection and removal system were engineered at the bottom, and a cap at the top, complete with a "mixture of cobbles," and climbing steps to encourage the public to come visit and view it all !!

This large volume of MCW nuclear-weapons-production wastes has been remediated because the wastes are dangerous. Unless and until the West Lake MCW wastes are removed, they will continue to migrate into groundwater used for farming and into the river used for drinking, irrigation; and fishing; and will continue to release radioactive radon gas and fugitive dusts into the air we breathe.

A. *Some of the radioactive wastes at West Lake are extremely rare and are particularly dangerous:*

Almost all natural uranium found on the planet is uranium-238 (that is, more than 99 percent of the Earth's uranium); only seven-tenths of one percent is uranium-235. The 235 isotope and its daughter products are not detected in American soils and water. Starting after the end of World War II, the U.S. Atomic Energy Commission announced its willingness to buy any ore that had at least one-tenth of one percent uranium. Most American ore contains only one to two percent uranium,. The Belgian Congo ore ("pitchblende") that was processed downtown at the Mallinckrodt Chemical Works averaged **60 to 65% uranium**. Therefore, the rare uranium-235 and its daughter products are detectable at our Metropolitan St. Louis sites. That is, these isotopes are not found elsewhere in the United States except where Belgian Congo uranium residues were processed or discarded. The St. Louis sites include the Airport Site, Latty Avenue in Hazelwood, Downtown Mallinckrodt, Weldon Spring, vicinity properties, and West Lake Landfill.

Mallinckrodt Chemical Works processed uranium and thorium, and accumulated and dispersed the resulting radioactive waste, for twenty-five years --- 15 years near Downtown, and then ten years at Weldon Spring. Some of the materials present in the MCW wastes include some of **the most radioactively toxic** of all radioactive materials identified to date. People who seek to assure the public that radioactive materials are not particularly dangerous often say that mankind has evolved in a radioactive world; that radioactivity exists in nature. (For example, they like to point out that bananas may contain small amounts of naturally radioactive potassium.)

However, some radioactive materials are far more dangerous than others, **and some of the most dangerous --- most radiotoxic --- are present at West Lake Landfill**. Here are some quotes from the CRC Handbook of Chemistry and Physics, 82nd Edition, from 2001-2002, about radioactive elements at West Lake:

Protactinium "is a dangerous toxic material and requires precautions similar to those used when handling plutonium." (page 4-24). The United Nation's International Atomic Energy Agency had ranked protactinium-231, which we have at West Lake, as the most radiotoxic of the 236 radionuclides it included in a 1963 report. ("A Basic Toxicity Classification of Radionuclides," p. 32) **Eleven** of the 31 nuclides classified in the 1963 IAEA report as the **most highly toxic** are present at West Lake !! --- namely, protactinium-231; actinium-227; thorium-230, -228, and -227; radium-228, -226, and -223; lead-210; uranium-234; and polonium-210. **(Please see recent information below about the IAEA and polonium-210.)**

Radium: "Inhalation, ingestion, or body exposure to radium [another West Lake material] can cause cancer and other body disorders." (CRC, p.4-25) **Actinium-227** "is about 150 times as [radio-] active as radium." (p. 4-3)

Polonium: One gram (or a thirtieth of an ounce) is the weight in a packet of artificial sugar. In addition to gamma rays, one gram of radium-226 gives off **37 billion** radioactive particles every second. (The radium-226 emission rate is the basis of the word "curie" – that is, a curie is that amount of a material that gives off

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37 billion radioactive emissions every second.) By comparison, **one gram of polonium-210 (which is present at West Lake) gives off 185 trillion alpha particles every second**. That is, one gram of Po-210 contains 5,000 curies. And as pointed out to me by Dr. John Gofman, one of the world's preeminent physicians and nuclear-physical chemists, polonium-214 (also at West Lake) is even more radioactive and, therefore, even more hazardous, than polonium-210.

Polonium-210 has recently achieved international notoriety as the radioactive isotope believed to have poisoned Alexander Litvinenko, a former Russian intelligence officer, who died 11/23/06.

→ → Extremely relevant to the evaluation of the EPA's proposal to leave the K-65 residues, including polonium-210, in the Missouri River floodplain is the following recent information: The UN's **Internatl. Atomic Energy Agency** has decided to undertake **a review** of the biological hazards of polonium-210, in order to include for the first time the risks of ingesting polonium. (FT.com – Financial Times / UK. Dec. 13)

Analyses for polonium-210 concentrations were apparently not specifically performed at West Lake. For example, Po-210 data were not included in the "Remedial Investigation Report" of April 2000 --- that is, as one of the isotopes in the uranium-238 decay series. It is not included in the analytical results in Table B-2 or B-10 (soil); Table C-2 (groundwater); Table D-1 (rainwater runoff, leachate, and surface water); Table E-1 (sediment); or Table 6-2 (subsurface soil in Area One) or Table 6-4 (Area Two).

However, highly elevated levels of the progenitors of polonium-210 were indeed reported at West Lake, such as uranium-238, thorium-230, radium-226, and **lead-210**. Daughter products of lead-210 include bismuth-210, **polonium-210**, and ultimately the stable, non-radioactive lead-206. **If lead-210 is present at West Lake --- and it is* --- then polonium-210 is there, too**. As, without doubt, are other polonium daughters of uranium-238, uranium-235 and thorium-232.

* Some evidence of **lead-210**, a grandparent of polonium-210, at West Lake: (1) a filtered sample of groundwater from deep-depth Monitoring Well D-6 contained 204 picocuries* per liter of lead-210 in May 1997. (RIR, Table C-3, Uranium-238 Decay Series); (2) Soil Boring WL-234 contained 1040 pCi per gram (RIR, Table B-10); and (3) rain-water runoff collected at Weir 8 in Area Two registered **9200 picocuries per liter** in April 1996 (RIR, Table D-1).

*A **picocurie** (pCi) or one trillionth of a curie, is that amount of a radioactive material that gives off about 2.2 radiation particles and rays per minute.

Specific evidence of the presence of polonium-210 in the K-65 residues: Some of the K-65 residues had been shipped from the Downtown MCW facility to the Fernald uranium processing plant in Cincinnati in 1953, and were stored there in Silos 1 and 2. The Silo One contents included **281,000 picocuries per gram of polonium-210 (!!)**, according to the "Fernald K-65 (Silos 1 and 2) Residues Fact Sheet," published by the Fernald Closure Project in 2006 (p. 2).

The silo residues were trucked from Cincinnati, starting in June 2005, through March 2006 — back through St. Louis — to Texas for interim storage. No one knows where they'll go for permanent disposal.

Quoting from the CRC Handbook: "Polonium-210 is very dangerous to handle in even milligram or microgram amounts, and special equipment and strict control is necessary. Damage arises from the complete absorption of the energy of the alpha particle into tissue. The maximum permissible body burden [for a nuclear worker] for ingested polonium is only 0.03 microcuries, which represents a particle weighing only

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6.8×10^{-12} grams." (p.4-23) [The nuclear industry is allowed to expose a nuclear worker to fifty times more radiation per year than a member of the public – that is, 5000 millirem, as compared to 100 mR.] **Radon gas:** The West Lake wastes also generate and release radioactive **radon** gas. "The main hazard is from inhalation of the [radon] element and its solid daughters, which are collected on dust in the air." (CRC, p.4-25) Radioactive **lead-210**, with a half-life* of 22 years, and **polonium-210** are among the radon daughter-products. The West Lake residues generate three different isotopes of radon --- radon-222 (from U-238), Rn-219 (from U-235), and Rn-220 (from Th-232) --- all of which emit alpha particles. Even the U.S. Nuclear Regulatory Commission admits that if alpha-emitters are swallowed or inhaled, the alpha radiation is twenty times more biologically harmful than beta or gamma. (Code of Federal Regulations, Title 10, Part 20, Table 1004(B).1.)

> * A **half-life** is the time required for half the atoms of a radioactive substance to change into another substance by emitting subatomic particles and rays. Another half of the original atoms – that is, one fourth – will release radioactive particles during the next half-life; half of the remaining fourth during the next half-life, etc. **A radioactive substance is generally considered hazardous through at least ten half-lives.**

West Lake's thorium-230 and actinium-227 were ranked along with plutonium, americium and neptunium as among the most radioactively dangerous materials known, in a 1965 paper written by Dr. Allen Brodsky, and contracted by the U.S. Atomic Energy Commission and the U.S. Public Health Service (reprinted in Health Physics, Vol. 38 [June 1980], pp. 1155-1171).

B. ***Floodplains are for flood waters --- NOT for radioactive wastes.***

During an extremely informative visit that I had at Washington University with Robert E. Criss, Ph.D., a professor in the Department of Earth and Planetary Sciences, on October 20, Dr. Criss dictated the following comments regarding the EPA's proposal to keep radioactive wastes at the West Lake Landfill. I had asked him, for example, if he agrees with the type of statement I have heard and read as a part of the defense of the EPA's "Proposed Plan" --- that "the Earth City Levee District [of the U.S. Army Corps of Engineers] does not consider this area to be a floodplain. It's behind a levee."

Dr. Criss gave me permission to submit the following along with my comments:

> "The West Lake Landfill is located in a geomorphic* floodplain. A floodplain is a place where a river floods commonly. Levees fail. Several levees in St. Louis County have failed in the last fifteen years. It's preposterous to claim that levees don't fail. These risks are chronically underestimated.
>
> "Levees can fail either by overtopping or by piping through or underneath the structure. That is, the river water can form blow-holes [known as "blew holes" or scour holes]. Water can pipe through or underneath the levee. The water bubbles up under the levee.
>
> "In the event of failure, you have high-energy, high-velocity water that catastrophically scours the ground, especially unconsolidated material which it scatters for miles. This is the wrong place to store hazardous material. It does not belong in a floodplain."
>
> [*Geomorphic refers to the description and interpretation of land forms.]

Dr. Criss said that he thinks the flow rate of the Missouri River near West Lake Landfill is about 70,000 cubic feet per second. I asked about how long he thought it could take for the landfill's contaminants to reach the Missouri American Water Company's North County water intake plant --- in Florissant, about 8.5

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river-miles downstream from the landfill, in the event of the levee's failure. Dr. Criss estimated "about a day. The wastes would be everywhere."

Dr. Criss also mentioned concerns about liquefaction --- that when wet dirt is shaken enough, during an earthquake, the ground liquefies; "turns to goo."

The West Lake radioactive wastes leach into the groundwater. And the groundwater flows into the Missouri River.

Quoting from the West Lake "Feasibility Study on Operable Unit One" (the radioactively contaminated area of the landfill), prepared by Engineering Management Support Inc, for the Respondents, May 2006:

> The regional direction of groundwater flow is in a generally northerly direction within the Missouri River alluvial* valley, parallel, or sub-parallel to the river alignment. ... Regional groundwater flow in the vicinity of the landfill is to the northwest, towards the Missouri River. (page 10)
>
> *Alluvium is "Detrital material which is transported by a river and deposited – usually temporarily – at points along the flood plain of a river." From the Penguin Dictionary of Geology, 1988, p.22

C. Longevity: *West Lake's radioactive wastes will continue releasing dangerous particles and rays into the Metropolitan St. Louis environment* virtually forever *– unless they are removed.*

The predominant isotope of concern at West Lake is **thorium-230**. It has a half-life of 75,000 years. Two other extremely long-lived isotopes present at West Lake are **uranium-238**, with a half-life of four-and-a-half billion years, and **thorium-232**, with a half-life of 14 billion years

Not only do concerns exist about the potential for the migration offsite of ground water and of Missouri River flood waters contaminated with radioactive Belgian Congo (K-65) residues, but the interrelationship of West Lake Landfill's radioactive wastes with the chemical toxins (present in the demolition and sanitary wastes of the landfill's contiguous, non-radioactive "Operable Unit 2") is also of concern. The National Research Council's Niagara Falls Storage Site (NFSS) report of 1995 describes similar potential impacts between the radioactive and non-radioactive components in adjoining acreage:

> The NFSS is bounded on two sides by major waste disposal facilities, the Chemical Waste Management (CWM) Chemical Services, Inc., to the north and Modern Landfill, Inc., to the east. Current site plans and ongoing monitoring do not address the present or long-term potential impacts of these sites on the waste storage at NFSS. This is particularly important given the time frame (perpetual care), hydrological uncertainty, and the potential public health impacts of the wastes at these sites. (p. 45; emphasis added)

D. *"Hot spots" are found at and below the surface at West Lake.*

The EPA's "Proposed Plan" claims that: "Because the radiologically contaminated soils are distributed widely in the landfill waste material, there are no areas that qualify as 'hot spots'." (page 12) Whether or not hot spots at West Lake qualify as "hot spots" under some arcane EPA guidance, the "West Lake Feasibility Study" data do indeed indicate that hot spots – highly radioactive areas -- exist throughout and beyond Areas One and Two of Operable Unit One. Furthermore, those hot wastes will without doubt continue to migrate up, down, and sideways, within and beyond the floodplain --- even if a "cap" were to be

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placed on top --- until they are exhumed. I believe the highly radioactive waste at West Lake should be carefully excavated, containerized, and transported to a licensed U.S. Department of Defense or Energy nuclear-weapons-waste site or to a licensed commercial disposal site --- away from water and away from people. For example, to the site(s) where other MCW wastes are currently being transported.

After studying some of the West Lake soil data in the Remedial Investigation Report (RIR) and The Feasibility Study, a noted Washington University professor of radiochemistry told me that the proper interpretation of the data is that there are indeed hot spots at West Lake.

He noted, for example, that Soil Boring WL-234 has clear multi-positive results for uranium-235 and its daughters at 10 feet deep. No data exist regarding the soil at 20 feet, except for a combination sample of uranium-235/236. (RIR, Tables B-4 and B-11) The chemist questioned whether this lack of data would justify a reevaluation of the local area around the boring hole to determine the depth profile of the radioactive contamination. He wonders what soil samples would indicate if taken at the surface and at 5 feet. (And I wonder about samples from depths even deeper than 20 feet.)

The chemist also noted that additional examples, at Boring Wells WL-209 and WL-210 (RIR, Table B-4), also show coincident positives for U-235 and its daughters at the surface and at 5 feet. For example, he said that protactinium-231, actinium-227, and radium-223 "are found at logically consistent levels ten to a hundred times background. The contaminant levels peaked at the surface, with the next highest values reported at five feet and again at 25 feet. **There is a huge gap in the data**."

I would like to add that no "Site Specific Background" level is given for **uranium-235 and its daughters** in the RIR tables, because they just are not normally detected in soils in the U.S. --- including in U.S. uranium mill tailings piles. That is why the RIR Table B-4 and others identify the background level as "N.E." or "Not Established." The "Site Characterization Summary Report" of August 1997 defines NE as "Not established; all background samples below minimum detectable activity." (Table 4-1 fn. The report was prepared by Engineering Management Support, Inc., for the West Lake OU-1 Respondents Group.)

The Site Specific Background levels for uranium-238 and its daughters are given as between 1.30 picocuries per gram for radium-226 --- and 3.77 for lead-210, in some RIR tables (Mean+2 Std Dev). The natural background level of U-238 and Ra-226 in soil is typically given as one pCi/g; thorium-230 typically ranges from 0.2 to one pCi/g. Most of the uranium on the planet --- 99.27% --- is U-238. Only 0.72 % in nature is U-235. [CRC Handbook of Chemistry and Physics, 82nd Ed.; p. 11-184]. That explains why the rare U-235 and its daughters are not normally detected --- except in tailings or residues from the milling and processing of extremely rich ores, such as the K-65 Belgian Congo residues at West Lake.

1. **Some relevant federal regulations and standards:**

a. Nuclear Regulatory Commission "reference levels": A "reference level" is that level of background radioactivity found in nature --- ***plus five*** picocuries per gram for surface soil samples (the top 15 centimeters, or about six inches); or ***plus fifteen*** picocuries per gram for subsurface soil (any 15-centimeter layer below the surface). Although the NRC's reference level for exposure to **gamma** is **20 microrads per hour**, the agency "aims at exposure rates less than 10 microrads per hour above background levels; background radiation was taken to be 10 microrads per hour also." (NRC's 1982 West Lake report, page 8.) Radioactive wastes within the public domain that exceed those reference levels should be cleaned up, according to standards dictated by the NRC's Branch Technical Position. (46 FR 52061. Oct. 23, 1981)

A downhole gamma reading of "**nearly 2,300,000 counts per minute** was measured at the 3-foot depth of PVC-11," a boring in West Lake's Area 2. (RIR: p. 96, Table 6-9, Figure 6-2) Radiation in nature in the Midwest typically registers at about 10 gamma counts per minute.

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b. Uranium Mill Tailings Radiation Control Act standards: Although West Lake was never a uranium processing facility, it contains wastes and residues generated at a uranium processing plant. **(This situation is the same as the Latty Avenue site in Hazelwood at which nuclear weapons materials were never processed, but were prepared for transport. Latty wastes were trucked to West Lake in 1973 and were illegally dumped there. Latty is currently being remediated by the Corps of Engineers.)** The types and levels of radioactive materials at West Lake pose the same risks as if they were still located at a uranium processing plant --- that is, at the site of their origin, the MCW plant near Downtown. (The same weapons wastes are also currently being remediated at Mallinckrodt Downtown by the Corps.). Relevant UMTRCA standards would limit uranium in groundwater to 230 picocuries per liter; radium in water to 5 pCi/liter; and the radon emission rate to 20 pCi per square meter, per second.

2. Spurious claims of "no problem": Various efforts are made throughout the RIR to try to explain-away elevated readings --- that is, evidence of radiologically impacted materials. For example, one hot area identified by hand-auger borings (instead of drilled borings) was discounted by saying it "appears to be associated with deposition of runoff sediments rather than surface exposure of in-place material." (95, 99)

E. ***Many unanswered questions remain about the monitoring of the West Lake radioactive wastes.***

1. Alleged "false positives": Why are the high levels of radioactivity found in West Lake monitoring samples so often discounted in the reports?

The West Lake reports were prepared by consultants hired by the entities (defendants) that ultimately might be held liable for the cleanup of the West Lake Superfund National Priorities List site --- that is, the corporations that have been designated as the "potentially responsible parties," or PRPs. The U.S. Department of Energy is also one of the PRPs.

The consultants have reported that many of the high levels of radioactive isotopes found at West Lake (such as thorium-230 and radium-226), are merely "false positives," caused by mistakes in sampling or analysis. For example, see the "Groundwater Conditions Report -- West Lake Landfill Areas 1 & 2," prepared by the McLaren/Hart Environmental Engineering Corp., for the West Lake Superfund Site Respondent Group; November 26, 1996. And the "Split Soil and Groundwater Sampling Data Summary Report – West Lake Landfill Areas 1 & 2," also prepared by McLaren/Hart for the PRPs; November 22, 1996.

a. Conflicting groundwater results:

(1) It was explained that detection-limit problems had existed with the groundwater monitoring equipment regarding the thorium-230 data collected by Quanterra Environmental Services of St. Louis, the initial analyzing laboratory, during the November 1995 and February 1996 sampling rounds. ("Groundwater Conditions Report," p. 2-5)

An additional round of groundwater samples was therefore collected in May 1996 to resolve such concerns. But it is curious that when the third round of samples was collected, Deep-Depth Well **D-14** was not included in the retesting. D-14 is a remedial-investigation monitoring well that is located in the eastern part of Radiological Area One, "at the edge of the alluvial valley." ("Groundwater Conditions Report," Figure 2-1) It had been reported to have extremely high levels of radioactive lead-214, bismuth-214, and radium-226 in both filtered and unfiltered samples in November 1995 and February 1996. (Ibid., Table 2-9) To repeat: why was Well D-14 not one of the wells that were retested in the May 1996 sampling round that was specifically designed to resolve Quanterra's quality control issues?

(2) Groundwater samples from three monitoring wells had been found to have levels of gross alpha radioactivity that exceeded the Metropolitan Sewer District's maximum permissible concentration for releasing waste water into the environment. (Ibid., pp. 2-2 and -3; Figure 2-1; and Tables

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2-1 through 2-5). However, samples from those unusually hot wells (S-80, S-88, and 1206) were not collected and analyzed in May 1996, during the Third Sampling Round. S-80 was one of two "background wells" that were designed to indicate "natural groundwater conditions for the geographical area." (Ibid., p. 3-3) Although considered a background well, S-80 was very near the landfill and the alluvial valley. It has since been abandoned.

b. Conflicting soil results:

(1) It was explained that the thorium-230 levels in soil samples Quanterra had collected during the first sampling round (November 1995) appeared to have contained "false positives or to have been reported at levels higher than actually present" due to a laboratory procedural issue. (RIR, p.47) Accu-Labs Research of Golden, Colorado, was contracted by McLaren/Hart to provide analyses of archived split soil samples. When Accu-Labs reported thorium-230 in soil at concentrations even higher than the high Quanterra Lab samples, McLaren/Hart blamed the disparity between the two labs' data on the fact that Quanterra had changed its "sample preparation procedures in late 1995," and that Accu-Labs had not. ("Split Sampling Report," page 6.)

(2) Many of the thorium-230 results from both labs, by the way, are extraordinarily high. It is important to remember that in nature, thorium in soil averages from two-tenths to one picocurie per gram. To repeat: a picocurie (pCi) or one trillionth of a curie, is that amount of a radioactive material that gives off about 2.2 radiation particles and rays per minute.

(a) In Radiological Area One at West Lake, split soil samples of thorium-230 collected at the surface, from Soil Boring **WL-106**, were reported at **9700** picocuries per gram (pCi/g) by Quanterra, and at **57,000** pCi/g by Accu-Labs. (RIR, April 2000, Table B-10)

(b) At ten feet below the surface, field-split samples of thorium-230 collected from boring location **WL-234** were also high --- **57,300** pCi/g, as reported by Quanterra, and **83,000** by Accu-Labs. (McLaren/Hart: "Split Sampling Report," Nov. 1996, Table 2-1; RIR, Table B-10). Both labs also reported high levels of other isotopes from the uranium-238 decay series in WL-234 samples from 10 feet below: radium-226 (3060 and 1800 pCi/gram) and of three other U-238 daughters: lead-214, bismuth-214 and lead-210. (loc.cit.) Quanterra also reported extremely high levels of the rare uranium-235 and its notoriously toxic daughters (protactinium-231, actinium-227, and radium-223) in WL-234 samples, also at 10 feet. (RIR, Table B-11) How did McLaren/Hart decide which high readings were or were not to be discounted as "false positives" or "biased high"?

(c) It is interesting to note that in the earliest radiological survey of West Lake's radioactive wastes, prepared for the NRC by Radiation Management Corp. of Northbrook, Illinois, thorium-230 was also reported high: 178,000 pCi/gram !! (NUREG/CR-2722, published in 1982. Table 4)

2. Why is there never any reported suspicion of false *negative* or "biased low" values?

3. Why were different sampling methods and analyses allowed to be used? Which experts determined which results of which methods were to be discounted as "false positives"?

The two laboratories contracted to study split samples of soil and groundwater at times used different monitoring equipment, sample preparation, and methods of analysis. When high radium-226, lead-214, and bismuth-214 were reported in groundwater monitoring wells and soil borings, McLaren/Hart often discounted the results, claiming one of the groundwater methodologies and a soil-sample preparation procedure had led to "false positives" or "biased high" results. ("Groundwater Conditions," page 3-6; and "Split Sampling," page 6.)

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4. Why were monitoring samples often filtered? If groundwater is being tested, for example, why filter the water sample and thus potentially remove the isotopes for which the technician is testing?

5. Why were the cited Minimum Detectable Activity (MDA) levels of the monitoring equipment so extremely varied, even when using the same instrument to test the same sample for the same isotope?

I believe the following information calls into question the claims of "false positives."

1. Uranium-238 is the predominant uranium isotope found on the planet --- specifically, the natural abundance of uranium-238 is 99.2745%. It decays into a series of daughter and granddaughter (etc.) products, including radium-226. Radium-226 in turn decays into radon-222 which ultimately decays into lead-214, bismuth-214, polonium-210, and other daughters.

(a) Groundwater Deep Well D-14: High levels of lead-214 and bismuth-214 were found in D-14. Lead-214 registered at 71 pCi/L in November 1995, and at 91.8 in February 1996. Bismuth-214 registered at 69.4 in November 1995. ("Groundwater Conditions," Table 2-9)

Faced with those high readings of radium daughters, McLaren/Hart claimed that not enough radium-226 was present to have been able to generate such high levels of lead-214 and bismuth-214. Therefore, they claimed the bismuth data could be ignored because the bismuth was not in "secular equilibrium" with its progenitors [radium and lead]. (Ibid., page 3-6)

However, radium-226 had indeed actually been found at high concentration levels. For example, an unfiltered sample in Deep Well D-14 registered at 69.8 picocuries per liter in November 1995, and a filtered sample registered at 96.7 in February 1996. (Ibid., Table 2-9)

Therefore, when faced with high levels of radium and its daughters, McLaren/Hart rejected the accuracy of the well data **by discounting the entire EPA gamma spectrometry methodology** (EPA Method 901.1) that had detected the high levels.

> **Quoting from "Groundwater Conditions": "The gamma spec results are susceptible to interferences and are not considered reliable by McLaren/Hart. Additionally, the minimum detectable activity for this method are [is] not acceptable for comparing results to MCLs" [maximum contaminant levels].**
>
> **If McLaren/Hart was willing to accept only results using the EPA's isotopic methodology (EPA 903.0), why had the corporation not specified that only EPA 903.0 – and not 901.1 – was to have been used for the split-sample analyses?** ("Groundwater Conditions," page 3-6)

(b) Soil Boring WL-234: According to the "Split Sampling" report, both Quanterra and Accu-Labs reported extremely high levels of radium-226 at 10 feet (3,060 and 1,800 pCi/L), and also of three radium daughters: lead-214, bismuth-214 and lead-210. (Table 2-1) Thorium-230, the progenitor of radium-226, was detected at 57,300 by Quanterra and 83,000 by Accu-Labs. **Please remember that thorium-230 in nature is found at about from 0.2 to one pCi/gram in soil.**

Further information about the thorium-230 issues in soil: McLaren/Hart discounted the high thorium-230 levels detected by Accu-Labs because the laboratory had not made the same changes in its sample preparation procedures that Quanterra had. ("Split Sampling," page 6) The new procedures were supposedly designed to keep possible interferences – such as the potential presence of plutonium and neptunium --- from distorting the analysis of the soil samples. (loc.cit.) How Quanterra could possibly have been worried about the presence of plutonium and neptunium is mystifying. Significant quantities of those two synthetic

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transuranic elements would only have been present at West Lake **if the wastes there had come from a reactor, which they clearly had not !!**

2. Uranium-235 and its daughters are rarely detected in the United States, in soil or water, because the uranium-235 isotope is present in the planet's uranium at only 0.72%. But because the Belgian Congo pitchblende (ore) that was processed at the Mallinckrodt Chemical Works in the late 1940s contained such high levels of uranium (60 to 65% pure, as compared to one percent found in American ore), the rare isotopes of the uranium-235 decay chain that are **not detected in United States' uranium residues** *are* detected in the Belgian Congo residues – such as in those residues that were dumped at the West Lake Landfill in 1973.

Quanterra reported extremely high levels of uranium-235 and its dangerous daughters in West Lake soil samples. For example, from the **WL-234 boring**, at 10 feet: Uranium-235: 774 picocuries per gram; protactinium-231: 1050; actinium-227: 952; and radium-223: 5270. For some unexplained reason, a combination of uranium-235 and -236 yielded only 10.9 pCi/g. ("Split Sampling Report," Table 2-2. The same data are reported in the "Remedial Investigation Report," Table B-11.)

Because uranium-235 and its daughters are not normally detected in the United States, instead of listing "Site Specific Background" levels for uranium-235 and its daughters in many of the West Lake reports, **the tables merely say "NE – Not Established" for those isotopes** (e.g., in the RIR, Table B-11 fn.).

3. The Washington University radiochemist cited above (p. 6), reading through some of the tables in the "Feasibility Study," explained to me that if two isotopes are detected positive by gamma spectrometry, those coincident positives should **not** be discarded (even if a different monitoring methodology has subsequently been deemed preferable). The coincident positives would indicate an absolute positive.

The West Lake reports contain significant monitoring incongruities regarding the quantities and locations of these dangerous materials. Would this fact not justify additional testing of soil and water samples by a team of scientists with no financial stake in the test results?

F. *Other monitoring issues at West Lake:*

1. Who would keep track of the West Lake radioactive wastes in the future --- and over how many generations? How would compliance monitoring be designed --- and for how many decades or centuries?

2. How many monitoring wells would be installed for ground and surface water sampling, and how many soil borings? In what locations at West Lake and its environs? How often would sampling be required? What public agency would be mandated to oversee the monitoring program and to inspect and maintain the monitoring wells? If the Missouri Department of Natural Resources were so designated, what would happen if the Missouri Legislature were to abolish the Department as has at times been threatened?

3, Which federal agency would dictate the effluent or concentration limits for the water and soil?

4. What if contaminants in the soil or water were to exceed the permissible limits? Who would design and carry out a **contingency plan** --- for example, who would provide alternative drinking water? How many cities downstream on the Mississippi River would be included?

5. Which laboratories would be used to analyze the soil and water samples? Who would pay for the sampling and analysis costs --- the State, the EPA, the Potentially Responsible Parties? What if some or all of the PRPs no longer exist, including the U.S. Department of Energy?

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6. Who would pay for the ongoing inspection, maintenance and repair of the two radioactive piles? Who would pay to remediate the rock/rubble/clay caps, if necessary, or --- alternatively --- to exhume and remove the wastes? For example, what actions would be taken when the vegetation that would have established itself on the surface of the cap dies? As the root system disintegrates, the resulting spaces could potentially serve as funnels for the expedited release of radon gas to the atmosphere. Also, would the cap be routinely refurbished as the contents of the piles settle and collapse over time?

7. If the Proposed Plan is approved, no liner would be installed beneath the two radiological areas and no leachate collection and disposal system. How, then, would the surface and subsurface discharges be monitored? At what location or facility would the radioactive leachate be discarded? (The leachate from the Weldon Spring bunker in St. Charles County is trucked all the way across St. Louis County and the City to the Metropolitan Sewer District's Bissell Point sewage treatment plant on East Grand. It is then dumped into the Mississippi River. I have never understood why the Department of Energy did not decide to have the Weldon Spring leachate dumped into the Missouri or Mississippi River near the Weldon Spring site --- upstream from St. Louis --- though I am glad it didn't.)

G. Safe removal of the wastes is possible: ***The excavation, containerization, and transport of the West Lake wastes away from the floodplain can and must be done safely, using state-of-the-art technologies that are safe for the workers, neighboring communities, and the environment.***

Legitimate concerns exist regarding the ability to excavate West Lake's radioactive contaminants safely, without dispersing radioactive dust and gases to nearby residential, industrial, commercial, and agricultural areas. Leaving the wastes in the floodplain to be dispersed over time should not be an option. The best available remediation technologies must be and can be pursued. Decisions about removing radioactive materials as permanently hazardous as those at West Lake must be made on the basis of safety, not cost. Safety for the remediation workers, neighboring residences, and workplaces, and for the environment.

As one example, a temporary pressurized structure could be installed above Operable Unit One that will keep the contaminants isolated during the excavation and containerization of the radioactive wastes. Major federal funding was provided to install and operate several water treatment plants and a Chemical Stabilization and Solidification Plant at Weldon Spring for processing radioactive sludge. Appropriate technologies should also be required to process the West Lake radioactive wastes in order to minimize water contamination and soil runoff and to filter dust and gaseous releases during remediation.

Companies that sell or lease waste remediation enclosures include the following: Environmental Structures Incorporated (www.esidome.com); Universal Fabric Structures (www.ufsinc.com); American Spaceframe Fabricators Intl. (www.asfi.net); Sprung Instant Structures (www.sprung.com); and Signature Structures (www.signaturestructureshome.com). The latter company, for example, advertises that it has "worked with private contractors, generators and on DOE sites. Airborne contaminants, dust control, noise reduction, and odor control are some of the reasons the contractors have chosen to enclose their project's excavation area. Signature's enclosure system can be completed with ventilation and air cleaning units . . . . "

The wastes should be transported to a federally licensed radioactive waste disposal facility.

H. ***Radioactivity cannot be destroyed. It decays only with the passage of time.***

The EPA Proposed Plan's "Alternative Six" is not a perfect solution for West Lake's radioactive wastes -- but it would clearly be better than leaving all the high-level wastes in the floodplain. Alternative Six would call for the "excavation of some accessible portion(s) of the landfill material containing relatively higher concentrations of radiologically contaminated material." (Proposed Plan, p.12)

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The EPA's preferred duck-and-cover "Alternative Four" would be to regrade the waste piles to a 2% slope and then cover them with rock, construction rubble, and clay. This would not provide protection for current or future generations.

The wastes would migrate at the time of flooding and are, in fact, already accessible now to ground- and surface-water and to the air. Adequate funding is essential to provide for the permanent, safe remediation of the site.

The wastes need to be taken away from water. The U.S. Nuclear Regulatory Commission requires that a near-surface radioactive waste disposal site "must minimize to the extent practicable the contact of water with waste." (Code of Federal Regulations, Title 10, Part 61.51.)

The reduction of the volume of water entering West Lake Landfill would of course be key to controlling runoff. However, the total diversion of surface- and ground-water and rain and snow is not possible, of course, nor is the diversion of surface and subsurface floodwaters, Even if the Earth City levee were to be inspected and maintained at an optimal level over the requisite millennia, floodwater could still have access to the waste piles. While the river water would perhaps not go over the levee, it could go under or through it.

Global warming could also have unpredictable impacts on the Missouri River and therefore on West Lake Landfill. Increased drought could result in less water for the dilution of contaminants. Or the river level could rise dramatically. As the ice caps melt and the global temperature increases, there could be a great increase in precipitation, river flow and flooding. And added pressure on the proposed rock and clay caps of the waste piles would help lead to a major dispersal of the wastes into the groundwater and into the river.

The mistakes of the past should not be allowed to contaminate the future.

I believe the Environmental Protection Agency should mandate, instead of its "Proposed Plan," that the West Lake radioactive wastes be dug up, containerized, and removed, using the most sophisticated equipment, technologies and worker protections possible; that the wastes be transported as safely as possible to a licensed nuclear-weapons-waste or other disposal facility; and that this commitment be made now.

P.S. In response to my husband's inquiry about what I was working on at the computer (and all over the house), I said I am concerned that the EPA wants to keep highly radioactive waste in the Missouri River floodplain. Leo's reassuring response: "Don't worry. It won't stay in the floodplain. It will move out !! "

Comments on West Lake Landfill — an addendum.

Additional history about the West Lake wastes follows— evidence that the wastes are high-level, not low-level:

1. The National Research Council's Committee on Remediation of Buried and Tank Wastes issued a report in 1995, entitled "Safety of the High-Level Uranium Ore Residues at the **Niagara Falls Storage Site**, (NFSS) Lewiston, New York." Most of the highest-level uranium residues addressed by the Committee have the same origin as those at West Lake Landfill --- that is, they are residues from the Belgian Congo pitchblende processed at the Mallinckrodt Chemical Works in St. Louis.

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Unlike the K-65 residues at West Lake Landfill, however, the K-65 residues at the Niagara Falls Storage Site, in Lewiston, New York, were not deposited in the floodplain of a gigantic, flood-prone river. The concerns about the possible infiltration of water into the buried residues at Niagara Falls were based on the potential contamination and transport of groundwater as the principal exposure pathway. It seems to me that the threat of cyclic flooding of the Missouri River makes the dispersal of West Lake's K-65 residues highly probable, not just possible.

Some significant and relevant quotes from the Niagara Falls Storage Site report follow:

a. "In about 1942, the Mallinckrodt Chemical Works in St. Louis, MO, began extracting uranium from very rich Belgian Congo ores received form the African Metals Corporation of Belgium (AMCB) for use in the Manhattan Engineering District Project. The residues remaining after uranium extraction (classified as K-65 residues; see Table 1) contain many of the uranium decay products that had been in secular equilibrium with the ^{238}U and ^{235}U [uranium] isotopes." (page 7) [Table 1 on page 8 defines K-65 residues as coming "from processing ore containing **35-60%** U_3O_8 [an oxide form of uranium]." Other non-K-65 uranium ore residues listed in Table 1 range from 3.5 to 10%.]

b. "All of the K-65 residues at the Niagara Falls Storage Site and in Silo 1 [and some in Silo 2] at the Fernald [Cincinnati] Environmental Management Project site were produced at the Mallinckrodt Chemical Works in St. Louis." (page 32)

[Recent information about the St. Louis connection: Some 1,888 truckloads, hauling 3,776 half-inch thick carbon-steel canisters of K-65 residues, "solidified" with flyash and cement, were shipped back through St. Louis from Fernald (from June 2005 – March 2006; ten to fifteen trucks per day) to an interim parking lot in Texas for ultimate disposal in an unknown location. It seems apparent that the only solution we have for radioactive waste is to ship it from place to place, and then back again.]

c. "The continuing high levels of radioactivity of the K-65 residues, the cumulative uncertainties in understanding and predicting local geological and hydrological behavior, the indeterminate nature of future land and water use and future demographics, the unpredictable physicochemical behavior of the residues such as possible complexation with reactants in the soil and colloid or pseudocolloid formation, and the large potential risk to the public, **all argue decisively against leaving the residues at the NFSS permanently** ... . The extraordinarily high concentrations of radium and its daughters, especially of radon, and the presence of substantial concentrations of ^{230}**Th** with a half life of **75,400 years** dictate that a potential for unacceptable radiation exposure will remain for a time far in excess of the 1,600-year half life of ^{226}**Ra**." (p. 39; emphases added.)

d. Regarding barium sulfate --- presumed to comprise the predominant contents of the Latty Avenue/Mallinckrodt residues that were dumped at West Lake:

"During processing of the high grade pitchblende ores [from the Belgian Congo] at the Mallinckrodt Chemical Works, the radium was precipitated as radium sulfate, along with lead sulfate (the ores contained about 6 percent lead) from a nitric acid dissolution of the ore. Barium was added to the solution from which the radium had been precipitated, causing precipitation of **barium sulfate**, which scavenged residual **radium** sulfate from the uranium solution. Uranium was then extracted using diethyl ether. The aqueous raffinate (waste stream) after uranium extraction contained the bulk of the thorium that precipitated. Thus, most of the ^{226}**Radium** and ^{230}**Thorium** in the residues is contained in insoluble sulfate salts. This does not mean, however, that all of the residues are sulfates, nor that the behavior of the radium and thorium in the residues would be those of the pure sulfate salts. [Letter from John Russell of Booz-Allen to J.E.Patterson, U.S. DOE, EM-421, re 'Briefing for the National Academy of Science[s] Panel -- Alternatives for Management of K-65 Residues at the NFSS,' June 28-30, 1994.] The K-65 residues are present with two distinct types of materials. Approximately 73 percent is characterized as 'slimes' (particle size less than 37 micrometers), and the remainder is sand. Most of the ^{226}Ra is in the slimes fraction." [U.S. DOE/EIS-0109F,

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re NFSS. 1986. Table 3.6, p. 3-15.]. (This paragraph is from the Natl. Research Council's NFSS report, p.40; emphases added.)

2. The U.S. Nuclear Regulatory Commission Office of Nuclear Material Safety and Safeguards (ONMSS) published a report in May **1982** entitled "Radiological Survey of the West Lake Landfill, St. Louis County, Missouri" (NUREG/CR-2722), prepared by the Radiation Management Corporation.)

a. "Analyses of soil samples from both areas [at West Lake – that is, Radiological Areas 1 and 2], as well as in situ measurements, show that the contaminants present at West Lake consist of uranium and uranium daughters. Chemical analyses reveal high concentrations of barium and sulfates in the radioactive deposits. These results tend to confirm the reports that this contaminated material is uranium and uranium ore, contained in leached barium sulfate residues, and presumably transferred from the Latty Avenue Site in Hazelwood, Missouri.

"Analysis of soils also shows a high Th-230 to Ra-226 ratio. Since the target criteria for Ra-226 is the most restrictive of those contaminants present, it has been assumed that Ra-226 would be the controlling radionuclide for remedial action determinations. However, since Th-230 levels may be from 5 to 50 times higher than Ra-226 concentrations, this assumption may be erroneous. It is likely that high concentrations of thorium resulted from separation of both uranium and radium from the ores, thus 'depleting' the ores of uranium and radium, or, 'enriching' the residues in thorium. This 'enrichment' would also be evident in the U-235 chain, despite the short half-lives of Th-227 [18.7 days] and Th-231 [1.1 days], since the long-lived Pa-231 [protactinium-231: 32,760 years] would remain in the residues. The concentrations of Pa-231, inferred from Ra-223 determinations [11.4 days], are also shown to be high." (pp. 20-21; emphasis added)

b. "An NRC investigation conducted by Region III in 1976 [IE Inspection Report No. 76-01, June and August] concluded that about 7 tons of U3O8, contained in 8700 tons of leached barium sulfate residues, had been mixed with about 39,000 tons of soil at Latty Avenue and the entire volume disposed of at the West Lake Landfill." (p. 4, emphasis added). [Please note that the soil used to "dilute" the wastes before disposing of them at the landfill came from Latty Avenue and was therefore also most probably contaminated.]

McLaren/Hart's "Overland Gamma Survey Report" of April 1996 also noted that the West Lake radiological areas contained "about 8,700 tons of uranium ore processing residue and 39,000 tons of clean soil." (pg.1-1)

3. The U.S. Nuclear Regulatory Commission's ONMSS then published a summary report in June **1988**, entitled "Radioactive Material in the West Lake Landfill." (NUREG-1308, Rev. 1) It concluded that "remedial action is called for" (p.15) and that if onsite disposal were to be possible at West Lake, the radiological conditions "will likely require moving the material to a carefully designed and constructed 'disposal cell'." (p. 13; emphasis added)

That is, it was suggested that **if** onsite disposal at West Lake were possible, the radioactive wastes would have to be excavated, and an engineered disposal cell would have to be built. Such a cell would have to provide protection from erosion, infiltration, biointrusion, etc., at the top, bottom, and sides, with a leachate collection and removal system. That is, the mobile, highly radioactive K-65 wastes should not just be left at West Lake in ***unlined*** piles with a "cap" of construction rubble, clay, and rocks on top. **They should be excavated, containerized, and transported --- away from water, and away from people.**

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