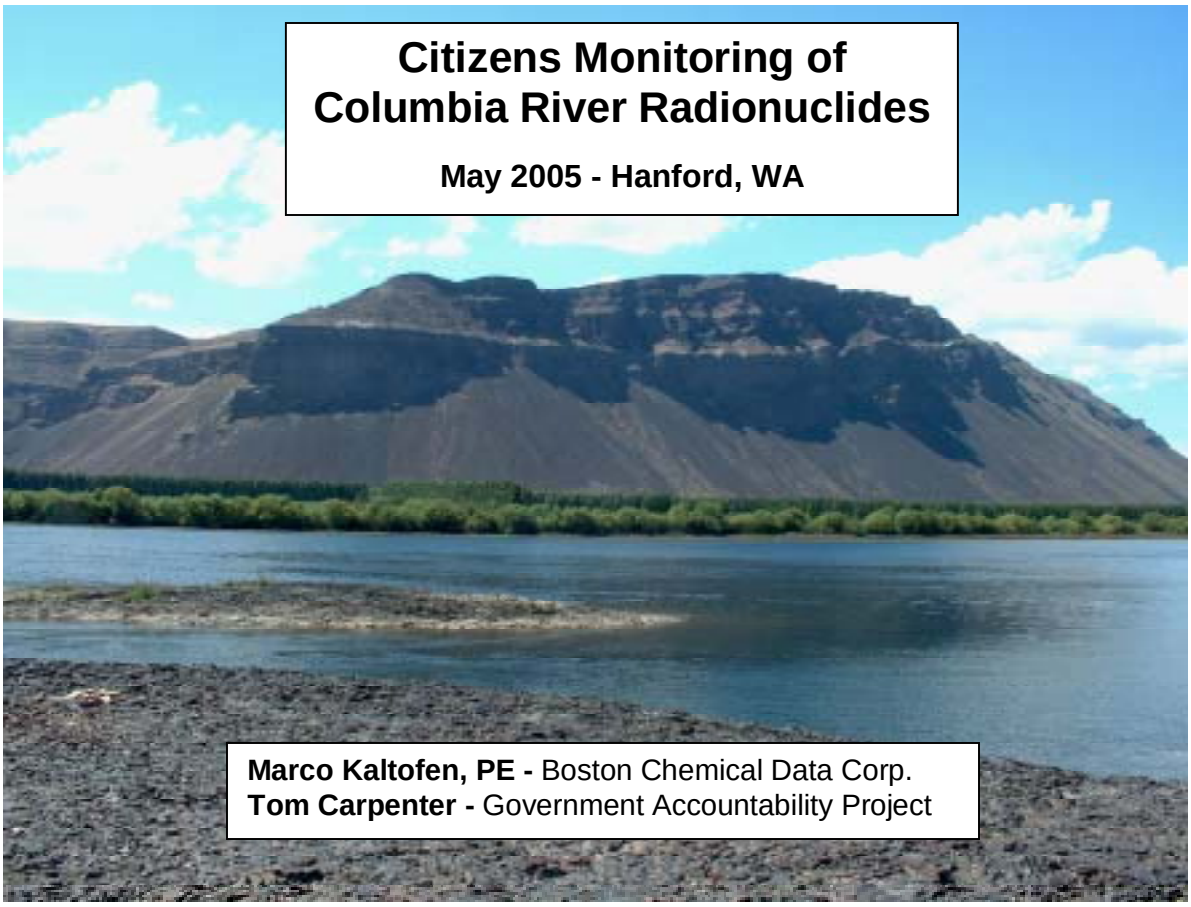

CITIZENS MONITORING AND TECHNICAL ASSESSMENT

ANALYSIS OF CHEMICAL CONTAMINANTS IN HANFORD REACH BIOTA AND ENVIRONMENTAL MATERIALS AT THE PERIMETER OF THE HANFORD NUCLEAR RESERVATION AND ON THE COLUMBIA RIVER.

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Executive Summary

The findings of this report include:

Radionuclide levels were higher in some offsite plant and animal tissues than had been previously reported for the Hanford site. These levels reach unacceptably high concentrations for plants such as mulberries, reinforcing mulberry plant data from past studies.

The size of the offsite area showing increased radionuclide concentrations also appears to be higher than previously reported, apparently including areas which lie upstream of the site on the Columbia River.

Increased levels of plutonium, strontium, mercury and beryllium (nonradioactive metals), uranium, and cesium were detected in both biological and mineral samples. The finding of plutonium in freshwater asian clams in particular requires further study.

Testing done on household attic dusts indicates that these may be an excellent indicator of past exposure to airborne radionuclides from Hanford.

Examples of data supporting these findings include:

Samples of environmental materials collected at the Columbia River/Hanford perimeter generally showed much greater elevations in radionuclide concentrations in biological materials compared to geological materials.

Strontium 90 levels are biomagnifying in plant and in animal materials at the perimeter of the Hanford Nuclear Reservation.

Strontium 90 levels in mulberry leaves in the B/C Area are 875 times higher than levels found near Richland, WA. At this level ingestion of 0.05 ounces per day of similarly-contaminated food would exceed EPA's maximum allowable risk level of 4 mRem per year.

Rodent scats from the B/C Area also showed greater than 13-fold elevated levels of Strontium 90 compared to downstream areas, showing that the material has entered the food chain for higher organisms.

Strontium 90 concentration in mulberry leaves represents a substantial bioconcentration vector for this radioactive material. This currently results in a significant source of increased environmental risk via transfer of groundwater hazards into the biosphere. Curiously this demonstrable plant uptake may also represent a potential remedial method for groundwater cleanup in Mulberry trees' root zone.

Uranium 238 levels were 10-fold elevated in sediments sampled from Area 300 compared to upstream sediments.

Plutonium 239/240 was 20-fold elevated compared to expected levels in lichens in Area 300, raising the potential for airborne plutonium sources in this location. This was also the only location sampled which was directly adjacent to populated areas. Pu238 levels in fresh water clams were routinely detectable at higher levels than in other media, making them an excellent candidate monitoring medium for future citizen testing.

Two locations upstream of the Hanford Reservation showed either elevations of Uranium in plants, or conventional metals in plants. These locations are not subject to wastewater or groundwater releases from Hanford. The increased metals or radionuclide concentrations must have another source such as air transport of Hanford material or an upstream waterborne source.

The upstream reference sample collection area selected on the Columbia River South of the I90 bridge at Vantage, WA produced an aquatic plant sample with elevated U238, U234, and U235 levels. In response an additional reference sample location was added in the Gorge area North (upstream) of the original reference site.

The upstream sampling location at the Wanapaum Dam showed elevated levels of Beryllium and Chromium in the sediment/slime accretions on the gravel bed.

A select number of samples were screened for total radiation. (see ref. 10) Of all samples screened the highest total counts were detected from an attic dust sample from an older home in Richland, WA. The result suggests that radionuclides may have become trapped in historic household dusts outside the Hanford facility, and that this type of sample is likely to allow present-day mapping of Hanford-impacted areas.

Introductory Notes:

Remedial investigations and clean up efforts at the Hanford Nuclear Reservation involve an enormous expenditure of scientific effort, funds, and expertise. As in all efforts to remediate federal facilities, there is a significant effort to involve nongovernmental stakeholders in the review of both data and workplans. The ability to perform independent analyses is an important component of public participation which ultimately improves the quality of stakeholder review, and can build community acceptance for remedial operations. A successful independent analysis may also result in helping to shape future priorities for remedial investigation.

Given the imbalance between resources available to the on-site contractors at Hanford, and those available to nongovernmental organizations, this report is limited in scope, particularly in the use of a focused (nonrandom) sampling plan. Sample density is deliberately higher for locations and samples which may reflect inputs of radionuclides from the Hanford Nuclear Facility, in order to identify potentially impacted locations.

Regardless of scope limitations, it is necessary that data quality not be compromised. New data must have some degree of comparability to existing datasets to maintain their utility. For this report, laboratory testing for radionuclides as well as for conventional chemical pollutants such as mercury and beryllium was performed by Pace Analytical Services, Inc. of Madison, PA.; a certified radiochemical laboratory. Additional conventional pollutants were tested by PASC/Maxxam of Burlington, Ontario, Canada.

Additional quality control and quality assurance information is available to reviewers which detail the calibration and validation procedures used to produce the data included in this report. Importantly, the actual holding times from sample collection to laboratory analysis are contained within this document package for each individual sample.

Finally, on page 19 of this report a reproduced U. S. Army Corps of Engineers graphic shows the various regions which were sampled for this study. The Corps' original graphic directs the reader to conclude that the Columbia River marks the end of the portions of the Hanford Reservation which are not yet cleaned of radionuclide wastes. One purpose of this study has been to determine whether the Columbia River truly represents the point where contamination ends. In reviewing the test results, the data do not show that the river is a barrier or boundary to Handford-related contamination. Instead, the Columbia River is both a sink and a transport mechanism for these wastes.

Section 1 - Introductory Information

Study Objectives:

1) Determine if anthropogenic contaminants, including both radiologically active and inactive substances, can be detected in biota and in other environmental materials within the Hanford Reach, specifically in areas immediately offsite of the Hanford Nuclear Facility.

2) Determine if any subset of these chemical contaminants of concern may be found in specific locations or environmental materials which would result in human exposure.

3) Determine whether resources which are part of the food chain for users and residents of the Hanford Reach including Native American Indian populations are degraded due to the presence of contaminants of concern.

4) Determine whether these detected contaminants are related to operations at the Hanford Nuclear Facility, or to environmental or other anthropogenic sources.

Specific subtasks of the study included:

A) Chromium, measured as hexavalent chromium and as total chromium may be detected in river sediments and in biota, as well as in groundwater and surface waters. Significant detections are defined for this report as concentrations above the analytical lower limit of detection for hexavalent chromium, and as concentrations significantly above those anticipated for uncontaminated environments for total chromium.

B) Strontium 90, Thorium 228, 230 and 232; Uranium 234, 235 and 238; Cesium 137 and 134; Americium 241; Plutonium 238 and 239/240; and Tritium were among the radionuclides detected in biota and environmental materials within the Hanford Reach. Sample test results were compared to previously published and current study reference and background levels.

C) Environmental material and biota chemical quality data which exceed expected values can be used to identify potential vectors for producing excess human health risk from exposure to environmental contaminants.

D) Agents for the Hanford Nuclear Facility use the Vernita Bridge and the Priest Rapids dam as background comparison sites. These may not be sufficiently free from Hanford's influence to be acceptable control sites. (ref. Hanford Annual Summary Monitoring Report Document: PNNL-13487-SUM September 2001)

Selection of Samples and Analytes

Biota and sediments represent both a sink for contaminant chemicals of concern (CCCs), and a reservoir of contaminants which can potentially result in human exposure to CCCs. This study is designed to favor the collection of biota and sediment samples which are most likely to result in human exposure to CCCs.

Samples were not randomly collected, rather they were taken from selected locations where the potential for human exposure was greater. Nonrandom samples are routinely collected in Handford environmental monitoring efforts, such as in DOE's near facility environmental monitoring; which favors samples collected from known or expected effffluent pathways. (PNNL-13910, App. 2) In addition, sample types were selected where the potential for human exposure was greater. For example fin fish which are normally taken for human consumption were favored over other biota.

For this study any contaminant of concern was selected if it been historically detected at environmentally significant levels within the Hanford Reach or it has specific human health significance.

Complete Set of Study Raw Data

Laboratory data provided by PACE, Waltz Mill meets Chapter 5 of the National Environmental Laboratory Accreditation Program standards. The original dataset and copies of the documentation package the original datafiles for this study can be found as pdf and tiff files at:

labs.pro/hanford/columbia1.tif

labs.pro/hanford/columbia2.tif

labs.pro/hanford/columbia3.pdf

labs.pro/hanford/columbia4.tif

labs.pro/hanford/columbia5.tif

labs.pro/hanford/columbia6.tif

The tabulated raw data can be found as an Excel file at:

"labs.pro/hanford/data.xls"

The current draft and final version of this report can be found at:

"labs.pro/hanford/finalreport.pdf"

Study Area

The study area included the Columbia River reaches from Vernita Bridge to Richland, WA; a distance of about 50 river miles. The entire Columbia River flows 1170 miles from Columbia Lake in British Columbia, to the Pacific Ocean. It drains an area of about 240,000 square miles in both the US and Canada, and it has eleven major tributaries.

Samples collected upstream of the Hanford Nuclear facility at the Vernita Bridge are not likely to reflect influences from waste disposal practices at Hanford. The number of samples collected at this upstream location were not sufficient to confidently represent a study of background conditions in the Columbia River. Likewise samples collected at this point would be influenced by the presence of CCCs which originate at points upstream at Hanford. Other published data exist which provide a more statistically significant source of background conditions, and these are noted in this report. The samples collected at Vernita Bridge do serve however, to provide a source of error detection should these data be significantly different from previously published studies.

Additional upstream samples were collected at the I90 Bridge area in Vantage, WA, and further upstream at the Gorge area of the Columbia River.

Sample Types and Description of Methods

Samples collected include sediments as grabs and composites, fish, aquatic plants, mammallian scats and avian guano, surface waters, mulberry leaves, lichens, bedrock samples and dusts. All samples except dusts were solidly frozen prior to overnight shipment to the analytical laboratory. No field separations were performed on any samples.

Mulberry Leaves were collected whole directly from individual plants, and bagged in polyethylene bags. Mulberry leaves were frozen prior to shipment for analyses.

Sediment samples were collected with the use of a stainless steel corer. Surface samples were sampled by using the corer tool repetitively to obtain only the upper two centimeters of sediments. For locations where the rocky, cobbled nature of sediments prevented this type of sample, the corer was used horizontally to obtain the required sample size of at least 250 g. The corer was wiped and rinsed between collections of sediment samples. All sediment samples were collected in 500 ml polyethylene wide mouth jars, labeled, double bagged and frozen prior to shipment in an iced cooler.

Scat samples were collected using a 4 Liter polyethylene bag. After sampling each bag was labeled, double bagged and frozen prior to shipment in an iced cooler.

Squaw fish samples were obtained from the Washington Department of Fish and Wildlife station at Vernita Bridge or collected by rod & reel. These samples generally represent a regional sample set, as most of these fish are captured in the Columbia River reach which runs from the Priest Rapids Dam to the Leslie Grove boat ramp in Richland. Two specific fish were noted by their capture sites. Given the number of river miles to the boat ramp, most of these are in fact actually more likely to come from portions of the river which are further North than the 300 area. Squaw fish samples ranged from 7 to 26 inches in length. Samples were triple bagged in polyethylene bags, labeled, and frozen with dry ice prior to shipment.

A mature sturgeon sample was also collected in the third round of sampling but results were not available as of June 13, 2005.

Fresh water clam samples are mixed whole and shell only samples.

Scat/guano samples are identified as from rodents, coyotes, deer, or birds.

Dust samples are indoor residential dusts, fine fractions only.

Notes on Sample Types and the Extent of the Study Area

As a group the biological samples can provide indications of potential bioaccumulation as well as the possibility for biological transport mechansims of radionuclides within the river basin.

Potential sources of radionuclides other than Hanford operations exist in the Columbia River basin including quarrying near the upstream Vantage, WA sampling site, long distance atmospheric transport of radionuclides from other generators outside of the area, natural sources, and remnants of historic atmospheric testing. Additional samples were collected north of the Vantage, WA site in the second testing round in order to include more information about background conditions.

Natural and Background Radiation Levels

Uranium in its natural form is 99.27 % U-238 and 0.72 % U-235. Common rock types contain 0.5 to 4.7 ppm total uranium. Sediments at West Lake (near the 200 Area) were found to contain 1.2 pCi/g dry wgt. Of U-238. (ref. PNNL data) Typical background Uranium concentration is 0.7 pCi/g (ref. 2)

Thorium 232 is found at up to 20 ppm in common rock types with a crustal average of 10.7 ppm. (1.1 pCi/g)

Radium 226 is found at 0.42 pCi/g in limestones and 1.3 pCi/g in many igneous rocks.

Strontium 90 is a fission product produced from weapons testing and fission reactors with a half-life of 28.78 years. The highest level found by Hanford's engineers is 0.73 pCi/g vs. <0.073 pCi/g median in carp. GAP result = <0.13pCi/g Strontium 90 is chemically similar to calcium.

Plutonium 239 does not have a natural component. It is produced through the neutron bombardment of U-238. It has a half-life of 24,100 years. New Mexico locations reported 239/240Pu concentrations at 0.008 to 0.01 pCi/g (ref. 6)

Photo Below: One of many bedrock outcrop which potentially contribute to natural Uranium species in sediment samples.

Cesium 137 is only found as a fission product produced from weapons testing and fission reactors. It is chemically similar to potassium, with a half-life of 30.17 years.

Natural potassium 40 in soils ranges from 1 to 30 pCi/g.

Background tritium is 0.032 pCi/Kg (NOTE: This is equivalent to 0.000032 pCi/g. 1000 pCi/Kg is equal to 1 pCi/g)

Background Dose

Concentrations (pCi/g) of residual radionuclides in soil that individually will result in an annual total effective dose equivalent of 15 mrem/y to the RME using RESRAD Version 5.7, January 1997, and Parameters in WDOH/320-015. (ref. 1)

Radionuclide	Rural Residential (pCi/g)
Am-241	31.
Cs-137	6.2
Pu-239	34.
Sr-90	4.5
U-234	160.
U-235	26.
U-238	85.

The dose limit for release of a site is 15 mrem/y (0.15 mSv/y) Total Effective Dose Equivalent (TEDE) to a reasonable maximally exposed (RME) individual, from residual radioactivity which is distinguishable from background radiation levels for 1000 years after completion of the cleanup. (ref. 1)

A Note on Units

Results in this study are as much as possible reported as pCi/g by dry weight, meaning picoCuries per gram of dried sample. One Curie is the equivalent radiation to 1 gram of radium. (Thus pure radium has 1 Curie per gram.) Occasionally pCi/Kg, which is picoCuries per Kilogram is used. A pCi/Kg is 1000 times less radioactivity than a pCi/g, and is sometimes used to prevent having more zeroes in a number than is conveniently understandable. Dry weights are used to allow easy correlation between samples of varying water content such as plants and soils.

For water samples, where a milliliter of water weighs exactly 1 gram, the units are pCi/mL which is equal to a pCi/g; and pCi/L which is equal to a pCi/Kg and is 1000 times less radioactivity than a pCi/mL.

Sample Results - Section 2 - As pCi/g dry weight unless noted

Tritium Results

Tritium in pCi/g or pCi/mL	ID	H3
(All values are dry wgt. unless noted)		
River Water @ Richland (pCi/mL)	HR047R	0.167
Mulberry leaves - 300 Area	HR045-300	ND <0.15
Mulberry leaves - 300 Area	HR044-300	0.67
Algae/aquatic plants 300 Area	HR043-300	0.12
Mulberry leaves - 300 Area	HR042-300	2.17
Mulberry leaves-300 Area	HR038-300	1.15
D-Island II Coyote Scat	HR033DB	3.81
Shoreline seep @ D Area (pCi/mL)	HR024D	0.105
Mulberry leaves lrg D	HR022D	ND <0.02
Sediment N downstream	HR019N	0.043
Seep Water @ N Area (pCi/mL)	HR015N	0.0375
Sediment - B/C Area intakes	HR006B/C	0.011
River Water @ I90 Vantage (pCi/mL)	HR001V	0.0726
Water blank (pCi/mL)	water blank	0.121
Solid blank	solid blank	0.107

The downstream river water sample slightly exceeded the upstream and blank samples. As with other radionuclides, the biological sample levels significantly exceeded the geological sample levels. The coyote scat sample contained 346-fold higher levels than the B/C Area sediments.

Among the 300 area mulberry leaves samples, HR042 (N 46 22 34.0 : W 119 16 22.6) was more than 14-fold higher than HR045 (N 46 22 08.6 : W 119 16 14.5).

Minimum and Maximum Study Levels
(in pCi/g Unless Noted)

Strontium 90

Max. 1	Area B/C	Mulberry leaves	10.5	(unc +/- 1.1)
Max. 2	Area B/C	Small animal scats	1.44	(unc +/- 0.29)
Max. 3	Area D	Large animal scats	1.36	
Max. 4	Area N	Sediments	1.08	
Max. 5	Area N	Mulberry leaves	1.01	
Min. 1	Area 300	Aquatic plants	0.011	
Min. 2	Area 300	Mulberry leaves	0.012	
Min. 3	Area N	Upstream sediments	0.034	
Max.	Clams	Area F	0.35	
Min.	Clams	Area H	0.02	
Max.	Scats	Area B/C	1.44	
Min.	Scats	Area 300	0.107	
Max.	Water	Vantage - Col. R.	0.342 in pCi/L	

The value for water above is the same as 0.000342 pCi/mL or pCi/g as wet weight. The literature background value for vegetation is 0.066 pCi/g. (ref. PNNL) A total of 44 samples were collected for Strontium 90 analysis.

Strontium-90 behaves like calcium in the human body and tends to deposit in bone and blood-forming tissue (bone marrow). Thus, strontium-90 is referred to as a "bone seeker" and exposure to it will increase the risk for several diseases including bone cancer, cancer of the soft tissue near the bone, and leukemia. Risks from exposure depend on the concentration on strontium-90 in air, water, and soil. (Ref. USEPA information sheet for Sr 90)

Uranium 238

Max. 1	300 Area	sediment	3.67	(unc +/- 0.82)	
Max. 2	Vantage	algae	1.86		
Max. 3	300 Area	upstream sediment	1.4		
Max. 4	K Area	soil	1.14	3.4 ppm	(ref. 5)
Min. 1	Gorge	algae	0.368		
Min. 2	N Area	downstream sed.	0.386	1.2 ppm	(ref. 5)

PNNL 300/400 Area vegetation average	0.01
PNNL 300/400 Area vegetation maximum	0.57

The maximum animal-related sample U238 concentration of 0.326 pCi/g was for freshwater clams taken from the 300 Area. Aquatic plant levels of U238 were higher than levels reported for terrestial plants, with maximum levels more than 300 % above those reported for the 300/400 area by PNNL. The limited number of terrestial animal scats averaged 0.06 pCi/g, well below the average for freshwater clams and aquatic plants of 0.66 pCi/g. The single bird guano sample was midway between these data points at 0.22 pCi/g, possibly reflecting a diet of aquatic versus terrestial foods.

Literature Background reported for soil U238 is 0.7 pCi/g (ref. 2) and the mean concentration of the [total of the three common forms of] uranium and thorium isotopes in background soils ranged from 44 to 52 mBq/g, equivalent to 1.2 to 1.4 pCi/g. For U 238 1 pCi/g = 3 ppm. (ref. 5)

A total of 33 samples were analyzed for uranium isotopes.

Uranium 235 in pCi/g

Max. 1	Area 300 sediment	0.109	(unc +/- 0.075)
Max. 2	Area 300 outfall sediment	0.108	
Min. 2	Area D deer scats	0.002	
Min. 2	Vantage, WA sediment	0.018	

Uranium 235 has a natural abundance of less than 1 % of Uranium 238, but the relative level of radioactivity in pCi/g among the uranium isotopes will reflect variances in decay rates and the degree of enrichment.

At the most upstream reference site in the Gorge area of the Columbia River, the relative radioactivity of U235 compared to U238 was 9 %, presumeably reflecting wide geographic trends potentially independent of Hanford activities. The maximum abundance of U235 compared to U238 in the study was 56 % in Columbia River surface water at the Richland public water supply intake, which lies downstream of the Hanford site. The values for U238 and U235 were 0.208 +/- 0.13 and 0.117 +/- 0.096 pCi/L respectively, numbers which are close to the detection limits but just above the limits of analytical uncertainty.

Uranium 234 in pCi/g

Max. 1	Area 300 sediment	2.96	(unc +/- 0.69)
Max. 2	Vantage, WA algae	2.27	
Min. 1	Squaw fish	0.014	
Min. 2	Area N sediment	0.497	
Min. 3	Vantage, WA sediment	0.507	

The aquatic vegetation sample from Vantage, WA contained 23-fold greater U234 than the PNNL reported terrestial vegetation average at Areas 300/400.

Thorium 230 in pCi/g

Conversions: For Thorium - 1 pCi/g = 9.1 ppm, 1 pCi = 0.037 Bq (ref. 5)

Max. 1	300 area	sediment	5.59	50.9 mg/Kg	
Min. 1	K Area	soil	1.73	15.7 mg/Kg	
Literature Background		soil	1.1	10.0 mg/Kg	(ref. 2)

Mean concentration of the uranium and thorium isotopes in background soil ranged from 44 to 52 mBq/g, equivalent to 1.2 to 1.4 pCi/g. (ref. 5) Compare to N. Buske 2002 maximum result of 6.0 pCi/g at Hanford Township site.

Plutonium 239/240 in pCi/Kg

Conversions: 1 pCi/g = 1000 pCi/Kg

Max. 1	F Area	whole clams	23	
Max. 2	N Area	sediment	16	
Max. 3	300 Area	lichens	15	
Min. 1	300 Area	sediment	1	
Literature Background		Shellfish	0.012	(ref. 4)
Literature Background		soil	8.0 to 10. pCi/Kg	(ref. 6)

Plutonium 238 in pCi/Kg

Conversions: 1 pCi/g = 1000 pCi/Kg

Max. 1	D Area	clams - shells only	134.
Max. 2	H Area	sediment	133.
Max. 3	F Area	whole clams	75.
Max. 4	H Area	whole clams	69.

Max. 5	N Area	clam shells	68.	
Max. 6	300 Area	lichens	65.	
Min. 1	D Area	mulberry leaves	6.0	
Min. 2	D Area	sediment	7.0	
Literature Background		soil	0.0 to 4.0 pCi/Kg	(ref. 6)

Cesium 134 in pCi/g

Max. 1	300 area outfall plants	0.028 pCi/g
Min. 1	300 area outfall sediment	0.0004 pCi/g

Cesium 137 in pCi/g

max. 1	300 Area sediment	0.532 pCi/g
Max. 2	fish	0.107
Max. 3	300 area outfall plants	0.038 pCi/g
Min. 1	Gorge area aquatic flora	0.026 pCi/g

Helsinki Commission target dose for fish 0.08 pCi/g
Compare to N Buske 2002 maximum two Cs137 results of 0.77 and 0.56 pCi/g at F Area.

Total Metals Results

Beryllium

Max. 1	Wanapaum	rock slime	0.614 ppm
Max. 2	K Area	soil	0.345 ppm
Min. 2	N Area	sed.	0.103 ppm
Min. 1	K Area	water	0.005 ppm - U (ND)

Chromium (Total)

Max. 1	Wanapaum	rock slime	86.0 ppm
Max. 2	K Area	soil	47.4 ppm
Min. 1	K Area	water	0.1 ppm - U (ND)

Copper

Max. 1	K Area	soil	36.7 ppm
Min. 1	K Area	water	0.01 ppm

Mercury

Squaw fish lrg (18 in.)	White Bluffs	HR061SQ	Hg	1,400 ug/Kg
Squaw fish sm & med.	White Bluffs	HR060SQ	Hg	390 ug/Kg
Squaw fish v. lrge (26 in.)	White Bluffs	HR072F	Hg	550 ug/Kg

Mercury concentrations from scientific literature in fish fillets collected in Lake Whatcom and Lake Roosevelt, Washington are shown below. This study found mercury at generally higher concentrations than the data below.

Fish species	**Tissue Type, µg/kg**		**Location, Reference**
walleye	composite	110 - 440	L. Roosevelt, Munn & Short 1997
walleye	individual	110 - 150	L. Roosevelt, 1998 Munn 2000
walleye	composite	160 - 200	Columbia R. Basin, 1996-1998
smallmouth bass	composite	160 - 620	L. Roosevelt, Munn et al., 1995
smallmouth bass	individual	100 - 1,840	L. Whatcom, Serdar et al., 2001
smallmouth bass	composite	380 - 470	Columbia R. Basin, 1996-1998
rainbow trout	individual	110 - 240	L. Roosevelt, Munn et al., 1995
rainbow trout	composite	45 - 150	Columbia River Basin, 1996-1998
perch	individual	120 - 290	L. Whatcom, Serdar et al., 2001
kokanee	individual	100 - 130	L. Whatcom, Serdar et al., 2001
pumpinkinseed	individual	70 -120	L. Whatcom, Serdar et al., 2001
cutthroat trout	individual	60 - 80	L. Whatcom, Serdar et al., 2001
brown bullhead	individual	70 - 440	L. Whatcom, Serdar et al., 2001

Total counts (After Blank subtraction)

Sample type: Biota

N-Springs clamshells	HR067C	Total counts = 0.43 uR / g-hr
N-Springs plant matter	HR018N	Total counts = 0.72 uR / g-hr
N-Springs plant matter	HR018N	b-shielded = ND < 0.15 uR/g-hr
Fish - bony carcass	HR068F	Total counts = 0.26 uR / g-hr
McNarry Clamshells	HR069C	Total counts = 0.06 uR / g-hr

Sample type: Mineral

McNary Rockscum	HR070R	Total counts = 0.75 uR / g-hr
Bedrock Outcrop - basaltic	HR071R	Total counts = 0.04 uR / g-hr

Sample type: House Dust

Seattle reference dust	HR073D	Total counts = 0.25 uR / g-hr
SW USA reference dust	HR075D	Total counts = ND <0.03 uR/g-hr
NE USA reference dusts avg.	HR077-78D	Total counts = 0.38 uR / g-hr
Richland, WA attic dust 1	HR074D	Total counts = 1.61 uR / g-hr
Richland, WA attic dust 1	HR074D	b-shielded = 0.27 uR / g-hr
Richland, WA bulk dust 2	HR076D	Total counts = ND <0.03 uR/g-hr

All total count samples are *blank subtracted*. Sample blank (detector blank) was equivalent to 0.15 uR/g-Hr to 0.25 uR/g-Hr.

Total radiation counts were included as a screening tool to help identify promising analytical candidates. The particular standout was the high level noted in the Richland, WA attic dust sample. GAP/BCD hopes to add data from future samples as more homes are made available for sampling.

The total counts testing on sample HR018N shows little or no gamma detection when the a, b, g detector was beta-shielded. This this is consistent with but not necessarily a Strontium-90 detection. Strontium-90 is prevalent at N-Springs. The beta shield used was a 2.39 mm silver plate.

Comparison of results - By Media

Aquatic Vegetation showed the highest level of U234 (2.27 pCi/g) in aquatic plants at Vantage, WA which is 23 times higher than the average level at the 300/400 area.

Mulberry leaves maximum Sr 90 concentration is 10.5 pCi/g at N-area vs. 0.011 pCi/g found in mulberry leaves at the 300 area, an elevation by > 950 times.

Sediment maximum Pu 238 at H area beach was 0.133 pCi/g vs. the minimum of 0.007 pCi/g found at the D area, 19-fold difference, and a 33-fold difference compared to the high end of the literature background range for soils.

Thorium 230 in sediment at the 300 area reached a maximum of 5.59 pCi/g vs. the literature reported background of 1.1 pCi/g.

Scats maximum Sr 90 concentration is 1.44 pCi/g at the B/C-area vs. a minimum concentration of 0.107 pCi/g found at the 300 area, a 13.4-fold difference.

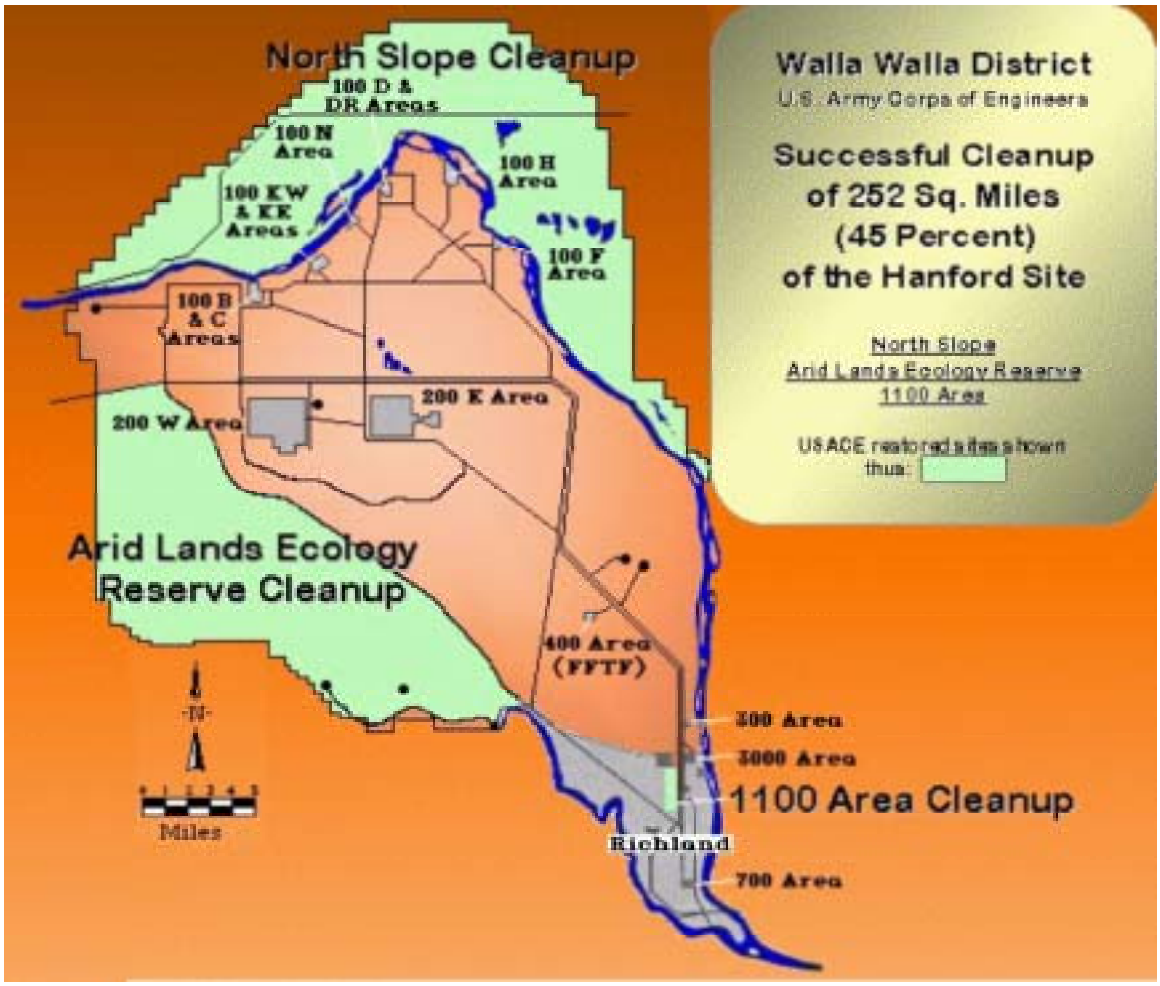
Water maximum Sr 90 is 0.342 pCi/L at Vantage, WA/I90.

Clams (Asian Freshwater) maximum Sr 90 at F Area with 0.35 pCi/g vs. 0.02 pCi/g at H Area, a 17-fold difference and maximum study Pu238 found at D Area for shells only at 0.134 pCi/g. Clams, particularly shells only samples vs. whole samples, generally showed higher Pu levels than other media.

A recent study (reference 8 - N. Buske) found 290 pCi/g of Sr 90 in clam shells from the N Springs area, and 0.86 PCi/g of U in clam shells at the 300 Area compared to those from the Vernita Bridge.

Lichens at 300 area have 0.015 pCi/g Pu239/240, double highest previously found (ref. PNNL) and 20 times above the normal level.

Fish showed up to 0.107 pCi/g of Cesium 137 compared to a Helsinki Commission target level of 0.08 pCi/g. The maximum fish level of mercury was 1.4 mg/Kg found in a squaw fish, which exceeds the USFDA limit of 1 mg/Kg.



Comparison of Results - Highest in Sediment, Water, Biota By Location
(From most upstream to most downstream - Map above by: US Army Corps of Engineers)

	Pu 238	U 234	U238	U238/U235
		(in pCi/g or pCi/L)		
Gorge	0.08Cl	0.783R	0.742 R	11.2
Vantage	0.006 Pl	-	1.86 Pl	22.4
Wanapaum	-	0.827R	0.737 Pl	26.3
B/C Area	-	0.937Sd	0.754Sd	26.0
K Area	0.025Pl	1.37S	1.14S	11.0
N Area	0.068Cl	0.528Sd	0.459Sd	27.0
D Area	0.007Sd	-	-	-

Comparison of Results - Highest in Sediment, Water, Biota By Location

(From most upstream to most downstream - Map above by: US Army Corps of Engineers)

	Pu 238	U 234	U238	U238/U235
	(in pCi/g or pCi/L)			
H Area	0.133Sd	0.68Sd	0.654Sd	13.9
F Area	0.075Cl	-	-	-
300 Area	0.065Pl	2.96Sd	3.67Sd	33.7
Richland	-	0.452W	0.208W	1.78

	Be	Cr	Cu	Cs 137	Sr 90	Tritium
	(ppm or mg/Kg)			(pCi/g or pCi/mL)		
Gorge	-	-	-	0.026 Pl	-	-
Vantage *	ND	ND	4.8Pl	-	0.199Cl	0.07W
Wanapaum	0.61R	86.R	14.R	0.164 Pl	-	-
B/C Area	0.20Sd	36Sd	24.5Sd	-	10.5Pl	0.011Sd
K Area	0.34S	47S	36.6S	-	0.102Cl	-
N Area *	0.25Sd	34S	15.3S	-	1.08Sd	0.038W
D Area *	0.20Sd	24Sd	17.2Sd	-	0.14Ss	3.81Ss
H Area	0.02Cl	ND	9.5Cl	-	0.42Pl	-
F Area	-	-	-	-	0.914Pl	-
300 Area	0.81Sd	36Sd	18.4Sd	0.532Sd	0.337Pl	2.17Pl
Richland *	ND	ND	ND	-	ND	0.167W

Key: Cl - Clams, Sd - Sediment, W - Water, Pl - Plants, Sediment & slime on rock or gravel surfaces - R, Scats - Ss (U238/U235 based on max. U238 sample)

* Note use of pCi/mL for Tritium in water samples on this page.

Review of Fish Data Results

Resident fish are those that live their entire lives in fresh water. Examples of resident fish are crappie, bass, river trout, whitefish and sturgeon. Due to spending more time in the contaminated portions of the Columbia River than anadromous fish, the resident fish collected higher concentrations of radioactivity. Most of the radiation in the fish came from eating smaller aquatic creatures such as algae and insects. The algae could concentrate the radiation up to 100,000 times the levels of contamination in the river water (WA State Dept. of Health, ref. http://www.doh.wa.gov/ hanford/publications/overview/columbia.html#VC2i10)

HR048F Squaw Fish small - medium size composited, n=8

Sr 90	ND < 0.13 pCi/g
Pu 238	0.031 pCi/g
Pu 239/240	0.008 pCi/g
U234	0.014 pCi/g
U238	0.014 pCi/g
U235	0.016 pCi/g

HR060SQ small - medium squaw fish, composited, n=8

Mercury (total)	0.39 mg/Kg
Pu 238	0.015 pCi/g
Pu 239/240	0.009 pCi/g

HR061SQ large squaw fish, n=1 size = 18 inches (approx. 12 years old)
Taken from White Bluffs area

Mercury (total)	1.4 mg/Kg (Exceeds 1.0 mg/Kg FDA limit)
Pu 238	ND
Pu 239/240	ND

HR072F V. large squaw fish

Mercury (total)	0.55 mg/Kg
Cesium 137	0.107 pCi/g
Cesium 134	ND < 0.039 pCi/g
Pu 238	0.005 pCi/g
Pu 239/240	ND < 0.006 pCi/g
Be (total)	ND < 0.20 mg/Kg
Cr (total)	ND < 0.50 mg/Kg
Cu (total)	ND < 1.0 mg/Kg

Identification of at-risk populations and ecosystems

A fish consumption survey which was conducted by the staff of CRITFC and its member tribes. The fish consumption survey was completed in 1994 (CRITFC 1994). The conclusions of the tribal survey were: “The rates of tribal members’ consumption across gender, age groups, persons who live on- vs. off-reservation, fish consumers only, seasons, nursing mothers, fishers, and non-fishers range from 6 to 11 times higher than the national estimate used by USEPA.”(quote from CRITFC, 1994, Page 59)” COLUMBIA RIVER BASIN FISH CONTAMINANT SURVEY 1996-1998 USEPA

For both resident and anadromous species, the major contributors to the hazard indices were PCBs (Aroclors) and mercury. DDT and its structural analogs were also important contributors for some resident species. The chemicals and or chemical classes that contributed the most to cancer risk for most of the resident fish were PCBs (Aroclors and dioxin-like PCBs), chlorinated dioxins and furans, and a limited number of pesticides. For most of the anadromous fish, the chemicals that contributed the most to cancer risk were PCBs (Aroclors and dioxin-like PCBs), chlorinated dioxins and furans, and arsenic.

Other Potential Sources of radionuclides:

Potential sources of radionuclides other than Hanford operations include Quarrying at Vantage, WA., long distance atmospheric transport of radionuclides from other generators outside of the area, natural sources, and remnants of historic atmospheric testing.

To distinguish Hanford emissions from these alternative sources of radionuclides, this report makes use of background locations and comparisons to known ratios of naturally occurring radionuclides, and comparisons to site specific background and reference locations.

In the end the study shows that Hanford-related radionuclide releases are ongoing and are accumulating in the Columbia river; particularly via the food chain.

Sample Sites and Field Test Results

Field tests were performed in order to assist in identifying potential sampling sites, based on potential sudden changes in water quality parameters such as total dissolved solids (TDS as measured electrometrically as conductivity), pH (as measured electrometrically), nitrate nitrogen (as measured by cadmium reduction and nitrite chromophore spectrophotometric method), hexavalent chromium (as measured spectrophotometrically), and iron (as measured colorimetrically). Total radioactivity was measured in ambient conditions throughout the sampling area as part of the site specific health and safety plan but was not recorded.

Site 1: At Vantage - upstream of Wanapum Dam near Interstate 90 Bridge, Coordinates (as degrees, minutes, seconds with decimal fractions by GPS): N 46 56' 01.1" W 119 57' 34.6". See location map below.

Samples collected at this location were presumed to be hydraulically isolated from water and wastes associated with the Hanford Nuclear Reservation. As such these samples provide a portion of the reference values for evaluating samples taken within the Hanford Reach of the Columbia River. Previously published literature references are noted elsewhere in this report as an additional comparative basis.

Field Results

Conductivity:	62.7 mg/L as TDS
pH	8.22 S.U.
Nitrate as N	0.20 mg/L
Chromium(VI):	ND < 0.003 mg/L
Fe(III)	ND <0.05 mg/L

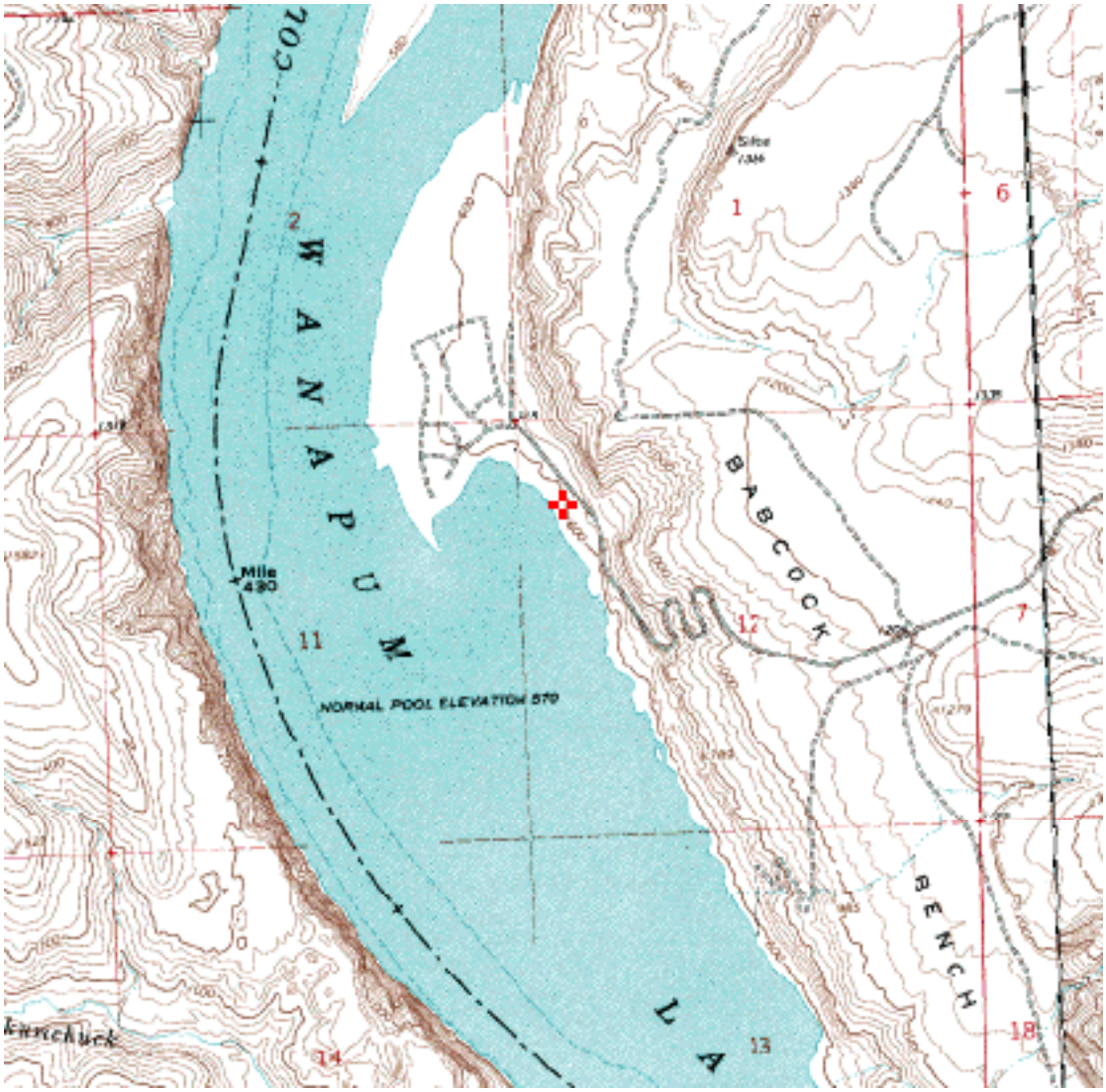
Sample Sites

Site 1) Vantage, WA at I90 Bridge, upstream of Wanapum Dam,
Collected Oct. 7, 2003
N 46 56.017 W 119 57.593

Columbia R. water	HR-001
Columbia River sediment	HR-002
Algae	HR-003A
Clams *	HR-003S

* (Corbicula fluminea)

Based upon the slightly elevated levels at this location, an additional upstream reference location was added at the Gorge area north of I90 at Vantage, Wa. Additional samples HR051 (plant material), HR052B (freshwater clams), and HR053S (sediment coating on rocks) were collected at GPS location: 47 04.173 N, 120 01.532 W. See map below.



Site 2) Downstream of Wanapum Dam, above Priest Rapids Dam.
N 46 48.395 W 119 55.400
Collected Oct. 7, 2003
No detectable total counts elevation for this site or sample.

Sediment	HR-004

Site 3) Downstream of Hanford Reactors B and C intake structure.
N 46 38.238 W 119 39.192
Collected Oct. 7, 2003

Mulberry leaves B/C	HR005B/C
Sediment - B/C intakes	HR006B/C
Aquatic plants - B/C	HR007B/C
Animal Scats - B/C	HR008B/C
Rock scum B/C	HR009B/C

Site 4) K Reactor Area
N 46 39.022 W 119 36.467
Collected October 8, 2003

Soil	HR010K
Mulberry leaves	HR011K
Clam shells	HR012K
Water - K Area	HR021K

Site 5) N Reactor Area
N 46 40.700 W 119 34.073
Collected October 9, 2003

Animal scats N Area	HR013N
Clam shells N Area	HR014N
Seep water N Area	HR015N
Sediment N Area	HR016N
Mulberry leaves - N Area	HR017N
Sediment N (downstream)	HR019N

Site 5B) N Area Sluice
N 46 40.445 W 119 34.358

Sediment N Sluice	HR020N

Photo Below: N Reactor Sampling Area

Site 6) D Area
N 46 41.923 W 119 32.539
Collected Oct. 8, 2003

Mulberry leaves (large) D Area	HR022D
Sediment D Area	HR023D
Shoreline seep - (Groundwater)	HR024D
Clams - shells only - D Area	HR027D
Water @ HR023D - D Area	HR028D

Site 7) H Area
N 46 42.165 W 199 32.482
Collected Oct. 9, 2003

Clams - whole - H Area	HR025H
Mulberry leaves H Area	HR026H
Sediment - H Area shore	HR027H
Shoreline seep H Area	HR028H

Site 8) F Area
N 46 39.603 W 119 26.345
Collected Oct. 9, 2003

Mulberry leaves F upstream	HR029F
Mulberry leaves F- Area - downstream end.	HR030F
Clams - F Area	HR031F
Sediment - F Area	HR032F

Site 6B) D Islands
N 46 42.165 W 119 32.482
Collected Oct. 9, 2003

D-Island II Coyote Scat	HR033DB
D-Island II Deer Scat	HR034DB
Moss D-Island	HR035DI
Bird guano at D-Island	HR036DI

Photo Below: D-Island, taken while collecting scat sample HR034DB

Site 9) 300 Area

Sediment upstr.	HR037-300	
Mulberry leaves-300	HR038-300	N 46 22 59.5" W 119 16 25.6"
Deer Scat -300	HR039-300	
Clams -300	HR040-300	
Lichens - 300	HR041-300	
Mulberry leaves - 300	HR042-300	
Algae/aquatic plants 300	HR043-300	
Mulberry leaves - 300	HR044-300	
Mulberry leaves - 300	HR045-300	
Sediment - 300 area	HR046-300	
Sediment - rcv'd from Tom C.	HR048-300	
Mulberry Leaves - 300	HR049-300	
Biota rcv'd from Tom C.	HR050-300	

Richland Water Intake

Columbia River Water	HR047R
Squaw fish	HR048F

Samples Collected August 4 & 5, 2004

Site 10) Columbia River Gorge N. of I90 Bridge
Alternate reference site
N 47 04.173 W 120 01.532

GORGE upstream of I90 flora	HR051
GORGE upstream of I90 clamshells	HR052B
GORGE upstream of I90 rockscum	HR053S

Site 1) Second sample set
N 46 56.017 W 119 57.593

Vantage Algae	HR054B
Vantage Lichen	HR055L
Vantage Clamshells	HR056C

Site 3) Second sample set
N 46 38.238 W 119 39.192

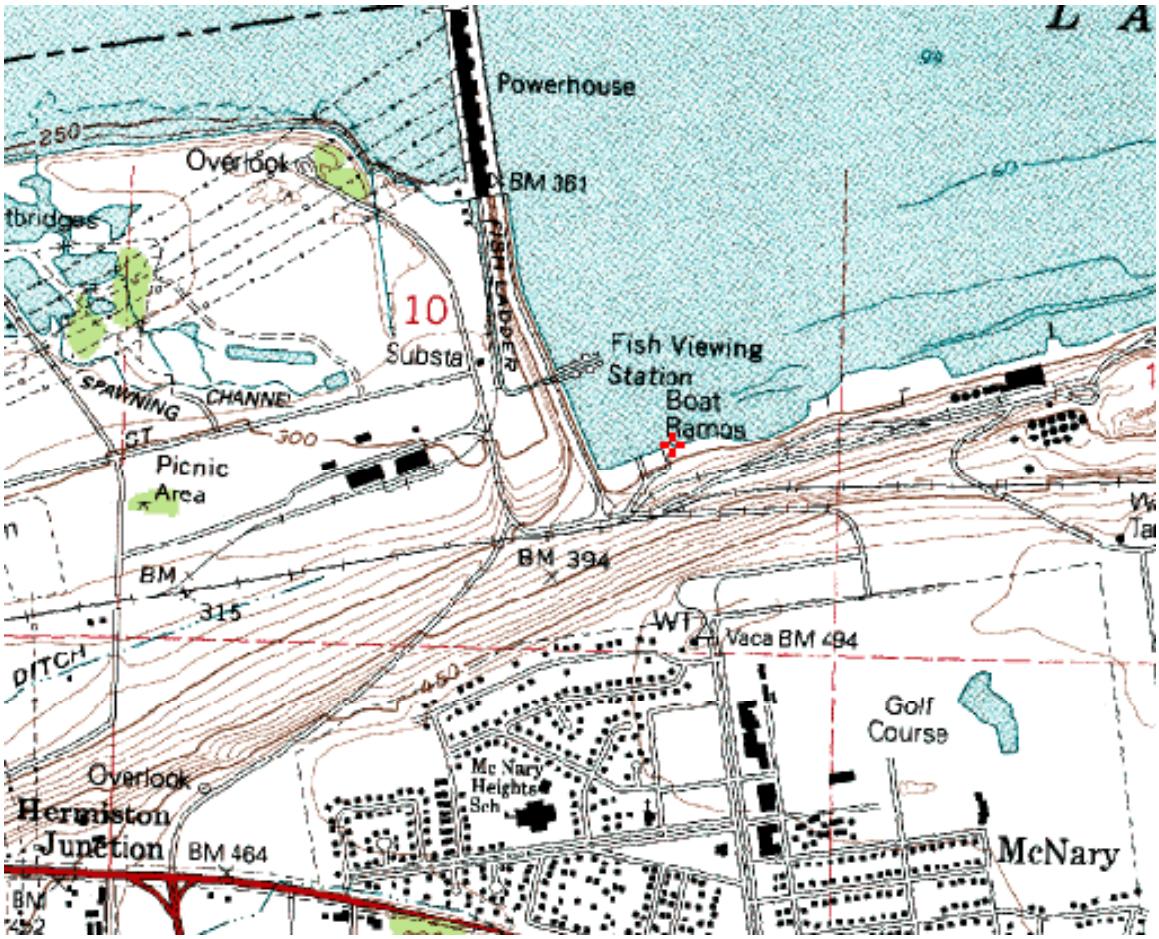
Wanapum Flora	HR057A
Wanapum Rockscum (see HR004W)	HR058R
Vernita landing rockscum	HR059R
Squaw fish sm/med. White Bluffs	HR060SQ
Squaw fish lrg White Bluffs	HR061SQ

Site 9) Second sample set
N 46 21.116 W 119 15.997

300 Area rockscum	HR062R
300 Area outfall sediment	HR063S
300 Area outfall algae	HR064A

Site 11) McNary Dam
N 45 55.624 W 119 17.487

McNarry clamshells	HR065C
McNarry rockscum (see map below)	HR066R



Total Counts Samples

N-Springs clamshells	HR067C
Fish - bony carcass	HR068F
McNarry Clamshells	HR069C
McNarry Rockscum	HR070R

Sample HR071R was collected at Vantage, WA at I90 Bridge, upstream of Wanapum Dam, on Jan. 13, 2005, N 46 54.577 W 119 56.798

Bedrock Outcrop - basaltic	HR071R

Dust samples are fine fractions from indoor residential dusts.

Seattle reference dust	HR073D
Richland site dust	HR074D
Coastal reference site dust	HR075D

All total count samples test results are reported in Section 2.

Additional Fish Sample

One additional squaw fish sample was collected during an unsuccessful attempt to collect a sturgeon specimen. The fish sample was a very large 26" individual, and given the ID of HR072F. This brought the total number of fish collected and tested to 19. Regretfully the species collected were not the optimal target species.

References:

1) WDOH/320-015 Environmental Radiation Program STATE OF WASHINGTON DEPARTMENT OF HEALTH INTERIM REGULATORY GUIDANCE HANFORD GUIDANCE FOR RADIOLOGICAL CLEANUP November 1997 Rev 1.

2) Radiation Information Network's - Radioactivity in Nature, Idaho State University, http://www.physics.isu.edu/radinf/natural.htm,

3) EPA 910-R-02-006 - COLUMBIA RIVER BASIN FISH CONTAMINANT SURVEY, 1996-1998 U.S. Environmental Protection Agency, Region 10 Seattle, Washington 98101

4) Bennet, B.G. (1976). Fallout in 239,240 Pu in Diet. (Report No. HASL-306). Washington, D.C.

5) Health Physics Society - hps.org - Environmental and Background Radiation, General, http://www.hps.org/publicinformation/ate/q1471.html

6) Excerpts from New Mexico State WIPP Operations Manual and the Los Alamos Environmental Monitoring Report for 1999, collected by the Health Physics Society.

7) Hanford Radioactivity in Salmon Spawning Grounds - quality, extent, and some implications, Norm Buske, GAP, August 2002

8) Pashenko, S.E. (ICKC, SSGR), Polesskiy, S.V. and Dublyansky, Y.V. (UIGGM)

9) Radioactive Bioaccumulation in Clams along the Hanford Reach, March 2005, By: Norm Buske, search@igc.org, Produced by The Radioactivist Campaign, www.radioactivist.org

10) Total radiation screening for alpha (>3.5MeV), beta (>35keV), X-ray and gamma (>6 keV)

11) Sergey Pashenko, (pashenko_ecolog@yahoo.com), senior scientist at the Institute for Chemical Kinetics and Combustion for the Siberian Branch of the Russian Academy of Scientists and the public institute "Siberian Scientists for Global Responsibility, personal communications, 10, 2003; 2, 2005; 4, 2005.

Substantial additional assistance in sample collection and study design was provided by Dr. Pashenko during 10, 2003.