## 3.4.4 Process Used to Select Data for Other Media

**The methods we used to select groundwater data are more complex than those used to select sediment, seep, surface water, and external radiation data because the groundwater sampling locations are fixed, are well known, and have provided an abundance of data. In contrast, the sampling locations for the other media are not fixed, often not known, and have provided fewer data. The goal in both cases, however, is to estimate the concentrations of the contaminants for each entire segment for which we have data.**

For the sediment, seeps, and surface water media, sampling locations within a segment cannot be easily pinpointed. Sampling locations tend to be regions rather than distinct locations such as a well. Also, in any one sampling period, few sampling events occur within a segment. Because the sampling does not occur at discrete locations for multiple times, the data do not need to be combined for a sampling location over time before segment values are calculated. The same practice of combining all data into a single data set was also applied to the external radiation data.

### 3.4.4.1 Process the Raw Data for Inconsistencies

The data for all media other than groundwater were processed to remove inconsistencies. Because of the number of programs from which data were used for media other than groundwater, reporting differences produced many inconsistencies. Once again, units were standardized for various contaminants to produce concentrations in micrograms/liter ($\mu$g/L) or micrograms/kilogram ($\mu$g/kg) for non-radiological concentration, and picocuries/liter (pCi/L) or picocuries/kilogram (pCi/kg) for radiological concentrations.

### 3.4.4.2 Identify at Most One Outlier

For each segment, Dixon's test (Barnett and Lewis 1994) was conducted to decide if the largest datum was an outlier. This test was applied to the set of all data over all sampling locations in the segment. As with the groundwater data, the data were log-transformed before this test was applied. The Dixon test used was described in the groundwater processing section above. When the data values were zero or negative, they were not used in testing the data for an outlier. Any data identified as an outlier by the Dixon test received individual attention to determine whether they should be deleted from the data set. This was done through a review of the data plots (see Appendix C in DOE 1997). Table 3.8 shows all data points that were removed from the data set because they were identified as an outlier.

### 3.4.4.3 Compute the Segment Maximum

After removing at most one outlier, the maximum detected concentration was selected as the segment maximum and was used for the deterministic screening assessment calculations.

### 3.4.4.4 Compute Stochastic Parameters

To compute the stochastic parameters, the geometric mean and geometric standard deviation of all measurements for the segment were calculated after outliers for the segment were removed. The geometric mean and geometric standard deviation were calculated as described in Section 3.4.3.2 in the groundwater

**Table 3.8**. Outlier Data Eliminated from the Other Media Data Sets

| Med -ium[(a)] | Segment | Contaminant | Concen- tration | Units | Sample Number | Sample Date | Sample Site Name | Owner ID | East-West Coordinate | North-South Coordinate |
|---|---|---|---|---|---|---|---|---|---|---|
| SD | 1 | Nitrate | 937.5 | µg/kg | CR389 | 22-Sep-94 | Wills Ranch Site | CRCIA | NA | NA |
| SD | 1 | Xylenes (total) | .975 | µg/kg | SESP1_3 | 22-Sep-94 | Priest Rapids Dam | CRCIA | 545436 | 146075 |
| SD | 2 | Chromium | 131000 | µg/kg | B07NF4 | 20-Nov-92 | | HEISPROD | 564535.5 | 145279.2 |
| SD | 2 | Europium-152 | 90 | pCi/kg | B07ND1 | 20-Nov-92 | | HEISPROD | 564635.7 | 145303.4 |
| SD | 2 | Mercury | 110 | µg/kg | B06KS3 | 19-Sep-91 | Seep 039-2 | HEISPROD | 564940 | 145350 |
| SD | 4 | Europium-152 | 320 | pCi/kg | B07NF9 | 21-Nov-92 | | HEISPROD | 568105.9 | 146712.5 |
| SD | 4 | Europium-154 | 200 | pCi/kg | B07NF9 | 21-Nov-92 | | HEISPROD | 568105.9 | 146712.5 |
| SD | 5 | Europium-152 | 125.5 | pCi/kg | B06KT3 | 16-Oct-91 | Seep 074-1 | HEISPROD | 569680 | 148070 |
| SD | 5 | Nickel | 13000 | µg/kg | B06KT8 | 18-Oct-91 | Seep 080-2 | HEISPROD | 570415 | 148780 |
| SD | 8 | Chromium | 122000 | µg/kg | B06KY0 | 26-Sep-91 | Seep 110-2 | HEISPROD | 573597 | 152470 |
| SD | 8 | Mercury | 130 | µg/kg | B06KX5 | 19-Sep-91 | Seep 110-1 | HEISPROD | 573480 | 152375 |
| SD | 9 | Chromium | 107000 | µg/kg | B06L50 | 20-Sep-91 | Seep 144-1 | HEISPROD | 577255 | 153660 |
| SD | 9 | Technetium-99 | 400 | pCi/kg | B06L55 | 25-Sep-91 | Seep 146-1 | HEISPROD | 577330 | 153615 |
| SD | 9 | Uranium-238 | 2000 | pCi/kg | B07NH2 | 23-Nov-92 | | HEISPROD | 574306.1 | 153825.1 |
| SD | 10 | Cobalt-60 | 380 | pCi/kg | B07NC0 | 13-Nov-92 | | HEISPROD | 578263 | 152108.2 |
| SD | 12 | Cesium-137 | 5100 | pCi/kg | 13165 | 13-Nov-92 | H-Slough | WDOH | NA | NA |
| SD | 12 | Cobalt-60 | 400 | pCi/kg | 13165 | 13-Nov-92 | H-Slough | WDOH | NA | NA |
| SD | 14 | Cobalt-60 | 360 | pCi/kg | B07NG9 | 23-Nov-92 | | HEISPROD | 582731.8 | 146871.7 |
| SD | 15 | Cobalt-60 | 250 | pCi/kg | B06LB0 | 28-Sep-91 | Seep 221-1 | HEISPROD | 583132 | 144317 |
| SD | 16 | Zinc | 1086262 | µg/kg | B0CWF1 | 21-Jul-95 | Hanford Slough | SESP | 585610 | 140352 |
| SD | 17 | Europium-152 | 278 | pCi/kg | B0G8W4 | 5-Sep-95 | Hanford Spring 28-2 | SESPMNT | 588305 | 138108 |
| SD | 24 | Phosphate | 3448.276 | µg/kg | SR3 | 17-Sep-94 | Downstream of Strawberry Island | CRCIA | NA | NA |
| SD | 27 | Phosphate | 8000 | µg/kg | CR310 | 15-Oct-94 | Lake Wallula | CRCIA | NA | NA |
| SD | 27 | Xylenes (total) | .8611111 | µg/kg | CR295 | 23-Sep-94 | McNary Dam | CRCIA | 596202 | 67431 |
| SP | 2 | Phosphate | 400 | µg/L | B091M1 | 22-Sep-93 | Seep 037-1 | HEISPROD | 564540 | 145275 |
| SP | 2 | Uranium-238 | 1.4 | pCi/L | B0G8B3 | 28-Aug-95 | 100-B Spring | SESPMNT | 564610 | 145304 |

**Table 3.8**. (Cont'd)

| Med -ium[(a)] | Segment | Contaminant | Concen- tration | Units | Sample Number | Sample Date | Sample Site Name | Owner ID | East-West Coordinate | North-South Coordinate |
|---|---|---|---|---|---|---|---|---|---|---|
| SP | 6 | Cobalt-60 | 91.8 | pCi/L | E122018 | 31-Dec-92 | 100 N Spring 8-13 | SESP | NA | NA |
| SP | 6 | Chromium | 45 | µg/L | B0CSF3 | 26-Sep-94 | 100-N Spring | SESP | 571676 | 150468 |
| SP | 6 | Copper | 30 | µg/L | B0CSF3 | 26-Sep-94 | 100-N Spring | SESP | 571676 | 150468 |
| SP | 6 | Nickel | 25 | µg/L | B0CSF3 | 26-Sep-94 | 100-N Spring | SESP | 571676 | 150468 |
| SP | 6 | Nitrate | 15000 | µg/L | B0CSF3 | 26-Sep-94 | 100-N Spring | SESP | 571676 | 150468 |
| SP | 6 | Sulfate | 26000 | µg/L | B0CSF3 | 26-Sep-94 | 100-N Spring | SESP | 571676 | 150468 |
| SP | 6 | Zinc | 460 | µg/L | B0CSF3 | 26-Sep-94 | 100-N Spring | SESP | 571676 | 150468 |
| SP | 8 | Nickel | 26 | µg/L | B0CSF5 | 22-Aug-94 | 100-D Spring | SESP | 573606 | 152482 |
| SP | 8 | Nitrite | 250 | µg/L | B0BMK5 | 1-Apr-94 | Seep 110-1 | HEISPROD | 573480 | 152375 |
| SP | 8 | Phosphate | 250 | µg/L | B0BMK5 | 1-Apr-94 | Seep 110-1 | HEISPROD | 573480 | 152375 |
| SP | 9 | Copper | 16.2 | µg/L | B091L5 | 20-Sep-93 | Seep 146-1 | SESP | 577330 | 153615 |
| SP | 9 | Phosphate | 400 | µg/L | B091L5 | 20-Sep-93 | Seep 146-1 | HEISPROD | 577330 | 153615 |
| SP | 13 | Copper | 2.7 | µg/L | B091L7 | 28-Sep-93 | Seep 189-1 | SESP | 580508.5 | 148524.2 |
| SP | 15 | Chromium | 32.1 | µg/L | B06L97 | 28-Sep-91 | Seep 221-1 | HEISPROD | 583132 | 144317 |
| SP | 15 | Copper | 5 | µg/L | B06L96 | 28-Sep-91 | Seep 221-1 | HEISPROD | 583132 | 144317 |
| SP | 15 | Nickel | 11.8 | µg/L | B06L97 | 28-Sep-91 | Seep 221-1 | SESP | 583132 | 144317 |
| SP | 15 | Zinc | 79.9 | µg/L | B06L83 | 29-Sep-91 | Seep 216-1 | HEISPROD | 582864 | 145130 |
| SW | 1 | Zinc | 94 | µg/L | 1006-1 | 17-Mar-94 | Vernita-2 | SESP | 559051 | 145897 |
| SW | 2 | Nickel | 130 | µg/L | B06KR4 | 18-Sep-91 | Seep 037-1 | HEISPROD | 564540 | 145275 |
| SW | 2 | Tritium (H-3) | 13000 | pCi/L | B06KR3 | 18-Sep-91 | Seep 037-1 | HEISPROD | 564540 | 145275 |
| SW | 6 | Cobalt-60 | 44.73 | pCi/L | B06KV1 | 15-Oct-91 | N Area | HEISPROD | 571300 | 149920 |
| SW | 6 | Nickel | 16 | µg/L | B09J76 | 25-Aug-94 | N Area | SESP | 571432 | 150755 |
| SW | 9 | Nitrate | 540 | µg/L | B06L43 | 20-Sep-91 | Seep 143-1 | HEISPROD | 577080 | 153770 |
| SW | 9 | Technetium-99 | 3 | pCi/L | B06L43 | 20-Sep-91 | Seep 143-1 | HEISPROD | 577080 | 153770 |
| SW | 9 | Tritium | 400 | pCi/L | B06L48 | 20-Sep-91 | Seep 144-1 | HEISPROD | 577255 | 153660 |

**Table 3.8**. (Cont'd)

| Medium(a) | Segment | Contaminant | Concentration | Units | Sample Number | Sample Date | Sample Site Name | Owner ID | East-West Coordinate | North-South Coordinate |
|---|---|---|---|---|---|---|---|---|---|---|
| SW | 10 | Zinc | 261 | µg/L | B06L59 | 26-Sep-91 | Seep 149-1 | HEISPROD | 577885 | 153160 |
| SW | 13 | Chromium | 58 | µg/L | B09J87 | 25-Aug-94 | 100-F 10 | SESP | 581458 | 148469 |
| SW | 13 | Lead | 1.8 | µg/L | B0G0T5 | 12-Sep-95 | 100--3 | SESP | 581377 | 147994 |
| SW | 15 | Nickel | 5.5 | µg/L | B06L93 | 28-Sep-91 | Seep 218-1 | HEISPROD | 582962 | 144813 |
| SW | 16 | Tritium (H-3) | 270 | pCi/L | B06LJ5 | 2-Oct-91 | Seep 246-1 | HEISPROD | 584986 | 140838 |
| SW | 17 | Ammonia | 70 | µg/L | RM362A | 1-Sep-91 | Hanford Townsite | WHC | | |
| SW | 17 | Strontium-90 | .54 | pCi/L | RM362D | 1-Sep-91 | Hanford Townsite | WHC | | |
| SW | 17 | Sulfate | 97000 | µg/L | RM362B | 1-Sep-91 | Hanford Townsite | WHC | | |
| SW | 17 | Uranium-234 | 1.8 | pCi/L | B0GNP9 | 26-Sep-95 | Hanford Townsite | SESPSPEC | 588305 | 138108 |
| SW | 17 | Uranium-238 | 1.09 | pCi/L | B0GNP9 | 26-Sep-95 | Hanford Townsite | SESPSPEC | 588305 | 138108 |
| SW | 18 | Phosphate | 200 | µg/L | WPPSSN O N290 | 30-Mar-95 | Downstream 91 m | WPPSS | | |
| SW | 20 | Copper | 7.2 | µg/L | BOC2S8 | 23-Jun-94 | 300 Area | HEISPROD | 594585 | 116209 |
| SW | 20 | Cyanide | 40 | µg/L | RM346F | 1-Sep-91 | 300 Area | WHC | | |
| SW | 20 | Mercury | .8 | µg/L | RM346F | 1-Sep-91 | 300 Area | WHC | | |
| SW | 20 | Nitrite | 30 | µg/L | RM346F | 1-Sep-91 | 300 Area | WHC | | |
| SW | 21 | Copper | 250 | µg/L | 5112767 | 9-Oct-90 | City of Richland Intake | City of Richland | 595593 | 109859 |
| SW | 21 | Cyanide | 1.7 | µg/L | B0G144 | 7-Dec-95 | Richland Pumphouse-9 | SESP | 596311 | 109915 |
| SW | 23 | Chromium | 20 | µg/L | 11195186 | 3-Nov-95 | Butterfield Water Treatment Plant | City of Pasco | 607500 | 99660 |
| SW | 23 | Nickel | 30 | µg/L | 11195186 | 3-Nov-95 | Butterfield Water Treatment Plant | City of Pasco | 607500 | 99660 |
| ER | 12 | ER | .813 | mR/d | E117102 | 28-Jun-91 | Lo End Locke Island | SESPMNT | 580220 | 151413 |
| ER | 15 | ER | .919 | mR/d | E117108 | 28-Jun-91 | Hanford Powerline Crossing | SESPMNT | 585632 | 140699 |
| ER | 17 | ER | .893 | mR/d | E117110 | 28-Jun-91 | Savage Island Slough | SESPMNT | 590292 | 137256 |

(a) SD = sediment SW = surface water SP = seeps ER = external radiation process using log probability plotting.  The truncation of the geometric standard deviation was also used for computing the stochastic parameters for media other than groundwater.  The geometric mean and geometric standard deviation define the specific two-parameter lognormal distribution used for the stochastic risk assessment calculations for the segment.

## 3.5  Final Data Sets

**Once the data were selected, they were organized by media into the "media files."  Because data are not available for each of the 23/28 contaminants in each of the 4 media at each of the 27 segments, the CRCIA Team decided to allow substitute data for missing seep and surface water data but considered it inappropriate to use substitute data for missing groundwater or sediment data.  The file containing the selected data in the media files plus the substituted data is the "final data file."  Following extrapolation and surrogation, sufficient data were available to analyze 24 of the 26 detected contaminants in 19 of the 27 segments.  The final data file was the file used in the human health (along with the external radiation media file) and ecological screening risk assessments.**

The concentration input files resulting from the data selection process are called the media files. The media files were derived from the Microsoft Access database of raw files (see Appendix A in Miley et al. 1997).  The media files are provided in Appendix I-B of this screening assessment.  The media files are comma separated files that can be opened and read by Microsoft Excel 5.0.  Plots of the maximum values and geometric means for each segment are also shown in Appendix I-B for each contaminant that was measured in each medium. Plots for Segment 1 indicate the reference levels of contaminants because Segment 1 is upstream of the operating areas.  Two contaminants, diesel oil and kerosene, were never detected in any medium and so were not analyzed in the screening assessment.

### 3.5.1  Extrapolation and Surrogation

Measured data are not available for all media for all contaminants of interest for all segments of the study area.  When a segment/contaminant combination has no measured data for a given medium, that represents a data gap.  A set of rules was adopted by the CRCIA Team to allow some of the data gaps to be filled.  The two types of data substitution are extrapolation and surrogation.  Extrapolation is the filling of data gaps using data from the same medium but from a different location.  Surrogation is the filling of data gaps using data from the same location but from a different medium.  The following rules were applied to fill some of the data gaps:

- groundwater: no substitutions
- sediment: no substitutions
- seep water: use groundwater data as a surrogate where available
- surface water:  if no measured data are available for Segment 1, extrapolate from Segment 2 if available; in Segments 2-27, extrapolate from the nearest upstream segment with measured data

Four possible results of this process are 1) measured data available so no substitution, 2) measured data not available and no substitution data available, 3) measured data not available so groundwater data used as a surrogate for seep data, and 4) measured data not available so data extrapolated from another segment for surface water.

Table 3.9 summarizes the final data availability after the surrogation/extrapolation process. With 4 media (not including external radiation), 28 contaminants of interest, and 27 segments, 3024 data values are possible. In Table 3.9 if a measured value for a contaminant was available in a segment for one of the media, the corresponding cell contains a "+" symbol. Measured data for a contaminant/segment/medium combination were available in 1303 of the 3024 cases.

For the seep medium, if no measured value was available, but a groundwater value was available as a surrogate, then the corresponding cell contains the acronym for groundwater, GW. Groundwater was used as a surrogate for seep water 206 times.

For the surface water medium, if no measured value was available, but an upstream value was available for extrapolation, then the corresponding cell contains the upstream segment number where the data were measured. For example, the "6" in the cell for strontium-90 in surface water in Segment 7 indicates that the surface water concentration from Segment 6 was used in Segment 7. Extrapolation of an upstream surface water concentration was done 362 times.

If no measured data were available and neither surrogation nor extrapolation was used, then the corresponding cell contains a "-" symbol. All cells that contain a "-" represent a gap in the available data. In 1153 occurrences, no data are available for a location, contaminant, and medium combination. The number of data gaps that should be filled with further sampling activity was not calculated. These data gaps should be further investigated to determine which areas would be the most important in improving an assessment of the Columbia River.

The final data file (provided in Appendix I-B) incorporates the substituted data into the data provided in the media files. The final data file was the file used in the human health (along with the external radiation media file) and ecological screening risk assessments.

### 3.5.2 Data Uncertainty

A major source of uncertainty in the data evaluation was the combination of data collected for different purposes, with different detection limits, and different quality levels. Performing a quality assessment for all of the 38,000 data values was not reasonable. Recent (1990 to present) data from reputable sources were used with the assumption that the data quality is suitable for a screening assessment. Since 1990, the Hanford programs have been collecting samples and analyzing data with accepted quality assurance/quality control programs. Much of the data used for this assessment were collected for RCRA and CERCLA programs. In this case, these data were evaluated according to EPA protocols that were appropriate for a screening assessment.

**Table 3.9**. Data Availability after the Surrogation/Extrapolation Process

| Segment | Medium[a] | Ammonia | Benzene | Carbon-14 | Cesium-137 | Chromium | Cobalt-60 | Copper | Cyanide | Diesel Oil | Europium-152 | Europium-154 | Iodine-129 | Kerosene | Lead | Mercury | Neptunium-237 | Nickel | Nitrate | Nitrite | Phosphate | Strontium-90 | Sulfate | Technetium-99 | Tritium (H-3) | Uranium-234 | Uranium-238 | Xylenes (total) | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GW | + | + | + | + | + | + | + | + | - | + | + | - | - | + | + | - | + | + | + | + | + | + | - | + | + | + | + | - |
| | SD | - | + | - | + | + | + | + | - | - | + | + | - | - | + | + | - | + | + | + | + | + | - | - | - | + | + | + | + |
| | SP | GW | GW | GW | GW | GW | GW | GW | GW | - | GW | GW | - | - | GW | GW | - | GW | GW | GW | GW | GW | GW | GW | GW | GW | GW | GW | GW |
| | SW | + | + | - | + | + | + | + | + | - | - | + | + | - | + | + | - | + | + | + | + | + | + | - | + | + | + | + | - |
| 2 | GW | + | + | + | + | + | + | + | + | - | + | + | + | - | + | + | - | + | + | + | + | + | + | - | + | - | + | + | - |
| | SD | - | - | - | + | + | + | + | - | - | + | - | - | - | + | + | - | + | - | - | - | + | - | - | - | + | + | - | + |
| | SP | GW | + | GW | + | + | + | + | GW | - | GW | + | GW | - | + | + | - | + | + | + | + | + | + | + | + | + | + | + | + |
| | SW | + | 1 | - | + | + | + | + | 1 | - | - | + | 1 | - | 1 | 1 | - | + | + | + | + | + | 1 | 1 | + | 1 | 1 | 1 | - |
| 3 | GW | + | + | + | + | + | + | + | + | - | + | + | + | - | + | + | - | + | + | + | + | + | + | - | + | + | + | + | - |
| | SD | - | - | - | + | + | + | + | - | - | + | - | - | - | - | + | - | + | - | - | - | + | - | - | - | - | + | - | + |
| | SP | GW | GW | GW | GW | - | GW | + | GW | - | GW | GW | GW | - | GW | GW | - | + | + | + | + | + | + | GW | + | GW | GW | GW | + |
| | SW | - | 1 | - | 2 | - | 2 | + | 1 | - | - | 2 | 1 | - | 1 | 1 | - | + | + | + | + | + | 1 | 1 | + | 1 | 1 | 1 | - |
| 4 | GW | + | + | + | + | + | + | + | + | - | + | + | + | - | + | + | - | + | + | + | + | + | + | + | + | + | + | + | - |
| | SD | - | - | - | + | + | + | + | - | - | + | + | - | - | + | + | - | + | - | - | - | + | - | - | - | - | + | - | - |
| | SP | GW | + | GW | + | + | + | + | GW | - | GW | - | GW | - | GW | GW | - | + | + | + | - | + | + | - | GW | + | + | + | + |
| | SW | 3 | 1 | - | 2 | 3 | 2 | 3 | 1 | - | - | 2 | 1 | - | 1 | 1 | - | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 3 | 1 | 1 | 1 | 3 |
| 5 | GW | - | + | + | + | - | + | + | - | - | + | - | + | - | - | + | - | + | + | + | + | + | + | + | + | + | + | + | + |
| | SD | - | - | - | + | - | + | + | - | - | + | + | - | - | + | + | - | + | - | - | - | + | - | - | - | - | + | - | - |
| | SP | GW | GW | GW | GW | + | GW | + | GW | - | GW | GW | GW | - | + | + | - | + | + | + | + | + | + | - | + | GW | GW | GW | - |
| | SW | + | 1 | - | 2 | + | 2 | + | 1 | - | - | 2 | 1 | - | 1 | 1 | - | - | + | - | - | - | 1 | - | + | 1 | 1 | 1 | - |
| 6 | GW | + | + | + | * + | + | + | + | + | + | + | + | + | + | - | + | - | + | + | + | - | + | + | - | + | + | + | + | + |
| | SD | - | - | - | + | - | + | + | - | - | + | - | - | - | - | - | - | + | - | - | - | + | - | - | - | - | - | - | + |
| | SP | GW | + | GW | + | + | + | + | GW | GW | GW | + | GW | GW | GW | GW | - | + | + | + | + | + | + | + | + | + | + | + | - |
| | SW | + | + | - | + | + | + | + | 1 | - | - | + | 1 | - | + | 1 | - | + | + | + | + | + | + | - | + | + | + | + | - |
| 7 | GW | + | + | + | + | + | + | + | + | - | + | + | - | - | + | + | - | + | + | + | + | + | + | - | + | + | + | + | - |
| | SD | - | - | - | + | + | + | + | - | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - |
| | SP | GW | GW | GW | GW | - | GW | GW | GW | - | GW | GW | - | - | GW | GW | - | GW | + | GW | GW | GW | GW | GW | GW | GW | GW | GW | GW |
| | SW | 6 | 6 | - | 6 | - | 6 | 6 | 1 | - | - | 6 | 1 | - | 6 | 1 | - | 6 | 1 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| 8 | GW | + | + | + | + | + | + | + | + | - | + | + | + | + | + | + | - | + | + | + | + | + | + | + | + | + | + | + | - |
| | SD | - | - | - | + | + | + | + | - | - | + | + | - | - | + | + | + | - | - | - | - | - | - | - | - | - | + | - | - |
| | SP | GW | + | GW | + | + | + | + | GW | - | GW | + | GW | GW | + | + | - | - | + | + | + | + | + | + | + | + | + | + | + |
| | SW | 6 | - | - | + | - | - | 6 | 1 | - | - | + | 1 | - | 6 | + | - | 6 | + | 6 | 6 | + | 6 | 6 | + | 6 | 6 | + | 6 |
| 9 | GW | + | - | + | + | - | - | + | + | - | - | - | + | - | + | + | - | + | + | + | + | + | + | + | + | + | + | + | + |
| | SD | - | - | - | + | + | - | + | - | - | + | + | - | - | + | + | + | + | - | - | - | + | - | + | - | + | + | - | - |
| | SP | GW | GW | GW | GW | + | GW | + | GW | - | - | - | GW | - | + | - | - | - | + | + | - | - | + | - | + | GW | GW | GW | + |
| | SW | - | 8 | - | 8 | - | 8 | + | 1 | - | - | 8 | 1 | - | 6 | 8 | - | - | - | + | - | - | 6 | + | + | 6 | 6 | 8 | + |
| 10 | GW | + | + | + | + | + | + | + | + | - | + | + | + | - | + | + | - | + | + | + | + | + | + | + | + | + | + | + | + |
| | SD | - | - | - | + | + | - | + | - | - | + | + | - | - | + | + | - | + | - | - | - | + | - | + | - | - | + | - | + |
| | SP | GW | + | GW | + | + | + | + | GW | - | GW | + | GW | - | + | + | - | + | + | + | + | + | + | - | + | + | + | + | - |
| | SW | + | 8 | - | 8 | + | 8 | + | 1 | - | - | 8 | 1 | - | 6 | 8 | - | - | + | + | - | - | 6 | - | + | + | + | 8 | - |

**Table 3.9**. (Cont'd)

| Segment | Medium[a] | Ammonia | Benzene | Carbon-14 | Cesium-137 | Chromium | Cobalt-60 | Copper | Cyanide | Diesel Oil | Europium-152 | Europium-154 | Iodine-129 | Kerosene | Lead | Mercury | Neptunium-237 | Nickel | Nitrate | Nitrite | Phosphate | Strontium-90 | Sulfate | Technetium-99 | Tritium (H-3) | Uranium-234 | Uranium-238 | Xylenes (total) | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | GW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SD | - | - | - | + | + | + | + | - | - | + | + | - | - | + | + | - | + | - | - | - | + | - | - | - | - | + | - | + |
| | SP | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SW | 10 | 8 | - | 8 | 10 | 8 | 10 | 1 | - | - | 8 | 1 | - | 6 | 8 | - | 10 | 10 | 10 | 10 | 10 | 6 | 10 | 10 | 10 | 10 | 8 | 10 |
| 12 | GW | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | + | - | + | - | - | + | + |
| | SD | - | + | - | + | + | + | + | - | - | + | + | - | - | + | + | - | + | + | + | + | + | - | - | - | + | + | + | + |
| | SP | - | GW | - | GW | GW | GW | GW | - | - | - | - | - | - | - | - | - | GW | GW | GW | GW | - | GW | GW | GW | - | - | GW | GW |
| | SW | 10 | 8 | - | 8 | 10 | 8 | 10 | 1 | - | - | 8 | 1 | - | 6 | 8 | - | 10 | 10 | 10 | 10 | 10 | 6 | 10 | 10 | 10 | 10 | 8 | 10 |
| 13 | GW | + | - | + | - | - | + | + | - | - | + | + | - | - | - | + | - | - | + | + | - | + | + | - | + | + | - | + | + |
| | SD | - | - | - | + | - | + | + | - | - | + | - | - | - | - | - | - | + | - | - | - | + | - | - | - | + | + | - | + |
| | SP | GW | GW | GW | GW | + | GW | + | GW | - | GW | GW | GW | - | + | + | - | + | + | + | + | + | + | GW | + | GW | GW | GW | + |
| | SW | + | + | - | 8 | - | 8 | + | 1 | - | - | 8 | 1 | - | - | 8 | - | - | + | + | - | + | + | 10 | + | + | - | + | - |
| 14 | GW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SD | - | - | - | - | - | + | + | - | - | + | + | - | - | + | + | - | - | + | + | - | + | - | - | - | + | - | + | + |
| | SP | - | + | - | + | + | + | + | - | - | - | + | - | - | + | + | - | + | + | + | + | + | + | + | + | + | + | + | + |
| | SW | + | 13 | - | 8 | + | 8 | + | 1 | - | - | 8 | 1 | - | 13 | 8 | - | + | + | + | + | + | 13 | 10 | + | 13 | 13 | 13 | + |
| 15 | GW | - | + | - | + | + | + | + | - | - | - | + | - | - | + | - | - | - | + | + | - | - | + | - | + | - | - | + | + |
| | SD | - | - | - | + | + | + | + | - | - | + | + | - | - | + | + | - | - | - | - | - | + | - | - | - | - | - | - | - |
| | SP | - | GW | - | GW | - | GW | + | - | - | - | GW | - | - | GW | - | - | + | + | + | - | + | + | GW | + | - | - | GW | + |
| | SW | + | 13 | - | 8 | + | 8 | + | 1 | - | - | 8 | 1 | - | 13 | 8 | - | + | + | + | + | + | 13 | 10 | + | 13 | 13 | 13 | + |
| 16 | GW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SD | - | + | - | + | + | + | + | - | - | + | + | - | - | + | + | - | + | + | + | + | + | - | - | - | + | + | + | + |
| | SP | - | - | - | - | + | - | + | - | - | - | - | - | - | - | - | - | + | - | + | - | + | + | - | + | - | - | - | + |
| | SW | + | 13 | - | 8 | + | 8 | + | 1 | - | - | 8 | 1 | - | 13 | 8 | - | + | + | + | + | + | 13 | 10 | + | 13 | 13 | 13 | + |
| 17 | GW | - | + | - | + | + | + | + | - | - | - | + | + | - | + | - | - | + | + | + | + | - | + | + | + | - | - | + | + |
| | SD | - | + | - | + | + | + | + | - | - | + | + | - | - | + | + | - | + | + | + | + | + | - | - | - | + | + | + | + |
| | SP | - | + | - | + | + | + | + | - | - | - | + | + | - | GW | - | - | + | - | + | + | + | + | + | + | + | + | + | + |
| | SW | + | + | - | + | + | + | + | + | - | - | + | 1 | - | + | - | - | + | - | + | + | - | + | + | - | + | + | + | + |
| 18 | GW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SD | - | + | - | + | + | - | + | - | - | - | + | - | - | + | + | - | + | + | + | + | + | - | - | - | + | + | + | + |
| | SP | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SW | + | 17 | - | + | + | + | + | 17 | - | - | 17 | 1 | - | + | + | - | + | - | 17 | + | 17 | + | 17 | - | 17 | 17 | 17 | + |

**Table 3.9**. (Cont'd)

| Segment | Medium(a) | Ammonia | Benzene | Carbon-14 | Cesium-137 | Chromium | Cobalt-60 | Copper | Cyanide | Diesel Oil | Europium-152 | Europium-154 | Iodine-129 | Kerosene | Lead | Mercury | Neptunium-237 | Nickel | Nitrate | Nitrite | Phosphate | Strontium-90 | Sulfate | Technetium-99 | Tritium (H-3) | Uranium-234 | Uranium-238 | Xylenes (total) | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19 | GW | + | + | - | + | + | + | + | + | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| | SD | - | + | - | + | - | + | + | - | - | + | + | - | - | + | + | - | + | + | - | + | + | - | - | - | - | + | - | - |
| | SP | GW | GW | - | GW | GW | GW | GW | GW | - | GW | GW | GW | GW | GW | GW | - | GW | GW | GW | GW | GW | GW | GW | GW | GW | GW | GW | GW |
| | SW | + | + | - | 18 | + | 18 | + | 17 | - | + | + | 1 | - | + | + | - | + | 18 | 17 | + | + | 18 | + | + | 17 | + | + | + |
| 20 | GW | + | + | - | + | + | + | + | + | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| | SD | - | + | - | + | + | + | + | - | - | + | + | - | - | + | + | - | + | + | - | + | + | - | + | - | + | + | + | + |
| | SP | GW | - | - | + | - | - | + | GW | - | GW | + | + | GW | GW | GW | - | + | + | - | + | + | - | + | + | - | + | - | - |
| | SW | + | - | - | + | + | + | + | + | - | + | + | 1 | - | + | + | - | + | + | - | + | + | + | + | + | + | + | + | + |
| 21 | GW | + | + | - | + | + | + | + | + | - | + | + | + | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| | SD | - | + | - | + | + | + | + | - | - | + | + | - | - | + | - | - | + | - | + | + | + | - | - | - | + | + | + | + |
| | SP | GW | GW | - | GW | GW | GW | GW | GW | - | GW | GW | GW | - | GW | GW | - | GW | GW | GW | GW | GW | GW | GW | GW | GW | GW | GW | GW |
| | SW | 20 | - | - | + | - | - | + | + | - | 20 | + | + | - | + | + | - | - | + | - | + | + | - | + | + | - | + | - | - |
| 22 | GW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SD | - | + | - | + | + | + | + | - | - | + | + | - | - | + | + | - | + | + | + | + | + | - | - | - | + | + | + | + |
| | SP | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SW | 20 | 21 | - | 21 | 21 | 21 | 21 | 21 | - | 20 | 21 | 21 | - | 21 | 21 | - | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| 23 | GW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SD | - | + | - | + | + | + | + | - | - | + | + | - | - | + | + | - | + | + | + | + | + | - | - | - | + | + | + | + |
| | SP | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SW | 20 | 21 | - | 21 | + | 21 | + | + | - | 20 | 21 | 21 | - | + | + | - | + | + | + | 21 | 21 | + | 21 | 21 | 21 | 21 | 21 | + |
| 24 | GW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SD | - | + | - | + | + | + | + | - | - | + | + | - | - | + | + | - | + | + | + | + | + | - | - | - | + | + | + | + |
| | SP | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SW | 20 | 21 | - | 21 | 23 | 21 | 23 | 23 | - | 20 | 21 | 21 | - | 23 | 23 | - | 23 | 23 | 23 | 21 | 21 | 23 | 21 | 21 | 21 | 21 | 21 | 23 |
| 25 | GW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SD | - | + | - | + | + | + | - | - | - | - | + | - | - | + | + | - | - | - | + | + | - | - | - | - | + | + | + | + |
| | SP | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SW | 20 | 21 | - | 21 | 23 | 21 | 23 | 23 | - | 20 | 21 | 21 | - | 23 | 23 | - | 23 | 23 | 23 | 21 | 21 | 23 | 21 | 21 | 21 | 21 | 21 | 23 |
| 26 | GW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SD | - | + | - | + | + | + | + | - | - | - | + | - | - | + | + | - | + | + | + | + | + | - | - | - | + | + | + | + |
| | SP | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SW | 20 | 21 | - | 21 | 23 | 21 | 23 | 23 | - | 20 | 21 | 21 | - | 23 | 23 | - | 23 | 23 | 23 | 21 | 21 | 23 | 21 | 21 | 21 | 21 | 21 | 23 |
| 27 | GW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SD | - | + | - | + | + | + | + | - | - | + | + | - | - | + | + | - | + | + | + | + | + | - | - | - | + | + | + | + |
| | SP | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | SW | 20 | 21 | - | 21 | 23 | 21 | 23 | 23 | - | 20 | 21 | 21 | - | 23 | 23 | - | 23 | 23 | 23 | 21 | 21 | 23 | 21 | + | 21 | 21 | 21 | 23 |

(a) GW = Groundwater
SD = Sediment
SP = Seeps
SW = Surface Water
\+ = Measured data were available for this contaminant in this segment.
\- = No measured data were available and no substitution was made.
GW in contaminant column = Groundwater data were used as a surrogate for seep water for this contaminant in this segment.
\# = A number indicates the segment from which surface water data were extrapolated to this segment.

The assumption of lognormality for all data sets introduces uncertainty into the data evaluation. Lognormality was assumed for all data sets to simplify the data evaluation process. Although environmental data are commonly assumed to be lognormally distributed, this may not be the actual underlying distribution. Also, in many cases data sets were too small to determine their underlying distribution. Approximately 38,000 data points were in 4000 data sets, or on average, just under 10 data values per data set.

Another contributor to the uncertainty in the actual media concentrations is sampling bias. Sampling activities at the Hanford Site were generally focused on characterizing contaminated sites. Thus, the available data for this assessment tend to be biased because they were collected near areas of known sources of contamination.

The data extrapolation/surrogation process was another source of uncertainty. The CRCIA Team agreed to this process to maximize the amount of available data for the human health and ecological risk assessments. The extrapolation and surrogation process would tend to make the assessment more conservative because the consensus was that the concentrations used were higher than would be measured in the media. Segments where extrapolated and surrogated data were used should be examined further in determining areas to study for later assessments.

### 3.5.3 Comparison to Other Data

The media data for the screening assessment were compared with the results of special studies done by the Environmental Restoration Contractor (ERC) on chromium and, as an aside, nitrate at the 100-D and 100-H Areas and by WHC on N Springs. The CRCIA Team decided to compare the assessment results with these special studies because the studies were a unique data set for very localized regions of the Columbia River.

Table 3.10 presents the ERC data comparison. Both the drive point (aquifer sample tube) and pore water data (shaded in the table) are compared with the groundwater, seep, and surface water media data. In Segment 7, the ERC sampling identified a localized area of high chromium concentration. This segment had only one groundwater well, and it is not located near the area of high concentration. Therefore, the ERC maxima are an order of magnitude higher than the media maxima in Segment 7. On a geometric mean basis, the data values represent the expected pattern with pore water concentrations lower than seep concentrations but higher than surface water concentrations. The data for Segments 8 and 10 show the expected pattern for both the maximum and mean concentrations.

Table 3.11 compares the data resulting from the special study of the shallow wells at N Springs in Segment 6 with the groundwater, seep, and surface water data for that segment. Only tritium (hydrogen-3) and strontium-90 data are available for N Springs. The maximum values for tritium (hydrogen-3) show the pattern that is expected with N Springs concentrations being higher than surface water and seeps but lower than groundwater. On a geometric mean basis, the pattern is maintained except that the seep concentration is very high, implying that the screening assessment is conservative for tritium (hydrogen-3) in the 100-N Area. For strontium-90, the maximum value in the N Springs is lower than expected, but the geometric mean is slightly higher.

**Table 3.10**.  Comparison of Media Data to Drive Point and Pore Water Data

| | | Maximum Values ( µg/L) | | | | |
|---|---|---|---|---|---|---|
| Contaminant | Segment | Ground-water | Drive Point Data | Seep Data | Pore Water Data | Surface Water Data |
| Chromium | 7 | 50.6 | 869.0 | 28.0 | 632.0 | 7.8 |
| | 8 | 538.0 | 172.0 | 400.0 | 84.7 | 9.0 |
| | 10 | 1300.0 | NA | 84.0 | 130.0 | ND |
| Nitrate | 7 | 46924.1 | NA | 1300.0 | 6670.0 | 300.0 |
| | 8 | 201419.4 | NA | 46000.0 | 2600.0 | 120.0 |
| | | Geometric Mean (µg/L) | | | | |
| Contaminant | Segment | Ground-water | Drive Point Data | Seep Data | Pore Water Data | Surface Water Data |
| Chromium | 7 | 46.4 | 84.2 | 3.5 | 2.4 | 1.5 |
| | 8 | 46.8 | 3.4 | 20.4 | 0.9 | 1.8 |
| | 10 | 50.1 | NA | 35.7 | 1.7 | ND |
| Nitrate | 7 | 30766.26 | NA | 237.8 | 260.0 | 71.0 |
| | 8 | 14830.3202 | NA | 631.3 | 110.0 | 51.5 |

**Table 3.11**.  Comparison of Media Data to N Springs Data

| | | Maximum (pCi/L) | | | | Geometric Mean (pCi/L) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Contaminant | Segment | Ground-water | N Springs | Seep Data | Surface Water Data | Ground-water | N Springs | Seep Data | Surface Water Data |
| Tritium (Hydrogen-3) | 6 | 104000.0 | 65000.0 | 30800.0 | 800.0 | 4955.4 | 492.2 | 13805.9 | 58.0 |
| Strontium-90 | 6 | 19100.0 | 1380.0 | 10900.0 | 65.1 | 11.7 | 31.2 | 5.9 | 0.1 |