S

DOCUMENT RELEASE FORM

(1) Document Number:	RPP-49066	**(2) Revision Number:** 0	**(3) Effective Date:** 03/01/201
(4) Document Type:	☐ Digital Image ☐ Hard copy ☒ PDF ☐ Video	**(a) Number of pages (including the DRF) or number of digital images**	68
(5) Release Type	☒ New ☐ Cancel	☐ Page Change	☐ Complete Revision
(6) Document Title:	Meeting Minutes for the WMA C PA Numerical Codes and Models Working Session		
(7) Change/Release Description:	Initial release		
(8) Change Justification:	N/A		

(9) Associated Structure, System, and Component (SSC) and Building Number:	**(a) Structure Location:** N/A	**(c) Building Number:** N/A	**(e) Project Number:** N/A
	(b) System Designator: N/A	**(d) Equipment ID Number (EIN):** N/A	

(10) Impacted Documents:	**(a) Document Type**	**(b) Document Number**	**(c) Document Revision**
	N/A	N/A	N/A

(11) Approvals:

(a) Author (Print/Sign): M. P. Connelly M. P. Connelly **Date:** 03/01/201

(b) Reviewer (Optional, Print/Sign):

K. J. Dunbar **Date:** 03/01/201

Date:

Date:

Date:

Date:

Date:

(c) Responsible Manager (Print/Sign): S. J. Eberlein **Date:** 03/01/201

(12) Distribution:

(a) Name	(b) MSIN	(a) Name	(b) MSIN
R. Gerhart	B1-46	E. A. Rochette	H0-57
M. P. Bergeron	E6-31	L. A. Fort	E6-31
M. P. Connelly	E6-31		
S. J. Eberlein	E6-31		
C. J. Kemp	H6-60		
R. W. Lober	H6-60		
J. J. Lyon	H0-57		

Release Stamp

MAR 08 2011
DATE:
STA: 15
HANFORD RELEASE
ID: 65

(13) Clearance	**(a) Cleared for Public Release**	**(b) Restricted Information?**	**(c) Restriction Type:**
	☒ Yes ☐ No	☐ Yes ☒ No	

(14) Clearance Review (Print/Sign): NANCY A FOUAD / Nancy A Fouad **Date:** 3/8/2011

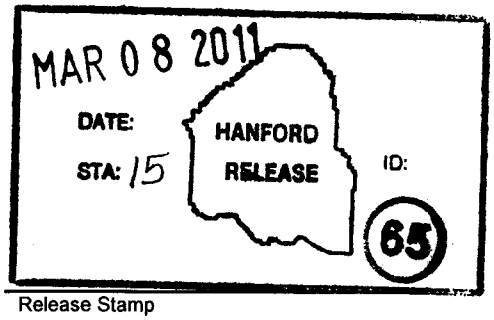
Meeting Minutes for the WMA C PA Numerical Codes and Models Working Session

M. P. Connelly
Washington River Protection Solutions, LLC
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-08RV14800

EDT/ECN: DRF UC:
Cost Center: Charge Code:
B&R Code: Total Pages: 68

Key Words: Waste Management Area C, Performance Assessment, tank closure, waste inventory

Abstract: Summary of meeting between DOE-ORP, Washington Department of Ecology, Environmental Protection Agency, Nuclear Regulator Commission, Native American Tribes, and stakeholders regarding Numerical Codes and Models Working Session for the Waste Management Area C performance assessment. The meeting minutes consist of roster of attendees, summary notes taken at the meeting and content of flip charts used during the meeting. Following the meeting minutes are the latest draft of the Working Session Glossary and accompanying reference list.



Nancy A Fouad 3/8/2011
Release Approval Date

Release Stamp

Approved For Public Release

Meeting Minutes
Waste Management Area C Performance Assessment
Numerical Codes and Models Working Session
held at
Washington State Department of Ecology Offices
3100 Port of Benton Boulevard
Richland, WA 99352
on
January 25 through January 27, 2011

LIST OF TERMS

Abbreviations and Acronyms

CA	Composite Analysis
CEES	Columbia Energy and Environmental Services, Inc.
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (Public Law 111-88, 123 Stat. 2924, 42 USC 9607 et seq.)
CESI	Columbia Environmental Sciences, Inc.
CHPRC	CH2M HILL Plateau Remediation Company
CRESP	Consortium for Risk Evaluation with Stakeholder Participation
DOE	U.S. Department of Energy
DOE-EM	U.S. Department of Energy-Office of Environmental Management
DOE-HQ	U.S. Department of Energy-Headquarters
DOE-ORP	U.S. Department of Energy-Office of River Protection
DOE-RL	U.S. Department of Energy, Richland Operations Office
Ecology	State of Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
FEPs	features, events, and processes
HAB	Hanford Advisory Board
HGI	hydroGEOPHYSICS, Inc.
Initial SST PA	DOE/ORP-2005-01, 2006, *Initial Single-Shell Tank System Performance Assessment for the Hanford Site*, Rev. 0, U.S. Department of Energy Office of River Protection, Richland, Washington.

MSC-PFM	Mission Support Contract – Portfolio Management
NPT-ERWM	Nez Perce Tribe – Environmental Restoration and Waste Management (program)
NRC	U.S. Nuclear Regulatory Commission
PA	performance assessment
PNNL	Pacific Northwest National Laboratory
RCRA	*Resource Conservation and Recovery Act of 1976*, Public Law 94-580, 90 Stat. 2795, 42 USC 901, et seq.
SAIC	Science Applications International Corporation
SGE	Surface Geophysical Exploration
SRNL	Savannah River National Laboratory
SST	single-shell tank
STOMP	Subsurface Transport Over Multiple Phases (code)
TC & WM EIS	Tank Closure and Waste Management Environmental Impact Statement
TPA	Tri-Party Agreement
Tri Party Agreement	*Hanford Federal Facility Agreement and Consent Order – Tri Party Agreement*, 2 vols., as amended, State of Washington Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.
OSU	Oregon State University
WMA	waste management area
WRPS	Washington River Protection Solutions, LLC

Attendees: Representatives from U.S. Department of Energy (DOE)-Office of River Protection (ORP), DOE Richland Operations Office (DOE-RL), DOE-Headquarters (DOE-HQ), the Washington State Department of Ecology (Ecology), the U.S. Nuclear Regulatory Commission (NRC), State of Oregon, and representatives of the Confederated Tribes of the Umatilla, Nez Perce, and Yakama Tribes met at the Ecology offices in Richland, Washington on 25 – 27 January 2011.

Roster of Participants			
Name	**Organization**	**Phone Number**	**E-Mail Address**
Saulnier, George	Areva	(425) 985-7722	George.saulnier@areva.com
Agnew, Steve	CEES	(509) 472-1035	sfagnew@columbia-energy.com
Crumpler, Dwayne	CEES	(509) 946-7111	dcrumpler@columbia-energy.com
Erikson, Bob	CESI	(509) 783-5571	Colnvsci_bob@att.net
Stengle, Ryan	CESI	(509) 783-5571	cesirms@pocketinet.com
Lehman, Linda	CHPRC	(509) 376-1473	Linda_L_Lehman@rl.gov
Mehta, Sunil	CHPRC	(509) 376-7478	Sunil_Mehta@rl.gov
Nichols, Will	CHPRC	(509) 376-4993	William_E_Nichols@rl.gov
Sizda, John	CHPRC	(505) 264-2383	jsizda@intera.com
Wood, Marc	CHPRC	(509) 373-3308	Marcus_I_Wood@rl.gov
Brown, Kevin	CRESP	615-343-0391	kevin.g.brown@vanderbilt.edu
Teimouri, Alex	DOE-EM-51	(509) 376-6222	Alex.teimouri@em.doe.gov
Crandall, Tom	DOE-HQ	(301) 903-7454	thomas.crandall@em.doe.gov
Letourneau, Martin	DOE-HQ	(301) 903-3532	Martin.Letourneau@em.doe.gov
Burandt, Mary E	DOE-ORP	(509) 372-7772	Mary_E_Burandt@orp.doe.gov
Kemp, Chris	DOE-ORP	(509) 373-0649	Christopher_J_Kemp@orp.doe.gov
Lober, Robert	DOE-ORP	(509) 373-7949	Robert_W_Lober@orp.doe.gov
Morse, John	DOE-RL	(509) 376-0057	John.morse@rl.doe.gov
Norton, Joni	DOE-RL	(509) 376-6202	Joanne.norton@rl.doe.gov
Barnes, Mike	Ecology	(509) 372-7927	Miba461@ecy.wa.gov
Caggiano, Joe	Ecology	(509) 372-7915	Jcag461@ecy.wa.gov
Delistraty, Damon	Ecology	(509) 329-3547	Ddel461@ecy.wa.gov
Goswami, Dib	Ecology	(509) 372-7902	Dgos461@ecy.wa.gov
Jackson, Zelma	Ecology	(509) 372-7910	Zjac461@ecy.wa.gov
Jentzen, Brenda	Ecology	(509) 372-7912	Bjen461@ecy.wa.gov
Price, John	Ecology	(509) 372-7921	John.Price@ecy.wa.gov
Whalen, Cheryl	Ecology	(509) 372-7972	cwha461@ecy.wa.gov
Yokel, Jerel	Ecology	(509) 372-7937	Jyok461@ecy.wa.gov

Roster of Participants			
Name	**Organization**	**Phone Number**	**E-Mail Address**
Gerhart, Rebecca	EPA	(206) 553-1094	Gerhart.rebecca@epa.gov
Panesko, Vince	HAB	(509) 946-1229	vince@owt.com
Rucker, Dale	HGI	(920) 647-3315	drucker@hgiworld.com
Kozak, Matt	Intera	(720) 339-5994	mkozak@intera.com
Sigda, Joseph	Intera	(505) 264-2383	jsigda@intera.com
Sully, Michael	Neptune & Co	(505) 662-0707 ext 25	msully@neptuneinc.org
Black, Paul	Neptune & Co	(720) 746-1803	pblack@neptuneinc.org
Tauxe, John	Neptune & Co	(505) 662-2121	jtauxe@neptuneinc.org
Potter, Ross	MSC-PFM	(509) 376-5542	Ross_D_Potter@rl.gov
Bernhard, David	NPT	(208) 507-1914	davidb@nezperce.org
Sobczyk, Stan	NPT-ERWM	(208) 621-3751	stans@nezperce.org
Arlt, Hans	NRC	(301) 415-5845	hda@urc.gov
Lowman, Don	NRC	(301) 415-2026	Donald.Lowman@nrc.gov
McKenney, Chris	NRC	(301) 415-6663	Christopher.mckenney@nrc.gov
Dunning, Dirk	Oregon	(503) 378-3187	Dirk.a.dunning@state.or.us
Stanisich, Nick	Portage Inc.	(406) 660-2836	nstanisich@portageinc.com
Thorne, David	Portage Inc.	(719) 375-0106	davethorne@comcast.net
Hostetler, Charles	SAIC	(509) 372-7700	Hostetler@saic.com
Johnson, Charlotte	SAIC	(301) 353-1868	johnsonch@saic.com
Martin, Todd	Self	(509) 270-2362	Toddmartin@telus.net
Seitz, Roger	SRNL	(803) 725-8269	Roger.seitz@srnl.doe.gov
Wulff, Jim	Tetra Tech	(303) 312-8834	Jim-wulff@tetratech.com
Rustick, Joseph	Vanderbilt University	(518) 929-1127	Joseph.rustick@vanderbilt.edu
Bergeron, Marcel	WRPS	(509) 373-9296	Marcel_P_Bergeron@rl.gov
Connelly, Mike	WRPS	(509) 373-3981	Michael_Connelly@rl.gov
Eberlein, Susan	WRPS	(509) 372-1689	Susan_J_Eberlein@rl.gov
Fort, Les	WRPS	(509) 372-1046	Leslie_A_Fort@rl.gov
Parker, Dan	WRPS	(509) 372-0766	Danny_L_Parker@rl.gov
Quigley, Keith	WRPS	(509) 372-9875	Keith_D_Quigley@rl.gov
Skorska, Maria	WRPS	(509) 373-3978	Maria_B_Skorska@rl.gov
Riggsbee, Wade	Yakama Nation	(509) 945-6756	wriggsbee@yahoo.com

Agenda for Waste Management Area C Performance Assessment – Numerical Codes and Models Working Session January 25–27, 2011	
Jan 25 AM	**Introductions, Goals and Objectives - Numerical Codes and Models, Characterization Updates, Overview of Surface Geophysical Exploration, Previous Independent Evaluation of Initial Single-Shell Tank System Performance Assessment (SST PA)**
8:00 AM	Refreshments
8:15 AM	Introductions (C. Kemp/S. Eberlein/T. Martin)
8:30 AM	Goals and Objectives of Numerical Models and Codes Working Session (S. Eberlein)
8:45 AM	Update on Characterization Efforts in WMA C (M. Connelly)
9:30 AM	Break
9:45 AM	Role of Surface Geophysical Exploration in Tank Farm Characterization (D. Rucker, HGI)
10:45 AM	Independent Evaluation of Initial SST PA Results (Jim Wulff, Tetra Tech)
11:30 AM	Lunch
Jan 25 PM	**Updates from Previous Sessions and Review of Alternative Modeling Approaches**
12:45 PM	Updates on Alternative Leak Volumes and Soil Inventory Estimates (S. Sobczyk/D. Bernhard Nez Perce)
1:45 PM	Updates on Previous Sessions & Open items (M. Bergeron)
2:00 PM	Context of Proposed Technical Approach and Scope (M. Bergeron)
2:15 PM	Break
2:30 PM	Review of Alternative Modeling Approaches and Recommendations for PA (Portage/Neptune Team)
3:15 PM	Selection of Process and System Model Software (Portage/Neptune Team)
4:00 PM	Adjournment
Jan 26 AM	**Overview of STOMP©[1] Capabilities, Proposed Modeling Approach and Scope**
8:00 AM	Refreshments
8:15 PM	Overview of Development and Capabilities of STOMP Code (M. White, Pacific Northwest National Laboratory)
9:30 AM	Break
9:45 PM	Overview of Proposed Technical Approach (Portage/Neptune Team)

[1] Subsurface Transport Over Multiple Phases (STOMP) is copyrighted by Battelle Memorial Institute, 1996.

Agenda for Waste Management Area C Performance Assessment – Numerical Codes and Models Working Session January 25–27, 2011	
10:15 AM	Proposed Model Design and Scope – Pre-Closure Period (Portage/Neptune Team)
11:30 AM	Lunch
Jan 26 PM	**Proposed Modeling Approach and Scope (continued)**
12:45 PM	Options for Analysis of Soil Inventory Uncertainty (Portage/Neptune Team)
1:30 PM	Proposed Model Design and Scope- Post-Closure Period (Portage/Neptune Team)
2:00 PM	Engineered System – Recharge (Portage/Neptune Team)
2:15 PM	Break
2:30 PM	Engineered System – Waste Release (Portage/Neptune Team)
2:45 PM	Vadose Zone/Groundwater Flow and Transport (Portage/Neptune Team)
3:15 PM	Use of GoldSim©[2] in Initial PA (Portage/Neptune Team)
4:00 PM	Adjournment
Jan 27 AM	**TC & WM EIS Update, Uncertainty and Sensitivity Analysis, Working Session Close-out/Feedback, Look Forward to Upcoming Working Sessions**
8:00 AM	Refreshments
8:15 AM	Review of TC & WM EIS Results Relevant to WMA C (TC & WM EIS Team)
9:30 AM	Break
9:45 AM	Role of Uncertainty and Sensitivity Analysis in Initial PA (Portage/Neptune Team)
10:45 AM	Numerical Codes and Models (Open Discussion and Q&A)
11:30 AM	Lunch
Jan 27 PM	**Meeting Review**
12:45 PM	Review of Consensuses and Notes (T. Martin)
1:00 PM	Working Session Feedback (T. Martin)
1:15 PM	Look Forward to Upcoming Working Sessions (S. Eberlein)
1:30 PM	Final Adjournment

[2] GoldSim simulation software is copyrighted by GoldSim Technology Group LLC of Issaquah, Washington.

Discussion: DOE is pursuing closure of Waste Management Area (WMA) C located at the Hanford Site. At some point in the future, DOE and NRC will consult on waste determinations for these tank closures; additionally these tanks will be closed in coordination with U.S. Environmental Protection Agency (EPA) and Ecology in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) and State-approved closure plans. The DOE, NRC, and Ecology met for the tenth of a series of technical exchanges on the proposed inputs for a WMA C Performance Assessment (PA). The technical exchanges are intended to capitalize on early interactions between the agencies with a goal of developing DOE's WMA C PA. Technical discussions during the meeting are intended to allow for the clarification of general modeling approaches and for the identification of other specific questions.

Topics: The following specific topical areas were discussed during the meeting:

1. Goals and Objectives of Numerical Models and Codes Working Session
2. Update on Characterization Efforts in WMA C
3. Role of Surface Geophysical Exploration in Tank Farm Characterization
4. Independent Evaluation of Initial Single-Shell Tank System Performance Assessment (SST PA) Results
5. Updates from Previous Sessions and Review of Alternative Modeling Approaches
6. Updates on Alternative Leak Volumes and Soil Inventory Estimates
7. Updates on Previous Sessions and Open Items
8. Context of Proposed Technical Approach and Scope
9. Review of Alternative Modeling Approaches and Recommendations for PA
10. Selection of Process and System Model Software
11. Overview of Subsurface Transport Over Multiple Phases (STOMP) Model Capabilities, Proposed Modeling Approach and Scope
12. Overview of Development and Capabilities of STOMP Code
13. Overview of Proposed Technical Approach
14. Proposed Model Design and Scope – Pre-Closure Period
15. Proposed Modeling Approach and Scope
16. Options for Analysis of Soil Inventory Uncertainty
17. Proposed Model Design and Scope – Post-Closure Period
18. Engineered System – Recharge
19. Engineered System – Waste Release
20. Vadose Zone/Groundwater Flow and Transport
21. Use of GoldSim in Initial PA
22. Tank Closure and Waste Management Environmental Impact Statement (TC & WM EIS) Update
23. Role of Uncertainty and Sensitivity Analysis in Initial WMA C PA

Summary: The following summarizes the discussion during the meeting, by topical area.

Goals and Objectives of Numerical Models and Codes Working Session

- DOE-ORP Staff provided an overview of the numerical models and codes working session and the scope of the discussion to follow, including context, evaluations of alternative approaches, and proposed technical modeling approaches and codes.

Update on Characterization Efforts in WMA C

- DOE-ORP Staff provided an update on characterization efforts in WMA C, including details concerning sampling that has occurred in WMA C for radionuclides, volatile chemicals, non-volatile chemicals, and polychlorinated biphenyls. These are the results from the Phase 1 and Phase 2 characterization efforts. An overview of the sampling and analysis efforts was also provided.

Role of Surface Geophysical Exploration in Tank Farm Characterization

- DOE-ORP provided an overview of Surface Geophysical Exploration activities being used in the characterization of the tank farm in WMA C. Surface Geophysical Exploration uses resistivity, ground-penetrating radar, electromagnetics, and magnetics to develop and process investigation of subsurface structures. It is a science for measuring physical properties of the earth, e.g., electrical, acoustic, magnetic.

Independent Evaluation of Initial Single-Shell Tank System Performance Assessment Results

- DOE-ORP Staff reported on an independent evaluation conducted on the results of the Initial SST PA.

Updates from Previous Sessions and Review of Alternative Modeling Approaches

- DOE-ORP Staff provided an overview of what updates would be presented from previous working sessions and alternative modeling approaches to be presented.

Updates on Alternative Leak Volumes and Soil Inventory Estimates

- Representatives of the Nez Perce Tribe provided an overview of efforts that have been taken to develop alternative estimates of leak volume and soil inventory estimates.
- Meeting participants discussed alternative interpretations or potential causes of various anomalies in the soil inventory data.
- Representatives of the Nez Perce proposed that changes be made to the proposed reference case in the PA to reflect an increase in inventory associated with historical releases from tanks 241-C-105, 241-C-108, 241-C-101, and unplanned release site UPR-82.

- Representatives of the Nez Perce presented a rationale for revised leak estimates based on irreducible volume wetting properties, and suggested that more realistic estimates should be used.

Updates on Previous Sessions and Open Items

- DOE-ORP Staff provided an update on new information placed on the working session web site, including new glossary definitions.
- DOE-ORP Staff provided an overview of the parameter matrix that has been maintained throughout the working sessions in order for meeting participants to review whether we have captured the correct information, including with respect to the ecological and risk scenarios that will need to be addressed through the PA.
- DOE-RL provided an update on what is happening with Central Plateau activities addressing baseline risk assessments and ecological risk, including parameters to be used in tribal scenarios.
- DOE-ORP Staff provided an overview of efforts that have been underway to re-evaluate leak and soil inventory information and re-assess our understandings based on information that has come forth from meeting participants.
- Meeting participants discussed the parameter matrix and sought clarifications on several items.

Context of Proposed Technical Approach and Scope

- DOE-ORP Staff provided a reminder of the context of why we are pursuing the technical approach and scope that we are, in order to meet the requirements of the Tri-Party Agreement, DOE Order 435.1, *Radioactive Waste Management* requirements, and State *Resource Conservation and Recovery Act of 1976* (RCRA) and *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) requirements.

Review of Alternative Modeling Approaches and Recommendations for PA

- DOE-ORP Staff provided an overview of what was originally proposed and what they think they have heard through the working sessions concerning conceptual model complexity, including complex lateral and preferential flow, uranium mobility and non-linear adsorption, and permutations of the Phase 1 characterization model.
- Meeting participants discussed how data and characterization information will be used between now and the issuance of decision-supporting documents.

Selection of Process and System Model Software

- DOE-ORP Support contractor provided an overview of modeling alternatives and software selection for PAs, including the considerations that may go into such decision making.

- DOE-ORP Support contractor provided an overview of the difference between process models and system models, emphasizing the role of process models in the PA and the need to maintain mass balance.
- DOE-ORP Support contractor identified that process models are valuable and effective for integrating spatial information especially associated with flows over time, heterogeneity, and time-varying (transient) actions.
- DOE-ORP Support contractor identified that system models are simplifications that represent the operation of the system as a whole, and tend to be "top-down" oriented.
- DOE-ORP Support contractor provided an example of how a set of process models can be abstracted and simplified.

Overview of STOMP Model Capabilities, Proposed Modeling Approach and Scope, and Development and Capabilities of STOMP Code

- Pacific Northwest National Laboratory Staff provided an overview of the STOMP model and its capabilities. STOMP is an acronym for Subsurface Transport Over Multiple Phases. STOMP capabilities include simulation of radionuclide migration and remediation, contaminant transport in the deep vadose zone, modeling of deep sedimentary formations, and other vadose zone migration and contaminant transport.
- Pacific Northwest National Laboratory Staff identified the operational modes and applications that STOMP can be used for, including multi-fluid flow and reactive transport through geologic media.

Proposed Model Design and Scope – Pre-Closure Period

- DOE-ORP Staff provided an overview of the proposed model design and scope for modeling the pre-closure period of the WMA C operations, including flow conditions, travel times, and contaminant transport expected to be representative of WMA C prior to closure.
- DOE-ORP Staff indicated that the primary goal of the pre-closure analysis is to explore the past to the extent we can, using various models, to get a favorable comparison between actual known contamination and expected model results to demonstrate understanding of the current vadose zone and transport systems.
- DOE-ORP Staff noted that the pre-closure analysis with focus on technetium and nitrate was primarily to establish and demonstrate understanding of observed contamination in the groundwater.
- DOE-ORP Staff identified the features, events, and processes that are being addressed in the pre-closure modeling, including surface layer, vadose zone, groundwater, tanks, and pipelines, both during construction and operations.
- DOE-ORP Staff noted that uncertainty concerning past practices and sources of water introduced into the tank farms is the primary obstacle to establishing a complete understanding of how to model the pre-closure period.

- DOE-ORP Staff provided more detail concerning the difficulties associated with the pre-closure model design. Of particular note are the discrepancies between observed contamination and known releases and vadose zone data.

Options for Analysis of Soil Inventory Uncertainty

- DOE-ORP Staff provided an overview of the soil inventory estimates based on current data. It was also noted that the staff analyzing the leak/loss estimates are in the process of updating and adding to this information.
- DOE-ORP Staff led a discussion concerning the proposed options for soil inventory modeling at WMA C, with an emphasis on the use of Bayesian statistical methods. Sources for developing soil inventory information includes tank waste knowledge, tank leak information, and field data.
- DOE-ORP Staff noted that some of the uncertainty associated with the soil inventory information includes limitations in reports, disconnects in timing of data acquisition, unrepresentative samples and lack of precision.

Proposed Model Design and Scope – Post-Closure Period

- DOE-ORP Staff provided an overview of the primary components proposed to be included in the model design and scope of the post-closure model for WMA C, including transport of chemicals and radionuclides over a 10,000+-year period of performance, inventory of the tanks and ancillary equipment residuals.
- DOE-ORP Staff indicated that three-dimensional STOMP will be used to determine flow and transport and intruder pathways.
- DOE-ORP Staff identified the primary recharge over time assumptions that have been agreed to during these working sessions for inclusion in the post-closure modeling.
- DOE-ORP Staff noted that assumptions concerning surface barrier and system degradation have been discussed in the working sessions for inclusion in the post-closure modeling.
- DOE-ORP Staff identified the initial PA conceptual model assumptions expected to be modeled in the post-closure period for WMA C. The conceptual models include assumption of a stratigraphic dip under the site, and a certain amount of lateral flow. Another conceptualization is roughly straight down migration without lateral flow. There will also be alternative conceptual models to account for increased recharge and increased soil inventory.
- DOE-ORP Staff indicated that the initial WMA C PA will include radionuclides and chemicals as agreed upon, model surface barrier and system degradation, using a three-dimensional vadose zone flow model using STOMP.

Engineered System – Recharge

- DOE-ORP Staff provided an overview of the proposed approach to addressing recharge in the WMA C PA, including factors affecting recharge such as vegetation, precipitation, and man-made features. An overview of the parameter values that have been agreed to date for the denominator and sensitivity cases was provided.

Engineered System – Waste Release

- DOE-ORP Staff provided an overview of the proposed approach to addressing waste release in the WMA C PA, including parameter values that have been agreed to for the denominator and sensitivity cases. Included are the tank features and release processes in near-term conditions, release processes for long-term conditions, and the associated key features, events, and processes. The waste release model will provide a time-dependent flux of contaminants to the vadose zone determined by physical condition of the engineered structures.

Vadose Zone/Groundwater Flow and Transport

- DOE-ORP Staff provided an overview of the proposed approach to addressing vadose zone/groundwater flow and transport in the WMA C PA, including parameter values that have been agreed to for the denominator and sensitivity cases. Included are the key features, events, and processes associated with vadose zone and groundwater transport. The vadose zone/groundwater flow and transport modeling will address alternative assumptions concerning different isotropic and anisotropic conditions.

Use of GoldSim in Initial PA

- DOE-ORP Staff provided an overview of the proposed approach to using GoldSim in the initial PA for WMA C.

TC & WM EIS Update

- TC & WM EIS Staff provided an update on the status of the TC & WM EIS modeling as pertains to WMA C, including the modeling methods used and the major assumptions as may relate to assumptions that the WMA C PA may need to consider.
- Meeting participants asked follow up questions of the TC & WM EIS Staff.

Role of Uncertainty and Sensitivity Analysis in Initial WMA C PA

- DOE-ORP Staff provided an overview of the role of uncertainty analysis and sensitivity analysis in the initial WMA C PA. Meeting participants discussed the definitions and roles of sensitivity analysis and uncertainty analysis.

Flip Charts from Waste Management Area C working session, Numeric Codes and Models, January 25-27, 2011

TC & WM-EIS discussion

- Need schedule from EIS team to understand PA process impacts. Need to figure out critical path items (Jeff) PA, CA, legal process, EIS all will probably become critical path (Dirk).
- Ecology expects a schedule soon that shows TPA compliance (Jeff).
- How does Atomic Energy Act authority interact with latest changes to schedule (Jeff)?
- WRPS plans are to use the additional time to complete the ecological risk session in May and more fully complete the FEPs process (Susan).

Updates on Characterization Efforts in WMA C discussion

- Mike C. will post pdf of C farm characterization map on the website.
- Characterization data does not explain how contaminants got to groundwater, or where they are today. Lacking these we do not understand the system and as a result can't make reasonable predictions about the future (Dirk).

Role of SGE in Tank Farm Characterization discussion

- SGE false positives could have very negative impacts as they could identify leaks where none exist (Dirk).
- Validation of SGE data against characterization data is important (Damon).

Independent Evaluation of Initial SST PA results discussion

- Why the difference between the S-SX farms results (Beth)? We're not sure but the differences don't appear to be significant (Mike C., Chris). Mike and Jim should talk to analyze differences (Beth).

Updates from Previous Sessions and Review of Alternative Modeling Approaches

- Page 5, Engineering Systems 1 box: Ecology 'min' and 'max' should show actual numbers.
- Both sensitivity and uncertainty are on this spreadsheet but are really just sensitivity (Hans).
- Consider solubility limitations for elements such as uranium (Dirk).

Context of Proposed Technical Approach and Scope

- Slide 12: Should include a line indicating that the PA informs what FEPs you are focusing on (Hans).
- BX farm report (by Andy Ward) shows how flow is being redirected/channeled (Dirk).
- Slide 16: Clarity on initial post-closure condition is needed (Beth).
- Slide 17: Analysis of FEPs should go between chapter 2 and chapter 3 because there is now extra time to more fully complete the FEPs effort. This extra time will impact the lines on this slide (Hans).
- Sensitivity versus model dominance needs to be clear (Dirk).
- Model uncertainty versus parameter uncertainty needs to be clear (Brenda).

Overview of Proposed Technical Approach

- Slide 4: Consider additional analytes (e.g., cyanide) in pre-closure analysis to determine post-closure impacts (Beth, Joe).
- Consider running backwards from Dale's SGE data to perform some rough validation of the forward model runs (Beth).
- Slide 6: Tank C-101 also has drywell activity. Not sure what occurred at UPR-86 (Stan).
- Stratigraphic dip merges with H3 layer outside the fence line so it would be better for the model to extract water outside the fence line to ensure maximum concentration (Hans).
- Data associated with stratigraphic dip show water will flow into C farm from outside. This input of water needs to be added to the model (Dirk). Stan will provide references to Mike for support.
- Concentration model should note groundwater would flow east post-closure (Stan).

Proposed Model Design Pre-Closure

- Slide 13: Put 'French Drain' in parentheses for 'Drywell near 241-C-801' (Stan).
- Not sure what aspect of data (e.g., water content, matrix potential) will be used to show model is working correctly. Matrix potential may be the best (John S.).

Engineered System – Recharge

- Ensure that bioturbation is addressed in the FEPs (Dirk).
- Slide 11: Operations period is missing (Beth).
- Slide 13: Word 'extreme' should be deleted from 'episodic recharge' (Hans).

Engineered System – Waste Release

- Pits on C tanks should be included in FEPs (Beth).
- Waste might be transferred in gap between grout and tank wall. This could be useful in GoldSim to understand if it is an important contaminant release mechanism.

Ecology needs

- Inputs and outputs before and after the abstraction process.
- A plan for addressing the stratigraphic uncertainty on the spreadsheet.
- Heterogeneous case is 'TBD'—need to show where lateral flow modeling is being performed.
- 10x issue needs to be resolved.
- Additional recharge case needs to be included in matrix.
- Inputs and outputs for both process and system models need to be reviewed.
- How climate change is being dealt with needs to be clearly communicated.
- Need to understand/compare any changes from past soil inventory estimates.

Vadose Zone/Groundwater Flow and Transport

- Slide 18: Need to be consistent with what we are calling the undifferentiated H3/cold creek/etc. layer (Hans).
- Slide 30: Consider effective porosity range (min-max) instead of just .25 (Hans).

TC & WM EIS Update

- Appears the EIS has very few data points supporting the model (17 boreholes vs. the broader array that is available) (Stan).

Role of Uncertainty and Sensitivity Analysis in Initial PA

- Slide 5: Definition of uncertainty much broader than this definition (Dirk).
- From DOE 435.1 perspective sensitivity is what drives the model; uncertainty refers to the quality of the knowledge base (Marty).
- Transparency and dialogue will be important in dealing with code uncertainty (Beth).
- 'Significance' is important. Additional discussion to ensure sensitivity deals with significance issues is necessary (Dib).
- Csoil is a code that may be more useful than just estimating (evapotranspiration for example) (Beth).

What We Did

- Ecology needs compliant schedule soon.
- Process(es) for Ecology list, FEPs, etc.
- Conceptual Models generally reflective of PA working session process.
- Wile E. Coyote problem.

What's Next?

More information on abstraction process would be useful (Hans).

- May need to spend more time discussing in FEPs bottom of the tank (e.g., relationships to grout, waste, liner, concrete, etc.) (Hans).
- More discussion on events in FEPs important (Dirk).
- FEPs: Need documentation (scoping, model runs, schedules, etc.), analysis, closing out, go to next level of detail. A document needs to be produced that meets these needs. Participants need to have access to this document prior to working session (Susan). Participants will provide a list of dominant FEPs and references to Mike.
- Clarity getting from spreadsheet to model (Hans).
- DOE PA schedule and TPA schedule to be provided by DOE (Marty)
- Porosity needs to be considered in the sensitivity analysis (Hans).
- Consider an access website for participants to comment on FEPs.
- For May session: 435.1 biota issues (Kathryn Higley at OSU?) (Chris M.).

Working Draft Glossary
(Proposed Changes updated for January 2011 Working Session)
Revision 2
01/24/2011

A

Absorption (new): The process by which substances in gaseous, liquid or solid form dissolve or mix with other substances (ASCE 1985).

Activity (radioactivity) (new): The rate of decay of radioactive material expressed as the number of atoms breaking down per second, measured in units called becquerels or curies (U.S. Nuclear Regulatory Commission Glossary).

Acute Exposure (new): Contact with a substance that occurs once or for only a short time (up to 14 days) (compare with **Intermediate Duration Exposure** and **Chronic Exposure**) (Agency for Toxic Substances and Disease Registry – Glossary of Terms).

Acute Toxicity (new): "Acute toxicity" means the ability of a hazardous substance to cause injury or death to an organism as a result of a short-term exposure to a hazardous substance (WAC 173-340-200, "Definitions").

Adsorption (new): Adherence of gas molecules, ions, or molecules in solution to the surface of solids (ASCE 1985).

Advection (new): The process whereby solutes are transported by the bulk mass of flowing fluid (Freeze and Cherry 1979). See also **Convective Transport**.

Ancillary equipment (same): "any device including, but not limited to, such devices as piping, fittings, flanges, valves, and pumps, that is used to distribute, meter, or control the flow of dangerous waste from its point of generation to a storage or treatment tank(s), between dangerous waste storage and treatment tanks to a point of disposal on-site, or to a point of shipment for disposal offsite" (WAC 173-303-040, "Definitions").

Analytical Model (new): A mathematical model generally assuming homogeneous aquifer properties, uniform flow direction and hydraulic gradient, uniform aquifer thickness, with simple upper and lower boundaries, and lateral boundaries placed at an infinite distance.

Anisotropy (new): The condition of having different values of hydraulic conductivity (in particular) in different directions in geologic materials. This is especially apparent in fractured bedrock or layered sediment.

Aquifer (new): An aquifer can be defined using the following definitions (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS):

(1) A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs (Lohman et al. 1972).

(2) A geologic formation, group of formations, or part of a formation capable of yielding a significant amount of groundwater to wells or springs (10 CFR Part 40 Appendix A).

(3) A formation, a group of formations, or a part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs (10 CFR Part 960.2).

(4) A zone, stratum, or groups of strata that can store or transmit water in sufficient quantities for a specific use (30 CFR Part 710.5).

(5) Geological formation, groups of formations, or part of a formation, that is capable of yielding a significant amount of water to a well or spring (40 CFR Parts 146.03; 260.10; 270.2).

(6) A geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs (40 CFR Parts 257.3-4).

Aquiclude (new): A hydrogeologic unit which, although porous and capable of storing water, does not transmit it at rates sufficient to furnish an appreciable supply for a well or spring (WMO 1974). See preferred term **Confining Unit**.

As Low As Is Reasonably Achievable (ALARA) (new): The process of determining what level of protection and safety makes exposures, and the probability and magnitude of potential exposures, "as low as reasonably achievable, economic and social factors being taken into account" (ALARA), as required by the International Commission on Radiological Protection System of Radiological Protection.

Assessment Context (new): The assessment context provides a framework for performance of the safety assessment, and it covers the following key aspects: purpose, regulatory framework, assessment end-points, assessment philosophy, disposal system (or facility) characteristics, and timeframes (IAEA 2004, *Safety Assessment Methodologies for Near Surface Disposal Facilities, Results of a co-ordinated research project, Volume 1: Review and enhancement of safety assessment approaches and tools*).

B

Background Radiation (new): The natural radiation that is always present in the environment. It includes cosmic radiation which comes from the sun and stars, terrestrial radiation which comes from the Earth, and internal radiation which exists in all living things. The typical average individual exposure in the United States from natural background sources is about 300 millirems per year (U.S. Nuclear Regulatory Commission Glossary).

Basalt (new): a dark colored igneous (lava) rock. Basalt is differentiated from other igneous rocks by its chemical composition. The basalt of the Eastern Snake River Plain is thought to have intermittently flowed from numerous vents across the Plain over long periods of time.

Baseline Risk Assessment (new): A baseline risk assessment is an assessment conducted before cleanup activities begin at a site to identify and evaluate the threat to human health and the environment. After remediation has been completed, the information obtained during a baseline risk assessment can be used to determine whether the cleanup levels were reached (U.S. Environmental Protection Agency Waste and Emergency Response Waste and Cleanup Risk Assessment Glossary).

Best Basis Inventory (BBI) (new): The best-basis inventory (BBI) represents a process used to establish the estimate of the current tank waste inventories for a standard set of chemicals and radionuclides (consisting of 46 radionuclides and 29 chemicals). In the BBI process, waste concentration and volume estimates are established and used to calculate inventories. Available analytical data (waste sample analyte results) are evaluated to determine the constituent concentrations that best represent the waste in a tank in comparison to actual waste volume measurements and the Hanford Defense Waste (HDW) waste type summaries. When analytical data is not available for a chemical or radionuclide, waste concentrations are estimated based on waste process information derived from the HDW summaries. Waste volume estimates in the BBI are based on tank measurements but can also be based on information associated with waste transfers compiled in the HDW. The most current version of the BBI process is provided in RPP-7625, *Best-Basis Inventory Process Requirements*, Rev. 9.

Biological Half-life (same): The time required for one half of the amount of a substance, such as a radionuclide, to be expelled from the body by natural metabolic processes, not counting radioactive decay, once it has been taken in through inhalation, ingestion, or absorption. See also **Radioactive Half-life**, **Effective Half-life**.

Boundary Condition (new): A mathematical statement specifying the dependent variable (e.g., hydraulic head of concentration) at the boundaries of the modeled domain which contain the equations of the mathematical model. Examples are Specified Head, Specified Concentration, Specified Flux (flow or mass flux), or Mixed Boundaries.

C

Cancer Risk (new): A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower (Agency for Toxic Substances and Disease Registry – Glossary of Terms).

Capillary Action (new): The movement of water in the interstices of a porous medium due to capillary forces (ASTM 1980).

Capillary Forces (new): Forces that cause ground water to rise above the surface of the saturated zone into the spaces between soil particles in the unsaturated zone (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Capillary Fringe (new): The lower subdivision of the unsaturated zone immediately above the water table in which the interstices are filled with water under pressure less than that of the atmosphere, being continuous with the water below the water table but held above it by capillary forces (ASCE 1985).

Capillary Pressure (new): The difference in pressure across the interface between two immiscible fluid phases jointly occupying the interstices of a porous medium caused by interfacial tension between the two phases (*Glossary of Geology* [Bates and Jackson 1980]).

Capillary Zone (new): Soil area above the water table where water can rise up slightly through the cohesive force of capillary action (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Carcinogen (new): a chemical classification for the purpose of risk assessment as an agent that is known or suspected to cause cancer in humans, including but not limited to a known or likely human carcinogen or a probable or possible human carcinogen under a U.S. Environmental Protection Agency (EPA) weight-of-evidence classification system (9 VAC 20-160-10, "Definitions," *Virginia Administrative Code*, as amended).

Cation Exchange Capacity (new): The sum total of exchangeable cations that a porous medium can absorb. Expressed in moles of ion charge per kilogram of soil (or of other exchanges such as clay) (SSSA 1975).

Chronic Exposure (new): Contact with a substance that occurs over a long time (more than 1 year) (compare with **Acute Exposure** and **Intermediate Duration Exposure**) (Agency for Toxic Substances and Disease Registry – Glossary of Terms).

Chronic Toxicity (new): "Chronic toxicity" means the ability of a hazardous substance to cause injury or death to an organism resulting from repeated or constant exposure to the hazardous substance over an extended period of time (WAC 173-340-200, "Definitions").

Climate (new): The composite or generally prevailing weather conditions of a region, throughout the year, averaged over a series of years (National Oceanic and Atmospheric Administration National Weather Service Glossary).

CLARC (new): Cleanup Levels and Risk Calculation tools (State of Washington Department of Ecology Toxics Cleanup Program Acronyms and Glossary).

Clastic Dikes (new): Clastic dikes are common structures that occur in many geologic units in the Pasco Basin and vicinity. Clastic dikes are tabular and tapered intrusive bodies that are composed of continental clastic sediments (BHI-01103, *Clastic Injection Dikes of the Pasco Basin and Vicinity: Geologic Atlas Series*, Rev. 0, page 1-1).

Clastic dikes in the Pasco Basin and vicinity can be classified into two basic types. The types of clastic dikes are based on field observations that were made during geologic mapping of the Pasco Basin and vicinity (Open File Report 94-13, *Geologic Map of the Priest Rapids 1:100,000 Quadrangle* and Open File Report 94-8, *Geologic Map of the Richland 1:100,000 Quadrangle, Washington*) and from unpublished information:

> Type I dikes occur within fissures that formed by several mechanisms involving pedogenic, seismic, and mass wasting processes and are filled with clastic sediments from air and by moving water. The dike infilling process involves transport of sediments in a low-pressure, gravity-dominated system. Sills have not been observed in Type I dikes in the Pasco Basin.
>
> Type II dikes occur within fissures that formed by several mechanisms involving multi-genetic processes and are filled with clastic sediments deposited. Sediments are deposited in this type of dike by the injection of sediments by primarily water escape and/or water invasion processes. This process involves the injection of sediments and water in a predominantly moderate- to high-pressure system. Gravitational processes may also be a significant component in Type II dikes. Type II dikes commonly form as sills.

Cleanup (new): Actions taken to deal with a release, or threatened release of hazardous substances that could affect public health and/or the environment. The term "cleanup" is often used broadly to describe various response actions or phases of remedial responses such as the remedial investigation/feasibility study (State of Washington Department of Ecology Toxics Cleanup Program Acronyms and Glossary).

Closure

- **Ecology Closure (new):** 1) The requirements placed upon all recycling, used oil, and TSD facilities, plus some generators, and some transporters to ensure that all such facilities are closed in an acceptable manner (see also **Post-closure**); and 2) Once taken out of service, the proper cleaning up and/or decontaminating of a dangerous waste management unit or a recycling unit and any areas affected by releases from the unit (WAC 173-303-040, "Definitions").

- **Single-Shell Tank (SST) System Closure (revised):** Closure of all components and environmental media associated with the SST system (i.e., the SSTs themselves; and associated ancillary equipment including waste transfer piping, valve pits, vaults, etc.; contaminated soils, and contaminated groundwater) including the retrieval of tank wastes in

compliance with all applicable regulatory requirements (*Hanford Federal Facility Agreement and Consent Order*, Appendix I).

- **Washington Administrative Code (WAC) Closure (same):** "The requirements placed upon all … TSD facilities … to ensure that all such facilities are closed in an acceptable manner"(WAC 173-303-040) ("acceptable" is defined in WAC 173-303-610, "Closure and Post-Closure").

- **Tri-Party Agreement (TPA) Closure (same):** Closure of a waste management area (WMA).

- **Closure (same):** "Deactivation and stabilization of a radioactive waste facility intended for long-term confinement of waste." (DOE M 435.1-1, *Radioactive Waste Management Manual*)

- **Interim / Operational Closure (same):** Closure of a component.

- **Final Closure (same):** Closure of a WMA (including cap).

Coefficient of Molecular Diffusion (same): The component of mass transport flux of solutes (at the microscopic level) due to variations in solute concentrations within the fluid phases (Bear 1979). Synonymous with **Diffusion Coefficient**.

Colloids (new): A colloid is a particle ranging in size from 1 nm to 100 nm. Particle can include bacteria, viruses, large macromolecules of dissolved organic carbon, small droplets of non-aqueous phase liquids, inorganic rock, or mineral fragments (*Physical and Chemical Hydrogeology* [Delmonico and Schwartz 1998]). The attachment (by adsorption or precipitation) of strongly sorbing radionuclides to colloidal-size materials (1 nm to 1 μm) that may be transported by mobile pore fluids is potentially an important transport mechanism that needs to be considered for certain contaminants at the Hanford Site (see Appendix G of DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*).

Complexation (new): Formation of a group of compounds in which a part of the molecular bonding between compounds is of the coordinate type (U.S. Environmental Protection Agency Solid Waste and Emergency Response Waste and Cleanup Risk Assessment Glossary).

Component (revised): Either the tank or ancillary equipment of a tank system (WAC 173-303-040).

Composite Analysis (revised): "An analysis that accounts for all sources of radioactive material that may contribute to the long-term dose projected to a hypothetical member of the public from an active or planned low-level waste disposal facility. The analysis is a planning tool intended to provide a reasonable expectation that current low-level waste disposal activities will not result in the need for future corrective or remedial actions to ensure protection of the public and the environment." (DOE M 435.1-1)

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 **(CERCLA) (new):** CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. The Agency for Toxic Substances and Disease Registry (ATSDR), which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Conceptual Site Model (CSM) (new): A CSM, a key element used in facilitating cleanup decisions during a site investigation, is a planning tool that organizes information that already is known about a site and identifies the additional information necessary to support decisions that will achieve the goals of the project. The project team then uses the CSM to direct field work that focuses on the information needed to remove significant unknowns from the model. The CSM serves several purposes: as a planning instrument; as a modeling and data interpretation tool; and as a means of communication among members of a project team, decision makers, stakeholders, and field personnel (U.S. Environmental Protection Agency Solid Waste and Emergency Response Waste and Cleanup Risk Assessment Glossary).

Confined (same): A modifier which describes a condition in which the potentiometric surface is above the top of the aquifer.

Confined Aquifer (new):

(1) An aquifer bounded above and below by confining units of distinctly lower permeability than that of the aquifer itself (ASCE 1985).

(2) An aquifer containing confined groundwater (ASCE 1985).

(3) An aquifer bounded above and below by impermeable beds or by beds of distinctly lower permeability than that of the aquifer itself; an aquifer containing confined groundwater (40 CFR 260.10).

Confining Bed (new):

(1) See **Confining Unit**.

(2) A body of impermeable or distinctly less permeable material stratigraphically adjacent to one or more aquifers (40 CFR 146.3).

Confining Unit (new):

(1) A hydrogeologic unit of impermeable or distinctly less permeable material bounding one or more aquifers and is a general term that replaces aquitard, aquifuge, aquiclude (Bates and Jackson 1980). See **Confining Bed.**

(2) Means a body of impermeable or distinctly less permeable material stratigraphically adjacent to one or more aquifers (10 CFR Part 960.2).

Consensus (same): Approach is likely to meet requirements identified by regulatory agencies.

Contaminant (new): Any man-made or man-induced alteration of the chemical, physical or biological integrity of soils, sediments, air and surface water or groundwater including, but not limited to, such alterations caused by any hazardous substance [as defined in CERCLA, 42 USC § 9601(14)], hazardous waste (as defined in COV 10.1-1400, "Definitions," Code of Virginia, as amended), solid waste (as defined in 9 VAC 20-80-10, "Definitions," Virginia Administrative Code, as amended), petroleum (as defined in Articles 9 [§ 62.1-44.34:8 et seq.] and 11 [§ 62.1-44.34:14 et seq.]) of the Virginia State Water Control Law, or natural gas.

Convective Transport (new): The component of movement of heat or mass induced by thermal gradients in groundwater (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Corrective Measure Study (CMS) (new): If the potential need for corrective measures is verified during a RCRA Facility Investigation (RFI), the owner or operator of a facility is then responsible for performing a CMS. A CMS is conducted to identify, evaluate, and recommend specific corrective measures based on a detailed engineering evaluation. Using data collected during the RFI, the CMS demonstrates that proposed measures will be effective in controlling the source of contamination, as well as problems posed by the migration of substances from the original source into the environment. The measures also must be assessed in terms of technical feasibility, ability to meet public health protection requirements and protect the environment, possible adverse environmental effects, and institutional constraints. See also **RCRA Facility Investigation (RFI)** (U.S. Environmental Protection Agency Solid Waste and Emergency Response Waste and Cleanup Risk Assessment Glossary).

Curie (new): "Curie" means the measure of radioactivity defined as that quantity of radioactive material which decays at the rate of 3.70×10^{10} transformations per second. This decay rate is nearly equivalent to that exhibited by 1 gram of radium in equilibrium with its disintegration products (WAC 173-340-200, "Definitions").

D

Dangerous wastes (same): "(T)hose solid wastes designated in WAC 173-303-070 through 173-303-100 as dangerous, or extremely hazardous or mixed waste." (WAC 173-303-040, "Definitions")

Darcian Velocity (new): See **Specific Discharge**.

Darcy's Law (new): An empirical law which states that the velocity of flow through a porous medium is directly proportional to the hydraulic gradient assuming that the flow is laminar and inertia can be neglected (Darcy 1856).

Data Quality Objective (DQO) (new): EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final*, Chapter 4 defines a DQO as "Qualitative and quantitative statements to ensure that data of known and documented quality are obtained during an RI/FS to support an Agency decision." DQOs are qualitative and quantitative statements specified to ensure that data of known and appropriate quality are obtained. The DQO process is a series of planning steps, typically conducted during site assessment and investigation that is designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate. The DQO process involves a logical, step-by-step procedure for determining which of the complex issues affecting a site are the most relevant to planning a site investigation before any data are collected (U.S. Environmental Protection Agency Solid Waste and Emergency Response Waste and Cleanup Risk Assessment Glossary).

Decay Chain (decay series) (new): The series of decays that certain radioisotopes go through before reaching a stable form. For example, the decay chain that begins with uranium-238 (U-238) ends in lead-206 (Pb-206), after forming isotopes, such as uranium-234 (U-234), thorium-230 (Th-230), radium-226 (Ra-226), and radon-222 (Rn-222) (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

Decay Constant (new): The fraction of a number of atoms of a radioactive nuclide that disintegrates in a unit of time. The decay constant is inversely proportional to the radioactive half-life (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

Decay Products (or daughter products) (new): The isotopes or elements formed and the particles and high-energy electromagnetic radiation emitted by the nuclei of radionuclides during radioactive decay. Also known as "decay chain products" or "progeny" (the isotopes and elements). A decay product may be either radioactive or stable (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

Deep Drainage (new): The drainage of soil water downward by gravity below the maximum effective depth of the root zone toward storage in subsurface strata (ASCE 1985). Also called "deep percolation."

Degree of Saturation (new): See **Percent Saturation**.

Degradation or Decomposition By-Products (new): "Degradation by-products" or "decomposition by-products" means the secondary product of biological or chemical processes that break down chemicals into other chemicals. The decomposition by-products may be more or less toxic than the parent compound (WAC 173-340-200, "Definitions").

Dermal Contact (new): Contact with (touching) the skin (see **Route of Exposure**) (Agency for Toxic Substances and Disease Registry – Glossary of Terms).

Desorption (new): The reverse process of sorption (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS). See also **Sorption**.

Detection Limit (new): The lowest quantity of a hazardous substance that can be distinguished from the normal random "noise" of an analytical instrument or method (U.S. Environmental Protection Agency Glossary of Terms and Acronyms Superfund A - L, Superfund).

Deterministic Analysis (new): An analysis using single numerical values (assumed to have a probability of 1) for key parameters leading to a single value of the result. Typically used with either "best estimate" or "worst case" values, based on expert judgment and knowledge of the phenomena being modeled. This was the general approach used in DOE/ORP-2005-01, *Initial Single-Shell Tank System Performance Assessment for the Hanford Site* (the SST PA).

Diffusion (new): Process whereby ionic or molecular constituents move under the influence of their kinetic activity in the direction of their concentration gradient (Freeze and Cherry 1979). See **Diffusion Coefficient**, **Fickian Diffusion**, **Molecular Diffusion**, **Coefficient of Molecular Diffusion**.

Diffusion Coefficient (new): The component of mass transport flux of solutes (at the microscopic level) due to variations in solute concentrations within the fluid phases (Bear 1979). Synonymous with **Coefficient of Molecular Diffusion**. This parameter has units of length^2 time^{-1} (example: cm^2/sec).

Direct Contact Exposure (new): Exposure to hazardous substances through ingestion and/or dermal contact (WAC 173-340-200, "Definitions").

Discharge Area (new): An area in which groundwater is discharged to the land surface, surface water, or atmosphere (WRC 1980).

Dispersion Coefficient (new): The component of mass transport flux of solutes caused by velocity variations at the microscopic level (Bear 1979).

Dispersion, Longitudinal (new): Process whereby some of the water molecules and solute molecules travel more rapidly than the average linear velocity and some travel more slowly; spreading of the solute in the direction of the bulk flow (Freeze and Cherry 1979).

Dispersion, Mechanical (new): The process whereby solutes are mechanically mixed during advective transport caused by the velocity variations at the microscopic level (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS). Synonymous with "hydraulic dispersion."

Dispersion, Transverse (new): Spreading of the solute in directions perpendicular to the bulk flow (Freeze and Cherry 1979).

Dispersivity (new): A geometric property of a porous medium which determines the dispersion characteristics of the medium by relating the components of pore velocity to the dispersion coefficient (ANSI/ANS-2.17-1980, *Evaluation of Radionuclide Transport in Ground Water for Nuclear Power Sites*).

Distribution Coefficient (Kd) (new): The quantity of the solute, chemical or radionuclide sorbed by the solid per unit weight of solid divided by the quantity dissolved in the water per unit volume of water (ANSI/ANS-2.17-1980).

Dose (for chemicals that are not radioactive) (new): The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs (Agency for Toxic Substances and Disease Registry – Glossary of Terms).

Dose (for radioactive chemicals) (new): The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment (Agency for Toxic Substances and Disease Registry – Glossary of Terms).

E

Ecological Risk Assessment (new): The application of a formal framework, analytical process, or model to estimate the effects of human actions(s) on a natural resource and to interpret the significance of those effects in light of the uncertainties identified in each component of the assessment process. Such analysis includes initial hazard identification, exposure and dose-response assessments, and risk characterization (U.S. Environmental Protection Agency Solid Waste and Emergency Response Waste and Cleanup Risk Assessment Glossary).

Ecosystem (new): The interacting system of a biological community and its non-living environmental surroundings; a complex system composed of a community of fauna and flora, taking into account the chemical and physical environment with which the system is interrelated.

Ecotoxicity (new): The study of toxic effects on nonhuman organisms, populations, or communities (U.S. Environmental Protection Agency Solid Waste and Emergency Response Waste and Cleanup Risk Assessment Glossary).

Effective Half-life (same): The time required for the amount of a radionuclide deposited in a living organism to be diminished by 50% as a result of the combined action of radioactive decay and biologic elimination. See also **Biological Half-life**, **Decay Constant**, **Radioactive Half-life**.

Engineered Barriers (new): Modern waste containment systems rely on surface and subsurface engineered barriers to contain hazardous and toxic waste, to prevent the offsite flow of contaminants, and/or to render waste less harmful to humans and ecosystems for tens to hundreds or thousands of years, depending on the type of waste, local conditions (e.g., geological setting, climate, land use), and regulations. The barriers may be at the bottom, top (cover), and/or sides (lateral barriers or walls) of the waste containment system, and they usually employ a variety of materials and mechanisms (e.g., liquid extraction) to control contaminant transport. Barriers are made of natural (e.g., soil, clay) and/or synthetic materials, such as polymeric materials (e.g., geomembranes, geosynthetic clay liners), usually arranged in layers.

Environmental Risk (new): Environmental risk is the chance that human health or the environment will suffer harm as the result of the presence of environmental hazards (U.S. Environmental Protection Agency Solid Waste and Emergency Response Waste and Cleanup Risk Assessment Glossary).

Evapotranspiration (new): The combined loss of water from a given area by evaporation from the land and transpiration from plants (SSSA 1975).

Existing TSD Facility (new): A facility which was in operation or for which construction commenced on or before November 19, 1980, for wastes designated by 40 CFR Part 261, or August 9, 1982, for wastes designated only by this chapter and not designated by 40 CFR Part 261. A facility has commenced construction if the owner or operator has obtained permits and approvals necessary under federal, state, and local statutes, regulations, and ordinances and either: 1) A continuous on-site, physical construction program has begun; or 2) The owner or operator has entered into contractual obligation, which cannot be canceled or

modified without substantial loss, for physical construction of the facility to be completed within a reasonable time (WAC 173-303-040, "Definitions").

Exposure (new): Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term (acute exposure), of intermediate duration, or long-term (chronic exposure) (Agency for Toxic Substances and Disease Registry – Glossary of Terms).

Exposure Assessment (new): The goals of the exposure evaluation step of a risk assessment are to analyze contaminant releases; to identify exposed populations; to identify potential exposure pathways; and to estimate exposure concentrations and contaminant intakes for each pathway (EPA/540/1-89/002, Section 1.1.2, Exhibit 1-2).

Exposure Medium (new): The contaminated environmental medium to which an individual is exposed, such as soil, water, sediment and air (U.S. Environmental Protection Agency Solid Waste and Emergency Response Waste and Cleanup Risk Assessment Glossary).

Exposure Parameters (new): "Exposure parameters" means those parameters used to derive an estimate of the exposure to a hazardous substance (WAC 173-340-200, "Definitions").

Exposure Pathways (new): The path a hazardous substance takes or could take from a source to an exposed organism. An exposure pathway describes the mechanism by which an individual or population is exposed or has the potential to be exposed to hazardous substances at or originating from a site. Each exposure pathway includes an actual or potential source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source of the hazardous substance, the exposure pathway also includes a transport/exposure medium (WAC 173-340-200, "Definitions").

Exposure Point (new): A location of potential contact between an organism and a chemical or physical agent (EPA/540/1-89/002, Definitions for Chapter 6).

Exposure Routes (new): The mechanism for which a contaminant comes in contact with a person (e.g., by ingestion, inhalation, dermal contact) (U.S. Environmental Protection Agency Solid Waste and Emergency Response Waste and Cleanup Risk Assessment Glossary).

Exposure Scenarios (new): A set of assumptions concerning how an exposure takes place, including assumptions about the exposure setting, stressor characteristics, and activities of an organism that can lead to exposure (U.S. Environmental Protection Agency Solid Waste and Emergency Response Waste and Cleanup Risk Assessment Glossary).

External Exposure (new): Exposure to radiation outside of the body (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

F

Features, Events, Processes (FEPs) (new): Definitions from NUREG 1804, *Yucca Mountain Review Plan*:

- **Features (new):** A feature is an object, structure, or condition that has a potential to affect disposal system performance

- **Event (new):** An event is a natural or human-caused phenomenon that has a potential to affect disposal system performance and that occurs during an interval that is short compared to the period of performance

- **Process (new):** A process is a natural or human-caused phenomenon that has a potential to affect disposal system performance and that operates during all or a significant part of the period of performance.

Fickian Diffusion (new): Spreading of solutes from regions of highest to regions of lower concentrations caused by the concentration gradient. In slow moving groundwater, this is the dominant mixing process (Freeze and Cherry 1979).

Flow Path (new): The subsurface course a water molecule or solute would follow in a given groundwater velocity field. (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Flow, Steady (new): A characteristic of a flow system where the magnitude and direction of specific discharge are constant in time at any point. See also **Flow, Unsteady** (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Flow, Uniform (new): A characteristic of a flow system where specific discharge has the same magnitude and direction at any point (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Flow, Unsteady (new): A characteristic of a flow system where the magnitude and/or direction of the specific discharge changes with time (Glossary of Hydrologic terms, Oregon Water Science Center, USGS).

Flow Velocity (new): See **Specific Discharge**.

G

Geohydrologic System (new):

(1) See **Groundwater System**.

(2) The geohydrologic units within a geologic setting, including any recharge, discharge, interconnections between units, and any natural or human-induced processes or events that could affect groundwater flow within or among those units (10 CFR Part 960.2).

Geohydrologic Unit (new):

(1) See hydrogeologic unit.

(2) An aquifer, a confining unit, or a combination of aquifers and confining units comprising a framework for a reasonably distinct geohydrologic system (10 CFR Part 960.2).

Groundwater (new):

(1) That part of the subsurface water that is in the saturated zone.

(2) Loosely, all subsurface water as distinct from surface water (ASCE 1985).

(3) All water which occurs below the land surface. It includes both water within the unsaturated and saturated zones (Hackbarth 1985).

(4) Means water below the land surface in a zone of saturation. For purpose of this appendix, groundwater is the water contained within an aquifer (10 CFR Part 40 Appendix A).

(5) All water which occurs below the land surface (10 CFR Part 60.2).

(6) All subsurface water as distinct from surface water (10 CFR Part 960).

(7) Subsurface water that fills available openings in rock or soil materials to the extent that they are considered water-saturated (30 CFR Part 710.5 and 710.5).

(8) Water below the land surface in a zone of saturation (40 CFR 270.2, 40 CFR 146.3, 40 CFR 144.3).

(9) Water in a saturated zone or stratum beneath the surface of land or water (40 CFR 300.6, 40 CFR 257.3-4).

Groundwater, Confined (new): Groundwater under pressure significantly greater than atmospheric and whose upper limit is the bottom of a confining unit (Lohman et al. 1972). See also **Confined**, **Confining Bed**, **Confining Unit**, and **Confined Aquifer**.

Groundwater Discharge (new):

(1) Flow of water from the zone of saturation

(2) The water released from the zone of saturation

(3) The quantity of water released (ASCE 1985).

Groundwater Divide (new): A ridge in the water table or other potentiometric surface from which groundwater moves away in both directions normal to the ridge line (WRC 1980).

Groundwater Flow (new): The movement of water in the zone of saturation.

Groundwater Flux (new):

(1) See **Specific Discharge**.

(2) The rate of groundwater flow per unit area of porous or fractured media measured perpendicular to the direction of flow (10 CFR Part 960.2).

Groundwater Mound (new): A raised area in a water table or other potentiometric surface created by groundwater recharge (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Groundwater, Perched (new):

(1) See **Perched Groundwater**.

(2) Unconfined groundwater separated from an underlying body of ground water by an unsaturated zone. Its water table is a perched water table. Perched groundwater is held up by a perching bed whose permeability is so low that water percolating downward through it is not able to bring water in the underlying unsaturated zone above atmospheric pressure (10 CFR Part 960.2).

Groundwater Recharge (new): The process of water addition to the saturated zone or the volume of water added by this process (ANSI/ANS-2.17-1980).

Groundwater System (new): A groundwater reservoir and its contained water. Also, the collective hydrodynamic and geochemical processes at work in the reservoir (Water-Supply Paper 2275, *National Water Summary 1984—Hydrologic Events, Selected Water-Quality Trends and Ground-Water Resources*).

Groundwater Travel Time (new):

(1) The time required for groundwater to travel between two locations.

(2) The time required for a unit volume of groundwater to travel between two locations. The travel time is the length of the flow path divided by the velocity, where velocity is the average groundwater flux passing through the cross-sectional area of the geologic medium through which flow occurs, perpendicular to the flow direction, divided by the effective porosity along the flow path. If discrete segments of the flow path have different hydrologic properties the total travel time will be the sum of the travel times for each discrete segment (10 CFR Part 960.2).

Groundwater, Unconfined (new): Water in an aquifer that has a water table (Lohman et al. 1972).

H

Half-life (new): The time any substance takes to decay by half of its original amount. See also **Biological Half-life**, **Decay Constant**, **Effective Half-life**, **Radioactive Half-life** (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

Hanford Defined Wastes (HDW) (new): The HDW is a model that was developed in the 1990s and used to estimate the composition of selected radioactive and hazardous chemical constituents in SSTs and double-shell tanks at the Hanford Site. The HDW model is composed of four parts.

1. Compilation of records of waste transfers up to January 1, 1994, for all of the tanks.

2. Solids histories for each tank based on waste additions.

3. Calculation of supernatant blending and concentrations.

4. Combination of process information along with some transaction information to derive compositions for about 50 waste types (which includes all of the waste types sent to C-Farm).

The HDW model uses a spreadsheet format to combine tank waste transfer and process information with Hanford Site irradiated fuel and separation plant process records from the Oak Ridge Isotope Generation 2 (ORIGEN2) model (RPP-13489, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989*) to produce total chemical and radionuclide compositions by waste type. These estimates comprise 46 radionuclides (the standard radioisotopes in the BBI) and 33 nonradioactive species (24 of the 25 standard chemicals from the BBI plus citrate, N-[hydroxyethyl]-ethylenediaminetriacetic acid, ethylenediaminetetraacetic acid, glycolate, acetate, dibutyl phosphate, butanol, ammonia, and ferrocyanide) and four properties (density, water wt%, total organic carbon wt% and sludge void fraction [total organic carbon is a standard constituent in BBI]). The most current version of the HDW is described in RPP-19822, *Hanford Defined Waste Model – Revision 5.0.*

Hanford Soil Inventory Model (SIM) (new): The Hanford SIM is a model in spreadsheet format developed in the early 2000 time frame that has been and is currently used to tabulate waste mass estimates released to the soil profile. The SIM uses the composition and volumes of radiological and hazardous chemical waste based on historical information of waste type and volume of waste releases to the soil profile from past-practice waste sites and facilities at the Hanford Site. The Hanford SIM provides information on waste composition that includes uncertainty estimates for the standard BBI set of 46 radionuclides and 29 chemicals (see Table 5-2 of RPP-RPT-42294, *Hanford Waste Management Area C Soil Contamination Inventory Estimates*, Rev. 1). The current SIM includes composition estimates for 196 waste streams applied to 377 liquid waste disposal sites, UPRs, and tank leaks over their operating lifetimes in intervals of 1 year from 1944 to 2001. The operating times for these sites varied from several weeks to decades in length and could consist of multiple waste streams. These calculated estimates provide uncertainty bounds around the mean waste concentrations as part of a Monte Carlo calculation. Monte Carlo calculations are used to establish a probability

distribution function of the input data to quantify the uncertainties in the input data. The Hanford SIM is described in RPP-26744, *Hanford Soil Inventory Model, Rev. 1*.

Hanford Tank Waste Operations Simulator (HTWOS) (new): HTWOS is a dynamic flow sheet model that tracks and predicts the movement of waste (mass balance) over the entire River Protection Project mission (that is, from current tank contents through treatment to disposal). It establishes the timing and sequencing of key process steps as well as the life-cycle system mass balance using a well-defined set of assumptions (the current set being described in ORP-11242, *River Protection Project System Plan*). The various processes are modeled in sufficient detail to estimate the overall operating conditions of each process and the quantities and composition of the primary and secondary waste streams, taking into account the interactions, including recycle, between the various processes and unit operations. The HTWOS model and validation of the model is described in RPP-RPT-39908, *Hanford Tank Waste Operations Simulator Model (HTWOS) Version 3.0 Verification and Validation Report.*

Hazard Index (new): Hazard index is the sum of two or more hazard quotients for multiple hazardous substances and/or multiple exposure pathways (WAC 173-340-200, "Definitions").

Hazard Quotient (new): The ratio of a single contaminant exposure level over a specified time period to a reference dose for that contaminant derived from a similar period (9 VAC 20-160-10, "Definitions").

Head, Static (new): The height above a standard datum of the surface of a column of water (or other liquid) that can be supported by the static pressure at a given point. The static head is the sum of the elevation head and the pressure head (Lohman et al. 1972).

Head, Total (new): The total head of a liquid at a given point is the sum of three components: (a) the elevation head, which is equal to the elevation of the point above a datum, (b) the pressure head, which is the height of a column of static water that can be supported by the static pressure at the point, and (c) the velocity head, which is the height to which the kinetic energy of the liquid is capable of lifting the liquid (Lohman et al. 1972).

Heterogeneity (new): A characteristic of a medium in which material properties vary from point to point (ANSI/ANS-2.17-1980).

High-Level Wastes (new): In the *Nuclear Waste Policy Act of 1982*, as amended, the term high-level radioactive waste is defined as:

"(A) the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and

(B) Other highly radioactive material that the Commission, consistent with existing law, determines by rule requires permanent isolation."

Homogeneity (new): A characteristic of a medium in which material properties are identical everywhere (Lohman et al. 1972).

Hydraulic Conductivity (new):

(1) A proportionality constant relating hydraulic gradient to specific discharge which for an isotropic medium and homogeneous fluid, equals the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow (after ASCE 1985).

(2) The volume of water that will move through a medium in a unit of time under a unit hydraulic gradient through a unit area measured perpendicular to the direction of flow (10 CFR Part 960.2).

Hydraulic Conductivity, Effective (new): The rate of flow of water through a porous medium that contains more than one fluid, such as water and air in the unsaturated zone, and which should be specified in terms of both the fluid type and content and the existing pressure (Lohman et al. 1972).

Hydraulic Gradient (new):

(1) The change in static head per unit of distance in a given direction. If not specified, the direction generally is understood to be that of the maximum rate of decrease in head (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

(2) Slope of the water table or potentiometric surface (ASCE 1985).

(3) A change in the static pressure of groundwater, expressed in terms of the height of water above a datum, per unit of distance in a given direction (10 CFR Part 960.2).

Hydraulic Head (new): The height above a datum plane (such as sea level) of the column of water that can be supported by the hydraulic pressure at a given point in a ground water system. For a well, the hydraulic head is equal to the distance between the water level in the well and the datum plane (ASCE 1985).

Hydraulic Gradient (new):

(1) The change in static head per unit of distance in a given direction. If not specified, the direction generally is understood to be that of the maximum rate of decrease in head (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

(2) Slope of the water table or potentiometric surface (ASCE 1985).

(3) A change in the static pressure of groundwater, expressed in terms of the height of water above a datum, per unit of distance in a given direction (10 CFR Part 960.2).

Hydraulic Head (new): The height above a datum plane (such as sea level) of the column of water that can be supported by the hydraulic pressure at a given point in a ground water system. For a well, the hydraulic head is equal to the distance between the water level in the well and the datum plane (ASCE 1985).

Hydrogeologic Unit (new):

(1) Any soil or rock unit or zone which by virtue of its hydraulic properties has a distinct influence on the storage or movement of groundwater (ANSI/ANS-2.17-1980).

(2) Means any soil or rock unit or zone which by virtue of its porosity or permeability, or lack thereof, has a distinct influence on the storage or movement of groundwater (10 CFR Part 61.2).

Hydrograph (new): A graph relating stage, flow, velocity, or other characteristics of water with respect to time (after ASCE 1985).

Hydrologic Properties (new): Those properties of a rock that govern the entrance of water and the capacity to hold, transmit, and deliver water, such as porosity, effective porosity, specific retention, permeability, and the directions of maximum and minimum permeabilities (10 CFR Part 960.2).

Hydrostratigraphic Unit (new): See **Hydrogeologic Unit**.

I

Inadvertent Intruder (new): Under DOE Order 435.1, *Radioactive Waste Management*, the "inadvertent intruder" is a hypothetical person who is assumed to inadvertently intrude into the low-level waste disposal facility.

Infiltration (new): The downward entry of water into the soil or rock (SSSA 1975).

Ingestion (new): The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way (see route of exposure) (Agency for Toxic Substances and Disease Registry – Glossary of Terms).

Inhalation (new): The act of breathing. A hazardous substance can enter the body this way (see route of exposure) (Agency for Toxic Substances and Disease Registry – Glossary of Terms).

Institutional Control (new): "Institutional control" means measures undertaken to limit or prohibit activities that may interfere with the integrity of an interim action or a cleanup action or result in exposure to hazardous substances at the site. For examples of institutional controls see WAC 173-340-440, "Institutional Controls," subsection (1). It is a legal or contractual restriction on property use that remains effective after remediation is completed and is used to meet remediation levels. The term may include, but is not limited to, deed and water use restrictions (9 VAC 20-160-10, "Definitions").

Intermediate Duration Exposure (new): Contact with a substance that occurs for more than 14 days and less than a year (compare with **Acute Exposure** and **Chronic Exposure**) (Agency for Toxic Substances and Disease Registry – Glossary of Terms).

Internal Exposure (new): Exposure to radioactive material taken into the body (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

Isotope (new): A nuclide of an element having the same number of protons but a different number of neutrons (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

J

K

L

Low-Level Wastes (new): Under DOE Order 435.1, low-level radioactive waste is defined by what it is not. The definition provides the framework for this concept by listing the basic radioactive waste types that are not low-level waste, thereby limiting the wastes that are to be managed as low-level waste. Thus, an understanding of the definitions of high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material, and naturally occurring radioactive material is necessary to determine whether a subject waste is to be managed as low-level waste in accordance with DOE M 435.1-1, Chapter IV. The definitions of and relevant guidance on high-level waste (see Chapter II.A) and transuranic waste (see Chapter III.A) are contained in the guidance on Chapters II and III of the Manual, respectively. The guidance on definitions in Chapters II and III should be consulted first for making a determination on how to properly manage a suspect waste stream. Specific waste determination cases discussed in that guidance may provide assistance on deciding which radioactive wastes are to be managed as low-level waste. Many of these specific waste stream decisions are referenced and/or discussed again in the following guidance on the definition of low-level waste.

M

Mixed Low-Level Wastes (new): Low-level waste determined to contain both source, special nuclear, or byproduct material subject to the *Atomic Energy Act of 1954*, as amended, and a hazardous component subject to the *Resource Conservation and Recovery Act of 1976* (RCRA), as amended, shall be managed in accordance with the requirements of RCRA and DOE O 435.1, and Chapter 4 of DOE G 435.1-1, *Implementation Guide for use with DOE M 435.1-1, Radioactive Waste Management Manual*.

Models and Code-related Terms:

- **Boundary Conditions (new):** Mathematical statements specifying the dependent variable or the derivative of the dependent variable at the boundaries of a problem domain (*Applied Groundwater Modeling Simulation of Flow and Advective Transport* [Anderson and Woessner 1991]).

- **Calibration (new):** Calibration refers to the process of adjusting estimates of aquifer characteristics used in numerical ground water models. The calibration usually attempts to minimize differences between simulated and measured characteristics such as aquifer water levels (Glossary of Hydrogeology Terms, Idaho Water Resources Research Institute at Idaho Falls).

- **Computer Codes (new): See Numerical Code(s).**

- **Conceptual Models (new):**

  (1) "An evolving hypothesis (or set of hypotheses) identifying the important features, processes, and events controlling fluid flow and contaminant and transport" (National Research Council, *Conceptual Models of Flow and Transport in the Fractured Vadose Zone*).

  (2) A conceptual understanding of a site that identifies potential or suspected sources of hazardous substances, types and concentrations of hazardous substances, potentially contaminated media, and actual and potential exposure pathways and receptors (WAC 173-340-200, "Definitions").

- **Data Abstraction (new):** A process of simplification, to describe something at a more general level than that seen in detailed interpretation of data and other information. The development and implementation of a groundwater flow and transport model would be an excellent example of the data abstraction process. These types of simulation models are typically numerical simplifications of the real natural groundwater flow and solute transport system that attempt to capture the key features, processes, and events to approximate overall system flow and transport processes or phenomena.

  The applicability of such a groundwater model to a real situation depends on the level of detail in the numerical implementation of the conceptual model, the **accuracy** of the input

data and the appropriateness of the estimated parameters to represent the overall behavior of the real system. Determination of these requires considerable study, like collection of hydrological data (rainfall, evapotranspiration, irrigation, drainage) and determination of the parameters mentioned before including pumping tests. As many parameters are quite variable in space, expert judgment is needed to arrive at representative values.

- **Initial Conditions (new):** Mathematical statements specifying the dependent variable or the derivative of the dependent variable at the beginning of a simulation (Anderson and Woessner 1991).

- **Mathematical Model(s) (new):** A model based on a governing equation or set of equations thought to represent important processes. Mathematical models can be solved analytically or numerically.

- **Numerical Code(s) (new):** A generic set of program commands or a computer program that contains numerically-implemented algorithm(s) to solve mathematical model(s).

- **Numerical Model(s) (new):** A numerical implementation of a specific conceptual model or set of conceptual models using a set of data inputs required for a particular numerical code. May require a set of boundary and initial conditions as well as site-specific parameter values and grid resolution to approximate key features, processes, and events of a specific site or domain.

- **Validation (new):** Validation is defined as "The process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model." (AIAA G-077, *Guide for the Verification and Validation of Computational Fluid Dynamics Simulations*). Validation is considered a quality assurance process of establishing evidence that provides a high degree of assurance that a product, service, or system accomplishes its intended requirements. This often involves acceptance of fitness for purpose with end users and other product stakeholders. Model validation is the process of determining whether a model is an adequate representation of the real system being modeled, by comparing the predictions of the model with observations of the real system. Normally contrasted with model verification, although verification will often be a part of the broader process of validation. There is some controversy about the extent to which model validation can be achieved, particularly in relation to modeling the long term migration of radionuclides from radioactive waste in repositories.

- **Verification (new):** Verification is defined as "The process of determining that a model implementation accurately represents the developer's conceptual description of the model and the solution to the model." (AIAA G-077, *Guide for the Verification and Validation of Computational Fluid Dynamics Simulations*). Verification is considered a quality control process that is used to evaluate whether or not a product, service, or system complies with regulations, specifications, or conditions imposed at the start of a development phase. Verification can be in development, scale-up, or production.

Model Toxics Control Act or MTCA (new): "Model Toxics Control Act" or "act" means chapter 70.105D RCW, "Hazardous Waste Cleanup — Model Toxics Control Act," first passed by the voters in the November 1988 general election as Initiative 97 and since amended by the legislature.

Moisture Content (new): The ratio, expressed as a percentage, of either (a) the weight of water to the weight of solid particles expressed as moisture weight percentage or (b) the volume of water to the volume of solid particles expressed as moisture volume percentage in a given volume of porous medium (ASTM 1980). See **Water Content.**

Molecular Diffusion (diffusion) (same): The process whereby solutes are transported at the microscopic level due to variations in the solute concentrations within the fluid phases.

N

Natural Background (new): "Natural background" means the concentration of hazardous substance consistently present in the environment that has not been influenced by localized human activities. For example, several metals and radionuclides naturally occur in the bedrock, sediments, and soils of Washington State due solely to the geologic processes that formed these materials and the concentration of these hazardous substances would be considered natural background. Also, low concentrations of some particularly persistent organic compounds such as polychlorinated biphenyls (PCBs) can be found in surficial soils and sediment throughout much of the State due to global distribution of these hazardous substances. These low concentrations would be considered natural background. Similarly, concentrations of various radionuclides that are present at low concentrations throughout the state due to global distribution of fallout from bomb testing and nuclear accidents would be considered natural background (WAC 173-340-200, "Definitions").

Non-Carcinogen (new): **A** term, for the purposes of risk assessment, which defines a chemical agent for which there is either inadequate toxicological data or is not likely to be a carcinogen based on an EPA weight-of-evidence classification system (9 VAC 20-160-10, "Definitions").

Non-Detect (new): **C**hemicals that are not detected in a sample above a certain limit, usually the quantitation limit for the chemical in the sample (EPA/540/1-89/002).

Nuclide (new): A general term applicable to all atomic forms of an element. Nuclides are characterized by the number of protons and neutrons in the nucleus, as well as by the amount of energy contained within the atom (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

O

P

Percent Saturation (new): The ratio, expressed as a percentage, of (a) the volume of water to (b) the total volume of intergranular space (voids) in a given porous medium (ASTM 1980). Synonymous with degree of saturation.

Perched Groundwater (new):

(1) Groundwater separated from an underlying body of groundwater by an unsaturated zone (ASCE 1985).

(2) Unconfined groundwater separated from an underlying body of groundwater by an unsaturated zone. Its water table is a perched water table. Perched groundwater is held up by a perching bed whose permeability is so low that water percolating downward through it is not able to bring water in the underlying unsaturated zone above atmospheric pressure (10 CFR Part 960.2).

Performance Assessment related topics:

- **TPA PA (revised):** The assessment that evaluates "whether SST system closure conditions are protective of human health and the environment for all contaminants of concern, both radiological and non-radiological. DOE intends that this performance assessment (PA) will document by reference relevant performance requirements defined by RCRA, HWMA, *Clean Water Act, Safe Drinking Water Act*, and the *Atomic Energy Act of 1954* (AEA) and any other performance requirements that might be ARARs under CERCLA. The PA is of larger scope than a risk assessment required solely for non-radiological contaminants. The PA is expected to provide a single source of information that DOE can use to satisfy potentially duplicative functional and/or documentation requirements. A PA will be developed for each WMA and will incorporate the latest information available." (*Hanford Federal Facility Agreement and Consent Order*, Appendix I, Section 2.5).

- **DOE PA (revised):** "An analysis of a radioactive waste disposal facility conducted to demonstrate there is a reasonable expectation that performance objectives established for the long-term protection of the public and the environment will not be exceeded following closure of the facility." (DOE M 435.1-1)

Performance Objective (new): In DOE Order 435.1, performance objectives are specific objectives that quantify, where possible, the desired protection of the public and the environment from disposed-of low-level waste. Specifically, these objectives are as follows.

- Dose to representative members of the public shall not exceed 25 mrem (0.25 mSv) in a year total effective dose equivalent from all exposure pathways, excluding the dose from radon and its progeny in air.

- Dose to representative members of the public via the air pathway shall not exceed 10 mrem (0.10 mSv) in a year total effective dose equivalent, excluding the dose from radon and its progeny.

- Release of radon shall be less than an average flux of 20 pCi/m2/s (0.74 Bq/m2/s) at the surface of the disposal facility. Alternatively, a limit of 0.5 pCi/1 (0.0185 Bq/l) of air may be applied at the boundary of the facility.

For purposes of establishing limits on the concentration of radionuclides that may be disposed of near-surface, another performance objective related to the assessment of impacts calculated for a hypothetical person assumed to inadvertently intrude for a temporary period into the low-level waste disposal facility has been established. For this intruder analysis, institutional controls shall be assumed to be effective in deterring intrusion for at least 100 years following closure. The intruder analysis shall use performance objectives/measures for chronic and acute exposure scenarios, respectively, of 100 mrem (1 mSv) in a year and 500 mrem (5 mSv) total effective dose equivalent excluding radon in air.

Permeability (new): The property of a porous medium to transmit fluids under a hydraulic gradient (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Permeability, Effective (new): The observed permeability of a porous medium to one fluid phase under conditions of physical interaction between this phase and other fluid phases present (Bates and Jackson 1980).

Permeability, Intrinsic (new):

(1) A measure of the relative ease with which a porous medium can transmit a fluid under a potential gradient and is a property of the medium alone (Lohman et al. 1972).

(2) The property of a porous medium itself that expresses the ease with which gases, liquids, or other substances can pass through it (SSSA 1975).

Permeability, Relative (new):

(1) The ratio of the effective permeability for a given flow phase to the intrinsic permeability of the porous medium (WMO 1974).

(2) The ratio of the effective and specific permeabilities (Thrush 1968).

Piezometer (new): A devise used to measure groundwater pressure head at a point in the subsurface (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Piezometric Surface (new): See **Potentiometric Surface**.

Points of Compliance (new): "Point of compliance" means the point or points where cleanup levels established in accordance with WAC 173-340-720, "Ground Water Cleanup Standards" through 173-340-760, "Sediment Cleanup Standards" shall be attained. This term includes both

standard and conditional points of compliance. A conditional point of compliance for particular media is only available as provided in WAC 173-340-720 through 173-340-760.

Points of Assessment (new): "Point of assessment" means the point or points where model calculations and results will be provided in an assessment.

Population (new): A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Pore Velocity (new): See **Velocity, Average Interstitial**.

Porosity (new):

(1) The ratio, usually expressed as a percentage, of the total volume of voids of a given porous medium to the total volume of the porous medium (after ASTM 1980).

(2) The volume percentage of the total bulk not occupied by solid particles (SSSA 1975).

Porosity, Effective (new):

(1) The ratio, usually expressed as a percentage, of the total volume of voids available for fluid transmission to the total volume of the porous medium.

(2) The ratio of the volume of the voids of a soil or rock mass that can be drained by gravity to the total volume of the mass (ASTM 1980).

(3) The amount of interconnected pore space and fracture openings available for the transmission of fluids, expressed as the ratio of the volume of interconnected pores and openings to the volume of rock (10 CFR Part 960.2).

Post-closure (new): The time period following the shutdown of a waste management or manufacturing facility (Glossary of Environmental Terms, City of St. Pete Beach, Florida Department of Public Works).

Potentiometric Surface (new): An imaginary surface representing the static head of groundwater and defined by the level to which water will rise in a tightly cased well (Lohman et al. 1972).

Pressure Head (new): Hydrostatic pressure expressed as the height of a column of water that the pressure can support at the point of measurement. See also **Head, Static**, and pressure, hydrostatic (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Pressure, Hydrostatic (same): The pressure exerted by the weight of water at any given point in a body of water at rest (*Glossary of Geology* [Bates and Jackson 1980]).

Probabilistic Analysis (new): A mathematical analysis of stochastic events or processes and their consequences (such an analysis is often performed through random simulation of the system, e.g., using Monte Carlo analysis).

Probabilistic Risk Assessment (new): "Probabilistic risk assessment" means a mathematical technique for assessing the variability and uncertainty in risk calculations. This is done by using distributions for model input parameters, rather than point values, where sufficient data exists to justify the distribution. These distributions are then used to compute various simulations using tools such as Monte Carlo analysis to examine the probability that a given outcome will result (such as a level of risk being exceeded). When using probabilistic techniques under this chapter for human health risk assessment, distributions shall not be used to represent dose response relationships (reference dose, reference concentration, cancer potency factor) (WAC 173-340-200, "Definitions").

Process-level Models (new): Model implementations that approximate key features, events, and/or processes of a site conceptual model using highly discretized, numerical modeling approaches. An example of process-level models would be the detailed cross-sectional numerical models used to approximate recharge, flow and contaminant transport processes through the buried tank to the underlying unsaturated and saturated zones as was done in the SST PA.

Q

Quality Assurance (new): An integrated system of planning, quality control, assessment, improvement and reporting (EPA 540-R-98-038, *Quality Assurance Guidance for Conducting Brownfields Site Assessments)*.

Quality Control (new): A system of technical activities that measure and control quality so that data meet users' needs (EPA 540-R-98-038).

R

Rad (radiation absorbed dose) (new): A basic unit of absorbed radiation dose. It is a measure of the amount of energy absorbed by the body. The rad is the traditional unit of absorbed dose. It is being replaced by the unit gray (Gy), which is equivalent to 100 rad. One rad equals the dose delivered to an object of 100 ergs of energy per gram of material (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

Radioactive Decay (new): The spontaneous disintegration of the nucleus of an atom (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

Radioactive Half-life (new): The time required for a quantity of a radioisotope to decay by half. For example, because the half-life of iodine-131 (I-131) is 8 days, a sample of I-131 that has 10 mCi of activity on January 1, will have 5 mCi of activity 8 days later, on January 9. See also **Biological Half-life**, **Decay Constant**, **Effective Half-life** (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

Radioactive Material (new): Material that contains unstable (radioactive) atoms that give off radiation as they decay (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

Radioactivity (new): The process of spontaneous transformation of the nucleus, generally with the emission of alpha or beta particles often accompanied by gamma rays. This process is referred to as decay or disintegration of an atom (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

Radioisotope (new): An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation (NUREG-0770, *Glossary of Terms, Nuclear Power and Radiation*).

Radionuclide (new): A radioisotope (NUREG-0770).

Range Fire (new): Any uncontrolled fire in combustible vegetation that occurs in the range land or desert environment. Any wildfire on rangeland (National Wildfire Coordinating Group Glossary of Wildland Fire Terminology).

RCRA Corrective Action (same): Activities to address past releases from facility (WAC 173-303-64620, "Requirements").

RCRA Facility Investigation (RFI) (same): The purpose of an RFI is to gather sufficient data at a facility to fully characterize the nature, extent, and rate of migration of contaminant releases identified in the RCRA Facility Assessment. The data generated during the RFI is used to determine the potential need for corrective measures and to aid in the selection and implementation of these measures. See also **Corrective Measure Study (CMS)** and *Resource Conservation and Recovery Act of 1976*.

Reasonable Maximum Exposure (new): "Reasonable maximum exposure" means the highest exposure that can be reasonably expected to occur for a human or other living organisms at a site under current and potential future site use (WAC 173-340-200, "Definitions").

Receptor (new): The species, population, community, habitat, etc. that may be exposed to contaminants (U.S. Environmental Protection Agency Region 5 Superfund Ecological Risk Assessment – Glossary of Terms).

Recharge (new): The process of addition of water to the saturated zone; also the water added (Water-Supply Paper 2275).

Recharge Area (new): An area in which water reaches the zone of saturation by surface infiltration (Heath 1984).

Regulatory Agencies (revised): For this process

U.S. Department of Energy

- Office of Environmental Management
- Office of River Protection
- Richland Operations Office

U.S. Environmental Protection Agency

U.S. Nuclear Regulatory Commission

Washington State Department of Ecology

Rem (roentgen equivalent, man) (new): A unit of equivalent dose. Not all radiation has the same biological effect, even for the same amount of absorbed dose. Rem relates the absorbed dose in human tissue to the effective biological damage of the radiation. It is determined by multiplying the number of rads by the quality factor, a number reflecting the potential damage caused by the particular type of radiation. The rem is the traditional unit of equivalent dose, but it is being replaced by the sievert (Sv), which is equal to 100 rem (Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary).

Restricted Use (new): Any use other than residential (9 VAC 20-160-10, "Definitions").

Retardation Factor (new): The ratio of the average linear velocity of groundwater to the velocity of the retarded constituent at C/Co=0.5 (Freeze and Cherry 1979).

Risk (new): "Risk" means the probability that a hazardous substance, when released into the environment, will cause an adverse effect in exposed humans or other living organisms (WAC 173-340-200, "Definitions").

Risk Assessment (new): The process used to determine the risk posed by contaminants released into the environment. Elements include identification of the contaminants present in the environmental media, assessment of exposure and exposure pathways, assessment of the toxicity of the contaminants present at the site, characterization of human health risks, and characterization of the impacts or risks to the environment (9 VAC 20-160-10, "Definitions").

Route of Exposure (same): The way people come into contact with a hazardous substance. Three routes of exposure are breathing (inhalation), eating or drinking (ingestion), or contact with the skin (dermal contact).

S

Saturated Zone (new):

(1) Those parts of the earth's crust in which all voids are filled with water under pressure greater than atmospheric (Lohman et al. 1972).

(2) That part of the earth's crust beneath the regional water table in which all voids, large and small, are filled with water under pressure greater than atmospheric (Hackbarth 1985).

(3) Means that part of the earth's crust beneath the regional water table in which all voids, large and small, are ideally filled with water under pressure greater than atmospheric (10 CFR Part 60.2).

(4) Means that part of the earth's crust beneath the water table in which all voids, large or small, are ideally filled with water under pressure greater than atmospheric (10 CFR Part 960.2).

Scenarios (new): Scenarios are descriptions of alternative, but internally consistent, future evolutions and conditions of the waste disposal system. They handle future uncertainty directly by describing alternative futures and allow for a mixture of quantitative analysis and qualitative judgments (IAEA 2004).

Sensitivity Analysis (new): Sensitivity studies are used to determine the relative importance of an input parameter to the resulting outcome in a mathematical model. For example, if the vadose zone hydraulic conductivity increases by a factor of 10, does the outcome increase/decrease by a similar amount or did it remain approximately the same as before the increase.

> *Discrete sensitivity analysis* is implemented by making a specific change to the value of one or more parameters. This approach is used in association with deterministic modeling, in which different cases are explored by changing input parameter values. Note that it can be applied to probabilistic modeling, in which a probabilistic parameter (e.g., a parameter of a distribution) can be changed discretely.
>
> *Global sensitivity analysis* is implemented by statistical analysis of the relationship between the input variables (parameters) and the output variable(s), or, the study of how the variation in the output of a model (numerical or otherwise) can be apportioned to different sources of variation in the input. This approach effectively involves changing all input variables simultaneously, and leads to identification of variables that are the best predictors of the model output. This can be followed by value of information analysis to determine where resources should be expended to reduce the overall uncertainty in the response.

Sensitivity Cases (new): A set of modeling cases selected to evaluate the sensitivity of outcomes to changes in parameters.

Slope Factor (new): An upper bound, approximating a 95% confidence limit, on the increased cancer risk from a lifetime exposure to an agent. This estimate, usually expressed in units of

proportion (of a population) affected per mg/kg/day, is generally reserved for use in the low-dose region of the dose-response relationship, that is, for exposures corresponding to risks less than 1 in 100 *(U.S. Environmental Protection Agency Integrated Risk Information System Glossary)*.

Soil Bulk Density (new): The mass of dry soil per unit bulk soil (SSSA 1975).

Soil Inventory (new): Inventory of radioactive and hazardous chemical constituents estimated to have been released to the soil from historical planned and unplanned releases for waste sites, facilities and operational activities at the Hanford Site.

Soil Moisture (new): Subsurface liquid water in the unsaturated zone expressed as a fraction of the total porous medium volume occupied by water. It is less than or equal to the porosity (Hackbarth 1985).

Solubility (new): The total amount of solute species that will remain indefinitely in a solution maintained at constant temperature and pressure in contact with the solid crystals from which the solutes were derived (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Solute (new): The substance present in a solution in the smaller amount. For convenience, water is generally considered the solvent even in concentrated solutions with water molecules in the minority (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Solute Transport (new): The net flux of solute through a hydrogeologic unit controlled by the flow of subsurface water and transport mechanisms (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

Sorption (new):

(1) A general term used to encompass the process of absorption and adsorption.

(2) All processes which remove solutes from the fluid phase and concentrate them on the solid phase of the medium (ANSI/ANS-2.17-1980).

Specific Conductance (new): A measure of the ability of water to conduct an electrical current expressed in micromhos per centimeter at 25°C (ASCE 1985).

Specific Discharge (new): The rate of discharge of groundwater per unit area of a porous medium measured at right angle to the direction of flow (Lohman et al. 1972). Synonymous with flow velocity or specific flux.

Specific Retention (new): The ratio of the volume of water which the porous medium, after being saturated, will retain against the pull of gravity to the volume of the porous medium (Lohman et al. 1972).

Specific Storage (new): The volume of water released from or taken into storage per unit volume of the porous medium per unit change in head (Lohman et al. 1972).

Specific Yield (new): The ratio of the volume of water which the porous medium, after being saturated, will yield by gravity to the volume of the porous medium (Lohman et al. 1972).

Surface Water (new): "Surface water" means lakes, rivers, ponds, streams, inland waters, salt waters, and all other surface waters and water courses within the State of Washington or under the jurisdiction of the State of Washington (WAC 173-340-200, "Definitions").

System (revised): Per Appendix I of the HFFACO, the System is defined as "… the Single-Shell Tanks (SSTs) themselves; and associated ancillary equipment including waste transfer piping, valve pits, vaults, etc.; contaminated soils, and contaminated groundwater." (*Hanford Federal Facility Agreement and Consent Order*, Appendix I, p. I-1).

System-level Models (new): Model implementations that approximate key features, events, and/or processes of a site-conceptual model using coarser or more compartmentalized modeling approaches that are more suitable for modeling under uncertainty. These types of models are typically developed from observations and/or data using a process of abstraction from data or more detailed process models.

T

Tank Farm (revised): Group of tanks and associated facilities, including soils. A tank farm is defined by fence line. There are 12 single-shell tank farms at Hanford (A, AX, B, BX, BY, C, S, SX, T, TX, TY, and U).

Tank Residual Inventory (new): Radioactive and hazardous chemical constituent inventories in tank waste residuals left after tank waste retrieval is completed.

Terrestrial Ecological Receptors (new): Plants and animals that live primarily or entirely on land (WAC 173-340-200, "Definitions").

Time Frame of Assessment (new): The time frame over which model calculations and results will be provided in an assessment.

Total Dissolved Solids (new):

(1) The total concentration of dissolved constituents in solution, usually expressed in milligrams per liter.

(2) The total concentration of dissolved material in water [as] ordinarily determined from the weight of the dry residue remaining after evaporation of the volatile portion of an aliquot of the water sample (*Study and Interpretation of the Chemical Characteristics of Natural Water* [Hem 1985]).

Total Excess Cancer Risk (new): "Total excess cancer risk" means the upper bound on the estimated excess cancer risk associated with exposure to multiple hazardous substances and multiple exposure pathways (WAC 173-340-200, "Definitions").

Total Effective Dose Equivalent (TEDE) (new): The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures) (U.S. Nuclear Regulatory Commission Glossary).

Toxicity (new): The degree to which a chemical substance elicits a deleterious or adverse effect upon the biological system of an organism exposed to the substance over a designated time period (U.S. Environmental Protection Agency Integrated Risk Information System Glossary).

Transmissivity (new): The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient. It is equal to an integration of the hydraulic conductivities across the saturated part of the aquifer perpendicular to the flow paths (Lohman et al. 1972).

Transuranic Wastes (new): According to DOE Order 435.1, "transuranic wastes" is defined as radioactive waste containing more than 100 nanocuries (3,700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for:

- High-level radioactive waste;
- Waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or
- Waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61.

TSD (same): Treatment, storage, or disposal unit.

U

Uncertainty Analysis (new): An evaluation of how: 1) definition of the physical setting; 2) model applicability and assumptions; 3) transport, fate and exposure parameter values; and 4) magnification of potential error through the steps of the risk assessment contribute to uncertainty in the results (EPA/540/1-89/002, Section 8.4.1).

Essentially, it is a comparison of probabilistic output with objectives of interest, or, the magnitude of the uncertainty of the model responses. Different statistical measures might be used to characterize the model output uncertainty, such as the standard deviation, or the range, or 95th percentiles of the simulated output data.

For deterministic modeling, uncertainty analysis pertains to an evaluation of how uncertainty in the input values might affect the output. Often this occurs when conservative values are used for some inputs, and some qualitative recognition is given to the potential for overestimating the response.

Unconfined Aquifer (new): An aquifer in which the water table forms the upper boundary (Freeze and Cherry 1979).

Unplanned Release (UPR) (new): A category of releases used for unexpected releases from waste sites and facilities at the Hanford Site as a part of the Waste Information Data System (WIDS).

Unrestricted Use (new): The designation of acceptable future use for a site at which the remediation levels, based on either background or standard residential exposure factors, have been attained throughout the site in all media (9 VAC 20-160-10, "Definitions").

Unsaturated Zone (new):

(1) The zone between the land surface and the water table (ASCE 1985).

(2) The zone between the land surface and the deepest water table which includes the capillary fringe. Water in this zone is generally under less than atmospheric pressure, and some of the voids may contain air or other gases at atmospheric pressure. Beneath flooded areas or in perched water bodies the water pressure locally may be greater than atmospheric (Lohman et al. 1972).

(3) The zone between the land surface and the regional water table. Generally, water in this zone is under less than atmospheric pressure, and some of the voids may contain air or other gases at atmospheric pressure. Beneath flooded areas or in perched water bodies the water pressure locally may be greater than atmospheric (Hackbarth 1985).

(4) Means the zone between the land surface and the regional water table. Generally, fluid pressure in this zone is less than atmospheric pressure, and some of the voids may contain air or other gases at atmospheric pressure. Beneath flooded areas or in perched water bodies the fluid pressure locally may be greater than atmospheric (10 CFR Part 60.2).

(5) The zone between the land surface and the water table. Generally, water in this zone is under less than atmospheric pressure, and some of the voids may contain air and other gases at atmospheric pressure. Beneath flooded areas or in perched water bodies, the water pressure locally may be greater than atmospheric (10 CFR Part 960.2).

V

Vadose Zone Sediments (revised): Unsaturated medium between the surface and groundwater (also collectively known as the vadose zone).

Variability (new): The range of possible outcomes of a given situation.

Velocity, Average Interstitial (same): The average rate of groundwater flow in interstices expressed as the product of hydraulic conductivity and hydraulic gradient divided by the effective porosity (Lohman et al. 1972). Synonymous with average linear groundwater velocity or effective velocity.

Volatiles or Volatile Compounds (new): Substances with relatively large vapor pressures. Many organic substances are almost insoluble in water so that they occur primarily in a gas phase in contact with water, even though their vapor pressure may be very small (Glossary of Hydrologic Terms, Oregon Water Science Center, USGS).

W

WAC (new): Washington Administrative Code.

Waste Management Area (WMA) (same): A collection of single-shell tank farms. There are seven SST WMAs at Hanford: A-AX, B-BX-BY, C, S-SX, T, TX-TY, and U.

Waste Incidental to Reprocessing (WIR) (new): Wastes that are incidental to the reprocessing of nuclear fuel that can be managed as low-level waste as defined by criteria in DOE Order 435.1.

Waste Information Data System (WIDs) (new): An information database system used to catalog all waste sites and facilities at the Hanford Site.

Water Content (new): The amount of water lost from the soil after drying it to constant weight at 105°C, expressed either as the weight of water per unit weight of dry soil or as the volume of water per unit bulk volume of soil (ASTM 1980). See also **Moisture Content**.

Water Table (new):

(1) The upper surface of a zone of saturation except where that surface is formed by a confining unit (after Lohman 1972).

(2) The upper surface of the zone of saturation on which the water pressure in the porous medium equals atmospheric pressure.

(3) Means that surface in a groundwater body at which the water pressure is atmospheric (10 CFR Part 60.2).

(4) That surface in a body of groundwater at which the water pressure is atmospheric (10 CFR Part 960.2).

(5) Upper surface of a zone of saturation, where the body of ground water is not confined by an overlying impermeable zone (30 CFR Part 701.5 and 710.5).

Water-table Aquifer (new): See **Unconfined Aquifer**.

Well (new): A bored, drilled or driven shaft, or a dug hole, whose depth is greater than the largest surface dimension (40 CFR 144.3 and 40 CFR 146.3).

Weather (new): The state of the atmosphere with respect to wind, temperature, cloudiness, moisture, pressure, etc. **Weather** refers to these conditions at a given point in time (e.g., today's high temperature), whereas **Climate** refers to the "average" weather conditions for an area over a long period of time (e.g., the average high temperature for today's date) (National Oceanic and Atmospheric Administration National Weather Service Glossary).

WMA C Supplemental Cumulative Assessment (revised): An analysis that accounts for all sources of radioactive and chemical hazardous material (other than those in the WMA C long-term human health and environmental assessment) that may contribute to long-term groundwater impacts at the points and times of assessment of the WMA C long-term human health and environmental assessment.

X

Y

Z

Glossary References

10 CFR 0-199, Chapter I, "Nuclear Regulatory Commission," *Code of Federal Regulations*, as amended.

10 CFR 700-999, Chapter III, "Department of Energy," *Code of Federal Regulations*, as amended.

30 CFR 700-999, Chapter VII, "Office of Surface Mining, Reclamation and Enforcement, Department of the Interior," *Code of Federal Regulations*, as amended.

40 CFR 1-799, Chapter I, "Environmental Protection Agency," *Code of Federal Regulations*, as amended.

9 VAC 20-80-10, "Definitions," *Virginia Administrative Code*, as amended.

9 VAC 20-160-10, "Definitions," *Virginia Administrative Code*, as amended.

Agency for Toxic Substances and Disease Registry – Glossary of Terms, http://www.atsdr.cdc.gov/glossary.html

AIAA G-077, 1998, *Guide for the Verification and Validation of Computational Fluid Dynamics Simulations*, American Institute of Aeronautics and Astronautics, Reston, Virginia.

Anderson, M. P. and W. W. Woessner, 1991, *Applied Groundwater Modeling Simulation of Flow and Advective Transport*, Academic Press, Inc., San Diego, California.

ANSI/ANS-2.17-1980, 1980, *Evaluation of Radionuclide Transport in Ground Water for Nuclear Power Sites*, American National Standards Institute/American Nuclear Society, La Grange Park, Illinois.

ASCE, 1985, *Ground Water Management (Manual of Practice No. 40)*, Subcommittee on Ground Water Management of the Committee on Ground Water of the Irrigation and Drainage Division of the American Society of Civil Engineers, New York, New York.

ASTM, 1980, "Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics," in (D653-80) *1981 Annual Book of ASTM Standards, Part 19*, American Society for Testing Materials, Philadelphia, Pennsylvania, p. 1402-1419.

Atomic Energy Act of 1954, 42 USC 2011, et seq., as amended.

Bates, R. L., and J. A. Jackson, 1980, *Glossary of Geology*, Second Edition, American Geological Institute, Falls Church, Virginia.

BHI-01103, 1999, *Clastic Injection Dikes of the Pasco Basin and Vicinity: Geologic Atlas Series*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

Bear, J., 1979, *Hydraulics of Groundwater*, McGraw-Hill Companies, New York, New York.

Centers for Disease Control and Prevention – Emergency Preparedness and Response Radiation Dictionary, http://www.bt.cdc.gov/radiation/glossary.asp#d

Clean Water Act of 1972, 33 USC 1251 et seq.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC § 9601 et seq.

COV 10.1-1400, "Definitions," *Code of Virginia*, as amended.

COV 62.1-44.34:8, "Definitions," *Code of Virginia*, as amended.

COV 62.1-44.34:14, "Definitions," *Code of Virginia*, as amended.

Darcy, H., 1856, *Les Fontaines Publiques de la Ville de Dijon*, Victor Dalmont, Paris, France.

DOE G 435.1-1, 1999, *Implementation Guide for Use with DOE M 435.1-1, Radioactive Waste Management Manual*, U.S. Department of Energy, Washington, D.C.

DOE M 435.1-1, 1999, *Radioactive Waste Management Manual*, U.S. Department of Energy, Washington, D.C.

DOE O 435.1, 1999, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C.

DOE/ORP-2005-01, 2006, *Initial Single-Shell Tank System Performance Assessment for the Hanford Site*, Rev. 0, U.S. Department of Energy Office of River Protection, Richland, Washington.

DOE/ORP-2008-01, 2010, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*, Rev. 1, U.S. Department of Energy, Office of River Protection, Richland, Washington.

Domenico, P. A., and F. W. Schwartz, 1998, *Physical and Chemical Hydrogeology*, Second Edition, John Wiley and Sons, Inc., New York, New York.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order – Tri-Party Agreement*, 2 vols., as amended, State of Washington Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

EPA 540-R-98-038, 1998, *Quality Assurance Guidance for Conducting Brownfields Site Assessments*, OSWER Directive 9230.0-83P, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA/540/1-89/002, 1989, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final*, U.S. Environmental Protection Agency, Washington, D.C.

EPA-600/7-80-134, 1980, *Monitoring In The Vadose Zone: A Review of Technical Elements and Methods – Interagency Energy-Environment Research and Development Program Report*, U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

Freeze, R. A. and J. A. Cherry, 1979, *Groundwater*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Geology.com, http://geology.com/rocks/basalt.shtml

Glossary, California Department of Toxics Substances Control, http://www.dtsc.ca.gov/InformationResources/Glossary_of_Environmental_Terms.cfm

Glossary of Environmental Health Terms, New York State Department of Health, http://www.health.state.ny.us/environmental/glossary/

Glossary of Environmental Terms, City of St. Pete Beach, Florida Department of Public Works, http://www.stpetebeach.org/glossary/p.asp

Glossary of Hydrogeology Terms, Idaho Water Resources Research Institute at Idaho Falls, http://www.if.uidaho.edu/~johnson/ifiwrri/sr3/gloss.html.

Glossary of Hydrologic Terms, Oregon Water Science Center, USGS, http://or.water.usgs.gov/projs_dir/willgw/glossary.html

GreenFacts – Facts on Health and the Environment, http://www.greenfacts.org/glossary/def/ecosystem.htm

Hackbarth, C. J., T. J. Nicholson, and D. D. Evans, 1985, *NUREG-1046, Disposal of High-Level Radioactive Wastes in the Unsaturated Zone—Technical Considerations and Response to Comments*, U.S. Nuclear Regulatory Commission, Washington, D.C.

Heath, R. C., 1984, *Ground-Water Regions of the United States*, Water-Supply Paper 2242, U.S. Geological Survey, Washington, D.C.

Hem, J. D., 1985, *Study and Interpretation of the Chemical Characteristics of Natural Water*, Third Edition, Water-Supply Paper 2254, U.S. Geological Survey, Alexandria, Virginia.

IAEA, 1993, *Radioactive Waste Management Glossary*, International Atomic Energy Agency, Vienna, Austria.

IAEA, 2004, *Safety Assessment Methodologies for Near Surface Disposal Facilities, Results of a co-ordinated research project, Volume 1: Review and enhancement of safety assessment approaches and tools*, International Atomic Energy Agency, Vienna, Austria.

Lohman, S. W., 1972, *Ground-Water Hydraulics*, Professional Paper 708, U.S. Geological Survey, Washington, D.C.

Lohman, S. W., R. R. Bennett, R. H. Brown, H. H. Cooper, Jr., W. J. Drescher, J. G. Ferris, A. I. Johnson, C. L. McGuinness, A. M. Piper, M. I. Rorabaugh, R. W. Stallman, and C. V. Theis, 1972, *Definitions of Selected Ground-Water Terms—Revisions and Conceptual Refinements*, Water-Supply Paper 1988, U.S. Geological Survey, Washington, D.C.

National Oceanic and Atmospheric Administration National Weather Service Glossary, http://www.crh.noaa.gov/glossary.php

National Research Council, 2001, *Conceptual Models of Flow and Transport in the Fractured Vadose Zone*, National Academy Press, Washington, D.C.

National Wildfire Coordinating Group Glossary of Wildland Fire Terminology, http://www.nwcg.gov/pms/pubs/glossary/

Nuclear Waste Policy Act of 1982, 42 USC 10101, et seq.

NUREG-0770, 1981, *Glossary of Terms, Nuclear Power and Radiation*, U.S. Nuclear Regulatory Commission, Washington, D.C.

NUREG-1804, 2003, *Yucca Mountain Review Plan*, Rev. 2, U.S. Nuclear Regulatory Commission, Washington, D.C.

Open File Report 94-8, 1994, *Geologic Map of the Richland 1:100,000 Quadrangle*, Washington, Washington State Department of Natural Resources, Olympia, Washington.

Open File Report 94-13, 1994, *Geologic Map of the Priest Rapids 1:100,000 Quadrangle*, Washington, Washington State Department of Natural Resources, Olympia, Washington.

ORP-11242, 2010, *River Protection Project System Plan*, Rev. 5, U.S. Department of Energy, Office of River Protection, Richland, Washington.

RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, as amended.

RCW 70.105D, "Hazardous Waste Cleanup — Model Toxics Control Act," *Revised Code of Washington*, as amended.

Regulatory Guide 4.17, 1987, *Standard Format and Content of Site Characterization Plans for High-Level-Waste Geologic Repositories*, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, D.C.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.

RPP-13489, 2002, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-19822, 2004, *Hanford Defined Waste Model – Revision 5.0*, Rev. 0, CH2M Hill Hanford Group, Inc., Richland, Washington.

RPP-26744, 2005, *Hanford Soil Inventory Model, Rev. 1*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-39908, 2009, *Hanford Tank Waste Operations Simulator Model (HTWOS) Version 3.0 Verification and Validation Report*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-42294, 2010, *Hanford Waste Management Area C Soil Contamination Inventory Estimates*, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.

Safe Drinking Water Act of 1974, 42 USC 300, et seq.

SSSA, 1975, *Glossary of Soil Science Terms*, Soil Science Society of America, Madison, Wisconsin.

State of Washington Department of Ecology Toxics Cleanup Program Acronyms and Glossary, http://www.ecy.wa.gov/programs/tcp/tcp_acronym_list.htm

Stumm, W. and J. J. Morgan, 1981, *Aquatic Chemistry*, Second Edition, John Wiley and Sons, New York, New York.

Thrush, P. W., ed., 1968, A Dictionary of Mining, Mineral, and Related Terms, Bureau of Mines, U.S. Department of the Interior, Washington, D.C.

U.S. Environmental Protection Agency Glossary of Terms and Acronyms Superfund A - L, Superfund, http://www.epa.gov/superfund/training/hrstrain/htmain/glossal.htm

U.S. Environmental Protection Agency Integrated Risk Information System Glossary, http://www.epa.gov/iris/help_gloss.htm

U.S. Environmental Protection Agency Region 5 Superfund Ecological Risk Assessment – Glossary of Terms, http://www.epa.gov/R5Super/ecology/html/glossary.html

U.S. Environmental Protection Agency Solid Waste and Emergency Response Waste and Cleanup Risk Assessment Glossary, http://earth1.epa.gov/oswer/riskassessment/glossary.htm

U.S. Nuclear Regulatory Commission Glossary, http://www.nrc.gov/reading-rm/basic-ref/glossary.html

WA7 89000 8967, 2007, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Rev. 8C, State of Washington Department of Ecology, Richland, Washington.

WAC 173-303-040, "Definitions," *Washington Administrative Code*, as amended.

WAC 173-303-610, "Closure and Post-Closure," *Washington Administrative Code*, as amended.

WAC 173-340-200, "Definitions," *Washington Administrative Code*, as amended.

WAC 173-340-440, "Institutional Controls," *Washington Administrative Code*, as amended.

WAC 173-340-720, "Ground Water Cleanup Standards," *Washington Administrative Code*, as amended.

WAC 173-340-760, "Sediment Cleanup Standards," *Washington Administrative Code*, as amended.

WAC 173-303-64620, "Requirements," *Washington Administrative Code*, as amended.

Water-Supply Paper 2275, 1985, *National Water Summary 1984—Hydrologic Events, Selected Water-Quality Trends and Ground-Water Resources*, U.S. Geological Survey, U.S. Government Printing Office, Washington, D.C.

WMO, 1974, *International Glossary of Hydrology/Glossaire International D'Hydrologie*, World Meteorological Organization No. 385, Geneva, Switzerland.

WRC, 1980, *Essentials of Ground-Water Hydrology Pertinent to Water-Resources Planning*, U.S. Water Resources Council Hydrology Committee Bulletin 16 (revised), Washington, D.C.