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Hanford Vapors
Integrated Safety Management Strategy

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SIGNATURE PAGE

Rob Gregory
Chief Operating Officer

9/20/18
Date

EXECUTIVE SUMMARY

Washington River Protection Solutions LLC's (WRPS) vision is to implement a strategy that both protects and is actively embraced by all workers on the Hanford Central Plateau so that workers *are* safe and *feel* safe. The WRPS Hanford Vapors Integrated Safety Management Strategy (HVISM) is a comprehensive approach to manage vapor-related hazards while building trust and confidence with workers and other stakeholders. While chemical vapor hazards have been reduced over the years, the U.S. Department of Energy-Office of River Protection (ORP) and WRPS recognized that new approaches and technologies could further reduce the potential for worker exposure to chemical vapors.

ORP and WRPS commit to further reducing or eliminating the potential for exposure to tank farm vapor emissions. By focusing on the following objectives, WRPS demonstrates its commitment to manage the hazards, employ a strong conduct of operations philosophy, and inform the workforce with transparent, clear, and timely communication:

- Manage the vapor hazards through Integrated Safety Management System principles
  - Know the hazards (industrial hygiene [IH] chemical technical basis)
  - Apply engineered controls (e.g., exhausters, dilution fan, and thermal oxidation)
  - Monitoring (vapor monitoring and detection system [VMDS])
  - Centralize command and control to be pre-emptive versus reactive
- Employ high-quality conduct of operations
  - Work boundary monitoring (plus mobile laboratory and increased worker communication via the use of signage, reader boards or a public announcement system)
  - Significantly reduce single-shell tank (SST) farm entries
  - Training and work planning
- Engage the workforce
  - Continue to engage the workforce in work planning, walkdowns, and preparation of activities in the tank farms
  - Maintain frequent, open, and transparent communication using workforce meetings, written announcements, the Hanfordvapors.com website (https://hanfordvapors.com) and other communication mechanisms
  - Support medical program enhancements to ensure appropriate measures are taken when workers report symptoms.

With these objectives in mind, the HVISM strategy is built upon eight core principles:

1. Centralize command and control to monitor farms and enable pre-emptive actions
2. Further demonstrate that unrestricted boundaries are safe from tank vapor exposures
3. Apply defense-in-depth safety controls for increased worker protection
4. Improve work sites through engineered controls and abatement technologies
5. Drive continuous improvement in the IH program technical basis, qualifications, and rigor
6. Continue to enhance worker involvement in determining how work is performed

7. Communicate effectively with the workforce and other stakeholders to continue to build trust and credibility
8. Support enhanced medical programs and systems

The eight core principles are derived from progress-to-date in completing Phase 1 of the recommended actions from a WRPS-chartered 2014 review to evaluate chemical vapor management and related worker-protection measures by a panel of external experts, the Tank Vapors Assessment Team (TVAT). TVAT-related improvements in fiscal years (FY) 2015-16 include:

- Expanded sampling and characterization of chemical constituents in tank headspace gases
- Evaluation and testing of new field and personnel monitoring equipment and personal protection equipment to improve detection and mitigate potential hazards
- Increased research and development and testing of new real-time monitoring technologies and respiratory protection options
- Initiatives and training to put WRPS IH staff and programs on par with the Radiological Control and Nuclear Safety programs
- Increased stakeholder communication, including a weekly vapor update briefing or newsletter, heightened interface with key stakeholders, and a vapor website
- Increased worker involvement in initiatives such as respirator cartridge testing and numerous other safety and health teams and work control initiatives

The eight core principles matured with input and recommendations from the Hanford workforce—through worker groups such as the Chemical Vapors Solutions Team and collaboration with the unions—as well as the results and recommendations from numerous recent independent external reviews. These reviews include:

- National Institute for Occupational Safety and Health
- Office of Inspector General
- Office of Enterprise Assessments, Worker Safety and Health Assessments (EA-32)
- Center for Toxicology and Environmental Health, LLC
- Vapors Management Expert Panel

To implement these core principles and demonstrate WRPS's commitment and responsiveness to workforce and external stakeholder input to the HVISM strategy, WRPS established enhanced, risk-based control strategies specific to various Hanford tank farm site configurations. These focused strategies are derived from a conservative, risk-based decision process that considered both current technical data and any uncertainties. WRPS's strategies will be operationalized under a centralized command and control architecture:

- SSTs with passive ventilation—Aimed at minimum entries
- Double-shell tanks and SSTs with active ventilation—Increase monitoring, engineered controls, and defense-in-depth monitoring and abatement configured appropriately for each farm
- Waste disturbing conditions—Apply customized hazard controls
- Outside tank farm boundaries—Establish boundaries to ensure safe unrestricted access, manage odors, and improve communication protocols.

WRPS and ORP have defined and implemented specific FY 2017-18 work scope and key performance parameters to implement the HVISM strategy via the Comprehensive Vapor Action Plan (CVAP). The CVAP encompasses the original intent of a second and final phase of TVAT-related improvements, while broadening its scope to embrace recommendations from the workforce and recent external assessments. The CVAP identifies enhancements in tank farm and communication infrastructure and engineered controls, including increased testing and development of abatement technologies. It evolves pilot-scale, real-time monitoring approaches into field operations to improve detection and notification to workers of vapor emissions, with implementation tailored to each farm. Further, the CVAP seeks to improve worker respiratory protection, safety and comfort under specific working conditions through testing and acceptance of alternative respiratory control equipment (e.g., filter cartridges, air lines, and ergonomic self-contained breathing apparatus [SCBA] versus current SCBA). It is possible to eliminate or reduce potential hazards by removing the need to enter selected SST farms frequently, and this SST limited entry initiative, too, will be implemented via the CVAP.

Once fully implemented, the CVAP results in *integrated chemical vapors management* with four primary outcomes:

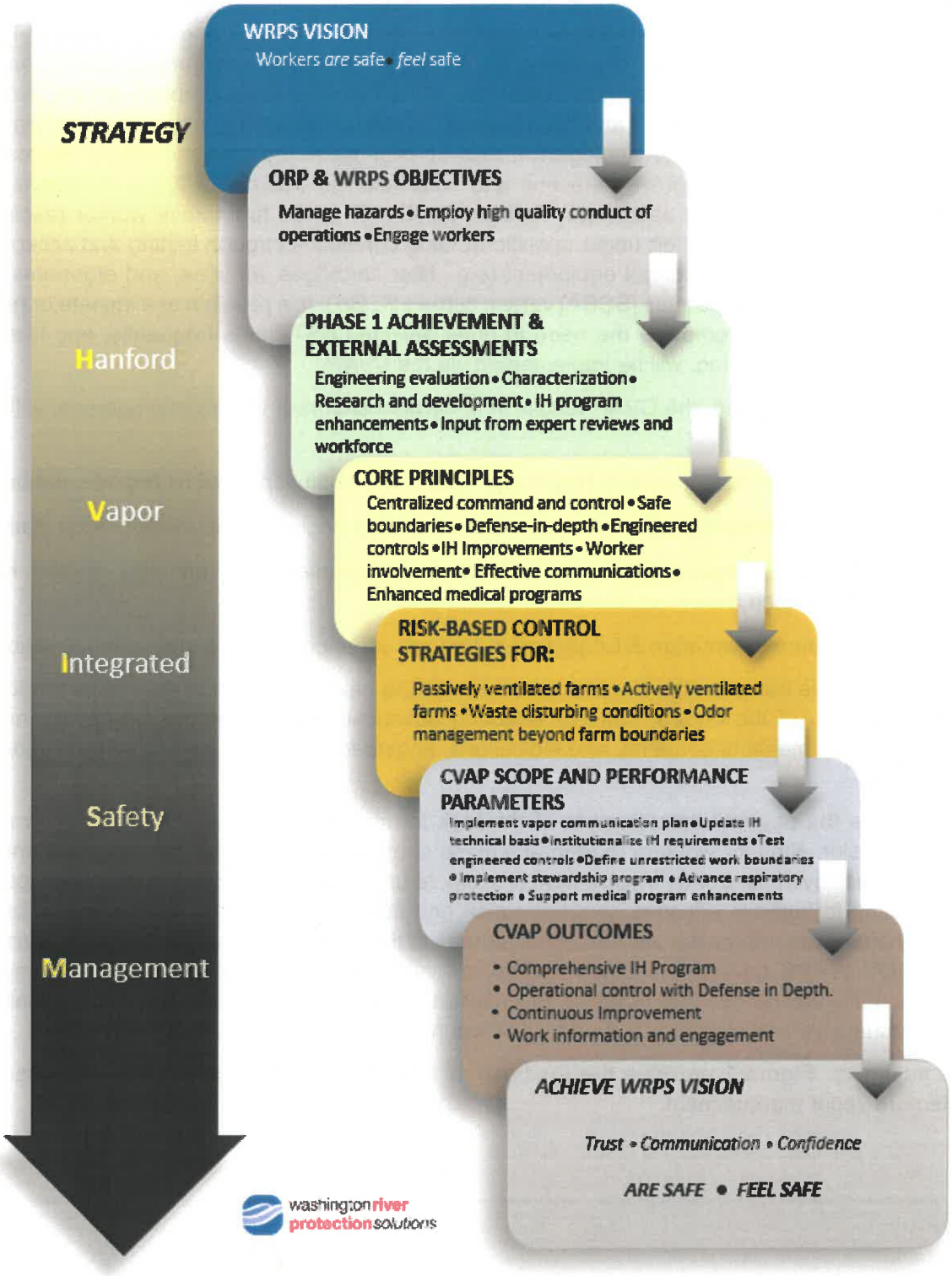
- A comprehensive industrial hygiene program with institutionalized IH Improvements
- Operational control with defense in depth including engineered controls/modernization
- Continuous Improvement with technology development and an implemented health process plan
- Workforce Information & Engagement through enhanced training and communications

CVAP activities transition the Hanford tank farms to the next generation of modernization toward a "Tank Farm of the Future" concept featuring advanced, remotely managed operations and maintenance, monitoring, alarms and indications, engineered controls, and characterization and sampling.

Finally, as the physical infrastructure of the tank farms continues to evolve, realization of the HVISM vision aims for workers to embrace these changes, knowing that they *are* safe and *feel* safe. To achieve this, worker involvement to promote understanding and implement changes, and continuing to improve effective communication and collaboration with workers, unions, and all stakeholders are imperative and essential features of the HVISM strategy. This includes ensuring that DOE, WRPS, the workers, other Hanford contractors on the Central Plateau, and the medical contractor continue to work together to ensure that medical management and protocols are comprehensive and may be relied on by workers now and in the future.

In summary, **Figure 1** provides the roadmap of how the HVISM strategy defines success for Hanford vapor management.

Figure 1. HVISM: Defines Success for Hanford Vapor Management



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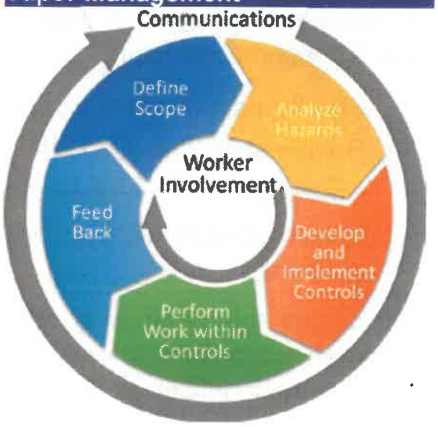
1.0 HANFORD VAPORS INTEGRATED SAFETY MANAGEMENT STRATEGY AND VISION

Washington River Protection Solutions LLC's (WRPS) vision is to implement a strategy that both protects and is actively embraced by all workers on the Hanford Central Plateau so that workers *are* safe and *feel* safe. The WRPS Hanford Vapors Integrated Safety Management Strategy (HVISM) is a comprehensive program to manage vapor-related hazards while building trust and confidence of employees and other key stakeholders in safe performance of tank farms activities. U.S. Department of Energy Office of River Protection (ORP) and WRPS commit to further reducing or eliminating the potential for exposure to tank farm vapor emissions. By focusing on the following objectives, WRPS will demonstrate its commitment to manage the hazards, employ a strong conduct of operations philosophy, and inform the workforce with transparent, clear, and timely communication:

- Manage the vapor hazards through Integrated Safety Management (ISM) principles
  - Know the hazards (industrial hygiene [IH] chemical technical basis)
  - Apply engineered controls (e.g., exhausters, dilution fan, and thermal oxidation)
  - Monitoring (vapor monitoring and detection system [VMDS])
  - Centralize command and control to be pre-emptive versus reactive
- Employ high-quality conduct of operations
  - Work boundary monitoring (plus mobile laboratory and posted odor zones)
  - Reduce or eliminate entries into passively ventilated farms
  - Training and work planning
- Engage the workforce
  - Continue to engage the workforce in work planning, walkdowns, and preparation of activities in the tank farms
  - Maintain frequent, open, and transparent communication using workforce meetings, written announcements, the Hanfordvapors.com website (https://hanfordvapors.com), and other communication mechanisms
  - Support medical program enhancements to ensure appropriate measures are taken when workers report symptoms.

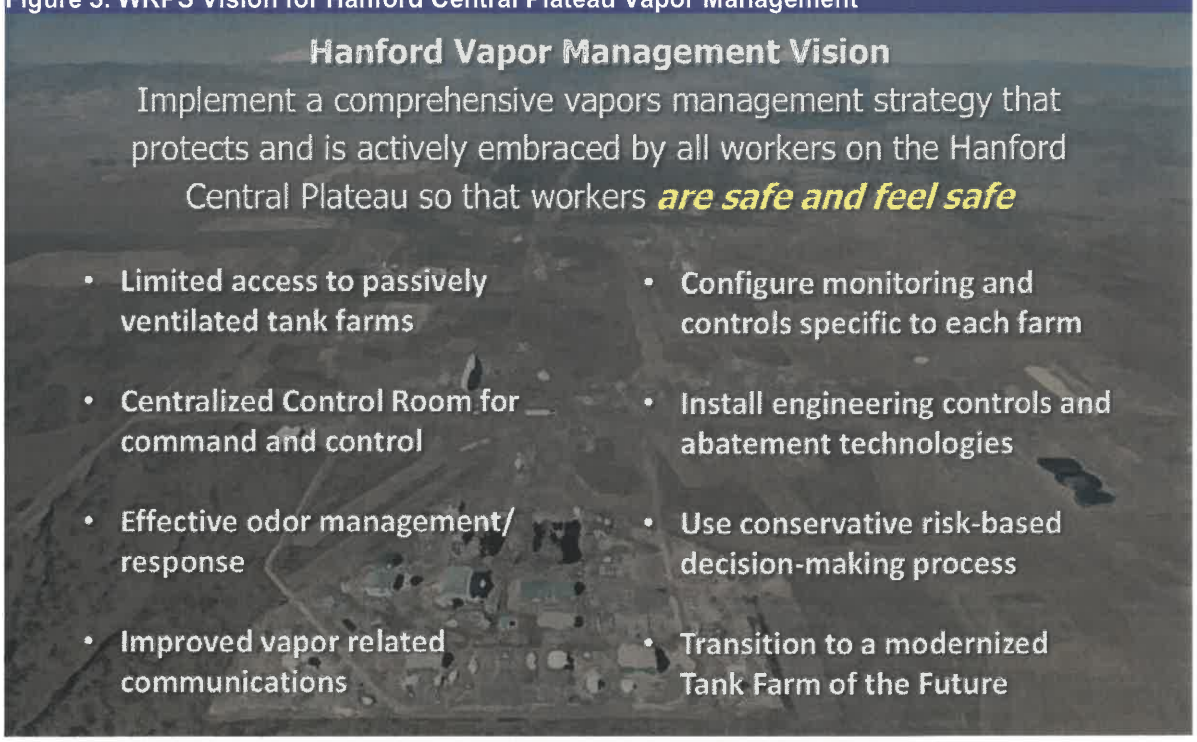
The foundation for this strategy is an ISM approach (**Figure 2**) to all tank farm work, where worker safety is the highest imperative and worker involvement is the core element. WRPS's ISM-based approach is encompassed by an internally and externally focused communication program to improve worker and stakeholder confidence in how work is performed.

Figure 2. ISM Approach to Hanford Vapor Management



WRPS will continue to protect all workers inside and outside tank farm boundaries as WRPS performs the Tank Operations Contract mission. This is the foundation of WRPS's vision to

Figure 3. WRPS Vision for Hanford Central Plateau Vapor Management



manage vapor hazards on the Hanford Central Plateau (**Figure 3**) using an approach that is actively embraced by workers who not only are safe, but *feel* safe.

Since assuming management responsibility for the Hanford tank farms, WRPS has implemented a robust and conservative ISM program and a strong risk-based decision-making approach to work planning and control to assure worker safety. As a result, tank farm work performance is at the leading edge of industrial standards and good practices. Implementation of appropriate hazard controls for chemical vapor management is a key consideration for every tank farm work activity undertaken by WRPS. In addition, WRPS is continuously striving to improve these practices through technology advances and development and implementation of improved controls.

WRPS's HVISM strategy involves infrastructure improvements, engineered controls, and administrative practices to add defense-in-depth, increasing the margin of safety taking into consideration both technical knowledge and uncertainties at the Hanford tank farms. HVISM incorporates risk-based decision-making associated with specific tank farm conditions and configurations, including:

- SST farms with passive ventilation
- Double-shell tank (DST)/SST farms with active ventilation
- Areas outside the tank farm work boundaries
- Enhanced vapor control zones (VCZ) and/or respiratory control during waste disturbing activities.

To ensure this strategy is effectively realized, WRPS has appointed a Chemical Protection Integration Manager to establish the HVISM strategy and drive initial implementation of vapor management initiatives across WRPS organizations, including Tank Farm Projects, Tank

Retrievals, Production Operations, ESH&Q, Chief Technology Office, and Engineering. WRPS also chartered the Chemical Protection Program Office (CPPO) for comprehensive vapor program integration. Like the Chemical Protection Integration Manager, the CPPO is also a temporary entity established to support the vapors efforts until such time that initiatives undertaken as part of the strategy have been institutionalized as part of integrated chemical vapors management. CPPO assists in strengthening management oversight, provides status tracking and reporting of progress and issues, and provides focused oversight of communication related to chemical vapor protection. Moving forward, CPPO will coordinate implementation of the HVISM strategy.

WRPS is transitioning chemical vapor management to an institutionalized program that relies upon centralized command and control—one that is predictive versus reactive—and which increases the safety margin against vapor-related concerns, including potential high-concentration, short-duration events. A forward-looking focus of the HVISM strategy is to work with ORP to define features of a modernized Tank Farm of the Future (Section 7.2).

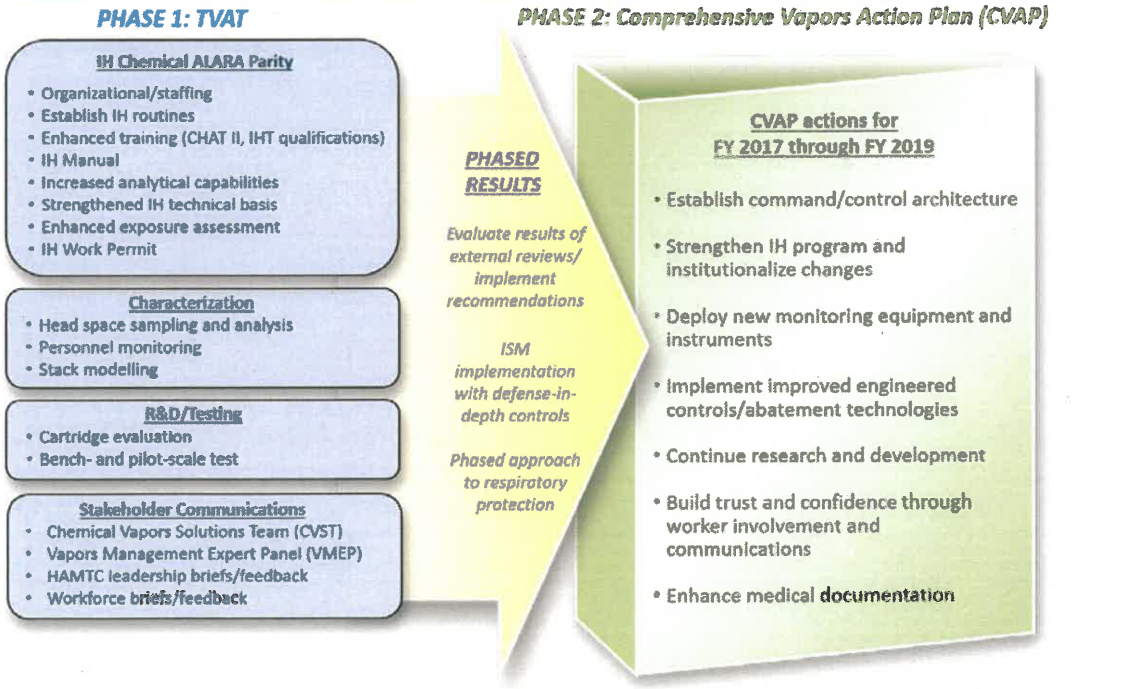
2.0 PHASE 1 PROGRESS

Concerns regarding tank vapor emissions at the Hanford Site have existed for decades and remain the subject of numerous assessments. To address concerns following several odor-related events in the spring of 2014, WRPS commissioned the Tank Vapors Assessment Team (TVAT), a group of outside experts, to offer independent recommendations to address Hanford tank vapor emissions and potential exposures. The plan to implement these recommendations formed the framework for WRPS vapor management activities up to the present time.

As shown in **Figure 4**, Phase 1 of WRPS's action plan in response to the TVAT recommendations focused on:

- Establishing a level of capability, discipline, and rigor in the IH Program to manage chemical vapor concentrations as low as reasonability achievable (ALARA). This is on par with today's Radiological Controls and Nuclear Safety programs and includes:
  - Increasing staff, training, and qualifications of IH personnel
  - Increasing rounds and routines, procedures and monitoring, and the analytical testing and evaluation capabilities necessary to support them
  - Strengthening what has proven to be a sound IH technical basis of knowledge on which to base decisions that establish controls for worker protection related to tank waste gases and vapor emissions, and establishing a systematic approach to maintain the technical basis going forward. Maintaining the technical basis includes reviewing toxicology information and the chemicals of potential concern (COPC) list; establishing the process for evaluating and updating occupational exposure limits; and using the best available modelling system/program.

Figure 4. TVAT Project Focus Demonstrates Commitment to Worker Safety



- Enhancing the characterization of the constituents of the chemical vapor via additional sampling and monitoring, including tank headspace sampling at multiple depths with over 14,000 data results and more than 800 chemical constituents.
  - This data supports a detailed review of the current COPCs and additional personnel monitoring and exhaust stack modelling.
- Increasing research, development, and testing to expand vapor monitoring and detection capabilities and enhance personal protection equipment (PPE).
  - Testing respirator filter cartridges in lieu of using self-contained breathing apparatus (SCBA) to improve worker safety and comfort
  - Conducting bench-scale and pilot tests designed to advance tank farm monitoring capabilities
- Improving communication with stakeholders, including:
  - Increasing worker engagement and communication, including formation and involvement of the Chemical Vapors Solutions Team (CVST) of workers which involves and represents workforce perspectives, as well as engagement of Volpentest HAMMER Federal Training Center (HAMMER) Worker/Trainers who represent all Hanford Site Contractors and are a key resource for input, training and communication
  - Launching a new vapor-related weekly update and website to better serve Hanford workers/ stakeholders by providing more real-time data and information
  - Continuing dialogue and partnership with the Hanford Atomic Metal Trades Council (HAMTC) and Building Trades as WRPS implements improvements in vapor management approaches for safe work performance.

3.0 HVISM CORE PRINCIPLES

Beyond the TVAT, WRPS sought input from recognized independent, outside experts including the CTEH, which reviewed WRPS's IH technical basis and approach to vapor management to identify any gaps. The Pacific Northwest National Laboratory (PNNL) is also collaborating with WRPS on vapor studies and modelling, piloting new monitoring technologies, and managing chemical constituencies and data outputs.

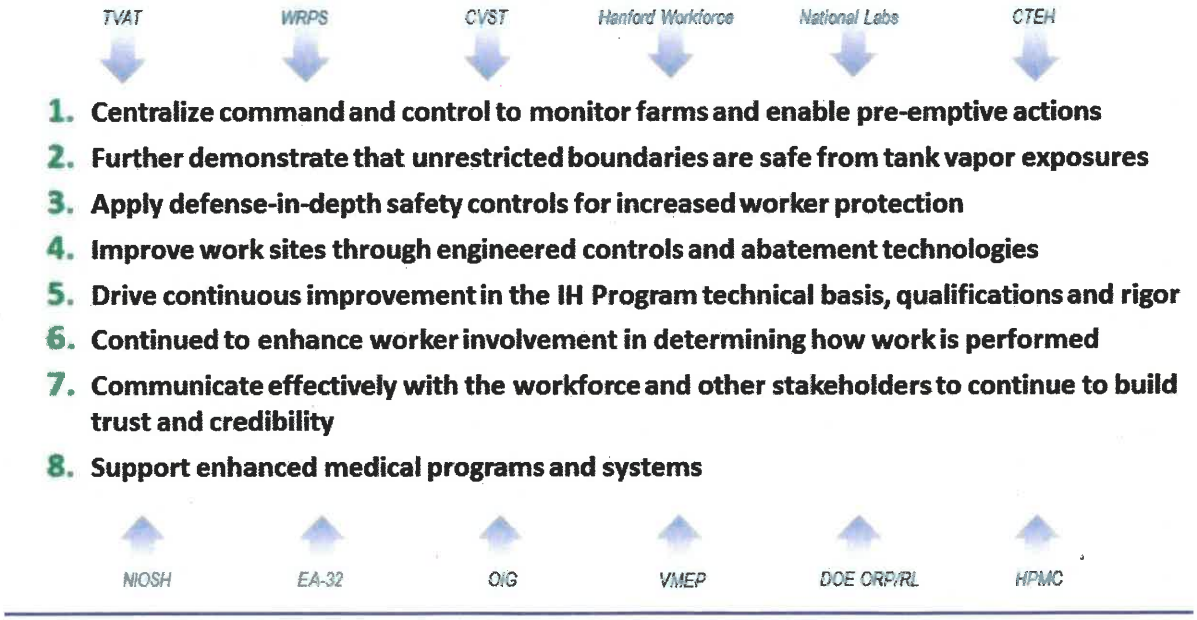
Further, ORP, which provides DOE oversight to the Tank Operations Contract and Hanford vapor management activities, recently engaged additional federal oversight from the National Institute of Occupational Safety and Health (NIOSH); Office of the Inspector General (OIG); DOE-Office of Environment, Safety, and Health Assessments (EA-32); and ORP's industry-based Vapors Management Expert Panel (VMEP) to independently review and provide input to WRPS's chemical vapor management approach. The assessments resulted in numerous recommendations which helped to shape the HVISM strategy, and focus the next phase of vapor management improvement activities across fiscal years 2017-18 as part of a new Comprehensive Vapor Action Plan (CVAP).

The WRPS HVISM strategy has been vetted with the workers in forums such as the CVST, the external groups listed above, and other stakeholders. Their feedback and the recommendations, coupled with the progress in TVAT Phase 1, helped WRPS create a set of core principles to guide future improvements. The eight core principles and sources of stakeholder input are provided in **Figure 5.**

These WRPS HVISM core principles, and the TVAT Phase 1 achievements that underlie them, are the foundation for future progress in vapor management, including:

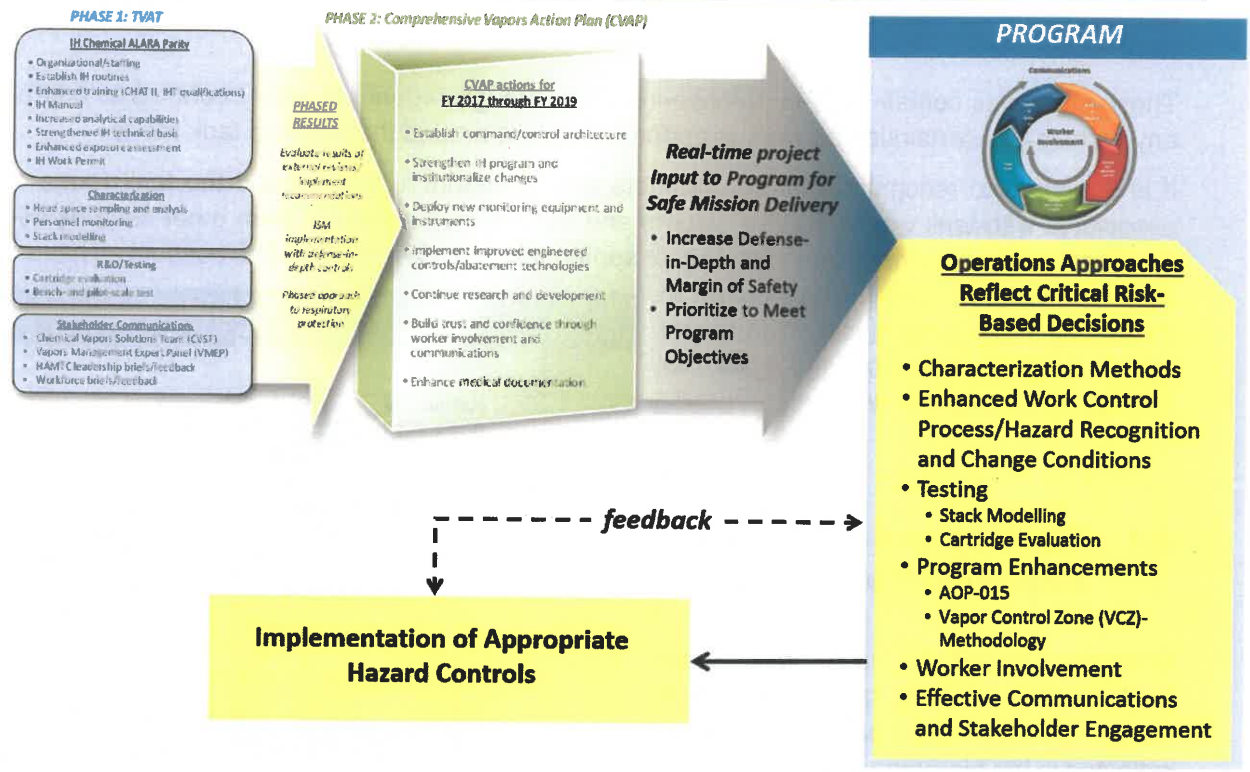
- ISM risk-based decision-making to plan and implement appropriate hazard controls for ongoing tank farm work activities (**Figure 6**)

Figure 5. WRPS HVISM Core Principles for Comprehensive Vapor Management



- Risk–based control strategies tailored to specific tank farm areas and boundaries as discussed in Section 4.0
- CVAP work scope for FY 2017-18, as outlined in Section 7.1.

Figure 6. Current Implementation of HVISM in Tank Farm Operations



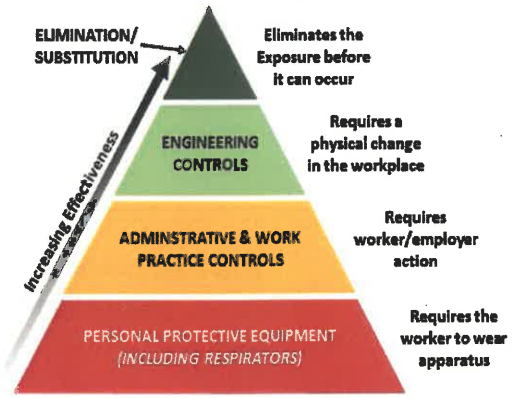
4.0 WRPS RISK-BASED CONTROL STRATEGY

As part of a risk-based decision logic, WRPS is driving the HVISM core principles down to a tactical, operational level. New and enhanced control strategies are now developed for SST farms with passive ventilation, DST/SST farms with active ventilation, and areas outside the tank farm work boundaries.

These strategies contain built-in defense-in-depth through redundant safety controls to address any technical uncertainties as work is performed in and around the Hanford tank farms.

It is important to recognize that not all odors and/or vapors in and around the tank farms are associated with tank waste. Rather, vapors and odors may be present from other sources such as, diesel generators, herbicide spraying, or septic cleaning. WRPS takes into account all hazards and conditions which may be present in the industrial and radiological environment when designing control strategies for chemical protection for workers.

Figure 7. Hierarchy of Controls Applied through ISM and Risk-Based Decision-Making



4.1 Develop and Implement Improved Controls

WRPS's approach to define and implement controls in the Hanford tank farms is based upon considerations as reflected in the hierarchy of controls model (**Figure 7**). In this model, the effectiveness of vapor-related controls is ranked hierarchically and achieved by:

- Elimination/substitution—Eliminates any exposure before it can occur. For example, working backshifts or weekends, relocating personnel, reducing entries into farms, and establishing farm boundaries where tank vapor exposures are not expected or impactful
- Engineering controls—Requires a physical/infrastructure change such as increased vent stack extensions, new tank ventilation systems, sealing of pits, stack and boundary monitoring, and response capabilities for upset conditions
- Administrative and work practice controls—Requires the worker or employer to adhere to procedural controls and work control processes
- Personal protective equipment—Requires the worker to wear protective devices, such as air-purifying respirators or SCBA, tailored to the identified hazards and based upon extensive vapor modelling and monitoring data.

4.1.1 Impact of Technology Advances

Technology and innovation play a critical role in managing vapor hazards at the Hanford tank farms. WRPS is maturing and adapting commercial, state-of-the art technologies (e.g., engineered controls, administrative controls, and PPE) as part of the control strategy to manage vapor hazards.

4.1.2 Strengthen Engineered Controls

WRPS is developing advanced engineered controls for vapor hazards management. A detailed review of potential engineered controls, led by the Savannah River National Laboratory, identified an enhanced mixed flow ventilation technology for greater effective dilution and dispersion. Active ventilation is the primary engineered control and has been, or is being, enhanced through stack extensions in the AP, AX, and AW farms, the 242-A Evaporator, and through ventilation installation in the A farm prior to retrieval. In addition, enhanced ventilation systems using dilution fans, which combine outside air with exhaust discharge, are being matured for demonstration. This system maximizes efficiency by sending a nearly vertical jet plume of vapor emissions high above the stack exhaust and even further away from worker breathing zones.

An abatement technology is also being matured for consideration, most notably a combination carbon adsorption and catalytic thermal oxidizer to destroy resident vapor. This technology is in the early stages of development and is currently undergoing a pilot-test program with WRPS oversight.

4.1.3 Enhance Administrative Controls

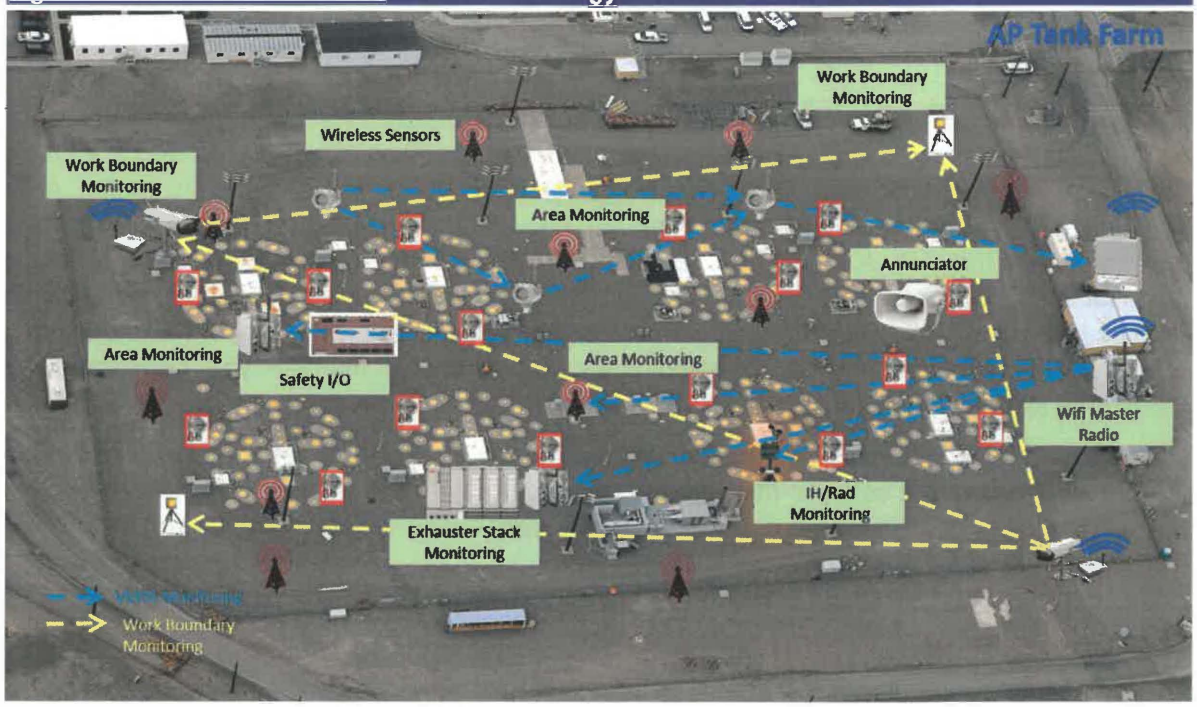
The VMDS is a comprehensive approach to monitoring using a combination of direct reading, spectroscopic, and meteorological measurement technologies. These monitoring technologies are part of a command and control architecture. Because it enables more immediate response, VMDS provides enhanced administrative control in vapor hazards management, as well as better identification of hazards in the breathing zones.

Technology maturation testing has included bench-scale testing at PNNL and a pilot-scale demonstration at the A and AP tank farms. This pilot-scale testing, illustrated in **Figure 8**, determined the parameters for each technology tested and the capability of the integrated system.

The pilot-scale test program was a unique combination of commercially available technologies and represented what is likely the most extensive vapor modelling and monitoring/sampling program in industrial use today. The VMDS demonstrated continuous, near real-time identification and measurement of tank farm vapor emissions and provided visualized information for response. The location of sensors and samplers at the A/AP tank farms included coverage near the primary sources, a more dispersed location of sensors covering the tank farms, and locations outside the tank farm boundaries to provide a baseline for monitoring and to detect any non-tank farm sources. Information from the VMDS will enable WRPS to develop a risk-based approach to sensor placement and specific sensor use.

The bench- and pilot-scale testing enables WRPS to determine the optimal components and configuration to deploy continuous monitoring in each tank farm. In addition, modelling tank farm work boundaries provides a qualitative risk assessment to inform future decisions on configuration and monitoring of each farm work boundary. Tailored, risk-based implementation across selected farms paves the way for an institutionalized program that will transition tank farm activities from reactive to predictive and one that offers even greater protection against vapor-related events, including potential high-concentration, short-duration events. The tailored approach will be developed in conjunction with I H programs to ensure compliance with monitoring requirements.

Figure 8. A/AP Farm Pilot-Scale VMDS Technology can be Tailored to Each Farm



4.1.4 Improve Personal Protective Equipment

WRPS made significant progress with worker PPE. The primary advancement is development of tank vapor-specific parameters for use of alternative air-purifying respirator cartridges, discussed further in Section 4.3. In addition, WRPS has evaluated and approved air lines for limited use in the tank farms. Lightweight, ergonomic SCBA harnesses are also being evaluated.

4.1.5 Centralize Command and Control

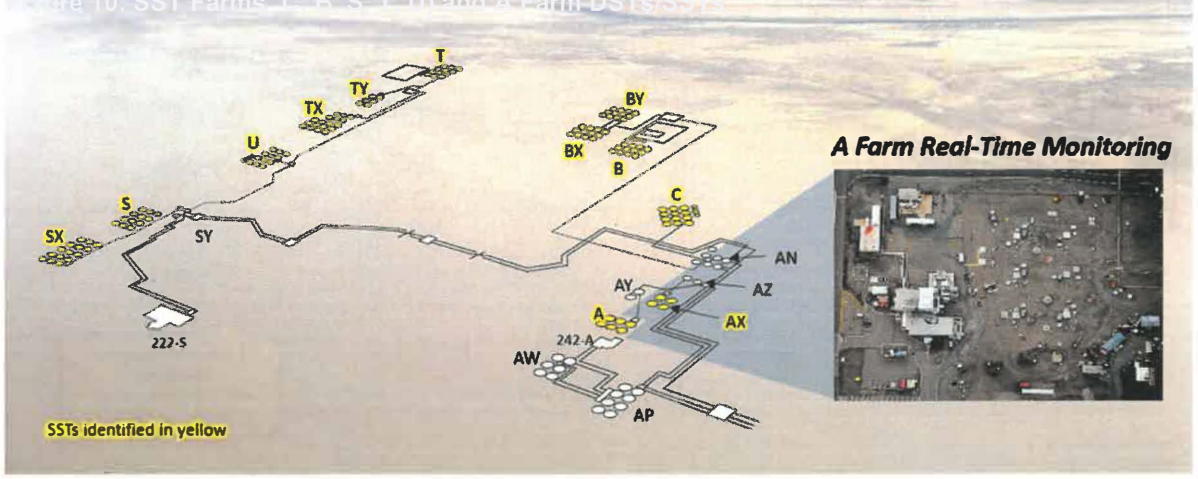
WRPS's approach to centralized command and control integrates the control strategies discussed in Sections 4.1.2 through 4.1.4 and advances predictive capabilities to manage tank farm activities and operations. **Figure 9** illustrates how a central shift office/control room provides effective monitoring and control from a central location. This facility would provide monitoring of leak detection, tank waste levels, waste transfers, and exhauster controls. It would also conduct real-time vapor monitoring of sources and tank farm boundaries to provide early warning for tank farm management to take pre-emptive actions and make advance communication to all workers on the Central Plateau. This concept is a linchpin in WRPS's vision for Hanford tank farms operations as improvements are made in infrastructure, engineered controls, and technology. As stack ventilation, stack monitoring, and boundary monitoring are implemented, as needed, on a farm-by-farm basis and additional communication infrastructure is added (e.g., public address [PA] systems and reader boards), this concept continues to demonstrate increasing value in the HVISM strategy.

Figure 9. Centralized Command and Control

4.2 Control Strategy for SST Farms with Passive Ventilation

For the SST passively ventilated tank farms highlighted in yellow in **Figure 10**, WRPS will implement an SST Stewardship Plan that will reduce entries through automation of selected tank farm activities in line with the WRPS Tank Farm of the Future concept. Environmental requirements would be tailored to support minimum entries to reduce potential exposure to hazards. The goal is to reduce entries to a one- to two-week period on an annual basis. To provide additional defense-in-depth, any work within these farms will remain on respiratory control, with the VCZ size based upon conservative modelling of hazard conditions. Farm boundaries will be evaluated and adjusted, as appropriate, and monitoring of these boundaries will be designed to provide additional data that farm boundaries are protective and safe. The proton transfer reaction mass spectrometry (PTR MS) mobile laboratory may also conduct perimeter surveillance. IH monitoring rounds and routines will be designed to identify sources and mitigate future emissions.

Figure 10. SST Farms C, B, S, T, U and A Farm DSTs/SSTs



Future DOE decisions on tank farm missions will dictate whether additional engineered controls or infrastructure improvements are required.

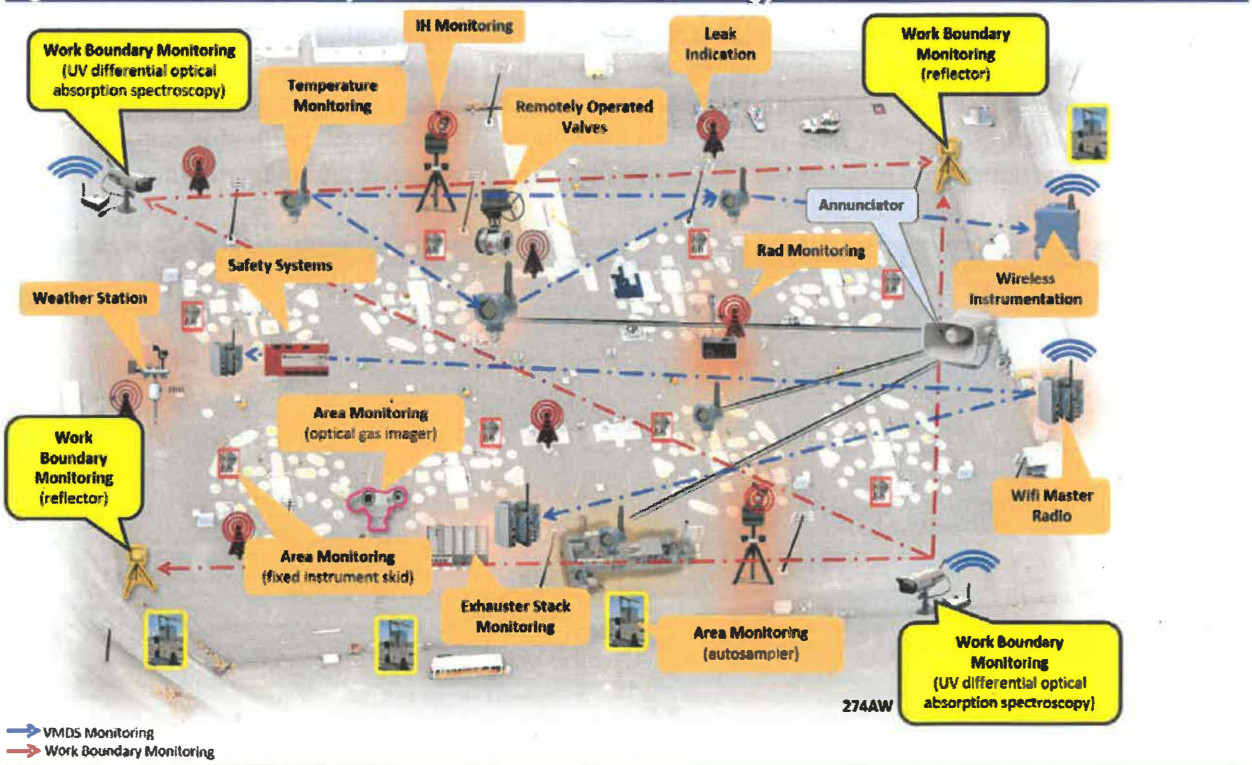
4.3 Control Strategy for DST/SST Farms with Active Ventilation

For the DSTs and A farm complex (**Figure 11**), the infrastructure plan for future hazard control/abatement is to install/maintain active ventilation and monitoring technologies. For AX farm, install and operate a new ventilation system in FY 2017-18, as well as installing an exhauster in A farm in FY 2018-19. The A/AP farm pilot-scale VMDS test will be turned over to operations for monitoring application and VMDS will be customized and extended to all farms, where deemed appropriate. Continuous stack and work boundary monitoring and upset condition response capability will be installed in farms where the majority of waste transfers are conducted to provide additional real-time data and to facilitate proactive response measures, if needed. Reader boards and PA systems will be installed to enhance communication throughout the 200 East and West Area plateau. The PTR-MS mobile laboratory may also conduct perimeter surveillances.

This comprehensive monitoring/surveillance strategy ensures that IH program implementation and engineered controls are effective and that modelling is conservative and predictive.

Cartridge testing (**Figure 12**) can provide safe alternatives to supplied breathing air. Cartridge testing to gather data was successfully completed in eight non-waste disturbing locations (AN exhaust stack; AP exhauster; AW and AY/AZ farms; and tanks A-101, AX-101, BY-108, and

Figure 11. DSTs/SST Actively Ventilated Farms Control Strategy and Infrastructure Plan



SY-102) in FY 2016. Laboratory analysis is complete for the eight locations and PNNL is finalizing its reports, which includes recommendations for conditions and locations where selected cartridges may be used for recommended lengths of time. The first cartridge testing during a waste disturbing condition was performed while transferring waste from tank AP-103 to AY-101. Additional testing of powered air purifying respirator (PAPR) cartridges was conducted in FY2018 on the same locations identified earlier. PNNL is evaluating the data and developing reports for issuance in FY2019.

Figure 12. Cartridge Testing Paves the Way for Safe, New PPE

In collaboration with HAMTC, WRPS established a memorandum of agreement that provides for use of interim respiratory protection in lieu of supplied air based upon independent third-party validation to identify whether/where existing interim air-purifying respiratory protection is adequate. In association with the Center for Construction Research and Training (CPWR), Stone Turn Consultants is the HAMTC-selected, nationally-recognized team of experts conducting this validation effort. Implementation of the MOA is an important foundation for increasing trust and collaboration with the workforce and the union as WRPS moves to operationalize the HVISM strategy. At the conclusion of this third party validation, air-purifying respirator use is being phased-in at appropriate locations for certain types of work, alleviating safety concerns with the broader use of SCBA. As previously noted, in addition to cartridge testing, WRPS has evaluated other means of supplied air, including using air lines and more lightweight, ergonomic SCBA.

4.3.1 Waste Disturbing Activities

Using a tailored, risk-based approach, WRPS will continue to use work planning processes to develop an appropriate hazard control strategy for each waste-disturbing activity in tank farms. Representatives from a cross-section of the workforce expected to perform the jobs associated with the particular waste-disturbing activity will be included in the work planning process.

Generally, the following five-step protocol is used in the work planning processes: (1) define the scope of work; (2) analyze the hazards; (3) develop and implement controls; (4) perform the work; and (5) obtain feedback and assess potential areas for improvement.

For each waste-disturbing activity, a customized set of hazard controls will be evaluated and implemented consistent with the outcomes of the work planning process, as appropriate. Accordingly, each hazard control strategy may be unique to each particular waste-disturbing activity. Such control strategies may include, for example: (1) engineered controls; (2) monitoring or detection equipment; (3) increased worker communication via the use of signage, reader boards, or a public announcement system; (4) temporary road closures or limited access areas for authorized personnel only; (5) deployment of a mobile lab to obtain vapors data; and (6) personal protective equipment (PPE).

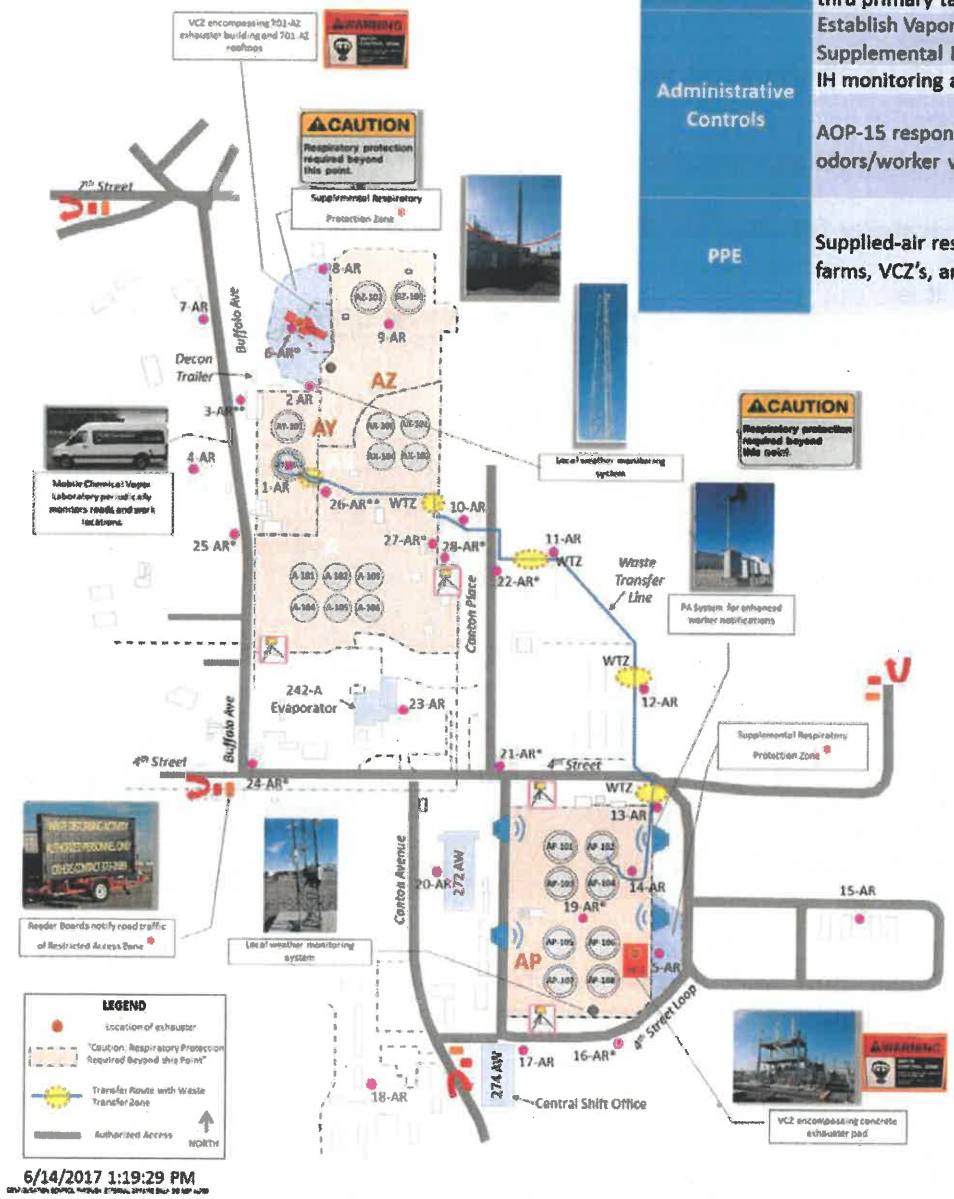
Figure 13 is a very conservative example of a hazard control strategy put into place during the AY-102 retrieval. As previously stated, each hazard control strategy may be unique to each

particular waste-disturbing activity and therefore may not require the deployment of the exact same set of hazard controls as was utilized during the AY-102 retrieval.

Figure 13. Customized AY-102 Control Strategy for Waste Disturbing Conditions

AY-102 to AP-102 Retrieval Industrial Hygiene Strategy

Hierarchy of Controls	Control
Eliminate the Hazard	Retrieval to be performed on backshifts and weekends only*. Access restricted to "Authorized Personnel Only" during retrieval*.
Engineered Systems	Retrieval operations only when AY/AZ and AP Farms ventilation operating. AY-102 Annulus exhauster off. Ventilation cross-tie installed between annulus space and primary tank to provide ventilation path thru primary tank exhauster.
Administrative Controls	Establish Vapor Control Zones (VCZ) and Supplemental Protection Zones* IH monitoring and sampling. AOP-15 response to reported unusual vapor odors/worker vapor exposure symptoms.
PPE	Supplied-air respirators required in AY and AP farms, VCZ's, and supplemental zones*.



CONTROLS	
PA System speaker locations	
Warning Sign *	
Reader board *	
Turnaround locations *	
AreaRAE locations (*past AOP-15 locations and/or AreaRAEs to be left out when retrieval is shut down ** required when performing annulus pumping *** only required when the annulus exhauster is operating)	
Vapor Control Zones	
Pilot Scale Vapor Monitoring and Detection System	
Supplemental zone with required respiratory protection *	
Local weather monitoring system	

4.3.2 Engineering and Infrastructure

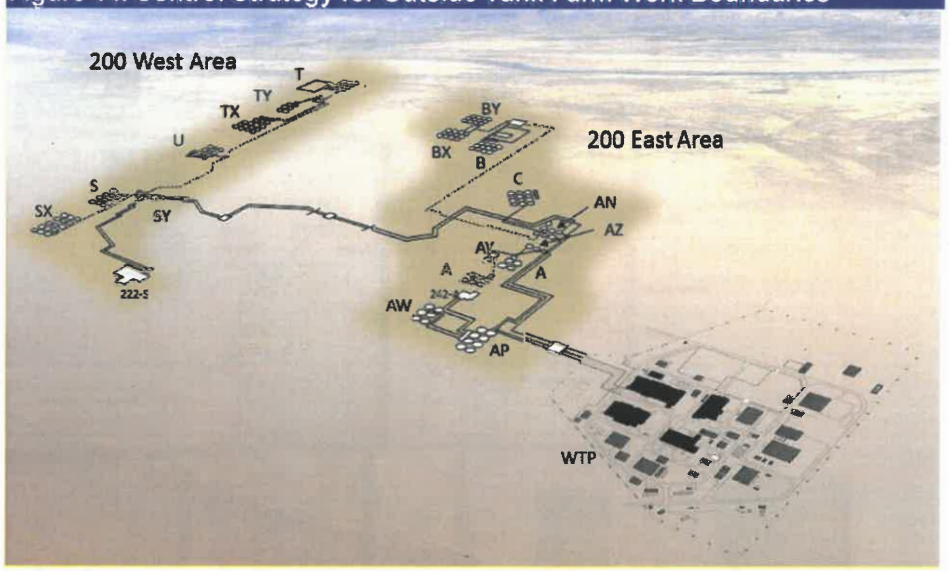
WRPS is implementing a significant infrastructure enhancement initiative as part of the CVAP work scope, in conjunction with baseline activities, to employ the engineered controls and control strategies discussed in Sections 4.2 and 4.3. This includes:

- Installing state-of-the-art wireless technology and automation to reduce farm entries for required routine surveillances, maintenance, and instrument calibration (e.g., freeze protection and leak detection systems)
- Installing ventilation stack extensions at the 242-A Evaporator and AW farm to reduce odors and emissions
- Installing an abatement technology (proof-of-concept testing of thermal oxidation to reduce vapor concentrations)
- Installing and replacing exhausters in A and SY farms
- Improving SCBA
- Employing supplied air lines, as applicable from the pilot testing results.

4.3.3 Control Strategy for Outside the Tank Farm Work Boundaries

As discussed earlier, it is important to recognize industrial odors and vapors in and around the tank farms, and tank waste vapors are not synonymous. Some vapors/odors may be attributable to other industrial sources such as diesel generators, herbicide spraying, or septic cleaning. WRPS takes both hazard and odor management into consideration when designing control strategies for chemical protection for workers.

Figure 14. Control Strategy for Outside Tank Farm Work Boundaries



In areas outside the tank farm work boundaries where odors may potentially be detected (**Figure 14**), the following requirements will be implemented:

- Posting to warn of potential odors
- Training for all personnel and visitors accessing 200 East and West areas
  - Worker training will include enhanced chemical vapor training, in addition to standard Hanford training (e.g., Hanford General Employee Training, pre-job briefings, Chemical

Hazard Awareness [CHAT], and Hazardous Waste Operations and Emergency Response [HAZWOPER] training, as job-specific activities require)

- Visitor training includes general chemical awareness.

In addition, adjustments/modifications to VRZs and VCZs will be made, as described in Section 4.3.1, based upon work scope requirements, data, and modelling validation. Continuous communication with stakeholders will also be maintained.

Underpinning this control strategy, WRPS will maintain an ongoing monitoring program to confirm that hazard controls are effective. This includes unrestricted boundary monitoring as part of rounds and routines, validation of model results and respiratory protection evaluations, as well as integration of source data and models to confirm qualitative evaluations. As an example, atmospheric conditions (e.g., inversion) may result in job-specific/work control boundary adjustments.

WRPS's approach to abnormal operating procedure (AOP)-015 events is maturing for odor events outside tank farm boundaries. In these areas, events are now termed "odor response" and are handled via a separate procedure, although they merit the same medical evaluation process as for any reported symptoms. Active and transparent communication of all odor-related events is maintained with the Hanford workforce and external stakeholders working in these areas via direct work group interfaces and broader electronic notifications.

4.3.4 IH Program Improvements

In TVAT Phase 1, WRPS took several steps to improve IH program discipline and rigor as discussed in Section 2.0.

In the CVAP, WRPS focuses on achieving the following IH program results:

- Institutionalize requirements and best management practices by developing and/or updating key IH program documents, such as the chemical vapor technical basis and COPC list
- Achieve parity in IH program rigor and discipline with today's Radiological Controls and Nuclear Safety programs
- Enhanced capability to measure monitor and predict vapor-related hazards
- Additional upskilling of IH personnel.

Taken together, these results ensure that appropriate monitoring and controls are in place to protect workers and maintain ALARA exposure to hazards. This approach will continue to ensure that workers *are* safe while improving confidence and trust to help workers *feel* safe.

Collaboration and support of medical monitoring is also vital to achieve the WRPS vision for worker acceptance of the HIVSM strategy. WRPS will work with DOE, the medical community, and other site contractors to support and maintain a reliable medical surveillance program, including:

- Obtain timely and accurate injury/illness information to support effective case management and to ensure appropriate services to workers
- Support ORP and the U.S. Department of Energy-Richland Operations Office (RL) and HPMC Occupational Medical Services (HPMC) assessment of communication protocols for worker medical evaluations associated with reported symptoms and medical protocols for tank farm surveillance and acute exposures

- Support the Hanford occupational medical providers as they consult with an occupational medical professional to comprehensively review medical data that are available for tank farm workers, and to provide expert advice on collection, analysis, and interpretation of these data and their potential to help assess any relationship between medical findings, reported health effects and/or exposures
- Work with ORP, RL, and HPMC to ensure that tank farm workers are designated on their employee job task analysis; confirm that processes and systems are in place to track tank farm access; and continue to encourage workers to report tank farm vapor-related symptoms
- Work with RL and ORP to expand worker awareness of the Washington State Labor and Industries Office of the Ombudsman for Injured Workers of Self-Insured Businesses that can address workers' questions, concerns, and issues related to the Workers' Compensation Program.

Figure 15. Institutionalizing Continuous Improvement in the Industrial Hygiene Program

Moving forward, **Figure 15** illustrates WRPS's focused approach to institutionalize continuous improvement in the IH Program to improve rigor in managing the IH technical basis, effective flow down of requirements, and reliable and consistent medical monitoring.

5.0 WORKER INVOLVEMENT

Worker involvement is the cornerstone to realizing WRPS's HVISM vision for a vapor management program that protects and is actively embraced by the Hanford workforce. Worker involvement is critical to strengthen the HVISM approach to vapor management, both technically and to build trust so that workers *are* safe and *feel* safe.

It is the comprehensive involvement of employees in every aspect of this strategy—whose feedback to supervisors and managers through forums such as the CVST and regular interfaces (e.g., plan-of-the-day meetings, pre-job briefings, and post-job lessons learned reviews)—that is critical in implementing the HVISM strategy and realizing the human aspect of the HVISM vision.

Moving forward, the strategy to enhance workforce involvement will continue to include worker participation in safety-related councils and committees—such as the WRPS Safety Culture Improvement Team—and increased worker input in processes and procedures, work planning, training, and participation in focus groups created to address specific workplace concerns and issues. Other initiatives include employee input to content/packaging of educational communications, including involving HAMMER worker trainers, and active, regular input to construct and refine the WRPS vapor website. Cartridge testing is an excellent example of both the strength and effectiveness of employee engagement and ownership—and a collaborative effort between management and employees—to identify a protective and worker-responsive respiratory control alternative to accomplish tank farm work. This type of worker involvement process is a model to be emulated. Effective, continuous improvement in worker involvement will be gauged using metrics. For the HVISM strategy to be successful, Hanford employees must embrace the approach to vapor management.

An important component of worker involvement is continued dialogue and partnership with union leadership, which has been enhanced through regular briefings on upcoming work activities and periodic meetings to share information, address worker concerns, and look ahead at upcoming challenges.

6.0 TRANSPARENT AND EFFECTIVE STAKEHOLDER COMMUNICATION

Effective, consistent, and transparent communication is a central element of the WRPS HVISM strategy and an overarching requirement for its success, as depicted in Figure 2.

For internal employee communication, WRPS implemented a campaign to improve trust using numerous communication mechanisms to inform the workforce. Increased opportunities for face-to-face communication between management and the workers is an important element. This includes roundtable meetings, focus groups, increased management visibility in the field, and continued plan-of-the-day and all employee meetings. First line supervisors, HAMTC safety representatives, HAMMER worker trainers, and CTEH also play a communication role to enhance worker knowledge.

Additionally, WRPS continues to improve employee access to information. WRPS employs mechanisms such as a comprehensive vapor website, a weekly vapors-related presentation made available to the workforce and a weekly newsletter. These enhanced vapors related communications would continue until such time that the vapors strategy has been realized and vapors actions have been institutionalized as a part of the integrated chemical vapors management. The website provides a user friendly interface for employees and stakeholders. It includes Google maps displays, a weekly recap of field monitoring data, fact sheets, and contextualized data on tank farm chemical vapor emissions. Also available is the Data Access Visualization (DAV) tool. The first phase of the DAV tool brought to life the more than one hundred thousand chemical samples from IH sampling taken with direct reading instruments (DRI) and logged into the Site Wide Industrial Hygiene Database (SWIHD). Vapor-related training sessions will also be conducted to enhance workers' understanding of tank farm vapor hazards and how worker safety and health is maintained via the control strategies discussed in Sections 4.2 and 4.3. Furthermore, WRPS also conducts Workforce Surveys on information and communication effectiveness to determine the effectiveness of WRPS's vapors communication and vapors information sharing efforts. The surveys provide direct worker feedback on how to continue to improve communications with the workforce. The surveys, conducted bi-annually, will continue while the enhanced vapors related communication efforts continue.

For external stakeholders, in addition to the website, WRPS implemented a routine process/action report and stakeholder-specific communication plans and schedules in coordination with DOE. WRPS's overall communication approach is depicted in **Figure 16**. WRPS commits to provide frequent, transparent, and up-to-date vapor-related information to all workers, stakeholders, and the public using all available communication mechanisms.

Figure 16. Communication Approach to Increase Trust and Confidence

WORKERS

- CVST communication sub-teams
- All employee meetings
- All employee messages
- Management roundtables
- Management presence in the field
- HAMMER (Worker Trainers)
- Employee briefings/training
- HPMC worker health updates
- Routine newsletter/articles
- Hanfordvapors.com

STAKEHOLDERS

- Stakeholder-specific communication plans include:
  - Working with unions
  - HAB updates
  - Meetings with community and political leaders
  - Regulator interfaces
- Weekly reports
- Hanfordvapors.com website

PUBLIC

- Media
- Press releases
- Hanfordvapors.com website

7.0 HVISM STRATEGY FUTURE OUTCOMES

As the vapor management work plan for FY 2017-18, the CVAP essentially translates remaining TVAT objectives and new recommendations from external reviews into a work scope and key performance parameters. The CVAP will institutionalize WRPS's planned improvements to manage chemical vapor hazards to achieve the operational vision described in this HVISM strategy.

7.1 Next Steps: The Comprehensive Vapor Action Plan

Figure 17. Example of Remote Operations and Status Control for Tank Farms

The CVAP starts to transition the tank farms to the Tank Farm of the Future concept, beginning the next generation of modernization, as discussed in Section 7.2. In FY 2017-18, WRPS enhanced tank farm infrastructure and automation capabilities, such as installing active ventilation in the entire A farm complex. Further, WRPS prioritized automation upgrades in AP farm, which most directly supports waste feed delivery to the Waste Treatment and Immobilization Plant. **Figure 17** illustrates the transformation of AP farm to more cutting-edge capabilities and technologies to monitor, control, and diagnose the farms remotely. This lowers the probability that a worker will encounter potential hazards.

The next generation farm is anticipated to include remotely managed:

- Monitoring (e.g.; operational, radiological, vapor-related (IH), and environmental)
- Alarms and indications (e.g.; warning systems and visual capabilities)
- Engineered controls (e.g.; vapor abatement and diffusion stacks)
- Characterization and sampling (e.g.; monitoring, sampling analysis, and plume monitoring)
- Actively ventilated farms (e.g.; real-time stack monitoring)
- Advanced operations and maintenance—System status and control, operational strategy, predictive maintenance, and facility status control (e.g.; leak detection, pH monitoring, vibration monitoring, remote pump and valve operations).

Figure 18 shows how the HVISM strategy and core principles drive CVAP performance to realize the HVISM vision.

Figure 18. Next Steps to Implement the HVISM in Tank Farm Operations

PHASE 1 ACHIEVEMENTS (FY 2015-2016)

Conducted engineering evaluation, characterization, research and development, and IH program enhancements

STRATEGY

Hanford

Vapor

Integrated

Safety

Management

STRATEGY CORE PRINCIPLES

1. Centralize Command and Control to monitor farms and enable pre-emptive actions
2. Further demonstrate that unrestricted boundaries are safe from tank vapor exposures
3. Apply defense-in-depth safety controls for increased worker protection
4. Improve work sites through engineered controls and abatement technologies
5. Drive continuous improvement in the IH program technical basis, qualifications, and rigor
6. Continue to enhance worker involvement in determining how work is performed
7. Communicate effectively with the workforce and other stakeholders to continue to build trust and credibility
8. Support enhanced medical programs and systems

CVAP KEY PERFORMANCE PARAMETERS

KPP-1	Establish a comprehensive vapor management communication plan, engagement processes, and effectiveness measurements (relates to core principles 6 and 7)
KPP-2	Maintain IH Chemical Vapors Technical Basis and chemicals of potential concern (COPC). Institutionalize a disciplined and rigorous process for updates to include new scientific findings and enhanced understandings of potential exposures (relates to core principle 5)
KPP-3	Maintain Industrial Hygiene Program and institutionalize vapor program requirements, best practices and program parity, and complete necessary training to support full implementation at the beginning of FY2018 (relates to core principles 3 and 5)
KPP-4	Complete engineering control concept demonstrations for Strobic Air Tri-Stack® and NUCON® International, Inc. thermal combustion in support of unrestricted work boundaries (relates to core principles 1,3,4,6)
KPP-5	Define unrestricted work boundaries and implement monitoring on active stack ventilation and unrestricted work boundaries in the A farms to provide defense-in-depth (relates to core principles 1,2,3,4, 6)
KPP-6	Institutionalize a tank operations stewardship program that minimizes required tank farm personnel entries; and establishes parameters for locating ancillary personnel and offices (relates to core principles 1,3,6)
KPP-7	Provide options to promote the hierarchy of controls for chemical vapor respiratory protection beyond current use self-contained breathing apparatus (relates to core principles 3,6)
KPP-8	Support medical program enhancements in conjunction with responsible Hanford Site organizations and establish update to WRPS process/procedures (relates to core principle 8)

CVAP OUTCOMES

Comprehensive Industrial Hygiene Program
Operational Control with Defense in Depth
Continuous Improvement
Workforce Engagement

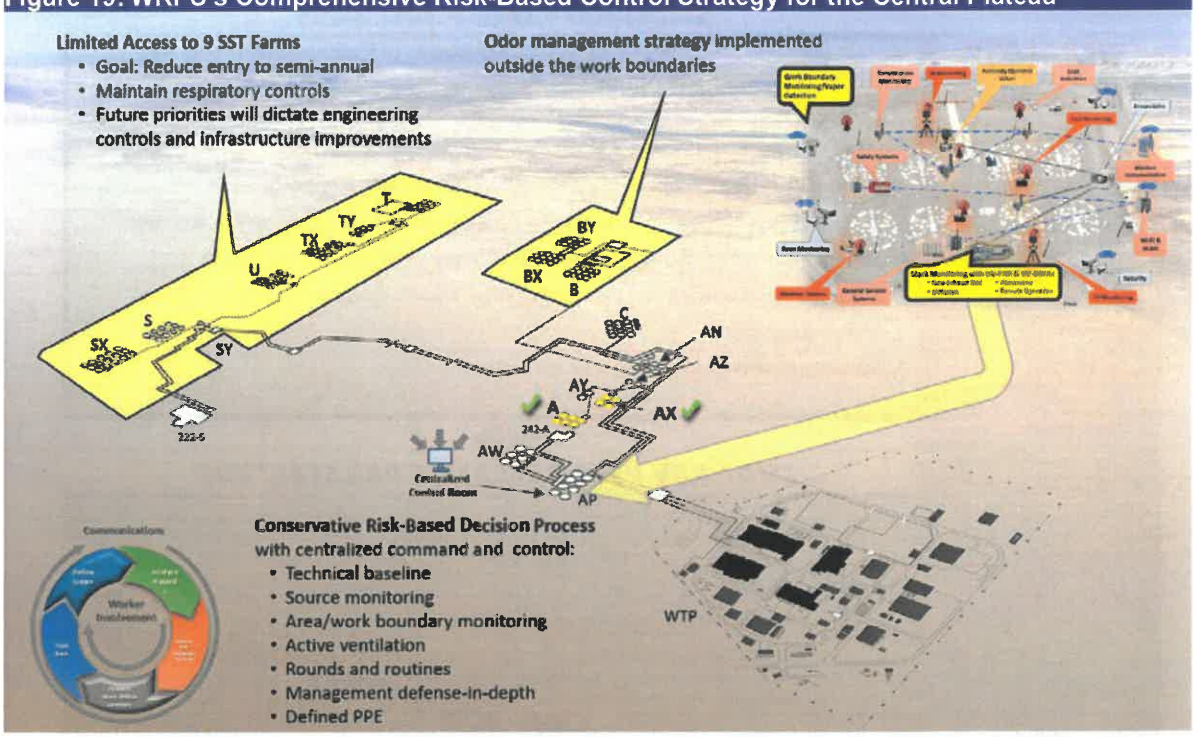
Trust, Communication, Confidence

ARE SAFE • FEEL SAFE

7.2 Hanford Tank Farm of the Future

Figure 19 summarizes WRPS's current overall risk-based control strategy for the Hanford Central Plateau. It is designed to be protective and safe, and to reflect defense-in-depth.

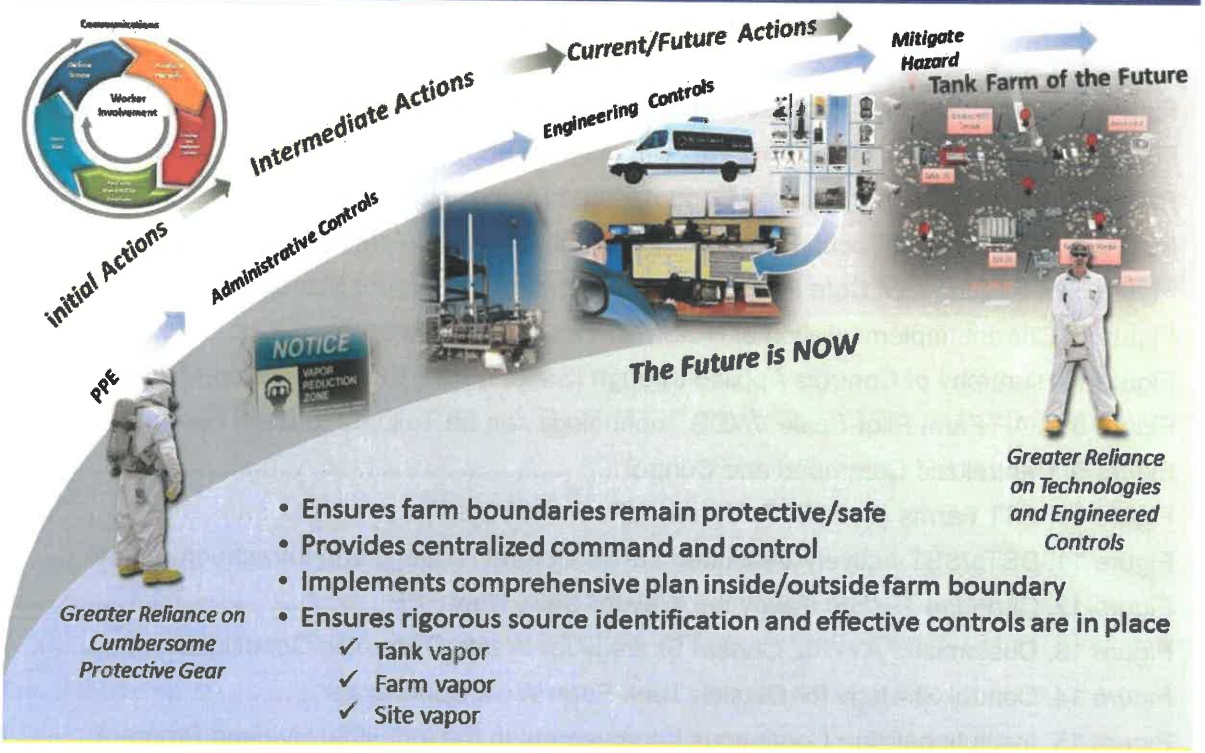
Figure 19. WRPS's Comprehensive Risk-Based Control Strategy for the Central Plateau



Implementing all of the WRPS HVISM strategy elements and objectives, as illustrated in **Figure 3**, will influence realization of the HVISM vision and future outcomes, such as how the Hanford tank farms will be managed and how the tank farm mission will be defined by DOE in the future. While there is a spectrum of modernization and retooling options that may be featured in the Tank Farm of the Future, the basic aim of the HVISM vision is to foster understanding that workers *are* safe and *feel* safe remains constant.

The pathway to achieve the Hanford Tank Farm of the Future is illustrated in **Figure 20**. The future end state of this journey can take many forms along the continuum of modernization and degree of hierarchy of controls implementation associated with vapor management. The effectiveness of WRPS's worker involvement and communications activities; continuously improving analytical modelling and monitoring initiatives; risk-based controls and engineered infrastructure improvements; and strengthening trust and confidence of key stakeholders are all factors that will affect, evolve, and create the ultimate definition of success for the Hanford Tank Farm of the Future.

Figure 20. Hanford Tank Farm of the Future



LIST OF FIGURES

ACRONYMS

ALARA	As Low As Reasonably Achievable
AOP	Abnormal Operating Procedure
CHAT	Chemical Hazard Awareness Training
COPC	Chemicals of Potential Concern
CPPO	Chemical Protection Program Office
CPWR	Center for Construction Research and Training
CTEH	Center for Toxicology and Environmental Health
CTO	Chief Technology Office
CVAP	Comprehensive Vapor Action Plan
CVST	Chemical Vapors Solutions Team
DOE	U.S. Department of Energy
DST	Double-Shell Tank
EA-32	DOE-Office of Environment, Safety, and Health Assessments
FY	Fiscal Year
HAMTC	Hanford Atomic Metal Trades Council
HAZWOPER	Hazardous Waste Operations and Emergency Response
HAMMER	Volpentest HAMMER Federal Training Center
HPMC	HPM Corporation
IH	Industrial Hygiene
ISM	Integrated Safety Management
NIOSH	National Institute of Occupational Safety and Health
OEL	Occupational Exposure Limit
OIG	Office of Inspector General
ORP	DOE-Office of River Protection
PHOENIX	PNNL Hanford Online Environmental Information Exchange
PNNL	Pacific Northwest National Laboratory
PPE	Personal Protection Equipment
PTR MS	Proton Transfer Reaction Mass Spectrometry
RL	DOE-Richland Operations Office
SCBA	Self-Contained Breathing Apparatus
SST	Single-Shell Tank
TVAT	Tank Vapors Assessment Team
VCZ	Vapor Control Zone
VRZ	Vapor Reduction Zone
VMEP	Vapors Management Expert Panel
VDMS	Vapor Monitoring and Detection System
WRPS	Washington River Protection Solutions LLC